SAFGRAD - ICRISAT

EASTERN AFRICA REGIONAL

SORGHUM AND MILLET

NETWORK

(EARSAM)

ANNUAL REPORT

1986

SEMI-ARID FOOD GRAINS RESEARCH AND

DEVELOPMENT PROJECT OF THE

SCIENTIFIC TECHNICAL AND RESEARCH

COMMISSION OF THE ORGANIZATION OF

AFRICAN UNITY

(OAU/STRC/SAFGRAD JP31)

AND

INTERNATIONAL CROPS RESEARCH INSTITUTE

FOR THE SEMI-ARID TROPICS

(ICRISAT)

C O N T E N T S

A C K N O W L E D G E M E N T

The contribution of the Inter-African Bureau for Animal Resources (IBAR) of the OAU/STRC in Nairobi in office space, facilities and administrative support to this regional network is acknowledged with appreciation.

The cooperation and participation of the national programs of eastern Africa made it possible to have a functioning regional network for sorghum and millet improvement.

EASTERN AFRICAN REGIONAL SORGHUM AND MILLET IMPROVEMENT PROGRAM

INTRODUCTION

There is a growing concern in eastern Africa over the need to both increase and stabilize food production and to improve the conditions of the poorer farmers through research and training, particularly in the drier areas prone to drought. The countries referred to in this annual report include Burundi, Ethiopia, Kenya, Rwanda, Somalia, Sudan, Uganda, North and South Yemens and Tanzania. Sorghum (*Sorghum bicolor* (L.) Moench) is the most important cereal in the semi-arid parts of this region (Table 1). The countries of eastern Africa collectively produce about 4 million tons of grain in just over 6 million hectare land, giving a regional mean yield of only about 600-800 kg/ha compared to a world average of about 1500 kg/ha. The Sudan alone has over 50% of the sorghum area although it has the lowest national mean yield in the region. The four countries with the largest hectarage in the region are Sudan, Ethiopia, Tanzania and Somalia, and they account for almost 90% of the eastern Africa sorghum area.

For most of the countries in this region, the crop is the traditional staple for the native population. Since sorghum is indigenous to this part of Africa, the genetic diversity of the crop in the region is wide. The major use of the sorghum crop in the region is for food in different forms although it is also widely used for beverages, feed, fuel, mulches and construction.

Table 1. Agricultural Development Indicators

	Indicators	Burundi	Ethiopia	Kenya	Rwanda	Somalia	Uganda	Sudan	Tanzania	N. & S. YEMENS
1-	SORGHUM SURFACE AREA (Hectare Ave., 1980-84)	160,000	900,000	167,000	169,000	500,000	233,000	3,500,000	650,000	-
2-	SORGHUM PRODUCTION (Tons Ave., 1980-84)	200,000	1,320,000	170,000	195,000	235,000	400,000	1,450,000	450,000	-
3-	GRAIN YIELD (kg/ha)	1,250	1,467	1,018	1,154	470	1,717	414	450	-
4-	MAJOR CEREAL CROPS IN PRODUCTION ORDER	MSRW	TBSMW	MSWR	SMRW	SMR	SMRW	-	-	-
5-	POPULATION (Millions 1985)	4.5	40.9	18.9	5.7	5.1	13.9			-
6-	PULULATION GROWTH RATE (% per year)	2.7	2.5	3.8	3.0	2.8	3.0			-
7-	PER CAPITA INCOME (US$ 1984)	240	120	240	270	250	250			-

Source: The Ministry of Agriculture of each country and FAO year book.

-R = Rice
-M = Maize
-S = Sorghum
-W = Wheat
-T = Tef
-B = Barley

Almost all the major sorghum ecological zones found worldwide are present in eastern Africa. High elevations (above 1800m), intermediate elevations (between 1500-1800m), and low elevations (below 1500m).

Both sorghu m and millets are grown in eastern Africa countries. However, the total national surface area and production of sorghum is significantly higher than that of millets in all the eastern African countries except Uganda. This is also reflected by the amount of research done on sorghum as compared to that on millets.

Among the millets, finger millet (*Eleucine coracana*) is the dominant type in all eastern Africa countries. Finger millet is most important to drier farming areas of the region with short growing seasons where yields of other crops are subject to most variation. On the other hand, pearl millet is grown only in limited areas of the region. The two countries in the region where they have a small millets improvement program are Kenya (east) and Uganda.

The ICRISAT Mission was informed that the present pearl millet areas could be substantially expanded and production increased, where large tracts of uncultivated, low rainfall areas are suitable for the crop.

In Phase I, ICRISAT and SAFGRAD jointly initiated an eastern Africa sorghum and millet program in August, 1982. The Phase II has been approved to continue with the same purpose to initiate a regional network of sorghum and millet research. The future plans of all the national programs in the region is to give high priority to the development of high yielding cultivars suitable for the various major ecological zones, accepted by the local consumers and should be resistant to the various pests and diseases dominant in each country.

BREEDING SORGHUM FOR HIGHLANDS OF EASTERN AFRICA

PROJECT TITLE: SORGHUM BREEDING FOR COLD RESISTANCE FOR HIGHLANDS OF EASTERN AFRICA

OBJECTIVES : To develop high altitude (1800m and above) cold resistant (resistant to temperatures less than 17°C) sorghum varieties and hybrids with superior traits such as resistance to pests, diseases and grain quality with stability of production and make them available freely and quickly to national programs on request.

Review of past background and present status

a) Sorghum germplasm introductions have been done by most of the national programs of the region over the past years. Such introductions and improvement have been useful at isolated national levels, such as in Ethiopia, Kenya and Yemen. Other countries such as Burundi, Rwanda, Uganda have not benefited from such introductions due to their different temperature regimes.

b) Movement of improved and polished material from one country to another was done for the last 3 years and I was informed such introductions were not very useful for the highland areas.

Present need:

a) There is a need of collecting climatic data such as minimum and maximum daily temperatures, rainfall data, soil type and texture etc., for each country where sorghums are growing or potential areas in the highlands of eastern Africa.

b) Movement of improved varieties from one highland to the other highland should be done carefully using climatic data.

c) There is a need to generate new genotypes for the highlands of eastern Africa. A representative breeding site should be identified in the region and segregating material generated (F_3) should be introduced to all highland areas in the region to select individual plants in their environments.

d) Regional uniform yield trials for the highland areas is needed to have a better understanding of genotype and environment interactions of improved varieties or hybrids developed.

HIGHLAND PROJECTS IN KENYA

a) Varietal development

In addition to the exploitation of the existing sorghum germplasm from the on-going program in Kenya, the ICRISAT/SAFGRAD regional coordinator in collaboration with the existing scientists in the Kenyan national program, will generate new breeding material with adaptation to highland areas of the region.

(i) <u>INTRODUCTIONS FROM MEXICAN HIGHLANDS - PEDIGREE METHOD</u>

Cold tolerant varieties were crossed in highlands of Mexico (El Batan 2250m) and 495 F_2 selections were made. These individual selections (F_3 seeds), are planted head to row in Kakamega (1585 meters, 800 mm rainfall) beginning of September of 1986 during the short rains. The objective is to select for Kakamega region and to advance the F_2 generation to F_3.

