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TRIP REPORT

CURRENT STATUS AND RECOMMENDATIONS
FOR
SORGHUM BREEDING AND IMPROVEMENT
IN
TANZANIA

by

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Institute of Agriculture and Natural Resources
University of Nebraska-Lincoln

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SEPTEMBER 1982

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Introduction: Sorghum is one of the most important cereal grain crops in Tanzania. It is cultivated by traditional peasant farmers for home consumption as Ugali, local brews and other foods. In the South sorghum is used in much the same way as rice. Important areas of sorghum production are located in the semi-arid areas with variable rainfall quantity and erratic distribution. There are resulting long dry periods where sorghum is subjected to severe water stress. Sorghum production is included in the central, northwest parts of the country from Morogoro westward through Tabora and North-South from Mwanza to near Mbeya. Sorghum is also a major crop in the Southeast in the vicinity of Mtwara, Machingwea and Tunduru.

Sorghum Bicolor (L.) Moench as it is grown in Tanzania is a varied species. There are mostly guineasia types which predominate but there are also dobbs and bicol r types in lesser quantity. Most of the sorghums grown and preferred for food are the local types. These are quite tall, late maturing (photoperiod sensitive) and low yielding. The local types are palatable and have hard of flinty kernels which store well. These hard local types are generally very open panicle types with seeds that are round to slight

and slightly oblong. Both thick and thin mesocarp types exist. The white types are most widely used in ugali whereas the brown and some white cultivars are used in local brews (beers). The brown sorghums appear to give some bird protection.

Available improved higher yielding cultivars (Lulu and Serena) are not widely accepted by the traditional sorghum growers or consumers because these cultivars lack the hard endosperm and because they store very poorly. Serena is particularly not liked because of its brown colour which imparts an unacceptable taste and colour to food products.

Sorghum is recognized as a major cereal of significant importance in the semi-arid regions of Tanzania. There are efforts underway to promote production and utilization in an effort to improve the overall food situation for many people in the more dry areas of the country. These marginal and agriculturally difficult regions account for more than 50% of Tanzania.

Many serious insect and disease problems affect sorghum production in Tanzania. Stem borers, mainly Chilo and Bussiola, are by far the most serious. Grain sucking bugs notably Calidea Dredi, shootfly and midge can cause major losses. Leaf diseases of sorghum are of questionable impact, but the most important are grey leaf spot, anthracnose and rust. Smuts downy mild and sugary disease are sometimes observed. Witchweed (Striga hermonthica and Striga asiatica cause heavy losses. Striga hermonthica is common in heavy soils in Mwanza and Shinyanga regions while S. asistica occurs in sandy soils in the central and coastal regions. Birds particularly Quelea are a serious problem to sorghum production in Tanzania. There are major losses annually. Palatable white-seeded cultivars preferred for food (ugali) are severely damaged by the Quelea brids.

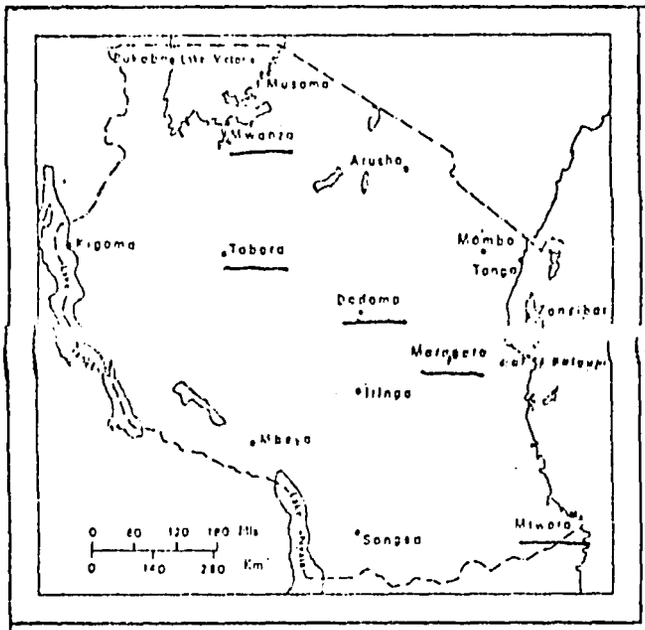
Climate: The climate of Tanzania is essentially of an equatorial type but varies with topography and latitude. Generally temperature is not a limiting factor in agricultural production. Temperature varies with elevation and with drylength and season but this variation is in the main very small. The only element that imposes restrictions on sorghum production is availability and distribution of water (rainfall).

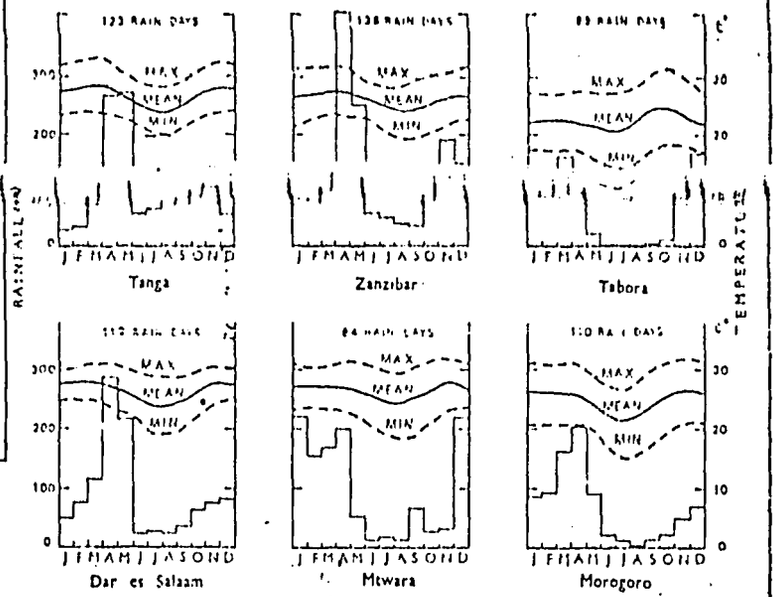
Histrograms of mean rainfall (monthly) are presented in attached figures. These distributions are given for areas which represent significant sorghum producing areas. These histrograms show the broad general pattern of distribution where rainfall is highest from January to March in the South and highest in March to May in the North.

