PROGRESS REPORT NO. 5

ETHIOPIAN SORGHUM IMPROVEMENT PROJECT

January 1, 1977 - December 31, 1977

Contributing Agencies

ADDIS ABABA UNIVERSITY, COLLEGE OF AGRICULTURE

INSTITUTE OF AGRICULTURAL RESEARCH

INTERNATIONAL DEVELOPMENT RESEARCH CENTRE

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We acknowledge gratefully the continued financial support and the genuine encouragement of the International Development Research Centre (IDRC) to the Ethiopian Sorghum Improvement Project (ESIP). We would like to acknowledge that IDRC has been and still is the primary force responsible for the realization and operation of ESIP in its present form. The efficiency and promptness of the office of the Director of Agriculture, Food and Nutrition Sciences Division of IDRC in Ottawa in handling all administrative matters related to ESIP are fully appreciated. The active backing and guidance of Dr. Hugh Doggett to the ESIP seem to give us fresh energy to move on with ever fresh enthusiasm in this project.

The encouragement and support of the Addis Ababa University and the Institute of Agricultural Research to the ESIP are acknowledged.

We would like to stress that the work contained in this report resulted from the efforts of the entire ESIP team covering all of our stations.

The entire ESIP staff of 1977, technical and administrative, are shown in front of the rented main ESIP office at Nazreth.

Project Personnel, 1977

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INTRODUCTION AND OBJECTIVES

Sorghum is second only to tef as an Ethiopian food crop. The tremendous range of genetic diversity of sorghum in Ethiopia has enabled it to thrive under wider range of environments than any other crop in the country. It is normally cultivated in altitudes as high as 2500 m and as low as near sea level. A significant feature of the Ethiopian sorghum is that, it is the dominant crop in the lowlands where droughts and poor harvests are common occurences. This means, any national work on sorghum improvement in Ethiopia must place a very high priority in developing sorghums and sorghum production systems which can give stable yields over years at reasonably high production levels in this moisture shortage areas.

The Ethiopian national agricultural research system, as in the past several years, continues to identify the Ethiopian Sorghum Improvement Project (ESIP) as nationally responsible for the improvement of the sorghum crop. The National Crop Improvement Committee goes on to recognize ESIP as the national coordinator for sorghum improvement and trials. Therefore, all national trials and nurseries are organized and prepared by ESIP. The project has more or less developed into a national center for handling almost all aspects of Ethiopian sorghum improvement.

ESIP is jointly supported by three agencies: a) Addis Ababa University (AAU); b) Institute of Agricultural Research (IAR); c) International Development Research Centre (IDRC). AAU provides mainly adminstrative support and also some physical facilities at Alemaya. IAR is the major local contributor of physical facilities at the majority of ESIP sites and also performing major station farm operations at these sites. IDRC provides the bulk of the finance needed for running the ESIP.

Objectives

The specific objectives of the ESIP as spelled out in the project proposal for Phase II of this project are:

1. To systematically collect, classify, and screen the valuable indigenous sorghum germplasm for its suitability as breeding material in better Ethiopian sorghums;
2. To screen and test improved sorghums in the various ecological zones of Ethiopia;
3. To continue and expand studies on crop agronomy and the determination of optimum inputs needed to provide maximum gain to the small farmer;
4. To initiate trials conducted by farmers in their own fields;
5. To develop resistant varieties of sorghum and crop protection technology to control pests, diseases, and the parasitic witchweed Striga;
6. To evaluate those sorghum lines which perform well under trial as a source of injera;
7. To provide continued training of local personnel; and
8. To develop a test cooking and quality-control facility.

In trying to relate these objectives to the totality of sorghum improvement and production problems in the country, ESIP found it necessary to run trials, nurseries, and other operations in a series of stations representing the different sorghum ecological zones in the country. Consequently, ESIP has been or is operating at eight different stations in the country. These are listed below:

	Station	Altitude (m)	Annual Rainfall (mm)	Latitude	Normal Sorghum Planting Month
1.	Alemaya	2000	870	9° 30'	April
2.	Arsi Negele	1960	900	7° 20'	April
3.	Asebot-Mieso	1600	700	9° 20'	April
4.	Dakata	1550	700	9° 10'	May
5.	Nazreth (Melkasa)	1500	800	8° 30'	June
6.	Kobo	1400	650	12° 10'	April
7.	Melka Werer	850	500	9° 10'	December
8.	Humera	590	600	14° 20'	July

1. Alemaya - The altitude of Alemaya being about 2000 m makes it the highest station. The 870 mm annual rainfall is typical of the good sorghum producing zones of this altitude. The latitude is 9° 30' N. The growing season ranging from April to December represents the long season sorghum areas of Ethiopia. The most important sorghum producing area served by this station is the vast Chercher Highland where the bulk of the Ethiopian highland sorghums are produced. Though most of ESIP's past efforts have been mostly at this site, pre-harvest grain mold, leaf diseases (particularly anthracnose), stalk borer (Busseola), ear-head bugs, shootfly on late planted sorghums, frost before grain filling and poor cultural practices continue to be major problems. Alemaya is the major highland sorghum breeding station in Ethiopia. The Ethiopian sorghum collections are yearly planted, evaluated, and permanently registered and stored here. Since several low altitude collections often turn sterile and do not set seed because of the low night temperatures at Alemaya, we now find it necessary to use a duplicate station of lower altitude for routinely growing out our collections. Our plans are to use

Asebot as a second site for growing and evaluating our collections.

2. Arsi Negele - This station is not located in a major sorghum producing zone. However, the yields from this station are often the highest among all Ethiopian sorghum stations. The altitude of Arsi Negele is lower than Alemaya by 40 m only. Growing conditions are almost the same as Alemaya. Past results indicate that the pattern of varietal performance at the two sites is very much alike. Since this location is an optimum environment site for highland sorghums it gives us chance to assess the real genetic potentials of our highland breeding lines and varieties. For the highland sorghum program, this is the only station which supplements the evaluations at Alemaya. The major problems at this site are also encountered at Alemaya namely grain mold, anthracnose and sugary disease.

3. Asebot-Mieso - This is the newest of ESIP's sites. It is located about mid-way between Nazreth and Alemaya on the main highway between these two towns. The rainfall and altitude are estimated to be about 700 mm, and 1600 m, re-sepctively. This station is in the middle of an important sorghum producing zones. The long season sorghums which are traditional in this area, because of the erratic rains, are often faced with moisture shortage and subsequent crop failure. The major thrust in this area is to introduce sorghums with reliable yields that can be planted in June instead of April and be harvested in November or December. The rationale for this approach is that, compared to normal April planting, the rains in the area from mid-June to mid-September are quite reliable and sufficient to support a good sorghum crop if the variety is of the right length of maturity.

4. Dakata - This station is located in the Dakata river valley about mid-way between Harer and Jigjiga. The main reason for having started a sorghum program at this site was that the Alemaya College of Agriculture ran a production farm and as a result the College encouraged ESIP to undertake varietal development for the valley and similar areas in Eastern Ethiopia. Dakata has an altitude of 1550 m and rainfall of 700 mm. The observations and results of 1975 and 1976 have shown that Dakata has high potential for good sorghum production. However, since very little sorghum is produced in the valley proper and because of the presence of Quelea it is difficult to harvest any sorghum here. In 1977, it has not been possible to continue work at Dakata because of security reasons.

5. Nazreth (Melkasa) - The altitude is about 1500 m and the rainfall averages about 800 mm. The station is centrally located and serves as a good coordinating and head quarter site for ESIP. Though sorghum is not a major crop here, the sorghum production potentials of the area are excellent. The first limiting factor to sorghum production here is undoubtedly Quelea. The bulk of ESIP's crossing work is done at this station. Seed preparation and packaging for almost all of ESIP's stations and other cooperators are done at Nazreth.

6. Kobo - his is perhaps ESIP's most important lowland site. It is situated in the vast Kobo-Alamata plain of the North-Eastern lowlands where the dominant crop is sorghum. Because of the standard practice of farmers growing long season sorghums in the area, crop failures have become common place in this part of the country. The development of early maturing sorghums suitable for the area appears essential for reliable farming in the Kobo-Alamata plain and similar areas. Kobo has altitude of 1400 m and rainfall of 650 mm received in bimodally distributed short rains (March-April) and long

rains (July-Sept.). Next to drought, another major sorghum production problem in this area is Striga.

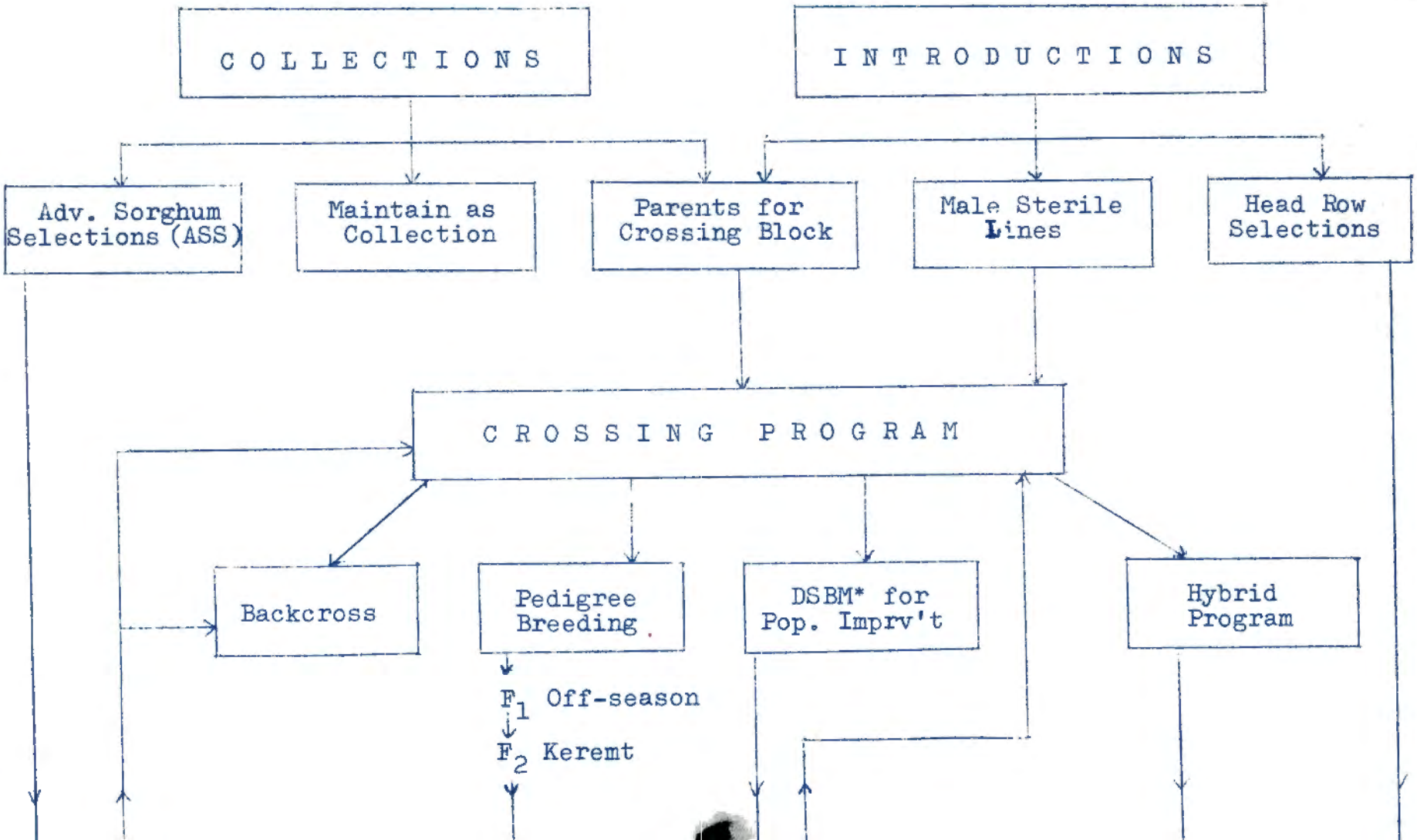
7. Melka Werer - The Institute of Agricultural Research has a well developed lowland and irrigated station here and we run our off-season programs at this station. Melka Werer is located on the Awash river (Middle Awash) where the major crop in the area is irrigated cotton. Our primary sorghum work here is hybrid crossing, generation advancing and increasing seed of selections for the coming Keremt season. Melka Werer continues to serve as ESIP's off-season nursery because of its relatively short and good road connection with Nazreth, availability of excellent working facilities at the station and above all the suitability of the area for growing good sorghum. As in many other stations, Quelea are a menace here which means that we have to bag every sorghum head we want to save. In an average season, we put on about 15,000 cloth bags in the nursery.

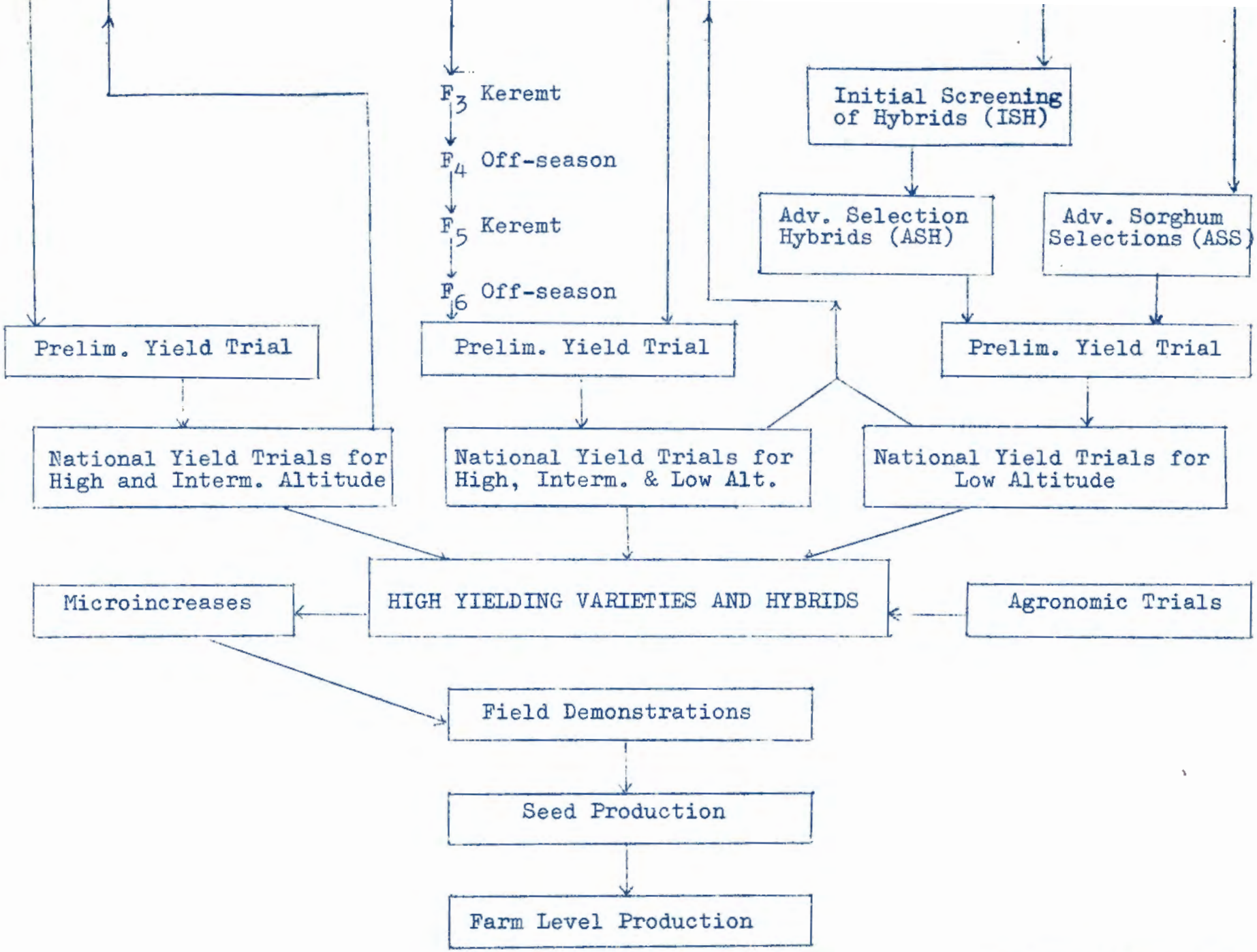
8. Humera - The North Western lowlands represent one of the most important sorghum producing zones of Ethiopia. Humera is typical of this zone. This station with its altitude of 590 m is the lowest of all ESIP sites and with the 14^{o} 20' N latitude it is the most Northern station. The crop season here which runs from July to October is also the shortest of all ESIP sites. The annual rainfall of about 600 mm enables the production of a reasonably good sorghum. We have been cooperating with the Humera Agricultural Development Project in running the sorghum program at Humera. Facilities including land for sorghum work at Humera used to be excellent. Unfortunately, for security reasons beyond our control and the serious difficulties in logistics, we have been forced to discontinue work at Humera in the 1977 crop season. However,

the crossing block planned for the Humera area has been completed at Nazreth, hoping that the segregating materials could be taken to Humera in the future for evaluation and selection.

The core programs of ESIP in the sites mentioned above and also the sequential interrelationships of these are shown in the "Schematic Diagram Summarizing the Interrelationships and Flow of ESIP's Programs" given on the next two pages, Figure 1.

SCHEMATIC DIAGRAM SUMMARIZING THE INTERRELATIONSHIPS AND FLOW OF ESIP'S PROGRAMS





*Dented Seed Breeding Method

ETHIOPIAN SORGHUM GERMPLASM COLLECTIONS (ESGPC), 1977

As one of its prime activities the ESIP annually undertakes local sorghum collections from the sorghum growing regions of the country previously not represented in the ESGPC. The 1976 collections, numbering 795, came from ten of the fourteen administrative regions of the country (see ESIP Annual Report No. 4 for a breakdown listing of areas of collection). These collections, besides broadening the existing germplasm base, provide source material for pure line selection as well as desirable traits to be used in a hybridization scheme.

These 795 collections were planted in single row plots of 3 m length and one meter width at Alemaya and Asebot for evaluation at these two different sites. The planting at Asebot did not germinate for lack of moisture, but at Alemaya, data on days to heading, plant height, panicle type as well as agronomic desirability have been obtained. In addition, half a kilogram of seed and representative panicle branch samples of each collection have been saved from all entries that reached fruition. Of the 795 collections that were planted out last season it was only from 658 or 83% that seed was harvested. The other entries failed to reach fruition mainly due to extreme lateness, failure to germinate or lack of adaptation which resulted in sterility. A few entries were also discarded because they were apparent duplicates.

In Figure 2 is presented a histogram showing the relative distribution of height groups of these collections. As in previous years, the diversity in these collections was notable in that height ranged from a low of 0.80 m (MT-30) to a high of 4.30 m (BGM-110). Close to 80% of these collections were in the height range of 1.5-3.5 m, of which 23% fell in the upper end of the range (3-3.5 m). Few entries (5%) had heights above 4 meters.

With respect to days to heading, the earliest entry headed in 80 days (BGM-215) while the latest came to head in 170 days (IB-26). A look at Figure 3 indicates that a good proportion (22%) of these entries were early in that they took less than 100 days to heading. On the other extreme there were less than 1% of the entries that took close to 6 months to head. The majority of the collections headed in between 100-140 days. Furthermore, ranges in seed color and size as well as panicle types were evident in this collection.

From these new collections, a total of 21 entries were selected since they possessed desirable seed and panicle types to be used as parents in the 1977 Crossing Block (see section on Crossing Block for details). A further 13 numbers were selected for disease resistance after evaluation in the 1977 Keremt season at Alemaya. In the 1977 season, the incidence of diseases, especially anthracnose, at Alemaya was very high and the majority of the entries in the ESGPC as well as in the other sorghum trials were severly affected by anthracnose. But these 13 resistant collections which almost all traced to Gambella were all of tan plant color and had clean leaves. These selections will be planted at Melka Werer in the 1978 off-season for further evaluation and seed increase purposes after which a selected few will go into the 1978 Crossing Block. In addition, 10 outstanding entries were selected for their overall desirability to go into the 1978 Advanced Sorghum Selection (ASS) nursery for a further replicated evaluation. 1977 agronomic data from Alemaya for all these selections are presented in Table 1.

In an effort to preserve these ESGPC much more safely, ESIP has deposited duplicate germplasm amounts of the entire Ethiopian sorghum collection with the Plant Genetic Resources Center/Ethiopia in Addis Ababa. In addition, ETS 2000-5000 have been sent to Beltsville for storage at the National Seed Storage Laboratory.

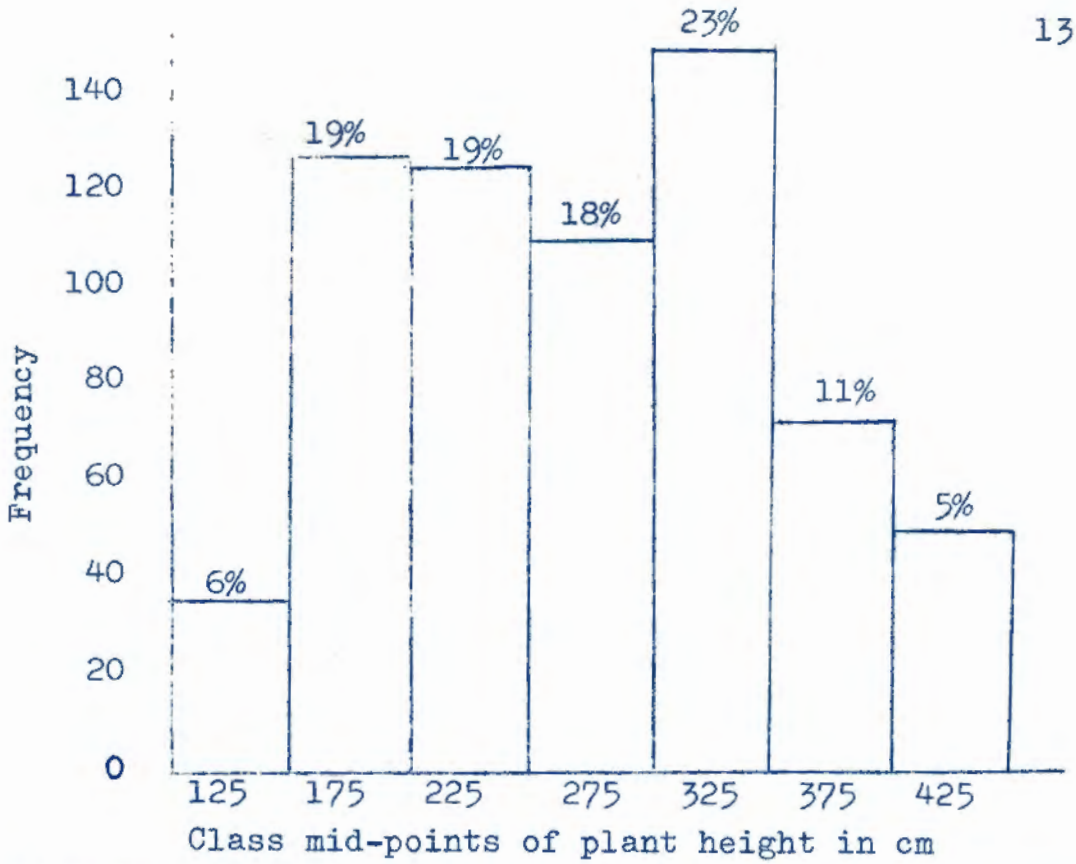


Fig. 2. Histogram showing the distribution of plant height groups of the 658 collections of 1976 grown at Alemaya in 1977.

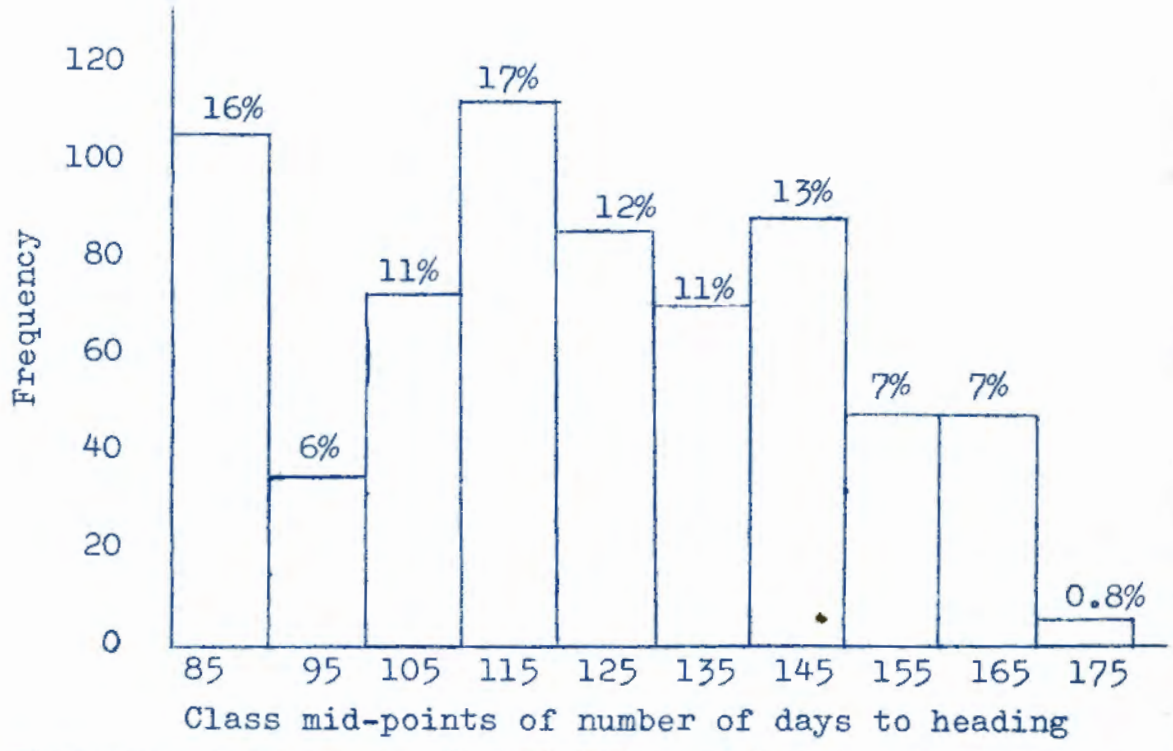


Fig. 3. Histogram showing the distribution of heading days groups of the 658 collections of 1976 at Alemaya in 1977.

