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NINTH ANNUAL REPORT

of the

AID-ARS Project

Major Cereals in West Africa
(STRC J.P. 26)
1972

TABLE OF CONTENTS

1972

NINTH ANNUAL REPORT

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Major Cereals in West Africa
Edited by S. A. Eberhart

GENERAL RESUME

The outstanding achievement of the Major Cereals Project has been to demonstrate that the Guinea Savanna Zone can become the "Corn-Belt" of West Africa if the improved maize varieties and variety crosses are grown with the recommended cultural practices. A new record yield (113 q/ha) was obtained in a Variety Productivity Level trial at Samaru with the BY x C10 hybrid when 505 kg/ha of 21-14-14 fertilizer was used. Three open-pollinated varieties (NCA, NCB, and SC3) and one variety cross hybrid (BY x C10) were recommended for official release and seed increase for use by farmers in Nigeria.

Two hybrids, Pioneer XB101 and NCA x NCB (Rb version in 1972), were the highest yielding entries throughout West Africa in the 1971 and 1972 yield trials. The open-pollinated variety, Ghana 4, gave a similar yield to these hybrids in 1972 and Pioneer X306A, NCA, NCB yielded well also. The Ejura Seed Farm, Ghana, expects to produce 500 acres of the Pioneer Hybrids (XB101, white and X306A, yellow) in 1973 and will be prepared to sell seed to interested farmers in West Africa for planting in 1974.

Unusual environmental conditions (periods of drought stress early in the growing season) resulted in severe attacks of striga (*Striga hermonthica*) on maize in the Samaru area which resulted in virtual crop failures under the most severe attacks. A program to determine the feasibility of developing genetically resistant breeding populations was initiated. Methods of chemical control are also being investigated.

Blight (*H. maydis*) and rust (*P. polysora*) resistant varieties NCA Rb and NCB Rb were developed by the maize pathologist-breeder at the Federal Research Center, Ibadan. NCB Rb outyielded NCB by 66% in a preliminary trial at Ibadan in 1971 and by 6% in 13 locations of the 1972 West African Regional Trials. The possibility of a new rust race capable of attacking the Rb varieties is being investigated. Future emphasis will be on multigenic resistance rather than the single gene or two gene resistance in the Rb versions.

The long-season photo-sensitive sorghum types indigenous to the Guniea Savanna zone have been shown to be unresponsive to improved cultural conditions, and the photo-sensitive maiwa types of bulrush millets seem to have much in common. Hence, it appears that research should be concentrated on the earlier maturing non-sensitive types of sorghum and millet. The Northrup King sorghum hybrids NK300 and C9357 (colored grain) and the locally produced hybrid, CK60 x SA7706-5-1 (white grain), have given top yields in the Regional Sudan Savanna Trials in spite of bird damage.

Yields of 60 q/ha were obtained at Samaru in 1971 with NK 300 under irrigation in the dry season. Breeding populations of this type have been developed and recurrent selection has been initiated by the IAR breeder at Kano.

Many entries of the World Collection of sorghum have been screened for resistance to disease and to striga. The resistant lines have been introgressed into breeding populations as the first step in obtaining disease resistant varieties and hybrids with a high yield potential. Lines that suffer less weather damage when they mature before the end of the rains have been identified. These are being used in the local breeding program and have been sent to the IRAT breeders at Bambey, Senegal.

More than 2500 items in the bulrush millet World Collection have been screened for desirable agronomic characters and disease resistance. Eight hundred elite S4 lines developed from this material were screened and 130 were found to have resistance to downy mildew (Sclerospora graminicola), long smut (Tolyposporium penicillariae) and ergot (Claviceps micocephala). These will be evaluated for yield potential in 1973 and elite lines will be synthesized into a new disease resistant, high yielding, early maturity millet variety. A West African Regional Millet Nursery was established. Syn. 70 from upper Volta was found to be outstanding for resistance to downy mildew but susceptible to smut. Ex Bornu from Samaru had moderate resistance to all three diseases. Grain yields of 41.7 q/ha were obtained at Samaru with 73,000 plants per ha and 627 kg/ha of 21-14-14 (132 kg/ha N).

In 1966 when the soil management phase of the project was started only nitrogen and phosphorus were recognized as limiting crop yields. Various field trials at several locations have shown that under intensive cropping potassium and zinc also become limiting for cereals. Results show that most soils of the savanna ecological zone do not fix phosphorus so relatively low rates of phosphorus are needed. Once the phosphorus requirements are satisfied, nitrogen is the limiting element. Soils of Nigeria supply about 20 to 40 kg/ha of nitrogen which is sufficient for about 5 to 15 q/ha of maize. An additional 100 to 150 kg/ha would be needed for a 50 to 60 q/ha yield. Potassium becomes limiting only after several years of intensive cropping and the need will depend on the soil type.

Forty Maize Variety and Levels of Productivity trials were conducted throughout Northern Nigeria in 1972. The varieties NCB, SC3, 096 and BY x C10 were grown at three productivity levels, but the analysis of the data had not been completed at the time of the report. These trials will be repeated in 1973 with NCA, NCB, SC123, 096 and XB101 x Lagos White in order to obtain information about these varieties over a wide range of conditions.

In a date of planting trial the nitrogen uptake before and after silking and the % nitrogen in the seed were determined and used to compute expected yield of maize. The computed and actual yields were in good agreement except for the June 25 planting in 1972 and the July 15 planting in 1971. Both of these plantings suffered severe drought stress during pollination and grain filling. Split applications of nitrogen failed to give increases in yield, but very little leaching of nitrogen was noted due to the dry season.

In an intercropped planting of early millet and a long-season sorghum the millet absorbed 80% of the available N leaving only 20% for the sorghum. The yield of the sole crop of sorghum (32 q/ha) or millet (31 q/ha) were both less than the total production of the intercropped plot (38 q/ha).

The stem borer, Busseola fusca, was the most serious pest on sorghum in 1972. The first generation was heavy in early planted fields and all fields at Samaru were 70-100% attacked by the second generation. Stem tunnelling appears to be the best measure of susceptibility as nearly all plants show leaf feeding. Preliminary screening has identified a large number of sorghum lines that may have resistance and additional evaluations will be conducted in 1973 to confirm the genetic resistance. A method of practical chemical control was developed and evaluated with carbaryl. A small pistol grip hand sprayer which costs $0.80 makes this feasible for use by the small scale farmer. Investigations are continuing on genetic resistance and chemical control for the other two major pests, shoot fly and sorghum midge.

Seed production investigations were initiated in 1972 with four objectives: (1) to increase breeders seed supplies of sorghum and maize varieties and parental lines; (2) to obtain seed production data pertaining to blooming time, to photoperiod reaction and to temperatures, and to determine yield potentials during the dry season; (3) to produce hybrid seed of sorghum and maize in small pilot production fields; and (4) to locate and to help interested seed producers initiate seed production. Seed produced in these pilot schemes will permit more extensive agronomic research and will permit the extension service to conduct demonstration trials on an expanded scale. Dry season irrigation plantings of the maize seed parents and hybrids, By x C10 and Lagos White x XB101, were made. The sorghum seed parents SA 7706, 5764, 249, and 257 were increased and blooming dates were recorded. Seed production fields of RCF x SA 7706 and CK60 x SA 7706 were planted in March, 1973, under irrigation.

The training of counterparts in progressing well. Two maize breeders, a plant pathologist, an entomologist, and a soil scientist have completed or soon will complete the requirements for the M.Sc. degree and have returned to Ahmadu Bello University. A plant pathologist-breeder has completed the Ph.D. degree and has returned to the Federal Department of Agricultural Research. Trainees in other West African countries have been identified and are being sent to Universities in the United States for graduate training.

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REPORT OF THE 1971 WEST AFRICAN REGIONAL SORGHUM AND MILLET TRIALS

Compiled by L. A. Tatum

For the 1971 trials seed of the late sorghum went to six countries, the early sorghums to eight countries and the pennisetum millet to seven countries. Data received from 11 locations in 5 countries are included in this report. As indicated in notes accompanying the individual trial results difficulties encountered sometimes reduced the reliability of data obtained. These limitations should be taken into account in drawing conclusions. Soil heterogeneity was an important factor as was rainfall amount and distribution. Damage by birds usually results from a plot ripening at a time different from most of the fields in the area.

Locations of Trials

Sudan Savanna Sorghum

The Gambia, Kwinella (Yundum Agric. Station)
Niger, Kolo (IRAT)
Niger, Tarna (IRAT)
Nigeria, Kano (ABU-IAR)
Nigeria, Samaru (ABU-IAR)
Senegal, Bambey (IRAT)
Upper Volta, Saria (IRAT)

Guinea Savanna Sorghum

The Gambia, Jambanjelly
The Gambia, Yundum
Nigeria, Samaru
Upper Volta, Farako-Ba
Senegal, Sefa

Millet

The Gambia, Kwinella
The Gambia, Yundum
Nigeria, Samaru, (ABU-IAR)
Niger, Tarna (IRAT)
Senegal, Bambey (IRAT)

Entries in the Trials

Sudan Savanna Sorghum

Name	Origin	Source of seed
CE 90	Senegal	Samaru, Nigeria
CE83-174	Senegal	Samaru, Nigeria
NK 300	USA	Northrup King Company
C 9357	USA	Northrup King Company
CK60 x SA 7706	Nigeria	Samaru, Nigeria
4dwf CK60 x SA 7706	Nigeria	Samaru, Nigeria
IS 9290	Nigeria	Samaru, Nigeria
Zanua Inuwa	Nigeria	Samaru, Nigeria
137-62	Niger	Samaru, Nigeria
96/12/7A	Mali	Bamako, Mali

Guinea Savanna Sorghum

Name	Origin	Source of seed
CK x 1216-9	Camerouns	Samaru, Nigeria
CK x 299b6	Camerouns	Samaru, Nigeria
CE 83-174	Senegal	Samaru, Nigeria
SK 5912	Nigeria	Samaru, Nigeria
FFBL 3-1-6	Nigeria	Samaru, Nigeria
453	Nigeria	Samaru, Nigeria
93 x 2083	Nigeria	Samaru, Nigeria
2123	Nigeria	Samaru, Nigeria

Entries in the Trials

Millet

Name	Origin	Source of seed
Souna 2	Senegal	Nigeria
Souna 3	Senegal	Senegal
115-4 x 106	Senegal	Nigeria
P3 Kolo	Niger	Nigeria
Zongo	Niger	Nigeria
Mangania	Ghana	Nigeria
M2	Ghana	Nigeria
Ex Bornu	Nigeria	Nigeria

The first nine tables summarize the yields, days to flower and plant heights of the trials at all locations. Detailed information is given for each location in the original report.

Table 1 YIELDS REPORTED FROM THE SUDAN SAVANNA REGIONAL SORGHUM TRIAL, 1971, (kg/ha)

Entry	Kolo Niger	Tarna Niger	Saria Upper Volta		Kwinella The Gambia	Bambey Senegal	Samaru Nigeria	Kano Nigeria	Samaru Nigeria**	Avg.†
			Theoretical	Actual						
137-62	2868	5050	4404	2686	2312	4295	1177	725	5037	3210
CE 90	2902	2323	3040	1733	768*	3713	1452	522	3867	2323*
CE 83-174	975	2626	--	--	2164	--	275	271	2821	--
NK 300	4100	5959	4315	3409	3997	5240	2407	999	4836	3982
CK60 x SA 7706-5-1	3914	4747	3804	2057	1670*	3698	1609	1050	6045	3317*
4dwf CK60 x SA7706-5-1	4434	5908	3128	1030	1190*	3590	1517	820	5481	3258*
IS 9290	3073	4141	3060	2066	2415	2114	--	515	4672	--
Zanua Inuwa	--	424	--	--	1690	--	1399	609	--	--
C 9357	4525	4898	3937	3566	3837	4448	2171	1240	5682	3842
96/12/7A	2968	4292	2685	2251	2850	940	588	--	3345	--
135-3	--	--	2174	1494	--	--	--	--	--	--
Basso	--	--	--	--	2557	--	--	--	--	--
63-18	--	--	--	--	--	3126	--	--	--	--

*These entries suffered bird damage at The Gambia.

**Irrigated in the dry season and heads bagged.

†Includes theoretical yields (adjusted for bird damage) at Saria Upper Volta.

Table 2 PLANT HEIGHTS (cm) REPORTED FROM THE SUDAN SAVANNA SORGHUM TRIAL, 1971

Entry	Kolo Niger	Tarna Niger	Saria Upper Volta	Kwinella The Gambia	Bambey Senegal	Kano Nigeria	Samaru Nigeria*	Avg.
137-62	190	200	161	191	235	162	190	190
CE 90	160	124	130	172	200	143	157	155
CE 83-174	140	135	-	155	-	129	177	-
NK 300	170	197	142	209	220	150	173	180
CK 60 x SA 7706-5-1	190	197	154	209	235	168	190	192
4dwf CK 60 x SA 7706-5-1	160	152	126	178	180	-	153	154
IS 9290	140	122	118	135	145	117	143	-
Zanua Inuwa	-	220	-	202	-	175	-	-
C 9357	150	162	143	161	190	144	160	158
96/12/7A	200	240	199	267	285	-	233	-
135-3	-	-	148	-	-	-	-	-
Basso	-	-	-	420	-	-	-	-
63-18	-	-	-	-	185	-	-	-

*Dry season irrigated

Table 3 DAYS TO BLOOM OR DATE OF FLOWERING FOR THE SUDAN SAVANNA SORGHUM TRIAL, 1971

Entry	Kolo Niger	Tarna Niger	Saria Upper Volta	Kwinella The Gambia	Bambey Senegal	Samaru Nigeria	Kano Nigeria	Samaru Nigeria*
137-62	67	62	3/9	72	75	65	80	68
CE 90	65	59	24/8	63	67	61	71	59
CE 83-174	85	80	--	82	--	88	94	86
NK 300	63	59	23/8	65	65	57	77	50
CK 60 x SA 7706-5-1	64	59	24/8	64	65	61	74	59
4dw CK 60 x SA 7706-5-1	60	57	21/8	63	65	59	-	57
IS 9290	72	66	3/9	72	72	--	83	68
Zanua Inuwa	119	89	--	103	--	95	106	--
C 9357	63	59	25/8	70	65	58	75	61
96/12/7A	74	71	6/9	77	82	69	-	79
135-3	-	--	5/9	-	--	--	-	--
Basso	-	--	--	96	--	--	-	--
63-18	-	--	--	-	70	--	-	--

*Dry season under irrigation

Table 4 YIELDS REPORTED FROM THE GUINEA SAVANNA REGIONAL SORGHUM TRIAL, 1971 (kg/ha)

Entry	Sefa Senegal	Samaru Nigeria	Yundum Gambia	Farako-Ba Upper Volta	Jambanjelly Gambia
CK x 1216-9	760	1279	36	--	--
CK x 299b6	640	785	82	--	--
CE 83-174	720	1722	705	937	937
Toko Bessonou	--	493	--	--	--
FFBL 3-1-6	1200	1081	4	--	2
93 x 2083	2800	3080	126	--	--
SK 5912	920	2843	4	--	--
453	960	1650	63	--	--
2123	640	2586	21	--	--
2347	720	785	59	--	--
Basso	--	--	404	--	27*
51-69	--	--	1041	--	16*
SH-60	--	--	1854	--	472*
56-63	--	--	701	--	1137
135-2	--	--	--	2108	--
Zanua Inuwa	--	--	--	0	--

*Bird damage at Jambanjelly.

Table 5

PLANT HEIGHTS (cm) REPORTED FOR GUINEA ZONE SORGHUM TRIAL, 1971

Entry	Sefa Senegal	Samaru Nigeria	Gambia Yundum	Gambia Jambanjelly	Gambia Average
CK 1216-9	150	175	111	113	112
CK x 299b6	170	188	150	131	140
CE 83-174	160	125	139	132	136
Toko Bessenou	-	400	-	-	-
FFBL 3-1-6	450	400	336	345	340
93 x 2083	170	165	229	152	190
SK 5912	160	225	210	172	191
453	420	170	156	137	146
2123	150	120	127	94	110
2347	170	145	145	125	135
*Basso	-	-	360	368	364
51-69	-	-	296	285	290
SH-60	-	-	313	328	320
56-63	-	-	257	275	266

Table 6 DAYS TO BLOOM OR DATE OF BLOOM FROM THE GUINEA ZONE REGIONAL SORGHUM TRIAL, 1971

Entry	Sefa Senegal	Samaru Nigeria date	Yundum Gambia	Jambanjelly Gambia
CK 1216-9	109	24/9	137	-
CK x 299b6	106	24/9	139	124
CE 83-174	86	4/9	96	88
Toko Bessenou	-	13/10	-	-
FFBL 3-1-6	115	8/10	134	119
93 x 2083	109	29/9	134	-
SK 5912	113	6/10	137	127
453	112	2/10	122	115
2123	106	29/9	127	-
2347	112	5/10	132	124
Basso	-	-	108	102
51-69	-	-	111	107
SH-60	-	-	90	85
56-63	-	-	92	86

Table 7 YIELDS REPORTED FROM J.P. 26 REGIONAL MILLET TRIALS, 1971 (kg/ha)

Entry	Tarna Niger	Samaru Nigeria	Yundum The Gambia	Kwinella The Gambia	Bambey Senegal	Avg.
Souna II	1320	612	Bird damage	498	2434	1216
Souna III	1730	543	" "	547	2580	1350
115-4 x 1067	1515	602	" "	956	2229	1326
P3 Kolo	1693	226	" "	482	1604	1001
Zongo	919	126	" "	369	1368	695
Mangania	880	534	" "	252	496	540
M2 Ghana	1764	240	" "	135	542	670
Ex Bornu	1536	513	" "	649	601	825
Sanio	--	--	831	942	--	--
Sanio de Sefa	--	--	1176	1586	--	--
Souna	--	--	--	351	--	--

Table 8 PLANT HEIGHTS (cm) REPORTED FROM J.P. 26 REGIONAL BULRUSH MILLET TRIAL, 1971

Entry	Tarna Niger	Samaru Nigeria	Yundum The Gambia	Kwinella The Gambia	Bambey Senegal	Avg.
Souna II	191	235	215	198	260	220
Souna III	172	235	229	244	255	227
115-4 x 1067	158	215	234	237	250	219
P3 Kolo	229	230	248	227	270	241
Zongo	209	233	247	265	240	239
Mangania	161	190	183	188	200	182
M2 Ghana	180	230	196	163	200	193
Ex Bornu	216	230	231	222	230	225
Sanio	-	-	331	338	-	-
Sanio de Sefa	-	-	302	343	-	-
Souna	-	-	-	228	-	-

Table 9 DAYS TO BLOOM IN J.P. 26 REGIONAL MILLET TRIALS, 1971

Entry	Tarna Niger	Samaru Nigeria	Yundum The Gambia	Kwinella The Gambia	Bambey Senegal
Souna II	57	57	53	63	51
Souna III	59	60	53	61	53
115-4 x 1067	60	57	53	60	52
P3 Kolo	57	54	52	66	50
Zongo	58	55	62	65	48
Mangania	43	47	50	43	39
M2 Ghana	39	54	47	43	38
Ex-Bornu	53	51	53	61	46
Sanio	--	--	85	82	--
Sanio de Sefa	--	--	89	82	--
Souna	--	--	--	64	--

1971 WEST AFRICAN UNIFORM MAIZE TRIAL REPORT

Compiled by

J. Craig

from reports submitted by I.R.A.T. Ivory Coast, Department of Agriculture Gambia, I.R.A.T. Niger, I.R.A.T. Dahomey, I.R.A.T. Upper Volta, I.R.A.T. Senegal and OAU/STRC Major Cereals Project Nigeria.

The West African uniform maize trials which began in 1967 are designed to compare maize cultivars produced by tropical maize improvement programs under a wide range of environmental conditions in West Africa. It is expected that the trial results will identify superior cultivars and their zones of adaptation and increase the utilization of superior cultivars by maize workers in West Africa.

The reports of the 1971 trial results were prepared by trial supervisors at each site and sent to the OAU/STRC Major Cereals Project at Ibadan, Nigeria, for compilation.

Discussion

Yields of varieties at 1971 uniform maize trial sites are shown in Table 10. The highest trial yields were attained at Samaru, Nigeria; and each entry yielded more there than at any other site. The outstanding trial entry was XB101, a commercial F_1 hybrid produced by the Pioneer Hi-Bred International in Jamaica. This hybrid was equal or superior to other trial entries at all test sites, and its yield of 97.3 quintal per acre at Samaru is the highest yield reported for the regional maize trial since its inception in 1967. The yields of the varieties GC3, NCB and CDN as well as the variety cross hybrid NCA x NCB equalled or exceeded the yield of the X306 hybrid. The poor performance of the Nigerian Composite NCA was caused by poor seed viability. Drought conditions were reported at trial sites in Niger, Upper Volta, Senegal and Ibadan, Nigeria.

The average performance of the varieties is shown in Table 11. The lodging percent and rust damage scores were less for the top yielding varieties and for the varieties with poorer yields.

Table 10 YIELDS OF ENTRIES IN 1971 WEST AFRICAN UNIFORM MAIZE TRIAL AT SEVEN SITES

SITES AND YIELD Q/HA*

Variety	Origin	Senegal		Upper Volta	Nigeria		Ivory Coast	Gambia	Dahomey	Mean*
		Sefa #1	Sefa #2	Farako-Ba	Ibadan	Samaru	Ferkessedougou	Yundum	Niaouli	
CJI	Dahomey	--	51.6AB	29.5BCDE	24.2DE	71.3	39.9CDE	40.5AB	26.2DE	38.6
NCA	Nigeria	--	42.1B	13.6G	19.1E	58.4	37.5CDEF	29.2CDEF	21.2E	29.8
NCB	Nigeria	--	49.8B	30.1BCDE	32.7BC	77.2	46.8BCD	43.5A	37.4BC	44.6
NCAxNCB	Nigeria	--	51.5AB	38.0AB	33.9BC	81.2	52.0AB	39.0ABC	42.0AB	47.7
BDS	Senegal	57.0AB	59.1A	25.4DEF	12.1F	64.4	30.9EF	35.0ABCD	18.6EF	31.1
CJB	Ivory Coast	--	44.7B	23.0EF	22.6DE	62.8	35.9DEF	25.2DEF	33.8BCD	33.9
CDN	Ivory Coast	--	48.5B	34.2ABCD	32.4BC	79.6	52.4AB	21.0F	41.9AB	43.6
GC 3	Ghana	--	45.9B	34.4ABCD	28.5CD	94.4	52.8AB	34.0ABCDE	34.5BCD	46.1
XB101	Jamaica	61.1A	--	43.5A	40.8A	97.3	61.3A	34.2ABCDE	47.2A	54.1
X306A	Jamaica	50.3BC	--	35.4ABC	37.0AB	81.6	48.3BC	29.0CDEF	32.7CD	44.0
X306	Jamaica	41.4D	--	26.9CDEF	33.2BC	81.3	44.7BCD	33.0BCDEF	23.5E	40.4
P3 Kolo	Niger	47.7C	--	19.2F	11.6F	62.3	27.0F	32.6BCDEF	13.0F	27.6
	Mean	51.4	49.1	29.4	27.3	75.9	44.1	33.0	31.0	40.1

*Only data from location including all 12 varieties were included in the mean

Table 11 AVERAGE PERFORMANCE OF VARIETIES IN THE 1971 WEST AFRICAN UNIFORM MAIZE TRIAL

Variety	Yield, q/ha	Days to Anthesis	Lodging, %	Rust damage score*
XB101	54.1	58	10	2
NCAxNCB	47.7	60	14	2
GC3	46.1	62	8	2
NCB	44.6	61	12	2
X306A	44.0	59	9	2
CDN	43.6	59	17	2
X306	40.4	60	7	1
CJI	38.6	58	28	3
CJB	33.9	62	22	3
BDS	31.1	56	38	3
NCA†	29.8	60	15	3
P3 KOLO	27.6	55	28	3
MEAN	40.1	59	17	2
No. locations	6	4	2	1

*1 (no damage) to 5 (severe damage)

†Yields were reduced by poor germination

1972 West African Regional Maize Trial Report

The regional maize trials formerly coordinated by Dr. J. Craig were covered in his final report previously submitted. Following Dr. Craig's end of tour and departure, Mr.B. R. Taylor, FTO assigned by British ODA to J.P. 26 in Nigeria, took responsibility for the maize trials. A summary of the 1972 results is given in Tables 12 and 12a. He is making preparations for similar trials in 1973. The relative performance of NCB and NCB Rb at the various locations is noteworthy as the resistance gene seems to still be important at some locations. Informal reports indicate the resistance may have been overcome at some sites.

The hybrid XB101, NCBRb x NCARb, and Ghana Composite 4 (GC 4) gave the highest overall yields. XB101 consistently outyielded the other Pioneer hybrid, X306A, which may be susceptible to drought conditions. Although GC 4 was the tallest variety, it lodged less than C.D.N. and P_3 Kolo.

The highest yields were attained at Samaru, Ferkessedougou and Farako-Ba. At Niaouli the trial was sown in the second season, and received little, poorly distributed rainfall. At Kolo where rainfall was about half the average only 50% of the plants survived from planting to harvest, resulting in low, variable yields.