Daylength (a critical factor in sorghum production) varies little throughout the year. At 10° South (Mtwara) the variation is from 11 hrs 32 minutes June 21 to 12 hrs. 43 minutes on December 21 (1 hr: 11 min); at 5° South (Singida) the variation is from 11 hrs 50 min to 12 hrs 25 mins (0 hrs: 35 min). Twilight is about 22 mins. Maximum hours of sunshine vary with rainfall, Tabora 3,142 hrs/year (892 mm. rainfall); Morogoro 1,845 hrs/year (892 mm rainfall). The differences in hours of sunshine here results from inland vs. coastal mountain.

Figure 1 Rainfall quantity and distribution at five critical locations in sorghum producing areas of Tanzania. Maximum, minimum and mean temperatures are given as well as number of days with rain. (Taken from Tanzania in Maps. L. Berry, Univ of London Press Ltd. p.41. 1945)

RAINFALL AND TEMPERATURE AT SELECTED STATIONS





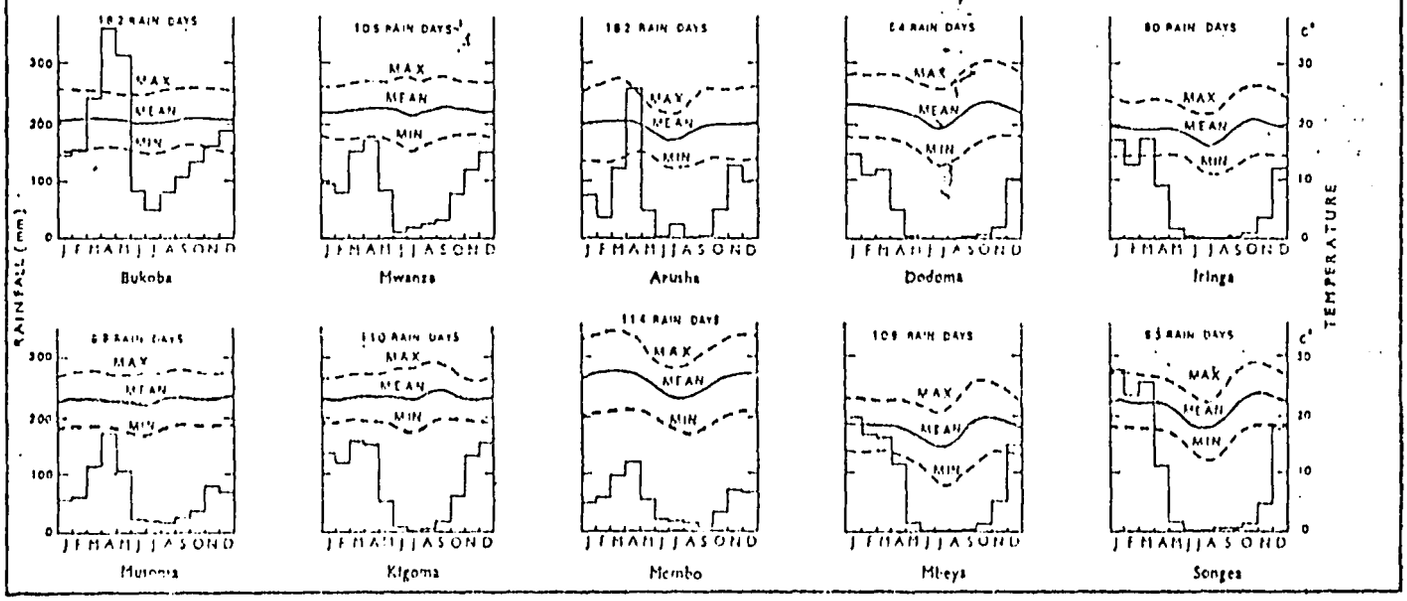


Figure 2. Mean Annual rainfall areas are shown in heavy lines and political boundaries are shown in light lines for the major sorghum producing

