Sorghum Improvement in West Africa Through USAID-OAU/STRC-SAFGRAD-ICRISAT West and Central Africa Sorghum Research Network[1]

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1. Paper presented at the Seventh East African Sorghum and Millet Research Network's (EARSAM) regional workshop, Nairobi, Kenya, June 24 to July 2, 1990.

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ABSTRACT

Sorghum (*Sorghum bicolor* (L) Moench) is an important food crop in semi-arid West Africa. Various factors contribute to the relatively low yields of local varieties. Although improved genotypes for the most part yield better than local landraces, they could be susceptible to such stress factors as diseases, insect pests, drought, and *Striga* of the objectives of the West and Central African Sorghum Research Network (WCASRN) is to increase the production of sorghum in order to contribute to the stabilization of food supplies in the region. Other important specific objectives of WCASRN are, to assist and strengthen national sorghum improvement programs, to develop improved varieties and hybrids and agronomic practices, and to facilitate the development of agricultural research manpower among nationals at all levels. In attempts to achieve some of these objectives, WCASRN has organized training workshops, regional trials, and collaborative research projects for the 17 member

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countries in the Network. Other activities of WCASRN which contribute to sorghum improvement in the region include monitoring tours, steering committee meetings, and regional workshops. This paper summarizes progress made in achieving some of these objectives between June 1987 and December 1989.

INTRODUCTION

Sorghum (*Sorghum bicolor* (L) Moench) is grown widely in many countries in semi-arid West Africa. In several of these countries, sorghum could be regarded as the staple food. Most of the sorghum is grown in the Sudanian Zone (500-1000 mm rainfall) and the Northern Guinean Zone (1000-1200 mm rainfall). Some sorghum is also grown in the Southern Sahelian Zone (400-500 mm rainfall). Along with pearl millet (*Peinnisetum glaucum* (L.) R.Br.), it provides the main energy source for the people of the Sudanian and Northern Guinean Zones (Curtis, 1965). There is a considerable variation in the type of sorghum grown in West Africa by farmers. These local varieties are low yielding, adapted to low fertility, and generally not responsive to high levels of fertilizer (Zummo, 1984). Average grain yields under traditional management vary from 800 kg ha^{-1} in the Sudanian Zone to 400 kg ha^{-1} in the Sahelian Zone (Stoop et al, 1982). Yields can also reach 1500 kg ha^{-1} in the Northern Guinean Zone (Matlon, 1983). Cereals, particularly sorghum and millet occupy nearly 70% of the total

cultivated area in Semi-Arid Tropics in West Africa (Matlon, 1983). Thus, sorghum is important in semi-arid West Africa for which its improvement, through research and extension and through training of personnel in National Agricultural Research Systems (NARS), is vital.

The first regional wokshop sponsored by ICRISAT/SAFGRAD/ USAID was held in Ouagadougou, Burkina Faso from 27-30 November, 1984. In this workshop, the NARS requested ICRISAT to coordinate the network activities. It was attended by a total of 46 participants from 16 countries. There were also representatives from ICRISAT, IRAT, INSAH/CILSS, and SADCC/ ICRISAT. The idea of a regional approach to sorghum improvement was discussed and approved. The West African Sorghum Research Network became operational in 1985 when a Steering Committee was formed. The Committee consisted of representatives from NARS as members and of representatives from several regional organizations as observers.

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Unity's Scientific, Technical and Research Commission (OAU/STRC), and is executed by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT).

At the third Steering Committee meeting in December 1987, it was proposed that the name of the Network be changed to the West and Central Africa Sorghum Research Network (WCASRN) in order to accomodate Cameroon and Central African Republic. The present Steering Committee consists of six members represented by Burkina Faso, Cameroon, Mali, Niger, Nigeria, and Chad. The current chairman is the representative from Mali. Representatives from Institut du Sahel (INSAH), Institut de Recherche Agronomique Tropicale/Centre de Cooperation Internationale en Recherche Agronomique pour le Developpement (IRAT/CIRAD), USAID, ICRISAT and SAFGRAD's Director of Research are observers. Recently, Global 2000 has been invited as an observer to the Steering Committee. The Coordinator is with ICRISAT's West African Sorghum Improvement Program in Mali (WASIP-Mali). He executes the activities of the Network with administrative and technical support from WASIP-Mali. The WCASRN consists of 17 member countries and its objectives are:

* To increase the production of sorghum thereby contributing to the stabilization of food supplies in

the region and contributing to improved nutrition and income for farmers in the drier areas of the region;

* To assist and strengthen national sorghum improvement programs, and contribute to their research needs in all agroecological semi-arid zones;

* To develop improved varieties and hybrids and agronomic/management practices capable of giving higher and more stable economic yields in the semi-arid environments;

* To organise and promote systematic regional testing of available and improved genetic material and technology in the semi-arid zone;

* To facilitate the development of agricultural research manpower among West African nationals at all levels; and

* To organise regional workshops and monitor uniform yield trials through field inspections.