Rainfall was deficient at a number of other sites, notably Yundum, the Gambia, and Sotuba, Mali, where highest yields were obtained from the early varieties B.D.S. and P_3 Kolo. These entries did not compare so well where rainfall was adequate. They appeared to be more susceptible to rust than other varieties.

Table 12. Performance of 11 entries in the 1972 West African Uniform Maize Trial.

Entry	Yield, q/ha	Days to anthesis	Ear height, cm	Lodging, %
NCA Rb x NCB Rb	43.6	56	155	23
XB101	43.5	56	147	17
GC4	42.0	59	171	16
NCB Rb	39.0	56	154	19
NCA Rb	38.2	57	152	17
X306A	37.3	56	144	20
NCB	36.6	55	151	21
C.D.N.	36.6	56	152	29
B.D.S.	33.4	53	132	19
C.J.B.	31.7	55	156	20
P_3 Kolo	30.1	52	130	26
No. of locations	12	11	6	5

Table 12a. Yields (q/ha) of entries in the 1972 West African Uniform Maize Trial at 13 sites*.

Entry**	1	2	3	4	5	6	7	8	9	10	11	12	13
NCBRb x NCARb	25.5	24.0	52.1	37.4	45.1	61.1	58.0	38.1	17.9		52.7	32.0	79.1
XB101	28.9	19.7	46.9	37.9	38.0	64.2	62.2	46.3	12.6	11.8	57.9	35.0	72.4
GC 4	22.6	17.2	40.6	37.9	43.0	61.1	61.1	36.2	18.1	9.5	55.3	35.0	75.7
NCBRb	29.0	24.0	36.7	37.7	40.5	53.4	54.4	33.6	19.8	12.1	45.1	31.0	62.5
NCARb	28.6	21.4	34.4	39.7	45.8	55.4	56.3	31.2	11.0	10.0	48.0	31.0	55.9
X306A	28.1	18.5	46.1	33.7	36.7	56.4	56.8	33.5	6.7	7.6	43.8	32.0	55.6
NCB	25.0	22.4	27.1	31.1	39.6	49.1	56.0	36.8	10.1	11.4	44.0	24.0	74.2
C.D.N.	25.9	20.6	36.0	34.1	34.3	52.0	53.4	29.4	9.7		45.7	28.0	69.6
B.D.S.	39.8	26.3	23.8	47.4	26.4	40.7	48.2	30.8	15.2	15.7	24.8	10.0	67.6
C.J.B	24.7	20.1	24.3	28.1	29.8	47.4	48.8	27.5	7.6	10.1	34.0	21.0	66.6
P_3 Kolo	36.3	24.0	14.9	41.5	28.0	45.0	37.8	18.9	17.8	8.1	22.0		54.8
Site mean	28.6	21.7	34.8	37.0	37.0	53.3	54.0	32.9	13.3	10.7	43.0	27.0	66.7
Coeff. Var. %	17.8	14.8	15.5	23.5	11.0	10.9	13.1	13.7	34.5	18.2	10.0	17.4	13.0

* Grown at (1) Sefa, Senegal, (2) Yundum, Gambia, (3) Njala Sierra Leone, (4) Sotuba, Mali, (5) Bouake, Ivory Coast, (6) Ferkessedougou, Ivory Coast, (7) Farako-Ba, Upper Volta, (8) Kwadaso, Ghana, (9) Kolo, Niger, (10) Niaouli, Dahomey, (11) FDAR, Nigeria, (12) IITA, Nigeria, (13) Samaru, Nigeria.

** NCA, NCB, NCB Rb from Nigeria, C.D.N. and C. J. B. from Ivory Coast, GC 4 from Ghana, B.D.S. from Senegal, P_3 Kolo from Niger, XB101 and X306A from Pioneer International (USA).

ENTOMOLOGY

Dean Barry

Insect situation

Maize stem borer - In the Samaru area this insect, *Busseola fusca* was the most important pest on sorghum this year. In early planted fields the first generation was quite heavy and nearly all fields were 70-100% attacked by the second generation.

Other stem borers - The infestations of the millet stem borer, *Hambochia (Coniesta) ignefusalis* were not general, but relatively heavy attacks were noted on scattered fields. *Sesamia spp.* were not found to any degree of significance in the Samaru area until the time we would expect the third generation of *B. fusca*. At this time *Sesemia spp.* were the predominant species in sorghum. However, by the time the populations of this pest had developed, most fields of sorghum had headed and set seed. Consequently, relatively little yield loss was attributable to these insects this year.

Sorghum shoot fly - *Atherigona varia soccata* appears to be the most important species of shoot fly on sorghum in the Samaru area. Except in late planted research plots, only light to moderate infestations of this insect developed on sorghum. In this area infestations of this pest can usually be avoided by planting early.

Sorghum midge - *Contarina sorghicola* was found in moderate to heavy infestations on late maturing short season varieties. However, early maturing varieties were relatively free of midge damage.

Aphids - *Rhopalosphum madis* is the primary aphid pest of sorghum, but during the regular growing season damage was not significant. However, during the dry season where sorghum is grown under irrigation, this pest promises to be a problem.

Leafhoppers - Only indirect evidence of populations of *Cicadulina spp.* have been noted in maize by the incidence of maize streak virus. This disease was observed to be moderate to heavy in much of the maize growing area of Nigeria. No work in this area was conducted on this pest this season, but the species, *C. mbila* was collected and identified by researchers in the Ibadan area.

Mealybug - *Heterococaus nigeriensis* was observed in association with "plant distortion" of maize and sorghum in research plots at Samaru.

Selection for Resistance

Selection programs were started for resistance to the maize stem borer, *B. fusca* and the sorghum shoot fly, *A. varia soccata*. For the latter insect, recovery (tolerance) and primary resistance are being selected.

We have a preliminary selection of 263 lines for maize stem borer resistance from 888 lines evaluated from the Samaru sorghum breeding program and 368 lines from over 3,000 lines of the world collection of sorghum. These lines will be screened further in replicated trials during 1973.

The above-mentioned lines were selected on the basis of plants attacked and degree of stem tunnelling. Observations were also made on the degree of leaf feeding, but this was not a satisfactory selection criterion since nearly all plants exhibited a fairly uniform degree of leaf feeding. This year the second generation of this stem borer attacked 70 to 100% of the plants in the Samaru area which was an exceptionally heavy natural infestation.

In contrast to the stem borer the infestations of sorghum shoot fly were relatively light, except in our experimental areas where we induced heavier populations of this insect. Screening trials resulted in selection of 439 lines for recovery resistance and 70 lines for primary resistance. The selection of recovery resistant (tolerant) materials was based on recovered plants vs. attacked plants, and the primary resistant materials were selected on the basis of non-attacked plants.

Besides the above-mentioned selections, evaluations were made on 13 I.S. lines with 2 control varieties (table 13) from India. Twelve of these have shown very good primary resistance and these have been crossed to other materials in our breeding program.

Selection for shoot fly resistance has been started (1st generation) within the West African B Composite of sorghum. This year during the first one half a breeding cycle selections were made from the male sterile plants.

Chemical Control

A method for practical control of *Busseola fusca* (maize stem borer) on sorghum with carbaryl (Vetox 85*) was developed for the Nigerian "hand farmer". A paper concerning this has been written and is to be published in the Samaru Agricultural Newsletter in early March, 1973. This paper presents experimental results which show that one generation of this stem borer can be controlled with 0.15 lb. (A.I.) of insecticide per acre on a plant population of 10,000. The insecticide was applied with a small pistol grip hand sprayer which cost 52 kobo ($0.80).

Other information about the biology of the maize stem borer is included in the paper. The paper will be distributed to interested parties in March after it is returned from the bindery.

Artificial Rearing

Attempts to adequately rear the maize stem borer on various artificial diets have not been successful. However, a very small percentage (5-10%) of those insects placed on some of the media have survived to the adult stage. Mass rearing of this insect (90+% survival) is necessary for the host plant resistance program.

Laboratory space and facilities for rearing are also limiting aspects of the program. The contracted renovation of laboratory space which was to be completed in September, 1972, has nothing but the masonary work done. Certain items of equipment (especially a humidifier) have not arrived from the U.S.A.

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* The mention of this product is for identification and does not imply any endorsement by the USDA.

Table 13 PER CENT OF PLANTS INFECTED BY CENTRAL SHOOT FLY AT SAMARU, NIGERIA, IN 1972*

Line	% Infested
I.S. 5072	12.3
I.S. 3962	16.9
I.S. 2123	18.8
I.S. 5566	16.7
I.S. 8315	16.4
I.S. 5604	16.7
I.S. 4646	18.0
I.S. 1054	20.0
I.S. 1082	22.8
I.S. 5383	12.5
I.S. 5642	9.8
I.S. 5622	8.0
I.S. 5469	32.9
Swarna	48.5
CK-60	66.7

*The I.S. lines were found to have primary resistance in India and were supplied by India for evaluation in Nigeria

MAIZE BREEDING - SAMARU

L. A. Tatum, G. Adeniyi, and D. Adedzwa

Introduction

The primary basis of the maize breeding program continued to be recurrent selection in composite populations. There was some merging of sub-populations to streamline the program and some introduction of exotic material such as opaque-2 modifiers. U.S. Corn Belt synthetics are being considered as sources of genes for earliness, low ear placement, lodging resistance, etc. to improve our basic composites. Additional Central American material obtained through IITA is being considered for inclusion. Elite populations derived from the composites are being multiplied for possible extension to farmers. A few superior variety crosses have been made for more extensive testing, and exploratory trials are being made of other types of hybrids. Mr. Clifton, the J.P. 26 Project seedsman, will be giving attention to various aspects of seed production. It is possible that inclusion of both maize and sorghum hybrids would encourage development of a seed industry in Nigeria and other parts of West Africa. The multiplication of more conventional varieties is not being neglected.

The season was effective in focusing attention on several problems that will become more important as maize production increases. Striga was very severe in some fields; Storey's streak virus caused heavy losses in some cases and,contrary to usual experience, seemed to increase in prevalence as the season progressed; white ants caused greater damage than previously noted in Samaru and certain other areas; midseason drought became an important factor at some sites which usually have uni-modal rainfall distribution; and valuable observations were made on reactions of genotypes to the rusts and leaf blights. All of these factors will need sustained attention in the research program. Control of losses may involve one or more approaches including genetic resistance, escape by modified maturity or growing season, or use of chemicals and tillage practices. In 1972 Variety x fertilizer trials, in general, confirmed previous experience. Good farmers obtained excellent yields by following our suggested practices. In some plots, responses were limited by one or more of the problems referred to above and reliability of the trials were seriously reduced.

The maize program was strengthened by the return of Mr. Gideon Adeniyi from a year of training at Iowa State University. He is now assisting with the project at Samaru and writing a thesis to meet requirements for his M.Sc. Mr. Daniel Adedzwa is responsible for the program at Mokwa. He has completed his thesis and will be taking the final examination for his master's degree soon. Mr. Richard Taylor, Field Trials Officer of J.P. 26, stationed at Kano has been active on variety-fertilizer trials and seed plots with maize. Mr. James Clifton, Seedsman of J.P. 26 stationed at Samaru, is including maize in his studies of seed production problems. Pilot scale seed production plots are being tried for C10 x Biu Yellow and XB101 x Lagos White. The IAR Cereal Committee is advising that NCA, NCB, SC3, and C10 x Biu Yellow be added to the list of approved varieties. The recommendation must be approved by the Professional Academic Board and the Board of Governors before it becomes effective. Meanwhile, more extensive trials and demonstrations in the region and other parts of West Africa are being undertaken.

Recurrent selection was carried out through performance trials of full-sib and S1 progenies in the basic breeding populations. These include NCA, NCB, Samaru 3 and Biu Yellow. A trend toward unmanageable proliferation in the number of related strains was reversed. For example, the Samaru Composite 1, Composite 2, and Composite 3 populations have much germplasm in common so the most elite progenies from all three have been merged to form the composite we call S123. For the immediate future a full-sib program of selection is proposed in S123. Consideration is being given to ultimate merging of S123 with NCA and Columbia Composite of Mokwa which are related to it. Similarly, the best progenies from NCA are being combined into one population as are the best from NCB. Attention will be concentrated on a single population of each. These changes are required to keep the program within the limits of land and other available resources. Efficiency would be further enhanced by fuller coordination of programs at Samaru, Mokwa and Ibadan. Efforts are being made to obtain three reliable trial sites for the recurrent selection yield trials as gain is not maximized when selections are based on data from a single location.

Experimental Procedures

Performance trials at Samaru were conducted on fields V-4, U-6, and Main Botany Farm. Planting was on the flat with hand "jabber" planters. Fields were marked by tractorsin one direction and cross marked with a hand drawn marker. Spacing of rows and of hills within the rows was 28". An exception was the National Zonal Trial on which the plots were 5 rows x 20' with 1 foot spacing within the rows. On this experiment the three center rows including end hills each with an extra plant were harvested for yield. Plot area of the NZT was computed to the center of the 3' alley at the end of the plots. Except in the NZT and population trial (Exp. 14) plots were thinned to three plants per hill - giving 18 plants per plot and 24,000 plants per acre.

At harvest plot yields were weighed on a spring milk scale to 1/10 pound. Samples were taken for shelling percentages and a 200 gram sample of grain was dried in an oven for moisture determination.

Atrazine used as a pre-emergent herbicide was very effective. I recommend that it or another such as Bladex* be used more generally next season. A few entries showed sensitivity at the 1½ lbs. rate,and several were damaged at approximately 3 lbs. but the benefits far outweigh the damage. A PC3 knapsack sprayer (Cooper, Pegler, and Company Limited)* of 4 imperial gallon capacity was used with a flood jet nozzle by ICI. The wide angle nozzle at the 15 lbs. setting delivers about 25 gallons per acre on a single pass at a slow walk taking a 6 foot swath. One-half pound of the 50 percent formulation per 5 gallons (US) gave about 1½ lbs. active ingredient per acre.

The daily rainfall at Samaru is shown in Table 14 for 1972.

*The mention of this product is for identification and does not imply any endorsement by the USDA.

Table 14 RAINFALL, MEAN RAINFALL, AND EVAPOTRANSPIRATION AT SAMARU FOR 1972 IN MM

Decade		Rainfall	45 year mean	ET measured by lysimeter
Jan	1 - 10			
	11 - 20			
	21 - 31		.2	
Feb	1 - 10		.2	
	11 - 20		.5	
	21 - 28		.8	
Mar	1 - 10		.5	
	11 - 20	.2	4.1	
	21 - 31		2.5	
Apr	1 - 10	9.4	6.9	
	11 - 20	25.9	9.4	
	21 - 30	16.0	19.3	
May	1 - 10	46.2	32.3	24.9
	11 - 20	34.8	34.5	9.9
	21 - 31	99.6	58.7	23.9
June	1 - 10	30.5	44.4	19.3
	11 - 20	18.0	56.9	23.6
	21 - 30	47.2	58.2	32.2
July	1 - 10	65.0	57.7	43.9
	11 - 20	38.6	70.6	50.5
	21 - 31	68.3	93.2	55.9
Aug	1 - 10	124.5	85.1	41.9
	11 - 20	91.2	87.4	45.7
	21 - 31	109.5	110.0	49.8
Sept	1 - 10	11.2	93.0	48.5
	11 - 20	21.8	80.5	39.1
	21 - 30	52.3	51.6	37.1
Oct	1 - 10	19.1	21.6	31.7
	11 - 20	5.1	9.7	33.5
	21 - 31		3.3	29.7
Nov	1 - 10		.5	
	11 - 20		.5	
	21 - 30		.2	
Dec	1 - 10			
	11 - 20			
	21 - 31			
Total		934.4	1094.5	

Experimental Results

National Zonal Trial - Exp. 1, 1972

This experiment is distributed by the Federal Ministry, Moor Plantation, Ibadan, to the various zones of Nigeria. Samaru is one of the important locations. The trial includes the leading recommended and experimental selections. Unfortunately, seed was not received of four of the entries in 1972. Other items of special interest to us were substituted for the missing entries. The highest yield was made by Nigerian Composite A with 6839 kg/ha. The variety cross, XB101 x Lagos White, yielded 6236 kg/ha and the Samaru selection of NCB yielded 6119 kg/ha. This selection of NCB was 9.8% above the original strain and S123 was 7.7% above SC3. It is interesting that five of the 14 entries exceeded the 5736 kg/ha produced by 096 which has consistently been among the high yielding varieties. The comparison between Bulk-3 and the related 096 is interesting and should be tested in further trials to determine whether 096 often has a 9% superiority. The data are reported in table 15.

West African Uniform Maize Trial, Exp. 2, 1972

This trial of 20 items included the 11 entries of the WAUMT, six additional entries from Pioneer Hi-Bred International (X_--) and three checks. Nine entries exceeded 7000 kg/ha . 096 and the cross of NCB Rb x NCA Rb yields were 8068 and 7941 kg/ha, respectively; but both were high eared. The variety cross BY x C10 with 7669 kg/ha was the outstanding entry with an ear height of only 148 cm and only 14 percent lodging. XB101 and SC3 performed well as expected. GC4 from Ghana has high ears but yielded well and was erect. The data are reported in table 16.

Table 15 NATIONAL ZONAL MAIZE VARIETY TRIAL, EXP. 1, 1972, SAMARU*

Variety	Plants/ plot, no.	Lodged Plants Root no.	Lodged Plants Stalk no.	Ear no.	Ear Height, cm	Days to 50% tassel	Yield, kg/ha
XB101 x Lagos White	59	40	4	76	185	61	6236
NCA	58	40	3	67	185	62	6839
NCB	62	52	5	68	181	63	5574
NCC	60	42	7	63	181	64	5146
NCD	59	42	5	66	202	63	5379
Samaru Comp. 3 (SC3)	62	37	4	62	164	57	5632
Bulk -3	56	46	9	60	183	63	5250
NS -1	58	39	13	61	208	65	4270
NS -5	60	47	6	59	178	62	4737
096, 1971	61	37	9	80	201	63	5736
NCB 1971/72 - Samaru†	60	44	8	67	181	60	6119
Comp. B C_2 x CAX - IITA	59	42	8	68	195	63	6580
096 x Iowa BS_3 - Samaru	62	31	7	66	160	58	5775
S123 - Samaru†	60	31	7	63	158	58	6067

*Seed of XB101, X306, X306A, and NCB Rb was not received

†Indicates improved selections

Table 16 WEST AFRICA UNIFORM MAIZE TRIAL EXPERIMENT 2 - 1972 SAMARU

Variety	Plants/ plot no.	Lodged plants Root no.	Lodged plants Stalk no.	Bare Tips no.	Usable Ears no.	Ear ht., cm	Days to 50% tassel	Color of grain*	Yield, kg/ha
NCB	36	10	4	3	30	168	60	M	7399
NCB Rb	35	16	1	2	31	174	60	M	6112
NCB Rb x NCA Rb	36	14	4	1	37	175	58	M	7941
NCA Rb	33	12	3	1	24	168	58	M	5455
CDN	34	19	3	4	32	161	57	M	6958
CJB	34	9	3	2	32	175	57	M	6643
GC4	33	8	2	2	34	186	63	W	7558
P3 Kolo	34	11	2	6	36	150	55	Y	5459
X306A	38	14	2	13	30	149	58	Y	5591
XB101	36	11	2	5	37	151	58	W	7220
BDS	35	12	2	4	34	138	54	W	6739
X101	36	14	4	7	35	153	58	W	6062
X304B	35	16	1	9	34	154	57	Y	5837
X101A	33	14	1	8	36	161	57	W	7624
X105A	32	8	0	7	35	155	58	W	7392
X306B	35	16	3	6	31	159	59	Y	6837
X304A	35	18	3	7	30	161	58	Y	5691
SC3	34	17	2	6	34	159	56	Y	7478
BY x C10	35	5	1	7	33	148	57	M	7669
096	37	14	1	1	39	181	62	Y	8068

*Mixed (M), yellow (Y), or white (W).

Performance of Composites and Inter-cross Exp. 11, 1972

This experiment of 30 entries was grown in Kano, Samaru and Mokwa to obtain information on adaptation over a range of conditions and to evaluate potential combining ability among some of the various populations. Data available from Kano and Samaru are summarized in Tables 17 and 18. Combined yields are presented in Table 19. Apparent differential responses emphasize the importance of testing in more than one environment in order to identify the superior genotypes. C10 x BY was one of the highest yielding entries as it has been in past trials. Variety crosses of the newer populations, NCA and NCB, also yielded well. BS3 and BS4 (synthetics of elite breeding material from the Corn Belt, USA) were not well adapted, but the yield of NCB x BS3 was reasonably good. An extensive trial of the original and improved breeding populations and their crosses are needed to evaluate progress from selection and to identify population cross hybrids for commercial use.

Table 17 PERFORMANCE TRIAL OF COMPOSITES AND INTER-CROSSES, EXPERIMENT 11, 1972 - SAMARU

Variety	Seed Source	Plants/ plot no.	Lodged Root no.	Lodged Stalk no.	Bare tips no.	Usable ears no.	Ear height, cm	Rust grades 1 - 3	Days to 50% tassel	Yield, kg/ha
096 x SC 3	1971/72	37	28	2	7	32	154	2	55	6251
096 x Col. Comp.	"	35	27	4	9	32	146	3	55	5609
096 x BY	"	34	25	4	7	30	149	3	55	5761
096 x NCB	"	36	27	5	6	34	176	2	55	6318
SC 3 x NCA	"	35	20	4	11	39	143	2	55	5538
SC 3 x BY	"	35	28	4	7	32	154	2	55	5561
SC 3 x BS3 & 4	"	35	23	3	7	29	130	3	55	4604
Col. Comp. x NCA	"	36	17	4	5	34	170	2	55	6655
Col. Comp. x NCB	"	36	24	7	9	33	158	3	56	5846
NCA x BY	"	33	24	6	6	30	158	2	55	6554
NCA x BS3	"	35	25	3	7	33	140	3	56	5501
BY x NCB	"	33	26	4	13	30	136	3	55	4662
NCB x BS3	"	33	28	1	14	34	133	2	55	6638
NCB W/field	1971	34	23	6	7	33	171	2	55	5455
NCA W/field	1971	35	22	2	8	28	161	3	54	5211
096 Soil Science	1971	35	28	3	7	36	196	2	55	5422
SC 3 Main Farm	1971	34	23	7	10	28	155	3	55	4783
BY S-4	1971	34	22	3	9	24	145	3	53	4425
BS3	1971	35	25	5	11	25	119	3	55	4206
BS4	1971	36	27	4	6	27	133	3	55	4177
SC123, Shika	1971/72	35	25	6	14	28	150	2	55	5082
NCB Samaru	"	34	29	3	8	30	155	3	54	5516
BS3 x SC 3 MF	1971	37	33	4	7	30	134	3	54	5381
BS4 x SC 3 MF	1971	34	26	4	10	31	134	3	55	5388
BSSS-2 x SC 3 MF	1971	35	28	2	9	33	138	2	54	6390

Table 17 (Continued)

Variety	Seed Source	Plants/ plot no.	Lodged Root no.	Lodged Stalk no.	Bare tips no.	Usable ears no.	Ear height, cm	Rust grades 1 - 3	Days to 50% tassel	Yield kg/ha
Iowa Com. Rootworm	1971	35	26	4	7	32	130	3	55	5621
SC 2 x SC 3 MF	1971	34	27	1	6	32	158	2	56	5905
SC 1 x SC 3 MF	1971	35	28	4	7	31	166	3	56	5561
SC 3 Opaque-2		34	28	3	12	30	140	3	55	5271
C10 x BY		34	27	4	8	29	146	3	56	5381

Table 18 PERFORMANCE TRIAL OF COMPOSITES AND INTERCROSSES, EXP. 11, 1972 - KANO

Variety	Seed Source	Plants/ plot no.	Lodged Root no.	Lodged Stalk no.	Usable ears no.	Ear height, cm	Days to 50% tassel	Yield, kg/ha
096 x SC 3	1971/72	24	1	2	29	116	55	8154
096 x Col. Comp.	"	24	1	1	26	82	53	7514
096 x BY	"	24	1	3	25	87	55	7024
SC 3 x NCA	"	24	0	2	27	93	54	6014
SC 3 x BY	"	24	1	2	27	104	53	7296
SC 3 x BS3 & 4	"	24	1	3	28	88	52	6625
NCA x BY	"	23	1	2	28	116	55	8431
NCA x BS3	"	24	1	2	32	74	52	6743
NCB x BS3	"	23	2	2	28	92	53	6508
NCB W-field	1971	22	1	2	29	109	56	6331
NCA W-field	1971	23	0	3	28	106	54	7028
096 Soil Science	1971	24	1	3	34	126	62	6456
SC 3 MF	1971	23	0	3	28	101	54	7044
BY S.4	1971	23	2	3	23	79	54	6749
BS3 Var. Maint	1971	24	1	3	27	73	52	5834
VS4 Var. Maint	1971	23	1	3	26	71	53	5369
SC 1,2,3, Shika	1971/72	23	0	2	30	90	54	7112
NCB Samaru	"	23	1	2	29	105	56	6527
BS3 x SC 3 MF	1971	23	0	2	26	84	52	6175
BS4 x SC 3 MF	1971	24	0	3	26	88	52	6403
BSSS-2 x SC 3 MF	1971	24	1	1	28	81	52	6912
Iowa Corn Rootworm - x SC 3 Syn.	1971	22	1	2	27	77	52	6541
SC 2 x SC 3	1971	23	2	2	29	112	58	7227
SC 1 x SC 3	1971	21	0	1	31	108	54	7118
SC 3 Opaque-2	1971	24	1	2	30	76	53	6608
C10 x BY		23	1	3	25	93	54	8305

Table 19 YIELDS (Q/HA) OF COMPOSITES AND INTERCROSSES AT KANO, SAMARU, AND MOKWA IN 1972

Variety	Location			Avg.
	Kano	Samaru	Mokwa	
096 x NCB	--	63.2	52.5	--
Col. Comp. x NCB	--	38.5	44.5	--
NCA x BY	84.3	65.5	38.0	62.6
096 x SC 3	81.5	62.5	38.3	60.8
096 x Col. Comp.	75.1	56.1	39.5	56.9
C10 x BY	83.0	53.8	43.5	60.1
SC 2 x SC 3 MF	72.3	59.0	36.2	55.9
096 x BY	70.2	57.6	35.0	54.3
NCA 1971	70.3	52.1	40.1	54.2
096	64.6	54.2	43.0	53.9
SC 3 x BY	73.0	55.6	32.0	53.5
SC 1 x SC 3 MF	71.2	55.6	31.7	52.8
BY 1971	67.5	44.2	20.6	44.1
NCB x BS3	65.1	66.4	25.3	52.3
NCB 1971	63.3	54.6	38.6	52.2
BS2 x SC 3 MF	69.1	63.9	23.5	52.2
NCB 1971/72	65.3	55.2	31.7	50.7
SC 3 MF	70.4	47.8	32.6	50.3
S123	71.1	50.8	27.5	49.8
SC 3 Opaque-2	66.1	52.7	27.2	48.7
NCA x BS3	67.4	55.0	21.1	47.8
SC 3 x NCA	60.1	55.4	25.7	47.1
BS3 x SC 3 MF	61.8	53.8	21.4	45.7
BS4 x SC 3 MF	64.0	53.9	18.5	45.5
Iowa Corn Rootworm Syn x SC 3	65.4	56.2	13.1	44.9
SC 3 x BS3 & BS4	66.2	46.0	21.1	44.4
BS3	58.3	42.1	12.8	37.7
BS4	53.7	41.8	13.4	36.3

Variety x Population x Fertility Level - Samaru, Exp. 14, 1972

The five leading breeding populations in the program (NCA, NCB, SC 3, SC123 and 096) were grown in four replications with 16, 20, and 24 thousand plants per acre. Two of the replications were given 78 lbs. per acre of supplemental N as nitrochalk at flowering time on August 5. Severe root lodging which occurred during August probably reduced yield levels. There was not a marked response to plant density nor to the extra N. The 5 genotypes likewise were surprisingly similar in yield. The trial confirms previous indications that they are adapted to a wide range of conditions. The intermediate rate of planting had a slight yield advantage and less lodging than the lower or high rates. The highest yields were by NCB at the low N and S123 at the high N levels. These two entries were approximately the same in over-all yields.