Table 1. Agronomic data from Alemaya in 1977 for entries selected from new collections for use in 1977 CB (group a), 1978 CB (group b) and as lines per se for 1978 ASS (group c).

a) Used in 1977 CB	Days to heading	Plant height (cm)	Panicle type	Area of Collection
77-FK-15, Goronjo	108	210	6	Minjar, Shoa
77-MT-57, Abola	124	360	6	Dejen, Gojam
77-MT-58, Netch Achiro	131	200	6	" "
77-MT-59, Keye Achiro	129	380	6	" "
77-MT-65, Amedma Achiro	122	310	5	" "
77-MT-84, Abola	128	340	4	Gohatsion, Shoa
77-MT -124, Gabisso	112	190	6	Id-wooha, Shoa
77-MT-146, Dalecho	129	190	6	Commando, Shoa
77-MT-160, Bishinga Adi	128	300	4	Chancho, Shoa
77-MT-193, Netch Kutta	122	320	4	" "
77-ZH-28, Goronjo	115	340	7	Asako, Arsi
77-ZH-29, Goronjo	111	220	7	" "
77-BGM-120, Oduok	87	190	5	Gambella, Illubabor
77-BGM-123	87	150	5	" "
77-BGM-201, Achwop Tong	87	170	6	" "
77-BGM-209, Pado	85	150	6	" "
77-IB-3, Mera	-	-	-	Deebate, Gojam
77-IB-26, Mera	170	320	9	Mandura, "
77-AS-7, Wottere	105	240	3	Kobo, Wollo
77-BGK-4	111	210	5	Karakore, Shoa

Table 1 Continued

	Days to Heading	Plant height (cm)	Panicle type	Area of Collection
b) To Go into 1978 CB				
77-BGM-115, Jualungo	81	130	5	Gambella, Illubabor
77-BGM-116, Ganga	81	130	5	" "
77-BGM-117, Otedit	87	140	5	" "
77-BGM-118, Ganga	83	180	5	" "
77-BGM-121, Jualungo	96	210	5	" "
77-BGM-123	87	150	5	" "
77-BGM-192, Jowo-lungo	84	150	6	" "
77-BGM-209, Pado	85	150	6	" "
77-BGM-214, Woro Gwigo	86	160	6	" "
77-BGM-216, Dtia	90	170	6	" "
77-BGM-225, Tuo-lungo	86	140	6	" "
77-BGM-227, Dibow	85	150	6	" "
77-BGM-234, Oita	89	140	6	" "
c) To Go into 1978 ASS				
77-BGM-43, Wagare	146	270	7	Darolebu, Hararghe
77-BGM-45, Wagare	115	250	7	" "
77-BGM-50, Muyra	122	260	7	" "
77-BGM-59, Flata	137	280	7	Gelemso, "
77-BGM-63, Welliso	148	290	8	" "
77-BGM-79, Regim Fendisha	143	320	7	Bedessa "
77-BGM-81, Dasle	124	300	7	Gelemso "
77-BGM-93, Wagau Hada	133	260	7	" "
77-MT-6, Tembelta	119	150	6	Aykel, Gondar
77-MT-86, Netch Achiro	139	260	6	Gohatsion, Shoa

So, including ESIP, there would be about 3 complete sets of the Ethiopian collection stored at 3 different places.

During the 1978 season, the entire ESGPC totalling close to 5700 will be grown out at Alemaya, a high altitude site and Asebot an intermediate altitude station for seed rejuvenation and a more detailed evaluation and documentation of these germplasm. Traditionally, evaluation of ESGPC had taken place only at Alemaya. It is hoped that addition of another site will afford an opportunity to select for types that did not stand out at Alemaya previously, especially those suited to lower altitudes. Moreover, planting at two locations should minimize the risk of losing entries. IS numbers of Ethiopian origin recently received from ICRISAT will also be grown alongside the ESGPC in 1978.

Collections during the 1977 season have not been as extensive as desired due to security problems but collections from the administrative regions of Shoa, Gojam and Wollo have been obtained totalling 164.

Advanced Sorghum Selection Nursery (ASS) 1977

This nursery, routinely run by ESIP, serves as an intermediate evaluation point for entries selected from new collections before they are advanced to National or Pre-National Yield Trials.

From among the approximately 1300 new collections that were planted at Alemaya during the 1976 crops season, 26 entries or 2% were selected for the 1977 Advanced Sorghum Selection trial. This trial was planted at Alemaya, Arsi Negele, and Asebot in plots that were 3 rows wide, 5 m long and with 75 cm row spacing. At each location two replications were planted.

Lack of moisture early in the season prevented any germination at Asebot. Bird damage at Alemaya and poor stand establishment at Arsi Negele made it very difficult to evaluate the nursery with certainity. Agronomic data for these entries are presented in Table 2. In general, days to heading for the ASS were longer at Arsi Negele than at Alemaya. Mean days to heading were 127 and 113 for Arsi Negele and Alemaya, respectively. This might have been due to differences in dates of planting between these locations. Plant heights at Alemaya ranged from 125-315 cm with a mean of 228. Most entries were below average in agronomic desirability rating and only 6 entries had an average score. No entry was better than average. Of the entries that had an average rating, a red seeded relatively early entry, ETS 4263, has been selected to be evaluated again in the 1978 ASS trial.

Table 2. Agronomic data for entries included in the Advanced Sorghum Selection Nursery, 1977.

Entry No.	Identification	Heading Days AL	Heading Days AN	Plant height (cm) AL	Agronomic Desirability Score* AL	
1	ETS 3665	105	115	250	4	
2	ETS 3682	120	114	240	4	
3	ETS 3683	102	115	233	4	
4	ETS 3695	108	114	235	5	
5	ETS 3705	96	112	242	5	
6	ETS 3723	108	115	145	5	
7	ETS 3933	110	146	125	3	
8	ETS 4019	87	126	145	4	
9	ETS 4098	112	115	253	4	
10	ETS 4117	112	119	240	4	
11	ETS 4155	108	119	225	5	
12	ETS 4158	121	113	228	5	
13	ETS 4263	108	120	225	3	selected for further evaluation
14	ETS 4271	118	119	295	4	
15	ETS 4363	108	118	240	5	
16	ETS 4371	117	120	290	5	
17	ETS 4418	108	121	235	5	
18	ETS 4518	114	153	140	4	
19	ETS 4615	107	150	140	4	
20	ETS 4722	114	122	290	3	
21	ETS 4728	127	150	270	3	
22	ETS 4735	133	126	275	3	
23	ETS 4777	114	121	170	4	
24	ETS 4793	122	148	240	4	
25	ETS 4798	129	153	315	4	
26	ETS 4911	120	156	235	3	
	Mean	113	127	228	*1 best	
	Planting date	29/IV	21/V		5 worst	

INTRODUCED TRIALS AND NURSERIES

As part of ESIP's cooperative activities with International Institutes and other national programs, we maintain an active exchange of germplasm and information with them. We find such cooperative activities mutually advantageous. In the 1977 season, we received a number of trials and nurseries from abroad for evaluation under Ethiopian conditions. Such trials often serve us as good sources of parental lines for our crossing programs as well as lines *per se* for direct use in our National Yield Trials.

Over 90% of the introduced trials and nurseries we received and grew in 1977 were from ICRISAT. The majority of these were standard trials sent out to ICRISAT's cooperating programs throughout the semi-arid tropics, one of which is ESIP. Some special purpose nurseries were requested and obtained from ICRISAT by ESIP. Texas A&M, CIMMYT and the Sudanese National Sorghum Program also sent us one trial each. Following is a summary of the results of all the introduced trials and nurseries grown at the various ESIP sites in 1977.

ICRISAT Trials, 1977

Among other trials received from ICRISAT for the 1977 season were six international sorghum trials (Trials 1-6), Trial 1 consisted of high yielding lines from populations in F_5 to F_8 while Trials 2 to 6 were composed mostly of S_2 lines from different source populations. The particulars about each trial are presented below:

Name of Trial	No of Entries	Locations Planting	Number of Entries Selected		
			Kobo	Nazreth	Mieso
Int'l Sorghum Prelim. Yield Trial 1	61	KB, NZ	4	16	NP*
Int'l Sorghum Pop'n Progeny Trial 2	170	KB, NZ	15	19	NP
Int'l Sorghum Pop'n Progeny Trial 3	200	KB, NZ	4	8	NP
Int'l Sorghum Pop'n Progeny Trail 4	200	MS, NZ	NP	0	0
Int'l Sorghum Pop'n Progeny Trial 5	150	MS, NZ	NP	5	0
Int'l Sorghum Pop'n Progeny Trial 6	110	KB, NZ	4	10	NP

*NP - not planted

Except for Trial 1, where the plot size consisted of 4 rows of 5 m length spaced 75 cm apart, the other Trials (2 to 6), the plot size used was 2 rows of 5 m length with 75 cm between rows. For each of the trials 2 replications were planted.

As depicted in the table above, plot or plant selections have been made from 85 different entries across trials and locations. By far the most number of entries selected in any one location was from Trial 2 followed by Trial 1, 6, 3, 5, 4 in descending order. Since as few as one and as many as ten individual selections have been made in any one of the 85 selected entries the total number of plant selections exceeds 200. The selected entries have been slated for use in yield trials or as parents in our 1978 Crossing Block though the majority are to be head rowed in the 1978 off-season nursery and grown as advanced lines in ESIP's lowland sites during 1978 Keremt season.

The most outstanding entry both at Kobo and Nazreth was entry #1 from Trial 1 designated as RS1 x VGC-1. In addition, entries from Texas (received from Dr. D.T. Rosenow direct, but included in Trial 1) i.e. ATx 622 x TAM 428, ATx 623 x SC 326-6, ATx 623 x (599 x 110), R-1750, 77 CS1 have had good performance

At Kobo, one of the most promising new introductions was RS1 x VGC-1 line, Entry #1 in ICRISAT's 1977 International Sorghum Preliminary Yield Trial (77 T1).

at Nazreth. The three Texas hybrids were especially outstanding. The two Texas lines are selected to be used in the 1978 crossing Block and as pollinator parents in the hybrid program. Other promising entries selected from Trial 1 and all marked for 1978 yield trials, crossing block, hybrid parents, with their agronomic data are:

1977 Entry No.	Pedigree	Flowering days KB	Flowering days NZ	Plant height (cm) KB	Plant height (cm) NZ	Selected at	Remarks
77 T1#1	RS1xVGC-1	87	73	110	138	KB & NZ	good panicle exertion
77 T1#5	Fast Lane 'R' (C1)	82	68	108	107	KB	early; good seed quality
77 T1#31	Bulk Y-3	85	73	108	115	KB	good seed quality
77 T1#43	RS/R-20	81	65	123	121	KB	large, pointed panicle

Following is a listing of the entry numbers of the entries from other trials out of which selections were made at Kobo:

Trial 2: 30, 39, 40, 53, 61, 68, 70 79, 83, 87, 119, 125, 147, 163.

Trial 3: 64, 74, 159, 164.

Trial 6: 1, 29, 39, 84.

Similarly, selections were made at Nazreth from the following entries in the Trial indicated.

Trial 1: entry no. 1, 2, 10, 15, 17, 22, 25, 34, 35, 39, 42, 47, 49, 51, 60, 61.

Trial 2: entry no. 39, 46, 60, 75, 76, 78, 85, 86, 93, 96, 99, 100, 101, 104, 110, 117, 118, 121, 140.

Trial 3: entry no. 20, 40, 70, 107, 120, 144, 161, 188.

Trial 5: entry no. 10, 15, 68, 80, 109.

Trial 6, entry no. 28, 46, 47, 53, 70, 71, 84, 88, 90, 103.

Out of the entries in which selections were made some had particularly good performance. In Trial 2, at Kobo, entry no. 87 and

163 and at Nazreth no. 46 figured prominently. From Trial 3 entry no. 164 and 144 were found to be outstanding entries at Kobo and Nazreth, respectively. In Trial 5, entries 15 and 80 at Nazreth and in Trial 6 entry no. 15 at Kobo appeared especially good.

Though Trials 4 and 5 were planted at Mieso (MS), because of poor plant development as a result of moisture shortage and poor soil we were unable to make any useful selection in these trials.

International Grain-Grass Sorghum Trial (IGGST-77)

This trial consisted of 25 highly tillering and early maturing grain-grass sorghums (70-80 days) supposedly adapted to low rainfall areas. Each entry was planted to 4 rows of 3 m length with a row spacing of 37.5 cm. The trial had four replications of which replications 1 and 2 were planted at Nazreth 3 and 4 at Kobo. As suggested, for comparison, regular sorghums were included in the trial with twice the row spacing used for the grain-grass sorghums.

The performance of these grain-grass sorghums compared to regular sorghum under our conditions was not very encouraging. Most of them were not as early as was expected. Moreover, excessive lodging and extra small panicles were apparent at both Kobo and Nazreth.

A separate grain-grass sorghums observation consisting of 20 entries assembled earlier by ESIP was also planted in single observation plots at Nazreth. Here too the entries did not show much promise. As a result, ESIP does not intend to pursue the grain-grass sorghums any further.

International Striga Resistant Nursery, (ISRN-77)

Striga is a menacing parasitic weed in most sorghum growing regions of northern Ethiopia. Conventional methods of weed control have not helped much in controlling Striga. Striga seeds germinate as a result of obtaining the sorghum root exudate strigol and further thrive on the photosynthate produced by the sorghum.

Recent research emphasis has been directed towards identifying low or no strigol exuding sorghums which would in effect hinder the germination of Striga. Low strigol producing sorghums are screened in the laboratory and are further tested in striga infested field plots.

On this basis, ICRISAT sent out in 1977 an ISRN consisting of 50 entries for field evaluations in Striga sick plots. Out of these entries, some were resistant to Striga asiatica and some to Striga hermonthica and a few susceptible checks for comparison. The trial had four replications, of which, replications 1 and 2 were planted at Kobo 3 and 4 at Chaffa, a state farm near Kobo, Wollo. The plot size per entry was 3 rows of 3 meters length with 75 cm row spacing.

No differential rating of entries could be made at Chaffa due to little or no apparent Striga infestation but at Kobo since there was adequate infestation of S. hermonthica it was possible to obtain data on the performance of the entries (Table 3).

Table 3. *Striga* plant counts and agronomic appearance score averaged over two replications for entries in the 1977 International *Striga* Resistant Nursery at Kobo.

Entry No.	Pedigree	No. of Striga Plants	Agronomic appearance score*	Entry No.	Pedigree	No. of Striga Plants	Agronomic appearance score*
1	SRN 4841	2	5	26	IS 5177	9	5
2	23-4	11	3	27	GC 373	0	5
3	IS 2643	8	5	28	BP 53	1	4
4	N-13	0	4	29	BC 9	10	4
5	SRN 1352	30	4	30	GC 580	1	3
6	SRN 4310A	4	5	31	IS 4202	3	4
7	IS 1464	1	4	32	SRN 6838A	16	5
8	SRN 6788A	8	4	33	NJ 1989/2	2	3
9	555	4	5	34	IS 8266	16	4
10	SRN 6838B	12	4	35	NJ 1421	10	5
11	IS 4242	1	4	36	UChV_1	32	2
12	IS 5218	7	4	37	IS 1469	7	3
13	IS 9985	15	3	38	IS 1054	9	4
14	IS 8264	10	5	39	IS 8265	11	4
15	IS 5106	15	3	40	IS 8269	71	5
16	IS 1562	0	4	41	SRN 4882A	13	3
17	Bongahilo	14	5	42	IS 8785	3	3
18	IS 2203	2	4	43	IS 6942	0	3
19	37-2-13	0	3	44	76K2/87	12	4
20	SRN 5790	22	3	45	IS 3962x WABC 1022	1	5
21	NJ 1515	12	4	46	Swarna	15	3
22	SRN 4882B	29	3	47	Swarna	43	4
23	16-3-4	1	4	48	Swarna	33	5
24	IS 3815	2	4	49	Swarna	5	4
25	Serena	21	5	50	Kobomash-76	19	3

*1 best ...5 worst

As presented in Table 3 almost all of the entries were average or below average in agronomic appearance score. Despite this, there were some interesting entries which were completely free from Striga infestation in both the replications they were planted, namely, N-13, IS 1562, 37-2-13, GC 373, and IS 6942. On the other hand, the most susceptible entries registering higher Striga counts than others were IS 8269, Swarna (47), swarna (48) and $UChV_1$.

The presence of Striga resistant entries is encouraging but in order to keep up with the race these entries need to possess agronomic eliteness as well, to be used directly as lines per se. Such low strigol producing lines are expected to be useful in a crossing program to combine agronomic eliteness with Striga resistance.

At this point it should be mentioned too that through separate funds made available from IDRC, ESIP, in cooperation with the IAR weed research section, is launching a more extensive Striga research aimed at screening for low exudate producers in the laboratory and the green house and thorough field evaluation of promising genotypes under heavy Striga infestation.

Sorghum Elite Progeny Observation Nursery (SEPON-77)

This nursery obtained from ICRISAT comprised of 72 F_4 derived progenies selected from crosses involving parents with wide adaptation and grain mold tolerance plus three checks. This nursery was planted at Arsi Negele and Alemaya with each entry to 3 rows of 5 m length and replicated twice.

Though the incidence of grain mold in this trial was very little, because of late planting, the agronomic performance rating of the entries was below average in most cases both at Alemaya and Arsi Negele. Furthermore, most entries exhibited a high degree of sterility at our cool conditions during flowering and

seed development. From the available information, it appears that these entries might best be suited for the lowland areas.

International Sorghum Grain Mold Nursery (ISGMN-77)

Vulnerability to grain mold in sorghum poses a problem in its utilization. Realizing this, ICRISAT, during the 1977 season, distributed an early season ISGMN containing sources of resistance for sorghum grain molds to be tested at locations where grain molds are consistently severe. This nursery had 27 entries and was planted at Alemaya and Arsi Negele where for the past few years molding due to late rains has spoiled otherwise acceptable grain. This was especially true of Alemaya.

The entries were planted to two rows of 3 m length each with two replications at each location.

More than 50% of the entries had a grain mold rating of 3 or above at both locations using a 1-5 scale. (1 being mold free and 5 representing severe molding). Meanwhile, the desirability rating of a still greater proportion of entries was not good. Despite this four agronomically superior and low molding entries which stood out at both locations have been selected to be put in a crossing block and in a yield trial during the coming season. These four entries were South African Kafirs with upright panicles. Agronomic data from Arsi Negele along with mold and desirability scores from Alemaya and Arsi Negele for these selections is presented below.

Pedigree	Heading Days	Plant height (cm)	Mold Score*		Agron. Accept. Score**	
			AL	AN	AL	AN
IS 9521	114	170	1	--	1	1
IS 9331	98	190	2	--	1	2
IS 9533	98	175	25	--	1	1
IS 9544	114	150	2	--	1	2

*1 - mold free ...5 severely molded

**1 - best ...5 worst

International Sorghum Leaf Disease Nursery (ISLDN-77)

The seriousness of epidemics and the destructive nature of diseases due to susceptible genotypes necessitate the identification and development of sources of resistance to diseases in sorghum.

The purpose of this nursery (ISLDN) is to provide sources of resistance to sorghum leaf diseases that can be utilized in breeding programs. During the 1977 season, ICRISAT distributed an early season ISLDN containing sources of resistance for leaf diseases in sorghum. This nursery comprised of 25 entries and was planted at Alemaya and Arsi Negele, two locations previously recognized as hot spots for leaf disease development. Two rows of 3 m length with two replications at each location was the plot size used.

The entries were evaluated for overall disease severity, agronomic acceptability and degree of sterility. At Arsi Negele only two entries were rated as having little or no leaf disease. They were IS 10264 and Bulk Y x GPR-165, but their agronomic desirability was average or below. Moreover, Bulk Y x GPR-165 exhibited an appreciable degree of sterility at both Alemaya and Arsi Negele. At Alemaya, again IS 10264 was rated as having little or no leaf disease but only with moderate agronomic desirability rating and with negligible sterility.

Considering the available data on disease, desirability, and sterility rating, one entry, Bulk Y x Entomology, which had a good agronomic desirability rating and no sterility but with some leaf diseases, was selected from Alemaya to be included in the 1978 Crossing Block.

International Sorghum Disease and Insect Nursery (IDIN)

The IDIN was received from Texas A&M through Dr. D.T. Rosenow and contained sorghum genotypes with resistance to diseases, insects, lodging and grain weathering. The 30 entries in this nursery were planted at Nazreth to 2 rows of 5 m length and replicated twice.

Due to poor establishment and later attack by Quelea birds effective evaluation of all entries in this nursery was not possible. Nevertheless, some visual ratings for some characteristics have been recorded for entries that have established. Incidence of insects was not apparent during the growing season, so no differential rating or insect resistance was obtained. But ratings were made on overall leaf disease severity, grain molds and agronomic acceptability.

For each of the characteristics on which ratings were obtained, there were some outstanding entries that deserve mention. QL 3 selection, SC 103-12, and SC 279-14 were especially free from grain molds. Also TAM 428 (SC 110-9), SC 748-5-3, and (B3197 x SC 170) sel 1750 were also rated as having only slight grain molding. With respect to leaf diseases, the most resistant entry was (IS 2930 x IS 3922) followed by GPR-148. Evaluation for agronomic acceptability indicated (B3197 x SC 170) sel 1750 and (IS 2930 x IS 3922) to be superior followed by TAM 428 (SC 110-9). Considering all the available data on the above mentioned entries (B3197 x SC 170) sel 1750, (IS 2930 x IS 3922) and TAM 428 (SC 110-9) were the most outstanding of the lot.

ESIP plans to use these outstanding entries in different aspects of the sorghum improvement program during the coming season. B Tx 624 which is a derivative of (B3197 x SC 170) has been selected for use in our hybrid program. (IS 2930 x IS 3922) or 77 CS1, a yellow endosperm line, will be put as a parent in both the 1978 Crossing Block and the hybrid program. TAM 428, a zerazera type, will be evaluated further in a special nursery received from Dr. Fred Miller of Texas A&M.

West African Population Crosses (WAPC)

This nursery was obtained as a result of ESIP's special request to ICRISAT for relatively late sorghums with good seed quality from the West African zone for evaluation in the Ethiopian highlands. Consequently, West African Population Cross consisting of 13 entries was received and planted at Alemaya and Arsi Negele for evaluation. Each entry was planted to 3 rows of 5 m length and replicated twice.

The planting of WAPC at Alemaya was relatively late, and as a result a killing frost at the end of November terminated further plant development, so no worthwhile selection could be made there. But at Arsi Negele since the entries attained full development, entry no. 6 (A-2344) was selected to be included in the 1978 Crossing Block as a leaf disease resistant entry.

Early IS Numbers

This was a special seed request by ESIP received from ICRISAT comprising of the earliest IS numbers in the world sorghum collection. This observation was intended to serve as a source of very early materials to be used in short rainfall areas either as lines per se or as parents in a crossing program. There were a total of 88 entries planted to 2 rows of 5 m length at Kobo.

Agronomic data from Kobo indicated that height ranged from 40 to 210 cm while the majority of the entries had heights between 1 and 1.5 m. Days to heading ranged from 74-102 days, but, the majority headed in 90-95 days. Five selected promising entries intended for use in yield trials and/or crossing block are listed below along with their agronomic data from Kobo.

Entry	Heading Days	Height (cm)	Remarks
IS 3558	94	175	Caudatum; pearly grains (CB)*
IS 3541	89	160	Awash-like panicle; pearly grains (CB&YT)
IS 3573	91	135	Compact panicle (CB)
IS 6084	89	160	Very compact, goose-necked durra (CB)
IS 6991	91	210	Tan plant, borer tolerant excellent seed quality (YT)

*CB and YT refer to Crossing Block and Yield Trial, respectively and denote for what use the entry is slated for during the 1978 season.

Broomcorn Varieties Observation

Recent local enquiries and interests prompted ESIP to look into the agronomic potentials of broomcorns under Ethiopian conditions. Consequently, we made a special seed request to ICRISAT and received 29 entries which were planted at Alemaya and Nazreth during the 1977 Keremt season. Each entry was planted to 5 rows of 5 m length, ¾ m width, and replicated three times.

The entries were evaluated for overall agronomic appearance, leaf disease resistance, general desirability for broom making as determined by panicle structure and brush length. On the basis of these overall evaluations and good adaptation for both Alemaya and Nazreth, five best entries were selected for further evaluations and possible multiplication and release. These entries were IS 11, IS 26, IS 29, IS 30, and IS 31.