The same cold tolerant 495 F_3 lines will be planted at Lanet station in Nakuru (1860 meters, 306 mm rainfall) end of March during the long rains in 1987. Eight sorghum elite cold resistant varieties and four millet varieties (2 foxtail, 1 proso and 1 pearl millet synthetic varieties) will be planted at Laikipia 1948 m, 230 mm rainfall) in October during the short rains in 1986.

The final objectives of all these introductions is to merge these varieties with the existing varieties and generate new genotypes for the highlands of eastern Africa.

(b) <u>Hybrid development</u>

Since susceptibility to low temperatures is dominant, therefore, in order to produce fertile hybrids on the highlands we need to develop A and B lines with genetic resistance to cold temperatures. The sorghum program in Mexico has developed 124 pairs of A and B lines and they are at 7th backcross stage. These A and B lines were introduced to Kenya and will be planted at Kakamega station in September.

Another set of the 124 pairs of the same A and B lines will be planted at Lanet station during the long rains in 1987.

It was also decided to keep a remnant seed of all the highland breeding materials introduced at Katumani in the cold storage room.

BREEDING SORGHUM AND MILLETS FOR LOWLANDS AND INTERMEDIATE AREAS OF EASTERN AFRICA

PROJECT TITLE: SORGHUM BREEDING FOR INTERMEDIATE AND LOWLAND AREAS OF EASTERN AFRICA

The two potential ecological zones for sorghum in eastern Africa are:

1. Intermediate elevations (1500-1800 meters),
2. Low elevations (below 1500 meters)

   a) Very dry lowlands (below 1500m with average rainfall of 200-400 mm)
   b) Humid lowlands (below 1500m with average rainfall of 1500mm)

These differences in location and physiography are reflected in the wide range of climates, soils, and crop requirements found within the region. Well over 75% of the region is semi-arid in nature, where average rainfall ranges from 200-1000mm. The rainfall is seasonal, falls for about 3.5 to 5 months and is highly erratic.

OBJECTIVES

a) To generate breeding material and improved varieties and hybrids for lowland and intermediate tropics of eastern Africa with high and stable yields coupled with acceptable grain qualities and good agronomic traits and make them available to national programs.

b) To develop varieties and hybrids with genetic resistances to drought, insects, diseases and striga.

BREEDING TECHNIQUES

1. Introductions:

Source materials will be introduced from Mexico and U.S.A., ICRISAT Center and SADDCC.

2. Pedigree method:

For handling the promising single and top crosses that appear to be agronomically desirable and with tropical adaptation in eastern Africa.

3. Hybrid development:

To evaluate the adapted varieties for their R or B reaction and evaluate their combining ability with different A lines.

4. Population improvement:

This method is a long term objective to derive genotypes from an adapted source population with genetic male sterility.

REVIEW OF PAST BACKGROUND

Sorghum germplasm introductions have been done by most of the national programs of the region over the past years. Such introductions and improvement have been useful at isolated national levels. Movement of improved and local varieties in yield trial and observation nurseries from national programs within the region have been to a certain extent useful.

RESEARCH NEEDS

1. There is a need to collect climatic data from each country where sorghum and millets are grown in the lowland and intermediate elevations.
2. There is a need to group similar zones of adaptation for lowland and intermediate areas in the region using climatic data and establish uniform yield trials and continue with the exploitation of materials developed in the region by national programs.
3. There is a need to screen for drought, striga, stem borers, shootfly, ergot, and mold, using the "Hot Spots" in the region.
4. There is a need to generate new breeding materials to develop improved varieties and hybrids for the region.

LOWLAND AND INTERMEDIATE PROJECTS IN KENYA

a) Varietal development

In addition to the exploitation of the existing sorghum germplasm from the on-going program in Kenya, the ICRISAT/SAFGRAD regional coordinator, in collaboration with the existing scientists in the Kenya national program will generate new breeding materials with adaptation to lowland and intermediate elevations.

1. INTRODUCTIONS

Three sets of 127 elite varieties were introduced from Mexico to be planted in Kenya at the following research stations:

i) Katumani station:(1560 m; 300 mm rainfall)
The 127 elite varieties are planted at Katumani research station on October 15 of 1986 during the short rains.

ii) Kiboko station:(1300 m; 280 mm rainfall)

The 127 elite varieties are planted at Kiboko research station on October 20 of 1986 during the short rains.

iii) Alupe station: (1170m; 800 mm rainfall)

The 127 elite varieties are planted at Alupe research station in September of 1986 during the short rains.

The objective of these introductions is to select adapted varieties.

2. PEDIGREE METHOD

Crosses were made among elite sorghum genotypes in Mexico at Poza Rica station. The F_1's were advanced to F_2 and 862 individual plant selections were made to advance to F_3. These 862 selections are planted head to row at Katumani station in October of 1986 during the short rains.

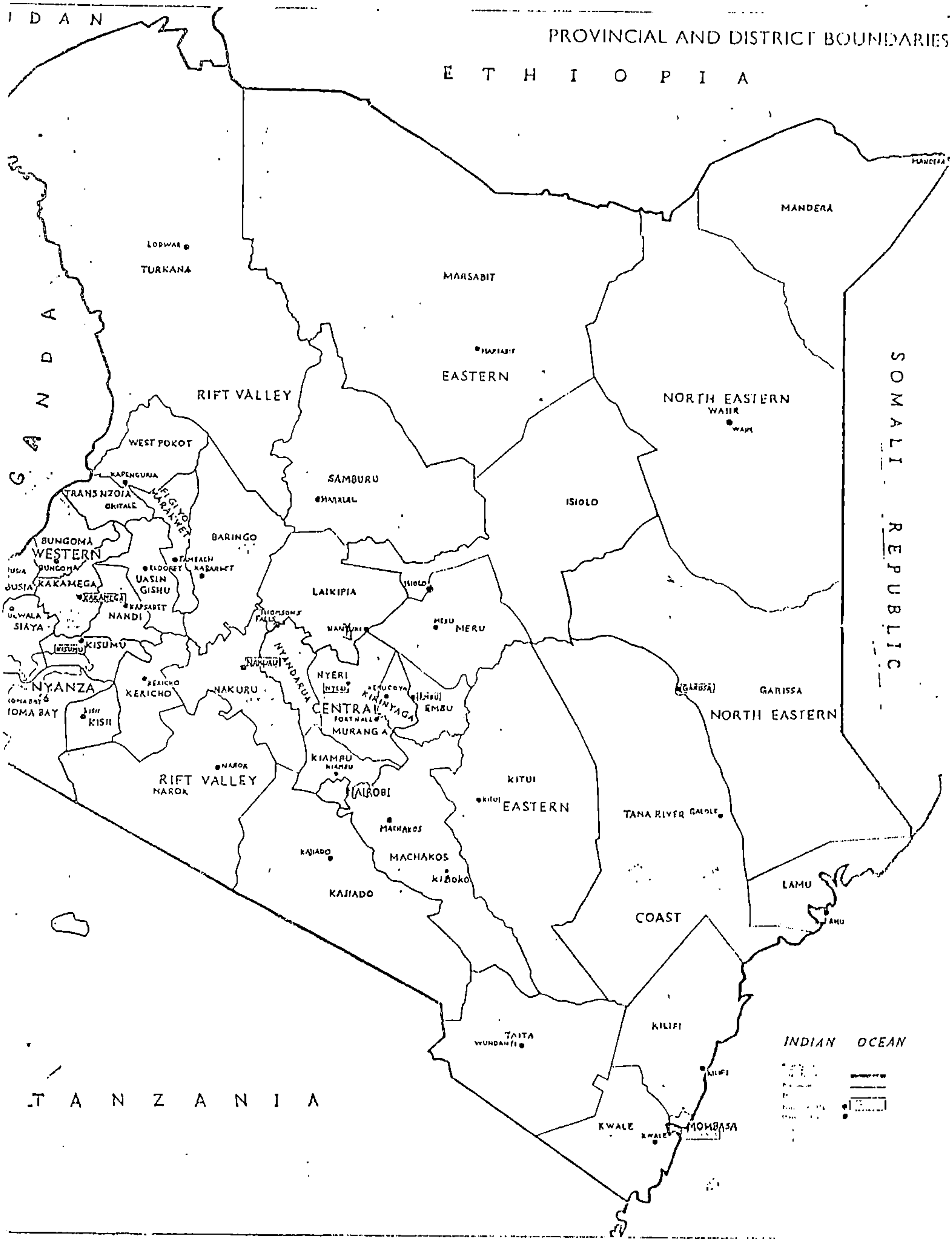
The objective of introducing this segregating breeding material is to select and develop adapted varieties.