This paper is a summary of progress made in achieving some of the above objectives through training workshops,

regional trials and nurseries, collaborative research projects, monitoring tours, steering committee meetings, and regional workshops, and covers the period between June 1987 and December 1989.

TRAINING

Striga Training Workshop

The first training workshop was on *Striga* control and was held in Ouagadougou from 5 to 10 October, 1987. There were 12 participants from the following 11 countries: Burkina Faso, Cameroon, Gambia, Ghana, Kenya, Mali, Niger, Nigeria, Sudan, Togo, and Uganda. Two participants came from Uganda. In addition to ICRISAT scientists, specialists from IRAT, Sudan, and Old Dominion University assisted in the training.

Training Workshop on Agronomic Research and On-Farm Testing

This workshop was held in the conference room at WASIP-Mali in Bamako between 9 and 29 September, 1989. Nine out of ten countries invited were represented. The representative from Central African Republic was absent. The countries invited were Central African Republic, Côte d'Ivoire, Gambia, Ghana, Guinea Bissau, Mauritania, Niger, Nigeria, Senegal, and Sierra Leone. There was a total of 11 lectures and five field visits. Lecture topics ranged from soil fertility, control approaches to *Striga*, and crop and animal interaction

to principles of on-farm testing. Field visits included a trip to the Cinzana station some 270 km from Bamako, the national program at the Sotuba station just outside Bamako, a special *Striga* field trip to Katibougou, about 70 km north of Bamako, and trials of WASIP at the new site at Samanko, 18 km from Bamako.

REGIONAL TRIALS AND NURSERIES

1987. Three regional sorghum adaptation trials were conducted in 1987. The West African Sorghum Variety Adaptation Trial early and medium duration varieties (WASVAT-Early and Medium) had 20 entries each. Seeds for these trials were multiplied under the supervision of the Coordinator, at ICRISAT's Kamboinse, Burkina Faso facilities. Seeds for WASVAT early and medium were sent to 10 and 14 countries, respectively. The choice of countries was based on their requests for these trials. The third trial was the West African Sorghum Hybrid Adaptation Trial (WASHAT) which had 25 entries and was sent to seven countries. Production of the hybrids for WASHAT and choice of countries were as described above for WASVATs. These trials were conducted for the second consecutive year and the entries were elite varieties and hybrids furnished by ICRISAT and by the national programs of Burkina Faso, Cameroon, Ghana, Mali, and Niger. Most of the entries in

the WASVATs were tested for the first time, whereas the others were the best entries from 1986. Results for 1987 were obtained from 9, 12, and 15 locations for WASVAT-Early, WASVAT-Medium, and WASHAT, respectively.

Because of high coefficients of variation, only data from 7 locations for both the WASVATs and from locations for WASHAT are presented. For WASVAT-Early, the variety Nagawhite had the highest mean yield (2800 kg ha^{-1}) for all seven locations (Table 1), and for WASVAT-Medium, it was ICSV 1063 BF (2580 kg^{-1}) (Table 2). For WASHAT, ICSH 336 had the highest mean yield (2800 kg^{-1}) for all ten locations (Table 3).

The West African Sorghum Disease Resistance Nursery (WASDRN) was sent for the first time in 1987 to five countries countries and was grown in six locations. The nursery had 36 entries of which 20 were promising genotypes observed for resistance to leaf diseases in preliminary observation nurseries of ICRISAT's Burkina Faso Pathology program since 1985. They originated from ICRISAT's breeding program in Burkina Faso. Thirteen of these lines were agronomically promising germplasm lines and the remaining three were susceptible controls. The leaf diseases, leaf anthracnose (*Colletotrichum graminicola*), sooty stripe (*Ramulispora sorghi*), and gray leaf spot (*Cercospora sorghi*) are important

in West Africa. Results received from five locations indicate that six genotypes, 84 W 19, 84 W 848, ICSV 85-4, ICSV 1034 BF, IS 9928, and IS 21658 had low severity scores (3.5 or less) for the prevalent leaf diseases at all locations (Table 4).