The yields averaged slightly less than 6000 kg/ha which was lower than we had expected. It is encouraging that NCA, NCB and S123 on which we are concentrating our breeding efforts exceeded the yield of 096 at both fertility levels. SC 3 was somewhat lower. Data on yield are summarized in table 20 and those on lodging in table 21.

Late Planting of Advanced Selections Exp. 19, 1972

Twenty entries of special interest were planted in six replications on July 4 which is about a month later than the optimum date. A heavy epidemic of *P. polysora* developed and drought stress was moderately severe in late August and early September. Nitrogen deficiency symptoms were prevalent. The yield level was near 3000 kg/ha - well below our normal expectation (Table 22). C10 x Biu Yellow was the highest with 4116 kg/ha. The NCB original population was higher than the one recombined from superior S1s. S123 was distinctly low yielding for no obvious reason. Biu Yellow from recombined S1s had an advantage over the mass selected strain. A late planting of this sort subjects the entries to a different set of stresses and reveals unusual differences among them. It should be repeated.

Table 20 YIELDS (KG/HA) IN EXP. 14

Variety	16,000 plants		20,000 plants		24,000 plants		Average		Overall Avg.
	Normal	+N	Normal	+N	Normal	+N	Normal	+N	
NCA	5409	5784	4869	6136	5984	5736	5440	5885	5662
NCB	6051	5079	6070	6022	6298	6089	6139	5730	5934
096	4945	5641	5441	5755	5174	5565	5185	5653	5419
SC 3	5126	5412	5479	5384	4736	4898	5113	5231	5172
S123	5441	6051	5793	6298	6403	5565	5879	5971	5925
Average	5406	5593	5530	5919	5719	5570	5551	5695	5623
Population average	5500		5725		5645				

Table 21 ROOT LODGED PLANTS, NUMBER PER PLOT IN EXP. 14

Variety	16,000 plants		20,000 plants		24,000 plants		Average		Overall Avg.
	Normal	+N	Normal	+N	Normal	+N	Normal	+N	
NCA	75	48	66	34	86	95	76	59	68
NCB	52	66	70	46	58	77	60	63	62
096	57	53	46	36	75	86	59	58	59
SC 3	40	50	65	68	72	82	59	67	63
S123	60	56	56	52	66	84	61	64	62
Average	57	54	60	47	72	85	63	62	63
Population average	55		54		79				

Table 22 YIELD AND OTHER DATA ON 20 ENTRIES PLANTED LATE, EXP. 19, 1972

Entry no.	Variety	Plants/ plot	Lodged no.	Bare tips no.	Usable ears no.	Ear height, cm	Days to 50% tassel	Yield kg/ha
1	096 Soil Sci. 1971/72	33	0	1	26	156	58	3020
2	Samaru 3 MF 1971	34	1	2	26	141	55	2930
3	NCB 1971	34	1	1	28	150	57	3717
4	NCB 1971/72	33	1	1	25	140	57	3239
5	SC 3 Full sibs Bulk	35	3	3	26	131	56	2681
6	NCB Rb - Craig	32	1	1	25	146	57	3099
7	NCA 1971 - W Field	33	1	1	27	139	57	3249
8	Samaru 1, 2, 3 1971/72	33	6	1	20	121	57	1774
9	XB101	32	6	1	27	138	58	2940
10	Biu Yellow S4 - 1971	34	2	4	28	136	55	3010
11	BY - Craig S1 Recombined	32	1	-	28	131	55	3438
12	C10 x BY	36	0	4	30	139	57	4116
13	BSSS2	35	0	4	25	110	56	2442
14	Iowa Rootworm	34	0	1	25	108	55	2711
15	(BS3 & BS4 x SC 3)BY	28	1	3	26	128	55	3030
16	BS3 x Samaru 3	35	1	4	29	134	54	3618
17	BS4 x Samaru 3	34	0	2	28	125	56	3129
18	BSS2 x Samaru 3	34	0	4	29	129	57	3159
19	Rootworm x Samaru 3	35	0	2	30	124	56	3249
20	Samaru 3, Synthetic 4	35	6	8	28	135	56	3119

Inbreds x 096 Experiment 4, 1972

A group of 66 inbred lines that have been developed during the past several years were top crossed to 096 and tested at Samaru. Thirteen of the top crosses yielded more than 8000 kg/ha while 096 yielded 7475 kg/ha and the highest check, NCB, yielded 7879 kg/ha. Two entries exceeded 8800 kg/ha. The yields of the 13 topcrosses involving these lines and the checks are listed in Table 23. The seven best lines are being crossed with each other and with the leading populations to seek superior hybrids. Some of the better lines should be multiplied in anticipation of hybrid production. Many of the top-yielding strains have high ears, but there are exceptions, such as lines 22, 23, and 32.

Table 23 PERFORMANCE OF TOPCROSSES (INBREDS x 096) IN EXP. 4, 1972

Entry No.		Lodged plants Root no.	Lodged plants Stalk no.	Ear height cm	Yield, kg/ha
23		2	1	168	8889
27		10	1	188	8788
51		16	0	195	8620
60		12	0	188	8620
7		5	0	185	8519
37		8	0	188	8519
32		10	1	170	8452
46		3	0	200	8452
45		3	1	198	8418
22		6	1	160	8384
28		12	2	185	8216
30		2	0	180	8216
47		3	1	198	8149
Mean of all topcrosses		9	1	180	7060
70	NCB	5	0	165	7879
67	096	8	4	203	7475
69	NCA	9	1	168	7442
68	SC 3	15	2	150	6903
71	BY x C10	2	1	165	6667
72	SC 3	5	3	158	6263

The four trials from CIMMYT arrived late and were planted the last of June (well past the optimum date) in Experiments 15, 16, 17, and 18. The results must be considered with reservations but several of the entries performed well enough that they should receive further attention. Of particular interest in the trials was performance of Tuxpeno and its derivatives, but several Tuxpeno entries were included in NCB when it was composited.

Exp. 15 International Opaque-2 Maize Trial

The 30 entries of this trial were grown in three replications of 1 x 6 hill plots (Table 24). It suffered from late planting, low fertility, a rust epidemic and a period of moisture stress so yields were relatively low. The trial was adjacent to normal maize so could not be considered a true evaluation of the opaque (recessive) form of the entries because of outcrossing to the normal type.

The local opaque-2 of Samaru 3 made among the top yields. Entry 1 (Nicarillo), 2 (La Posta), 3 (Comp. Grano Duro) and 8 (Tuxpeno Crema 1) were other promising ones. The top yield was 3667 kg/ha for La Posta.

Table 24 INTERNATIONAL OPAQUE-2 MAIZE TRIAL, EXP. 15

Entry No.	Variety	Plants/ plot no.	Lodged plants, no.	Bare tips no.	Usable Ears no.	Ear height, cm	Days to 50% tassel	Yield, kg/ha
1	Nicarillo	19	3	0	15	157	62	3069
2	La Posta	15	1	1	16	162	63	3667
3	Grano Duro	17	1	2	14	162	62	3508
4	Ato Am x Gr.	16	4	2	16	150	63	2113
5	Amarillos	17	3	0	11	153	63	2392
6	Amarillos	19	3	3	14	140	62	2870
7	Azteca Opaco	17	2	1	15	160	61	2511
8	Tuxp. Crema 1	18	2	1	14	138	64	3269
9	Mix 1 x Col.	16	2	1	11	147	62	2312
10	Ila	18	1	4	14	143	62	2511
11	Gr. Amar x Cuba	16	4	0	11	167	62	2750
12	Tuxp. x Ant.	16	2	2	12	143	62	2312
13	Comp. Bl. Caribe	17	5	0	12	152	62	1634
14	Comp. K	14	3	1	11	142	60	2750
15	Ver. 181 x Ant.	16	4	3	11	137	62	1475
16	Flint Comp.	18	2	0	12	147	62	2033
17	Thai Opaque-2	16	1	1	11	130	62	1834
18	Comp. Opaco 1	18	1	1	15	135	62	2352
19	Eto Blanco	16	4	3	11	142	63	1913
20	Agroceres	15	0	0	14	143	62	3189
21	Shakti	15	2	2	14	118	63	1834
22	D 19	17	2	1	16	143	62	2790
23	Comp. 1	17	1	3	13	130	61	2352
24	H 208	16	4	1	11	135	63	2113
25	Agroceres 502	12	1	0	12	143	61	2432
26	" 504	16	1	2	15	133	60	2870
27	Rattan EQ366	17	1	4	13	135	61	2272
28	D 17	19	1	1	15	133	62	2352
29	Local 02 (SC 3)	17	0	4	16	110	60	3348
30	Local Normal	15	4	2	10	120	63	1714

Central American Experimental Varieties
(CIMMYT No. 49) Experiment 16, 1972

The 22 entries of this trial were grown in three replications at Samaru. Entries 2, 10, 11, 14, 15, 17 and 22 are interesting (Table 25). Entry 22 (H-507) has yielded well in previous trials in F1 and advanced generations. Tuxpeno and Pfister Hy entries were prominent.

Table 25 CENTRAL AMERICAN EXPERIMENTAL VARIETIES, EXP. 16, U6 - 1972

Variety	Stand, no.	Lodged plant, no.	Bare tips, no.	Usable Ears, no.	Ear height, cm	Days to 50% tassel	Yield, kg/ha
Na-1 (Nic-SM_3)	17	5	-	14	156	63	2930
Ant. Gpo 2 x Pfister	17	0	7	17	143	62	4126
Ant. Gpo x cup. st.	17	4	4	14	131	63	2930
DV - 206	16	5	1	14	145	63	2631
DH - 253	13	2	1	9	131	63	1435
Sel. P-C IV Dimag	17	2	2	15	155	56	3020
Comp. Inter. C. III	13	3	-	10	16C	62	2272
X 338	18	0	6	15	154	62	2900
X 306 B	18	3	4	15	140	63	2811
SB-105	17	0	2	16	143	62	3738
Tuxp. x Ant. S. Bl.	17	2	2	14	144	63	3738
Ant. Gp. 2 x Ver.	15	2	0	13	150	64	2751
V520C, x A-21, A-24	18	2	0	12	130	62	2631
Pfister Hy x SS Syn.	18	0	3	16	153	62	3648
Tuxp. Cr 1 normal	16	2	0	14	145	64	4007
Mix 1 x Col Gpo	18	0	0	11	125	62	2362
(Eto x Tuxp)Sem.	18	0	2	15	138	64	3797
Comp. Caribe Sc 1	17	0	3	15	145	63	2870
Mez. Am. Sel. pta	14	0	2	12	125	63	2302
Comp. 301 Sel.	18	2	4	13	136	63	2183
Puebla Gpo 1 M-C III	17	4	0	11	162	63	2093
H-507	14	1	2	14	150	66	3648

Central American White and Yellow Commercial Varieties (CIMMYT No. 59) Exp. 17, 1972

The 30 entries of this trial were grown in four replications of 1 x 6 hill plots. Planting was not until June 29 which is three or four weeks after optimum date. Being late, the test was vulnerable to the epidemic of rust (*P. polysora*) which came in late. The fertilizer rate was not adequate and side dressing was too little and too late to correct deficiency symptoms. There was a conspicuous effect of tree roots competing for moisture and nutrients on one side of the plot. As expected, yields were low (Table 26). HB 105 from Honduras was highest with 3767 kg/ha followed by H 507 with 3647 kg/ha. XB101 with 2690 kg/ha ranked 13th. XB101A was better with 3408 in 6th place. Entry 16, Sint. Tuxp. from Honduras should receive further attention as germplasm for our program.

Table 26 CENTRAL AMERICAN WHITE AND YELLOW COMMERCIAL VARIETIES, EXP. 17, 1972

Variety	Plants/ plot no.	Lodged plants, no.	Bare tips, no.	Usable Ears, no.	Ear height, cm	Days to 50% tassel	Yield, kg/ha
Salco	18	0	1	14	145	61	2212
Sint. Nil. 2	17	1	3	15	135	60	1973
Nicarillo	17	2	0	14	176	62	2781
Tocumen - 70	17	3	0	12	172	63	2093
H - 3	18	3	0	16	154	60	3229
T - 27	18	0	1	14	151	62	2960
Comp. Precoz SM	18	2	0	15	160	60	2870
Tuxp. Crema 1 Planta Baja	18	1	2	12	155	62	2571
X 304	16	0	6	14	150	62	2302
XB 101	18	2	0	14	144	61	2691
XB101A	17	1	4	18	160	61	3409
Desarrural HB 105	17	3	1	13	166	62	3767
Desarrural HB 101	18	1	2	14	178	63	2900
X 354	17	2	2	11	137	60	1973
X 306	16	1	8	12	144	63	1734
Sint. Tuxp.	17	3	0	14	170	62	3558
Eto Blanco Pl. Baja	18	0	1	13	139	61	2003
B-Doble 2	18	0	1	13	153	61	1585
Coyuta H-2	18	3	2	11	164	64	1615
T-23	18	2	0	14	173	62	2781
T-66	17	2	1	14	163	64	2542
T-72	18	3	0	15	170	63	3438
H 101	18	2	3	12	169	62	2063
TR - 1	18	2	1	14	164	62	3468
H - 5	13	2	0	10	169	62	2661
H 154 ICA	16	0	1	15	156	61	2960
ICA H 104	17	0	2	12	141	61	1854
ICA H 207	16	2	1	13	175	61	2571
ICA H 302	18	2	1	13	174	62	2900
H 507	17	1	0	15	182	64	3648

<u>International Maize Adaptation Nursery (CIMMYT Exp. 1) Exp. 18, 1972</u>

The 43 entries of this trial were grown on two replications of 1 x 6 hill plots. Yields ranged from 1256 to 4784 kg/ha. A few that seemed well adapted were Ilonga Composite A, ICA H-352, ICA H-154, CCBX TC, and Agroceres - 105. The first of these had excessively high ear placement. Data are reported in table 27.

<u>Opaque-2 lines and single crosses from Missouri - Exp. 20, 1972</u>

A single row observation plot was grown of each of the 26 hybrids and six parent inbreds from Missouri, USA. In general, they were poorly adapted but a few did surprisingly well. Most were extremely susceptible to rust (*Puccinia polysora*). MO 20WO2, MO$_2$ RF$_{O2}$, and K410$_2$ were the best lines and MO$_2$RF$_{O2}$ x K410$_2$ and MO2RF x MO 20WO2 the best hybrids. Dr. Zuber reports that MO$_2$RF$_{O2}$ x K410$_2$ has an almost normal kernel. These and some of those from the International opaque-2 trial should be grown from remnant seed. The data are on file for reference as needed. Another possible source of opaque-2 is Exp. 5, 1972, full-sib trial. At University Farm at least 22 entries seemed to have some opaque seeds. See the report of Exp. 5 for details.

Table 27 INTERNATIONAL MAIZE ADAPTATION NURSERY, EXP. 18, U6, 1972

Variety	Stand count, no.	Lodged plants, no.	Bare tips, no.	Usable Ears, no.	Ear height, cm	Days to 50% tassel	Yield, kg/ha
Agroceres 206	17	0	0	11	173	65	1256
Inia H-412	17	1	3	14	158	63	2452
Caripeno	18	1	0	14	175	63	3050
Hibrido Honduras H-5	4	0	0	4	165	65	1495
Sintetico Amarelo M 2	17	0	2	13	178	62	3289
Pioneer X304	18	0	3	16	145	62	2452
Salco	18	1	0	14	160	63	2392
ICA H - 352	18	1	3	17	152	61	4186
White Star	18	9	0	11	150	61	2093
Central Mex	18	1	0	14	180	62	3468
Ilonga Comp. A	19	0	0	16	198	66	4784
Diacol H - 104	17	0	0	12	153	62	3229
ICA H-154	19	0	1	18	165	63	3947
ICA H-207	11	1	0	7	170	65	1734
Sintetico Perla	18	5	1	12	183	66	3050
Syn. 66	17	1	2	10	120	61	1555
Diacol H - 253	15	1	0	11	165	64	3169
ICA H - 302	18	1	0	15	175	65	2811
Pioneer XB101	18	1	2	16	158	63	3409
Branco Redondo	18	2	0	14	165	65	2093
Sintetico Tuxp. Hond.	18	1	0	15	193	65	2153
Diacol H. 401	16	3	1	13	195	65	2033
Chontalpa Enano	18	1	0	12	155	64	2093
Agroceres Me	17	1	0	14	168	66	3229
Ukiriguro Comp. A C_2	19	1	0	15	178	66	2512
Sintetico Centroame Ri.	18	6	1	16	188	65	2930
Comp. L (Me)C5	18	2	1	15	155	64	2870
Upca Var. 2	17	0	1	12	163	61	2751
Agroceres M-105	18	2	0	17	173	62	3050
H - 507	18	0	0	14	183	65	2751
Carribbean Comp.	18	4	0	9	185	67	1555
Agroceres - 105	18	0	0	12	175	64	3708
CCB x Tc	18	2	0	17	175	65	3827
Compuesto A (CA)	18	1	1	19	168	62	3468
Guatemala H-2	19	0	2	10	180	65	2751
Cuba x Rep. Dom.	17	2	2	15	165	63	2990
Inia H-503-E	15	0	2	9	108	66	2990
Inia H-503	18	0	0	15	173	66	3409
Poey T - 23	18	1	0	9	173	64	2153
Comp. Rep. Dom.	18	3	2	14	163	63	3588
Inia H - 507 - E	17	0	0	13	103	66	2033
Poey T - 84	18	0	0	13	165	65	2452
Local Variety	18	1	1	13	173	65	2452

NCA Full-sib trial - Exp. 5, 1972 - Samaru

This trial consisted of 144 full sibs from the NCA population. Data were available from only the Samaru location. Entries for the next cycle were chosen on the basis of field weights, ear heights and lodging counts. Yields ranged from 2768 to 7530 kg/ha; ear heights from 130 cm to 193 cm and root lodging from 11 plants to 34 plants out of 36 per plot.

Sixteen full-sib lines or about 11% of those tested were chosen to initiate the next cycle (Table 28).

Table 28 PERFORMANCE 16 SELECTED ENTRIES IN THE TRIAL OF 144 NCA FULL SIBS TESTED IN EXPERIMENT 5 AT SAMARU IN 1972

Entry no.	Source 1971/72	Lodging Root no.	Lodging Stalk no.	Ear height, cm	Yield, kg/ha
7	2 x 10	21	0	168	7253
13	2 x 18	22	1	170	7032
16	2 x 21	25	2	168	7198
19	2 x 25	12	1	183	7530
23	3 x 8	19	5	155	6367
45	6 x 27	30	4	155	7475
58	8 x 17	27	3	158	6921
65	9 x 12	22	4	155	6921
91	12 x 23	21	2	160	6644
127	5 x 24	24	8	153	6700
128	5 x 25	23	1	153	6866
135	12 x 18	19	0	155	6589
137	14 x 19	22	3	153	6589
140	18 x 25	11	0	150	6478
142	21 x 25	15	3	155	6423
141	18 x 26	11	3	145	5980

These are being recombined into a set of diallel in the 1972-73 winter nursery for testing during the 1973 rainy season. The population has now had one cycle of S_1 selection and one of full-sib testing. Yield has been the primary criterion of selection, but it is probable that greatest progress has been made in more highly heritable ear height and lodging resistance. Two replications at a single location are not an adequate basis for evaluating yield. There is a critical need for more sites suitable for yield trials. The detailed data from Exp. 5 are on file but there seems little point in reporting them here.

In the 1971/72 winter nursery there were problems in pollinating and seed sets were poor in many instances. Sometimes several ears from a pair of rows were bulked in order to have enough seed for testing. As a result of poor performance in the hand pollinating nursery many pairs were discarded so that 144 were available for testing out of the 378 that would have resulted from the complete diallel of the 28 lines used. There is a relatively high frequency of male sterility and poor pollen production in progenies of NCA. This may trace in part to Biu Yellow and its male sterility. In the planting at University Farm 22 entries had a few opaque kernels on the open-pollinated ears. These entries and their sources were:

Exp. 5 Entry no.	1971/72 Source	Entry no.	1971/72 Source
13	2 x 18	55	8 x 11
17	2 x 23	56	8 x 12
18	2 x 24	57	8 x 16
23	3 x 8	58	8 x 17
46	8 x 12	59	8 x 18
49	7 x 21	60	8 x 19
50	7 x 24	61	8 x 20
51	7 x 25	62	8 x 21
52	7 x 26	70	10 x 12
53	8 x 9	92	12 x 24
54	8 x 10	93	12 x 25

No simple explanation for the opaque kernels is evident. It almost seems that a partially dominant rather than a recessive gene is involved.

Samaru 1, 2, and 3 diallels tested in Exp. 6, 1972, Samaru

In 1971 S1s of these three populations were evaluated as well as a group of full sibs of Samaru 3. In the same season they were selfed in the hand-pollinated nursery. This selfed seed of selected lines was used to make diallels in the 1971/72 winter nursery to be tested in Exp. 6 in the 1972 main crop. The Samaru 3 full-sib group was represented by a 5-line diallel making ten entries. Samaru 1 S1s were represented by a 5-line diallel. Samaru 2 S1s were represented by 51 entries consisting of a partial diallel among 15 lines.

Experiment 6 thus consisted of 47 crosses from Samaru 3, ten crosses from Samaru 1, and 51 crosses from Samaru 2. Twelve check varieties were included to make the 121 entries. On the basis of performance in Exp. 6 in 1972 16 entries were chosen to continue a merged Samaru 1, 2, and 3 composite (Table 29). Thirteen came from the Samaru 2 group and three from the Samaru 3 S_1 source. The 16-line diallel being made in the 1972/73 winter nursery for testing in 1973 thus is derived primarily from Samaru 2. Samaru 1 is entirely eliminated. I suggest that Samaru 3 be maintained by mass selection until its future as a variety is clear. Another population called S123 was made by bulking remnant seed of the 40 lines used as parents of the diallels made in 1971/72. This bulked seed was grown in isolation in 1971/72. Seed from this isolation was grown in a one-acre increase field by a farmer in Daudawa in 1972. This and Samaru 3 and NCA should be compared with the diallels to be tested in 1973 to see which show a clear superiority and merit continuing in a recurrent selection program. Samaru 3 and S123 might be continued as varieties for demonstration and production in the north-east, while recurrent selection is concentrated on NCA which should have wider adaptation and more long range potential for improvement.