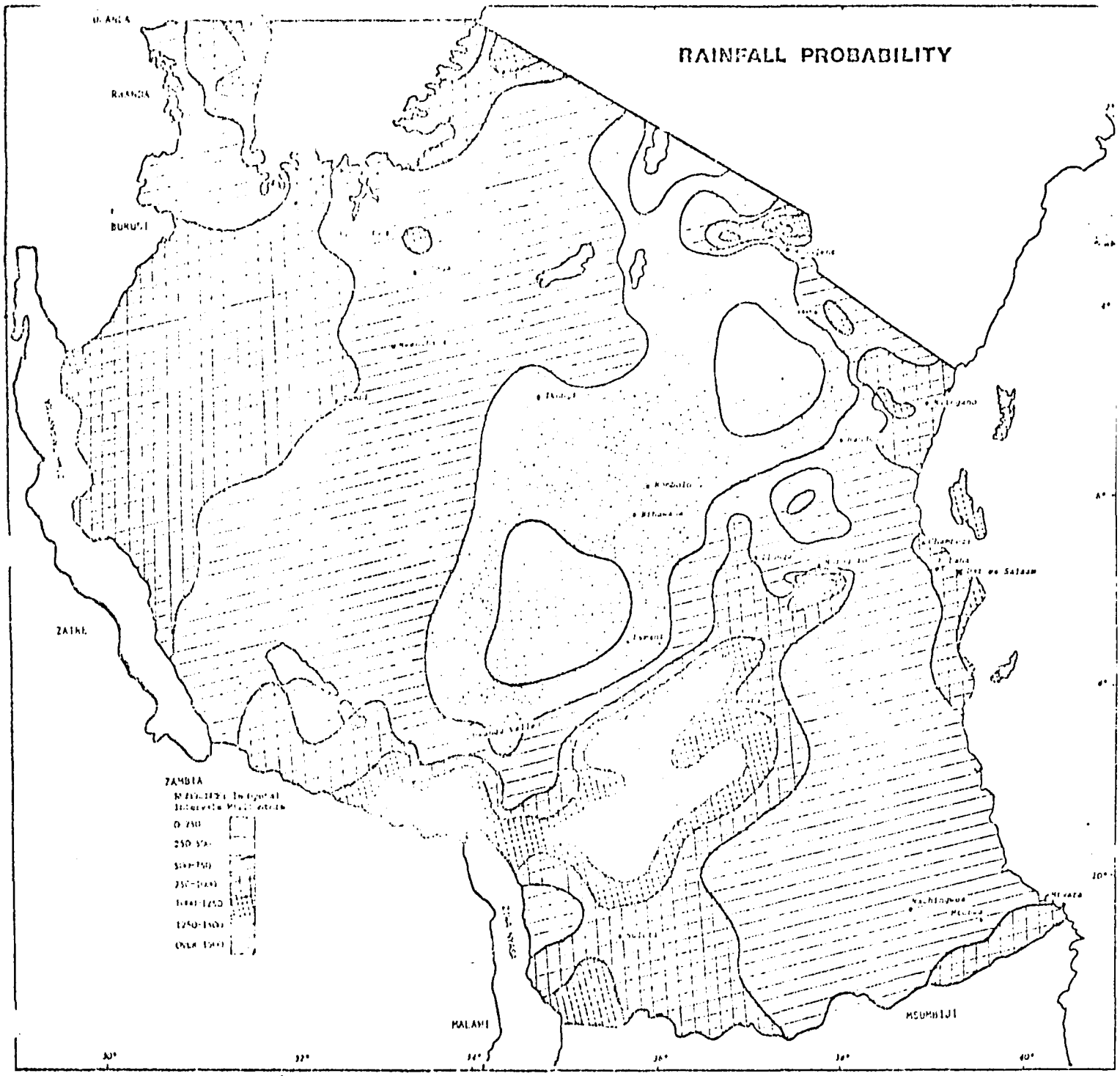


Figure 3. Rainfall probabilities are given for Tanzania showing isohyetal interwals in millimeters. The major sorghum producing areas fall inside the 250 to 750 millimeter isohyetals.

MAJOR SORGHUM, MILLET & MAIZE PRODUCING AREAS

MAJOR SORGAUM GROWING AREAS

MAJOR MILLET GROWING AREAS

MAJOR MAIZE GROWING AREAS

MAJOR AGRICULTURAL RESEARCH INSTITUTES IN TANZANIA.

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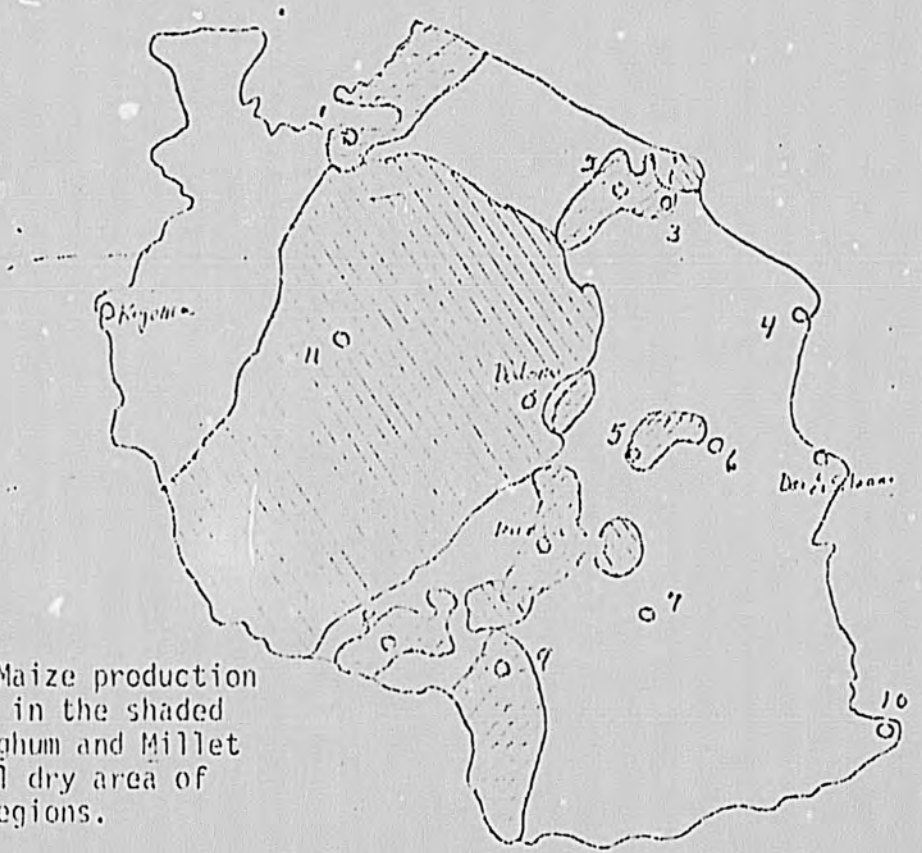