It is hoped that enough local interest could be generated through the popularization of such varieties so as to set up a cottage industry for brooms whereby low cost brooms with good quality could be made for local use. There is very little justification for importing brooms. The fact that broom making does demand a substantial amount of hand labor and since the broom making technology is quite simple, such a cottage industry should be quite appropriate for our present conditions.

Group Representatives for Sorghum Classification

These were 62 entries obtained from ICRISAT on special request by ESIP. These sorghums collectively serve to demonstrate the simplified classification of cultivated sorghums of Harlan and de Wet (Crop Sci. 12:172-176). These sorghums were originally intended to be grown out and later be used for preparing herbarium samples as reference material. But, evaluation of the material has also yielded some interesting types to be included in the 1978 crossing program.

These were: IS 6448 - Durra (Nandyal)
IS 6846 - Guinea (Conspicuum)
IS 11025 - Durra (Durra-Kaura)
IS 11150 - Durra (Subglabrescens)

International Cold Tolerance Sorghum Adaptation Nursery (ICTSAN)

This nursery, received from CIMMYT and planted at Alemaya, was composed of high altitude type sorghums with source material for cold tolerance. Each of the 144 entries in this trial was planted to two rows of 3 meters length spaced 75 cm apart and was replicated twice.

Relative to the Ethiopian highland types, these entries were short (less than 1.5 m) and were mostly early in heading. Unlike previous years, where all entries were red or brown seeded and thus of poor quality, this season's ICTSAN contained largely of light seeded (white or yellow) lines. However, materials in ICTSAN trial did not at all measure up agronomically (yield, vigor, quality) to the type of sorghums grown in the Ethiopian highlands which already appear to possess a good level of cold tolerance in combination with agronomic eliteness.

Sudanese Selections

These selections, totalling 150, were received from the Sudanese program at Wad Medane. These seeds were sent to us from Dr. M.A. Mahmoud of the Sudanese National Sorghum Program as a result of the request of Dr. L.R. House. Each entry was planted in non-replicated observation plots at Kobo and Nazreth. The plot size used was 2 rows wide and 5 m long with 75 cm row to row spacing.

Of these selections, Cross 34:8 (Sud. Sel. #1) and Cross 35:24 (Sud. Sel. #4) looked excellent at Kobo and Nazreth, respectively, and it is intended to include these entries in the 1978 yield trials and also as parents in the crossing block. In addition, head selections have been made from Cross 67:77 (Sud. Sel. #117) and Cross 67:98 (Sud. Sel. #121) at Nazreth for head rowing in the off-season and fruther observation during the 1978 Keremt season.

At Kobo, some advanced lines from the Sudanese Program appeared to have good potential.

FAO Regional Cooperative Sorghum Yield Nursery, 1977

This is a regional cooperative sorghum yield trial consisting of 16 entries plus a local check. Most of the entries were assembled from the different countries covered by the Near East Regional Project.

The trial was laid out as a randomized complete block with 3 replications. A plot consisted of 4 rows of 3 m length spaced 75 cm apart. This trial was planted at Alemaya and Nazreth. Data from Alemaya are presented here with only an overall agronomic desirability rating from Nazreth since yield data could not be obtained due to severe Quelea bird damage.

Agronomic data for all the entries are presented in Table 4. There was a highly significant difference among entries in number of days from planting to heading, plant height and grain yield. All of the entries were much earlier and shorter than the local check (ETS 2113). The latest and tallest entry was the local check and it took nearly twice as many days to head and grew to more than twice the height of the earliest and shortest entry R920. Yield levels were very low, part of the reason for such low yields is the damage inflicted by birds because these entries matured earlier than any of the sorghums in the immediate area. However, it seemed unlikely whether there is any potential in most of these sorghums to excel the local sorghum, which gave a high yield of 88 Q/ha. Of the rest, better yields were obtained from AKS618, 7502 and SSII. AKS618 had reddish brown seeds thus was of a poor quality. In fact its high yield many have been due to less bird damage because of its low bird preference. 7502 though it has red seeds had better quality but its disease rating was on the high side and its desirability rating was low (Table 4). SSII, on the other hand, had good quality light red seeds and good agronomic appearnace both at Alemaya and Nazreth and its disease rating was among the best. This entry has been selected and put in our 1978 Advanced Sorghum Selection (ASS) nursery for further evaluation.

Table 4. Agronomic data for 17 entries in the FAO Sorghum Yield nursery, 1977.

Entry	Days to Heading	Plant Height (cm)	Grain Yield (Kg/ha)	Disease score*	Desirability rating** AL	NZ
1. Giza 3	83	112	300	9	4	3
2. Giza 15	83	175	300	9	4	3
3. Giza 114	80	182	377	9	4	3
4. R920	58	93	1067	9	4	4
5. SSI	74	132	1311	3	2	3
6. SSII	87	155	1789	3	2	2
7. 7502	80	97	2055	6	3	4
8. Sarokartho	74	143	322	9	4	4
9. D.G. Pearl	74	147	756	9	4	3
10. Dabar	64	102	389	8	4	2
11. Gadam El Hamam	76	80	1133	8	4	4
12. Karktib	74	75	1100	8	3	3
13. TUB7	60	83	600	6	5	5
14. TUB22	73	98	1389	6	5	4
15. White Dwarf Milo	71	87	800	9	4	4
16. AKS618	67	97	2988	5	5	4
17. Check (ETS 2113)	102	230	8822	5	1	-
Mean	75	123	1500			
LSD (0.05)	3.9	17.3	1078			
CV (%)	3.1	8.4	43			

*1 resistant, 9 susceptible

**1 best, 5 worst

HEAD ROW SELECTIONS, 1977

In the lowland ESIP stations, where most introduced trials and nurseries are normally evaluated, single plant selections have been made from such materials in the 1976 and '77 Keremt season. The single plant selections of 1976 were grown out in 1977 as separate head row derivatives after being grown out as head rows in the off-season of the same year. The head row derivatives of 1977 were mostly of foreign sources.

There were five groups of head row selections grown out in the year. These were a) 683 selections from Alemaya b) 172 selections from Humera c) 617 selections from Kobo d) 257 selections from Nazreth and e) 315 yellow endosperm selections from Nazreth. In 1977, mostly depending on the location of selection, each group of material was designated, respectively, according to the following range a) AL-76-1 to AL-76-683 b) HU-76-1 to HU-76-172 c) KB-76-1 to KB-76-617 d) NZ-76-1 to NZ-76-257 e) YE 141 to YE 456.

These total of 2044 head row selections was grown out at Kobo (KB), Nazreth (NZ), and Mieso (MS) using a plot size of 2 rows x 5 m x ¾ m with two replications at each station. The entire material was visually evaluated at each location and further individual plant selections were made from most promising head row derivatives. The number of selections varied from group to group but a total of 210 head row derivatives or about 10% had one or more single plants or entire plot selected in them for further advance and various uses in the 1978 season.

The summary of 1977 selections is shown in Table 5. Out of the AL-76-HR selections a total of 23 were further selected out of which 20 were advanced for 1978 head rows (S for HR) and three as 1978 Lowland National Yield Trials (L-NYT) entries. The HU-76-HR selections had 29 entries further selected in them, 28 for 1978 head rows and one for L-NYT. The KB-76-HR selections with 84 selections advanced had the largest number of entries going into the 1978 season with 72 for head rows and 12 for L-NYT.

All the 24 advanced selections from the NZ-76-HR group will go into head rows evaluations again. Of the 50 yellow endosperm advanced selections, 29 will be used as pollinators in the 1978 hybrid program (S for Hy) and 21 will be further evaluated as head rows. Therefore, in summary, from the three sites (KB, MS, and NZ) the 210 further selected entries in this nursery will be distributed in the 1978 season as follows: 165 for further head rows evaluations (S for HR), 29 as pollinators in the 1978 hybrid program (S for Hy), and 16 for 1978 L-NYT. The following four head rows were selected to go into the 1978 Crossing Block: NZ-76-167 from NZ, KB-76-430 and KB-76-617 from KB, and HU-76-160 from MS.

Detailed information on identification of these advanced selections, location where each entry has been selected in 1977, number of plants selected in each head row, and the projected use of each selection in 1978 are given in Appendix Table A1.

Table 5. Summary of selection results of the 1977 Head Row Selections planted at Kobo, Mieso, and Nazreth.

	KB			MS		NZ	
HR Group	S for HR	S for Hy	L-NYT	S for HR	S for Hy	S for HR	Total
AL-76-HR Sel.	15		3			5	23
HU-76-HR Sel.	7		1	3		18	29
KB-76-HR Sel.	22		12	34		16	84
NZ-76-HR Sel.	3			7		14	24
YE HR Sel.	21	17			12		50
Total	68	17	16	44	12	53	210

CROSSING PROGRAMS

During the year we had four different crossing programs undertaken at different ESIP sites. The objectives of making crosses in each program was different. The first program was hybrid crossing with the intention of developing F_1 hybrids for direct use by farmers. This work was undertaken at Melka Werer during the off-season. Since details of this program are given in the section on "Prospects of Hybrid Sorghum in Ethiopia" they will not be covered here. The second program was backcrossing in which anthracnose resistance from selected exotic sorghums is to be transferred to selected elite Ethiopian varieties which are anthracnose susceptible. This activity was undertaken at Alemaya. The third crossing program, which was also done at Alemaya, involved random mating among selected Ethiopian elite sorghums using the dented (high lysine) seed marker. The fourth program, which is often referred to as the Crossing Block (CB) in this report, dealt with the hand emasuclated crossing for our pedigree breeding. This work was done at Nazreth. Details about each of these crossing programs except the first one are given below:

Backcrossing

Some of the outstanding and high yielding varieties released by ESIP have become very susceptible to anthracnose which has made it inadvisable for us to continue pushing these varieties. Consequently, in 1977, we initiated this backcrossing program in which five high yielding and agronomically elite ESIP varieties were selected to be used as recurrent parents in the program. These five are ETS 2111, ETS 2113, Awash 1050, ETS 3235, and WB 77. The first four, though susceptible to anthracnose, have been included in our National Yield Trials for several years and have consistently been among the top yielders in our high altitude zones. The last one is a high lysine selection with excellent agronomic desirability and high yield potential but with anthracnose susceptibility at high altitudes. It is the intention of

this program to maintain the essential agronomic identities of these varieties but bring in anthracnose resistance to them.

The sources of resistance, non-recurrent parents, in this program were also five lines or varieties, namely, IS 2230, IS 158, (Hafukagne x Hirna 305/547), NES 8827, and NES 8835. All of these were selected for their clean leaves and apparent anthracnose resistance under severe anthracnose presence at Alemaya in the 1976 Keremt season. These lines in general were much earlier and shorter than the Ethiopian varieties. The taller Ethiopian varieties were used as pollinator parents. The two groups of varieties were made to nick in flowering time by staggered planting.

Plans were to make all possible 25 combinations between the two groups of varieties out of which 23 were completed.

The F_1's from this program will be grown in the off-season at Melka Werer. The resulting F_2's are planned to be grown at Alemaya under conditions favorable for anthracnose development. Anthracnose resistant segregates will be crossed again to the five recurrent parents in Keremt 1978.

Dented Seed Breeding Method (DSBM)

The major objective in this program is population improvement by effecting random mating among selected Ethiopian highland genotypes through using the dented seed high lysine marker gene of the Ethiopian high lysine lines from Wollo. The basic principles and justifications in the DSBM for population improvement are those of half-sib tests. The field techniques are essentially the same as those used in the Ear-to-Row Selection Method used in maize. It is known that the dented high lysine seeds are homozygous recessive (hl hl). Open pollination between dented seed females and plump (normal) seeded pollinators as a result of xenia give few plump F_1 seeds. Such outcrossed plump seeded F_1's could easily be handpicked from the majority of the selfed

and dented seeds of the mother panicle. A couple of advantages associated with the DSBM as compared to using genetic male steriles for mass crossing are: first, locally adapted and agronomically elite parents on both the male and the female side are used. Second, the DSBM should offer increased opportunities for breaking up tight linkages associated with the dented seed character thus releasing fresh variability for selection in high lysine background.

In the 1977 DSBM, the female lines (dented) used were 60 in number. These 60 seed parents were selected both from our high lysine collections from Wollo and also from segregating highland populations from earlier crosses involving high lysine parents. Attempts were made to include as much as possible of the available range of genetic variability in the Ethiopian high lysine background.

The pollinators used were 46 of the best highland sorghums available in our program in 1977. Out of the 46 Ethiopian elite pollinators, 10, 10, and 26 were included in the 1977 Highland NYT, Intermediate NYT, and Advanced Sorghum Selection Trial, respectively. A mechanical mixture of equal amount of seed of each of the 46 selections was made to serve as the composite pollinator for the DSBM. The lists and identifications of the 46 varieties could be found in the section dealing with NYT and ASS results.

The planting arrangement was such that odd numbered rows were planted with the composite pollinator and all even numbered rows with the 60 different dented high lysine female lines. Each row was 5 m long and 75 cm wide and was replicated twice. Since the entries were in the same general range of maturity it was assumed that random mating would take place because open pollination was allowed. After grain maturity, heads were cut from two of the phenotypically best appearing plants. From these two best heads in each female row, the plump seeds were hand picked

in the laboratory and saved as crossed seeds. These crossed seeds are to be grwon in the off-season to generate 3 plump: 1 dented segregating seeds on panicles of the selected plants. From the harvests of the off-season, only dented seeds will be hand picked and advanced to Keremt 1978 season to start the cycle again. The dented seeds always serve as the female rows in the DSBM.

We had also initiated DSBM for lowland populations at Nazreth in 1977. However, because of poor establishment and Quelea damage we were neither able to carry out any effective selection nor harvest any thing in this material.

Crossing Block (CB) for Pedigree Breeding

The Crossing Block (CB) for pedigree breeding was by far the most involved and time consuming of all the crossing programs undertaken by ESIP. In 1977, the CB at Nazreth included a sufficient range of genotypes and parental combinations to cover the needs of the major sorghum ecological zones of Ethiopia.

In this year's CB, there were eleven major blocks of combinations involving parents both from local sources and introductions. Several parents were involved in each block of combinations. Each block of combination is intended for a given sorghum producing zone in the country. Most of the parents have been selected on the basis of their performance per se at the various ESIP sites in different ecological zones. There were a total of 137 parents involved in the 1977 CB. The list of parents and description of each is given in Table 6.

In the 1977 Crossing Block, for the Pedigree and Backcross Programs, nearly 10,000 heads with about 100 florets each were emasculated.

Table 6. List and identification of the 137 parents used in the 1977 Crossing Block (CB) at Nazreth (Melkasa) along with their description.

Group I. Alemaya (AL) Highland Selections

1977 CB #	Seed Source	Identification or Parentage	Remarks
1.	AL 76, ASS #5	ETS 2901	Upright panicle, thick stalk, white seed, 77 I-NYT
2.	AL 76, ASS #1	ETS 2988	Short red seeded, 77 I-NYT
3.	AL 76, ASS #14 & #12	ETS 3233	Large white seeds with upright panicle
4.	AL 76, ASS #17	ETS 3235	Large white seeds with Awash like upright panicle, 77 I-NYT
5.	AL 76, ASS #2	ETS 3376	77 I-NYT
6.	AL 76, ASS #4	ETS 3378	Yellow seeded and upright panicle, 77 I-NYT
7.	AL 76, ASS #6		Very large Hafukagne like seeds but on small heads
8.	AL 76, PNYT #5	ETS 2283	Bishinga Worabesa, tall and late with good quality grain completely covered by glume, 77 H-NYT
9.	AL 76, PNYT #10	ETS 2339	
10.	AL 76, PNYT #8	ETS 2537	77-H-NYT
11.	AL 76, PNYT #1	ETS 2547	77 I-NYT
12.	AL 76, PNYT #4	ETS 2644	Good grain quality and white
13.	AL 76, PNYT #3	ETS 2647	White and good grain quality
14.	AL 76, PNYT #6	ETS 2741	77 H-NYT
15.	AL 76, PNYT #11	ETS 2752	Late, 77 H-NYT
16.	AL 76, NYT	ETS 2111	Good grain quality, short with goose neck panicle, anthracnose susceptible more than 3 years in NYT

Table 6 continued

1977 CB #	Seed Source	Identification or Parentage	Remarks
17.	AL 76, NYT	ETS 2113	Good grain quality, more than 3 yrs in NYT
18.	AL 76, NYT	Alemaya 70	Good grain quality, standard ESIP variety
19.	AL 76, NYT	Awash 1050	Good grain quality, anthracnose susceptible, standard ESIP variety
20.	MW 77, HYT 205	IS-857xAwash 1050/1 MW 818-1	Susceptible to leaf diseases but good agronomically
21.	MW 77, HYT 207	IS-857xAwash 1050/1 MW 818-2	Susceptible to leaf diseases but good agronomically
22.	MW 77, HYT 210	IS-857xAwash 1050/4 MW 819-1-210	Susceptible to leaf diseases but good agronomically
23.	MW 77, HYT 212	IS-857xAwash 1050/4 MW 819-1-212	Susceptible to leaf diseases but good agronomically
24.	MW 77, HYT 217	NES-1849xAwash 1050 (S_1)-MW 822	Tan plant
	Group II.	Good Grain Quality (GQ) Selections	
25.	MW 77, HR 307	Hafukagne x Hirna 305/547	
26.	MW 77, HR 406	NES-821 x Awash 1050/2-811	
27.	MW 77, HR 511	NES 8692	
28.	MW 77, HR 533	NES 8820	
29.	MW 77, HR 534	NES 8822	
30.	MW 77, HR 535	NES 8824	
31.	MW 77, HR 539	NES 8827	
32.	MW 77, HR 540	NES 8827	Also used in AL 1977 Backcross program
33.	MW 77, HR 542	NES 8835	Clean leaves
34.	MW 77, HR 544	NES 8835	
35.	MW 77, HR 546	NES 8835	Clean leaves

Table 6 continued

1977 CB #	Seed Source	Identification or Parentage	Remarks
36.	MW 77, HR 548	NES 8835	Used in AL 1977 Backcross program also
37.	MW 77, HR 551	NES 8839	
38.	MW 77, HR 552	NES 8841	
39.	MW 77, HR 553	NES 8846	Clean leaves
40.	MW 77, HR 556	NES 8847	Clean leaves
41.	MW 77, HR 557	NES 8858	
42.	MW 77, HR 558	NES 8876	
43.	MW 77, HR 566	NES 8907	
44.	MW 77, HR 567	NES 8913	
45.	MW 77, HR 571	NES 8922	
46.	MW 77, HR 597	NES 9315	
47.	MW 77, HR 606	NES 9435	Used also in AL 1977 Backcross program
48.	MW 77, HR 629	IS 158	ALAD variety
49.	MW 77, F_2, 1188 AL	(Hx57)xWS 1509/8) x WB 77	Pearly and corneous grains with mold resistance
50.	HARBU, EPID	Hafukagne	
51.	KB 76	CSV-1 (Swarna)	Indian variety
52.	KB 76	CSV-2	" "
53.	KB 76	CSV-6	" "
	Group III. Humera (HU) Lowland Selections		
54.	MW 77, H-178	HU 76, ALAD 3671	
55.	MW 77, H-179	HU 76, ALAD 4022	
56.	MW 77, H-181	(NES 821xAwash 1050/7)-H-181	
57.	MW 77, H-183	(NES 821xAwash 1050/7)-H-181	
58.	MW 77, H-209	NES 4256	
59.	MW 77, H-227	NES 5307	
60.	MW 77, H-234	NES 5516	

Table 6 continued

Group IV. Kobo (KB) Lowland Selections

1977 CB #	Seed Source	Identification or Parentage	Remarks
61	MW 77, LYT 251	76 T1 #14 = Diallel 15683	
62	KB 76	76 T1 #28=CSV-5	Indian variety
63.	MW 77, LYT 256	76 T2 #3	
64.	MW 77, K-63	76 T2 #21	
65.	MW 77, LYT 260	76 T3 #25	Best plot at KB in 76
66.	KB 76	76 T3 #177	
67.	KB 76	76 T3 #181	
68.	MW 77, LYT 264	76 T4 #178	
69.	MW 77, LYT 265	76 T4 #260	Excellent plot at KB in 76
70.	MW 77, LYT 266	76 T4 #408	Long panicle and uniculm
71	MW 77, K-646	76 T4 #412	
72.	MW 77, LYT 267	76 T4 #416	Very good plot at KB in 76
73.	MW 77, LYT 271	76 T4 #441	
74.		76 T4 #459	
75.	MW 77, LYT 272	76 T4 #473	Good panicle exertion
76.	MW 77, LYT 273	76 T4 #476	Excellent grain quality but lacks vigor
77.	MW 77, K-586	76 T4 #477	
78.	MW 77, LYT 274	76 T4 #478	Large panicle
79.	MW 77, LYT 275	76 T4 #487	Good grain quality but lacks vigor
80.	KB 76	CSV-4, (CS 3541)	Indian variety, pollinator for CSH6
81.	MW 77, LYT 279	NES 830 x 705	Different from Kobomash
82.		NES 635	Standard ALAD variety
83.	MW 77, Incr.	Kobomash 76	ESIP variety
84.	MW 77, LYT 276	76 ESIP 3054	Compact Durra, Egyptian type

Table 6 continued

Group VI. Nazreth (NZ) Intermediate Altitude Selections

1977 CB #	Seed Source	Identification or Parentage	Remarks
106.	MW 77, LYT 252	76 T1 #18=Pickett 3	
107.	MW 77, LYT 253	76 T1 #19 = Pickett 4-8	Selected at KB also
108.	MW 77, LYT 254	76 T1 #21 = W.A. x Nigerian	Excellent and early at NZ & KB in 76
109.	MW 77, LYT 255	76 T1 #23 = 954062 x 73PP9	Selected at KB also
110.	MW 77, LYT 258	76 T2 #59	Excellent plot at NZ in 76
111.	MW 77, LYT 259	76 T2 #72	
112.	MW 77, LYT 261	76 T3 #40	
113.	MW 77, LYT 263	76 T4 #161-6	Good plot at NZ in 76
114.	MW 77, LYT 268	76 T4 #420	Very good but late at NZ in 76
115.	MW 77, Incr.	76 T4 #429	Selected at KB & NZ in 76
116.	MW 77, LYT 269	76 T4 #432-1/269	Very good but late at NZ
117.	MW 77, LYT 270	76 T4 #432-1/270	Very good but late at NZ
118.	MW 77, Incr.	76 T4 #587	Selected at KB & NZ in 76
119.	MW 77, LYT 283	NES 8582	ALAD Nursery in 76
120.	MW 77, LYT 284	NES 8598	" " " "
121.	MW 77, LYT 277	ESIP #3178 in 76	Similar to Kobomash
122.	MW 77, Incr.	Shufun	Extra-large papery glume
123.	MW 77, HYT 222	P-721 x ETS 651	Excellent grain quality
124.	NZ 76,	76 T4 #432	

Table 6 continued

Group V. New (NC) Collections

1977 CB #	Seed Source	Identification or Parentage	Remarks
85.	1976 FK Coll'n	77 FK 15, Goronjo	Extra-large-long panicle
86.	1976 MT Coll'n	77 MT 57, Abola	Yellowish white and large seeds
87.	1976 MT Coll'n	77 MT 58, Netch Achiro	
88.	1976 MT Coll'n	77 MT 59, Keye Achiro	Pinkish white seeds
89.	1976 MT Coll'n	77 MT 65, Amedma Achiro	Yellowish and large seeds
90.	1976 MT Coll'n	77 MT 84, Abola	Large compact panicle, white seeds
91.	1976 MT Coll'n	77 MT 124, Gabisso	
92.	1976 MT Coll'n	77 MT 146, Dalecho	Short and very compact
93.	1976 MT Coll'n	77 MT 160, Bishinga Adi	Makes good quality injera
94.	1976 MT Coll'n	77 MT 193, Netch Kutta	Makes best quality injera
95.	1976 ZH Coll'n	77 ZH 28, Goronjo	Large panicle
96.	1976 ZH Coll'n	77 ZH 29, Goronjo	Large panicle
97.	1976 BGM Coll'n	77 BGM 120, Oduok	
98.	1976 BGM Coll'n	77 BGM 123	
99.	1976 BGM Coll'n	77 BGM 201, Chwop	
100.	1976 BGM Coll'n	77 BGM 209, Pado	
101.	1976 IB Coll'n	77 IB 3, Mera	Black glume, white seed
102.	1976 IB Coll'n	77 IB 26, Mera	Extra small seed size
103.	1976 AS Coll'n	77 AS 7, Wottere	Large panicle
104.	1976 BGK Coll'n	77 BGK 4	Lusterous yellowish red
105.	1976 BT 318	Embush	Extra-large seed size

Table 6 continued

Group VII. Yellow (YE) Endosperm Lowland Selections

1977 CB #	Seed Source	Identification	Remarks
125.	NZ 76, ALAD Nursery	YE-11	All of these Yellow Endosperm selections have looked excellent at NZ in 1976 and also in 1977 MW Off-Season. They have all been used as male parents in the 1977 ESIP Hybrid Crossing Program at MW.
126.	" " " "	YE-38	
127.	" " " "	YE-47	
128.	" " " "	YE-52	
129.	" " " "	YE-53	
130.	" " " "	YE-67	
131.	" " " "	YE-96	
132.	" " " "	YE-100	
133.	" " " "	YE-104	
134.	" " " "	YE 105	
135.	" " " "	YE-126	
136.	" " " "	YE-130	
137.	AL 76, Green House	Tx 430	

The 137 parents were divided into seven groups according to the location or kinds of selection. These seven groups were planned to go into the eleven crossing combinations according to the following table:

	AL	GQ	HU	KB	NC	NZ	YE
AL		Comb'n A					Comb'n B
GQ			Comb'n C	Comb'n D	Comb'n E		
HU				Comb'n F		Comb'n G	Comb'n H
KB						Comb'n I	Comb'n J
NC							
NZ							Comb'n K
YE							

Comb'n A. GQxAL. 29 good grain quality and disease resistant early introduced lines crossed with 24 highland Ethiopian elite selections to give a total number of 696 specific combinations. These combinations are primarily designed for highland zones.