Table 29 COMPARISON OF THE PERFORMANCE OF THE 16 FULL SIB WITH CHECK STRAINS IN EXP. 6 AT SAMARU IN 1972

Entry no.	Lodging		Ear height, cm	Yield, kg/ha	Source
	Root, no.	Stalk, no.			
23	22	0	140	7713	SC2 3008 1 x 9
27	24	4	153	7355	SC2 3014 1 x 15
40	23	1	155	7833	SC2 3039 3 x 15
41	15	3	153	6577	SC2 3041 4 x 6
44	26	2	153	7534	SC2 3045 4 x 10
50	14	2	158	7534	SC2 3067 6 x 13
51	12	0	153	7056	SC2 3068 6 x 14
54	8	1	170	7355	SC2 3077 7 x 15
59	21	0	158	9029	SC2 3085 9 x 10
64	14	0	153	8670	SC2 3090 9 x 15
66	27	1	150	8132	SC2 3093 10x 13
69	23	5	155	7654	SC2 3097 11x 13
70	11	0	155	7654	SC2 3098 11x 14
84	24	1	120	6996	SC3 2034 3 x 10
87	28	2	145	8132	SC3 2059 5 x 14
94	18	1	123	6876	SC3 2075 7 x 13
Mean (all 108 families)				6192	
BS3 x SC3	32	2	143	6578	
096	24	4	145	6757	
NCA	27	3	163	6698	
NCB	21	3	173	5621	
SC3	23	1	140	5083	
Syn. Gr 2	26	1	148	4096	
Syn. Gr 3	25	1	148	5412	
Syn. Gr 4	25	3	148	4844	
Syn. Gr 5	23	3	150	4365	
Syn. Gr 6	30	0	148	5322	
SC3(F)C?	29	1	153	3050	
NCB(S)C2	28	2	150	7056	
S123	26	0	158	5113	

Recurrent selection in 3rd cycle S1 lines of NCB grown in Exp. 9, 1972

The NCB recurrent selection program has been conducted cooperatively with the Federal Ministry of Agriculture, Research Division at Moor Plantation at Ibadan. The third cycle S_1 lines (300 entries) were tested at Samaru in Exp. 9, 1972. Planting was made July 1 due to late arrival of the seed. Nitrogen deficiency symptoms were pronounced during the later stages of growth. A relatively heavy infection of P. polysora rust developed and good differentials were evident. Field weights, ear heights and rust scores of the 30 lines selected for the next cycle are reported in table 30. In the next cycle full sibs rather than S1s will be tested because the test crosses must be made in the winter season at Samaru rather than in the two seasons at Ibadan. In 1973 there should be a thorough comparison of the original NCB, the bulk made following one year of testing S1s made at Samaru, the bulk of Samaru-Ibadan material after two cycles of S1 testing, and the full sibs being made among lines selected after the third cycle of S1 testing in Experiment 9, 1972, and the NCB of IITA. NCB gave an excellent account of itself in the various trials in which it was included in 1972. The lines selected from the Samaru S1s in 1971 were recombined in 1971/72 winter crop by open pollination in isolation. Part of this seed was used for a one-acre increase field by a farmer in Daudawa, who got more than 3000 lbs. of grain. We obtained about 1000 lbs. of this for extensive trials and further multiplication if needed. It is important that we find out how much better the material is after three cycles of S1 testing so the best version may be multiplied. It is, of course, important also that the population continued in recurrent selection be one which has high potential. NCB seems to have very wide adaptation and already yields at a high level. A major increment of outside germplasm probably should not be added until a trend and rate of progress already being made is ascertained. When new material is added it should come from Central or South American sources rather than from North American or US sources except for very special reasons. The NCA on the other hand contains a large increment of US Corn Belt germplasm so should represent a high degree of divergence from NCB.

Table 30 PERFORMANCE OF 30 ENTRIES SELECTED AMONG THE 300 S1 PROGENIES OF NCB TESTED IN EXP. 9, 1972, AT MAIN BOTANY FARM, SAMARU

Entry no.	Lodged Root, no.	Lodged Stalk, no.	Ear height, cm	Yield, kg/ha	Rust score*
	Set 1 (1-100)				
10	0	0	113	3986	1
14	0	1	128	3986	1
23	0	0	127	3787	1
36	0	0	132	3627	2
44	0	0	113	4026	2
47	0	0	122	3867	2
49	2	1	140	4026	2
54	1	0	138	4345	2
58	0	0	120	4026	1
60	0	0	128	4106	2
66	0	0	137	4584	2
75	0	0	112	3707	2
90	0	0	132	3906	2
93	0	0	138	4146	2
98	0	0	122	4504	2
	Set II (101-200)				
121	0	0	145	3747	1
122	0	1	124	3707	2
123	3	1	136	5501	3
131	1	1	133	3747	2
136	0	0	146	4066	2
139	0	1	135	3867	2
144	0	0	140	3827	2
154	0	1	141	3867	2
169	0	1	145	3906	2
181	0	0	132	3867	2
200	1	0	140	3548	2
	Set III				
231	0	0	140	3508	2
261	3	0	123	3468	2
269	3	0	130	3428	1
270	1	0	134	3627	1

*1 (resistant) to 3 (susceptible)

Recurrent selection in 4th cycle S1s of Biu Yellow, Exp. 10, 1972

Following the trial of 3rd cycle S1s in Samaru in 1971 Dr. Craig recombined 16 selected lines and then in the second winter crop selfed in the recombined population. He sent us 169 S1 progenies that we grew in 4 reps of 1 x 6 hills or 18 plants per plot. The seed arrived late and could not be planted until July 3. A severe rust epidemic developed in it. There was also a moisture and nitrogen stress.

Performance of the 20 highest yielding lines is reported in table 31. Six of these rated higher than 2.0 for rust susceptibility and should be dropped leaving 14 selected progenies that should be recombined in the 1973 main crop. There was not space for them in the 1972/73 winter crop. After the 14 selected lines are recombined, the mass selected Biu Yellow (S-4 1971); the recombination after three cycles of S1 testing (U-8 1972); and the recombination after four cycles of testing should be compared for yield as a variety and in variety crosses north and east of Samaru. The improved strains of Biu Yellow x C10 especially should be tested.

Table 31 PERFORMANCE DATA FROM EXP. 10, 1972 ON 20 SELECTED ENTRIES FROM THE TRIAL OF 169 S1 4TH CYCLE PROGENIES OF BIU YELLOW RECEIVED FROM IBADAN

Entry	Plants/ plot no.	Plants lodged no.	Bare tips no.	Usable ears no.	Yield, kg/ha	Ear height, cm	Days to 50% tassel	Rust score*
2	18	1	1	15	2571	110	55	2.5
10	18	1	0	16	2482	93	56	1.5
27	18	1	1	15	2721	101	55	1.2
35	18	0	1	15	3618	126	57	1.8
38	18	0	0	15	2900	93	56	1.3
39	18	1	7	15	2482	98	58	3.0
43	19	1	4	15	3259	111	58	1.2
57	16	1	3	13	2541	115	58	2.0
64	18	0	2	15	2631	99	56	2.5
80	18	0	3	14	2422	125	59	1.5
98	18	1	2	16	2751	83	55	2.3
102	19	1	0	18	2691	96	56	2.0
103	18	0	3	16	2482	91	54	2.3
111	17	2	1	16	2900	100	56	1.0
114	19	2	0	16	2870	93	56	1.3
121	18	2	0	15	2781	100	59	2.0
125	16	0	1	14	2482	90	56	2.0
137	18	1	0	13	2452	114	61	1.8
140	18	1	1	15	2541	94	56	2.0
141	18	1	2	14	2422	101	56	2.5

*1 (resistant) to 3 (susceptible)

S1 selection in 096 variety, Exp. 8, 1972

The variety, 096, has given excellent results in Samaru and at other test sites but it has certain weaknesses. Among these are high ears, flinty grain, susceptibility to aphids and top firing or tassel blast in the irrigated season. The ten highest selections from the 121 S1 progenies of variety 096 ranged from 8512 kg/ha to 6481 kg/ha and from an ear height of 148 cm to 177 cm as compared to 6975 kg/ha and 185 cm for the 096 check. If the 096 reconstituted from these S1 lines performs as well as expected it should be a distinct improvement. Table 32 presents a summary of the data from the 17 highest yielding selections and the 096 check. The 10 high yielding lines are being crossed into a diallel in the 1972/73 winter nursery. These crosses should be bulked to reconstitute the variety for trial. The crosses also should be tested in a performance trial that includes mass selected 096 x BS 3 and BS 4. Adding an increment of Corn Belt germplasm may be a more effective approach to improving 096 than recurrent selection within the variety. I don't recommend sustained recurrent selection in 096.

Table 32 PERFORMANCE DATA ON 17 SUPERIOR ENTRIES FROM TRIAL OF 121 S1 PROGENIES OF 096 GROWN IN EXP. 8, 1972 - SAMARU

Entry No.	Plants/ plot, no.	Ear height, cm	Lodged Root, no.	Lodged Stalk, no.	Ears/ plant, no.	Days to 50% tassel	Grain Yield, kg/ha
39	26	164	51	1	.97	64	8512
20	28	155	79	5	.93	60	7393
8	26	162	81	4	1.12	62	7364
82	26	168	55	4	.76	62	7290
85	25	166	92	4	.94	61	7051
121	25	162	75	4	1.15	61	6951
94	25	177	81	4	.91	61	6809
64	26	148	64	3	1.01	60	6793
87	23	161	81	0	1.00	62	6542
63	26	149	80	2	1.00	62	6481
76	26	171	81	3	.97	61	6196
89	22	172	68	3	1.10	62	5852
106	26	167	62	4	.98	62	5802
114	26	162	84	1	1.00	61	5656
88	25	165	62	6	.90	63	5358
112	23	157	87	3	1.19	62	5245
21	25	154	81	6	.88	64	5060
Check 096	25	185	73	6	1.15	62	6975

Maize Varieties and Levels of Productivity Trials - 1972

In cooperation with Agronomy and Soil Science Sections of IAR about 40 such trials were arranged for the six northern states of Nigeria. A number of the trials, as expected, were virtual failures for a variety of reasons. Nevertheless, a considerable body of valuable information was obtained. The computing laboratory is now carrying out an analysis which is not yet available to us. Casual inspection of results indicates a clear advantage for the BY x C10 and BY x H507 variety crosses. The yield of BY x C10 was 19% more than the average of the varieties NCB, Samaru 3, and 096 (Table 33). The yield of 11,334 kg/ha of BY x C10 at Samaru demonstrates that extremely high yields are obtainable.

Increasing from 100 lbs. per acre to 450 lbs. per acre of 21-14-14 fertilizer gave a major increase in yield. The increase from additional 350 lbs. per acre of 21-14-14 fertilizer was not very marked at most locations. Obviously, some constraint other than fertility was generally limiting yields at the higher levels. Rainfall deficit was important at some locations. This set of trials is to be repeated in 1973 with some revision of varieties included. In 1973 these will be NCA, NCB, Samaru 123, 096 and XB101 x Lagos White. Present indications are that these strains may be prominent in maize production during the next several years. NCA and NCB are primary composites in the breeding program, and they gave the highest yields of the breeding populations in 1972 (Table 34). S123 is expected to replace SC3 as it goes through recurrent selection improvement. 096 is related to Bulk 3 or Western Yellow 1 which is recommended throughout Nigeria. There are indications that 096 is superior to Bulk 3 in lodging resistance and yield. If this is verified, it should be substituted. XB101 x Lagos White should provide a high yielding white grain type for areas where preference is strong for white grain. It is therefore important to obtain information about these strains over a wide range of conditions.

Because farmers usually expect a certain degree of uniformity with improved varieties, NCA and NCB under full-sib or S_1 selection should be gradually moved toward the yellow grain type as IITA is concentrating on white. Germplasm pools of NCA and NCB should be maintained under mild mass selection, and the mixed colors should probably be maintained in these.

Table 33 VARIETY PRODUCTIVITY LEVELS (KG/HA) - 1972

Locations		Bulk-3 (096)	SC 3	BY x C10	NCB	Mean
Jalingo	low	476	440	699	681	574
	med.	1272	1332	1833	1290	1432
	high	1133	1381	1782	1381	1419
	Average	960	1051	1438	1117	
Samaru	low	4220	4943	5124	4642	4732
	med.	7415	8560	9103	8380	8364
	high	9344	9947	11334	8741	9841
	Average	6993	7817	8520	7254	
Kadawa (Irrigated)		1490	1344	1715	1238	
Jekarde "		2208	2668	3161	2063	
Gusau		224	930	1087	415	
Daudawa		5773	5470	5773	5123	
Overall mean		3459	3823	4297	3527	

Table 34 SUMMARY OF YIELD PERFORMANCE OF MAIZE VARIETIES NCA, NCB, SC 3, S123, 096, AND THE VARIETY-CROSS BIU YELLOW X C10 IN 1972

Experiment		NCA				096		SC 3		BY x C10		NCB		S123	
Exp. 4 - Samaru		7475				7475			6936	6667		7879			
Exp. 19 - Samaru		3249				3020			2930	4116	1971/72	3239		1774	
											1971	3717			
Exp. 11 - Samaru		5211				5422			4783	5381	1971/72	5516		5082	
											1971	5455			
Exp. 11 - Kano		7028				6456			7044	8305	1971/72	6527		7112	
											1971	6331			
Exp. 11 - Mokwa		4014				4300			3262		1971/72	3172		2751	
											1971	3864			
Exp. 1 - Samaru*		6839							5632		1971/72	6119		6067	
						5736 (096)					1971	5574			
Exp. 2 - Samaru		5455				8068			7478	7669	NCB	7339			
											NCBRb	6112			
Exp. 13 - Samaru		6390			6500			6260		5710		6550			
Exp. 13 - Kano		4890			3810			5120		5480		4400			
Exp. 13 - Mokwa		2460			2490			2250		2000		2000			
Exp. 14 - Samaru		5663				5420			5175			5934		5925	
	-N		+N	-N		+N	-N		+N			-N	+N	-N	+N
16,000 plants	5469		5784	4945		5641	5126		5412			6051	5079	5441	6051
20,000 plants	4869		6136	5441		5755	5479		5384			6070	6022	5793	6298
24,000 plants	5984		5736	5174		5565	4736		4898			6298	6089	6403	5565
average	5440		5885	5186		5653	5113		5231			6139	5730	5879	5971
Mean 1†		5522			5265			5013				5570		5436	
Overall mean		5472			5371			5171				5587		--	

*N.B. In 1972 Exp. 1 Samaru (National zonal trial) NS-1 yielded 4270 kg/ha and NS-5 yielded 4737 kg/ha.

†Exp. 2, 4, and 13 were excluded because S123 was not included.

Release of varieties for farm use

At a recent meeting the Institute of Agricultural Research Cereals Committee decided to recommend the addition of four maize strains to the list of those approved for production. They are the composites NCA, NCB, and SC3 and the variety cross, Biu Yellow x C10. NCA and NCB have given excellent performance in West African Regional Trials and in numerous trials in Samaru and vicinity. They have performed well in National Zonal Trials in Nigeria even before the recurrent selection that has further improved them. They are suggested for production throughout the region. Biu Yellow x C10 is a variety-cross hybrid that has been tested in Samaru and other parts of the north for several years. It usually yields higher than the better varieties and composites and is outstanding for resistance to lodging. The plant and ear heights are decidedly lower than other recommended strains. The improvement in Biu Yellow should be reflected in the Biu Yellow x C10 variety-cross hybrid.

SC3 is a composite that has performed especially well in Samaru and to the north and east of here. The grain is yellow and softer than NS1 and Bulk 3 or 096 which are objectionable because of flintiness. SC3 also has shorter plants and lower ears than these varieties. It is not suggested for areas to the south because of susceptibility to *P. polysora* rust.

Nutritive Value of the Grain

One of the objectives of the cereals program is improvement of nutritive value of the grain. One important criterion of quality is level of protein in the grain. Another measure is ratio of amino acids for biological balance. Maize higher in lysine and tryptophan are major goals. Protein level may be influenced by use of nitrogenous fertilizers and by selecting high protein genotypes. Our hope is to breed a type that will absorb and synthesize into protein an abundant supply of soil nitrogen. By selecting for yield at the same time we expect to be able to increase protein to 12% or more without sacrificing yield per acre of grain. To be constructive we need to raise lbs. of protein per acre rather than simply increasing percentage content which in general is known to be negatively associated with yield. Including the opaque-2 gene should give a biologically balanced protein which at the 12% protein level would meet normal requirements for protein in an adult diet.

High Protein

Selection for high protein content was started in 1971 in Samaru Composite 3 by selfing in a bulk planting. At harvest 840 selfed ears were saved and a sample of grain sent to Beltsville where Dr. Wiser and his staff made nitrogen determinations. There were 15 samples in .80 - .89% N (5.0 - 5.6% Protein) class and one sample in the 2.31 - 2.40 N (14.4 - 15.0% Protein) class. The mode was 1.41 to 1.50 N (8.8 - 9.4% Protein). Approximately twenty-five percent or 200 of those with high protein were chosen for inclusion in a yield trial in 1972. These were grown in two replications in Samaru. Primary consideration was given to yield with secondary attention to root lodging within the highest yielding group in choosing 20 progenies to recombine in 1973 main crop. Protein determinations on composite samples of each of the entries were made in Dr. Stockinger's laboratory. These values will be used to determine association of protein contents with those from the corresponding S_1 ears. The association between yield and protein content will be studied. The analysis is not yet complete but a casual inspection shows that much of the gain from protein selection among the S_1 ears was retained. Protein value obtained for the parent composite was 9.31% in 1972 as compared to 9.75% in 1971. The 20 lines selected for high yield in 1972 averaged 11.09 percent protein in 1971 and 10.41 percent in 1972. This shows that selecting for high yield did not negate the inital differential established for protein content. The planting in which the initial selfs were made grew under fairly severe nitrogen deficiency stress, whereas the 1972 samples were at a more favorable level of soil nitrogen. Further evidence on the conditions which are most favorable for selecting for high protein are expected to come from Exp. 7 in which a group of the S_1 lines covering the range of protein contents were grown with and without supplemental nitrogen fertilizer applied at flowering time.

Performance data for the 20 lines (10%) selected in Exp. 12 are reported in table 35. It appears that protein may have been increased by about one percentage point, i.e. from 9·3% to 10·4% in one cycle while retaining pressure for high yield with the 20 highest yielding S_1 lines. By reducing this number to ten lines the protein would go to 11.5 and 11.1 for 1971 and 1972 respectively. I recommend that the 20 lines be recombined in 1973 main crop and another group of S_1 made in 1973/74 for another cycle of testing at high soil nitrogen level. Perhaps the S_1 ears could be tested for protein at Beltsville or Samaru prior to yield testing the top 25% as was done before.

Table 35 PERFORMANCE DATA ON TEN S_1 LINES SELECTED IN EXP. 12-1, 1972 AND THE TEN SELECTED IN EXP. 12-2, 1972

Exp. 12-1 Entry no.	1971 Ear no.	Stand count no.	Ear height, cm	Ears/ plot, no.	Root lodging, no.	Grain yield kg/ha	Nitrogen 1971	Nitrogen 1972
1	6	28	125	31	15	4754	1.85	1.45
15	49	27	133	28	7	4784	1.56	1.60
18	57	34	115	37	26	5830	2.02	1.66
20	61	34	139	33	21	4634	1.57	1.63
21	72	32	130	29	4	4575	1.56	1.58
24	71	28	120	32	12	5262	1.94	1.81
28	87	34	133	32	7	5412	1.86	1.68
29	89	35	125	33	18	5083	1.71	1.44
84	336	33	143	29	25	4909	1.71	1.68
99	410	35	123	34	14	4784	1.84	1.49
Exp. 12-2								
4	437	31	120	37	15	4784	1.76	1.74
17	493	37	135	40	9	9000	1.76	1.57
18	494	36	118	30	31	5113	1.84	1.55
29	520	34	129	34	10	5173	1.73	1.64
40	576	33	137	34	24	6130	1.74	1.70
41	577	32	119	20	25	5322	1.76	1.83
60	703	36	113	30	36	4844	1.89	1.99
68	733	38	120	40	27	4993	1.75	1.87
70	746	36	125	34	18	4784	1.82	1.70
72	748	29	133	27	23	4605	1.82	1.72

Protein selection method study

In experiment 7, forty-five of the S_1 progenies were grown with and without a 300 lbs. per acre application of 26% N nitrochalk at flowering time. The 45 entries were chosen to cover the range in N content from .87 to 1.86. The objective was to learn something of the genotype x nitrogen metabolism interaction. The experiment should provide some information on how to grow material to maximize protein content differences or to identify strains with more capacity than others to utilize an abundance of soil nitrogen. In the case of wheat it is known that most genotypes absorb surplus nitrogen and retain it in vegetative portions of the plant whereas exceptional strains are very effective in translocating the nitrogen and metabolizing it into protein which is stored in the grain. A similar situation presumably exists in maize and what we seek is the type with grain that is high in protein because it has a greater capacity to absorb and metabolize nitrogen into protein when N is abundantly supplied in the soil. This is what we must have to increase protein percentage without the usual corresponding reduction in yield.

Yields and protein contents of the 48 entries in Exp. 7 are reported in table 36. The application of 78 lbs/acre (87 kg/ha) of N increased the nitrogen in the grain from 1.678 (10.49% protein) to 1.740 (10.88% protein). There was no Line by Nitrogen interaction indicating that gain from selection would be the same with or without Nitrogen added at flowering time (.165 N or 1.033% protein per cycle for a 10% selection intensity). If only 2 replications were used, expected gain for a 10% selection intensity would be .150 N (or .94% protein) which is 91% of the expected gain from 4 replications. The regression of S_1 line means on the parental values gave heritibilities of 0.16 on a single plant basis (selection among parental plants) compared to a heritability of 0.79 on the mean basis for S_1 lines (4 replications).

Opaque-2

The opaque-2 gene had been crossed into Samaru Composite 3 and back crossed twice to the normal then selfed. Kernels that seemed to be nearest normal in weight but opaque were bulked and planted in an isolated plot U-8 in 1971 where they open pollinated. At harvest some ears were segregating for normal seed and expression of kernel density in the population. We selected kernels that were relatively plump and in some cases with vitreous zones in the endosperm to plant an isolated plot, V-6, in 1972. A few seeds of 2 "modified" opaque-2 lines from Illinois and the cross between them were planted in the isolation and detasselled. Some of the selfed ears were homozygosis opaque, some were segregating normal and some were segregating intermediate endosperm types with opaque and vitreous zones. Some resembled the lines from Illinois in appearance. The Illinois lines were grown in the 1972 selfing nursery in plots as follows:

1972 Ros No.	
276	04026-7O_2 vitreous Ill. 11198-1(x)
277	F_2Va35 O_2/O_2 x 04026-7 O_2/O_2 Ill. 11168-2(x)
278	Va35 O_2/O_2 modified Ill. 11194-1(x)

The pattern of kernel types and segregation on the selfed ears in the V-6 planting suggested that most of the seed we had chosen were heterozygotes rather than carrying modifying genes to give endosperms approaching normal type. We noted that normal SC 3 and the related S123 contained kernels with opaque or chalky appearing sectors resembling some of those we had planted in V-6. Thirteen samples of grain from the selfed ears and four samples from SC 3 and S123 analyzed for us in Beltsville by Dr. Wiser.