b) Hybrid development

Two sets of 124 pairs of A and B lines were introduced from Mexico. One set is planted at Alupe station in September of 1986 and the other set is planted at Katumani station in October. The objective is to increase the A and B lines and select the best pairs for hybrid development.

The value of hybrids, particularly in the lower elevations and harsh growing conditions such as in Somalia, Sudan, Ethiopia, Kenya and Uganda have already been demonstrated to have potential on their research stations.

Note: It was decided to keep a remnant seed of all the lowland breeding materials at Katumani in the cold storage room.


PROVINCIAL AND DISTRICT BOUNDARIES
E T H I O P I A
TANZANIA
SOMALI REPUBLIC
INDIAN OCEAN
MANDERA
MARSABIT
EASTERN
NORTH EASTERN
TURKANA
RIFT VALLEY
WEST POKOT
SAMBURU
ISIOLO
TRANS NZOIA
BARINGO
BUNGOMA
WESTERN
KAKAMEGA
UASIN GISHU
NANDI
SIAYA
KISUMU
LAIKIPIA
MERU
NYANZA
KERICHO
NAKURU
NYERI
CENTRAL
EMBU
GARISSA
KISII
MURANGA
KIAMBU
RIFT VALLEY
NAROK
KITUI
EASTERN
TANA RIVER
MACHAKOS
KAJIADO
LAMU
COAST
TAITA
KILIFI
KWALE
MOMBASA

RESEARCH STATIONS IN KENYA FOR SORGHUM AND MILLET

Research Stations	ALTITUDE (m)	RAINFALL (mm)		TEMPERATURE (°C)		PLANTING		HARVESTING		Z O N E
		LONG RAINS	SHORT RAINS	Minimum	Maximum	LONG RAINS	SHORT RAINS	LONG RAINS	SHORT RAINS	
LANET (Nakuru)	1860	306	197	9.0	24.0	April	Oct.	Aug.	Feb.	SEMI-ARID HIGHLAND
NANYUKI (Laikipia)	1948	305	230	9.0	24.0	April	Oct.	Aug.	Feb.	SEMI-ARID HIGHLAND
KAKAMEGA (Kakamega)	1585	1200	800	11.3	27.7	March	Sept	July	Dec.	HUMID-IRRATIC INTERMEDIATE
ALUPE (Busia)	1170	865	611	15.5	29.0	March	Sept	July	Dec.	HUMID-IRRATIC INTERMEDIATE
KATUMANI (Machakos)	1560	300	300	13.7	19.5	March	Oct.	Aug.	Dec.	SEMI-ARID INTERMEDIATE
KIBOKO (Makindu)	1300	183	280	16.5	22.6	March	Oct.	Aug.	Dec.	SEMI-ARID INTERMEDIATE
MTWAPA (Kikambala)	21	640	268	22.0	25.8	April	Nov.	Aug.	Feb.	HUMID-IRRATIC LOWLAND
MARIAKANI (Malindi)	100	500	200	22.0	25.8	April	Nov.	Aug.	Jan.	SEMI-ARID LOWLAND

UNFERMENTED AND FERMENTED BEVERAGES PREPARED FROM HIGH TANNIN SORGHUMS

Most of the sorghums produced in eastern Africa are used in the homes for food and beverages. Sorghum beverages (unfermented and fermented) are regarded as important "food" item in the rural areas of Uganda, Rwanda and Burundi. These beverages are used in every day life for social gatherings and festivals and are considered a key factor for social ties.

The ICRISAT Mission was interested in the local preparation of the beverages and the chemical changes and their nutritional effects. Samples were sent to Mexico and detailed analysis were carried out and are shown in Tables 2, 3, 4, and 5.

The ash composition in Table 2 was determined to find out what causes the change of pericarp color from red to almost black color and what causes the arrest of plumule growth. Examining the composition of the ash in Table 2 it is probably due to high levels of iron, calcium and PH.

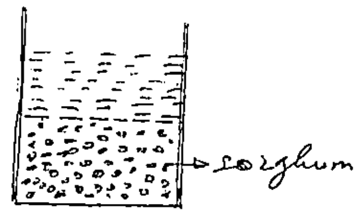
Sorghum varieties used for beverage preparations are very high in tannins and it is very interesting how the anti-nutritional effects of high tannins are tied up by soaking and germination with ash (Table 3) treatment. It is also interesting to note the decrease in protein content after germination. This is probably due to the utilization of the storage protein in the endosperm for germination. The fiber content increases obviously for the radical elongation.

Amino acid content of the sorghum samples are shown in Table 4. There is no significant changes in Amino acid content of the four samples.

Pepsin digestibilities are shown in Table 5. It is interesting to note both in uncooked or cooked samples the digestibility increases with germination process.

Stage I. FLOUR preparation

1. Whole grain, put into water
   Soak overnight.



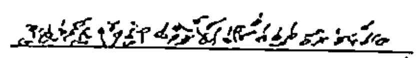
2. Spread soaked grain out on the floor and cover with straw, branches and banana leaves or net.

1 day
until germination takes place.

3. When it starts to germinate, only radicle no plumule appearance, add ash and mix well
   2 kg ash : 100 kg wet grain

2 days
/4 days total up to this stage.

4. After 2 days dry in open sun.



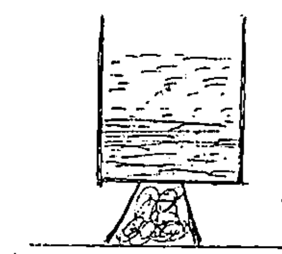
drying with radicle

Note: the ash will arrest the plumule growth and let radicle growth.
the seed color changes to darker color.