Comb'n B. YExAL. 13 yellow endosperm and early introductions crossed with 24 highland Ethiopian elite selections to give a total number of 312 specific combinations. These combinations are also designed primarily for highland zones.

Comb'n C. GQxHU. 29 good grain quality and disease resistant early introduced lines crossed with 7 Humera elite selections to give a total number of 203 specific combinations. These combinations are designed for lowland zones.

Comb'n D. GQxKB. 29 good grain quality and disease resistant early introduced lines crossed with 24 Kobo elite selections to give a total number of 696 specific combinations. These combinations are designed for lowland zones.

Comb'n E. GQxNC. 29 good grain quality and disease resistant early introductions crossed with 21 selections from the 1977 Ethiopian new collections to give a total number of 609 specific combinations. These combinations are mostly intended for highland zones.

Comb'n F. HUxKB. 7 Humera elite selections crossed with 24 Kobo elite selections to give a total number of 168 specific combinations. These crosses are intended for lowland zones.

Comb'n G. HUxNZ. 7 Humera elite selections crossed with 19 Nazreth elite selections to give a total number of 133 specific combinations. The crosses are meant to be for lowland and intermediate altitude zones.

Comb'n H. HUxYE. 7 Humera elite selections crossed with 13 yellow endosperm selections to give a total number of 91 specific combinations. These are crosses for lowlands.

Comb'n I. KBxNZ. 24 Kobo elite selections crossed with 19 Nazreth elite selections to give a total number of 456 specific combinations. These crosses are intended for lowlands.

Comb'n J. KBxYE. 24 Kobo selections crossed with 13 yellow endosperm selections to give a total number of 312 specific combinations. These are crosses for lowlands.

Comb'n K. NZxYE. 19 Nazreth elite selections crossed with 13 yellow endosperm selections to give a total number of 247 specific combinations. These are crosses for intermediate and lowland zones.

The grand total number of planned crosses in these eleven combination blocks was 3923 out of which 2643 have been completed and harvested to go into the 1978 off-season at Melka Werer. All emasculations and pollinations were done by hand by trained school girls and ESIP technical assistants, respectively.

The usual pattern of handling the crosses in subsequent generations is as follows. All F_1 seeds are taken in late November or early December from Nazreth to the off-season station, Melka Werer, and grown there in the Bega season under irrigation. F_2 seeds are harvested and grown during the following Keremt season at the different ESIP sites representing the projected areas of production. At each site, outstanding F_2 single plant selections are made out of selected crosses. Seeds from all selected F_2 plants at highland stations are harvested separately and grouped together for distribution to all ESIP highland stations for growing as F_3 families during the next Keremt season. The same method of grouping is followed for lowland crosses also. Notice that both F_2 and F_3 are screened and selected at the projected sites of production because these two generations offer the maximum segregation and opportunity for selection. F_4's are normally head rowed in the Bega off-season nursery at Melka Werer. Yield Trials of different stages at production areas are conducted using F_5-F_7 generations. From here on, selected lines are normally included in micro-increases and subsequently advanced to large scale seed productions.

SEGREGATING POPULATIONS AND ADVANCED LINES

In the 1977 Keremt season, approximately 2480 populations and lines in F_2 to F_8 were planted at Alemaya (AL), Arsi Negele (AN), Asebot (AT), and Nazreth (NZ). All of these populations and advanced lines mostly trace to ESIP's crossing blocks of 1973, 1974, 1975, and 1976. The planning of crosses and selection of parents have steadily improved in our project since our first crossing season of 1973.

F_2 Populations

In 1977, we grew 776 F_2 populations tracing to the same number of crosses of Keremt 1976 at Alemaya and Nazreth. These F_2's were grown at our four high and intermediate altitude sites (AL, AN, AT, and NZ). In the 1976 CB, since most of the parents were selected on the basis of good performance at high altitude sites, the F_2's tended to do better at the high altitude stations (AL and AN) than at the intermediate ones (NZ and AT). The plot size used was 10 m x ¾ m x 4 rows. Spacing between plants in the row after thinning was 20 cm thus giving 200 F_2 plants to select from in each cross at each location.

Our F_2 populations of 1977 were numbered from 2001 to 2776. These populations were evaluated visually at each of the four sites.

At Asebot, because of shortage of moisture through the growing season it was not possible to make any meaningful selection. The stands were very poor and the majority of the F_2's did not even head.

At Alemaya, stand establishment and growth conditions were good. Anthracnose attack was very severe. This made it possible for us to make what appeared effective and reliable selection. Out of the 776 F_2 crosses evaluated, 61 (7.9%) crosses had one

or more F_2 plants selected in them. A total of 119 plants were selected in the 61 crosses.

At Arsi Negele also environmental conditions were good for establishment and development. Visual selections of outstanding single plants were made in selected crosses. The most number of crosses, 82 (16.6%), had at least one plant selected in them for advancing to the F_3. Out of these 82 crosses, 129 F_2 single plants were selected.

At Nazreth, the nursery was also well established. However, because of the usual heavy Quelea attack, we lost almost the entire F_2 populations to them. We were, on the other hand, able to put on cloth bags on few selected F_2 plants at flowering. After seed maturity, we selected among the bagged heads on the basis of seed quality and head type and were able to advance to F_3 one plant from each of 37 (4.8%) of the 776 F_2 populations.

The F_3 seeds of all the selected F_2 plants from all three sites will be pooled and kept until 1978 Keremt for further evaluation and selection at high altitude sites.

For the three locations in which selection of F_2 plants were made for each location, the number of crosses and plants selected and their pedigrees along with their 1977 Breeding Nursery Number is given in Appendix Table A2.

F_3 Populations

The total number of F_3 populations evaluated in 1977 were 1188. These were all advanced from single F_2 plant selections of 1976 at five ESIP sites. The original source of all these is the 1975 Crossing Block at Alemaya. The two highland locations, Alemaya and Arsi Negele, jointly contributed 975 F_3's. The other three stations, Dakata, Humera, and Nazreth contributed 92, 36, and 85, respectively. In 1977, the F_3's obtained from the different F_2 single plants selections of the different locations in

1976 Keremt were numbered as follows: Alemaya and Arsi Negele selections - 3001 to 3975, Dakata selections - 3001D to 3092D, Humera selections - 3093H to 3128H, and Nazreth selections - 3129N to 3213N. All of these were pooled and planted at Alemaya, Arsi Negele, Nazreth, and Asebot in 1977. Typical plot size used was 10 m x ¾ m x 2 rows with 20 cm spacing between plants in each row giving an effective F_3 population size of 100 per family.

At each location, visual selection was made for general agronomic desirability, earliness, seed quality, disease and insect resistance both within and between families. The number of single plants selected from each family ranged from 0 to 6 depending on the desirability of the family.

At Nazreth and Asebot, for reasons mentioned under F_2 above, we were unable to make any useful selection in the F_3's. However, at Alemaya, it was possible to make reliable selections in these populations. The heavy anthracnose attack in the nursery eliminated most of the families. Out of those which appeared reasonably resistant 92 (7.7%) F_3 families had one or more plants selected in them. In these selected families, a total of 147 single plants were selected for head rowing as F_4 in the 1978 off-season at Melka Werer.

We were able to make good selections at Arsi Negele also. Since anthracnose or other diseases and pest pressures were not as severe at Arsi Negele as Alemaya, we managed to select outstanding plants from 181 (15.2%) families or twice the number of families selected at Alemaya. The total number of F_3 single plants selected at Arsi Negele for F_4 head rowing were 241. They will also be planted in the 1978 off-season nursery.

Examining the results of selection at Alemaya and Arsi Negele, it was found that only 33 families, about 3% of all the F_3 families evaluated, were selected at both sites. Tracing the F_2 origin of these and the majority of the other selections at one or the other site reveals that they were obtained from Alemaya

or Arsi Negele. Of the 213 F_3's entered from relatively lowland sites only seven (4D, 2H, and 1N) or 3% were selected at either Alemaya or Arsi Negele. For all the selected families, the pedigrees along with the 1977 Breeding Nursery Numbers and the number of plants selected in each family in each of the two sites is given in Appendix Table A3.

F_4 to F_8 Lines

There were a total of 516 lines planted in 1977 in F_4, F_5, F_6, F_7, and F_8 generations at Alemaya, Arsi Negele, Asebot, and Nazreth. These lines trace to different generations described in ESIP Progress Report No. 4, 1976. More details about the background of these lines could be obtained from that report. The following is the correspondence in generations of 1976 and 1977 nurseries:

1976 Generation	1977 Generation	Remarks
F_2	F_4	Selections from F_2 parents used in CB 1976 at NZ.
F_3	F_5	ALAD crosses grown as F_2 in MW 1975-76.
F_4	F_6	ESIP's PP crosses of 1974 and NES by ETS crosses of ALAD.
F_5	F_7	NES by IS 11758 or 11167 crosses of ALAD.
F_6	F_8	ESIP's Exotic by ETS crosses of 1973.

In general, we were able to select only very few lines from all of these generations. At Arsi Negele, Asebot, and Nazreth, nothing was selected out of these lines. However, at Alemaya, the following seven lines were selected for Crossing Block (CB), Intermediate National Yield Trials (I-NYT), and Advanced Sorghum Selection (ASS) Trial as indicated below:

Several promising lines were identified from the 1977 nurseries at most of the ESIP sites.

1977 ESIP Breeding Nurserny No.	Parentage	Use in 1978
76-5106	IS 10586B x IS 11758	CB, I-NYT
76-5084	IS 460 x IS 11758	CB
76-6027	NES 821 x Awash 1050	CB
7010	IS 10566 x IS 11758	ASS
7060	IS 10586B x IS 11758	ASS
8028	NES 821 x Awash 1050	ASS
8161	NES 712 x Awash 1050	ASS

The number of selected lines from the crosses evaluated at these advanced generations is much below our expectations, at least for Alemaya and Arsi Negele, because a good number of hihgland elites were used as pollen parents in many of the crosses. The major reasons for the poor recovery of elite lines appear to be the severe selection pressure provided by the heavy anthracnose attack of 1977 and the poor adaptability of the exotic parents to Ethiopian conditions. In our more recent crosses, we have made better selections for adaptability, disease resistance, seed quality, and agronomic eliteness both within the exotic and the indigenous parents used in our crossing programs.

PROSPECTS OF HYBRID SORGHUM IN ETHIOPIA

Advantages associated with hybrid sorghum production in several countries have been written up by so many workers in so many technical and non-technical papers that it appears unnecessary to go into details of this issue. Even the experiences of enough number of developing countries do encourage the exploration of the potentials of hybrid sorghums under Ethiopian conditions. After careful consideration of the cumulative experiences of other sorghum workers in other countries, ESIP became convinced that hybrid sorghum appears to have a great potential in the near future in increasing food production in the lowland sorghum zones of the country.

Since about the last three years, ESIP started concerted effort towards developing an Ethiopian sorghum hybrid program. To this end the necessary germplasm was accumulated, local personnel were trained, appropriate locations for making crosses were developed, hybrid evaluation sites were identified and in general all of the necessary details for getting a viable hybrid program going were worked out.

As a first step in our hybrid program, we accumulated about 150 pairs of A and B lines all from foreign sources. The majority of these A and B lines were obtained through the courtesy of Dr. L.R. House when he was with the ALAD program in Lebanon. Several others were obtained later from ICRISAT, Purdue, and Texas. These lines were grown out at Alemaya in 1975 and Nazreth in 1976 for evaluations of the lines *per se* and also for seed increases.

A and B Lines Introduction and Evaluation

In preparation to initiating the hybrid breeding program, we have been introducing A and B lines from different sources for the last few years. As of the end of 1977 we had accumulated 166 pairs of A and B lines. In the 1977 Keremt season, almost all of these were grown out at Melkasa and Nazreth under rainfed conditions for evaluation and seed increase purposes. The majority of these were also grown and evaluated at Melkasa in the 1976 season.

Based on overall agronomic appearance of these lines in 1977 and 1976, 20 pairs of A and B lines were selected to go into the hybrid programs of 1977 and/or 1978. The following is the list of the 20 selected lines.

ESIP Ref. No.	1977 Female Code	Identification	ESIP Ref. No.	1978 Female Code	Identification
1	C	CK-60	20	M	IS 3677
14	D	IS 896	31	N	IS 10256
15	E	2219	38	F	IS 10317
38	F	IS 10317	43	G	IS 10360
43	G	IS 10360	75	Q	IS 10454
47	H	IS 10368	77	R	IS 10460
48	I	IS 10376	79	S	IS 10464
67	J	IS 10430	80	T	IS 10468
81	K	IS 10473	81	K	IS 10473
86	L	IS 10493	151	P	P 954066-1
			161	U	Tx 622
			162	V	Tx 623
			163	W	Tx 624

The complete list of all A and B lines available with ESIP as of the end of 1966 and some agronomic data on these are given in Appendix Table A4. ESIP is maintaining A and B line seeds of all these and will continue to introduce new A and B lines.

Selected Male Steriles

On the basis of the 1976 evaluations at Nazreth and also considering the wide utilization of a line in other countries, the 10 pairs of A and B lines were selected for the first extensive crossing program in 1977 at Melka Werer off-season nursery. These were:

Serial No.	Identification	ESIP's Code in 1977 MW	Days to Heading at NZ	Seed Color	Remarks
1.	CK-60	C	77	white	stable and widely used
2.	IS 896	D	72	light red	good appearance
3.	IS 2219	E	72	pearly	good quality and widely used in India
4.	IS 10317	F	77	white	tan and leaf disease resistant
5.	IS 10360	G	75	white	good appearance and disease resistant
6.	IS 10368	H	74	white	good appearance
7.	IS 10376	I	67	light red	good appearance
8.	IS 10430	J	71	white	good appearance
9.	IS 10473	K	74	white	good appearance
10.	IS 10493	L	74	white	good appearance

In the 1976 Keremt (K) season at Nazreth, sufficient amount of seed of these selected A and B lines was increased for the off-season crossing program.

Selected Pollinators

Mainly on the basis of line performance per se in Nazreth in 1976 and also on agronomic eliteness of Ethiopian collections in past years at Alemaya, 163 pollinator lines were selected for the 1977 extensive hybrid crossing program at Melka Werer. Of these, 130 were yellow endosperm lines selected at Nazreth in 1976 from Karper's yellow endosperm nursery obtained through Dr. L.R. House of the ALAD program. In 1976, ALAD did in fact run an extensive sorghum screening nursery cooperatively with ESIP at Nazreth in which was the yellow endosperm nursery. Dr. House was at Nazreth at three different times in the season and offered most valuable consultancy at this early stage of our hybrid program and helped us make selections of pollinators in Karper's yellow endosperm nursery. Seventeen best looking lines were also selected as pollinators from ICRISAT's trials grown at Nazreth in 1976. At the time of selection in ICRISAT's nursery, Dr. Hugh Doggett came from ICISAT, India to Nazreth and assisted in the evaluation of these nurseries and provided valuable advice. The rest of the pollinators were mainly high yielding and elite agronomic lines from ESIP's highland nurseries.

The list of the 163 pollinators used in the 1977 hybrid program is given below:

Serial No. 1-130 are YE 11-YE 140 - All Yellow Endosperm Selections

Serial No.	Identification	Serial No.	Identification
131*	T1#14	148**	ETS 3235
132	T1#21	149	ETS 179
133	T1#23	150	ETS 2644
134	T2#3	151	Awash 1050
135	T2#57	152	ETS 2339
136	T2#59	153	ETS 2752
137	T4#178	154	ETS 2547
138	T4#260	155	ETS 2337
139	T4#408	156	ETS 2113
140	T4#416	157	ETS 2111
141	T4#429	158	ETS 717
142	T4#441	159	ETS 396
143	T4#473	160	CSV-4
144	T4#476	161	Tx-430
145	T4#478	162	NES 830 x 3145
146	T4#487	163	Kobomash 76
147	T4#587		

*131-147 are from 1976 ICRISAT nurseries.

**148-163 are ETS Highland Elites and miscellaneous introductions.

ESIP's entire technical staff normally stays at Melka Werer for about one month every year in our off-season sorghum plantings. In MW 77, thousands of crosses using cytoplasmic male steriles were made for the 1978 Hybrid Program.

Making of Hybrids

All of the seed for the hybrids in our project are normally produced at Melka Werer in the off-season immediately following the Keremt season of parental and hybrid evaluation. In the 1977 off-season, each of the 10 male sterile lines was planted in plot size 10 m x ¾ m x 10 rows. Two border rows of the corresponding B line were planted in each plot for seed increase purposes. Two planting dates, two weeks apart, were used. The 163 pollinator lines were planted in single rows of 5 m length with 75 cm distance between rows. Both the female and the pollinator lines were planted on two dates, two weeks apart, for proper nicking of as many combinations as possible.

Plans were to make all possible hybrids between the 10 females and the 163 males with 2-3 female heads pollinated for each combination and we were able to get seeds of 1575 of these combinations or 97%. Pollen shedding at Melka Werer is quite good upto 11 a.m. and all crossings are normally made from about 7:30 a.m. to 11:00 a.m. Ready female heads are usually marked with paper clips the afternoon preceeding pollination. Clipping and bagging of female heads is also done in the afternoons. We have had no problem with getting good seed set.

Evaluations of Hybrids

The 1575 hybrids of MW 1977 plus all the males and the B lines of the females were planted at selected ESIP sites in the Keremt season of the same year. In addition, 10 standard hybrids from India and Israel, namely CSH-6, MSH-8, MSH-11, MSH-21, MSH-33, MSH-40, Hazera no. 226, 610, 726, and 6060 were included in the nursery. The trial was divided into two groups, lowlands and highlands.

In the lowland group there were 1480 of ESIP hybrids from all those combinations not involving the ETS Highland Elites. Including the introduced hybrids and the parental lines of the 1480 hybrids, there were 1651 entries in the 1977 Initial Screening of Hybrids (ISH) planted at three lowland stations. The three stations were Kobo, Nazreth, and Asebot. At each site, each entry was planted in plot size of 5 m x ¾ m x 2 rows replicated twice. Depending on seed availability, the most number of entries was at Kobo and the least at Asebot. At all three sites, the nurseries were well established though each site had significant problems unique to that site. These were stalk borers and drought at Kobo, Quelea and weeds at Nazreth, charcoal rot and low fertility at Asebot. Under these varying conditions, for all of the entries, number of days to heading were recorded and the hybrids were visually evaluated for general agronomic desirability, yield, seed quality, and sterility.

Accordingly, certain female and male lines appeared distinctly outstanding in that they produced superior hybrids in several combinations in which they were involved.

The females which produced the best hybrids were IS 10317A, IS 10360A, and IS 10473A. The hybrids of the first two particularly those of IS 10360A, were best at Nazreth whereas hybrids of IS 10473A were outstanding at Kobo. 2219A which is a popular line in India has not given particularly impressive hybrids at any of our sites. However, most of the hybrids having 2219A as female parent had excellent seed quality. The well known stable seed parent CK-60A also has not looked as good as our three selected females mentioned above. Our plans for next year are to use only the three selected females as seed parents along with new male steriles which we did not use in the 1977 program.

Approximately 1500 ESIP hybrids were evaluated at three sites in 1977. One of the promising hybrids at Nazreth is shown.

Since the general combining ability of the 10 females appeared to be distinctly different, to get an overall general impression of this parameter for the females used, we harvested in bulk all hybrids of each female parent and weighed the bulked grain by female group both at Nazreth and Kobo. For our three selected females seed parents (IS 10317A, IS 10360A, and IS 10473A), the high general combining ability of these females for grain yield could be judged from the data given below:

Females		Relative Grain Yield in Kg of All Hybrids	
ESIP'S 1977 Code	Identification	Nazreth	Kobo
C	CK-60A	384	147
D	IS 896A	579	84
E	2219A	491	111
F	IS 10317A	606	104
G	IS 10360A	837	110
H	IS 10368A	574	125
I	IS 10376A	579	120
J	IS 10430A	446	175
K	IS 10473A	478	243
L	IS 10493A	452	156
	Mean	543	138

The overall low yields at Kobo were mainly due to the very heavy infestation of stalk borers. However, the comparative superiority of IS 10473A at Kobo is obvious. At Nazreth, the superior performance of IS 10360A hybrids is also clear.

The evaluations of the hybrids also revealed that the following 10 pollinators produced the best hybrids: YE 24, YE 55, YE 64, YE 66, YE 67, YE 96, YE 98, YE 121, YE 126, and YE 137. Especially outstanding in producing superior hybrids

were YE 96 and YE 121. The following 40 pollinators were also selected for further evaluations:

YE 15	YE 45	YE 60	YE 87
YE 20	YE 46	YE 61	YE 90
YE 26	YE 50	YE 62	YE 99
YE 27	YE 51	YE 63	YE 114
YE 28	YE 52	YE 65	YE 117
YE 36	YE 53	YE 71	YE 122
YE 37	YE 54	YE 82	YE 123
YE 40	YE 57	YE 83	YE 131
YE 42	YE 58	YE 84	Tx-430
YE 43	YE 59	YE 85	Kobomash 76

In the course of evaluating the hybrids, the B or R line reactions of all the pollinators was determined. Most of the lines were good restorers and a few YE lines had good B line reactions. There were a few in the yellow endosperm group also which were partial restorers. The selected best 50 pollinators listed above were all good restorers. Six YE lines gave most outstanding hybrids in combination with almost all males but they had B line reactions. These were YE 23, YE 56, YE 88, YE 110, YE 113, and YE 116. Since these lines appear to have excellent general combining ability, it would be worthwhile to make their corresponding A lines. We are planning for 1978 MW off-season to use these pollinators on A2Tx2753 which reportedly has cytoplasm system different from that of the standard Milo cytoplasm. We are expecting that some or all of them will be restorers in the Texas A2 cytoplasm.

In the evaluations of the hybrids at Nazreth and Kobo, the best 30 of the 1480 lowland hybrids were designated Star Selected Hybrids (SSH) and will be put into replicated yield trials in the 1978 Keremt season. These 30 resulted from all possible combinations of the most outstanding three females and ten males mentioned above. The hybrids of these same selected females and

Some of the 1500 ESIP hybrids appeared very promising in 1977 at Kobo also. Hybrid #1240, IS 10473A x YE 66, was one of the best looking.

the group of 40 selected pollinators listed above were designated Ordinary Selected Hybrids (OSH) and will also go into more advanced evaluations in 1978. Sufficient amount of seed of all these hybrids will be produced at Melka Werer off-season early in 1978.

At Asebot, because of lack of vigor and spindly development of the plants and severe lodging caused by charcoal rot it was not possible to make any meaningful selection in the hybrid nursery. In general, the hybrids of CK-60A and 2219A appeared to be the most susceptible to charcoal rot.

At all the three lowland locations, none of the introduced standard hybrids from India and Israel were good enough to be included in the SSH group. Some appeared to be good enough to be grouped with the OSH. The best of the introduced hybrids were CSH-6, MSH-33 and MSH-21. The Hazera hybrids were the worst of the lot.

The highland hybrids i.e. those resulting from the 10 females and the 12 pollinators designated as highland elites were planted at Alemaya and Nazreth. There were 95 hybrids in this group. At Nazreth, this group was in general much taller and later, more vigorous and produced bigger panicles than the lowland hybrids. Because of complete Quelea damage of this group at Nazreth, it was not possible to make any selection. At Alemaya, though planted late, the nursery was well established and evaluations were made. The female parents of the best looking hybrids were IS 10368, IS 10430 and IS 10493. The pollinators producing the best hybrids were ETS 2547, Awash 1050, and ETS 2113. The six SSH hybrids in this group were IS 10317xETS 2547, IS 10430xETS 2547, IS 10473xETS 2547, IS 10493xAwash 1050, IS 10368xETS 2337, and IS 10317xETS 2111.

On the basis of the request of Dr. L.R. House, 535 hybrids of the lowland group were sent to Dr. M.A. Mahmoud of Wad Medani, Sudan, for evaluations there. The trial was grown in the Sudan in 1977 at Wad Medani. Dr. House had chance to visually score the nursery in the Sudan and in 1 to 5 appearance score where 1 represented the best looking hybrid and 5 the worst, about 3% of the hybrids or 16 in number received appearance score of 1. These are listed below:

1. CK-60AxYE 88
2. CK-60Ax76 T1#14
3. 2219AxYE 21
4. 2219AxKobomash 76
5. IS 10317AxYE 19
6. IS 10317AxYE 40
7. IS 10317AxTx-430
8. IS 10493AxYE 102
9. IS 10360AxYE 28
10. IS 10360AxYE 63
11. IS 10360AxYE 88
12. IS 10360AxYE 116
13. IS 10360AxKobomash 76
14. IS 10368AxYE 63
15. IS 10368AxYE 88
16. IS 10430AxYE 56

Out of the 10 female parents used, seven had at least one hybrid selected in it. The most number of hybrids (5) received best appearance score when IS 10360A was the seed parent and the next highest number of best score received hybrids from the same female parent were those of IS 10317A. These same two IS numbers were also found to be the best hybrid producing females at Nazreth.