Table 36. Protein selection method study - Exp. 7, 1972 Samaru

Entry no.	No. plants	Lodged no.	Bare tips no.	Useable ears	Yields kg/ha	Ear Height cm	Days to tassel	1971 N	1972 N
1	15	9	0	14	2541	134	54	.97	1.66
1	15	11	4	10	1824	129	54	.97	1.72
2	18	11	3	16	3433	134	55	.87	1.53
2	19	15	2	12	3199	133	55	.87	1.62
3	17	15	2	14	2751	134	55	.88	1.65
3	17	9	3	14	3409	134	54	.88	1.56
4	18	14	2	11	2153	136	56	.92	1.56
4	18	11	2	13	3110	128	53	.92	1.61
5	17	12	1	12	3259	141	54	.92	1.55
5	18	15	0	14	4036	130	55	.92	1.69
6	18	14	4	11	2542	143	56	1.09	1.88
6	17	11	2	13	3498	133	55	1.09	1.89
7	18	15	2	11	2482	134	54	1.04	1.63
7	17	13	3	12	3409	138	55	1.04	1.63
8	17	8	2	16	4216	153	56	1.02	1.70
8	17	14	2	17	4216	139	55	1.02	1.68
9	18	9	10	14	3409	128	55	1.01	1.54
9	18	10	10	16	3409	125	54	1.01	1.62
10	18	16	3	17	5502	138	54	1.04	1.56
10	17	10	2	17	6937	133	54	1.04	1.72
11	18	8	9	14	2571	134	54	1.15	1.83
11	18	9	2	10	2123	133	54	1.15	1.77
12	18	14	1	13	2063	131	56	1.14	1.78
12	17	12	0	14	2542	133	55	1.14	1.90
13	17	7	6	9	1585	139	54	1.18	1.75
13	17	7	6	8	2213	131	55	1.18	1.92
14	17	15	1	13	2870	138	56	1.17	1.48
14	18	15	2	13	3917	133	53	1.17	1.48
15	17	15	3	9	1585	144	58	1.24	1.70
15	18	10	2	12	3199	141	57	1.24	1.70
16	19	14	2	21	3917	149	54	1.29	1.60
16	17	11	3	13	2990	146	54	1.29	1.74
17	16	13	1	13	2601	138	54	1.24	1.54
17	14	10	2	10	1944	134	56	1.24	1.71
18	17	17	1	16	3409	134	57	1.28	1.79
18	17	11	2	18	4186	139	54	1.28	1.77
19	16	13	0	13	3229	138	56	1.24	1.48
19	14	10	2	11	3648	131	53	1.24	1.60
20	17	15	2	10	1824	131	57	1.28	1.79
20	17	16	2	9	1495	135	54	1.28	1.82
21	17	14	2	11	2930	129	57	1.35	1.49
21	17	16	2	9	1495	135	54	1.35	1.67
22	16	14	2	11	2781	128	56	1.34	1.94
22	18	9	1	12	2482	138	54	1.34	1.89
23	18	14	1	16	3708	133	55	1.40	1.73
23	16	13	1	13	4096	115	59	1.40	1.78
24	18	12	1	12	2452	141	56	1.36	1.53

Table 36. (Continued)

Entry no.	No. plants	Lodged no.	Bare tips no.	Useable ears	Yields kg/ha	Ear height cm	Days to tassel	1971 N	1972 N
24	17	12	0	11	2631	133	57	1.36	1.69
25	18	14	1	18	3528	136	54	1.37	1.52
25	16	10	2	17	3917	143	56	1.37	1.62
26	16	10	2	10	1525	136	57	1.42	1.61
26	15	9	2	12	2960	141	58	1.42	1.71
27	18	11	3	12	1973	129	55	1.44	1.64
27	18	8	3	10	2063	140	54	1.44	1.66
28	18	11	2	18	5711	139	54	1.41	1.60
28	18	8	1	16	5681	138	54	1.41	1.68
29	17	9	4	16	3439	136	57	1.48	1.54
29	18	10	3	18	4066	133	54	1.48	1.71
30	17	8	5	15	3319	139	57	1.43	1.61
30	18	10	3	18	4066	133	54	1.43	1.79
31	18	18	1	7	1017	148	54	1.53	1.92
31	18	18	3	11	1854	138	56	1.53	1.98
32	16	12	1	12	1884	126	56	1.59	1.71
32	16	13	1	11	2452	140	54	1.59	1.83
33	17	8	1	13	1973	135	56	1.53	1.84
33	16	11	0	10	2392	133	53	1.53	1.80
34	18	11	0	13	2332	141	57	1.57	1.65
34	18	10	0	14	3199	136	54	1.57	1.74
35	15	15	1	10	2003	141	54	1.58	1.76
35	17	13	0	12	3050	138	55	1.58	1.64
36	17	16	1	8	1884	145	54	1.63	1.66
36	17	16	1	7	1824	146	55	1.63	1.77
37	15	12	1	4	688	135	58	1.62	1.86
37	13	8	0	4	1405	136	53	1.62	1.91
38	17	15	1	10	2183	136	55	1.68	1.79
38	17	12	1	11	3140	130	54	1.68	1.85
39	18	13	0	7	1076	133	58	1.64	1.88
39	17	16	0	9	2183	133	54	1.64	1.86
40	16	14	1	13	4096	129	54	1.62	1.70
40	15	10	1	9	3229	138	55	1.62	1.65
41	16	14	1	13	4066	129	54	1.67	1.72
41	15	10	1	12	4365	135	55	1.67	1.79
42	18	16	0	11	2691	136	54	1.68	1.58
42	15	12	2	9	2332	131	55	1.68	1.78
43	18	12	2	15	4425	136	55	1.68	1.60
43	18	13	0	15	5053	144	54	1.68	1.59
44	18	12	5	12	2302	149	56	1.66	1.81
44	17	13	1	10	3199	142	55	1.66	1.94
45	17	11	2	10	2542	140	57	1.86	1.81
45	15	10	3	8	2093	148	55	1.86	1.82
SC3	18	12	16	20	6219	129	55		1.60
SC3	16	13	1	14	6638	135	57		1.65
096	18	10	2	23	7027	140	55		1.62
096	17	10	2	20	7714	145	55		1.78
NCB	18	12	3	17	7924	134	55		1.68
NCB	17	8	2	16	6578	143	54		1.76

Samples and data from them were as follows:

Laboratory Number	1972 (x) Ears	% nitrogen Micro.	% Lysine	% Protein	% Lysine in Protein
36403	1 Opaque	1.75	.39	10.94	3.56
36404	7 "	1.64	.41	10.25	4.00
36405	9 "	1.93	.47	12.06	3.90
36406	14 "	1.83	.46	11.44	4.02
36407	17 "	1.39	.36	8.69	4.14
36408	26 "	1.68	.43	10.50	4.10
36409	14 partially vitreous	1.82	.39	11.38	3.43
36410	66 " "	1.40	.24	8.75	2.74
36411	66 Opaque	1.39	.32	8.69	3.68
36412	66 Flinty	1.34	.22	8.38	2.63
36413	59 Opaque	1.52	.36	9.50	3.79
36414	59 Partly opaque	1.41	.24	8.81	2.72
36415	59 Vitreous	1.41	.24	8.81	2.72
36416	SC 3 Normal	1.42	.21	8.88	2.36
36417	S 123	1.55	.25	9.69	2.58
36418	SC 3 Modified	1.23	.20	7.69	2.60
36418A	S123 "	1.30	.22	8.12	2.71

In general, grain that was not clearly opaque was not high in lysine. An interesting exception is the partially vitreous sample from ear no. 14 which was in the opaque range for lysine. Some of the opaque-2 material from Zuber in Missouri has a near normal appearance. (See experiment 2 and report from Zuber). Other opaque-2 material grown in 1972 was the International Trial grown CIMMYT in Exp. 15. Remnants are in cold storage. Some of the entries seem well enough adapted to be of interest. Some of the Samaru 3 material from field V-6 is being grown in the 1972/73 winter nursery.

An observation on the ears from 1972 V-6 field is the high frequency (perhaps 10%) of apparently semi-sterile ears. These should be followed up to determine whether a chromosomal translocation may be involved. This could be important relative to future use of SC 3 and of inbreds derived from it. Perhaps they are unique to the opaque-2 version. I have not become aware of them in normal SC 3, but I have not looked at ears with this in mind. We are hoping my successor will give special attention and impetus to protein content and quality in maize as well as sorghum and millet. The Chemistry Department at ABU (Dr. Mary Hallaway and Dr. Mathieson) have expressed an interest in cooperating on the project. Equipment for amino acid analysis is expected to be in operation.

SEED PRODUCTION INVESTIGATIONS/1

J. H. Clifton in cooperation with Cereals Breeder D. J. Andrews

Introduction

This report is made to reflect progress to date rather than as an annual report, in that, the writer arrived in Nigeria October 15, 1972. D. J. Andrews expedited the necessary orientation; so that very quickly a seasonal work plan was cooperatively developed and our first planting was made at Mokwa, November 7, 1972. Mr. Andrews was also instrumental in arranging the Bacita Sugar Plantation project. It is most unfortunate that Mr. Andrews left Nigeria in December, 1972, to return to Cambridge.

Northern Nigeria has two distinct seasons, a rainy season and an extremely dry season. The length of the dry season diminishes from north to south. Insects, diseases and isolation from contaminating crops during the rainy season caused us to focus on the dry season as the most logical period for first investigation of seed production possibilities. Seeds produced under natural drying conditions are less costly in terms of drying, handling, storage and seed quality (germination and seedling vigor). Seeds produced with supplemental irrigation allows the producer more latitude as to varieties he can produce, this is especially true when producing hybrid sorghum and maize seeds. One dry season will be insufficient to obtain the necessary seed production data on the released varieties and to determine the best areas and time of planting for seed production. The wet season should be tested because it is quite possible that some varieties will not produce economical amounts of seed during the short and relatively cold dry season.

The first dry season program was to be at Mokwa and Samaru. Subsequently the Bacita Sugar Plantation project was added. In late February a small sorghum seed crossing block was planned for the Northwestern state research station at Bakura, Nigeria. Plantings began March 8 through March 20. Two of the hybrids to be produced at Bakura have performed very well in Niger and should perform well in dry areas of northern Nigeria. Another crossing block of two male sterile sorghums and one restorer line were planted in mid-March at Tarna Research Station, Maradi, Niger, in cooperation with the Institute de Rescherche, IRAT, Niger.

It is too early to evaluate the economics of dry season and seed production. Some valid indications should become evident following harvest. For example, the non-sensitive sorghums were near normal at Mokwa (plant height and head size) whereas, one sensitive line made a very poor yield. It is essential for the seed producer and for the development of a seed industry that high yields of seed be obtained per unit of production. It would be premature to attach much significance to the low yields and other economic indicators in the early phase of the seed project. Lack of experience in mechanized row crop farming, irrigation techniques or a shortage of farming equipment caused most of the problems so far, therefore production efficiency is very low.

Objectives:

1. Increase breeders seed supply of sorghum and maize varieties, sorghum steriles and restorer lines.
2. Obtain seed production data during a part of the dry season. Data on blooming times, pollen shed, reaction to photo period, temperature and relative yields.

3. Produce test quantatives of sorghum and maize hybrid seeds.
4. Locate and help develop interested seed producers.

Method:
1. Establish a flowering date record of sorghum varieties and steriles for varied planting times.
2. Evaluate pollen production from 12 varieties and the sterility of male steriles.
3. Produce quantities of seed sufficient to test throughout West Africa for evaluation as to adaptability, yield, acceptance by farmer, disease and insect resistance. Several promising or potential hybrids have not heretofore been made because of the spread in flowering times. By producing the seed under irrigation the two lines can be made to bloom together.
4. Restorability of the R-lines will be checked at various locations where the hybrids are grown.
5. Male sterile lines are to be maintained pure by bagging and hand pollination.
6. Seed increase operations are to simulate as closely as possible those of large or small scale commercial seed operation so they could be duplicated on a commercial basis.
7. The activities of this part of the project could provide seed production training. Training in planting methods, time of planting, record keeping, split plantings, field irrigation, harvest and handling of seed, logistics and storage of seed.
8. Yields, costs, etc. of dry season production will be obtained where possible to have some indication of the economics of winter production.

Details of plantings at Mokwa, Bacita, Bakura follow:

Mokwa

Five sorghum steriles, three varieties and one maize variety were increased. Five plantings were made in the date of planting trial where six ms lines and eight varieties were used. Approximately 0.5 acre of a maize crossing block was produced.

Bacita Sugar Plantation

Seed increase:

A. Maize	
1. Lagos White	0.48 acre
2. C-10	0.36 acre
3. Hybrid maize seed production	
a. Lagos White x XB101	1.42 acres
b. C-10 x Biu Yellow	.55 acre
B. Sorghum variety seed increase	
1. SA 7706	0.34 acre
2. 5764 (CKB x Short Kura)	0.29 acre
3. 249 (CK x 2743) late	0.29 acre
4. 257 (CK x 2743) early	0.12 acre

Other varieties such as FFBL 3-1-6 and Short Kura were increased during rainy season at Samaru. Plantings were made December 21 through December 23. Harvest will begin in approximately mid-April except for sorghum variety SA 7706 which will be harvested in late March.

Isolation was to be attained by variation of blooming dates and sorghum between maize.

Bakura - Northwestern State

A small crossing block was planted at the Northwest State research station at Bakura. First planting of RCF A line and SA 7706 R-line was made March 8, 1973. Second planting was made March 13. The second planting was CK-60 and four dwarf Kafir A-lines and one-half the pollinator rows of SA 7706. The third planting on March 20 was the remaining pollinator rows of SA 7706. The RCF and SA 7706 of the first planting was emerging by March 13.

This crossing block, if successful, will provide three hybrids and enough seed for more testing and observation over the region one year earlier than was anticipated. The Bakura block will provide needed data as to late planting possibilities including: a) pollen shed and seed set during higher temperature months, and b) seed quality problems when harvest is near the rainy season.

Tarna Research Station - Maradi, Niger

Seed for a small crossing block of SA 7706, CK-60 and four dwarf Kafir was carried to Maradi on March 14. The seed had been harvested March 10 and 11 at Mokwa. A discussion was held with Mr. Charoy, director of the Tarna Station, about the possible success of the crossing block and concluded it was worth trying. Mr. Sapin of the station would return from tour by the 15th of March and details of row width, planting pattern, plant population were worked out. The block was to be planted as soon as dormancy of the seed had been broken. The planting was probably made on March 18 or 19.

High temperature at Maradi during flowering period is the most probable anticipated cause for failure of this crossing block. Temperatures are expected to be higher at Maradi than at Bakura. Mr. Dick Taylor accompanied me on the trip from Samaru to the Bakura planting and on to Maradi. He procured some of the millet seeds and made arrangements for others to be mailed to Dr. Khadr, the millet breeder at Kano. He also arranged for Mr. Charoy and Mr. Sapin to distribute the regional maize trials to other IRAT stations in West Africa.

/1 This project is only possible because of the very able assistance of the IAR (Institute for Agricultural Research, Ahmadu Bello University, Samaru Nigeria) staff working with cereals.

SOIL MANAGEMENT

K. R. Stockinger and M. Jones

Introduction

For the third successive year rainfall was below normal and yields were affected by lack of rainfall during critical stages of plant growth. Rainfall (Table 14) was normal in May and August and deficient in June, July, and September. This resulted in reduced yields of late planted maize and late sorghum.

Since several of the experiments planned for 1972 dealt with late applications of nitrogen to compensate for leaching losses deficient moisture especially in September did not help. Yields of the soil experiments were all below normal because of interaction of weather conditions, diseases, and insects on yield. It will be necessary to repeat these experiments this year and hope that the rainfall pattern will be more nearly normal.

Maize Experiments

The maize date of planting experiment was repeated for the third year on the same site. The yields were below normal (Table 38) probably because of poor rainfall distribution. Evapotranspiration (Table 14) exceeded rainfall during mid-July and throughout September. Since mid-July was the period when the silks of June 5 planting were elongating and September was the time of silking and pollination of the June 25 planting, both plantings were adversely affected by moisture stress.

Results and observations from previous experiments have indicated that lack of nitrogen after pollination may be the cause of reduced yields of late planted maize. Since this year results also have two periods of drought stress, it would be interesting to see if nitrogen was limiting under the moisture stress conditions. Nitrogen uptake data by Hanway and others indicates that plant takes up about 1/3 of its nitrogen after silking. They also showed that all of this nitrogen plus ½ of the nitrogen taken up before silking are transferred to the grain. Knowing the amount of nitrogen taken up by the plant before and after silking and also the percent of nitrogen in the seed we can calculate the expected yield. This is shown in Table 38 under calculated yield for 1971 and 1972. The nitrogen uptake and percent of nitrogen are given in Table 39. The calculated and computed yields agree surprisingly well for the two years except for the June 25 planting in 1972 and the July 15 planting in 1971. Both plantings suffered severe drought conditions during pollination and grain filling resulting in fewer seeds and less nitrogen being transferred to the grain. Also both the second and third planting took up more nitrogen in 1972 than 1971 indicating less leaching loss of nitrogen. The higher nitrogen percentage in the seed in 1972 than in 1971 also indicates that there was more nitrogen available but the yield potential was reduced by other factors such as drought.

Table 38 ACTUAL AND CALCULATED YIELD AND IN QUINTALS PER HECTARE

Date of planting	1972		1971	
	Actual	Computed	Actual	Computed
May 15	39.5	37.6	67.9	68.4
June 5	57.5	59.7	73.9	72.6
June 25	45.0	54.4	49.4	48.2
July 15	23.5	21.7	29.3	36.6

Table 39 NITROGEN CONTENT OF THE SEED AND NITROGEN UPTAKE OF THE MAIZE PLANT AT SILKING AND AT FINAL HARVEST IN KG/HA

Date of Planting	% N in seed		N uptake at silking		N uptake at harvest	
	1972	1971	1972	1971	1972	1971
May 15	1.65	1.41	124	101	115	147
June 5	1.65	1.26	161	115	179	149
June 24	1.59	1.36	133	93	153	112
July 15	1.80	1.46	78	59	77	83

From these results it can be concluded that in 1972 yields were limited by other factors such as drought in this experiment.

In another experiment the leaching losses of nitrogen were studied by means of drainage lysimeters. Nitrogen was applied to fallow and to early and late planted maize. The nitrogen was applied at planting or split with half at planting and half at tasselling. The yields and the amount of water and nitrogen lost by leaching are shown in table 40. Since the number of lysimeters available is only sixteen the experiment was replicated twice so small differences cannot be detected. Differences in yield between early and late plantings are similar to the previous experiment, but the split application of nitrogen had no significant effect on yield. It is interesting to note that the amount of leachate was only 40 mm for the June 1 planting compared to 103 for the July 1 planting. The amount of nitrogen leached was only 7 kg/ha for the early maize compared to 20 kg/ha for the late maize and 41 kg/ha for the fallow plots.

Table 40 YIELD OF MAIZE LEACHATE, AND MINERAL NITROGEN IN THE LEACHATE FROM THE DRAINAGE LYSIMETER

DOP	Time of N application				Yield	Leachate	N leached
	June 1	July 1	Aug 1	Sept 1	Quintals/ha	mm	kg/ha
Fallow	0	0	0	0	--	113	24
Fallow	375				--	89	41
Fallow	187		188		--	135	51
June 1	0		0		39.6	97	3
June 1	375				81.7	40	7
June 1	187		188		72.6	44	3
July 1		375			41.8	100	25
July 1		187		188	49.4	103	20

These figures bear out the contention that late planted maize is more intensively leached than early maize. However, last year because of the low rainfall leaching of nitrogen was not a factor in its effect on yield. The loss of nitrogen was 12% of the applied nitrogen under fallow conditions, 6% for the late planted maize and less than 2% for early planted maize. The leaching losses had essentially stopped by the first of September when they should have been at their peak according to the long-term average rainfall (Table 14).

These results indicate that nitrogen loss by leaching was minimal in 1972 and does not account for the low yield of late maize for this year. The yield reduction was probably due to the moisture stress during the pollination and grain filling period of the late maize.

Another experiment to determine the effects of the time of application of nitrogen on yield of two dates of planting was carried out on a split plot trial with four replications. The treatments and yields are given in table 41. All treatments received at total of 375 kg/ha of nitrogen as ammonium nitrate-calcium carbonate mixture analyzing 26% N. The site was droughty and was attacked by the Storey streak virus. The July 1 planting was severely hit by this disease and Dr. King estimated that yields were reduced at least 50% as a result of this disease. Lack of rain during pollination and grain filling would also reduce yields.

The yields were generally low and showed no significant response to delayed application of nitrogen. The low rainfall in September resulted in less leaching of nitrogen and also reduced yields of the second planting. Because of the poor site, the effect of the Storey streak virus, and the abnormal rainfall distribution, the experiment did not answer the question if late applications of nitrogen would overcome the reduced yields due to late planting of maize.

Table 41 YIELDS (Q/HA) FOR A MAIZE NITROGEN TIMING/DATE OF PLANTING TRIAL

Nitrogen timing	Date of Planting	
	June 1	July 1
All at planting	28.7	11.9
½ at planting ½ at 8 weeks	31.6	16.1
½ at planting ½ one week after silk	31.3	11.1
½ at planting ¼ at 8 wks ¼ one wk after silk	31.7	13.6
¼ at plant, ¼ at 4 wks, ¼ 8 weeks one ¼ week after silk	35.3	14.7
1/8 at 0, 3, 6, 7, 8, 9, 10, 12 wks.	37.1	15.3

In 1972 at both Kano and Samaru the long term fertility trials comparing three rates of cattle dung (D), nitrogen (N), phosphorus (P) and potassium (K) in all combinations was planted to maize. The nitrogen and phosphorus levels were increased from 0, 12, and 24 kg/ha of N and P_2O_5 to 0, 66 and 132 kg/ha. Potassium was increased from 14 and 28 kg/ha to 56 and 112 kg/ha. The dung remained at the old level of 5.5 and 11 T/ha. The treatments at the old levels had been applied to the soil for twenty-two years with various crops mainly cotton.

The previous years results indicated that the manure gave the only positive response with nitrogen causing a decrease in yield. The nitrogen effect was primarily due to the acidity developed by the use of ammonium sulfate as a ferilizer. However, limeing the nitrogen treated plots did not result in a response to nitrogen. It was felt that to adequately evaluate the treatments a more responsive crop must be used and the chemical fertilizer rates must be raised. This year's results from Samaru show that with a responsive crop and adequate levels of fertility the yield levels are similar to those from other less intensively cropped fields on the experimental farm. Table 42 gives the results for nitrogen and phosphorus at the various levels of dung. For the 0 level of dung the yields for the nitrogen section are from the plots which received phosphorus and for the phosphorus section are from the plots which received N. The results show that either 5.5 or 11 T/ha of dung supply enough phosphate for maximum yields and that the 67 kg/ha of P_2O_5 is adequate for those plots without dung. It must be remembered that the residual effects of twenty-two years of dung and phosphorus applications are also present. In the case of nitrogen additional increments of either dung or nitrogen fertilizer result in increasing yields and the maximum does not appear to have been reached. From the nitrogen response curve it can be estimated that the manure treatments supply roughly the equivalent of 25 kg/ha at the 5.5 T/ha level and 50 kg/ha at the 11 T/ha of nitrogen fertilizer. The results show that the factors limiting yield are nitrogen and phosphorus both of which were supplied by manure in amounts greater than the old rates of fertilization. Since the 5.5 T/ha rate of manure supplies as much nitrogen as the old high rate of nitrogen fertilizer, it is not surprising that the manure treatment was superior.

Table 42 YIELD OF MAIZE GRAIN (Q/HA) FROM THE LONG-TERM SAMARU DNPK EXPERIMENT FROM SELECTED TREATMENTS

Dung (T/ha)	N (kg/ha)		
	0	67	134
0 (with P)	4.8	34.5	45.8
5.5	14.0	43.6	50.8
11.0	28.8	52.0	62.0
	P_2O_5 (kg/ha)		
Dung (T/ha)	0	67	134
0 (with N)	7.4	42.4	37.9
5.5	35.6	35.8	37.1
11.0	47.4	48.8	46.5

Also the previous crops of cotton and sorghum need some nitrogen late in the season for formation of the seeds which would be supplied by the slow release of nitrogen by manure but not by an early application of commercial fertilizer. The apparent superiority of manure in previous years appears to have primarily been due to the extra amount of nitrogen applied in the manure and its continued release stimulating the yield of the late developing crops used as test crops. It would appear that with proper management commercial fertilizers can be used to maintain yields in a continuous cropping system.

At Kano under extreme drought conditions only the manure treatment showed a significant increase in yield. The highest yield at the 11 T/ha of manure was 8.8 quintals/ha. Under these conditions manure may have improved the soil physical conditions so that slightly more of the rain was made available for plant growth resulting in some yield compared to yields of less than 1 quintal/ha from the plots which received only chemical fertilizers.

In addition to these trials, I cooperated with Dr. Tatum on several selection experiments to improve the protein content of maize and the results are reported in the Maize Breeding Investigations Report.

Sorghum Experiments

K. R. Stockinger and A. Kassam

Since the photosensitive varieties of sorghum are planted about June 1 in Samaru, initiate their heads in mid-August, and have head emergence and pollination occur about October 1, it is quite likely that the supply of nitrogen from a June or July application of fertilizer would be exhausted or leached below the active root zone before the heavy demand for nitrogen for seed formation has begun. To investigate this an experiment was set up with four photosensitive varieties and one short seasoned American hybrid to determine the effect of late application of nitrogen fertilizer on yield of grain. The five nitrogen timings ranged from all on by early July to application just before the rains stopped to dividing the extra nitrogen into five portions applied throughout the season. The experiment was plagued with a number of problems ranging from a very heavy infestation of striga to drought during head initiation and anthesis. The yields were very poor and the effects of nitrogen treatments were not statistically significant on any of the varieties.

However, one rather startling effect was observed with regard to striga. The short-seasoned American hybrid Northrup King C9357 was planted late (August 1) so that it would head at the same time as the other varieties. To protect it from shoot fly Thimet granules were applied in the seedbed below the seed at planting. This was the only variety which was not heavily infested with striga and only a few plants on the border rows were infested. It would appear that Thimet may control striga, the variety is resistant, or striga seed was dormant in the latter part of the season. This observation was called to the attention of the people working on striga control and will be followed up in 1973.