5. When dry use rubbing action to remove the radicles and blow them away and you have grain ready for milling to receive flour. (Note: you can leave grain at this stage for sometime before milling) FLOUR

Stage II Unfermented drink preparation

1. Fill container with H_2O and add the FLOUR ratio: 30 kg FLOUR : 100 L H_2O

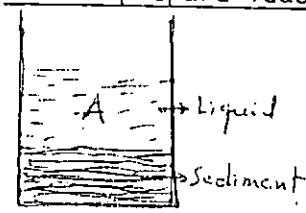


container
fire
(at Mutara, Rwanda)

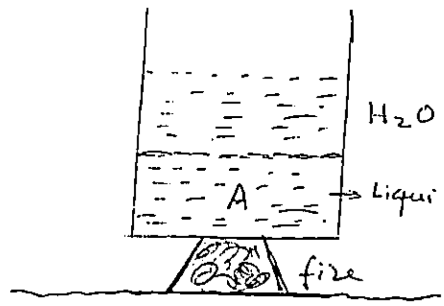
2. Then boil and mix gently until the taste is developed (taste every now and then)

3. Then remove container from fire and set aside and add H_2O to dilute the gluey consistency until it becomes liquid consistency. Then ready to dring.
   To the sedimented part after taking dring out you can add H_2O again to dring. You can repeat this process until the taste disappears.

Stage III. <u>How to prepare Yeast</u>

1. 

Take liquid out from stage II and place it in another container.



2. Add equal amount H_2O : unfermented liquid.

3. Boil gently for long time mixing and scooping until you evaporate and remain with 1/3 of the liquid.

4. Store the 1/3 of the liquid in a pot loosely covered for 3 days and then add FLOUR slowly.

5. Add one handful of FLOUR to 1/3 liquid to see if bubbles will appear - if you do not see bubbles try again, and if you fail to see bubbles stop. Something is wrong.

6. If you see bubbles keep adding FLOUR until you develop the gluey (for some regions) or thick liquid (Mutura region).

This is the YEAST.

Stage IV. Local beer preparation (fermented beverage)

Mix 15 L YEAST with 400 L of unfermented liquid from stage II, mix well and let stay for overnight, and drink your LOCAL BEER.

Note: Always start with YEAST preparation 4-5 days before and then start with the unfermented drink preparation. It is very important to add YEAST when unfermented drink is not too hot or not too cold.

You can prepare FLOUR along with YEAST.

Table 2. ASH MIXED WITH WET GRAIN FOR BEER MAKING

ASH COMPOSITION

% NITROGEN (N)	= 0.177%	IRON (Fc)	= 9765 ppm
% PHOSPOROUS (P)	= 1.298%	MANGANESE (Mn)	= 3300 ppm
% POTASSIUM (K)	= 7.065%	COPPER (Cu)	= 93.4 ppm
% CALCIUM (Ca)	= 16.530%	ZINC (Zn)	= 394.5 ppm
% MAGNESIUM (Mg)	= 3.565%	pH	= 11.20
% SODIUM (Na)	= 0.2286%		

Table 3. SORGHUM SAMPLES FOR BEER PREPARATION IN RWANDA

SORGHUM SAMPLES	% MOISTURE	TANNIN C.E. (1)	PHENOL (2)	% PROTEIN	% FIBER
UNGERMINATED WHOLE GRAIN	11.14	7.198	7.6720	9.66	2.27
GERMINATED GRAIN	11.40	0.135	1.0717	8.36	3.23
GERMINATED PHASE I NOT WINNOWED	10.98	0.302	0.4246	9.22	3.01
GERMINATED PHASE II READY TO MAKE FLOUR	10.84	0.369	0.5221	9.41	2.85

(1) CATEQUIN EQUIVALENT/GRAM OF SAMPLE

(2) mg TANIC ACID/GRAM OF SAMPLE

Table 4. AMINO ACID CONTENT OF SORGHUM SAMPLES FOR BEER MAKING

AMINO ACIDS (g/100g PROTEIN)	UNGERMINATED WHOLE GRAIN	GERMINATED GRAIN	GERMINATED PHASE II	CLEAN
ASPARTIC ACID	7.7	9.2	7.7	7.5
THREONINE	3.6	3.7	3.7	3.6
SERINE	5.1	5.0	4.8	4.8
GLUTAMIC ACID	19.8	19.0	20.0	20.1
PROLINE	8.5	8.7	7.2	7.0
GLYCINE	3.6	3.7	3.5	3.5
ALANINE	9.5	9.0	9.8	10.0
CYSTINE*	0.9	0.8	0.8	0.8
VALINE	5.0	6.5	5.4	5.4
METHIONINE*	1.5	1.6	1.8	1.8
ISOLEUCINE	3.9	3.9	4.2	4.1
LEUCINE	12.7	11.6	12.3	12.5
TYROSINE	3.6	3.7	4.1	4.0
PHENYLALANINE	5.2	5.3	5.2	5.5
LYSINE	2.3	2.7	2.3	2.2
HISTIDINE	2.0	2.1	2.0	2.0
ARGININE	3.4	3.7	3.0	3.0
% PROTEIN (DRY BASIS)	8.6	7.4	8.1	8.1

* DESTROYED PARTIALLY DURING OXIDATION.

Table 5. PEPSIN DIGESTIBILITIES (percent)

	Samples	Uncooked	Cooked
1.	Ungerminated sorghum	12.5	8.1
2.	Germinated sorghum	74.1	31.5
3.	Germinated dry and cleaned	64.6	22.8
4.	Unfermented beverage	-	-
5.	Fermented beverage	-	-

MUSALAC - A NEW PRODUCT IN BURUNDI

As mentioned earlier, high tannin sorghums in Burundi are mainly consumed in the form of beverages. However, a new product is already in market in production in the form of mixed flour (Table 6) prepared mainly for infants and lactating women.

ICRISAT Mission was interested in the nutritional level of this new product. Samples were sent to ICRISAT Center and the chemical analyses are shown in Tables 7 and 8. The flour of this mixed product is consumed by adding hot water only.

Proximate compositions of Musalac and SPV-351 - a white seeded sorghum grain are compared and results are shown in Table 7. Musalac has much higher content of protein, fat, sugars, energy, calcium, iron, potassium and sodium than SPV-351.

Amino acid composition of Musalac and SPV-351 are shown in Table 8. From the essential amino acids, the lysine content (3.76) is significantly higher in Musalac as compared to the lysine content (2.84) of SPV-351. Other amino acids except for leucine are almost the same in both samples.

The chemical analyses indicate that Musalac product is quite high in nutrition and such new products should be encouraged in addition to the use of sorghums as beverages.