Figure 4. Sorghum/Millet and Maize production areas in Tanzania are indicated in the shaded portions of the map. Major sorghum and Millet production occurs in the central dry area of Shinyanga, Singida and Dodoma regions.

Sorghum:

Present Supply: There are few reliable figures which exist on the production of sorghum. We have attached estimates of production and per hectare yields. The major producing regions for sorghum are Shinyanga, Dodoma, Singida, Tabora and Mtwara.

National Milling Corporation (NMC) purchases of sorghum were first made in 1972/73. Purchases remained at a low level of about 4,000 tons until 1976/77 when they began to grow rapidly.

Table 1 Sorghum Purchases by NMC in 1,000 Tons

Year	Tons
1975/76	2.9
1976/77	10.1
1977/78	33.6
1978/79	58.6
1979/80	20.7

Source: NMC

Factors responsible for the decline in purchases in 1979/80 were greater producer retention of sorghum in response to dry conditions prevailing during the season and losses from birds and insects.

Present Demand

Table 2 National Milling Corporation Sales of Sorghum in 1,000 Tons

Year	Local Sorghum	Imported Sorghum Grits	Total
1976/77	2.3	19.7	22.0
1977/78	1.1	18.7	19.8
1978/79	2.2	2.3	4.5
1979/80	23.8	3.6	27.4

Source: NMC

About 40 percent of all sorghum sales took place in Dar es Salaam. Other significant sales were made in Tanga, Morogoro and Dodoma regions. The use of imported sorghum grits as famine relief increased to a level of 3,600 tons in 1979/80 but considerably below the record amount in 1976/77.

There is considerable potential for the production of milled sorghum for use as flour or for inclusion in mixes with wheat flour.

Amount of sorghum used in animal feed preparation in recent years is in the order of 4,000 tons. Exports of sorghum started by the end of 1977/78 and continued until their suspension in February 1980 due to financial losses arising from these exports.

Sorghum purchases are used by local beer brewing companies in an estimated amount of 2,600 tons (1,500 tons for Chibuku and 1,200 tons to Tanzania Breweries Ltd).

- Sorghum -

Table 3. Producer Prices for Products Purchased by NMC in 1982/83 Marketing Season

(cents per kg)

Region/District	Producer Price
Dodoma	160
Shinyanga	160
Singida	160
Tabora	160
Mwanza	160
Mtwara	160
Selected other regions	
Morogoro	130
Arusha	130
Iringa	130

Source: Marketing Development Bureau, July 1981

Table 4 Area under production of Sorghum in Tanzania for 1979/80 and future Projections through 1990

Region	Area 1979/80	PROJECTIONS 1985	1990
Shinyanga	48.2 1/	54.0	62.8
Mwanza	18.7	20.2	22.6
Mara	49.0	51.6	55.6
Singida	101.0	108.3	119.2
Dodoma	114.4	123.7	137.6
Arusha	39.0	42.4	47.4
Lindi	18.3	19.3	20.8
Mtwara	62.6	65.3	69.3
Morogoro	21.3	22.7	24.8
Tanga	23.5	24.2	25.0
Tabora	20.3	23.9	29.4
Rukwa	32.2	34.2	37.2
Ruvuma	27.0	30.4	35.0
Other	19.1	22.5	28.0
TOTAL	594.6	642.7	714.7

1/ hax1000

Table 3. Area Devoted to Sorghum, production and yield per ha in 1979/80 as well as yield per ha projections for 1985 to 2000 yr in Tanzania

Region	Area (ha) 1979/80	Production 1979/80	Yield/ha 1979/80	PROJECTIONS 1985	1990	2000
Shinyanga	46.2[1/]	31.7[2/]	0.69[3/]	0.73[3/]	0.81[3/]	0.91[3/]
Mwanza	18.7	18.7	1.00	1.03	1.05	1.09
Mara	49.0	49.0	1.00	1.02	1.05	1.10
Singida	101.0	80.9	0.80	0.85	0.91	1.00
Dodoma	114.4	105.0	0.92	0.96	1.02	1.11
Arusha	39.0	39.0	1.00	1.02	1.06	1.10
Lindi	18.3	18.3	1.00	1.04	1.00	1.20
Mtwara	62.6	43.8	0.70	0.75	0.80	0.89
Morogoro	21.3	42.7	2.00	2.01	2.01	2.03
Tanga	23.5	23.5	1.00	1.09	1.24	1.49
Tabora	20.3	20.3	1.00	1.06	1.13	1.20
Rukwa	32.2	32.2	1.00	1.00	1.00	1.00
Ruvuma	27.0	27.0	1.00	1.02	1.05	1.10
Other	19.1	19.1	-	-	-	-
TOTAL or X	594.6	551.2	0.93	0.97	1.02	1.09