In 1972 the Agronomy Section started several projects to study the growth curves of sorghum and millet. One study involved a comparison of intercropped sorghum and millet versus sole cropped sorghum or millet. Previous studies have shown that the total grain yield of the intercropped plots is greater than the sole crops. Since long-seasoned sorghums are used with a short-seasoned millet, the millet is harvested in mid-August and the sorghum gets the benefit of additional light, moisture and nutrients. To see how these factors are inter-related, the nutrient uptake of N, P, and K were determined on samples from the dry matter production study. Only the dry matter production and the nitrogen have been completed and will be reported.

The experiment was planted May 15, all crops being planted at a row spacing of 71 cm and a total population of 46,200 plants/ha. All plots were fertilized with 627 kg/ha of 21-14-14 giving 132 kg/ha of nitrogen. The intercropped treatment consisted of alternate rows of sorghum and millet. The crops were sampled a month after planting and every two weeks thereafter until harvest and analyzed for dry matter and nutrient uptake.

The dry matter production, nitrogen uptake and grain yields are given in table 43.

The combined yield of the intercropped sorghum and millet of 3790 kg/ha is 17% greater than sole sorghum which occuped the land the same length of time. The crops were very inefficient in the proportion of the dry matter production which was harvestable as grain varying from 17 to 21%. Millet continued to grow additional stems and leaves after anthesis resulting in high dry matter production but lower yield. The sorghum yields were undoubtedly influenced by the drought in September. Since the intercropped sorghum had more area available to get its water from it probably suffered less from moisture stress and this may account for the yield per plant being nearly the same for sole and intercropped sorghum.

Table 43 DRY MATTER PRODUCTION, NITROGEN UPTAKE AND YIELD OF SOLE AND INTERCROPPED MILLET AND SORGHUM IN KG/HA.

Date	Dry matter production			Nitrogen Uptake		
	Sole sorg.	Inter sorg.	Inter millet	Sole sorg.	Inter sor.	Int. millet
June 14	59	35	94	2.3	1.5	3.3
June 28	720	830	1110	22.5	12.0	38.1
July 12	3300	1140	4410	89.6	23.9	91.1
July 26	7200	2080	7250	138.0	33.5	115.5
Aug 9	9530	3240	10720	139.5	32.5	140.3
Aug 23	11770	3910		124.7	31.6	
Sept 6	12100	4380		116.0	30.1	
Sept 20	14340	5890		137.7	41.7	
Oct 4	16450	6230		125.1	42.2	
Oct 18	16340	6580		126.5	40.6	
Nov 14	18440	7430				
Grain yield	3230	1570	2220	Sole millet 3100		

The nitrogen uptake figures show that intercropped millet absorbed 80% of the available nitrogen leaving only 20% for the sorghum. The millet used all of the nitrogen taken up after heading (July 12) plus 16.2 kg/ha from the stems and leaves for growth of the head. The sorghum (sole and intercropped) used only nitrogen already taken up by anthesis (Sept. 29) since little or no nitrogen was taken up after this date. At the last sampling date for which the analysis has been completed the intercropped sorghum had taken up 40.6 kg/ha of nitrogen compared to 126.5 kg/ha for the sole crop but the grain yield of the sole sorghum was only double that of the intercropped. The intercropped sorghums yield was probably determined by the amount of nitrogen available to it while other factors such as moisture may have been limiting the yield of the sole crop. The data also shows that on September 20 there was an increase in nitrogen uptake. This may have been due to the more intense wetting and drying cycle due to the drought causing more soil organic nitrogen to be released or because the plant starting to head was more active in absorbing additional nitrogen. The data also show appreciable losses of nitrogen by the plants which were probably due to loss of old leaves due to weathering and decomposition. The total amount of dry matter produced and nitrogen taken up are underestimated because of this loss but the conclusions drawn are still valid.

The two methods of cropping removed a maximum of 140 kg/ha of nitrogen in sole sorghum and 182 kg/ha in the case of intercropped sorghum and millet.

This is more than the amount of N applied indicating that both crops were very efficient in foraging for nitrogen and allowed little or no nitrogen to escape. The advantage of intercropping appears to be due to a more efficient use of nitrogen by the sorghum.

Millet

The growth curves of long and short-seasoned millet at four populations were also studied and the nutrient uptake of two of the plant populations was determined. The varieties used and populations attained were: Short seasoned ex Bornu: 9,900; 73,000; 188,000; 238,000 pl/ha. Long seasoned ex Mokwa 9,900; 45,700; 126,000; 194,000 pl/ha. The populations were achieved by square planting so that each plant was equidistant from all other and each treatment was duplicated. All plots received 627 kg/ha of 21-14-14 giving 132 kg/ha of nitrogen. The crops were sampled on the dates shown in Table 44. The dry matter production and nitrogen uptake on the sampling dates are shown as well as the final grain yield. Since there were only two replicates the results are extremely variable.

The nitrogen uptake figures indicate that all of the nitrogen available was rapidly absorbed and then translocated to the new growth. In the short seasoned variety this resulted in reasonable yields at all population levels while in the long-seasoned variety the amount of nitrogen tied up in dead leaves and unproductive tissue was so large that yield was a declining function of population. The lowest population of the long seasoned variety had time and space to develop and mature a large number of tillers. It was able to develop a yield capacity which fit the nutrient supply better than other populations.

The millets are a very efficient producer of dry matter but the varieties grown in this test were not able to put very much of the production into grain. Using long seasoned varieties at high nitrogen levels and high plant population accentuates the problem.

Table 44 DRY MATTER PRODUCTION, NITROGEN UPTAKE AND YIELD OF TWO VARIETIES AND TWO POPULATIONS OF MILLET IN KG/HA

Date	Dry matter production				Nitrogen uptake			
	Ex Bornu		Ex Mokwa		Ex Bornu		Ex Mokwa	
	P_2	P_4	P_2	P_4	P_2	P_4	P_2	P_4
June 19	1360	3040	500	1030	45	68	21	61
July 3	10560	13360	4300	7820	244	264	123	230
July 18	13400	17670	9860	13110	172	187	179	165
Aug 1	22130	22110	20280	16460	240	219	196	164
Aug 15	18920	20800	21170	20320	180	169	180	138
Aug 29			22560	24510			143	139
Sept 12			23270	28210			136	144
Sept 26			25800	34640			116	152
Oct 13			34580	49650			124	178
Nov 10			34500	53200				

	Ex Bornu				Ex Mokwa			
	P_1	P_2	P_3	P_4	P_1	P_2	P_3	P_4
Grain yield	2530	4170	3620	3150	3180	1620	1190	960

PLANT PATHOLOGY & BREEDING - IBADAN

Final Report - J. Craig

INTRODUCTION

The maize improvement program, of the AID-ARS major cereals project, located at Ibadan, Nigeria, was started in September 1965. The ojbectives of this program are:

1. to conduct research on problems limiting maize improvement in west Africa.
2. to improve liaison and cooperation among maize improvement programs in west Africa and
3. to provide training in maize improvement techniques.

The project center is at the Federal Department of Agricultural Research. The following report is concerned with the activities of this project during the period of my supervision which began in September, 1965 and ended in July, 1972.

Abstract

During the 1965-72 period of the AID-ARS major cereals project program of maize improvement at Ibadan, Nigeria, work was carried out in the areas of maize diseases, maize breeding, liaison among maize improvement programs in west Africa and training of personnel in maize improvement techniques.

As a result of the disease and breeding studies maize Composites highly resistant to rust (P. polysora) and blight (H. maydis) and with good potential for selection of superior synthetics and hybrids have been produced. These composites have been distributed to maize breeders in west Africa for trial and use in recurrent selection programs for production of synthetics. Studies of recurrent selection methods, Storey's streak, a virus disease of maize and environmental effects on yield have been started.

Uniform maize trials for west Africa were started in 1967; these have served to identify the better maize cultivars available in west Africa and have increased the exchange of seed and information among west African countries. Tours were made of West African countries to provide assistance with improvement or initiation of their maize improvement programs. During this seven year period 17 members of the staff of the Federal Department of Agricultural Research of Nigeria received training in maize improvement techniques.

Research Activities

I. Disease Resistance Studies:

Two maize diseases, southern maize leaf blight (Helminthosporium maydis) and southern maize leaf rust (Puccinia polysora) are major limiting factors in maize production in west Africa (Craig, 1966; Eijnatten 1962). Project studies of these diseases were started in 1965 with the screening of a large collection of local and introduced maize cultivars for resistance to H. maydis and P. polysora.

An extremely effective type of resistance to H. maydis was found in the Kenyan maize introduction AFRO P. 59. 289. This resistance was characterized by reduction in the amount of leaf damage and inhibition of sporulation by the pathogen in lesions on the leaf (Craig and Daniel-Kalio 1968). Inheritance studies of this resistance revealed that the resistant reaction was controlled by two linked genes (Craig and Fajemisin 1969).

As part of the program to find maize genotypes resistant P. polysora a study was made to determine the number of races of P. polysora present in Nigeria. Maize selections suitable for use as differentials were produced and tests of collections of P. polysora revealed two races of P. polysora (Lallamahomed and Craig 1968). Tests were continued for three years but no new races have been found. Screening of the maize collection for rust resistance identified two maize selections from Kenya and one selection from Colombia which possessed hypersensitive resistance to the two Nigerian races of P. polysora.

Inheritance studies were conducted to determine the number of relationship of the genes controlling rust resistance in those three maize selections. The results of these studies indicate that resistance to P. polysora is controlled by a single gene and that this gene is identical or allelic in the three resistant maize cultivars. The blight resistance and rust resistance factors described above were combined in one maize cultivar. The cultivar, Rb, was distributed to several countries in west Africa, Brazil and Jamaica for observation of reaction to H. maydis, and P. polysora. Rb was found to be resistant to races O and T (Craig, 1971) of blight and to rust at all these sites.

A project to develop maize populations resistant to Storey's streak, a virus disease, was started in 1972. This disease causes severe reduction in yield and height of affected plants but is not economically important because epiphytotics of streak usually occur in the November to January period when very little maize is grown commercially in west Africa. However, the November--January period is important to maize improvement specialists because maize must be grown throughout the year to achieve maximum progress from recurrent selection programs.

The program to develop maize cultivars resistant to Storey's streak is conducted with the assistance of the entomology section of the Federal Department of Agricultural Research of Nigeria (F.D.A.R.). The initial phase will be concerned with development of techniques for the maintenance of viruliferous populations of the vector of Storey's streak, Cicadulina sp.

II. Maize Composites:

A limiting factor in the development of superior maize synthetics and hybrids in west Africa has been the limited potential of the breeding material used. Recent work in Kenya has demonstrated the value of maize composites, formed by synthesis of large numbers of maize cultivars, as source populations for maize improvement. I suggested that the Federal Department of Agricultural Research in cooperation with other agricultural institutions in Nigeria undertake the formation of maize composites for similar use in west Africa.

After discussions with maize improvement specialist from East and West Africa a composite development program was started in 1968. This program was designed to produce three composites, NCA, NCB and NCC, with sufficient variability in each composite to insure good selection possibilities and sufficient genetic divergence between composites to provide appreciable heterosis when selections from these composites were crossed. The production of these composites was completed in 1969. (Craig, 1970a).

In an attempt to familiarize maize breeders with these composites and insure their utilization by breeders in West Africa Composites NCA and NCB were distributed to several west African countries for trial in 1970 and 1971. The results achieved in 1970 were encouraging; the composites were equal or superior in yield to most of the maize varieties presently recommended in these countries. NCB gave equally good performances in 1971 but NCA performed badly because of the poor viability of the seed.

The maize selections resistant to maize leaf blight and maize rust were used to produce disease resistant versions of the NCA and NCB composites. These disease resistant composites named NCARb and NCBRb were produced in 1971. NCB and its disease resistant version NCBRb were compared for yield when subjected to a severe attack of maize rust. NCBRb yielded 66% more than NCB (Table 45). A high lysine version of NCBRb named $NCBRbo_2$ was produced in 1971.

NCARb and NCBRb were distributed to 12 West African countries for trial in 1972. I believe that the disease resistance and good selection potential for other desirable characters present in these composites will be of value to maize improvement programs in West Africa and other tropical areas.

Table 45 Yield and disease score of 4 maize varieties at Moor Plantation in 1971.

Variety	Yield, q/ha	Disease score*
NCB-Rb	33.3a	2.9a
096	22.8b	4.8b
X306	22.1b	4.9b
NCB	20.0b	5.8b

* Disease score is the mean number of leaves per plant dead for one-third of their length.

III. Recurrent Selection Programs

The maize composites will be used as base populations for recurrent selection programs designed to produce improved maize cultivars. Various methods of recurrent selection have been proposed. These methods differ in time required per cycle, rate or progress expected, level of training required by personnel, amount of labor, land area and necessary environmental conditions. In an attempt to provide information which will assist breeders in West Africa to make a choice among the various selection systems I assisted in planning a study to compare the effects of three types of recurrent selection on a maize population in Nigeria. This study, conducted by Mr. Raghunathan of the Federal Department of Agricultural Research compares S_1 testing for yield, mass selection for ear weight and mass selection for ear prolificacy. This study was started in 1969; six cycles of selection for ear prolificacy, six cycles of selection for ear weight and three cycles of selection for S_1 yields have been completed. Trials to determine the effects of these cycles on yields and other agronomic characters of the original maize population will be conducted in 1972.

The wide range of variability for agronomic characters exhibited by the maize composites permit selection for many features other than yield. A study I conducted in 1968 demonstrated that root strength in a maize population could be increased significantly by mass selection (Craig, 1968). It is expected that maize breeders using NCARb and NCBRb in their programs will attempt phenotypic selection for characters which they consider desirable and that these selections may be carried out independently of selection for yield. In such cases if the relationship between the character being selected for and yield of grain is not known deleterious effects of this selection on the yielding ability of the population may result. To provide some information for guidance of breeders a study was conducted to determine the correlations between certain agronomic characters and yield in the composites NCB. The results of this study indicate that selection for the desirable characters of lower plant height, good husk coverage and drooping ears should be handled with caution because of the negative correlation between these characters and yield.

Cooperative programs with the Federal Department of Agricultural Research to produce high lysine maize synthetics were started in 1971. In these programs the maize composite $NCBRbo_2$ is being subjected to mass selection for ear weight at sites in East Central Nigeria and Southeastern Nigeria. A similar program has been planned for the Rivers State of Nigeria.

IV. Environmental Effect Study

It was noted that maize varieties invariably yield better at Samaru in Northern Nigeria than at Ibadan in Southern Nigeria. Samaru differs from Ibadan in several environmental factors which may affect yields e.g. disease incidence, soil type, temperature. A study to determine the more probable of the environmental causes involved in these maize yield differences was started in 1972. In this cooperative study involving Dr. Pandey, Federal Department of Agricultural Research soils chemist, Dr. Stockinger, USDA-ARS soils specialist at Samaru, and myself the disease resistant composite NCBRb will be grown at Samaru and Ibadan for a number of years and detailed observations will be made on environmental conditions and performance of the NCBRb at each site.

If this study is successful in identifying the environmental factors involved in the differences in yield between these sites the information would provide maize breeders and agronomists with clearly defined objectives for their efforts to improve maize yields in southern Nigeria and areas with a similar environment.

Regional Activities

I. West African Uniform Maize Trials

Many countries in West Africa have maize improvement programs which have been operating for several years, however, the benefits of these programs were usually restricted to their place of origin because of insufficient exchange of information between the various countries. In an attempt to alleviate this situation I proposed the initiation of uniform maize trials in 1966. These proposed trials were designed to evaluate maize cultivars derived from tropical maize improvement programs at several sites in West Africa. Seed of trials entries would be sent to the major cereals project at Ibadan for distribution to participating countries. The trials would be supervised by maize workers in participating countries and trial results would be sent to Ibadan for compilation and distribution to participants.

The proposal for uniform maize trials was accepted by maize improvement specialist in seven countries and trials were started in 1967 (Craig, 1970b). These trials have been successful in identifying superior maize cultivars and their zones of adaptation. The information provided by these trials has enabled maize breeders and agronomists to improve their programs by utilization of desirable maize cultivars from other countries. The number of countries participating in these trials has increased from seven in 1967 to 11 in 1972.

II. Consultation

During the 1965-72 period requests were received from Liberia, Ghana, Dahomey, and Zaire for assistance with maize improvement programs. In response I visited these countries, observed conditions, conferred with officials and suggested procedures for achieving the desired objective.

Training

In the seven year period covered by this report 9 agricultural assistants, 4 laboratory assistants and 4 research officers of the Federal Department of Agricultural Research were assigned to the major cereals project for training. In addition two students of the University of Ibadan were assigned to the project for a three month training period. One of the Research Officers, Mr. Fajemisin is presently doing graduate study in maize pathology and maize breeding in the United States. He is expected to complete his studies and return to Nigeria in 1973.

Suggestions

I. Diseases

The disease resistant Composites NCARb and NCBRb have satisfactory levels of resistance to both _H. maydis_ and _P. polysora_ however this resistance is monogenic for P. polysora and involves only 2 genes for reaction to H. maydis. It is conceivable that strains of these pathogens may appear which will exhibit virulence to these cultivars. The maize breeder at the International Institute of Tropical Agriculture (IITA) in Ibadan is attempting to develop versions of NCA and NCB composites possessing multigenic resistance to H. maydis and P. polysora. Such resistance will probably be of a lower order than the resistance exhibited by NCARb and NCBRb but is less likely to be endangered by new virulent biotypes of the pathogen.

If the IITA efforts are successful the multigenic resistant populations can be combined with NCARb and NCBRb to produce populations having hypersentive resistance to P. polysora and chlorotic lesion resistance to H. maydis as their first line of defence to diseases and a secondary multigenic resistance as insurance against the occurrence of virulent new strains of these pathogens.

II. Lodging Resistance

Root lodging and stalk breakage of maize is a serious problem in many parts of West Africa. A program of recurrent selection for lodging resistance should be started with the Composites NCARb and NCBRb. Lodging resistance like rust and blight resistance would be of value in most of the maize growing areas in West Africa.

The causes of lodging are varied e.g. root rots, stalk rots, insect damage to roots and stalks, structural weakness of roots and stalk. Due to the diverse nature of the causes I believe the most efficient approach would be a cooperative one involving entomologist, pathologist, agronomist and breeder.

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CEREAL PATHOLOGY - SAMARU

S. B. King

Sorghum

World Sorghum collection

Eight hundred eighty lines of the world collection were screened for reaction to leaf diseases and received preliminary screening for Striga resistance. The range of I.S. numbers represented ranged from 10944 through 12330. Seed planted came from either India or Puerto Rico, and seed of missing entries (about 1/3 of the entries within this range of I.S. numbers) could not be obtained. Reaction to six leaf diseases and Striga was scored against natural infection. A summary of disease reaction is given in table 45. A high percent of lines were susceptible to sooty stripe, grey leaf spot, and Striga. Relatively little anthracnose, oval leaf spot, and zonate leaf spot occurred. This part of the world collection did not show the extent of variation in plant type usually observed. Information on pedigrees would be relatively narrow. Data were also obtained on heading date, height, panicle type, seed color and size, and plant pigment.

All data obtained on the world sorghum collection at Samaru (over 8,000 lines) since 1965 have been taken from log books and put onto work sheets. Work is now beginning on transferring this information to 80-column computer cards.

Field screening for head mold resistance was conducted for 279 entries of the world collection. These entries had been previously selected from all entries of the world collection which bloomed before the first week of September. Hence, seed developed and matured under wet and humid conditions. Sixty-three lines from the conversion program and 20 entries of an All Disease Nursery from Texas were also evaluated. About 50 of the best lines are being sent to the sorghum breeder and pathologist in Senegal for use in their program. One of the objectives of their program is to develop material which can be harvested before the end of the rains. One requirement of this type of material is that it have head mold resistance. This type of material is likely to become more important in West Africa, since the period of rainfall is frequently too short for the relatively late, local varieties to mature, especially in the northern Sudan zone. An earlier maturing type with head mold resistance could alleviate loss due to an abbreviated growing season.

Table 46 SUMMARY OF REACTION OF 880 ENTRIES (IS 10944-12330) OF THE WORLD SORGHUM COLLECTION TO LEAF DISEASES AND STRIGA IN 1972*

Disease (Pathogen)	% of entries showing	
	Resistant or escape reaction	Definite susceptible reaction
Anthracnose (Colletotrichum graminicola)	87.5	12.5
Rough leaf spot (Ascbochyta sorghinia)	51.2	48.8
Sooty stripe (Ramulispore sorghi)	6.5	93.5
Oval leaf spot (R. sorghicola)	87.4	12.6
Zonate leaf spot (Celococercoapora sorghi)	84.6	15.6
Grey leaf spot (Cercospora sorghi)	12.8	87.2
Witchweed (Striga hermonthica)	21.4	78.6

*Natural infection used only.

Striga

a. Stage I screening. - Eight hundred eighty lines of the world sorghum collection were passed through Stage I of Striga resistance screening on Field T-10. The only criterion used for evaluation in Stage I is whether or not leaf symptoms appear in leaves of sorghum. About 20% of the lines remained free of symptoms and will be further evaluated in Stage II in 1973.

b. Stage II screening. - Over 1500 lines of the world collection, which were selected from over 3200 lines in Stage I screening in 1971, were passed through the second stage of screening. This involves planting in a Striga infested field and adding additional Striga seed to the planting furrow. Evaluation is based on numbers of emerged Striga plants associated with each entry and Striga symptoms in leaves. About 40% of these lines will be further tested in Stage III in 1973.

c. Stage III screening. - Four hundred seventy lines of the collection were passed through Stage III screening. These had been selected from over 1500 lines in Stage II in 1971, and 4000 lines in Stage I in 1970. The same evaluation criteria used in Stage II are used in Stage III, except planting is replicated and in soil with heavier Striga infestation. About 150 of these lines are to be further screened in 1973.

d. Greenhouse screening. - About 100 of the best lines coming out of Stage II in 1971 were screened for Striga resistance in the greenhouse. Evaluation was based on actual number of Striga attachments to roots of plants growing in Striga infested soil. Plants were grown in 40 ml glass vials, 3" plastic pots, and 5" plastic pots and roots were examined 2, 4, and 8 weeks after planting, respectively. Results were generally not consistent for each of the three tests, and agreement between replications at two weeks was often not apparent. Low attachment numbers were consistently obtained for only a few lines. There is some doubt as to the usefulness of this screening technique.

e. Root exudate screening. - The same 100 lines as in "d" above were tested for production of root exudates having the stimulant required to germinate Striga seed. This technique involves growing plants in clean, coarse sand in plastic pots for 9 to 11 days after which 5 to 10 ml leachate containing the exudate is removed from pots with a vacuum pump. Striga seed having been pretreated under moist conditions for 11 to 13 days at 22o C is then incubated for 5 days at 32 to 34^{o} C in the presence of the leachate obtained from pots. The last of three replications is now being read. Percent germination of Striga seed rarely exceeds 25 percent and some very significant variability is noted between replications. Leachate from sand only, gives less than 0.5% germination. Some lines appear to give consistently low germination. The technique needs some refinement, but should prove to be a useful tool in the screening program.

f. Striga resistant composite. - Work has been initiated on developing a Striga resistant composite using the West African Bulk Composite (X) which has the ms7 gene for sterility. Over 500 sterile panicles were pollinated with pollen from a total of 77 lines thought to have resistance to Striga. Seed from 300 of these crosses was planted separately in the 1972/73 irrigated nursery. These will be harvested soon applying little selection pressure and seed within entries will be bulked. This seed will be planted in alternate rows with Bulk X in 1973. Mr. Andrews drew up a plan for compositing which will require about three and one-half years to complete recombination through three cycles.

g. Genetics of resistance. - Forty-five lines with some Striga resistance were crossed onto CK 60A, a Striga susceptible line, to initiate a study on genetics of Striga resistance. The F_1's were planted under Striga infestation and evaluated for resistance on the basis of emerged Striga plants and Striga leaf symptoms. F_2's of several of the more promising crosses for resistance will be planted under heavy infestation in 1973.

Smuts

a. Covered smut. - Very low infection rates were obtained in covered smut (Sphacelotheca sorghi) trials in 1972. Entries in the West African regional sorghum nurseries were evaluated for their reaction to covered smut. Due to low infection level, reliable data were not obtained on resistant material, but the following entries appeared to be susceptible to both isolates of S. sorghi used: H 37, H 135-2, Naga White, CE 90-13-2, 2141, SK 5912, and 137-2.

Two isolates of S. sorghi were tested in the West African S. sorghi Nursery 1972. Slight infection was obtained using the normal inoculation techniques of dusting seed with teliospores before planting, but moderate infection occurred when entries were inoculated as seedlings by injecting sporidia into the growing point. Durra Selection, Spur Feterita and Kafir x Feterita showed no infection by either isolate; and White Yalo, Dwf. Hegari, Pink Kafir, Reed Kafir, and Red Amber x Feterita were readily infected by both isolates. Dwf. Yellow Milo was not infected by one isolate, but had 34% infection by the other. Pierce Kaferita was slightly infected by both isolates.