Table 6. COMPOSITION OF MUSALAC PRODUCT IN BURUNDI

- High Tannin sorghum flour	35%
- Maize flour	30%
- Soybean flour	20%
- Sugar	10%
- Milk powder	5%

Table 7. Proximate Composition of Musalac and SPV-351 sorghum grain

Constituents %	Musalac	SPV-351
1. Protein	15.8	12.0
2. Fat	8.8	4.7
3. Starch	53.2	73.1
4. Sugars	13.1	1.1
5. Ash	2.1	1.6
6. Crude Fiber	1.9	2.3
7. pH (in 10% aqueous extract)	6.6	-
8. Protein digestibility % in vitro	77.0	79.0
9. Energy (Kcal/100g)	439.0	-
10. Fat acidity (mg KOH/g)	1.35	0.20
11. Calcium (mg/100g)	27.0	6.0
12. Iron (mg/100g)	17.0	3.0
13. Potassium (mg/100g)	639.0	342.0
14. Sodium (mg/100g)	57.0	27.0
15. Magnesium (mg/100g)	107.0	111.0
16. Zinc (mg/g)	20.0	16.0
17. Manganese (mg/g)	9.0	13.0
18. Copper (mg/g)	9.0	6.0
19. Thiamine (mg/100g)	0.17	0.32
20. Niacin (mg/100g)	2.5	4.3

Table 8. Amino Acid Composition of Musalac & SPV-351

Amino Acid g/100g protein	Musalac	SPV-351
1. Lysine	3.76	2.84
2. Histidine	2.52	2.84
3. Arginine	4.44	4.85
4. Aspartic acid	7.70	8.00
5. Threonine	3.24	3.62
6. Sernine	4.41	5.05
7. Glutamic acid	17.24	20.31
8. Proline	5.30	8.00
9. Glycine	3.10	3.83
10. Alanine	5.12	8.84
11. Half Cystine	1.20	1.21
12. Valine	4.10	5.33
13. Methionine	1.32	1.27
14. Isoleucine	3.77	4.04
15. Leucine	7.30	11.78
16. Tyrosine	3.51	4.42
17. Phenylalanine	4.26	5.38

ICRISAT/ICIPE JOINT PROJECT FOR THE EVALUATION OF SORGHUM LINES FROM EASTERN AFRICA FOR RESISTANCE TO STEM BORERS

In most of the eastern Africa countries, the sorghum crop suffers heavy losses as a result of attack by various insect pests, of which the most serious ones are stem borers such as *Chilo partellus*, *Busseola fusca*, *Sesamia calamistis* and *Eldana saccharina*. A majority of the farmers growing this crop have poor resources. Among the methods for the control of these borers the one which is safe and most readily feasible for the resource-poor small scale farmers is the cultivation of the pest resistant sorghum cultivars. For this purpose, evaluation of sorghum materials from various regions and sources is necessary in order to identify and develop cultivars which would combine borer resistance with other desirable characters.

One hundred and thirty four sorghum lines received from the ICRISAT/SAFGRAD have been evaluated for resistance to stem borers under artificial infestation with *Chilo partellus* at the ICIPE's Mbita Point Field Station, Kenya. The lines tested include those representative of very dry lands, low elevations and intermediate/high elevation zones. The parameters measured include dead heart (% plants), stem-tunnelling (% length), infestation levels (No. of borers/10 plants) and foliar damage (1-9 scale rating). Their weightage decreasing in this order. Certain lines are more resistant in respect of one parameter but more susceptible in respect of another parameter than other lines. The overall resistance of the lines contributed by all the four parameters combined, has been considered. The ten lines listed in Table13 are relatively more resistant to the stem borers than others.

Table 9. Levels of infestation and damage by the stem borer, C. partellus to sorghum lines of Group A.

Serial No.	Identification	Infestation levels[a] No.of borers/ 10 plants	DAMAGE LEVELS[a] % dead heart	Foliar rating (average per plant)	% stem tunnelling	Days to 50% flg.	Grain wt./pl (g)
1	83SR/KAT/368	33 (4)	33 (4)	2	52 (6)	67	72
2	83SR/KAT/369	38 (4)	38 (4)	2	52 (6)	66	81
3	83SR/KAT/370	42 (5)	42 (5)	1	63 (7)	69	41
4	83SR/KAT/371	30 (3)	30 (3)	2	52 (6)	67	45
5	83SR/KAT/372	37 (4)	23 (3)	2	46 (5)	68	53
6	83SR/KAT/382	45 (5)	36 (4)	2	50 (5)	68	45
7	83SR/KAT/384	29 (3)	20 (2)	2	44 (5)	65	59
8	83SR/KAT/386	40 (4)	43 (5)	2	63 (7)	67	54
9	83SR/KAT/393	42 (5)	41 (5)	2	36 (4)	65	72
10	83SR/KAT/403	32 (4)	46 (5)	1	58 (6)	67	69
11	83SR/KAT/412	33 (4)	24 (3)	2	63 (7)	67	79
12	83SR/KAT/456	66 (7)	30 (3)	2	59 (6)	66	65
13	83SR/KAT/457	32 (4)	32 (4)	2	54 (6)	67	64
14	83SR/KAT/458	33 (4)	43 (5)	1	65 (7)	67	81
15	83SR/KAT/462	42 (5)	36 (4)	2	57 (6)	68	63
16	83SR/KAT/487	16 (2)	56 (6)	1	63 (7)	64	71
17	83SR/KAT/485	23 (3)	33 (4)	1	55 (6)	71	48
18	83SR/KAT/485-1	30 (3)	33 (4)	2	59 (6)	68	59
19	83SR/KAT/485-2	26 (3)	40 (4)	1	58 (6)	63	49
20	83SR/KAT/492	37 (4)	40 (4)	1	57 (6)	66	63
21	83SR/KAT/496	21 (3)	23 (3)	2	50 (5)	66	55
22	83SR/KAT/504	36 (4)	46 (5)	2	65 (7)	72	59
23	83SR/KAT/506	29 (3)	20 (2)	1	56 (6)	67	70
24	83SR/KAT/511	34 (4)	13 (2)	1	56 (6)	66	48

Table 9. (Contd.)

Serial No.	Identification	Infestation levels[a] No.of borers/10 plants	DAMAGE LEVELS[a] % dead heart	Foliar rating (average per plant)	% stem tunnelling	Days to 50% flg.	Grain wt./pl (g)
25	83SR/KAT/549	26 (3)	26 (3)	1	44 (5)	66	70
26	83SR/KAT/552	39 (4)	33 (4)	1	57 (6)	69	62
27	83SR/KAT/554	34 (4)	43 (5)	1	45 (5)	66	62
28	83SR/KAT/558	52 (6)	13 (2)	2	59 (6)	66	64
29	83SR/KAT/578	30 (3)	30 (3)	1	51 (6)	65	60
30	83SR/KAT/620	32 (4)	30 (3)	2	54 (6)	71	64
31	83SR/KAT/626	37 (4)	50 (5)	1	65 (7)	68	60
32	83SR/KAT/652	28 (3)	43 (5)	1	69 (7)	69	87
33	83SR/KAT/655	29 (4)	33 (5)	2	59 (6)	70	76
34	83SR/KAT/659	24 (3)	50 (5)	1	60 (6)	68	71
35	83SR/KAT/666	35 (4)	30 (3)	2	44 (5)	67	69
36	83SR/KAT/667	34 (4)	33 (4)	1	51 (5)	70	50
37	83SR/KAT/668	25 (3)	47 (5)	1	67 (7)	65	62
38	83SR/KAT/676	22 (3)	53 (6)	2	73 (8)	67	62
39	83SR/KAT/678	33 (4)	23 (3)	3	51 (61)	69	61
40	83SR/KAT/1052	42 (5)	50 (5)	1	69 (7)	66	59
41	83SR/DB/822	46 (5)	43 (5)	1	57 (6)	70	58
42	83SR/KAT/365	44 (5)	20 (2)	2	57 (6)	65	59
43	83SR/KAT/366	45 (5)	20 (2)	2	42 (5)	67	56
44	83SR/KAT/367	37 (4)	40 (4)	2	64 (7)	64	61
45	83SR/KAT/395	34 (4)	46 (5)	2	58 (6)	67	73
46	83SR/KAT/487	29 (3)	40 (4)	1	50 (5)	64	69
47	83SR/KAT/505	42 (5)	30 (3)	1	53 (6)	67	70
48	83SR/KAT/570	44 (5)	33 (4)	1	61 (7)	64	69
49	83SR/KAT/946	21 (3)	40 (4)	1	56 (6)	65	48
50	83SR/KAT/941	27 (3)	40 (4)	1	51 (6)	66	51
51	83SR/KAT/953	26 (3)	33 (4)	2	54 (6)	65	60
52	83SR/KAT/960	49 (5)	30 (3)	2	61 (7)	66	85
53	83SR/KAT/961	29 (3)	53 (6)	1	68 (7)	69	71
54	83SR/DB/833	44 (5)	26 (3)	1	65 (7)	65	57

Table 9. (Contd.)