Judging from the number of hybrids scored best, the best pollinators for Wad Madani are apparently YE 88 and Kobomash 76. Since YE 88 has excellent B line reaction it cannot be used as pollinator in hybrid seed production. YE 88 also gave superior hybrids in the Ethiopian evaluations. It is interesting to note that of the six best pollinators, i.e. those giving superior hybrids and yet gave B line reaction according to Nazreth and Kobo evaluations, three were also found best in the Sudan. These are YE 88, YE 116, and YE 56. It is worth repeating that these should be converted to A lines.

Prospects of Hybrid Seed Production, Processing and Distribution

The Ethiopian Seed Corporation is in the process of being established. It will start functioning in 1978 as a National Seeds Program (NSP) using government support with long term intentions of being changed to a corporation. NSP considers ESIP as its source of breeders seed and we are planning to increase seeds of selected varieties for them in 1978. It is hoped that by the time ESIP gets ready with its first hybrids, in about two years, for release, NSP will also be sufficiently well organized to take over the hybrid seed production and processing. The distribution aspect will probably be handled through the appropriate government agencies namely AMC and EPID.

Anticipating the eventual complete handling of the national hybrid sorghum seed production by the NSP, ESIP will be increasing seeds of the most promising A and B lines as well as outstanding pollinators to be passed on to the NSP. Obviously, a close functional relationship between NSP and ESIP will be essential for making hybrid sorghum seed production a reality.

SORGHUM NATIONAL YIELD TRIALS, 1977

The Sorghum National Yield Trials (NYT) in 1977 included three types of trials which corresponded to three approximate ecological groupings. The first group included 10 highland sorghum cultivars which are normally tall and late with best adaptation to near 2000 m altitude. The second group included 10 sorghum cultivars which are best adapted to highland and intermediate altitude zones. The intermediate group is normally earlier and shorter than the highland group. The third group included early and short sorghums which are best adapted to altitude below 1500 m. In the lowland yield trials, there were three independent sets of trials. Set one included 27 lowland sorghums which were selected from the 1976 crop season screening nurseries at Kobo and Melkasa. Set two consisted of 34 lowland sorghums which appeared to be the most promising lines in the 1976 season at Humera. Set three was composed of 15 early and short sorghum lines selected in the 1976 nursery at Alemaya.

The number of replications used at each station for each trial was four. For all the trials, the design used was randomized complete block. The plot size and spacing used was 5 rows by 5.2 m x .75 m x .20 m for the highland sorghums using the center three rows only for data recording. For the intermediate and lowland trials also the same plot size was used except that plants within the row were spaced 15 cm apart. Seed was packaged and sent to each cooperator to over-plant each plot with the intention of thinning to the recommended spacing after 2-3 weeks following germination. The most optimum fertilization and cultural practices were suggested to be followed at each site.

RESULTS

The results of the 1977 NYT's are presented in three parts. The first part is on the highland sorghums, the second on the intermediate sorghums, and the third on the lowland sorghums.

1. Highland Sorghums - Several high yielding varieties are available for the highland sorghum zones of the country. The altitude range in this zone is about 1700 m - 2200 m. The annual rainfall in general in this zone is better than 900 mm.

Yield results have been received from five highland stations and these are presented in Table 7. At the Alemaya station, the trial was planted on two dates, April 28 and May 10 and the data are reported under the heading of Alemaya I and Alemaya II, respectively. The coefficient of variation at all stations, except Alemaya II, was too high. The major factor responsible for this high CV was poor and erratic stand. Most stations reported poor germination for some of the varieties. This was primarily due to grain mold on the seeds used as a consequence of the late rains at Alemaya in the 1976 crop season. Though it appears most meaningful to examine relative yields of varieties by location, it is worth noting that the local check was the overall best yielder. Alemaya 70, ETS 717 and 2113 with 53, 48, and 47 q/ha overall yield, respecively, were among the overall top yielders. These varieties have shown consistently high yields in the highland sorghum zone over several years.

The yield results obtained from Alaba do not allow any meaningful generalization about varietal performance there. From previous years results, it is known that the total environment at Alaba can produce yields several fold than those reported this year. Bird damage was reported high on all of the varieties except ETS 2283 and the local check. Leaf diseases were also reported very high except on ETS 3271 and the local check. Stand count for some varieties was very low also. Combinations of these factors even do not appear to explain the unusually low yields obtained for all varieties at Alaba.

Table 7. Grain Yield, in Kg/Ha, of 10 tall highland sorghum varieties in the National Yield Trials at 5 locations, 1977.

	Variety	Alaba	Alemaya I	Alemaya II	Ambo	Arsi N.	Bako	Mean	Rank
1.	ETS-601	769	3858	5920	5176	3496	4563	3964	6
2.	ETS-717	1402	7056	5099	5460	4834	4833	4781	3
3.	ETS-2113	1805	5315	4343	5600	5722	5485	4712	4
4.	ETS-2283	989	3674	4102	880	--	3290	2587	10
5.	ETS-2537	1034	2093	5186	2620	2880	2477	2715	9
6.	ETS-2752	650	2685	6275	3680	2981	3220	3248	7
7.	ETS-2741	827	3897	5637	1450	3459	3875	3191	8
8.	ETS-3271	1461	5891	4217	---	3607	4887	4013	5
9.	Alemaya 70	1242	6728	6876	6445	4904	5324	5253	2
10.	Local Check	2727	5815	6425	6755	6267	5286	5546	1
Mean		1291	4701	5408	4230	4239	4324		
LSD		766	2253	1365	--	1724	1960		
C.V.		41	33	17	--	28	31		
Rainfall (mm)		--	--	--	1925	--	1274		
Altitude (m)		1900	1980	1980	2250	1960	1650		
Planting Date		May 10	April 28	May 10	May 4	May 12	May 16		

The overall grain yields at Alemaya for both dates of planting were the highest of all participating stations this year. For the April 28 planting, the differences in grain yield among the 10 varieties was highly significant. The highest yielders were ETS 717 and Alemaya 70 with 71 and 67 q/ha, respectively. In the May 10 planting also, the varietal differences in yield were also highly significant, Alemaya 70, the local check (Muyra), and ETS 2752 all yielding over 60 q/ha. The overall yields of Alemaya II were better than Alemaya I mainly because of improved plant population in the former. The best varieties for the Alemaya area appear to be the established varieties Alemaya 70 and ETS 717 and the local Muyra and the new variety ETS 2752. All of these varieties, except Muyra with red grains have excellent quality pearly grains.

Arsi Negelie, which normally reports the highest grain yield, had an overall average of 42 q/ha. The varietal differences in yield were highly significant. The local brown seeded sorghum was the highest yielder with ETS 2113, Alemaya 70 and ETS 717 giving about 50 q/ha or better.

As usual, the similarities in varietal performance at Alemaya and Arsi Negelie are evident this year also. The low yield of ETS 2752 at Arsi Negelie appeared to be mainly due to poor stands. Despite the low plant population in each plot, on the basis of general appearance and overall agronomic desirability, ETS 2752 had the best score of all the highland varieties both at Arsi Negelie and Alemaya. Other varieties receiving high score for general desirability were Alemaya 70, ETS 717 and ETS 601.

The station with the highest altitude, 2250 m, planting the 1977 sorghum NYT was Ambo. This station also had the highest annual rainfall, 1925 mm. Since the reported data were from a single replication it was not possible to analyze the Ambo data statistically. The station mean yield was about 42 q/ha. The local check and Alemaya 70 gave over 60 q/ha. Other high yielders were ETS 2113, 717, and 601 all of which gave over 50 q/ha.

Bako was the lowest altitude station, 1650 m, planting this year's highland NYT's. The station mean yield of 43 q/ha is somewhat lower than other years. The highest yielders were almost the same high yielding varieties mentioned under other stations above. These varieties are ETS 2113 with 55 q/ha, Alemaya 70 and the local check with 53 q/ha. As observed at many other stations also, the entries with the least leaf disease incidence were the local check and ETS 3271.

Table 8 gives the mean number of days from planting to 50% heading at each station. Across all stations reporting results, the varieties taking longer than 130 days were ETS 2283, 2741, and 2752. The earliest varieties were ETS 2537 and 2113. Most varieties were latest at Ambo, as expected, perhaps mainly due to the cool growing conditions.

Plant height data of the 10 highland varieties under each reporting station are given in Table 9. The latest variety, ETS 2283, was also the tallest, 324 cm. Both Alemaya 70 and ETS 2752 were about 300 cm tall. The earliest varieties ETS 2537 and 2113 were also the shortest with approximately 250 cm. Though these varieties are tall as a group, the amount of lodging reported in general was less than 10% for each variety at each location. Those showing the highest lodging were ETS 2283 and 3271.

2. Intermediate Sorghums - The cultivars included in this group are in general also suitable for the highland zone. In addition, they may be grown in altitudes as low as 1500 m if the rainfall situation is favorable.

In this group, the overall best yielders (Table 10) across all locations were Awash 1050 and ETS 2111. Both of these varieties have shown good stability for high yield over several years despite their susceptibility to anthracnose at high altitudes under high rainfall conditions. The grain quality of both of them is excellent and makes excellent quality injera.

Table 4. Number of days to heading of 10 highland sorghum varieties in the National Yield Trials at 4 locations, 1977.

	Variety	Alaba	Alemaya I	Alemaya II	Ambo	Bako	Mean	Rank
1.	ETS-601	104	122	122	151	123	124	4
2.	ETS-717	96	121	127	136	117	119	6
3.	ETS-2113	87	114	110	122	110	109	7
4.	ETS-2283	106	144	140	167	127	137	1
5.	ETS-2537	85	111	110	129	96	106	8
6.	ETS-2752	95	141	136	155	130	131	3
7.	ETS-2741	106	133	129	155	143	133	2
8.	ETS-3271	99	132	145	123	123	124	4
9.	Alemaya 70	101	123	130	136	120	122	5
10.	Local Check	90	135	131	115	124	119	6
Mean		97	128	128	139	121	123	
LSD		7	4	3	-	6		
C.V.		5	2	2	-	3		
Rainfall (mm)		-	-	-	1925	1274		
Altitude (m)		1900	1980	1980	2250	1650		
Planting Date		May 10	April 28	May 10	May 4	May 16		

Table 9 Plant height, in cm, of 10 highland sorghum varieties in the National Yield Trials at 4 locations, 1977.

	Variety	Alaba	Alemaya I	Alemaya II	Ambo	Bako	Mean	Rank
1.	ETS-601	241	280	262	263	365	282	5
2.	ETS-717	300	268	255	258	324	281	6
3.	ETS-2113	235	228	212	238	333	249	9
4.	ETS-2283	276	338	320	301	386	324	1
5.	ETS-2537	211	228	222	240	320	244	10
6.	ETS-2752	246	310	295	248	408	301	3
7.	ETS-2741	294	265	268	212	352	278	7
8.	ETS-3271	254	220	255	-	327	264	8
9.	Alemaya 70	296	285	268	289	384	304	2
10.	Local Check	249	325	312	239	368	299	4
Mean		260	275	267	229	357		
LSD		9	23	32	-	32		
C.V.		2	6	8	-	6		
Rainfall (mm)		-	-	-	1925	1274		
Altitude (m)		1900	1980	1980	2250	1650		
Planting Date		May 10	April 28	May 10	May 4	May 16		

Table 10. Grain Yield, in Kg/Ha, of 10 intermediate sorghum varieties in the National Yield Trials at 4 locations, 1977.

	Variety	Alaba	Alemaya I	Alemaya II	Ambo	Arsi N.	Mean	Rank
1.	Awash 1050	3226	4064	4496	4534	5857	4435	1
2.	ETS-2111	3107	5321	3860	4175	4900	4273	2
3.	ETS-2547	2545	3930	2897	--	4816	3547	6
4.	ETS-2901	3925	2594	2296	4773	4855	3689	5
5.	ETS-2988	1019	3279	2600	--	3808	2677	10
6.	ETS-3234	1269	4114	2873	4354	3077	3137	9
7.	ETS-3235	1763	5307	3496	4655	3312	3707	4
8.	ETS-3376	1163	3686	3820	--	4526	3299	8
9.	ETS-3378	2186	4176	4190	3056	4066	3535	7
10.	Local Check	4400	1926	2104	7530	4902	4172	3
Mean		2460	3840	3263	4725	4412		
LSD		1041	1584	1458	1211	1777		
C.V.		29	29	31	17	28		
Rainfall (mm)		--	--	--	1925	1274		
Altitude (m)		1900	1980	1980	2250	1650		
Planting Date		May 12	May 10	May 26	May 4	May 3		

At Alaba, the local check with 44 q/ha was the highest yielder. Other varieties with relatively good yield were ETS 2901, 2111 and Awash 1050. The differences in yield among varieties was highly significant.

The highest mean yield in the May 10 planting at Alemaya was 53 q/ha for the old variety ETS 2111 and also the new variety ETS 3235. The yields of most varieties under late planting (May 26) was much lower than the early planted trial. Most of the varieties in this group yield best if they are planted early May.

At Ambo the local check with 75 q/ha was by far the highest yielder. The main reason for the comparatively low yields of the other varieties was low plant population. Except the local check, all entries had some amount of bird damage. Leaf diseases in general were reported high on all varieties except the local check.

The highest yielder with 59 q/ha at Arsi Negele was the established variety Awash 1050. The local check, ETS 2111, 2901, 2547 also yielded relatively well.

For the intermediate group, the number of days needed from planting to 50% heading at each location for each variety are given in Table 11. The latest varieties took about four months to head. Among these are ETS 3378, 3235, and 3234. The earliest entries in this group were ETS 2547, 2988, 2901, and Awash 1050. The varieties took longest to head at the highest altitude station, Ambo. The data reported from Alaba appear to be underestimated by 20-30 days for each variety.

Table 12 gives heights of the varieties in the intermediate group for four locations. As a group, these varieties are distinctly shorter than the tall highland sorghums. Lodging in these varieties was reported negligible at all stations.

Table 11. Number of days to heading of 10 intermediate sorghum varieties in the National Yield Trials at 4 locations, 1977.

Variety	Alaba	Alemaya I	Alemaya II	Ambo	Melkasa	Mean	Rank
1. Awash 1050	76	103	103	122	108	102	7
2. ETS-2111	78	112	102	128	113	107	5
3. ETS-2547	76	112	102		108	100	9
4. ETS-2901	74	101	100	133	106	103	6
5. ETS-2988	82	108	99		113	101	8
6. ETS-3234	98	126	108	145	132	122	2
7. ETS-3235	97	123	110	144	123	119	3
8. ETS-3376	94	120	103		119	109	4
9. ETS-3378	96	124	110	160	124	123	1
10. Local Check	85	102	98	122	128	107	5
Mean	86	113	104	136	117		
LSD	1.07	6	3	0.82	7		
C.V.	0.85	4	2	0.40	4		
Rainfall (mm)	--	--	--	1925	1147		
Altitude (m)	1900	1980	1980	2250	1500		
Planting Date	May 12	May 10	May 26	May 4	May 24		

Table 12. Plant height, in cm, of 10 intermediate sorghum varieties in the National Yield Trials at 4 locations, 1977.

	Variety	Alaba	Alemaya I	Alemaya II	Ambo	Melkasa	Mean	Rank
1.	Awash 1050	228	225	215	228	301	239	2
2.	ETS-2111	246	160	220	210	224	212	3
3.	ETS-2547	148	172	152	-	191	166	8
4.	ETS-2901	134	175	147	167	218	168	7
5.	ETS-2988	144	165	215	-	220	186	5
6.	ETS-3234	110	190	190	191	224	181	6
7.	ETS-3235	169	205	192	194	238	200	4
8.	ETS-3376	126	170	140	-	152	147	10
9.	ETS-3378	164	168	122	150	174	156	9
10.	Local Check	205	258	225	268	340	259	1
Mean		167	189	181	201	228		
LSD		8	33	18	17	24		
C.V.		4	12	7	6	7		
Rainfall (mm)					1925	1147		
Altitude (m)		1900	1980	1980	2250	1500		
Planting Date		May 12	May 10	May 26	May 4	May 24		

For the intermediate group varieties, general agronomic appearance scores at Alemaya, Arsi Negele and Nazreth indicated that the best looking varieties were ETS 2901, 3378, 3234, and 3235. The first two varieties showed distinct susceptibilities to grain mold under the late rains while the last two appeared to be susceptible to anthracnose at Alemaya.

An independent trial consisting of 14 advanced sorghum lines which are similar in adaptation and agronomic characteristics as the varieties mentioned under intermediate sorghums above was conducted as a Pre-National Yield Trials (PNYT). This trial was planted at Alemaya, Arsi Negele, Melkasa and Kobo. At Kobo, almost all of the entries failed to head and/or set seed. Therefore, the trial has been considered failure and no data are reported. At Melkasa also, because of severe Quelea problem it was not possible to measure grain yields. For Alemaya and Arsi Negele, Table 13 gives data on grain yield. The highest yielding entry with a mean of 44 q/ha across the two locations was ESIP-77-8 followed by ESIP-77-9 with 35 q/ha. General appearance and leaf disease resistance of these two lines were very good also. Data on days to heading and plant height for the PNYT are given in Table 14 and 15. This set is in general earlier and shorter than the intermediate group. Only four entries (no. 8-11) had good resistance to anthracnose while all others were heavily attacked by this leaf disease at all stations. These four anthracnose resistant lines also had the best appearance scores.

3. Lowland Sorghums - The range of varieties available for the lowland conditions of the country has been very narrow. In 1976, a large screening program primarily using exotic germplasm was undertaken by the Ethiopian Sorghum Improvement Project (ESIP) with the intention of identifying early maturing and short statured sorghums with high yield potential with locally acceptable grain quality under the environmental conditions of the major lowland

Table 35. Grain Yield, in Kg/Ha, of 14 highland sorghum lines in the Pre-National Yield Trials at 2 locations, 1977.

	Entry	Alemaya	Arsi N.	Mean	Rank
1.	ESIP-77-1	3023	3205	3014	6
2.	ESIP-77-2	2041	3702	2872	9
3.	ESIP-77-3	2381	3376	2878	8
4.	ESIP-77-4	2962	3285	3124	4
5.	ESIP-77-5	2605	3483	3044	5
6.	ESIP-77-6	2438	3734	2586	11
7.	ESIP-77-7	3244	3370	3307	3
8.	ESIP-77-8	4216	4539	4378	1
9.	ESIP-77-9	2831	4183	3507	2
10.	ESIP-77-10	2300	2906	2603	10
11.	ESIP-77-11	1576	3045	2310	13
12.	ESIP-77-12	2686	2350	2518	12
13.	ESIP-77-13	1041	1041	1041	14
14.	Local Check	2972		2972	7
	Mean	2594	3248		
	LSD	1344	785		
	C.V.	36	17		
	Rainfall (mm)	--	--		
	Altitude (m)	1980	1960		
	Planting Date	May 19	May 19		

Table 14. Number of days to heading of 14 highland sorghum lines in the Pre-National Yield Trials at 3 locations, 1977.

	Entry	Alemaya	Arsi N.	Melkasa	Mean	Rank
1.	ESIP-77-1	86	108	104	99	4
2.	ESIP-77-2	81	107	93	94	7
3.	ESIP-77-3	79	102	98	93	8
4.	ESIP-77-4	79	101	97	92	9
5.	ESIP-77-5	81	103	91	92	9
6.	ESIP-77-6	90	110	95	98	5
7.	ESIP-77-7	80	132	92	101	3
8.	ESIP-77-8	86	110	93	96	6
9.	ESIP-77-9	88	136	102	109	2
10.	ESIP-77-10	86	107	102	98	5
11.	ESIP-77-11	78	103	91	91	10
12.	ESIP-77-12	81	107	94	94	7
13.	ESIP-77-13	80	107	96	94	7
14.	Local Check	92	145	100	112	1
Mean		83	112	96		
LSD		3		15		
C.V.		3		11		
Rainfall (mm)		--	--	1147		
Altitude (m)		1980	1960	1500		
Planting Date		May 19	May 19	May 24		

Table 15. Plant height, in cm, of 14 highland sorghum lines in the Pre-National Yield Trials at 3 locations, 1977.

	Entry	Alemaya	Arsi N.	Melkasa	Mean	Rank
1.	ESIP-77-1	192	200	183	192	2
2.	ESIP-77-2	147	160	185	164	8
3.	ESIP-77-3	140	140	171	150	12
4.	ESIP-77-4	157	165	202	175	6
5.	ESIP-77-5	155	160	185	167	7
6.	ESIP-77-6	152	155	174	160	10
7.	ESIP-77-7	145	160	177	161	9
8.	ESIP-77-8	180	175	182	179	3
9.	ESIP-77-9	142	160	199	167	7
10.	ESIP-77-10	165	160	204	176	5
11.	ESIP-77-11	142	130	162	145	13
12.	ESIP-77-12	130	155	175	153	11
13.	ESIP-77-13	162	170	203	178	4
14.	Local Check	195	350	197	247	1
Mean		157	174	186		
LSD		27	-	64		
C.V.		12	-	24		
Rainfall (mm)		--	--	1147		
Altitude (m)		1980	1960	1500		
Planting Date		May 19	May 19	May 24		

sorghum producing parts of Ethiopia. A dominant component of the environment in this regions is limited rainfall often resulting in moisture stress and consequent poor harvests or complete crop failures. The major thrust in ESIP now is identifying and developing sorghum varieties suitable for this stress environments. The 1976 screening was undertaken at four locations, Nazreth, Kobo, Humera, and Alemaya. Most promising lines were selected at each of these locations and these selections were used as entries in the three sets of lowland sorghum NYT's for 1977. These three sets were NZ-KB selections from Nazreth and Kobo, HU selections from Humera, and AL selections from Alemaya. Each of these sets was planted at Nazreth (Melkasa), Kobo, and Mieso (Asebot) in the 1977 main crop season using randomized complete block design with four replications.

Agronomic data including days to heading, plant height, grain yield, and overall visual appearance score for the 27 NZ-KB selections are given in Table 16. This trial was planted at Nazreth, Kobo, and Mieso. Quelea menace at Nazreth, very severe stalk borer infestation at Kobo made it almost impossible to evaluate with reasonable confidence the yield potentials of these selections. The best yielder at Kobo (12 q/ha) and second best at Nazreth (30 q/ha) was 76-T4#416. This entry is earlier and shorter than the overall respective means for the trial at both locations. The top yielder at Nazreth, NES-830x705, gave about 39 q/ha but was almost completely destroyed by stalk borer at Kobo. Other entries yielding about 28 q/ha at Nazreth were 76-T1 #18, Kobomash 76, and NES-830x3145. At the three locations, the entry with the overall best appearance was CSH-6, though its yield in this trial was low. Another entry with an overall good appearance score was 76-T1 #23.

Table 17 presents the agronomic data for the 34 HU selections grown at Nazreth, Kobo, and Mieso. The yields of most entries was very low. As mentioned above, the major reasons were quelea and stalk borer at Nazreth and Kobo, respectively. At Nazreth the top

Table 16. Agronomic data for the 27 NZ-KB sorghum selections of 1976 included in the lowland National Yield Trials grown at Nazreth, Kobo and Mieso in 1977.