Too little infection was obtained in other covered smut trials for reliable results. The inoculum used germinated well on water agar, suggesting good viability of spores. However, environmental conditions during planting, seed germination, and early seedling growth are critical with regard to infection, and these may not have favored infection in 1972.

b. Loose smut. - Five Nigerian isolates of loose smut were tested against six different varieties. As usual, Reed Kafir, White Yalo, and Red Amber x Feterita were highly infected (20 to 70%) by all isolates, white Kafir x Feterita appeared immune. Pierce Kaferita showed a surprisingly high rate of infection (7 to 18%) and CI 182 Std. Feterita was surprisingly low (5 to 23%) for all five isolates.

It was interesting to note a rather high rate of tiller infection in entries of the world sorghum collection growing in close proximity to the loose smut trial. Presumably, airborne teliospores from the loose smut trial provided inoculum for infection of axillary buds. This type of infection has been suspected in Nigeria, particularly in late maturing local varieties.

c. Head smut. - Various methods for artificially inoculating sorghum with head smut (S. reiliana) were investigated. It was hoped that a simplified technique could be found which could be used where lack of personnel and/or facilities did not permit the use of the more sophisticated hypodermic syringe technique. The hypodermic syringe technique involves injection of sporidia into the growing point of 2- to 3-week old plants with a hypodermic syringe and needle (generally 22 to 24 gauge). In all work described below, each inoculum was produced by separately growing 4 monoteliospore cultures in potato dextrose broth for 5 to 7 days on a wrist-action shaker at room temperature, and mixing the four cultures immediately before injection. Basically two other techniques were tested: 1) adding about 7 ml of a 1:3, teliospore: soil, V:V, mixture to each planting hole at planting, and 2) planting seed in soil flats having the same ratio of teliospore: soil mixture in 1 above was divided into three equal lots and kept moist for 26, 7, and 0 days before planting. The mixture in 2 was similarly divided and kept moist for 31, 6, and 0 days before planting. Three sorghum varieties, representing both early and late flowering types, were used. Results are presented in Table 2.

Starting plants in infested soil in flats gave a fairly high rate of infection. This could be used for artificial inoculation by staff with little or no training in pathology. Moistening soil for 31 days before planting increased smut incidence considerably over no advanced moistening. Adding a teliospore : soil mix to the planting hole did not increase smut incidence enough for this method to be used, regardless of the time the mixture was kept moist.

Table 47 PERCENT HEAD SMUT INFECTION OBTAINED IN 3 SORGHUM VARIETIES USING 2 SOURCES OF INOCULUM (A & B) AND 7 METHODS OF INOCULATION*

Inoculation method	FC 16185 Rex (I.S. 684		FC 6606 (Spur Fet.		Dwf. Farafara 2123	
	A	B	A	B	A	B
Hypodermic injection	39.2	51.5	61.1	87.2	84.4	92.4
31-day spore/soil mix in flats	18.7	--	46.8	--	57.5	--
6 " " " "	11.5	--	37.4	--	46.0	--
0 " " " "	6.3	--	26.8	--	19.8	--
26-day spore/soil mix in field planting hole	0.0	0.0	5.0	1.1	0.0	1.1
7-day spore/soil mix in field planting hole	0.0	0.0	1.1	0.0	2.2	3.4
0-day spore/soil mix in field planting hole	0.0	0.0	4.3	1.3	5.3	1.6
Control (no artificial inoculation)	2.4		1.1		1.0	

*Each figure represents average of three replications. Inoculum "A" collected from 1971 wet season nursery, inoculum "B" from 1971/72 irrigated nursery. For hypodermic injection, inoculum A from Sumac 6550 and inoculum B from FC 6606 Spur Feterita.

A set of sorghum differentials was used to identify two isolates with respect to physiologic races. The hypodermic syringe technique was employed. Results are presented in Table 48. In addition to the susceptible check, Norkan, only FC 6606 Spur Feterita became infected to any significant degree. This is the only one of the differentials which does not become infected in the U.S., the only country where this type of work has been reported. These results agree well with results of similar trials conducted at Samaru during the past two years.

The West African regional sorghum nurseries were tested for reaction to head smut using the hypodermic syringe technique and one isolate. Results are presented in Table 49. Variety 453 again appeared immune, and NK 300, C 9357, CK 60 x SA 7706, and 4 Dwf. CK x SA 7706 also showed little infection, just as they did in 1971. U-10, variety 708, H 37, and H 135-2 were tested for the first time in 1972 and showed no infection. Most varieties showed far more susceptibility than would be acceptable in areas of heavy head smut infestation.

d. Long smut. - Long smut (Tolyposporium ehrenbergii) trials were conducted at Kano. In a trial involving two dates of planting and 43 exotic sorghum varieties, results were obtained very similar to those of 1971. No infection was found on Durra Selection, Pierce Kaferita, Eup. Dwf. Broomcorn, D. Dwf. Feterita, Piper, Desert Bishop, AS 3749 Std. Feterita, and Butch Boy. Moderate to heavy infection occurred on Red Amber x Feterita, Leoti, and I.S. 453 Dwf. Shallu. Other varieties gave an intermediate response. Bagging apparently increased long smut by two to four times. Observations have been made on long smut reaction to many Nigerian varieties grown in the Sudan Savannah zone, and all appear to be moderate to highly susceptible.

To gain a better understanding of long smut infection with respect to anthesis, the A and B lines of CK 60 were planted and incidence of long smut recorded. Incidence was 2 to 10 times greater in CK 60 A than in CK 60 B, particularly on panicles under pollinating bags. These results suggest that floral infection by long smut is similar to ergot infection in some cereals in that flowers remain susceptible only until fertilization.

Four fungicides were tested as seed dressings in a replicated trial to control long smut. Fungicides were: Aldrex T, Plantvax, Vitavax, and Benlate. None significantly reduced the incidence of long smut over the control. This suggests that little or no long smut infection occurs during seed germination or very early seedling growth.

Table 48 PERCENT HEAD SMUT INFECTION ON 5 DIFFERENTIAL HOST VARIETIES USING TWO SOURCES OF INOCULUM

Differential	% infestation*	
	Inoc. A	Inoc. B
Combine 7078	1.0	0.0
Tx 414	0.0	0.0
SA 281 Early Hegari	0.0	0.0
FC 6606 Spur Feterita	38.0	85.6
I.S. 674 Norkan (Susc. check)	94.2	91.3

*Each figure represents an average of three replications. Inoculum A from Sumac 6550, inoculum B from FC 6606 Spur Feterita.

Table 49 REACTION TO WEST AFRICAN GUINEA (G) AND SUDAN (S) SAVANNAH ZONE NURSERIES TO HEAD SMUT*

Entry	Country	Nursery	% Infection
CK x 1216-9	Cameroun	G	100.0
CK x 299b6	"	G	60.0
SK 5912	Nigeria	G	83.7
453	"	G	0.0
181	"	G	60.0
2141	"	G	100.0
2347	"	G	12.0
137-62	Niger	S	76.5
L6 (137-62 x JJ)	"	S	90.0
L30 (137-62 x JJ)	"	S	70.0
NK 300	USA	S	3.6
C 9357	"	S	2.7
CK 60 x SA 7706	Nigeria	S	2.1
4Dwf. CK x SA 7706	"	S	2.1
U-10	Uganda	S	0.0
CE 90-13-2	Senegal	S	66.7
I.S. 9290	Sudan	S	24.0
I.S. 9289	"	S	70.0
I.S. 7047	"	S	33.3
708	Chad	S	0.0
936	"	S	18.2
CG 70	"	S	64.3
981	"	S	45.2
96/12/7A	Mali	S	50.0
H 37	Upper Volta	S	0.0
H 135-2	"	S	0.0
Naga White	Ghana	S	58.3
Damougari No. 55	Cameroun	S	93.5

*Inoculum from Sumac 6550

Bulrush Millet

Screening for diseases resistance

A screening and selection program for disease resistance has been going on at Samaru and Kano for the past several years. Diseases of interest have been downy mildew (Sclerospora graminicola), smut (Tolyposporium penicillariae) and ergot (Claviceps microcephala). With few exceptions, resistance has been evaluated on the basis of host response to natural infection. Bagging spikes, planting spreader rows, and late planting have also been adopted to increase the challenge by the pathogen. Dependence on natural infection has lead to somewhat inconsistent results from one year to the next. Hence, more than one season is required to evaluate host response.

Material which has received considerable attention includes a world collection of millet which at one time included over 2500 entries. All disease reaction information which has been obtained on this collection since 1967 has been collected from the various logbooks and summarized. Selections from some entries have shown promising resistance over several seasons at both Kano and Samaru. Many entries were dropped from the collection by the millet breeder because of poor agronomic characters. Some of these may have had high types of resistance but did not receive sufficient testing. Eight hundred entries selected by the breeder were scored for reaction to downy mildew at Samaru or Kano on 4 to 7 occasions over 3 to 5 growing seasons. Entries received selection pressure for smut, and to a lesser extent for downy mildew. Numbers of lines which showed varying degrees of multiple resistance are shown in Table 50.

Another set of material which has received considerable attention for disease resistance is a group of 200 lines that came from the United States, but which originated in West Africa.

Table 50 NUMBER OF MILLET LINES IDENTIFIED FROM THE WORLD COLLECTION WHICH SHOW MULTIPLE DISEASE RESISTANCE

No. of lines	Resistance to* Downy mildew	Smut	Ergot
11	D	D	D
10	D	D	P
14	D	P	D
14	P	D	D
30	D	P	P
8	P	D	P
13	P	P	D
30	P	P	P
Total 130			

*D = definitely a high type of resistance, P = possibly a high type of resistance

This material was evaluated and selected for smut and downy mildew resistance in 1968, smut only in 1969 and 1970, and all three diseases in 1971 and 1972. Forty selections thought to have excellent smut resistance were planted in 140 plant plots in a field known to have a high level of both smut and downy mildew inoculum. Four of these lines were evaluated as having excellent multiple resistance to all three diseases, eight showed excellent resistance to two diseases, and 15 showed excellent resistance to only one disease. Remaining lines generally showed moderate resistance to one or more diseases.

About 100 other selections from the original 200 lines showed promising resistance to at least two diseases, but these require further testing. Many lines which were kept in the screening and selection program because of promising smut resistance have been dropped because of relatively high susceptibility to downy mildew. Due to low downy mildew infection pressure during 1970 and 1971, there was little or no selection for downy mildew during these years.

Seed of disease resistant millet and some susceptible control varieties have been sent to both Bambey, Senegal, and Maradi, Niger, for evaluation of resistance to downy mildew and smut. Smut resistant lines will be sent to Chad for evaluation since this disease is a serious problem in some areas.

The most advanced generation of Ex Bornu was screened for plants having resistance to downy mildew. Seed of Tift 23 was mixed with Ex Bornu before planting in 7.6 m rows. Every third row was planted with Tift 23 only. Tift 23 is extremely susceptible to downy mildew and it was used to increase airborne spores of S. graminicola. On the basis of height and head type it could easily be differentiated from Ex Bornu. Virtually all Tift 23 plots showed downy mildew symptoms within three weeks after planting, and few developed to flowering. Five hundred seventy-three Ex Bornu plants were allowed to complete their growth cycle, and 45.7% remained free of symptoms. Single spikes were selected from 68 of the best-looking plants, evaluated for smut, and seed was saved for further testing.

Seed of a pearl millet composite developed in the United States was sent by Dr. O. J. Webster for an observation trial in Nigeria. In general, the composite was extremely susceptible to ergot (25 to 75% ergot on about 50% of the spikes) and smut (all 75 bagged heads showed more than 50% smut). The composite was also susceptible to stem borer and generally had poor seed set. Quite surprisingly, however, the composite had fairly good downy mildew resistance (less than 7% of plants with symptoms) It seems doubtful that this composite is of much value to the millet breeding programs in W. Africa.

West African millet nursery

This nursery was planted and evaluated for reaction to three millet diseases. Results are presented in Table 51. Syn. 70 (Upper Volta) showed the best resistance to downy mildew. Entries from Upper Volta showed the least downy mildew infection, but they were susceptible to smut.

Table 51 DISEASE REACTION OF WEST AFRICAN REGIONAL MILLET NURSERY

Entry	Country	Downy mildew (%)	Ergot (1-3 scale)	Smut (1-5 scale)
P_3 Kolo	Niger	37.0	1	3.2
HKN	Upper Volta	15.2	2	2.4
Syn. 70	Upper Volta	7.1	1*	3.3
M-2	Ghana	68.2	2	1.2
Nyanza	Ghana	18.5	1*	2.7
Souna 3	Senegal	23.3	2	3.1
Ex Bornu	Nigeria	37.0	2	1.7

*Flowering possibly too late in season for reliable information

M-2 (Ghana) likely has a fairly high type of smut resistance, but it is extremely susceptible to downy mildew. P_3 Kolo (Niger) and Ex Bornu (Nigeria) may have some resistance to ergot and smut, respectively.

Mode of smut infection

Most smut infection in millet is thought to be the result of airborne spores which germinate and invade individual florets sometime before or during anthesis. However, it is not clear whether a significant amount of infection is also initiated during the very early stages of plant development between seed formation and early seedling growth. Most cereal smuts enter the host through the seed or during seedling development, and continue to grow in apical meristems, virtually unnoticed until head exertion. Three experiments were designed to study whether or not a significant amount of early infection actually occurs in the millet smut disease, and whether fungicidal seed treatment can be an effective means of control.

Experiment I - If I. penicilariae enters seed during seed formation it seems that such infected seeds most likely would be located in close proximity to infected florets which produce sori. Based on this assumption, separate lots of seed were collected from heavily infected areas (seed surrounded by or adjacent to several sori) and from smut free areas (seed removed a distance of at least 10 mm from sori) of single spikes from 11 S4 lines. These lines represented a range of susceptibility to smut. Seeds were surface sterilized in 2% sodium hypochlorite for 10 minutes followed by thorough rinsing in water. A randomized block design with only two replications was followed for planting in the field. Lack of sufficient seed did not allow more replications. Plots were single, 7.6 m rows with a maximum of 39 plants per row. Up to five spikes on half the plants in each row were bagged and all spikes on remaining plants were left unbagged. All bagged spikes and up to five spikes from each unbagged plant were harvested and scored individually for the incidence of smut using a 0 to 11 scale.

As anticipated, unbagged spikes showed considerably less smut than bagged spikes. High variability in smut incidence was found among spikes within the same row and even among spikes of the same plant. No statistically significant differences in smut incidence were found between plants arising from the two different types of seed for any of the 11 entries.

b. Experiment 2. - This experiment investigated the possibility of infection by seedborne or soilborne spores. Three inbred millet lines with moderate susceptibility were used and plants were started in soil flats and transplanted to the field 18 to 20 days later. Surface sterilized seed of each inbred was divided into two equal lots: one lot was dusted with teliospores immediately before planting and the other lot remained untreated. Soil for flats was obtained from land which had been fallow for twelve years and was unlikely to contain teliospores of T. penicillariae. Soil in half the flats was amended with teliospores at the rate of 1:14, teliospores:soil, V:V, and soil in remaining flats were untreated. Flats were prepared three weeks before planting and were watered twice weekly. One week after initial watering, the surface of teliospore amended soil had a whitish cast which on closer examination was found to be the result of abundant germination of teliospores to form light colored basidiospores. This was present until well after seedling emergence. Each of the three millet inbreds received the following four treatments: 1) both seed and soil without teliospores, 2) seed without teliospores and soil with teliospores, 3) seed with teliospores and soil without teliospores, and 4) both seed and soil with teliospores. Seedlings were transplanted to the field in a randomized block with four replications. Plot size, bagging, and scoring for smut were conducted as described in Experiment 1.

Variability in smut score among spikes from the same plant and plants within the same row was great. None of the four treatments significantly influenced the incidence of smut.

Experiment 3. - This experiment was conducted to determine whether or not fungicidal seed treatment influences the incidence of millet smut. Seed of two smut susceptible inbreds were used. Seeds were dusted with teliospores before fungicides were applied at a 0.35% rate. A total of five treatments including a fungicide free control were used. Fungicides were: Aldrex T, a thiram/aldrin mixture which is the commonly recommended cereal seed dressing in Nigeria; and Plantvax, Vitavax, and Benlate, fungicides known to have systemic action against basidiomycetes. Experimental design was a randomized block with four replications. Plot size, bagging, and smut scoring were conducted in the same way as is described in Experiment 1.

Variability in smut score among spikes from the same plant and plants within the same row were great. None of the four fungicides significantly reduced the incidence of smut.

Results of these three experiments show that a significant level of smut infection is not initiated during early plant development. Hence, it is not surprising that no significant control of smut was obtained with seed dressings in Experiment 3.

Maize

Striga

a. Yield in relation to soil nitrogen level. - An experiment was conducted to determine the influence of nitrogen (N) on damage to maize caused by Striga hermonthica. A randomized complete block design with three replications and three levels of N (31.9, 54.4, and 77.1 kg/ha) was used. Each plot was subdivided into four subplots, each planted with one of four maize composites (SC 3, NCA, NCB, and 096). Subplots consisted of two, 7.6 m rows spaced 0.7 m apart. Maize seed was planted in excess with a tractor mounted V-belt planter and thinned two to three weeks later to 25 evenly spaced single plant stands per row (45,000 plants/ha). Two border rows were planted surrounding each block. Nine blocks were planted, five in Striga infested soil and four in Striga free soil. All blocks received a preplant application of a 21-14-14 compound fertilizer at the rate of 152 kg/ha. Low N plots received no additional fertilizer. Medium and high N plots received the appropriate amounts of additional N as a broadcast side dressing in the form of nitrochalk (26% N) in split applications five and nine weeks after planting.

Striga damage to maize was first observed four and one-half weeks after planting as small water soaked spots in the leaves. Generally the more vigorous plants were the first to show spotting. Spots increased in size and number, coalescing and drying, leaving the greater part of some leaves entirely functionless within ten days. Seven weeks after planting, almost all maize planted in Striga infested soil showed some leaf damage. Emerged Striga plants were first observed six weeks after planting, Striga flowering started ten weeks after planting, and Striga seed was first shed about fourteen weeks after planting.

Data have not yet been statistically analyzed and significant differences between treatments are not yet known. However, certain trends pertaining to mean plot yield and mean plot Striga count are apparent in data presented in Table 52. Striga decreased yields considerably. Mean yields under heavy (UF-15A and B) and moderate (V-2) Striga infestation were reduced 93 to 95% and 31 to 33%, respectively, from overall mean yields obtained at the same N levels in Striga free soil. An increase in N level resulted in an increase in yield in both Striga infested and Striga free soil. However, there was little indication that N increased yields more, proportionally, in Striga infested soil than in Striga free soil. Hence, it would seem that the need for high N levels for maize growing in Striga infested soil are no more acute than is the need for high N for maize growing in Striga free soil. Economic returns from nitrogen use would be greater in Striga free soil than Striga infested soil. Soil factors were likely partly responsible for exceptionally low yields obtained in blocks in field UF-15B.

Table 52 YIELDS OF MAIZE AND ASSOCIATED STRIGA POPULATIONS AT 3 LEVELS OF NITROGEN (N)

Location (Field)	Yield of dried grain (kg/ha)*			Approximate number of emerged Striga plants x 10^5		
	Low N	Medium N	High N	Low N	Medium N	High N
UF-15A	244	578	697	4.2	3.1	2.4
UF-15A	367	478	855	2.4	2.6	2.3
UF-15B	99	119	132	1.0	1.2	1.4
UF-15B	49	41	76	1.6	1.9	1.8
V-2	2880	3631	4085	0.33	0.21	0.24
Mean (Striga infested)	728	969	1169	1.9	1.8	1.6
W-6	2551	4556	5536	0	0	0
Y-3A	4972	6026	6072	0	trace	trace
Y-3B	5018	5896	6460	trace	0	0
Y-3C	4288	5259	5739	0	0	0
Mean (Striga free)	4207	5434	5952			

*Each figure represents the mean of 3 plot replications. Nitrogen level: Low = 31.7 kg/ha, Medium = 54.4kg/ha, High = 77.1 kg/ha.

In heavily infested Striga fields (UF-15A and B), Striga emerged slightly earlier in the maize than in adjacent long-season sorghum. Striga counts recorded in Table 52 were made nine weeks after planting. Figures might have been somewhat higher if counts had been made a few weeks later, but there would not have been a great increase. After emergence, Striga generally grew more poorly on maize than on adjacent long-season sorghum, but leaf damage occurred earlier and to a greater degree on maize than sorghum. It would seem that herbicides applied to Striga as a foliar application would reduce yield loss less in maize than in sorghum. If tolerant maize can be developed, the effectiveness of foliar applied herbicides might be greater.

b. Resistance. - Some preliminary field screening for Striga resistance in maize was conducted in 1972. Over 1000 plants each of SC3 and NCA were grown in Striga infested soil to which additional Striga seed was added at planting. All plants became infected and showed some degree of leaf damage. Plants with moderate to severe leaf damage were removed at tasselling and seed of the remaining open-pollinated plants (about 25% of SC 3 and 10% of NCA) was harvested and saved.

Seed was also saved from about 200 open-pollinated plants from Striga infested plots in the Striga x nitrogen study reported above. These selected plants, which were from NCA, NCB, SC 3, and 096, appeared to show relatively good vigor compared to surrounding plants which were severely damaged. Additional selections with possible resistance or tolerance were found among full sibs of 096, which happened to be planted in heavily infested soil. Seed of many of these is available.

In 1973 the above materials will be further tested for Striga reaction. A request has gone in CIMMYT for seed representing a wide genetic spectrum, possibly representatives of the various races of maize identified in Central and South America. It is hoped that this seed will arrive in sufficient time for field screening this year. The prospect of finding resistance or tolerance to Striga in maize may not be high. The only other work I know was done in South Africa and United States (N. Carolina). These investigations met with little or no success; however, they involved a relatively narrow range of the available maize germplasm.

Maize streak virus

a. Occurrence. - Maize streak virus disease is limited to the Africa continent and some nearby islands. The disease has been best known in Eastern and Southern Africa, but it has generally not been considered a serious disease except in limited areas in some years. Until recently, maize streak has been somewhat of a novelty in Nigeria. The disease has been observed in various parts of West Africa for some time, but diseased plants have been widely scattered and incidence has rarely exceeded 2 to 3 percent in any given field. In February 1969, an exceptional case, in which over 50 percent of the plants showed streak symptoms, was observed in irrigated maize at Tunfafia (N. W. State). In August 1971, streak in excess of 50 percent was noted in a few fields along the Akwanga-Jos road and as high as 20 percent indicence was commonly observed along the Abuja-Akwanga road. Farmers in the area indicated that the incidence of streak in 1971 was the greatest they had seen and that there had been more streak in 1970 than in the previous year. An extremely high indicence of streak, 80 to 100 percent, was experienced in Ibadan during the 1971-72 dry season in irrigated breeding nurseries.

Considerably more streak occurred in northern Nigeria during 1972 than in previous years. Several farmers' maize plots in the Zaria area were observed with streak in excess of 15 percent. The incidence of streak in several breeding and agronomy plots at Samaru was in excess of 25 percent. At the Farm Center, Sabon Gida (southern Zaria Province), 40 to 80 percent streak incidence was observed in several fields of a 500 acre maize production scheme. Streak incidence in excess of 40 percent was commonly observed at the research center and cattle farms at Mokwa. A survey involving 4 of the 6 northern states in Nigeria commonly found cases of streak in excess of 10 percent.

b. Yield loss. - Little is known regarding the relationship of streak symptom severity and yield loss. Plants which become infected within the first 3 weeks after planting are generally stunted and produce little or no grain. However, the yield loss in later infected plants, or plants in which symptoms fail to fully develop, is more difficult to assess. In order to study the relationship between symptom severity and yield loss, pairs of plants, one streaked and the other healthy, were identified shortly after tasseling, marked, and harvested separately. Dry grain yield of each number of each pair was recorded. The streaked plant within each pair was rated for streak severity on a scale of 1 to 4. A total of 275 pairs were treated in this manner from Bomo Local (130 pairs), Samaru Synthetic (93 pairs), and 096 (152 pairs). Table 8 gives information pertaining to the streak severity scale used and the estimated yield loss associated with each degree of severity. The data have been given to the IAR statistician for analysis.

The information in Table 53 was used to estimate yield loss due to streak in Dr. Stockinger's maize plots which had been planted to study the effect of time of nitrogen application on yield. Streaked plants within each of the 48 plots (300 plants per plot) were classified according to the severity scale soon after tasselling. Twenty-four plots were planted on June 1 and 24 on July 1. The variety used was 096. Analysis of the data has not yet been completed, but an indication of yield loss in relation to incidence of maize streak is given in Table 54. The figures show not only that the incidence of maize streak increased considerably in the second planting, but also that yield loss due to streak increased at a proportionately faster rate. The latter is presumably due to an overall earlier attack, with respect to plant development, by the insect vector on the second planting than on the first. Data from a similar type of study at Sabon Gida have not yet been received.

c. Resistance - An attempt was made to evaluate and identify resistance to maize streak in breeding material using natural infection. Data were obtained on both incidence (i.e. percentage of plants with streak symptoms) and severity (i.e. the degree to which symptoms developed on infected plants). Streaked plants were scored for severity because it was felt that the apparent inhibition of streak development in some plants was due to factors for resistance in the host. A scoring system was developed to evaluate resistance in infected plants based on observations at Samaru and work reported earlier in East and South Africa (Table 55). For a resistant type reaction the lowest leaf with symptoms had to be located not closer than six leaves from the top of the plant so that symptoms had ample opportunity to fully develop.