1/ ha x 1000
2/ MT x 1000
3/ T/ha

Table 6. Sorghum Production ('000 tons) in Tanzania by Region for the period 1971/72 through 1979/80

Region	Year 1971/72	72/73	73/74	74/75	75/76	76/77	77/78	78/79	79/80
Dodoma	50.00	34.50	24.00	47.50	58.10	45.20	131.64	138.00	148.30
Shinyanga	13.04	52.08	21.60	49.60	137.11	181.04	118.15	204.50	94.70
Singida	26.00	28.20	29.31	42.57	40.08	40.40	63.25	91.70	110.50
Tabora	8.00	26.66	18.58	9.04	24.27	100.79	62.53	83.70	61.00
Mwanza	0.35	0.78	0.78	18.25	14.20	26.12	26.50	32.00	40.00
Morogoro	14.96	9.00	13.00	10.00	13.00	23.81	14.95	53.10	42.60
Mtwara	4.00	7.60	1.30	15.00	20.24	52.02	62.05	37.80	-
Others	58.36	33.60	65.99	85.45	92.49	88.04	134.90	121.00	175.30
TOTAL	175.21	192.42	174.53	277.41	400.29	558.23	613.97	761.30	680.00
NMC Purchases		0.6	1.7	1.9	2.9	10.1	33.6	58.6	20.7
% of Total		0.3	1.0	0.7	0.7	1.8	5.5	7.7	2.9

Table 7. Potential Sorghum Research/Evaluation Centers in Tanzania

Region I. Western Ecological Zone

1. Ukiriguru*
2. Mwinhala
3. Lubaga
4. Tumbi

Region II. Central Ecological Zone

1. Hombolo
2. Isamani
3. Ikungi (proposed) +
4. Bihawana

Region III. Southern and Coastal Ecological Zone

1. Ilonga*
2. Morogoro
3. Mtopwa
4. Naliendele
5. Nachingwea

* Major breeding sites where senior sorghum breeders should be located.

+ Singida region is in the heart of the sorghum production area in Tanzania, but has no agricultural experiment station to base the sorghum research activities. In 1979 the Ministry of Agriculture in collaboration with the Singida regional authorities identified Ikungi as a suitable site. This however has not been developed due to shortage of funds.

Table 8. Constraints and sorghum characteristics needing attention in the three ecological zones of major sorghum production

Region I Western Ecological Zone

1. Strigia -- mostly S. hermonthica some S. asiatica
2. Brown sorghum
3. Birds
4. Drought (slight bimodal distribution
5. Insects (stem borer, shoot fly, sucking bugs and midge) (most important)
6. Disease (anthracnose, grey leaf spot) (most important)
7. Milling and processing

Region II Central High Plateau Ecological Zone

1. Severe drought/short season sorghums
2. Food sorghums - white
3. Birds
4. Insects (stem borer, sucking bugs and midge)
5. Disease (long smut, leaf blight)
6. Milling and processing

Region III Southern and Coastal Ecological Zone

1. Rice like products
2. Good moisture
3. Low fertility
4. Strigia/S. asiatica
5. Insects (stem borer)
6. Diseases (grey leaf spot)
7. Milling and processing

- Milling as a constraint to acceptance -

During the time we have been here it has been apparent that a major constraint to sorghum utilization in Tanzania (especially in the urban areas) is an unacceptable product. Sorghum which is purchased by NMC is primarily Serena which is brown and contains high level of polyphenols. When this grain is milled into flour or is otherwise made available to the public it is not accepted. The Small Industry Development Organization (SIDO) has been researching sorghum milling and processing using a Canadian developed mill (IDRC). Currently available local mills and the one IDRC mill (located near Kilosa) are used to process maize. Because of its size and shape sorghum cannot be processed with the same technology used to mill maize.

We were informed by SIDO that the IDRC mill would satisfactorily process Serena and give a 74% recovery which when processed into flour was acceptable. Similarly, Lulu would give 80% recovery and a good flour when dehulled and milled using the IDRC mill. Using 6 to 8 kg samples of six sorghum cultivars from Ilonga we milled these at Kilosa using the IDRC mill. Maize was being processed when we arrived at the mill. We obtained the following results:

Serena - 51.3% recovery*; Udo - 34.1% recovery*; Lulu - 50.8% recovery; 2K x 17/8/1 - 56% recovery; E35-1 - 59.7% recovery; and 2K x 17/6 - 61.1% recovery. *Even at these low recovery values Serena and Udo (both brown sorghums) were unaceptably dehulled.

We recommend that the breeder pay attention to these traits already known to affect acceptance. He should work closely with Tanzania Food and Nutrition Center (TFNC) and SIDO who must make available adequate technology to properly mill sorghum and must assist the breeder in making proper selections from among his breeding lines.

Milling is critical! It affects all aspects of acceptance. A proper cultivar must also be available. However, a superior cultivar can be destroyed by poor milling technology but a poor cultivar cannot be salvaged by a superior milling.

STATUS OF PRESENT SORGHUM BREEDING PROGRAM IN TANZANIA

The Sorghum Breeding Program was initiated in early 1978 under the IITA/USAID Tanzania project with ICRISAT technical input with its headquarters at Ilonga Agricultural Research Institute near Kilosa. The program utilized Kabobolo, Ukiriguru, Itonya, and Mwainhola as key sub centers for selections, screening and evaluation of introduced and local germ plasm. The objectives of the breeding program were:

1. To assemble a large collection of introduced and indigenous sorghum germ plasm, evaluate and screen the assembled collection for genetic sources of resistance to major insect, pests, and diseases, grain quality characteristics and other desirable agronomic attributes for utilization in the breeding program.