Serial No.	Identification	Infestation levels[a] No.of borers/ 10 plants	DAMAGE LEVELS[a] % dead heart	Foliar rating	% stem tunnelling	Days to 50% flg.	Grain wt./pl (g)
55	83SR/KAT/358	46 (5)	33 (4)	1	59 (6)	67	57
56	83SR/KAT/373	42 (5)	20 (2)	1	58 (6)	64	73
57	83SR/KAT/374	36 (4)	43 (5)	1	53 (6)	66	77
58	83SR/KAT/383	32 (4)	36 (4)	1	58 (6)	69	59
59	83SR/KAT/390	51 (6)	26 (3)	1	32 (4)	69	56
60	83SR/KAT/398	22 (3)	33 (4)	1	51 (6)	67	46
61	83SR/KAT/401	49 (5)	13 (2)	1	50 (5)	68	78
62	83SR/KAT/404	49 (5)	16 (2)	1	55 (6)	66	75
63	83SR/KAT/409	32 (4)	30 (3)	1	57 (6)	65	63
64	83SR/KAT/419	42 (5)	36 (4)	1	62 (7)	67	52
65	83SR/KAT/455	23 (3)	60 (6)	1	73 (8)	67	81
66	83SR/KAT/480	31 (4)	33 (4)	1	52 (6)	65	63
67	83SR/KAT/503	26 (3)	50 (5)	1	75 (8)	69	53
68	83SR/KAT/508	26 (3)	53 (6)	2	57 (6)	69	67
69	83SR/KAT/509	31 (4)	40 (4)	1	51 (6)	68	57
70	83SR/KAT/450	19 (2)	43 (5)	1	56 (6)	68	68
71	83SR/KAT/502	23 (3)	36 (4)	1	58 (6)	64	47
72	83SR/KAT/543	25 (3)	40 (4)	1	58 (6)	64	58
73	83SR/KAT/545	19 (2)	30 (3)	1	61 (7)	67	53
74	83SR/KAT/548	28 (3)	33 (4)	2	61 (7)	66	61
75	83SR/KAT/555	29 (5)	30 (3)	1	56 (6)	68	67
76	83SR/KAT/559	57 (6)	6 (1)	2	55 (6)	67	68
77	83SR/KAT/571	29 (3)	36 (4)	1	60 (6)	67	55
78	83SR/KAT/581	23 (3)	40 (4)	1	63 (7)	64	31
79	83SR/KAT/585	43 (5)	20 (2)	2	50 (5)	68	68
80	83SR/KAT/589	44 (5)	36 (4)	2	58 (6)	70	66

Table 9. (Contd.)

Serial No.	Identification	Infestation levels[a] No.of borers/ 10 plants	DAMAGE LEVELS[a] % dead heart	Foliar rating (av. per plant)	% Stem tunnelling	Days to 50% flg.	Grain wt./Pl (g)
81	83SR/KAT/601	29 (3)	30 (3)	3	62 (7)	66	57
82	83SR/KAT/617	36 (4)	43 (5)	1	59 (6)	68	65
83	83SR/KAT/619	43 (5)	33 (4)	2	61 (7)	66	94
84	83SR/KAT/625	34 (4)	40 (4)	1	64 (7)	66	60
85	83SR/KAT/629	21 (3)	33 (4)	1	63 (7)	64	64
86	83SR/KAT/630	34 (4)	33 (4)	1	65 (7)	66	44
87	83SR/KAT/653	34 (4)	16 (2)	1	53 (6)	69	56
88	83SR/KAT/658	43 (5)	33 (4)	1	55 (6)	66	73

[a]Fractions rounded off to nearest whole number. The numerals within the parentheses represent the grade of infestation or damage:

For all parameters except foliar damage: values ≤ 10 = grade 1; $>10 \leq 20$ = grade 2; $>20 \leq 30$ = grade 3; $>30 \leq 40$ = grade 4; $>40 \leq 50$ = grade 5; $>50 \leq 60$ = grade 6; $>60 \leq 70$ = grade 7; $>70 \leq 80$ = grade 8; >80 = grade 9.

For Foliar damage, the values given themselves represent the grades.

Table 10. Levels of infestation and damage by the stem borer, <u>Chilo partellus</u> to sorghum lines of Group B (Very Dry Lands set)

Serial No.	Identification	Seed source	Infestation levels[a] No. of borers/10 plants	DAMAGE LEVELS[a] Dead heart	Foliar rating	% stem tunnelling	Days to 50% flg.	Grain wt./pl (g)
1	MELKAMASH 79	Ethiopia	30 (3)	26 (3)	1	52 (6)	66	29
2	GAMBELLA 1107	Ethiopia	40 (4)	30 (3)	2	58 (6)	65	84
3	76 T1 23	Ethiopia	31 (4)	40 (4)	1	58 (6)	62	59
4	MY 146 BAIDOA	Kenya	30 (3)	36 (4)	1	62 (7)	64	48
5	BAIDOA LOCAL	Somalia	33 (4)	32 (4)	2	45 (5)	60	19
6	CROSS. 60:6	Sudan	16 (2)	20 (2)	1	61 (7)	58	34
7	P-898012	Sudan	15 (2)	26 (3)	2	70 (7)	58	31
8	P-967083	Sudan	58 (6)	43 (5)	2	69 (7)	68	59
9	SD x 135/ICSV 83487	Tanzania	29 (3)	60 (6)	2	63 (7)	65	59
10	ICSV 83487 KYSF	Kenya SAFGRAD/ ICRISAT	30 (3)	38 (4)	1	51 (6)	68	67
11	ICSV 83570 KYSF	Kenya SAFGRAD/ICRISAT	23 (3)	46 (5)	2	60 (6)	65	51
12	ICSV-83386 KYSF	Kenya SAFGRAD/ICRISAT	26 (3)	46 (5)	2	61 (7)	66	64
13	ICSV 83620 KYSF	Kenya SAFGRAD/ICRISAT	42 (5)	33 (4)	2	65 (7)	65	67
14	ICSV 83628 KYSF	KENYA SAFGRAD/ICRISAT	24 (3)	36 (4)	1	61 (7)	69	62

[a] = As in Table 1.