1988. In 1988, WASVAT-Early consisted of 20 entries and 14 sets were sent to seven countries. The 20 varieties were the same as for 1987. The variety Nagawhite had the highest mean yield (3530 kg ha^{-1}) over all 10 locations (Table 5).

WASVAT-Medium also consisted of the same 20 entries as in 1987, and 19 sets were sent to 15 countries. Results were received from 11 locations. The coefficients of variation were higher than 40% for five locations. Thus, only yield data for the remaining six locations are given in Table 6. The variety ICSV 1003 BF had the highest mean yield (3349 kg ha^{-1}) for all 11 locations.

The hybrid trial, WASHAT, consisted of 20 entries and was grown at 12 locations in seven countries. Results for grain yield from seven locations are given in Table 7. The hybrid ICSH 507 ranked first for mean yield (3315 kg ha^{-1}) over all seven locations, and exibited consistent performance across locations.

The disease nursery WASDRN contained the same 36 entries as in 1987 and was grown at seven locations in six countries. Three genotypes, 84 S 82, 84 S 18 103-3, and 84 S 130, had low levels of infection to the three most important leaf diseases at all seven locations (Table 8). Sooty stripe severity was very low (disease score of 3 or less in a 1-6 scale) at all locations except Bengou, in Niger. Disease severity did not exceed 3.0 for any disease for all 36 genotypes in Ghana. Ghana is thus not included in Table 8.

The West African Sorghum *Striga* Trial (WASST) was organized for the first time at the request of several national programs. The trial consisted of 11 entries which had been tested by ICRISAT in fields with high Striga infestation and one local control. The trial was sent to Cameroon, Ghana, Mali, Niger, Nigeria, and Togo, and results were received from Cameroon, Ghana, and Mali. The results showed that IS 9830 and ICSV 1007 BF were promising lines for *Striga* resistance.

1989. All the trials and nurseries for 1989 consisted of the same entries as in 1988. WASVAT-Early was sent to 12 locations in 9 countries whereas WASVAT-Medium was dispatched to 18 locations in 16 countries. WASLDN and WASST each were sent to eight and seven locations, respectively in seven countries and

WASHAT to 8 locations in 6 countries. The results are still being analyzed.

COLLABORATIVE RESEARCH PROJECTS WITH NATIONAL AGRICULTURAL RESEARCH SYSTEMS

The West and Central Africa Sorghum Research Network initiated four research projects in four NARS in June 1989. These projects are leaf anthracnose in Burkina Faso, long smut in Niger, head bug in Mali and technology of wheat-sorghum composite flour in Nigeria.

The main objectives of the anthracnose project are to determine whether pathotypes of the pathogen occur in Burkina Faso and to identify genotypes resistant to the pathotypes. The objective of the long smut project in Niger is to develop a simple and effective inoculation method for use as a screening technique. The project on head bug in Mali emphasizes among other things, the biology of the insect, its economic importance, and identification of resistant sources. In Nigeria, the project scientists hope to develop a technology for producing acceptable wheat-sorghum composite flour for bread and confectionery, aimed at increasing the sorghum component as high as possible.

MONITORING TOURS

As a follow up to the recommendations of the 1985 regional workshop, the third monitoring tour was conducted in Burkina Faso from 30 September to 3 October, 1987. Representatives from national programs of Benin, Burkina Faso, Cameroon, Chad, Côte d'Ivoire, Gambia, Ghana, Niger, Nigeria, Senegal, and Togo participated in the tour. Four scientists from Mali joined part of the tour. Research stations at Farako-Bâ, Saria and Kamboinse were visited. On-farm testing trials in villages were also visited.

In 1988, the monitoring tour took place between 9 and 18 October. The objectives of the tour were to enable national scientists to visit trials and nurseries of neighboring NARS and to give them the opportunity to evaluate breeding materials and select those they find interesting for use in their respective programs. The national programs of Mali, Burkina Faso and Niger were visited by representatives from Benin, Burkina Faso, Cameroon, Guinea Bissau, Mali, Tchad, and Togo. The tour started in Mali and ended in Niger. The participants evaluated national, regional, and international trials in each of the three countries visited and held periodic group discussions.