		Days to Heading		Plant Height		Grain Yield, Kg/Ha		Appearance*		
Entry No.	IDENTIFICATION	NZ	KB	NZ	KB	NZ	KB	NZ	KB	MS
1.	76-T1 #14	73	80	152	108	--	--	3	2	3
2.	76-T1 #18	78	84	104	78	2885	--	2	4	3
3.	76-T1 #19	70	75	125	118	2265	923	3	2	4
4.	76-T1 #21	71	76	134	108	1774	--	3	2	5
5.	76-T1 #23	70	76	121	103	1068	564	3	2	2
6.	76-T2 #3	73	81	149	117	683	917	4	3	4
7.	76-T2 #59	74	83	136	88	--	607	3	3	4
8.	76-T3 #25	74	83	149	113	--	712	3	3	5
9.	76-T3 #40	76	81	146	110	1282	--	3	4	5
10.	76-T3 #97	90	96	134	95	--	--	3	4	4
11.	76-T4 #260	72	82	136	100	1816	--	3	4	3
12.	76-T4 #408	75	83	168	120	--	--	3	4	-
13.	76-T4 #416	72	78	123	98	2992	1202	3	3	4
14.	76-T4 #420	85	95	71	70	1827	--	3	5	5
15.	76-T4 #429	81	89	131	103	--	--	3	5	2
16.	76-T4 #432-1	103	--	132	--	--	601	2	5	-
17.	76-T4 #441	75	82	107	92	2265	601	5	4	4
18.	76-T4 #478	72	81	126	103	1923	987	3	3	5
19.	76-T4 # 587	84	94	94	120	--	--	4	5	3
20.	NES-1424x1573	71	80	177	143	987	--	5	4	-
21.	NES-830x705	77	85	102	70	3917	--	2	4	-
22.	NES-830x3145	78	87	81	82	2752	--	3	5	2
23.	Kobomash-76	77	84	103	73	2835	--	2	4	3
24.	Shufun	79	90	151	135	962	--	3	5	3
25.	NES-8598	84	91	177	107	--	--	5	5	-
26.	76-T4 #412	78	88	121	110	1709	--	2	4	4
27.	CSH-6	70	78	141	115	--	1068	3	2	1
	MEAN	77	84	129	103	1997	818	*1 Best 5 Worst		
	Rainfall (mm)	1147		781						
	Altitude (m)	1500		1450						
	Planting Date	June 16		June 22				June 20		

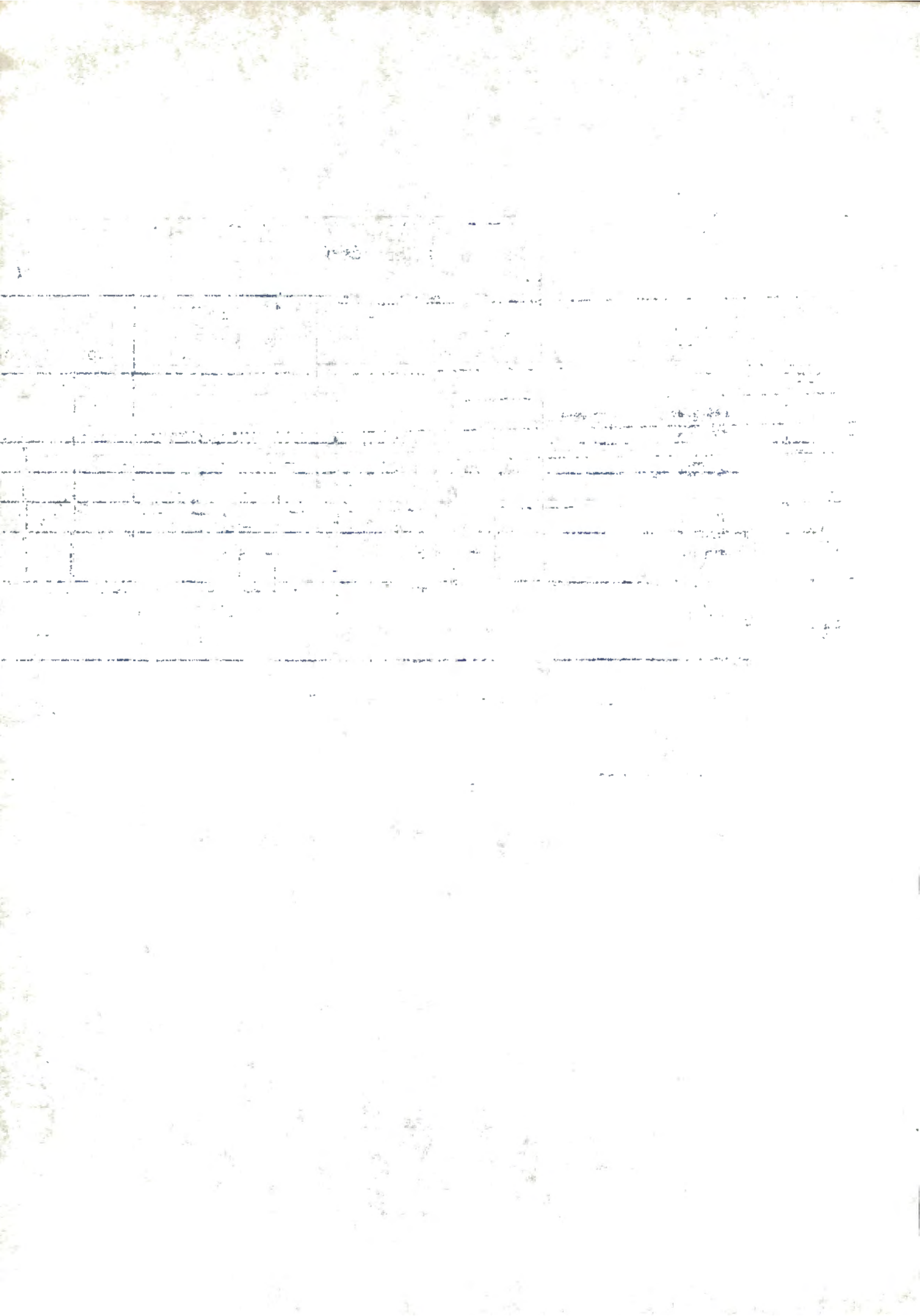
Table 17. Agronomic data for the 34 HU sorghum selections of 1976 included in the lowland National Yield Trials grown at Nazreth, Kobo and Mieso in 1977.

Entry No.	IDENTIFICATION	Days to Heading		Plant Height, cm		Grain Yield, Kg/Ha		Appearance *		
		NZ	KB	NZ	KB	NZ	KB	NZ	KΣ	MS
1.	ALAD-3671	78	85	98	78	--	--	5	5	3
2.	ALAD-4022	76	87	114	82	641	--	4	5	-
3.	NES-821xAwash 1050/7	82	98	156	110	--	--	3	5	1
4.	NES-821xAwash 1050/7	83	95	153	107	--	--	2	5	-
5.	NES-648xNES-5403	74	84	105	85	1638	--	3	4	3
6.	NES-648xNES-5702	76	85	106	88	513	--	4	5	4
7.	NES-705xNES-5479	72	83	136	107	--	529	3	4	3
8.	NES-710xNES-5689	73	83	114	92	1496	--	3	4	5
9.	NES-710xNES-5404	72	82	107	97	--		3	5	3
10.	NES-5610xNES-1596	83	87	77	77	513	--	5	5	-
11.	NES-7360	71	82	119	108	1068	1045	3	3	4
12.	NES-7363	71	80	121	108	1068	1137	4	2	4
13.	NES-4091	71	82	130	98	1439	698	3	2	2
14.	NES-4137	71	80	141	103	1709	667	3	3	4
15.	NES-4164	74	81	115	95	769	--	5	4	3
16.	NES-4208	72	81	118	92	2137	595	3	4	2
17.	NES-4256	75	80	115	108	1237	957	3	3	-
18.	NES-4256	71	79	105	87	1068	--	5	4	3
19.	NES-4264	72	78	120	103	962	701	3	4	4
20.	NES-4069	69	75	98	102	513	--	4	3	4
21.	NES-4074	73	80	118	97	1368	612	3	3	2
22.	NES-4078	76	85	123	90	--	--	4	5	4
23.	NES-4085	76	86	95	78	897	--	3	5	4
24.	NES-4222	79	81	111	103	--	--	4	5	3
25.	NES-4237	76	85	113	73	641	--	4	4	-
26.	NES-5307	78	84	169	172	683	--	3	4	4
27.	NES-5927	79	85	116	105	--	--	4	5	5
28.	NES-5387	75	86	141	123	--	889	5	4	2
29.	NES-5410	68	77	113	93	1282	561	4	4	4
30.	NES-5977	78	95	159	130	--	--	5	5	5

Table 17 continued

Entry No.	IDENTIFICATION	Days to Heading		Plant Height, cm		Grain Yield, Kg/Ha		Appearance*		
		NZ	KB	NZ	KB	NZ	KB	NZ	KB	MS
31.	NES-6104	79	92	216	147	--	--	4	5	3
32.	NES-5516	75	84	120	103	--	--	4	5	2
33.	NES-5301	75	84	146	126	1068	--	3	5	5
34.	CSH-6	69	80	145	113	2992	784	2	2	1
	MEAN	75	84	124	102	1168	764	*1 Best 5 Worst		

Rainfall (mm)	1147	781	
Altitude	1500	1450	
Planting Date	June 16	June 22	June 20



yielder in this trial was CSH-6 with 30 q/ha and the overall best looking entry at all three locations was also this hybrid. NES-4208 with 21 q/ha was the second best yielder at Nazreth. Ato Kobo, NES-7363 and 4091, with a high appearance score of 2, looked as good as CSH-6, but, yields were 11 and 7 q/ha only. At Mieso, CSH-6 and NES-821xAwash 1050/7 with the highest appearance score were distinctly the best of all the HU selections there. The sister line of the latter entry received high appearance score at Nazreth also.

Agronomic data for the 15 AL selections are given in Table 18. Because of the very poor stand establishment at Nazreth, it was not possible to record agronomic data other than number of days to 50% heading. At Kobo, the best yielding entry with 16 q/ha and the best appearing entry was again the hybrid CSH-6. The overall good performance and apparent yield potential of the hybrid CSH-6 has prompted ESIP to go into a hybrid program seriously. IS 8534 which is also known to do well at high and intermediate altitudes received high appearance score.

Out of the total 74 entries included in the three sets of lowland trials, 55 of them were put into a special single plot evaluation nursery at Tibila and Dhera in cooperation with ARDU. The plot size used was 30 m^2 for each entry at each location. The nursery at Dhera was completely destroyed by Quelea, therefore, it was not possible to make any meaningful evaluation. However, at Tibila, most of the entries in the nursery were well established and produced outstanding sorghums. Though the maize crop in the Tibila area failed almost completely in 1978, these sorghum plots produced reasonably high yields. The general appearance score and the grain yield results for the top 22 entries is given in Table 19. Four entries looked especially outstanding and produced at least 40 q/ha. These entries were 76-T1 #14, 76-T1 #19, 76-T4 #408 and NES-830x705. The last entry is also designated as Kobomash 76. ARDU has received enough seed of this entry from ESIP to increase and distribute to Tibila farmers in the 1978 crop season for a total area of 100 ha.

Table 18. Agronomic data for the 15 AL sorghum selections of 1976 included in the lowland National Yield Trials grown at Nazreth and Kobo in 1977.

Entry No.	IDENTIFICATION	Days to Heading NZ	Days to Heading KB	Plant Height KB	Grain Yield, Kg/Ha KB	Appearance KB
1.	IS 158	82	90	73	--	4
2.	NES 635	--	80	98	560	3
3.	NES-705x830	79	85	73	--	5
4.	13019	--	79	107	540	4
5.	13056 & 13057	77	79	103	--	4
6.	13204	75	80	93	--	4
7.	13211	--	82	105	--	4
8.	13281	79	88	78	--	4
9.	14087	73	81	112	--	4
10.	14254	73	86	118	--	4
11.	14271	75	80	118	703	4
12.	14492	79	80	107	--	4
13.	14769	77	80	112	--	4
14.	IS-8534	79	90	98	647	2
15.	CSH-6	70	78	117	1550	2
	MEAN	77	82	101	800	
	Rainfall (mm)	1147		781		
	Altitude (m)	1500		1450		
	Planting Date	June 16		June 22		

Table 19. Grain yield and general appearance score for 22 most promising lowland sorghums grown at Tibila, ARDU, 1977.

Serial No.	IDENTIFICATION	Appearance*	Grain Yield, Kg/Ha
1.	76-T1 #14	2.0	4262
2.	76-T1 #18	3.0	2630
3.	76-T1 #19	1.5	3929
4.	76-T1 #21	2.5	2097
5.	76-T1 #23	2.5	2164
6.	76-T2 #72	2.0 (late)	3030
7.	76-T4 #161-6	1.5	3030
8.	76-T4 #178	2.5	2564
9.	76-T4 #260	3.0	2664
10.	76-T4 #408	2.0 (late)	3996
11.	76-T4 #412	2.0	2664
12.	76-T4 #416	3.0	2264
13.	76-T4 #432-1	2.0	2997
14.	76-T4 #441	2.5	1798
15.	76-T4 #473	3.0	1898
16.	76-T4 #476	2.0	2531
17.	76-T4 #478	2.5	2597
18.	76-T4 #487	2.0	3097
19.	NES-1424xNES-1573	2.0	0633
20.	NES-830xNES-705	1.0	4162
21.	1974 MW #5003	2.5	1432
22.	Shufun	1.5	1399

*1 Best.... 5 Worst

PROBLEMS

The perennial problem of lack of an effective national scheme for the production, processing, quality controlling, and distribution of good quality seed is still with us. Though the establishment of the Ethiopian Seeds Corporation is a step in the right direction, it still remains to be seen whether this Corporation will effect quality seed production, processing and distribution to the farmer. ESIP continues to make ad hoc arrangements with producers for increase of seeds of promising varieties.

The linkage between research and extension, the effectiveness of the national extension system in reaching farmers' associations and/or individual farmers with improved seeds still leave a lot to be desired. This problem and that of seeds have been belabored so much in so many national meetings that they seem to have no significant meaning and importance outside such meetings.

More specific to sorghum, the major technical bottleneck to production and expansion of good quality sorghum in the lowlands continue to be Quelea.

With regard to diseases, with late rains after grain filling, grain mold is a serious problem at all locations. This problem was specially exagerated in the 1977 crop season because of the unexpected heavy late rains in October and November. This was a very serious problem at almost all stations in 1977. In the highland and intermediate zones, again if late rains are heavy and humid conditions persist, anthracnose is the leading leaf disese . In thise same zones, particularly in Arsi Negelie and Alemaya area, honeydew disease (Sphacelia sorghi) appears in significant amount when the flowering period coincides with high humidity.

More than past years, by far the single most important insect problem continues to be stalk borer. In 1977, in the Kobo-Alamata area, it was estimated that as much 50% of the sorghum crop was destroyed by stalk borer (Chilo). Kobomash 76, which was being

Stalk borers, Chilo partellus, devastated the sorghum crop in the entrie Kobo area in 1977, with some fields suffering upto 80% yield losses. A seed increase plot of Kobomash 76 destroyed by borers is shown.

increased in the Kobo area, was very heavily attacked by borer. This variety appears to be especially susceptible to borer. If borers are significant problems where Kobomash 76 is intended for production, it is mandatory that insecticides be used for control. Another significant insect problem in most stations was the boll-worm (Heliothis armigera). The sorghum shoot fly has been a problem only in late planted sorghums.

The general weed problem which perhaps accounts for more yield loss than any other single factor nationally is usually under-estimated. Weed control in the early stages of sorghum growth is particularly important. Striga is a more special sorghum parasitic weed which has infested the sorghum areas of all five of the northern administrative regions and Shoa. Extreme care has to be taken not to introduce this menance to the East of the Awash river.

Where rainfall is very low, moisture stress is often limiting sorghum production. For such areas where other crops are almost impossible to produce, sorghum, of course, is often the best choice.

RECOMMENDATIONS

Varietal recommendations are now available for the three sorghum ecological zones. However, seeds of the recommended varieties are yet to be increased.

1. Highland Zone - This zone is roughly within 1700-2100 m altitude and the annual rainfall is often in excess of 900 mm and temperatures (particularly night) are low. Leaf diseases, especially anthracnose, are significant. Five varieties which have done well under these environmental conditions are, in order of decreasing lateness, ETS 2752, ETS 601, Alemaya 70, ETS 717, and ETS 2113.

ETS 2752 - is normally over 3 m in height with little lodging problem, takes about four and a half months to heading, has very large goose-necked compact panicle with good quality white seeds.

ETS 601 - is somewhat shorter and earlier than 2752, its panicle is goose-necked and large, but, with bright red seeds.

Alemaya 70 - normally takes about four months to heading, is just under 3 m in height, has large semi-compact goose-necked panicle with good quality pearly grains.

ETS 717 - is very similar to Alemaya 70 but is a few days earlier and shorter.

ETS 2113 - has panicles and seeds similar to Alemaya 70, but, it is shorter by about half a meter and earlier by about three weeks.

Where early planting is done, 2752 and 601 are to be preferred, but, with progressively later plantings, the other three varieties have distinct advantages. Ideally, these varieties should be grown in 75 cm rows with 20 cm spacing between plants using about 5 kg seed/ha. Seed treatment is essential for good germination and stand establishment. For obtaining high yields, clean seed bed, optimum plant population level, complete weed control in the first three months, application of DAP at planting and urea side dressing at about the boot stage, control of stalk borers and birds are essential management practices.

2. Intermediate Zone - For the purposes of sorghum production in Ethiopia, this zone is roughly within the altitude range of 1500-1900m. Annual rainfall decreases progressively as the altitude decreases. The leaf disease problem also decreases with lowering of the annual rainfall. Three varieties which are recommended for this zone, in decreasing lateness, are ETS 3235, ETS 2111, and Awash 1050. These varieties also do well at higher altitudes, but, anthracnose problem does not permit their extension to high rainfall areas because they are all susceptible to this disease.

ETS 3235 - takes about four months to head, attains about 2 m height, has long and large panicle on a straight peduncle, the seeds are large and pearly.

ETS 2111 - is earlier than 3235 by about 10 days, the plant height is normally under 2 m, the panicle is of medium size and goose-necked, the seeds are pearly and of good quality, is distinctly susceptible to anthracnose.

Awash 1050 - is earlier than 2111 by about one week, the plant height is slightly taller than 3235, the panicle is long with straight peduncle, the seed is pearly and makes excellent injera, the variety is very susceptible to anthracnose.

Higher plant populations could be used in this group than in the highland varieties. General management practices for attaining high yield mentioned under the highland varieties are also applicable here.

3. Lowland Zone - This zone is considered to cover all sorghum areas under 1500 m altitude in the country. Rainfall in much of this area is below 700 mm annually. Though diseases are normally not much of a problem, insects, particularly stalk borers, are very serious. Since the work on lowland sorghums in Ethiopia is very recent, the yield data available from this zone do not extend over as many years as the highland and intermediate areas. However, because of the urgent needs for lowland sorghums, and the high national demand for such sorghums, it has become necessary to recommend varieties though the number of years of testing is not as many as one would normally like for such recommendations. To a certain extent, the number of locations does compensate for the limitations in years of testing. Consequently, the varieties now recommended for this zone are Kobomash 76 or NES-830x705, 76-T1 #14, 76-T1 #19, 76-T1 #23, and 76-T4 #416.

All of these varieties are relatively early, heading in about two and a half months. Optimum planting time for all of them is about mid-June. They are all in general short, attaining a height

Kobomash 76, in the absence of stalk borers, produced sturdy and vigorous plants with good head size at Nazreth in 1977.

of about one meter in most places. Under low rainfall situations, if cultural practices are optimum, they have potentials of yielding near 40 q/ha. Out of these varieties, Kobomash 76 is particularly susceptible to stalk borer which means that if this insect is a problem in the area, chemical control must be used.

In addition to these varieties, Serena is also agronomically suitable for the lowland zone. Poor grain quality for injera making is the major drawback of this variety. Another variety which is being grown in large scale in the irrigated lowlands is Gambella 1107. This variety has excellent grain quality and could be grown in similar areas.

The general management practices for high yield mentioned earlier are also applicable here. If moisture stress is severe in an area, lower plant population is to be preferred. The need for effective weed control in this zone cannot be overemphasized.

SEED SOURCES AND INCREASES FOR SORGHUM

Though varieties are recommended for the different ecological zones, there is not any reliable national seed source for these varieties. Under these circumstances, some possible sources of sorghum seed are indicated below:

1. Some research stations participating in the NYT normally put in micro-increases of the best varieties at those stations. ESIP is a source of experimental amounts of all varieties included in the NYT's. Larger quantities of breeder's seed of the varieties recommended above are usually available with ESIP also.

2. For the highland sorghums, several quintals of each of the highland and intermediate sorghums are expected to be available with the Kuyera station of the Ethiopian Adventist College by the end of this season. Arsi Negele and Alemaya should also have few quintals of the highland varieties recommended above. The settlement authority of the Ministry of Agriculture and Settlement has received

seeds of these varieties from ESIP for increases and demonstrations at selected sites during this crop season.

3. By far, the single most important source of seed for lowlands is the Chafa State Farm. Several hundred hectares are intended to be put into Kobomash 76 and other lowland ESIP varieties for this coming season. Several thousand quintals of lowland sorghum seeds should be available with the Chafa Farm at the end of this crop season. Chafa has also been the major source of Serena seed for the past few years.

4. Another possible source of lowland sorghum seeds in substantial amounts, particularly Gambella 1107, is the Tendaho State Farm.

5. The Tibila area, under ARDU should produce several hundred quintals of Kobomash 76 by the end of this crop season.

The Chaffa State Farm received in 1977 from ESIP elite seed of seven most promising varieties sufficient to plant 90 ha. The field shown here is that of Kobomash 76.

AGRONOMIC TRIALS

It is obvious that when a new variety or hybrid is released for large scale production in a given area, it must go out with a package of recommended cultural practices. At each of its major production sites, ESIP intends to run relevant agronomic trials to establish the most optimum production practices for the leading varieties or hybrids. Often many of these trials, at many of the sites, are or likely to be done in cooperation with other colleagues who have interest in specific areas of sorghum agronomy or crop protection. In some cases, ESIP is involved only as a supplier of seeds of recommended varieties and as advisor in running these agronomic trials. In other cases, we may be involved in jointly running such trials cooperatively with other colleagues. Still in other cases, ESIP may run independent agronomic trials alone.

In 1977 we had four agronomic trials involving sorghum which were either entirely conducted by us or partially done by others with ESIP's active participation. These were:

1. Plant Population Trial in Sorghum at Alemaya.
2. Weed Control in Sorghum with Herbicides at Alemaya.
3. Sorghum and Sweet Potato Intercropping Trial at Nazreth.
4. Effect of Date of Planting on the Performance of Sorghum at Nazreth.

The following pages report on these four agronomic trials of 1977.

PLANT POPULATION TRIAL IN SORGHUM AT ALEMAYA

Seeding rates need to be adjusted to the production conditions under which one operates, but inadequate population densities of sorghum are common place in sorghum growing fields of the country whether by design or default thus sacrificing yields as well as underutilizing or wasting inputs. Moreover, optimum density levels for different promising varieties need to be worked out as they become available so as to put in a recommendation package.

At Alemaya during the 1977 crop season, a trial using two promising varieties was designed to determine which plant density level at what row spacing was best to obtain optimum yields.

Materials and Methods

ETS 601 and ETS 3235 were planted at six plant population levels (25, 50, 75, 100, 125, and 150 thousand plants per hectare) with each of 50, 60, 70 cm row spacings. ETS 601 is normally late and tall (3 m) with goose necked panicle, whereas ETS 3235 is medium in height (2 m) and has upright panicle. The treatments were laid out in a split - split plot design with varieties in the main plot and row spacings and plant density levels in the sub-plot and sub-sub-plot, respecitvely. The sub-sub-plot size was 5 or 6 rows 5 m long and 75 cm wide; and replicated four times.

This trial was planted at Alemaya on May 10 on a clay loam alluvial soil and was fertilized with DAP at planting at a rate of 100 kg/ha (46 kg P_2O_5 and 18 kg N/ha).

Results and Discussion

The agronomic data for the trial are shown in Table 20. Examination of the results for stand count revealed that except for the lowest population, the desired plant stands were not achieved so conclusive and meaningful comparison based on anticipated population levels could not be made. However, some general trends could be pointed out. Statistical analysis for yield did not reveal any significant difference between treatment means. There was a general decline in the number of heads per plant and seeds per head with increasing population levels which was as would be expected and as also indicated by such studies elsewhere. Though ETS 3235 had a higher number of heads per plant and number of heads per plot than ETS 601, it did not give any enhanced yield over ETS 601 because it had less number of seeds per head. Varietal difference was also most apparent with respect to plant height, ETS 601 being 60 cm taller than ETS 3235.

Differences in some of the characters studied as a result of row spacing were not of a greater magnitude to warrant much attention, though at 60 cm row spacing plants had a relatively more number of heads per plots, higher grain yields and taller plants compared to either 50 or 70 cm row spacings.

Seed size as indicated by thousand seed weight and days to heading seem to be the least affected by any of the treatments under study.

In summary, though some general expected trends have been obtained from this trial, it will have to be repeated with closer attention to achieving the density levels since it is central to any meaningful comparison and logical deductions.

Table 20. Effects of varieties, row spacings and plant population on some agronomic attributes of sorghum grown at Alemaya, 1977.

Treatments	Grain Yields (kg/Ha)	Stand Count/ha ('000)	No. of heads/ha ('000)	No. of heads/plant	Seeds/head	Plant height	1000 seed wt., gm	Days to Heading
Varieties (a)								
ETS 601	5665	48.6	58.8	1.2	2528	291	38	121
ETS 3235	5756	37.5	65.1	1.7	2172	231	41	123
Row Spacing (b)								
50 cm	5461	42.7	58.8	1.4	2361	257	39	122
60 cm	5878	44.4	65.7	1.5	2232	266	40	121
70 cm	5792	42.0	61.2	1.5	2426	261	39	122
Plant Pop.(c)								
25,000	5602	23.2	49.3	2.1	2833	262	40	123
50,000	5220	34.6	57.2	1.7	2291	257	40	122
75,000	6061	42.8	64.8	1.5	2367	261	40	122
100,000	5880	51.0	67.8	1.3	2217	265	39	121
125,000	5547	54.5	65.6	1.2	2167	265	39	121
150,000	5652	52.3	67.4	1.3	2132	257	39	121
Varieties	n.s							
Row Spacing	n.s							
Plant Pop.	n.s							
CV (a) %	31							
CV (b) %	24							
CV (c) %	15							

Table 21. Effects of different herbicide applications on the grain yield, plant height and stand count of sorghum, 1977, at Alemaya.

Treatments	Grain Yield (kg/ha)	%age Increase Over Control	Plant Height (cm)	Stand Count	Visual Score*
Varieties					
ETS 601	4727	--	218	25	--
ETS 2113	2848	--	180	28	--
Herbicide levels					
1. Gesaprim Combi 500 FW, 2.5 l/ha	4725	118	200	31	2
2. " " " " 5.0 l/ha	4640	114	225	25	3
3. " " " " 10.0 l/ha	4048	87	207	22	4
4. Igran 500 FW 1.5 l/ha	2878	32	197	29	4
5. " " " 3.0 l/ha	2956	36	190	24	4
6. " " " 6.0 l/ha	3302	52	197	22	4
7. Gesaprim 500 FW 1 l/ha	4018	85	197	27	2
8. " " " 2 l/ha	3192	47	192	26	4
9. " " " 4 l/ha	5152	137	207	32	2
10. Gesaprim 80 WP 0.75 kg/ha	2862	32	202	26	4
11. " " " 1.5 kg/ha	4734	118	207	32	3
12. " " " 3.0 kg/ha	3442	59	225	31	3
13. Untreated check-control	2167	--	180	22	5
14. Hand-weeded	4907	126	197	27	2

*The score represents the relative abundance of weeds in the plots as determined visually before harvest. 1 representing least number of weeds and 5 a high weed count.