Table 11. Levels of infestation and damage by the stem borer, <u>Chilo partellus</u> to sorghum lines from Group C (Low Elevation set)

Serial No.	Identification	Seed Source	Infestation levels[a] No.of borers/ 10 plants	DAMAGE LEVELS[a] Dead heart	Foliar rating	% stem tunnelling	Days to 50% flg.	Grain wt./pl (g)
1	GAMBELLA 1107 79	Ethiopia	32 (4)	27 (3)	1	67 (7)	67	70
2	MELKAMASH	Ethiopia	18 (2)	50 (5)	1	62 (7)	68	43
3	DABAR	Sudan	28 (3)	20 (2)	2	71 (8)	60	41
4	CROSS 35:5	Sudan	32 (4)	37 (4)	3	70 (7)	59	38
5	M-90950	Sudan	25 (3)	63 (7)	1	47 (5)	69	55
6	M-62641	Sudan	29 (3)	33 (4)	2	63 (7)	62	80
7	2KX 89	Tanzania	31 (4)	33 (4)	2	51 (6)	67	58
8	TEGEMEO	Tanzania	28 (3)	23 (3)	3	51 (6)	71	60
9	SEREDO	Uganda	29 (3)	27 (3)	1	47 (5)	65	58
10	4MX 11/10	Uganda	36 (4)	27 (3)	2	55 (6)	69	51
11	BEINI	Yemen PDR	25 (3)	17 (2)	2	87 (9)	54	33
12	ICSV 83395 KYSF	Kenya SAFGRAD/ICRISAT	43 (5)	33 (4)	2	50 (5)	70	47
13	ICSV 83487 KYSF	Kenya SAFGRAD/ICRISAT	41 (5)	50 (5)	2	69 (7)	67	84
14	ICSV 83570 KYSF	Kenya SAFGRAD/ICRISAT	36 (4)	20 (2)	1	56 (6)	65	74
15	ICSV 83369 KYSF	Kenya SAFGRAD/ICRISAT	33 (4)	20 (2)	1	52 (6)	64	85
16	ICSV 83386 KYSF	Kenya SAFGRAD/ICRISAT	34 (4)	33 (4)	1	65 (7)	66	63
17	ICSV 83457 KYSF	Kenya SAFGRAD/ICRISAT	22 (3)	33 (4)	2	57 (6)	67	59
18	ICSV 83620 KYSF	Kenya SAFGRAD/ICRISAT	39 (4)	20 (2)	1	58 (6)	69	59
19	ICSV 83628 KYSF	Kenya SAFGRAD/ICRISAT	39 (4)	27 (3)	2	59 (6)	71	49

[a] = As in Table 1.

Table 12. Levels of infestation and damage by the stem borer, C. partellus to sorghum lines from Group D (High/Intermediate Elevation Set)

Serial No.	Identification	Seed Source	Infestation levels[a] No. of borers/ 10 plants		DAMAGE LEVELS[a] Dead heart	Foliar rating	% stem tunnelling		Days to 50% flg.	Grain wt./pl (g)
1	ALEMAYO 70	Ethiopia	40	(4)	23 (3)	2	58	(6)	75	32
2	ESIP 11 (IS 9302)	Ethiopia	23	(3)	43 (5)	2	61	(7)	63	37
3	ETS 2752	Ethiopia	41	(5)	43 (5)	2	57	(6)	87	27
4	URUMIMBI	Rwanda	34	(4)	43 (5)	2	67	(7)	79	40
5	BM 10	Rwanda	33	(4)	26 (3)	1	73	(8)	60	12
6	BM 27	Rwanda	34	(4)	40 (4)	1	68	(7)	64	50
7	SUSA	Rwanda	24	(3)	40 (4)	2	65	(7)	65	30
8	SVR 157	Rwanda	29	(3)	54 (6)	1	66	(7)	80	19
9	WS 1297	Rwanda	36	(4)	40 (4)	1	54	(6)	76	28
10	E 525 HT	Uganda	39	(4)	39 (4)	1	61	(7)	65	42
11	ABU-ALI	Yemen PDR	38	(4)	30 (3)	2	67	(7)	67	19
12	E 525	Kenya	38	(4)	37 (4)	1	59	(6)	66	60
13	80 ESIP 12 (IS 9323)	ETHIOPIA	32	(4)	27 (3)	2	66	(7)	66	34
14	IS 18520 (SERENA) Check	Kenya	38	(4)	27 (3)	1	62	(7)	64	45

[a] = As in Table 1.

Table 13. Ranking of 10 most resistant sorghum lines to stem borers complex[a]

Rank	Pedigree	Grades of different parameters			
		Dead heart	stem tunnelling	Infes-tation	Foliar damage
1	83 SR/KAT/559	1	6	6	2
2	83 SR/KAT/384	2	5	3	2
3	83 SR/KAT/401	2	5	5	1
4	83 SR/KAT/585	2	5	5	2
5	ICSV 83570 KYSF	2	6	4	1
6	ICSV 83369 KYSF	2	6	4	1
7	ICSV 83620 KYSF	2	6	4	1
8	Cross 60:6	2	7	2	1
9	Dabar	2	8	3	2
10	Beini	2	9	3	2

[a] The grades of different parameters for the listed lines taken from Tables 1 - 4

FIFTH REGIONAL WORKSHOP OF THE EASTERN AFRICA SORGHUM AND MILLET IMPROVEMENT NETWORK

This workshop was held in Bujumbura, Burundi, 5-11 July, 1986. There were approximately 50 participants from Burundi, Rwanda, Tanzania, Uganda, Somalia, Sudan, Kenya, and Ethiopia. All participants were active workers in sorghum and millet research and presented their research findings in different disciplines. Special papers on tannins, striga, cropping systems and drought were presented by experts from INTSORMIL and ICRISAT. The major recommendations of the workshop were:

1. The regional network be given an identity and such an identity evolved in the form of EARSAM (Eastern Africa Regional Sorghum and Millet-network).
2. The formation of an Advisory Committee to provide overall guidance for the networking activities.

In the EARSAM network, the following were identified as common priority areas of research:

- Breeding : Crop improvement for high and low altitudes
- Agronomy : Soil and crop management
- Entomology : Stalk borer and shoot-fly
- Pathology : Striga, Ergot, and grain mould.

The proceedings of this meeting are available from the SAFGRAD/ICRISAT Regional Office, Nairobi Kenya. The sixth Regional Workshop will be held in Somalia in 1988.

PUBLICATIONS IN 1986

1. Bujumbura, Burundi, ISABU, Ministry of Agriculture of Burundi, 1986. Proceedings of the 5th Annual Workshop on sorghum and millets for Eastern Africa, Bujumbura, Burundi, July 5-11, 1986.

1a. Guiragossian, V., 1986. Sorghum production constraints and research needs in Eastern Africa. Pages .... in the proceedings of the Regional Workshop on sorghum and millets for eastern Africa, Bujumbura, Burundi, 5-11 July, 1986.

1b. Guiragossian, V. and Peacock, J.M. 1986. Breeding for environmental stress drought and cold tolerance. Pages .... in the proceedings of the regional workshop on sorghum and millets for eastern Africa, Bujumbura, Burundi, 5-11 July, 1986.

1c. Sehene, C. and Guiragossian V., 1986. The use of grain sorghum for beverages in Rwanda. Pages ...., in proceedings of the regional workshop on sorghum and millets for eastern Africa, Bujumbura, Burundi, 5-11 July, 1986.