THIRD REGIONAL WORKSHOP

The third WCASRN Regional Workshop was held at Maroua, Cameroon, between September 19 and 23, 1988. The objectives of the workshop were :

- to discuss the results of sorghum research carried out in 1986 and 1987 in NARS, with emphasis on regional trials;

- to finalize entries of regional trials and nurseries for 1989 and 1990, and

- to select new Steering Committee members.

There were 52 participants, and 14 out of 17 national programs were represented. Participants included representatives from SAFGRAD, IRAT/CIRAD, and ICRISAT.

CONCLUSION

There are many components in an overall strategy to improve sorghum production in semi-arid West Africa. If these components are well defined and are tailored towards the needs of the region on a strictly priority basis, then the facets in a strategic plan become clearer and less complex. For example, training should concentrate on upgrading

present staff and replacing expatriates rather than training to fill new posts (Eicher, 1988). Eicher (1988) also suggested that the effectiveness of regional research networks could be enhanced if sub-regional geographical units formed the operational units for developing research strategies. This suggestion is in line with one of SAFGRAD's thrusts on research program activities which is to promote the improvement of food grains by supporting regionally oriented research in sub-Saharian Africa (Bezuneh, 1987). A strategic priority in the 1990's should be the strengthening of national commodity research teams on a few priority commodities (Eicher, 1988).

During the past several years, WCASRN has made some modest impact in contributing to some of these philosophies underlying the overall strategy for sorghum improvement in West and Central Africa. For example, some of the improved varieties in the regional trials have been tested by NARS and those that are in advanced stages of testing are given in Table 9. In Mali, ICSV 1063 BF and ICSV 1079 BF were tested on farmers' fields and ICSV 1063 BF produced superior grain yields over the local variety in all the treatments. This variety will be tested in several villages during the 1990 crop season. ICSV 111 IN and M 66118 have received greater attention in Ghana. ICSV 1063 BF and Mali Sor 84-1

were included in on-farm tests by extension agencies in Côte d'Ivoire. Promising sources of resistance to the prevalent leaf diseases and to *Striga* have been identified through the leaf disease nursery and the *Striga* trial.

The five collaborative projects have created further incentive to scientists in NARS to engage in research. Working group meetings on these projects are planned for this year, in which experts from NARS will meet and discuss results obtained and future work plans. Scientists in NARS are thus interacting to solve common problems.

Training workshops and regional tours provided a broader forum for interaction between NARS scientists. For example, regional tours enabled NARS scientists to visit trials and nurseries of neighboring countries, to evaluate the materials they saw, and to select those they found interesting for use in their programs.

There is a lot more to be done through WCASRN especially in the area of agronomy. The approaches the Network use to meet its objectives are constantly being evaluated and revised. More inputs from the 17 member countries especially in the area of management of the Network, is envisaged for the future.

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Table 1. Mean grain yield (t ha^{-1}) of highest yielding early duration varieties in the West African Sorghum Variety Adaptation Trial (WASVAT) at seven locations in West Africa, rainy season 1987[1].

Variety	Farako-Ba	Saria	Sourou	Fada	Samaru	Sapu	Maroua	Mean
Nagawhite	2.81 3	2.90 13	3.08 1	2.07 1	1.48 1	3.58 2	3.68 12	2.80
ICSV 111 IN	2.08 8	3.14 10	1.42 7	1.84 3	0.72 11	2.98 9	5.79 1	2.57
ICSV 1083 BF	2.58 5	3.65 2	1.80 4	1.29 13	1.33 3	2.25 12	4.60 5	2.50
CE 180-33	1.43 16	2.75 16	2.97 2	2.01 2	1.39 2	4.00 1	2.14 20	2.38
S 35	2.47 6	2.77 15	0.86 14	1.69 5	0.50 15	3.04 8	5.30 3	2.37
ICSV 230 IN	3.23 1	3.11 9	2.03 3	1.56 8	0.89 9	2.67 10	2.86 17	2.33
Controls								
ICSH 109 IN	2.97 2	3.80 1	1.33 9	1.46 9	1.02 6	3.42 3	5.25 4	2.75
Local	1.59 13	3.20 7	0.47 16	1.34 11	0.50 15	0.12 14	5.37 2	
SE	±0.38	±0.19	±0.28	±0.21	±0.17	±0.40	±0.62	
Trial mean (20 entries)	2.00	3.07	1.49	1.42	0.94	2.79	3.86	
CV (%)	33	11	33	26	32	25	28	

1. Randomized block design with three replications, plot size ranged from 7.5 to 8 m^2. Numbers following each yield value indicate the ranking of the cultivars.