2. To evaluate the performance of selected promising varieties over a wide range of environments in the major sorghum production areas in order to identify suitable varieties for release to the farmers.

3. To initiate a crossing program involving local cultivars preferred for food and developing high yielding varieties acceptable for food by the traditional sorghum growers and consumers.

4. To collaborate with international and regional institutions involved in sorghum research with the main objective of obtaining additional better sources of yield potential, better grain quality and higher levels of resistance to insects and diseases for direct utilization in the breeding program.

Summary of Past Activities on Sorghum Breeding

At the beginning of the sorghum breeding program in 1978, much effort was directed to the evaluation of a wide range of sorghum germ plasm and breeding lines from sorghum breeding programs all over the world. The bulk of this germplasm was introduced from the former E.A.A.F.R.O Sorghum and Millet Research Unit at Serere, Uganda; ICRISAT, Hyderabad, India; Texas A&M and Purdue Universities in U.S.A.; and from sorghum breeding programs in Kenya and the Sudan. A total of over 3,000 germplasm and breeding lines was evaluated and selected in 1978 and 1979. The selected promising varieties were extensively tested in multilocational trials in Tanzania while the selected germplasm or breeding lines were utilized in the breeding program.

A total of 306 indigenous sorghum cultivars were collected from the main sorghum producing areas in Tanzania. These have been evaluated and screened at Ilonga. Most of the local varieties are tall (4 meters) with loose panicles and are late maturing (6 months). Considerable variation does exist in this germplasm for grain size, shape and color, endosperm hardness and texture, plant and glume pigmentation, etc. Several germplasm lines possessing valuable agronomic traits were selected and utilized in the crossing program.

All the collected indigenous germplasm is maintained at Ilonga and ICRISAT Genetic Resources Unit at Hyderabad.

In 1979 a multilocational national variety trial was initiated and was largely composed of promising 2K% derivatives originating from Serere, Uganda. This was repeated in 1980 and 1981 at several locations in the major sorghum production areas in Tanzania. Three white-seeded varieties, 2KX 88, 2K% 97 and 2K% 17/3/1 have consistently and significantly outyielded Lulu D, the recommended white-seeded variety and these are currently being considered for release and to be recommended for farmers' cultivation.

A crossing program involving the long term local sorghum and improved cultivars was initiated in 1978 with the main objective of incorporating desirable traits from the locals into the improved varieties. The crossing program was continued and intensified in 1979. An array of genetically diverse segregating material derived from these crosses was selected and advanced and is now in the 4th, 5th and 6th generations of selfing. The most advanced selections are now at a stage for yield and adaptation testing.

Several introduced sorghum A & B lines have been evaluated and screened at Ilonga. The most promising male steriles identified are ATX 623, ATX 624 from Texas A&I, IS 2077 and IS 2219 from India and IBC 23A and MSCIA from Serere, Uganda.

The above selected male steriles were evaluated in hybrid combination with the local pollinators initially at Ilonga and later at key locations in the major sorghum production areas. The results thus far obtained indicate that sorghum hybrids are significantly superior to sorghum varieties. ATX 623 in particular has given outstanding hybrids.

Table 9. Grain Yields in Kg/Ha of the Most Promising New Varieties Versus Lulu D and Serena Across Several Locations in Tanzania in 1978/79

Ecological Zones and Locations	VARIETIES					
	ZKM30	ZSR 17/6/1	ZKM07	Lulu D	Serena	SSR 135/13/1
Coastal Zone						
Ilonga 1st						
Ilonga 2nd	3594	2767	2456	1926	3267	3017
Kisiba	956	2011	1278	989	556	650
Kibaha	2078	1944	2011	1372	1867	2339
Chambezi	1361	1500	1306	1944	1361	2056
Ilingano	4050	4308	4111	3394	3967	3372
Kaliendele						
Kitopwa						
Makuru	3489	2939	4100	2683	4128	4639
Manchersvea	2378	2767	3045	1606	2473	2067
Tunduru	3290	2512	3004	2123	2239	2284
Suluti	3167	2751	2017	1973	1945	2848
Mean	2763	2517	2756	2002	2434	2641
Central Zone						
Kongolo	3345	2333	2678	1378	2922	3489
Kilawana	3941	4078	5123	5218	5019	4325
Ismani	5306	5339	5004	5361	4672	5917
Gairo						
Same						
Mivalene						
Mpabo						
Kanteni						
Ukungi						
Mean	4197	3917	4232	4152	4204	4577
Western Zone						
Ukiriguru	2978	2617	2589	2733	3656	3267
Mwanihala						
Lubaga						
Tumbi	1543	1916	1543	1213	2265	2439
Geita	2611	2667	1833	2722	1944	2667
Kyakakera						
Mean	2377	2400	1988	2223	2622	2791
GRAND MEAN	2972	2751	2908	2476	2829	3065

Table 18. Grain Yields in Kg/Ha of the Most Promising New Varieties Versus Lulu 3 and Serena Across Several Locations in Tanzania in 1979/80