PCCMCA WORKSHOP FOR 1986

2. San Salvador, El Salvador, Ministry of Agriculture, 1986. Proceedings of the XXXI Annual Workshop of PCCMCA. Annual workshop for Central America, San Salvador, El Salvador, 17-22 March, 1986.

2a. Guiragossian, V. and Ramirez, L.G., 1986. Evaluacion de variedades de CLAIS en Centro America y su analisis de estabilidad. (In Es.) pages -----, in proceedings of the PCCMCA for Central America. San Salvador, El Salvador, 17-22 March, 1986.

2b. Guiragossian, V., Ramirez, L.G., 1986. Evaluacion de hibridos de CLAIS en Centro America y su analisis de estabilidad. (In Es.) pages ......, in proceedings of the PCCMCA for Central America. San Salvador, El Salvador, 17-22 March, 1986.

2c. Guiragossian, V. and Ramirez, L.G., 1986. Ensayo de rendimiento de variedades de sorgho de ICRISAT bajo condiciones de temporal en Centro America. (In Es.) pages ....., in proceedings of the PCCMCA for Central America. San Salvador, El Salvador, 17-22 March, 1986.

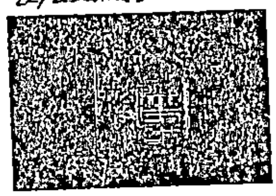
A PROJECT PROPOSAL FOR A REGIONAL SORGHUM AND MILLET RESEARCH AND TRAINING PROGRAM

The directors of research of eastern Africa countries (Burundi, Ethiopia, Kenya, Somalia, Rwanda, Uganda) in the CDA (Cooperation for Development in Africa) organized meeting from June 25 to 26, 1984 in Nairobi, identified sorghum and millets as priority commodities for regional research. The meeting agreed that ICRISAT be responsible for developing and implementing a CDA supported project for the region.

ICRISAT undertook a consultancy mission represented by Dr. Vartan Guiragossian to develop a project proposal for the region. Detailed visits to and consultations with the national programs and authorities of the programs are reflected in the proposal document presented to IDRC and copies are available at ICRISAT Center.

SPECIAL AWARDS AND RECOMMENDATIONS

AWARD PRESENTED FOR VARTAN
BY all Nat'l prog. representatives



during PCCMCA 1986 in San Salvador

El Programa Cooperativo Centroamericano para el Mejoramiento de Cultivos Alimenticios (PCCMCA) Otorga al Doctor

VANTAN Y. GUIRAGOSSIAN

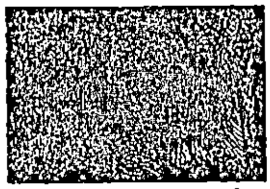
Cientifico del ICRISAT, el presente reconocimiento por su contribucion al mejoramiento del Cultivo de Sorgo en Centro Ameirca y el Caribe.

San Salvador, El Salvador, 21 de Marzo, 1986

Mexico	Guatemala
El Salvador	Honduras
Nicaragua	Costa Rica
Panama	Rep. Dominica
Puerto Rico	Haiti

Award presented by a local seed company AGROCONSA IN EL...

FOR VARTAN G



IN EL SALVADOR for the release and production of ISIAP DORADO Variety

A NUESTRO AMIGO

DR. VARTAN GUIRAGOSSIAN

COMO UNA MUESTRA DE
AGRADECIMIENTO POR SU
APOYO A LA PRODUCCION
DE SEMILLAS DE SORGOS

SEMILLAS LA PORTADA
AGRO-CONSULTORES, S.A. DE C.V.

San Salvador, Marzo de 1986

El Salvador C.A.

LA COMISION LATINOAMERICANA
DE INVESTIGADORES EN SORGO

AL Dr. Vartan Guiragossian

Fundador de CLAIS por su dinamismo, colaboracion y mejoramiento del cultivo de sorgo en la region.

Programas Nacionales de sorgo

Mexico — EL Salvador
Guatemala — Costa Rica
Honduras — Panama
Republica Dominicana

Guatemala, 31 octubre 1985.

Award received from CLAIS
Round Silver plate

RECOGNITION TO DR. VARTAN GUIRAGOSSIAN

A few years ago, there was only a small group of agricultural scientists in our region working on sorghum. Some of us had met, and thanks to CIMMYT, we had the opportunity to exchange information and to get to know other countries in the region a bit more. However, our only means of contact was through PCCMCA.

The PCCMCA work in sorghum had become a business of transnational seed companies, plus some testing of sorghum hybrids from other areas, and few isolated efforts by Central American Scientists.

From time to time, a brave scientist would take the risk of presenting results on his own sorghum materials, and faced by two possibilities: envied by his colleagues, or be their laughingstock. No clear goals had been established, no programs, no regional planning.

Then Dr. Vartan Guiragossian, an ICRISAT scientist, arrived in our region. We remember very well the first time I met him. He used to go jogging early in the morning, wearing a red and blue jacket, a bunch of necklaces. His Spanish was a mixture of Arabic, Spanish and English. We soon realized that his daily exercises were a part of his dynamic personality, and that this outfit was as original as his research ideas. In time we come to understand his Spanish well: "No problem, amigo; in your country, no money!". He still repeats that sentence. One thing is true: Vartan is not only intelligent and dynamic, he is also simpático.

Today, the national flags of our countries wave outside the building, and they are linked together by one factor: SORGHUM. Now there is planning, joint work, each national program knows what the other programs are doing, and what its responsibilities are.

There is no envy nor jealousy among us; if a country needs something it simply asks for it. We have hybrids, we have varieties, we have technology, and there is exchange of germplasm, training courses, and fellowships. This is CLAIS. This is what Vartan came to do. Thank you Vartan.

There is still much to be done, but now there is planning, capability, and we are united and willing to work toaccomplish our tasks. You, Vartan, have acheived your goals and objectives. We, the representatives of the national programs in Mexico, El Salvador, Guatemala, Costa Rica, Honduras, Panamá, and the Dominican Republic, thank you on behalf of our countries.

Guatemala City
October 31, 1985.

El Comité Organizador de la XXXII Reunión Anual del Programa Cooperativo Centroamericano para el Mejoramiento de Cultivos Alimenticios

Por Cuanto:

el **Dr. Vartan Guiragossian**

Se ha desempeñado como asesor del ICRISAT de Fito-mejoramiento en el cultivo de sorgo en Latinoamérica, con énfasis en Centro América y el Caribe, de 1977 a 1986;

Por Tanto:

Le otorga el presente

Diploma de Honor al Mérito

Por su inestimable aporte científico para el fortalecimiento de este Programa, de trascendencia significativa en beneficio de mejores y mayores producciones agropecuarias en el área de Centroamérica y del Caribe.

Dado en San Salvador, El Salvador, C.A., a los veintiún días del mes de marzo de mil novecientos ochenta y seis.

Bertha Amelia de Belloso Presidenta	Roberto Rodríguez Sandoval Vicepresidente

Salvador González Alvarado Secretario	Romeo López Sánchez Tesorero	Napoleón Puente Márquez Vocal

Jorge Alberto Sermeño Auditor	Víctor Manuel Rodríguez Coordinador General

1986

EASTERN AFRICA REGIONAL SORGHUM AND MILLET NETWORK (EARSAM) ANNUAL REPORT 1986

OUA/CSTR-SAFGRAD

ICRISAT