Table 2. Mean grain yield (t ha^{-1}) of highest yielding medium duration varieties in the West African Sorghum Variety Adaptation Trial (WASVAT) at seven locations in West Africa, rainy season 1987[1].

Variety	Farako-Ba	Saria	Sotuba	Ferkè	Samaru	Sapu	Nyankpala	Mean
ICSV 1063 BF	3.20 5	4.00 2	4.87 2	2.76 1	0.94 6	1.67 12	0.62 6	2.58
ICSV 1089 BF	3.52 1	4.26 1	4.49 3	1.33 8	1.50 1	2.29 6	0.59 12	2.56
M 24581	3.26 4	3.35 8	5.04 1	1.58 5	0.93 7	2.67 3	0.56 9	2.48
Malisor 84-1	2.92 8	3.31 10	4.04 8	2.60 2	0.72 14	2.67 3	0.87 3	2.45
ICSV 1093 BF	2.97 7	3.55 4	4.15 7	1.35 7	0.87 10	2.54 4	0.58 8	2.29
BF 80-10-23-2-1	2.97 7	3.35 8	3.15 18	1.60 4	1.24 2	2.25 7	0.99 2	2.22
Controls								
Local	2.50 13	3.42 6	1.16 20	1.99 3	0.67 15	1.33 15	1.68 1	
SE	±0.45	±0.19	±0.44	±0.25	±0.15	±0.28	±0.30	
Trial mean (20 entries)	2.68	3.35	3.78	1.32	0.88	2.05	0.61	
CV (%)	29	10	20	33	30	24	31	

1. Randomized block design with three replications, plot size ranged from 7.5 to 8 m^2. Numbers following each yield value indicate the ranking of the cultivars.

Table 3. Mean grain yield (t ha-[1]) of highest yielding hybrids in the West African Sorghum Hybrid Adaptation Trial (WASHAT) at 10 locations in West Africa, rainy season, 1987[1].

Hybrid	LOCATIONS										Mean
	1	2	3	4	5	6	7	8	9	10	
ICSH 336	3.90 3	3.26 14	1.81 3	3.15 2	3.11 1	4.33 13	2.61 2	3.51 3	3.72 20	1.04 9	2.8
ICSH 232	3.28 13	3.51 6	2.07 1	3.42 1	2.56 11	4.72 1	1.64 16	3.61 2	4.29 10	0.98 11	2.7
ICSH 643	3.92 2	3.81 1	1.53 8	1.88 11	2.49 13	3.73 8	2.38 4	3.51 3	5.58 2	0.89 15	2.7
ICSH 642	3.39 9	3.34 9	1.92 2	1.70 14	2.75 6	2.87 22	3.16 1	1.44 1	4.90 5	0.98 11	2.6
ICSH 479	3.08 17	3.17 17	1.54 7	1.80 12	2.51 12	3.72 9	1.90 8	0.98 17	6.31 1	1.11 7	2.6
ICSH 229	3.12 16	3.23 15	1.52 19	3.15 2	2.73 8	3.55 11	2.27 5	1.07 5	3.92 16	1.44 2	2.5
Controls											
ICSH 109	2.26 23	3.65 3	1.50 10	1.24 21	2.23 17	3.24 15	0.92 21	1.16 6	4.03 13	0.94 12	2.1
Hageen Durra	0.93 25	2.21 24	1.23 14	2.01 10	2.45 15	3.09 18	0.71 24	1.12 12	2.91 23	0.70 19	1.7
Framida	2.80 21	2.31 23	0.69 24	1.31 20	0.49 21	3.07 20	2.49 3	1.05 15	2.59 24	0.93 13	1.7
Nagawhite	3.24 14	3.50 7	1.10 15	1.23 22	2.20 18	3.97 5	1.86 12	0.91 19	3.09 22	1.19 5	2.2
Local variety	1.35 24	2.40 22	0.92 21	0.72 24	1.95 19	2.54 23	1.98 9	1.12 12	5.58 2	0.60 22	-
SE	±0.27	±0.26	±0.23	±0.39	±0.29	±0.39	±0.31	±0.06	±0.64	±0.19	
Mean	3.12	3.22	1.33	1.94	2.48	3.57	1.73	1.08	4.28	0.97	
CV (%)	15	14	30	35	20	19	31	10	26	35	

1. Locations : 1 = Farako-Ba, 2 = Saria, 3 = Fada, 4 = Gampela, 5 = Kolo, 6 = Sotuba, 7 = Ferkè, 8 = Dapaong, 9 = Maroua, 10 = Bouakè. Lattice design (5 x 5), three replications. Plot size ranged from 7.5 to 8 m^2. Numbers following each yield value indicate the ranking of the cultivars.