Ecological Zone and Locations	VARIETIES					
	2KK 69	2KK17/3/1	2KK 37	Lulu 3	Serena	5KK 135/13/
Coastal Zone						
Ilonga 1st	5911	4956	6444	3578	5111	6022
Ilonga 2nd	4356	4839	4444	3400	3922	3778
Kisaba						
Kibaha						
Chambezi						
Mlingano						
Naliendele	1158	1122	1347	1014	2144	1828
Mtopwa	2922	2378	2467	1444	2356	2844
Makara						
Hanchergwea	2389	2306	2817	1358	1767	2117
Tunduru						
Suluti	3611	3472	3333	2500	3817	4579
Morogoro	2178	1944	2122	2067	1733	2333
Mean	3218	3010	3282	2256	3036	3357
Central Zone						
Mombolo						
Bihawana						
Ismani	3161	2672	2044	3194	2705	2756
Gairo	2961	2378	756	1139	1544	1222
Same						
Hiwalena						
Mombo	1375	1417	1453	2486	2736	2079
Hanenani						
Ikungi						
Mean	2499	2156	1419	2273	2328	2019
Western Zone						
Ukiriguru	3994	2933	3383	3028	2194	3139
Kanihala	778	889	1311	1744	1800	1933
Lubaga						
Tumbi	4922	5178	4344	4222	4150	4811
Geita						
Kyakakera						
Mean	3231	3017	3013	2998	2715	3294
GRAND MEAN	3055	2814	2790	2437	2822	3035

Table 11. Grain Yields in Kg/ha of the Most Promising New Varieties Versus Lulu D and Serena evaluated over Across Several Locations in Tanzania in 1990/91 season

Ecological Zone and Location	VARIETIES					
	20339	20417/6/1	20397	Lulu D	Serena	SDK 135/13/1
Coastal Zone						
Ilonga 1st	3342	3230	3316	3044	3000	3133
Ilonga 2nd	3644	3511	3333	2389	3244	3822
Msiuba	3817	2856	2528	2028	3255	3332
Kibaha						
Chambezi						
Mlingano	2278	2139	2250	1917	2306	1917
Naliendele	3000	2356	2278	1283	2594	2678
Mtopwa	1411	1639	1406	1983	816	866
Ifakara	2006	2017	3078	1639	2411	2700
Nachingwea						
Tunduru						
Sluluti						
Morogoro						
Mean	2785	2543	2598	2126	2560	2635
Central Zone						
Hombolo	2911	3367	3061	3157	2578	2939
Bihawana						
Ismani						
Gairo	1922	2328	1722	1022	2222	3144
Same						
Mwalene						
Mpwapwa						
Handeni						
Ukiriguru						
Mean	2417	2848	2392	2095	2400	3067
Western Zone						
Ukiriguru	1156	778	944	700	1511	1233
Kanihala	972	1449	793	1300	1931	1366
Subaya	1078	1089	900	1022	1300	1356
Tumbi	2467	3311	2322	2533	3833	4139
Seita						
Kyakakera	1889	1139	1250	1667	2806	1917
Mean	1512	1553	1222	1446	2296	2012
GRAND MEAN	2278	2283	2077	1879	2416	2523

Recommendations: The following series of recommendations are made based on a reasonable knowledge of sorghum germplasms, constraints to sorghum production and an awareness of the need to have an increased productinn of an acceptable sorghum in Tanzania.

In order that a viable sorghum program can exist it is necessary to have a staff of professionally qualified scientists. We recommend a staffing of professionals as outlined in Table 12 . We feel it is essential to have two breeders, one located at Ilonga and another at Ukiriguru. Neither of these sites are optimum locations for sorghum research but each has its merits. Kumbolo probably more nearly represents the sorghum growing areas of Tanzania but it is not developed to an acceptable level at this time.

It is essential, if not imperative, that adequate staffing be followed with vehicles, fuel and other technical support to both Tanzanians and contract breeders to insure success. Nothing can be accomplished without the ability to get to trials to collect valuable data or to distribute information.

Table 12. Recommended Professional Staffing requirements for the National Sorghum Research Program in Tanzania

Displine	Level of training Recommended	Positions Recommended	Potential Candidates Currently in Training	Locations
Breeder and Coordinator	Ph.D	1	1	*Ilonga
Agronomist/Physiologist	Ph.D	1	1	Ilonga
Entomologist	Ph.D	1	1	Ilonga
Breeder	Ph.D	1	1	Ukiriguru
Agronomist	M.S.	1	1	Ukiriguru
Agronomist	M.S.	1	1	Kumbolo
Agronomist	M.S.	1	1	Maliendele
Agronomist	M.S.	1		Singida

* Kumbolo, because it more nearly represents conditions where sorghum is grown in Tanzania, would be ideally suited for a headquarters of the sorghum research program. As soon as facilities at Kumbolo are developed to an acceptable level it is recommended that sorghum breeding and coordinating center be moved from Ilonga to Kumbolo. Until that time Ilonga and Ukiriguru will need to cover the total area.

It is recommended that a sorghum breeder be placed at Ukiriguru Research Center with adequate facilities to carryout his responsibilities. Because of travel constraints the present team was unable to go to Ukiriguru to discuss the potential of placing a sorghum breeder there with the Director of Agriculture Research Institute. Therefore, it is extremely important that before implementation of the sorghum support program takes place some one from USAID or CSU must negotiate with TARO and Ukiriguru for adequate facilities. These facilities should include:

a. Offices for breeder and associates
b. laboratory and seed storage
c. land for research plots and equipment to operate research plots.
d. housing for sorghum breeding staff.

It is strongly recommended that the sorghum breeder(s) working with all entities involved with sorghum critically evaluate production regions and establish the ecological zones where end product use is different, where constraints to production are different and where environment is different. Such a preliminary plan is necessary to assist in developing a more realistic breeding and improvement program because it delineates objectives.