WEED CONTROL IN SORGHUM WITH HERBICIDES AT ALEMAYA

Weeds, among other hazards (pests, diseases and insects) pose a great limitation to sorghum production because of their competition for valuable inputs (water, nutrients, light and space). Reports elsewhere indicate that as much as a fifth of the potentially realizeable yeild of a crop could be lost due to weed competition. The principle of weed control is to minimize the unwanted competition by weed growth which subjects the young sorghum plants to severe handicaps. Sorghum, especially at early stages of growth, since it does not establish very quickly, is a poor competitor of weeds.

Traditionally, sorghum plots are weeded by hand as and when necessary so chemical controls have not been used much in the country. However, with recent emphasis on extensive production, the need for timely and economical weeding of experimental as well as production areas necessitated the assessment of the best type and level of herbicide under the highland environmental conditions of Ethiopia. To this end, a chemical weed control trial using different types and levels of herbicides and varieties of sorghum was carried out at Alemaya.

Materials and Methods

Two varieties of sorghum ETS 601 and ETS 2113 were planted on May 2, 1977 on a loamy soil. At sowing, 46 kg P_2O_5 and 18 kg N/ha was applied through DAP fertilizer.

Each plot consisted of 5 rows, 3.5 m long and 75 cm apart and was replicated twice. Only the center three rows were used for recording data. The experimental design was a split-plot with varieties in the main plot and herbicide treatments in the sub-plots. Four different types of herbicides at three levels each plus an untreated check and a hand-weeded control plot were the treatments applied. The herbicides were applied pre-emergence

when the ground was wet with the specified dose that was applicable to the plot dissolved in 10 l. of water.

Results and Discussion

The agronomic data under different treatments are presented in Table 21. Other variables being equal and taking the highest yielding treatment as an indicator of best control of weeds, applications of Geasprim 500 FW at 4 l/ha gave the best yield (Table 21). This average yield over the two varieties was slightly better than the next best treatment, hand weeding, thus implying that a good herbicide applied once and at the right dose and time could substitute for hand weeding. Application of Gesaprim controlled most broad-leaf weeds and gave a 137% increase over the unweeded check plots (Table 21). Applications of Igran 500 FW did not help much in control of weeds in sorghum.

With respect to plant height, the best weed controlled plots did not necessarily have enhanced plant height over other herbicide treatments but a look at results of a plant height for the untreated check plot indicated that plants in this treatment plot had a shorter stature compared to plots that have received herbicied treatments. Weeds that were left unchecked did compete with the sorghum crop for whatever available inputs thus effectively reducing the yield as well as plant height.

From data on stand count for the different treatments, it could not be ascertained beyond doubt whether the loss in stand count in some treatments especially 3, 6 and 13 was due to the treatment per se or poor establishment. In any case, the treatments mentioned above represent high dosages of Gesaprim Combi 500 FW, Igran 500 FW and the untreated control so the speculation might lead itself to the fact that high dosage treatments and high weed competetion have reduced the stand.

Since actual weed counts or weighings were not made in this preliminary trial, the score represents the relative abundance of weeds in the plots as determined visually i.e. 1 - representing few weeds and 5 a high population of weeds. The visual score and yield ranking showed a close association (see Table 21).

Though the economics of using herbicidal controls need to be worked out as more information is available, this initial result warrants further investigation and also seems to be encouraging both from the yield point of view as well as ease of operation. Unlike hand weedings which need to be done several times during the crop season, herbicide application happen to overcome this repeated weedings in significantly reducing or eliminating them.

SORGHUM AND SWEET POTATO INTERCROPPING TRIAL AT NAZRETH

Efforts towards stepping up productivity in the semi-arid tropics have focused on multiple cropping systems, one of which is intercropping. In Ethiopia, a significant proportion of the sorghum crop is intercropped with one or more crops. Since both sorghums and sweet potatoes are well adapted to the semi-arid parts of the country, investigations on the potentials of intercropping using these two crops were felt worthwhile. Towards this end, in cooperation with the horticulture section of IAR-Nazreth, an intercropping trial involving sorghum and sweet potato was initiated in 1977 at Nazreth.

Materials and Methods

Two varieties each of sorghum and sweet potato were planted at Nazreth in the rainy season in May 1977. The sorghum entries were Kobomash 76 and 76 ESIP 3178 while the sweet potato lines were designated as Koka 18 and Koka 23. There were a total of eight treatments four of which were the four possible combinations of sorghum and sweet potato varieties. The other four were pure stands of each variety of sorghum and sweet potato used. In the intercropped plots, sorghums were planted in the furrows in between the one meter spaced ridges of the sweet potatoes. For the pure stands of sorghums, rows were 75 cm apart, while for sweet potatoes they were one meter apart. Plots were 6 rows wide and 6 m long with the outside two rows ignored for data collection. The sorghum was fertilized at the rate of 100 kg DAP/ha. The design used was randomized complete block with two replications.

Results and Discussion

A summary of the yield data is presented in Table 22. Differences in yield between the two sorghum entries as well as between the sweet potato lines in pure stands were in the order of 30 and 44%, respectively. However, when intercropped, the differences in yield of the two sorghum varieties were negligible while the case was not true for the sweet potato entries.

Compared to the pure stand there was a reduction in yield, as a result of intercropping, in both the sorghum and sweet potato. There was an average of 27% reduction in yield compared to pure stand in Koka 18 sweet potato as against a 34% loss in yield in Koka 23 as a consequence of being intercropped with sorghum. Similarly, yield losses in sorghum were of the order of 18% and 35% for Kobomash 76 and 76 ESIP 3178, respectively, when intercropped with sweet potatoes. This indicated that the loss in yield in the better yielding sorghum (76 ESIP 3178) was higher than the relatively poorer one (Kobomash 76).

From the point of view of a sweet potato farmer, the reduction in sweet potato yields as a result of intercropping with sorghum may not be welcome while on the other hand a sorghum farmer may think otherwise in that by intercropping with sweet potatoes the reduction in yield in his sorghum may be more than offset, in terms of monetary gain, obtained by additional sweet potato harvest.

Table 22. Yield in q/ha, of sweet potato and sorghum intercropping, Nazreth, 1977.

Trt. No.	Treatment Descriptions	Yield in Q/Ha	
		Sorghum	Sweet Potato
1	Kobomash 76 Pure Stand	17	0
2	76 ESIP 3178 Pure Stand	24	0
3	Koka 18 Pure Stand	0	223
4	Koka 23 Pure Stand	0	401
5	Kobomash 76 with Koka 18	15	170
6	Kobomash 76 with Koka 23	14	264
7	76 ESIP 3178 with Koka 18	15	151
8	76 ESIP 3178 with Koka 23	16	259

The preliminary intercropping trial conducted cooperatively between the Horticulture Section of IAR and ESIP has given positive indications that this combination of crops may have some potential in the Nazreth area.

EFFECT OF DATE OF PLANTING ON THE PERFORMANCE OF SORGHUM AT NAZRETH

Since the 1977 crop season was only the second season of operation of ESIP in the Nazreth area, it was deemed necessary to find out the most appropriate planting date for the most promising sorghum varieties identified in the 1976 season for Nazreth and its surroundings. This information is essential in recommending a package of optimum production practices to the extension service and farmers.

Materials and Methods

Three early maturing varieties of sorghum viz. Kobomash 76, Shufun and ESIP 3178 were planted on 6 dates with 10 day intervals starting from May 21. The trial was laid out as a split-plot design with four replications. Planting dates were assigned to main-plots and varieties to sub-plots. The sub-plot consisted of 5 rows of 5.2 m length 75 cm apart. The trial was fertilized with 100 kg DAP/ha at planting. The heads in the center three rows of Kobomash 76 and ESIP 3178 were covered with cloth bag because quelea birds were very heavy. Since Shufun has super-large glumes it was hoped that its grains will not be taken by quelea.

Results and Discussion

Agronomic data for varieties and planting dates are presented in Table 23. In general, there was no trend or effect of planting dates with respect to days to heading or plant height. A noticeable deviation for plant height is the last planting date (July 11) in which plants were relatively shorter than other planting dates. Yields were also lowest for the final date of planting. Reduced plant stature and poor yields obtained in the last planting date appears to be due to moisture shortage at critical stages of growth.

Table 23. Agronomic data for three sorghum varieties planted on six dates at Nazreth in 1977.

Days to Heading

	May 21	May 31	June 10	June 20	June 30	July 11	Mean
V_1	73	72	73	75	72	74	73
V_2	78	75	75	76	77	78	74
V_3	74	73	71	74	73	77	77
Mean	75	73	73	75	74	76	74

Plant Height (cm)

	May 21	May 31	June 10	June 20	June 30	July 11	Mean
V_1	102	98	94	107	107	93	100
V_2	159	169	176	162	164	146	163
V_3	102	103	100	101	98	91	99
Mean	121	123	123	123	123	110	121

Grain Yield (kg/ha)

	May 21	May 31	June 10	June 20	June 30	July 11	Mean
V_1	2927	1869	3632	2278	2189	1366	2376
V_2	(1762)*	....	....	....	....	....	....
V_3	3001	2361	2297	3792	1955	1677	2513
Mean	2964	2115	2965	3035	2072	1522	2445

V_1-Kobomash 76, V_2-Shufun, V_3-76 ESIP 3178.

*Not included in taking means.

The relatively low yield obtained in the second planting date is mainly due to inadequate moisture for optimum germination. Stand establishment was poorest for this planting date. In general, the similarity in yield of most of the planting dates appears to be as a result of the atypically high amount of rainfall received during the season. Moisture, in general, was plentiful and these short-season varieties thrived well regardless of the delay in date of planting.

With respect to varieties, Shufun was relatively later in heading and taller than either Kobomash 76 or ESIP 3178. Yield level of Shufun appeared to be lower as seen in the first planting date though this was influenced by bird damage. Grain yield for Shufun could not be obtained for the other planting dates because of complete bird damage.

Recommendation for the better planting date in this area using these type of varieties will have to await further trials.

SORGHUM INJERA TESTS

ESIP varieties entered in NYT's are routinely evaluated mainly for injera making quality in ESIP's small test cooking facility at Alemaya. A typical injera making procedure involves the following steps, "The sorghum grain is wetted with water and then pounded in traditional mortar and pestle. It is then dried in the sun followed by winnowing and pounding again to remove the seed coat completely. The grain is then cleaned and ground as in making any other flour. The flour is sifted and mixed with water and kneaded to make dough. The dough is let to stand for two or three days until fermented. Discarding water from top, small amount of dough is taken out and cooked in boiling water by stirring constantly until it is somewhat thick. The cooked dough is poured into the rest of the dough and thinned with addition of more water. This is covered for about one hour until it rises. After the thinned dough has risen it is poured onto a hot greased baking pan using a pitcher. Starting from the outside of the pan, closing concentric circles are made leading into the center of the pan. The pan is covered with lid and the poured dough baked for about three minutes until it shrinks from the edge of the pan and can be easily pulled out after removing the lid. This cooked product is called injera." The size of a typical injera is about 30 cm in radius and the thickness is usually less than half cm. Good quality injera should have closely spaced deep eyes all over its surface and should stay soft and pliable and fresh for two to three days. The most preferred color for good quality injera is somewhat white.

The procedure that has been in use in ESIP in evaluating, after baking the sorghum injera, involves a rating by a panel of experts who after sampling (taste, feel, smell, color preference) submit their individual rankings for the 10 varieties being scored. These individual rankings are tallied to come up with an overall ranking of each of the sorghum injeras. Such tests are usually run using 3 to 4 replications over time.

In almost all cases, the choice of the best 50% of the injeras is not disputable among panel members who generally are very familiar with sorghum foods including injera. A typical summary of a series of injera tests on 20 varieties included in the 1977 Highland and Intermediate National Yield Trials is presented in Table 24.

The amount of water needed to reach a desired dough consistency ranged between 1 and 1.4 l per 500 gm of sorghum flour, and in most cases fermentation time was between 32 and 40 hours. It appears from Table 24 that the water taking capacity of the flour has bearing on the number of injera that can be baked from a given volume of flour, i.e. the more water taking sorghum flour produces more injera. From the highland sorghum varieties of 1977, no sorghum variety made unacceptable injera, but of the 10 entries, injera of ETS 2283, Alemaya 70, and the local entry were found to be superior. From the Intermediate set varieties, ETS 3376, ETS 3234, ETS 3235, and ETS 2111 were the best while ETS 3378 was rated as making unacceptable injera. The low injera ranks for ETS 2113 and Awash 1050, which in past tests have ranked high, are due to the grain molds which developed on these varieties due to late rains of 1977.

Kobomash 76, a lowland entry, has been tested and found to make very good white colored injera.

Sorghum varieties that result in good injera do generally make better injera in mixture with teff or barley as well.

Table 24. Results of injera baking tests of I) highland and II) intermediate sorghum varieties included in the National Yield Trials, 1977.

	Variety	Water needed in ml to reach desired dough consistency per ½ kg flour	No. of injera of 55 cm diam. baked from ½ kg flour	General accept. ranking	Remarks
I)	Highland				
1.	ETS 601	1135	4	7	
2.	ETS 717	1150	3½	4	
3.	ETS 2113	1060	3	8	
4.	ETS 2283	1225	3-3½	1	White, soft and tasty
5.	ETS 2537	1100	3½	8	
6.	ETS 2752	1375	3	6	
7.	ETS 2741	1075	3	7	
8.	ETS 3271	1195	4	5	
9.	Alemaya 70	1200	4	2	White, soft and tasty
10.	Local Check	1075	3	3	Red and soft with good flavor
II)	Intermediate				
1.	Awash 1050	1300	4	9	
2.	ETS 2111	1400	5	4	Acceptable color & taste
3.	ETS 2547	1265	3½	7	
4.	ETS 2901	1200	4	5	Soft, but dull appearance
5.	ETS 2988	1325	4	6	
6.	ETS 3234	1150	3½	2	Whitish soft injera, keeps well
7.	ETS 3235	1150	3½	3	" " " " "
8.	ETS 3376	1200	3½	1	Soft, good taste acceptable red color
9.	ETS 3378	1100	4	10	Poor injera, dries fast
10.	Local Check	1200	4½	8	

ESIP COOPERATIVE ACTIVITIES

ESIP, in all its endeavor to improve sorghum production in Ethiopia, is aware of the fact that maintenance of a close link with institutions concerned with sorghum improvement and production is vital to achieving its objectives.

Such cooperative links might be in the form of conducting ESIP's regular or specially prepared trials or nurseries, making seed increases of released varieties, running demonstration fields of improved varieties, or exchange of germplasm. To cover these ranges of activities, agencies such as Institute of Agricultural Research (IAR), Extension and Program Implementation Department (EPID), Arsi Rural Development Unit (ARDU), State Farms, Kobo-Alamata Agricultural Development Project - Relief and Rehabilitation Commission (KAADP/RRC) as well as foreign institutions have been approached. Their responses have been positive and encouraging.

Following is a brief account of some of the cooperative activities that were initiated last season.

Seed Increases of Promising Varieties

ESIP now has high yielding varieties for the different ecological zones in the country. For lowland areas the variety currently recommended is Kobomash 76. In addition, 76 T1 #14, 19, 21, 23 and 76 T4 #416 have been found promising. For highland areas, Alemaya 70, ETS 717, ETS 2113 continue to do well although the new varieties ETS 2752 and ETS 601 are likely to replace them soon. In the Intermediate Altitude Zones, ETS 3235, which is a new addition, and is under micro-increase, rivals the already established varieties Awash 1050 and ETS 2111. Agronomic detail on these varieties has already been given in the section Sorghum National Yield Trials, 1977. Others like Dedessa 1057 and Gambella 1107, currently being grown in the Dedessa area of Wollega Administrative Region and Tendaho State Farms, respectively, are elite varieties, that have earlier come out of the ESIP

and have reached large scale production stage.

Until the establishment of the National Seeds Program (NSP) this year, there has been no established seed production scheme in the country. As a result, no significant headway in terms of large scale seed distribution of improved varieties has been made. Last season, ESIP had found it necessary to make temporary arrangements with concerned agencies (ARDU, KAADP, Research Stations, and State Farms) to produce seeds of promising varieties. It is expected that about 300 quintals of seed of Kobomash 76 from different experiment stations and the Chafa State Farm would be available for distribution the coming season. Breeder amounts of the other recommended varieties are available with ESIP and await further multiplication in the coming main crop season. It is hoped that increases of this sort will provide the basic seeds necessary for starting large scale seed increases envisaged by the newly established NSP.

Field Demonstrations of Promising Varieties

Field demonstrations on individual farmer's fields, cooperative farms, state farms, and research stations have been done with the best of ESIP's varieties in different ecological zones of the country.

Around Alemaya, ESIP made contacts with 40 individual sorghum farmers and arrangements were made to plant about 1000 m^2 plot with a recommended variety along with a package of recommended production practices for demonstration purposes. The varieties distributed in the area were ETS 601, Alemaya 70, and ETS 2113. Planting instructions as well as supervision was provided by ESIP technical assistants. All the fields were planted according to plan and thinning was done at appropriate time. From then on, security reasons made it impossible to follow up the progress of these fields.

The absence of a seed program of any sort in the country led ESIP to make its own arrangements with interested farms for increasing seeds of superior varieties identified by ESIP. The Kobo-Alamata Development Project cooperated with ESIP in this effort in 1977.

In Nazreth area also, about 30 demonstration fields were planted to either Shufun, Kobomash 76, 74 MW 5020, ESIP 3182 or IS 158. Seeds and instructions on management practices were distributed through the EPID system in the area. Kobomash 76 was the variety distributed to most of the farmers. Because of poor management and follow up and Quelea problem many of the demonstration fields did not look as good as expected.

Arrangements were also made with ARDU to plant early maturing sorghums in the lowlands of Arsi. Several varieties were planted in demonstrational plots. Results of such trial are reported in the section Sorghum National Yield Trials. Since Kobomash 76 looked excellent in the Tibila area, ARDU is very much interested in increasing the seed and distributing the variety to farmers.

In the Kobo area, Kobomash 76 was planted in large demonstrational fields in cooperation with EPID, the Relief and Rehabilitation Commission, Cooperative Farms, Chafa State Farm, and the Kobo ESIP site. In the immediate vicinity of Kobo, the variety was seriously attacked by Chilo stalk borer. Future management practices in the Kobo area in producing Kobomash 76 must have an effective borer control program. At Chafa, among other lowland entries planted there, Kobomash 76 looked good towards harvest though the field was water logged and weedy early in the season. Besides, IS 158 and ESIP 6012 also looked promising and have been included in the list of sorghum entries to be produced by the Chafa State Farm this coming Keremt.

Germplasm Exchanges

Exchange of germplasm continues to be one of the major links of the ESIP with research institutions, both local and international, concerned with sorghum improvement.

As a result, during the period covered in this report, sorghum seed from international sources included either in regular trials or through specific seed requests by ESIP have been received from Rao, House, Ramaiah, Verma and Murty (all of ICRISAT)/Hyderabad, India; Pattanayak/ICRISAT, Upper Volta; Aboti/Mahrashtra, India. Others were obtained from Van Arkel/Nakuru, Kenya; Singh/CIMMYT, Mexico; Girard/Bambey, Senegal; Mahmoud/Wad Medani, Sudan; Bhardwaj/FAO, Syria; Axtell/Purdue, USA; Schertz, Miller and Rosenow/Texas, USA. Local seed receipts are treated as new collections which have already been dealt with in the section on ESGPC.

Likewise ESIP has answered specific seed requests from: House/ICRISAT, India; Van Arkel/Nakuru, Kenya; El Rouby/Zaria, Nigeria; Faris/Khartoum, Sudan; May/Yei, Sudan; Mahmoud/Wad Medani, Sudan; Mukuru/Dar es Salaam, Tanzania; Fredricksen and Miller/Texas, USA; Eastin /Nebraska, USA; Mawly/Saana, YAR; Agriculture Office/ Aden, PDRY. Locally, seeds have been supplied to Debela and Gugsa/ARDU, Jemal and Birru/IAR, Demissie/EPID, Agafanov/Phytopathology Institute, Beneberu/Chafa State Farm, Estate Manager/MAESCO, Tamling/KAADP-RRC, and EPID/Nazreth.

In summary, the ESIP's total seed exchange during the season accounted for 10 different countries and 36 individuals or organizations.

TRAINING AND WORKSHOP

Training

In our efforts to improve the technical competence of our Ethiopian team concerned with the improvement of sorghum in Ethiopia, local training of field and laboratory research assistants is continuously a core activity in ESIP. At all of ESIP's sites all field and laboratory works are being competently handled by our research assistants. Of the 18 research assistants we have in the project, none has more than secondary school formal education. We are now convinced that properly motivated young men with this education level are trainable to handle most jobs in a comprehensive sorghum improvement program. Since there are literally thousands of Ethiopian youth of this education level unemployed, their availability has not been a constraint at all.

Our local training activities have concentrated mostly on training our research assistants to understand and handle the various jobs in the general area of sorghum improvement. The major part of this training has been on-the-job where the professional staff of ESIP explain the basic reasons for many of the jobs done and also imparting certain skills where this is appropriate.

Supportive to this on-the-job training, in late February 1977, we organized at Nazreth a two-week long lecture type of training session for all of the research assistants of the project. This training session dealt with elementary theoretical and basic principles of sorghum improvement. The training was all handled by ESIP's professional staff. Outline of topics discussed is given below.

Outline for ESIP's Training Program, 1977

1. Objectives and responsibilities of the ESIP.
2. Brief review of the year's activities at each ESIP site.
3. Reports by research technicians on their respective sites.
4. Reports by ESIP's sorghum collectors on their collection activities in the year.
5. A brief review of ESIP's Annual Report.
6. Acquaintance with the system of sorghum classification of Harlan and de Wet.
7. Examining ESIP's collections of 1976 and identifing each to Basic and Intermediate Races.
8. Importance of genetic variability in sorghum improvement.
9. Vavilovian centers of crop genetic diversity.
10. Importance of Ethiopia as a center for field crops genetic diversity.
11. Ethiopia as a major world center for genetic diversity of sorghums.
12. Major sources of variability for the breeder - collection, introduction, hybridization, mutation.
13. Cells, chromosomes and genes.
14. Meiosis and mitosis.
15. Selection - meaning and importance.
16. Major Ethiopian field crops classifed according to pollination habits.
17. Self-pollinators vs. cross pollinators - Emphasis on sorghum.
18. Vegetative propagation - Ratooning in sorghum.
19. Parts of the sorghum plant and growth stages.
20. Sorghum floral structures as related to crossing.
21. Breeding methods as related to modes of pollination.
22. Breeding methods
    - a. For self pollinators
      - a.1. Pure line selection
      - a.2. Mass selection
      - a.3. Hybridization and methods of handling segregating populations
        - a.3.1. Pedigree method - F_1, F_2, F_3, F_4, F_5 - Population size in each
        - a.3.2. Bulk method

a.3. Backcross method
a.3.3. Single seed descent method

b. For cross pollinators
b.1. Mass selection for maternal characters
b.2. Hybridization of inbred lines or cultivars
b.3. Recurrent selection-using genetic male steriles and dented seed marker.

23. Breeding methods appropriate for self-and cross-pollinators as applicable to sorghum.

24. Inbreeding and outbreeding as related to inbreeding depression and heterosis.

25. Importance and method of isolation in space, time, and bagging.

26. Heterozygosity and homozygosity - meaning and relevance in sorghum.

27. Segregation and uniformity - meaning and relevance in sorghum.

28. Concept of heritability - genotype and phenotype.

29. Crossing
a. Objectives
b. Choice of parents
c. Method - hand emasculation, genetic male steriles, cytoplasmic male steriles.
d. Management of hybrid populations.

30. Hybrids as target populations.

31. Methods of making sorghum hybrids - discussions on and maintenance of A, B, and R lines.

32. Breeding for disease resistance.

33. Seed production and certification - Breeder seed, Basic seed, Foundation seed, Certified seed.

34. Importance of records for efficient sorghum improvement.

35. Acquaintance with units of measure
a. Length - cm, m, km
b. Area - m^2, ha, gasha, km^2
c. Volume - ml, l
d. Mass - gm, kg, quintal, ton
e. Yield and/or seeding rate - gm/plot, kg or q/ha, ton/ha, no. of plants/ha
f. Temperature and rainfall - C, mm
g. Plot size in m^2 = (No. of rows width, m) x (Row Length,m)
h. Calculation of fertilizer, insecticide, herbicide, and other chemical rates per ha.

36. Principal sorghum diseases in Ethiopia.

37. Principal sorghum insects in Ethiopia.
38. Principal sorghum weeds in Ethiopia.
39. Importance of proper planting date.
40. Importance of proper plant density.
41. Data recording and harvesting of trials.
42. Introduction to field plot technique and experimental designs
    a. Clear and concise objectives, truth and integrity
    b. Brief introduction to experimental design
    c. Soil variation - influence on plot size and replication number.
    d. Border effect - harvested plot size
    e. The null hypothesis
    f. Observation trials
    g. Result demonstration trials
    h. Replicated yield trials
    i. Randomization and replication
    j. The Randomized Complete Block Design (RCBD)
    k. Analysis and summarization of data from RCBD

At the conclusion of the training session at Nazreth, ESIP's entire group of research assistants and professional staff moved to our off-season nursery at Melka Werer where we did all of our crossing work for the 1977 hybrid program. The research assistants were first shown how to identify, maintain, and increase A, B, and R lines, how to make sorghum hybrids using cytoplasmic sterile lines and restorer pollinators, and a host of other jobs associated with hybrid making. After this, for about the entire month of March they spent most of the time making hybrids and related jobs in the off-season nursery. The research assistants stationed at Nazreth were responsible for managing the off-season nursery all the way from planting to harvesting.