Data were obtained for NCA, NCB, SC 3 and 096 on incidence of streak and frequency of a resistant type reaction. These are summarized in Table 56. Although not statistically analyzed, these data suggest that SC 3 is most resistant, 096 is least resistant, and NCA and NCB are somewhere between.

Table 53 MAIZE STREAK SEVERITY RATING SCALE AND ASSOCIATED YIELD LOSS

Severity Scale	Description of streak symptoms	Estimated yield loss (%)
0	no streaking	0
1	overall streaking slight, limited to only a few upper leaves; no leaves with severe streaking	10
2	overall streaking moderate; not more than a few upper leaves severely streaked; several leaves with slight to moderate streaking	20
3	overall streaking severe; most or all leaves above ear severely streaked; a few leaves below ear moderately streaked; no obvious plant stunting	45-60
4	overall streak symptoms very severe; most leaves of plant including some below ear severely streaked; stunting likely apparent	80-93

Table 54 MAIZE STREAK INCIDENCE AND YIELD LOSS FOR 2 PLANTING DATES

Planting date	Range of Streak incidence (%)		Range of Estimated yield loss (%)	
	lowest	highest	lowest	highest
June 1	6.0	24.3	2.4	9.7
July 1	51.0	86.7	24.4	50.2

Table 55 SCORING SYSTEM USED TO EVALUATE STREAK REACTION IN INFECTED PLANTS

Score	Symptoms	Reaction type
1	streaking on at least 6 leaves and never more than slight streaking on any	Resistant (highest)
2	streaking on at least 6 leaves, all slight except for 1 or 2 with slight-moderate streaking	Resistant (Intermediate)
3	streaking on at least 6 leaves, all slight or slight-moderate except 1 or 2 with moderate streaking	Resistant (Lowest)
4	1 or more leaves showing moderate-severe streaking	Susceptible
5	streaking not exceeding moderate level on any leaf, but only 5 or few leaves showing streaking	Uncertain

A "3" reaction was by far the most frequent resistant reaction type noted. Open-pollinated seed was saved from some plants. Incidence and severity scores were made of single, unreplicated rows of: 190 S_1 lines from NCA, NCB, SC 1, SC 2, and SC 3; 83 long time inbreds; and 21 other lines. Streak incidence in these lines ranged from 0 to 100% and frequency of a resistant type reaction varied considerably. Selfed seed was saved from one or more plants in almost all lines.

d. Insect vector. - Three related leaf hoppers have been reported to be vectors of maize streak virus in East and/or South Africa. By far the most important of these is Cicadulina mbila. The insect toxonomist at IAR made sw ps through several maize fields showing a high incidence of streak in an effort to determine whether or not this vector is present here. Cicadulina was identified and specimens were sent to the British Museum for further identification to species. However, unfortunately all specimens were females and as a result could not be identified.

Table 56 MAIZE STREAK REACTION IN 4 MAIZE COMPOSITES

Composite	Incidence %	% of streaked plants with resistance
SC3	14.1	19.4
NCB	18.8	16.5
NCA	19.4	16.2
096	23.5	10.8

e. Other grass hosts. - Four grasses were observed with typical maize streak virus symptoms in the Samaru area. These were identified as: Digitaria ciliaris, Eleusine indica, Setaria barbhata, and Eragrostis gangetica. Of these symptoms were most frequently associated with Digitaria ciliaris. Some of these species and many others have been reported in East or South Africa. The importance of grass hosts to the etiology of maize streak is not known.

f. Further work. - It is impossible to forcast the incidence of maize streak from one year to the next. Whether or not it is on the increase in northern Nigeria is anybody's guess. At present I do not feel that an extensive screening program merits high priority. However, it would be useful to know the important vector(s) of streak in the savannah zone of West Africa. This information would be essential in any future screening program which, by necessity, would require the use of controlled inoculation by viruliferous insects. Due to unpredictability of the level of natural infection, no further work is planned on this disease in 1973. Seed of possibly resistant material will be kept in storage in event that a screening program is started at some future date.

Maize Blight

Progeny of crosses between plants showing a highly susceptible reaction and those showing a highly resistant reaction to Race T of southern leaf blight (Helminthosporium maydis) were studied for their reaction to blight in 1972. Plants were artificially inoculated in the field four weeks after planting by adding a few grams of ground, Race T infected leaf trash from the 1971 crop to the whorl of each plant. A blight epiphytotic developed and a susceptible check variety, CI 64 Tms, was killed prematurely. Blight reactions were scored separately for severity of symptoms on leaf blades, leaf sheaths, and ear husks, in the same manner which the parents had been scored in 1971. Material studied is listed below:

a) 65 reciprocal crosses among and within lines which showed: 1) 100% resistance (CI 64 normal, A-49, Serti 4, and C-33), 2) generally high resistance with some segregation for moderate susceptibility (EAAFRO 231), 3) segregation for highly resistant and highly susceptible plants (A-154, Mexico 5, and Biu Yellow) and 4) 100% susceptible (Serti 3 and CI 64 Tms).

b) 13 reciprocal crosses with Samaru Composite 3 (unselected for resistance to Race T).

c) eight reciprocal crosses within NS-5

d) seven additional reciprocal crosses among plants in a, b, and c

e) 24 single crosses among plants in a, b, and c

f) 33 selfs among plants in a, b, and c

g) 27 open-pollinated selections among plants in a, b, and c.

The results overwhelmingly showed that reaction to blight was controlled by cytoplasm of the female parent. There was no evidence for genetic controlled reaction in any of the crosses.

CI 64 Tms was planted at the University Farm and another field on the IAR farm at Samaru to monitor the Race T pathogen in the Samaru area. At both locations plants became severely infected and died prematurely. This indicates that material in the breeding program at IAR should have had sufficient exposure to Race T in 1972 to recognize susceptible germplasm.

Travel

Trips were made to the Jos Plateau (September quarterly report), Sokoto area and southern Niger (December quarterly report), Ibadan (IITA), and Cameroun and Chad. It became necessary to cancel the month long trip by road to several countries in West Africa scheduled for last September/October. This was unfortunate, as Mr. Dumont had made previous arrangements for us to meet with research workers, government officials, etc. It was not possible to inform these people in advance of the cancellation.

Some points of interest in connection with the trip Dr. Barry and I made in January to Cameroun and Chad follow:

Certain areas of northeastern Nigeria were severely affected by drought. Grain from elsewhere in Nigeria and possibly abroad will have to be imported into the area. Relatively little transplanted sorghum, referred to in Nigeria as "masakwa", was grown this year due to low soil moisture. This type of sorghum is transplanted onto heavy clay soils in the region south of Lake Chad after water from the rainy season has receeded. Transplanting is usually done in October and harvest is in January. The crop grows on residual moisture. The few fields of masakwa observed along the Maiduguri-Gambrua road had severe bird damage, presumably because there was so little this year for birds to eat. The P.A.O., Maiduguri, informed us that masakwa farmers generally keep an extra year's supply of grain in storage to offset the frequent crop failure. Hence, the government anticipates having to bring little grain in to the masakwa growing area this year.

Mr. Leger accompanied us and served as interpreter during our stay in Chad and Cameroun. One of the highlights of our visit in Ft. Lamy was a visit with the director of the irrigation scheme along the northwest side of Lake Chad. There are numerous long narrow islands in this area separated by shallow bodies of water. Dikes have been built connecting the ends of parallel islands, the water has been pumped out, and the lake bed is then used to grow crops with irrigation water coming from the lake. About 4,000 hectars are now in production and there are plans to increase the scheme to 40,000 hectars. The land is extremely fertile and three good crops of a wheat/maize rotation can be grown per year, or five crops of a wheat/maize/cotton rotation can be grown over two years. It would have been interesting to visit the site of this irrigation project, but time did not permit. The journey (Ft. Lamy-Bol-Ft. Lamy) would take three days by road, but arrangements can be made (in advance for air transport to make the trip and visit the site all in one day).

During our visit at the Ministry of Agriculture, Ft. Lamy, we were told that the sorghum crop in Chad had been poor due to drought. The government intended to import 40,000 metric tons of grain. The mouskwari crop, as the transplanted sorghum is called in Chad and Cameroun, was also poor this year.

People in the ministry felt that *Striga* was a very serious problem on sorghum, and also on millet in some areas. Smut is also a serious problem on the photoperiod sensitive late millet. I have since learned that smut is also a problem on late millet in the main millet growing area of Mali. It seems that seed dressings are rarely used by farmers on sorghum in Chad.

Mouskwari is a very important cereal crop in northern Cameroun and comprises about 50% of the sorghum crop. The IRAT station at Maroua has been involved in research on various aspects of the mouskwari crop including selection for higher yield, and spacing and fertilizer trials. This type of sorghum seems to be peculiar to the area south of Lake Chad which at one time formed a part of the old lake bed. Farmer's yields of mouskwari are generally somewhat higher than yields of wet season sorghum. The varieties grown are photoperiod sensitive, and although they do not exceed about two meters in height during the dry season, they would be extremely tall if grown during the wet season. Heads are generally large and compact, and grain is soft. We saw red, yellow, and white grain types with white as the predominant type.

All four sorghum smuts were observed, but none seemed to cause significant grain loss, although covered smut can cause serious losses locally in some years. A rather large field at Waza had about 5% loose smut infection within the part of the field we observed.

Much of the area which we observed in N. Cameroun was primitive, especially in the area of the Mandara Mts. Here wet season sorghum was cultivated on narrow (0.5 to 2 m) terraces on the sides of steep, rocky hills. Grain color did not seem to be an important factor in this area where a mixture of all colors from light to dark was generally observed in villages.

Training

During the past year Mr. S. K. Manzo conducted research on long smut of sorghum. Information obtained will be included in his thesis for the M. Sc. degree in plant pathology from Ahmadu Bello University. Earlier he had received fifteen months training (primarily course work) in plant pathology in the U.S. under sponsorship of the Major Cereals Project. He is now on the staff at IAR with duties in the area of cereal pathology research.

A project for another student is being developed in the area of host resistance to *Striga*. It is quite likely that this will be assigned to an M. Sc. student at ABU.

COUNTRY REPORT BY THE FIELD TRIAL OFFICER

Mr. S. Dumont

Arriving on board, my 1st job was to get in touch with the people, official departments of agencies concerned by cereals.

Although research is one of the main goals of project 26, I tried to extend my activities and contacts to other field of activities than research, namely extension services, commercialisation and processing companies when they exist, etc.

Although project 26 is officially dealing with cereals only, I tried also to have formal contacts with agencies whose 1st concern is a cash crop like is CFDT for cotton in francophone countries. Because my opinion is that all the annual crops rotate with one another in the farmer's field and thus problem of fertility, labour requirements, farm economics, etc. for all these crops are closely connected and sometimes very similar. Besides the competition between the points of view of various research or development agencies, may be very stimulating in a job like ours involving exchange of information.

One of the main problems I had to face is the great number of countries I must keep contact with: officially 10, + Nigeria because the heart of the project is here and because Samaru being the most outstanding research station in anglophone West Africa, I am highly interested to know what is done over there.

So I expressed many times to the leaders of the project my desire of releasing the 3 southern countries of my zone, Ivory Coast, Togo and Dahomey.

Effectively it turns out that it is impossible to make a serious work in such a wide area. I kept in mind as a target to visit each of these countries twice a year: once if possible during the growing season, another few months later when the experimental results are known and the yearly documents ready to be collected.

I failed in fulfilling that. So far 3, countries have been more or less deliberately neglected: Niger, Togo and Dahomey.

So this 1st year was devoted to achieve a few works which may be considered as basic, regarding the orientation and organization of my job.

These I shall describe now:

Despite this name of FTO of our assignment, I must say I took no direct responsibilities in the laying out of trials. There are enough research workers in these countries to do this job. It would have been rather confusing and wasting of time for me to intervene in such a matter.

Therefore I decided to limit strictly my job to the exchange of technical information which is also an important goal of the project and which is fully sufficient to engross my time.

Thus during this year I tried to get in touch with as many people involved directly or not in the problem of cereals as possible, to collect documents and to make them informed of my new assignment.

I believe this part of my work is now over. I have arranged sufficiently formal connections to make the exchange and dissemination of documents fluent enough.

The second stage of this liaison job was to make the best use of the information collected.

My leading idea was to set up such exchanges in both direction, i.e. to the francophones and to the anglophones. That's why the same kind of documents are prepared in French for the Francophone and in English for the anglophone.

These kinds of documents are the following:

1. Liaison documents: usually rather informal papers giving general information about the food problems in the different countries, the way they are to be solved, the objectives, difficulties and progresses of the agronomic research, the results obtained, the projects on hand, etc. These are issued in general after the completion of a work trip and not on a well determined periodical basis.

2. Lists of documents available with a short analysis of them and my personal comments so that the readers may have a precise idea of the papers recorded.

3. Analysis of the periodic reports of research agencies with a description of the trials and a record of the most significant results. This has been done for IRAT Senegal, Mali, Upper Volta, Niger, Ivory Coast and IAR Samaru.

4. Translations: These are carried out either in request, or on my own decision when they are sufficiently important and of widespread value.

Documents 1, 2 and 3 are intended to guide the choice of the research workers when they want to gather informations disposal on a well defined problem.

Of course I am at anybody's disposal to collect more precise information on any requested item. That's what I had to do for example:

- about wheat to satisfy a demant of Mauritania.

- about the ridging vs flat cultivation for Mali.

- about the split application of N for Dr. Stockinger.

- about the problem of soil pH which is a main concern in several countries, especially Nigeria, Senegal and Ivory Coast.

I have not mentioned yet the part of my job involving the exchange of material and the regional trials of JP 26.

I must say this was a small deception to me for several reasons.

First, I realized these trials, not always fit exactly the needs of the country. The same varieties either successful or not are tested from year to year without definite conclusion. There is also some duplication with the "zonal" trials carried out by IRAT in the various countries where it is installed. Besides the amount of seeds is often very low to lay out several replications and one replication only does not allow very conclusive results.

An above all, the distribution of the seeds was a pretty mess this year. Seeds from Upper Volta were lost. Those from Dahomey are still waiting for an import permit; others reached Samaru very late. There are a few things to do to improve this situation and 1st of all to arrange a small work meeting by the middle of the dry season to set up the necessary arrangements which was not done last year.

As a conclusion I would try to anticipate a few things about the evolution of my FTO's job.

I think it would be desirable to devote a larger part of my time to collecting and disseminating information on more precise and definite items, assuming that the general information about research work in West Africa has been already fairly widely spread and will not require as much effort as last year.

These items might be research items strictly speaking (problem of soil pH, entomology of cereals) or problems connected with extension like seed multiplication, or the methods to make acceptable by the farmer the recommendations of research, etc.

COUNTRY REPORT BY THE FIELD TRIAL OFFICER

Mr. Taylor

Working in Nigeria means that in terms of agricultural research I am in an area which is already quite well explored. Apart from the institutes which are specifically concerned with the cash crops, in the South of the country there is the Federal Department of Agricultural Research at Moor Plantation, Ibadan, and IITA at Ibadan. Both of these stations are concerned, among other things, with the cereals, rice and maize. In addition to this the States Ministries of Agriculture are involved in their own testing programmes of recommendations made by Moor Plantation, and in the future by IITA.

In the North of Nigeria IAR conducts experiments on maize millet and sorghum, as well as other crops. The Northern States Ministries of Agriculture, in collaboration with IAR, conduct experiments which cover the whole of the north. These experiments concern such factors as variety, fertilizer practice, husbandry practice, insect control, etc. The Extension Research Liaison Service, a part of IAR, is involved in the dissemination of research findings, in forming a link between the research worker and the extension worker, and this is done by the production of leaflets, of posters, of demonstration of well tried recommended practices.

I have had the opportunity of visiting Moor Plantation and IITA and of course IAR, and also many of the experimental sites in the North of Nigeria. This has been useful in giving an indication of what the farmer is doing in his varieties, fertilizers, husbandry and expected yields - and what the farmer is capable of doing, as shown by the crops grown on the Ministry farms and experimental sites. The gulf between what the farmer is doing and what he could do is very wide. Why -

a) Economic reasons - most farmers are unable to afford the amounts of fertilizers, insecticides, labour, etc. necessary to maximise yields.

b) The farmer cannot always afford to take risks. In many cases he intercrops.

c) Traditional - Some areas prefer to maize - white seed to yellow seed etc.

Research is, and always will be, far ahead of the farmer; the problem is to persuade the farmer to do in future what the research worker is doing now.

This can be best achieved through the existing framework of the States Ministries of Natural Resources, Agricultural extension services. There is an Extension Officer in every large village or small town. To the extension service it is necessary to demonstrate the new practices which we have available, to show that our new ideas will work on farmers' land. Up to now, recommendations have been of the low input, moderate return type. Now what is required is a package of practices, which although not foolproof, will take as much risk as possible out of high input cereal production.

During the last season I have arranged high-input - high production plots of maize and sorghum, in four of the Northern States.

a) Demonstration of potentials in cereal production.

b) Multiplication of seed.

c) Allowing the farmers to assess the so-called advanced practices.

In some cases these plots have been successful, but in others they have merely demonstrated the importance of other factors such as insect control, Striga Control, level of management.

It is proposed to make a more thorough test of a more comprehensive package next season.

In a series of maize trials over the whole of the North of Nigeria, trials in which Dr. Tatum has been involved in the planning and design and I have been involved in monitoring and analysis of results, it has been shown that in terms of seed and fertilizer, there is the potential for very high maize yields.

This also has been shown to be the case in other trials involving sorghum including ones which I have at Kano and Dawa.

At the moment there are farmers who are capable of growing high yielding crops of maize and sorghum. Sulphate of Ammonia and Superphosphate fertilizers are available through Ministries of Natural Resources. Improved varieties, often outdated unfortunately, are also available from Ministry Multiplication Sites.

What is needed now is:

a) The stimulation of demand.

b) To feed in at the Ministry and the right variety.

c) To provide guidelines on which seed should be produced.

To stimulate demand the best course is demonstration - demonstration of an improved package of practices, since demonstrating the potentially best varieties, without the fertilizers or the husbandry is worthless.

Rapport d'activités

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Du 19/11/1971 [illegible] 30/9/1972

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François Léger
Ingénieur de liaison pour
l'Afrique du Centre. PC26.

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1. Emploi du temps - Déplacements -
2. Implantation à MAROUA - Cameroun -
3. Réduction de documents - Traduction -
4. Mise en place d'essais -
5. Projets de développement -
6. Documentation rassemblée -
7. Perspectives -

1. Emploi du temps. Déplacements

Nous résumerons les principaux déplacements et leurs objectifs:

19 Nov. 27 Novembre, 1971: Nigeria - Cameroun

Il s'agissait de la première prise de contact avec l'OUA/CSTR et avec les chercheurs du projet conjoint 26 travaillant à SAMARU. (Dr. TATUM, Dr. STOKINGER, Dr. YORK, Dr. ANDREWS.)

1.4. Décembre 1971. Garoua, -

Accident de voiture, m'immobilisant jusque vers la mi-janvier.

7-12 Février: Mission au Tchad, à Deli, principale station de recherches en matière céréalière -

18 Février - 8 Mars: Mission à Yaoundé - Nombreuses prises de contact officielles et scientifiques et voyage en Land-Rover en RCA et au Tchad -

17-25 Mars: Nigeria
Lagos puis Samaru -

28 Avril - 10 Mai: voyage d'études au Gabon et au Congo R.P.

23-25 Mai: SEMRY et Tchad -

6-8 Juin: Tchad (SODELAC: Bol Matafo.)

16-24 Juin: Mission dans l'Ouest-Cameroun -

18-19 Juillet = Garoua -

21-27 Juillet = Fort-Lamy -

2 Août - 6 Octobre: Vacances intermédiaires en FRANCE.

2. Implantation à Maroua - Cameroun -

Les moyens de travail n'ont été disponibles que progressivement;

- Le bureau a été immédiatement fourni par l'IRAT.
- L'équipement de bureau est arrivé vers fin Janvier 72.
- La Land-Rover de service a été disponible à Douala à partir du 25 Février 1972. (soit 3 mois après l'entrée en fonction.)

3. Rédaction de documents. Traductions.

Un certain nombre de traductions ont été réalisées (voir liste en annexe 1.) et partiellement diffusées -

Des rapports de mission ont été écrits après chaque voyage d'étude important (ou les préparant.)

4. Mise en place d'essais.

41 Au Cameroun: dans le cadre de l'IRAT et avec l'aide de ses chercheurs continuation du travail entrepris les années précédentes =

- Essais uniformes régionaux dans l'Ouest-Cameroun (IRAT Ouest, Dschang.) en matière de Maïs

- Essais uniformes régionaux dans le Nord Cameroun (IRAT Nord, MAROUA Guiring) en matière de sorgho -

Les essais de pénicillaire n'ont pas été réalisés (venue trop tardive des semences.)

Des actions nouvelles s'y sont jointes;
essais maïs sur les 3 écologies principales au Nord-Cameroun (MAROUA, Guider, Garoua.)

essais maïs sur rizières à Yagoua (SEMRY)

Petits essais dans centres de vulgarisation et des écoles d'agriculture (Goyang, Douvangar.) (Quelques variétés seulement.)

42 au Tchad:

- à Bol MATAFO; mise en place d'essais variétaux systématiques en matière de maïs
  fourniture, via l'USDA, de variérés d'orge de brasserie

  La SODELAC (Société de Développement du Lac) est le maître d'oeuvre -

- à Déli. Important matériel végétal (sorgho, maïs, millet) fourni pour expérimenter sur la station et en multilocal -

- à Bekamba = Essais de sorgho et de mil fourrager - avec Coton-Tchad -

43. En RCA:

Essais maïs, à Damara, avec la FAO.

44. Au Gabon

- Essais maïs avec le Ministère de l'Agriculture à N'Toum-Oyem
- Essais maïs avec la FAO (Moanda-France-Ville)
- Essais maïs avec la Mission Agricole Chinoise

45. Au Congo R.P.

Essais maïs avec le Ministère de l'Agriculture Kombé, N' kenkó, Malela (3 variétés)

Remarque: D'une façon générale, en particulier pour le Congo R.P. le Gabon, insuffisance de l'offre par rapport à la demande. Mes demandes n'ont pas été suivies d'envois suffisants et cela m'a placé dans une position difficile. La date tardive du voyage d'études effectué dans ces deux pays en est peut'être la cause.

Par ailleurs, le projet conjoint 26 ne doit pas fonctionner dans un seul sens et il est très souhaitable que du matériel végétatif aille des pays engagés vers SAMARU. La station de Déli (avec Mr Assegninou) a été la seule à envoyer du matériel, avec l'IRAT Ouest (Dschang).

(5) Projets de développement

- Au Cameroun

La situation semble mûre pour créer ou lancer un système de diffusion des semences améliorées de maïs dans l'Ouest-Cameroun (cf rapport de la mission dans l'Ouest- Cameroun; 16-24 Juin 1972)
c

- Au Tchad
  Le projet de développement des polders du Lac est à un stade très avancé (présentation d'un dossier à laBIRD)

(6) Documentation rassemblée. Elle est très importante.
-collection complète de l'Agronomie Tropicale
-nombreux rapports originaires de la SAMARU
- études ORSTOM
- rapports IRAT Cameroun
- nombreuses études régionales:
  ex: Budget et conditions de vie des ménages en zone rurale gabonaise Région de N'gounie et Woleu N'Tem
  - 15 ans de travaux et recherches dans les pays du Niari (Congo R.P.)

- Ouvrages scientifiques de référence (génétique, statistique, économie)

- Dictionnaires et glossaires (génétique, science des sols)

- Rapports ASECNA (météorologie)

- Cartes pédologiques, géographiques etc.

7. <u>Perspectives</u>

Il faut à la fois intensifier et multiplier dans l'espace le travail de "débroussaillage" variétal et s'attacher à la réalisation de projets concrets afin d'éviter que la "révolution verte" ne reste littérature en chambre.

Par ailleurs, répondre à des demandes précises concernant d'autres céréales (orge, riz par exemple)

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A N N E X E 1

Liste des traductions effectuées

1. Traduction du rapport de J.B. Eckert, Ford Foundation "Accelerating the rate of cereals growth in Cameroun"

2. Le maïs comme culture céréalière dans le Nord Nigéria (L.A. Tatum)

3. Les cultures intercalaires avec le sorgho (D.J. Andrews)

4. Résumé du 8ème rapport annuel du projet AID-ARS PC 26

5. Extraits de la partie agropédologique du précédent rapport
   - essais dates de semis
   - essais de fertilisation sur le long terme

6. Maladies fongiques des feuilles de sorgho (W. Tuner - H. Dogget)

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