A suggested ecological zone separation for sorghum is attached which gives general constraints. Area research sites within the suggested ecological zones are indicated. This suggested zoning needs much more critical evaluation before it is adequate for absolute implementation. Care should be given, however, not to become overly zealous or the benefit of zoning will be lost. It is strongly recommended that the sorghum coordinator establish contact with all individuals and organizations doing research or related activities on sorghum in Tanzania. As a first step, all entities involved with the crop should be made aware of all efforts on sorghum in the country. This could be done by a general workshop or in a less formal way.

Currently there exists a problem within the commodity. During our brief evaluation we have found individuals and agencies involved in some significant sorghum activity but who are completely unaware of other significant work on the crop. There must be an effort made to get people aware of work going on in sorghum. Such awareness will generate further cooperative research and sorghum promotion. With time this consortium of individuals involved in sorghum can be formalized. Such a formal commodity group could be a strong force in securing research funds and promoting coordinated research as well as promoting sorghum as a major cereal in Tanzania. Such a formal organization would be of benefit to the government and to all individuals working on sorghum.

It is recommended that the sorghum program maintain in a viable condition those germplasm collections previously obtained from international centers and universities as well as the local germplasm types previously collected. Additional collections and breeding materials for specific objectives should be obtained from ICRISAT and INTSORMIL; such as food type populations, cultivars posessing superior food quality, and cultivars with identified drought resistance. These materials should supplement the breeding materials developed in the current Tanzanian sorghum program.

Critical evaluatinn in multilocational trials in Tanzania of the promising introduced varieties (2kx 89, 2kx17/B/1 and 2kx97) clearly shows them to be significantly superior to Lulu and Serena cultivars in grain yield (table) and grain quality. Before these varieties are released

and distributed to farmers, we strongly recommend that they should be extensively tested on the farmer's field to assess their performance and stability of yield under farmers field conditions as well as the farmers attitude and acceptance of these varieties.

Similarly extensive tests on milling and acceptability studies should be initiated on these varieties in collaboration with TFNC, SIDO and NMC. If found acceptable the varieties should be multiplied and distributed to the farmers.

It is recommended that the breeder pay close attention to all these characteristics or traits which are known to affect acceptance. These would become a major part of the breeding effort. He should work closely with TFNC, NMC and SIDO to properly evaluate methods of measuring acceptance and milling procedures on technology. It was very clear during the recent past that acceptance of sorghum milled products was nil. Close coordination between the breeders and the agencies mentioned above should lead to an effective removal of the bottleneck to sorghum utilization. It is further recommended that the Faculty of Agriculture could be enlisted to assist in basic research needs which impact sorghum acceptance and utilization. Since IDRC is funding research on sorghum in the Department of Food Technology it seems natural to enlist their assistance. The breeders' materials must be properly evaluated for food quality prior to the consideration of release or advanced agronomic testing. Appropriate milling and quality tests must be devised to compare improved sorghums with locally accepted cultivars.

Bird pests primarily Quelea Quelea are considered to be the main constraints to sorghum production in parts of Mwanza, Shinyanga, Singida and Dodoma. The brown-seeded high tanniu types are less susceptable to bird damage and as a result a significant amount of these types are produced in these areas. Both white and brown-seeded, high tannin types are consumed for food in these areas, although the preference is for white. The improved brown seeded high tannin cultivar, serena is less liked for food and stores very poorly. Efforts to dehull serena have not been successful due to its soft endosperm type. We recommend that breeding and selection efforts should be directed at developing high yielding brown-seeded, high tannin types with good storage properties and less susceptable to birds but which can be dehulled successfully to produce acceptable products.

It is recommended that a close working relationship be developed with the Faculty of Agriculture at Morogoro in order that basic agricultural research can be engendered to support applied research. Within the sorghum commodity, those areas of mutual cooperation will be breeding, pest management, food science/quality, and agronomy.

Using existing materials from Ilonga (ICRISAT Program) and ICRISAT, the breeders are strongly encouraged to develop a breeding program which emphasizes selection for photoperiod sensitive higher yielding types. This breeding program should be developed from crosses between local cultivars with the correct photoperiod response and high yielding food quality types from ICRISAT and INTSORMIL. This is a critical objective and must be viewed separately for each of the ecological zones in Tanzania. It is imperative to develop cultivars which mature their grain outside the high rainfall season.

Concurrently a screening program which separates various round kernel types with white pericarp should be developed and practiced. Both white thick and white thin mesocarp types should be evaluated. The above described types appear to have food acceptable quality traits. Critical evaluations can then be made for superior quality among this broad group. All white hard types are not necessarily acceptable for ugali etc.

Long term involvement of staff should be encouraged to create a continuity of research on the sorghum commodity. Training at a U.S. University for advanced degree and short-term training at ICRISAT should be encouraged. Once these staff return to the local program they should receive support to allow them to use their acquired expertise.

We believe that for a dynamic and effective national program to be developed, collaboration and close contact should be developed with international and regional organizations involved in sorghum improvement. There is great scope for the sorghum program in Tanzania to play a leading role in regional sorghum improvement programs both in Southern and Eastern Africa in the exchange of improved germplasm and information. We recommend that as a first step, the contracted breeder should be given ample opportunity to personally acquaint himself with scientists in international and regional organizations with a view to developing greater and lasting contacts and scientific inputs in the Tanzania national program.