Table 4. Disease severity scores for three leaf diseases of six sorghum genotypes with low disease severity from the West Africa Sorghum Disease Resistance Nursery (WASDRN) in Burkina Faso, Niger, Mali, and Côte d'Ivoire, rainy season, 1987.

	Disease severity[2]										Time to 50% flowering (days)[3]
	Gray Leaf Spot				Leaf anthracnose			Sooty stripe			
Genotype[1]	FAR	NIA	MAL	COT	FAR	MAL	COT	FAR	MAL	NIG	
84 W 19	1.0	3.5	2.5	2.2	3.5	2.0	1.0	2.0	1.0	2.0	74
84 W 848	1.0	3.0	3.5	2.0	3.0	1.0	1.0	2.0	1.0	3.0	72
ICSV 85-4	1.5	3.5	2.1	3.0	1.0	1.0	1.0	1.5	1.5	3.0	70
ICSV 1034 BF	1.5	3.5	3.0	2.0	3.5	2.0	1.0	2.0	1.0	3.5	71
IS 9928	2.5	3.0	3.0	2.2	3.0	1.0	1.5	2.0	1.0	2.0	71
IS 21658	2.0	3.5	3.5	1.7	2.0	1.0	1.0	1.5	1.0	1.5	73
Controls											
ICSV 20-1 BF	5.0	5.0	5.0	3.5	2.0	2.0	2.0	1.0	1.0	2.0	79
84 S 85	2.5	5.0	3.5	2.1	3.5	3.5	1.0	1.5	1.0	1.5	64
IS 18696	1.5	6.0	5.5	1.2	6.0	6.0	6.0	1.0	1.0	4.0	68
SE	±0.4	±0.4	±0.6	±0.1	±0.3	±0.8	±0.3	±0.3	±0.1	±0.9	
Trial Mean (36 entries)	1.5	4.0	3.3	2.1	3.3	2.3	1.4	1.6	1.1	2.7	
CV (%)	36.0	13.0	24.0	9.0	19.0	51.0	32.0	25.0	19.0	48.0	

1. The three controls are susceptible checks for gray leaf spot and leaf anthracnose.

2. Based on a 1-6 scale where 1 = no disease symptoms and 6 = more than 75% leaf area infected, given as plot scores taking into consideration the top four leaves scored at each location when entries were at various stages between soft dough and maturity.
FAR = Farako-Ba in Burkina Faso. NIA = Niangoloko in Burkina Faso. MAL = Mali. COT = Cote d'Ivoire. NIG = Niger

3. Mean from three locations, Burkina Faso, Mali, and Côte d'Ivoire. Time to 50% flowering was similar in all thre locations. Entries flowered between 10 and 27 days later in Niger.

Table 5. Mean grain yield (t ha^{-1}) of highest-yielding early duration varieties in the West African Sorghum Variety Adaptation Trial (WASVAT) at 10 locations in West Africa, rainy season 1988[1].

	L O C A T I O N[2]										
Entry	1	2	3	4	5	6	7	8	9	10	Mean
Nagawhite	4.78 1	2.88 19	2.86 1	2.59 7	3.79 5	6.35 2	3.60 2	3.00 4	2.98 5	2.44 4	3.53
ICSV 210 IN	3.90 7	4.57 1	1.98 14	2.72 6	4.32 1	5.93 4	3.05 4	3.18 5	1.95 8	2.54 3	3.41
ICSV 111 IN	4.18 4	3.57 9	2.11 13	2.09 15	3.56 6	5.45 11	3.12 3	2.81 8	3.19 3	2.60 2	3.27
S-35	3.32 13	3.51 10	1.69 17	1.93 17	4.15 3	5.55 9	3.69 1	2.44 16	3.19 3	2.81 1	3.23
ICSV 1087 BF	4.09 5	3.38 8	2.85 2	2.23 11	1.89 18	5.90 5	2.81 6	4.10 1	2.35 9	2.18 5	3.18
CE 180-33	2.95 15	3.77 3	1.83 16	3.36 1	4.25 2	5.50 10	2.39 11	2.61 13	3.31 2	1.68 8	3.17
ICSV 1078 BF	2.86 16	2.99 17	2.31 10	3.01 4	3.01 7	6.92 3	2.89 5	2.71 12	2.50 7	2.60 2	3.12
ICSV 1054 BF	3.82 9	3.21 15	2.40 6	1.89 18	2.07 16	6.42 1	2.81 6	3.47 3	2.88 6	2.10 7	3.11
ICSV 1083 BF	4.68 2	4.13 2	2.37 7	2.19 16	3.94 4	5.83 6	1.38 18	2.73 11	2.33 10	0.99 19	3.06
Controls											
IRAT 204	3.66 12	2.76 20	2.23 9	2.41 10	0.72 20	5.27 15	2.22 12	3.39 4	2.16 11	1.36 14	2.62
Local	2.02 18	3.19 16	2.34 8	1.30 19	2.81 10	5.64 8	1.48 17	1.68 18	1.80 13	1.41 13	2.37
SE	± 0.483	± 0.344	± 0.202	± 0.289	± 0.333	± 0.442	± 0.334	± 0.339	± 0.475	± 0.194	
Trial mean (20 entries)	3.49	2.59	1.67	2.39	2.75	5.47	2.41	2.80	2.35	1.77	
CV (%)	24	23	21	21	21	14	24	21	35	19	

1. Randomized-block design with three replications, plot size ranged from 6.4 to 19.4 m^2.

2. Locations: 1 = Saria, Burkina Faso; 2 = Bema, Mali; 3 = Cinzana, Mali; 4 = Bagauda, Nigeria; 5 = Tarna, Niger; 6 = Maroua, Cameroon; 7 = Farako-Ba, Burkina Faso; 8 = Kolo, Niger; 9 = Bambey, Senegal; and 10 = Nyankpala, Ghana. Numbers following each yield value indicate the ranking of the cultivars.

Table 6. Mean grain yield (t ha^{-1}) of highest-yielding medium duration varieties in the West African Sorghum Variety Adaptation Trial (WASVAT) at six locations in West Africa, rainy season, 1988[1].

	Burkina Faso		Mali		Nigeria		
Entry	Farako-Ba	Saria	Sotuba	Samanko	Bagauda	Karewa	Mean
ICSV 1063 BF	3.45 1	4.66 11	4.33 1	1.20 3	3.00 4	3.42 3	3.34
Mali Sor 84-1	3.16 2	4.38 13	3.10 13	1.27 1	2.67 8	3.91 2	3.08
ICSV 1089 BF	2.81 3	4.90 8	3.45 7	0.91 11	3.31 2	2.67 13	3.01
BF 80-7-7-2-1	2.78 4	5.18 5	3.71 5	1.23 2	1.83 12	3.11 4	2.97
ICSV 1092 BF	2.38 10	4.38 13	3.18 11	1.12 5	3.48 1	2.71 12	2.88
BF 80-9-8-3-1	2.59 7	4.56 12	3.10 13	0.95 10	2.91 6	2.98 7	2.85
Control							
Local	1.61 17	2.23 20	3.11 12	0.65 20	0.83 20	4.44 1	2.15 18
SE	± 0.32	± 0.52	± 0.24	± 0.16	± 0.38	± 0.27	
Trial mean (20 entries)	2.25	4.58	3.31	0.98	2.41	3.02	
CV (%)	25	20	13	29	28	16	

1. Randomized-block design with three replications, plot size ranged from 6.4 to 19.4 m^2. Numbers following each yield value indicate the ranking of the cultivars.

Table 7. Mean grain yield (t ha-1) of selected hybrids in the West African Sorghum Hybrids Adaptation Trial (WASHAT) at seven locations in West Africa, rainy season 1988[1].

Entry	Mali		Niger		Nigeria	Burkina Faso	Côte d'Ivoire	Mean
	Samanko	Cinzana	Kolo	Tarna-2	Bagauda	Farako-Ba	Ferké	
ICSH 507	3.67 4	3.16 2	3.54 1	4.14 6	3.98 1	3.05 1	1.66 1	3.32
ICSH 330	3.87 2	2.99 4	3.28 3	4.49 4	3.25 4	2.45 3	1.32 3	3.09
ICSH 88042	3.93 1	3.06 3	2.88 4	4.61 3	3.14 5	2.39 4	1.19 4	3.03
ICSH 88040	3.84 3	2.75 5	3.31 2	4.75 2	3.28 3	1.74 6	0.77 5	2.92
ICSH 88038	3.40 5	3.38 1	2.67 5	4.92 1	3.11 6	2.26 5	0.70 6	2.92
ICSH 780	2.62 6	2.23 6	2.59 6	4.25 5	3.89 2	2.76 2	1.61 2	2.85
Controls								
ICSV 111	2.47	2.49	1.50	4.32	3.58	3.04	0.56	2.57 14
Local	1.00	2.14	1.65	2.72	1.41	1.77	1.52	1.74 20
SE	± 0.26	± 0.33	± 0.45	± 0.37	± 0.41	± 0.28	± 0.23	
Trial mean (20 entries)	3.08	2.54	2.57	4.01	3.11	2.28	1.08	
CV (%)	15	23	31	16	23	22	38	

1. Randomized-block design with three replications, plot size ranged from 6.4 to 19.4 m^2. Numbers following each yield value indicate the ranking of the cultivars.

Table 8. Three genotypes with disease severity scores of three or less (1-6 scale) for the three more important leaf diseases of sorghum in the West African Sorghum Disease Resistance Nursery, rainy season, 1988[1].

	Disease severity											
	Leaf anthracnose						Gray leaf spot					Sooty stripe
Genotype	BEN	FAR	FER	LON	NIA	SAM	FAR	FER	LON	NIA	SAM	BEN
84 S 82	1.0	2.0	2.0	1.5	1.5	1.0	2.0	2.0	2.0	2.0	3.0	2.0
84 S 103-2	1.0	2.5	2.0	1.5	2.0	1.0	2.0	1.5	2.0	2.2	2.5	3.0
84 S 130	1.0	2.5	2.5	1.5	3.0	1.0	2.0	1.5	1.5	2.0	3.0	3.0
Controls												
ICSV 20-1 BF	1.0	1.5	2.0	1.5	1.6	1.0	4.0	4.0	1.5	3.7	3.5	5.5
IS 18696	1.0	2.0	3.0	1.5	3.7	1.0	5.0	4.0	1.5	4.5	3.5	5.5
SE	±0.5	±0.5	±0.3	±0.5	±0.3	±0.2	±0.4	±0.3	±0.4	±0.2	±0.3	±1.2
Trial Mean (36 entries)	1.2	3.0	2.2	1.0	2.2	1.5	2.1	2.1	1.8	2.4	3.2	3.8
CV (%)	58	23	21	39	23	17	30	18	33	10	12	43

1. 6 x 6 simple lattice, two replications, two row plots, 4 m x 0.8 m. Controls : ICSV 20-1 BF for gray leaf spot and IS 18696 for leaf anthracnose and gray leaf spot. BEN = Bengou in Niger, FAR and NIA = Farako-Ba and Niangoloko in Burkina Faso, FER = Ferkessedougou in Côte d'Ivoire, LON = Longorola in Mali, SAM = Samaru in Nigeria.

Table 9. Varieties in prerelease stage or advanced stage in some NARS.

COUNTRY	VARIETIES
Burkina Faso	Sudanian zone: ICSV 1002 BF, E35-1, 80 W 68, ICSV 1049 BF, Framida, ICSV 126 IN, 193-2, SPV 35, ICSV 16-5 BF North Guinea Zone: SPV 35 ICSV III IN, ICSV 1002 BF, IS 6928, Framida, E35-1, 84 W 966
Niger	SEPON-82: Multilocation trials with extension services SRN 39 (ICSV 1007 BF): on-farm and on station *Striga* resistance trials S-35: same stage as SRN 39
Ghana	Multilocation trials in northern region: ICSV III IN, ICSV 1087 BF, ICSV 1078 BF, ICSV 16-5 BF, ICSV 210 IN, ICSV 1054 BF, ICSV 1093 BF, ICSV 1063 BF, ICSV 1089 BF, ICSV 1092 BF.
Togo	ICSV 111 IN and M 66118 - advanced farmers' tests SEPON-82 in multilocation trials ICSV 1007 BF - *Striga* resistance
Côte d'Ivoire	ICSV 1063 BF and Mali Sor 84-1 in on-farm multilocation testing
Nigeria	ICSV 1002 BF and ICSV 1007 BF for Striga resistance
Sierra Leone	Mali Sor 84-7 in multilocation testing
Guinea-Bissau	ICSV 126 IN and ICSV 1074 BF in multilocation testing
Central African Republic	ICSV 1063 BF and ICSV 1093 BF
Mali	ICSV 1063 BF and ICSV 1079 BF in multilocation and on-farm testing

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