Another type of training we conducted in the year was in the Keremt season at Melkasa where we did all of the hand emasculated crosses. School girls who are normally on vacation in the Keremt season were given a two weeks intensive training on emasculating sorghum. About 15 of these girls were hired in the season for emasculation. The research assistants were also given general training on the management of a Crossing Block and also on

Our emasculating crew is formed of school girls who are normally on vacation during our crossing season. They are given an intensive on-the-job training for about two weeks before they are employed for the season.

crossing hand emasculated heads. All of the crossing and record keeping was done by our research assistants.

Workshop

The first workshop on Sorghum Improvement in Ethiopia was organized by ESIP and held at Nazreth from October 27-29, 1977. The workshop was primarily for researchers, cooperators, and administrators who have direct linkage with ESIP. About 40 participants both from local institutions and foreign countries attended the three days workshop.

The major objectives of the workshop were to acquaint the participants with the major activities of ESIP and also to get the views of the participants about these activities. The papers presented during the workshop have been compiled and distributed to the participants as well as to other concerned agencies. The opening address of the workshop was given by the General Manager of the IAR. The subject matter papers dealt with sorghum improvement, management, and diseases. Reviews of ESIP's 1977 activities both in report and slides were also given. Details of the workshop activities are contained in the papers distributed then.

The participants were taken on a field tour to ESIP's nurseries and trials at Melkasa. Visits were also made to the crossing block at Melkasa. Plans to visit one of ESIP's high altitude sites, Arsi Negele, had to be abandoned when the group was forced to return back when the road to Arsi Negele was blocked by the overflowing of the Awash river.

The first Workshop on Sorghum Improvement in Ethiopia organized by ESIP had nearly 40 participants who joined not only from Ethiopia but also from foreign countries.

Table A1. Head rows further selected out of the AL-76-HR selections planted at KB, MS, and NZ in the 1977 Keremt season.

Serial No.	1977 HR No.	Identification	Location of Selection and (No. of plants selected)
1	AL-76-24 to 25	NES 896	KB (L-NYT)
2	" -56	" 8835	NZ (1)
3	" -59	" 8839	NZ (1)
4	" -62	" 8841*	KB (L-NYT)
5	" -146 to 155	" 635**	KB (L-NYT)
6	" -178	" 8698-3	KB (2)
7	" -179	" " -4	KB (2)
8	" -180	" " -5	KB (3)
9	" -181	" " -6	KB (2)
10	" -222	" 8828-1	KB (2)
11	" -223	" " -2	KB (3)
12	" -224 to 232	" 8831-1 to 9	KB (7)
13	" -228	" " -5	KB (2)
14	" -240	" 8833-4	NZ (1)
15	" -255	" 8835-10	NZ (1)
16	" -264	" 8839-1	KB (1)
17	" -267	" " -4	KB (3)
18	" -280	" 8843-1	KB (2)
19	" -340	" 8861-6	KB (3)
20	" -341 to 346	" 8867-1 to 6	KB (6)
21	" -357	" 8884-1	KB (2)
22	" -560	" 9879-2	NZ (1)
23	" -659	" 10266-3	KB (2)

*Similar to Kobomash 76 but taller

**Very tolerant to stalk borer

Table A1 continued

Head rows further selected out of the HU-76-HR selections planted at KB, MS, and NZ in the 1977 Keremt Season.

Serial No.	1977 HR No.	Identification	Location of Selection and (No. of plants selected)
1	HU-76-6	HU-76 ALAD 3661-2	NZ (1)
2	" -9	" " 3746-1	NZ (1)
3	" -13	" " 3747-2	NZ (1)
4	" -14	" " 3747-3	NZ (2)
5	" -41	NES 7306	NZ (1)
6	" -44	" 7306	NZ (2)
7	" -50 to 51	" 4100	KB (L-NYT)
8	" -52	" 4160	KB (2)
9	" -69	" 4078	KB (3)
10	" -78	" 4085	KB (2)
11	" -91	" 4219	NZ (1)
12	" -103	" 5290	NZ (1)
13	" -117	" 5612	NZ (1)
14	" -125	" 5410	KB (1)
15	" -133	" 1849xAwash 1050/S_1	NZ (3)
16	" -134	" " "	NZ (1)
17	" -137	NES 712xAwash 1050	KB (1)
18	" -142	Karative 4/1/xIS 11167	NZ (1)
19	" -145	" " "	NZ (1)
20	" -147	" " "	MS (1)
21	" -154	NES 712xAwash 1050	MS (1)
22	" -157	" "	NZ (1)
23	" -160	ALAD 4022	MS (2); MS(CB)
24	" -161	NES 821xAwash 1050/7	NZ (1)
25	" -162	" "	NZ (2)
26	" -163	" "	NZ (2)
27	" -164	" "	NZ (1)
28	" -168	NES 4250	KB (2)
29	" -170	NES 4263	KB (1)

Table A1 continued

Head rows further selected out of the KB-76-HR selections planted at KB, MS, and NZ in the 1977 Keremt season.

Serial No.	1977 HR No.	Identification	Location of Selection and (No. of plants selected)
1	KB-76-1	NES 830x705 (77 MW 485-1)	NZ (1)
2	" -3	NES 830x705 (77 MW 485-3)	NZ (1)
3	" -13 to 20	74 MW #1013	KB (L-NYT) (Stalk borer tolerant)
4	" -21	74 MW #5001	NZ (1)
5	" -49	76 T2 #8	NZ (1)
6	" -62	76 T2 #193	MS (1)
7	" -72	76 T2 #124	MS (1)
8	" -73	76 T2 #124	MS (2)
9	" -77	76 T2 #137	NZ (1)
10	" -83	76 T2 #157	KB (5)
11	" -84	76 T2 #38	MS (1)
12	" -85	76 T2 #38	MS (1)
13	" -86	76 T2 #38	MS (1)
14	" -113	76 T2 #88	MS (1)
15	" -115	76 T2 #88	MS (2)
16	" -119	76 T2 #41	MS (1)
17	" -123	76 T2 #41	KB (2)
18	" -142	76 T2 #18	MS (3)
19	" -144	76 T2 #18	MS (1)
20	" -163	76 T3 #192	KB (2); NZ (1)
21	" -167	76 T3 #162	NZ (1)
22	" -172	76 T3 #162	NZ (1)
23	" -219 to 240	76 T3 #25	KB (L-NYT; NZ (1)
24	" -225	76 T3 #25	NZ (1)
25	" -237	76 T3 #25	MS (1)
26	" -245	76 T3 #119	NZ (1)

Table A1 continued

KB-76-HR Selections

Serial No.	1977 HR No.	Identification	Location of Selection and (No. of plants selected)
27	KB-76-266	76 T3 #32	KB (4)
28	" -269	76 T3 #180	MS (1)
29	" -296	76 T3 #106	KB (1)
30	" -325	76 T4 #168	NZ (1)
31	" -331	76 T4 #14	KB (L-NYT)
32	" -338	76 T4 #418	MS (2); NZ (1)
33	" -340	76 T4 #418	MS (1)
34	" -342	76 T4 #418	MS (2)
35	" -343	76 T4 #418	MS (1)
36	" -344	76 T4 #418	MS (1)
37	" -349	76 T4 #570	MS (2)
38	" -361	76 T4 #20	KB (2)
39	" -379	76 T4 #261	KB (1)
40	" -386	76 T4 #62	KB (4)
41	" -401	76 T4 #166	MS (2)
42	" -402	76 T4 #482	KB (4); MS (2)
43	" -403	76 T4 #482	KB (8); MS (1)
44	" -406	76 T4 #482	KB (2)
45	" -417 to 421	76 T4 #377	KB (L-NYT)
46	" -427 to 435	76 T4 #473	KB (1); KB (L-NYT); KB (CB)
47	" "	" "	" " " "
48	" "	" "	" " " "
49	" -438	76 T4 #1	KB (2); KB (L-NYT)
50	" -439	" "	KB (1); " "
51	" -440 to 452	76 T4 #408	KB (L-NYT)
52	" -454	76 T4 #162	NZ (1)
53	" -477	76 T4 #423	KB (1)

Table A1 continued

KB-76-HR Selections

Serial No.	1977 HR No.	Identification	Location of Selection and (No. of plants selected)
54	KB-76-483	76 T4 #421	MS (1)
55	" -484	76 T4 #421	NZ (1)
56	" -485	76 T4 #333	MS (1)
57	" -493 to 500	76 T4 #478	KB (L-NYT)
58	" -501 to 509	76 T4 #416	KB (3); KB (L-NYT)
59	" "	" "	KB (1)
60	" -523	76 T4 #492	KB (1); MS (1)
61	" -526	76 T4 #437	MS (1)
62	" -527	76 T4 #437	MS (1)
63	" -538	76 T4 #296	KB (3); MS (1)
64	" -539	" "	KB (1)
65	" -541	" "	MS (1)
66	" -542	" "	MS (1)
67	" -551	76 T4 #446	MS (1)
68	" -571	76 T4 #13	KB (L-NYT)
69	" -586	76 T4 #319	MS (1)
70	" -596	76 T4 #417	MS (1)
71	" -609	76 T1 #7	MS (2)
72	" -610	76 T1 #7	MS (2)
73	" -611	76 T1 #20	KB (L-NYT)
74	" -616	76 T4 #473	KB (L-NYT)
75	" -617	NES 830x705	NZ (1); KB (CB)

NOTE: The discrepancy in the number of selections in the KB-76-HR group indicated in the Summary Table 5 and this one is due to the fact that some entries have been counted more than once in that table because they were selected at more than one location and/or they were selected for more than one use.

Table A1 continued

Head rows further selected out of the NZ-76-HR selections planted at KB, MS, and NZ in the 1977 Keremt season.

Serial No.	1977 HR No.	Identification	Location of Selection and (No. of plants selected)
1	NZ-76-2	76 T2 #72	NZ (1)
2	" -6	76 T2 #72	NZ (1)
3	" -23	76 T4 #420	NZ (1)
4	" -24	76 T4 #420	NZ (1)
5	" -25	76 T4 #420	MS (1)
6	" -27	76 T4 #420	MS (1); NZ (1)
7	" -28	76 T4 #420	MS (1)
8	" -29	76 T4 #420	MS (4); NZ (1)
9	" -34	76 T4 #420	NZ (1)
10	" -38	76 T4 #420	MS (2); NZ (1)
11	" -39	NES 8582	MS (1)
12	" -56	76 T2 #6	NZ (2)
13	" -70	76 T3 #13	NZ (1)
14	" -127	76 T3 #151	NZ (1)
15	" -167	76 T4 #262	NZ (1); NZ (CB)
16	" -189	ET-76-W-1065	KB (3); NZ (1)
17	" -236	ET-76-W-13632	MS (2)
18	" -242	ET-76-W-50011	KB (2)
19	" -243	ET-76-W-50013	KB (3)
20	" -254	76 T4 #432-1	NZ (2)

NOTE: The discrepancy in the number of selections in the NZ-76-HR group indicated in the Summary Table 5 and this one is due to the fact that some entries have been counted more than once in that table because they were selected at more than one location.

Table A1 continued

Head rows further selected out of the YE selections planted at KB, MS, and NZ in the 1977 Keremt season.

Serial No.	1977 HR No.	Identification	Location of Selection and (No. of plants selected)
1	YE-53	NES 10818	KB (2)
2	" -55	" 10870	KB (1)
3	" -68	" 10977	KB (1)
4	" -73	" 11072	KB (3)
5	" -126	" 12138	KB (1)
6	" -149	" 10306	KB (1)
7	" -151	" 10308	MS (S for Hy)
8	" -156	" 10313	KB (1)
9	" -159	" 10317	KB (2); MS (S for Hy)
10	" -178	" 10441	MS (S for Hy)
11	" -217	" 10576	MS (S for Hy)
12	" -219	" 10579	MS (S for Hy)
13	" -227	" 10598	KB (S for Hy)
14	" -228	" 10600	KB (2)
15	" -254	" 10691	KB (6)
16	" -269	" 10715	KB (1); KB (S for Hy)
17	" -271	" 10718	KB (1)
18	" -276	" 10725	KB (S for Hy)
19	" -287	" 10753	MS (S for Hy)
20	" -288	" 10755	KB (S for Hy)
21	" -293	" 10815	KB (S for Hy); MS (S for Hy)
22	" -294	" 10817	KB (S for Hy); MS (S for Hy)
23	" -305	" 10847	MS (S for Hy)
24	" -315	" 10871	KB (4)
25	" -330	" 10927	KB (2)
26	" -331	" 10928	KB (S for Hy)

Table A1 continued

YE Selections

Serial No.	1977 HR No.	Identification	Location of Selection and (No. of plants selected)
27	YE-333	NES 10932	KB (2); KB (S for Hy)
28	" -334	" 10933	KB (2)
29	" -335	" 10935	KB (1); KB (S for Hy); MS (S for Hy)
30	" -336	" 10936	KB (2)
31	" -337	" 10937	KB (S for Hy)
32	" -352	" 10963	KB (S for Hy)
33	" -356	" 10967	KB (S for Hy)
34	" -357	" 10971	KB (S for Hy)
35	" -359	" 10973	KB (S for Hy)
36	" -363	" 10979	MS (S for Hy)
37	" -367	" 10983	KB (S for Hy)
38	" -369	" 10986	KB (S for Hy)
39	" -383	" 11004	KB (1)
40	" -401	" 11101	MS (S for Hy)
41	" -425	" 11266	KB (3)
42	" -426	" 11267	KB (1)
43	" -435	" 11534	KB (S for Hy)

NOTE: The discrepancy in the number of selections in the YE selections indicated in the Summary Table 5 and this one is due to the fact that some entries have been counted more than once in the table because they were selected at more than one location.

Table A2. F_2 populations out of which individual plant or plants were selected at one or more ESIP sites in the 1977 Keremt season.

1977 Brdg Nrsy No.	Pedigree	Number of Plants Selected		
		Alemaya	Arsi Negele	Nazreth
2001	ETS 3337xETS 717	1	0	0
2010	ETS 3337xETS 3011	1	1	0
2019	ETS 3315xETS 396	0	1	0
2051	(IS 858xAwash 1050/19)xETS 717	0	1	0
2054	(IS 858xAwash 1050/19)xETS 396	0	1	0
2056	(IS 858xAwash 1050/19)xETS 2111	1	0	0
2064	(IS 858xAwash 1050/19)x75 MD 27	1	0	0
2065	(IS 858xAwash 1050/19)x75 MD 24	4	1	0
2072	(IS 858xAwash 1050/19)xETS 3505	0	1	0
2077	(IS 858xAwash 1050/40)xETS 396	3	1	0
2080	(" " ")xETS 2111	2	0	1
2082	(" ")xETS 2283	4	2	1
2087	(" ")xBGK Twins	1	0	0
2104	(Hx57)xWS 1509/8)xETS 916	0	0	1
2111	" " xETS 3505	2	1	1
2112	(NES 1849xAwash 1050 (S1)xETS 601	2	1	0
2113	" " xETS 2111	4	2	1
2114	" " xETS 2113	4	0	1
2115	" " x75 BT 500	1	0	0
2121	(CSH3xAwash 1050/B-16)xETS 396	3	0	0
2126	" " x75 BT 500	2	0	0
2150	(NES 854xAwash 1050/B-18)xETS 3169	0	0	1
2152	(NES 712xAwash 1050/B-24)xETS 916	0	3	1
2153	" " xAwash 1050	0	1	0
2155	" " x Daslie	0	0	1
2160	" " x ETS 3530	0	1	0
2162	" " x ETS 717	4	2	0
2167	" " x ETS 2111	0	0	1

Table A2 continued

1977 Brdg Nrsy No.	Pedigree	Number of Plants Selected		
		Alemaya	Arsi Negele	Nazreth
2168	(NES 712xAwash 1050/B-24)xETS 2113	3	3	1
2169	" " x75 BT 624	1	0	0
2178	(NES 702xAlemaya 70/B-27)xETS 717	2	1	0
2180	" " x ETS 2111	2	3	0
2181	" " x Abdellota	1	3	0
2183	" " x 75 BT 500	1	3	0
2185	" " x 75 BT 474	0	0	1
2187	" " x 75 MD 27	0	1	0
2188	" " x 75 MD 24	1	0	1
2189	" " x Unknown	0	0	1
2191	" " x ETS 2952	0	0	1
2192	" " x ETS 2982	0	0	1
2196	" " x ETS 3286	1	0	0
2200	(NES 702xAlemaya 70/B)x 75 MT 99	0	1	0
2202	IS 2230xETS 916	3	0	0
2221	IS 8534xETS 2113	3	1	0
2224	" x75 MT 117	1	1	0
2225	" x75 BT 500	0	1	0
2227	" x75 BT 474	2	0	0
2229	" x75 BT 623	3	0	0
2232	" x75 MD 24	2	1	0
2244	" xETS 3169	2	1	0
2245	" "	1	0	0
2246	" xETS 3286	0	1	0
2261	IS 10262xBGK Twins	4	0	0
2272	IS 10262xETS 3169	4	0	0
2278	SPV-4xBGK Twins	1	0	0
2294	CSV-1xBGK Twins	3	0	0
2311	SPV-35xETS 3169	0	0	1
2331	(CaprockxIS 11758)x(IS 2230xETS 396)	3	0	0
2356	(CaprockxIS 11758)x (IS 9618xAlemaya 70)	0	1	0

Table A2 continued

1977 Brdg Nrsy No.	Pedigree	Number of Plants Selected		
		Alemaya	Arsi Negele	Nazreth
2359	(CaprockxIS 11758)x (IS 10600xIS 11758)	0	0	1
2366	(CaprockxIS 11758)x (Karitive 4/1/1xIS 11167)	3	0	0
2381	(RazinaxIS 11758)x(IS 10586xIS 11758)	0	1	0
2414	(NES 2202xIS 11758)x (NES 1707xETS 2113)	0	0	1
2445	(NES 3222xIS 11758)x (Gambella 1096xETS 3507)	3	0	0
2450	(NES 3222xIS 11758)x (IS 10600xIS 11758)	1	0	0
2480	(IS 460xIS 11758)x (Karitive 4/1/1xIS 11167)	1	0	0
2490	(NES 821xAwash 1050/2)x (IS 9618xAlemaya 70)	1	1	0
2496	(NES 821xAwash 1050/2)x(ISQC-2)	0	1	0
2497	(NES 821xAwash 1050/2)x (IS 10491xIS 11758)	0	0	1
2502	(NES 821xAwash 1050/2)x (IS 2230xETS 396)	1	0	1
2503	(NES 821xAwash 1050/2)x (IS 2230xAwash 1050)	0	0	1
2504	(NES 821xAwash 1050/2)x (IS 9243xETS 2113)	0	0	1
2509	(NES 821xAwash 1050/2)x (P-721xWhite Marchuke)	0	1	0
2515	(NES 821xAwash 1050/2)x (PP_1xETS 1470)	1	0	1
2518	(NES 821xAwash 1050/2)x(ISQC-2)	0	1	0
2521	(NES 821xAwash 1050/2)x (IS 10586xIS 11758)	0	1	0
2523	(NES 821xAwash 1050/2)x (Karitive 4/1/1xIS 11167)	0	1	0
2524	(NES 821xAwash 1050/2)x (Karitive 4/1/1xIS 11167)	0	1	0
2534	(NES 821xAwash 1050/1)x (IS 9243xETS 3507)	1	0	0

Table A2 continued

1977 Brdg Nrsy No.	Pedigree	Number of Plants Selected		
		Alemaya	Arsi Negele	Nazreth
2539	(NES 821xAwash 1050/1)x (Karitive 4/1/1xIS 11167)	1	0	0
2541	(NES 821xAwash 1050/1)x (IS 223CxAwash 1050)	2	2	0
2544	(NES 821xAwash 1050/1)x (Karitive 4/1/1xIS 11167)	0	2	0
2545	(NES 821xAwash 1050/1)x (Karitive 4/1/1xIS 11167)	2	1	0
2546	(NES 821xAwash 1050/1)x (Karitive 4/1/1xIS 11167)	0	2	0
2547	(NES 821xAwash 1050/4)x (IS 9243xETS 3000)	1	0	0
2552	(NES 821xAwash 1050/4)x (Awash 1050xDekalab Mounder)	0	2	0
2553	(NES 821xAwash 1050/4)x (PP_4xIS 11758)	0	4	1
2554	(NES 821xAwash 1050/4)x (IS 10586xIS 11758)	1	5	0
2555	(NES 821xAwash 1050/4)x (IS 10586xIS 11758)	0	2	0
2557	(IS 858xAwash 1050/37)x (IS 9243xETS 3507)	0	1	0
2566	(IS 858xAwash 1050/37)x (Karitive 4/1/1xIS 11167)	0	1	0
2572	(IS 858xAwash 1050/37)x (IS 9618xAlemaya 70)	0	1	0
2574	(IS 858xAwash 1050/37)xMiscellaneous	0	0	1
2575	(IS 858xAwash 1050/37)x (IS 10586xIS 11758)	2	1	0
2578	(IS 825xAwash 1050/37)x (Karitive 4/1/1xIS 11167)	0	0	1
2593	(IS 857xAdi Ugri)x (Karitive 4/1/1xIS 11167)	0	1	0
2597	(IS 857xAdi Ugri)x (IS 9618xAlemaya 70)	0	1	0
2607	(NES 712xAwash 1050)x (IS 2230xETS 396)	0	1	0

Table A2 continued

1977 Brdg Nrsy No.	Pedigree	Number of Plants Selected		
		Alemaya	Arsi Negele	Nazreth
2616	(NES 712xAwash 1050)x (IS 2230xETS 396)	0	3	0
2619	(NES 712xAwash 1050)x (MSH-21xETS 651)	0	0	1
2623	(NES 712xAwash 1050)x (ISQC-2)	0	0	1
2625	(NES 712xAwash 1050)x (IS 10600xIS 11758)	0	3	0
2628	(NES 712xAwash 1050)x (Karitive 4/1/1xIS 11167)	0	1	0
2631	(NES 712xAwash 1050)x (IS 9618xAlemaya 70)	0	3	1
2642	(NES 712xAwash 1050)x (PP_1xDedessa 36)	0	1	0
2652	(NES 712xAwash 1050)x (IS 22302xETS 396)	0	0	1
2657	(NES 712xAwash 1050)x (P-721xWhite Marchuke)	0	1	0
2658	(NES 712xAwash 1050)x (Gambella 1096xETS 3508)	0	2	0
2661	(NES 712xAwash 1050)x (Karitive 4/1/1xIS 11167)	0	1	0
2664	(NES 712xAwash 1050)x (MSH 8xETS 2997)	0	1	0
2667	(NES 712xAwash 1050)x (Gambella 1096xETS 3507)	2	0	0
2668	(NES 712xAwash 1050)x (PP_1xETS 1470)	1	0	0
2670	(NES 712xAwash 1050)x (Karitive 4/1/1xIS 11167)	1	0	0
2672	(NES 712xAwash 1050)x (Gambella 1096xETS 2113)	0	1	0
2676	(NES 712xAwash 1050)x (Karitive 4/1/1xIS 11167)	2	2	0
2686	(NES 712xAwash 1050)x (Karitive 4/1/1xIS 11167)	0	3	0
2687	(NES 712xAwash 1050)x (Karitive 4/1/1xIS 11167)	0	1	0

Table A2 Continued

1977 Brdg Nrsy No.	Pedigree	Number of Plants Selected		
		Alemaya	Arsi Negele	Nazreth
2694	(NES 712xAwash 1050)x (Gambella 1096xETS 2113)	0	0	1
2697	(NES 712xAwash 1050)x (PP_1xETS 1470)	1	0	0
2700	(NES 712xAwash 1050)x (Karitive 4/1/1xIS 11167)	0	1	1
2701	(NES 712xAwash 1050)x (Karitive 4/1/1xIS 11167)	0	1	0
2703	(NES 712xAwash 1050)x (IS 8534xETS 3502)	0	0	1
2709	(NES 712xAwash 1050)x (IS 9243xETS 2113)	0	2	0
2713	(NES 712xAwash 1050)x (Karitive 4/1/1xIS 11167)	1	2	0
2714	(NES 712xAwash 1050)x (IS 9243xETS 2113)	0	2	0
2715	(NES 712xAwash 1050)x (IS 9618xAlemaya 70)	1	2	0
2718	(NES 712xAwash 1050)x(ISQC-2)	0	0	1
2720	(NES 712xAwash 1050)x (Karitive 4/1/1xIS 11167)	0	0	1
2726	(NES 712xAwash 1050)x (IS 10491xIS 11758)	1	0	0
2727	(NES 712xAwash 1050)x (Karitive 4/1/1xIS 11167)	0	1	0
2738	(NES 712xAwash 1050)x (Gambella 1096xETS 3507)	0	2	0
2740	(NES 712xAwash 1050)x (CK-60AxETS 211)	0	1	0
2743	(NES 712xAwash 1050)x (Karitive 4/1/1xIS 11167)	0	1	0
2744	(NES 712xAwash 1050)x (Karitive 4/1/1xIS 11167)	0	4	0
2746	(NES 712xAwash 1050)x (Karitive 4/1/1xIS 11167)	0	2	0

Table A2 continued

1977 Brdg Nrsy No.	Pedigree	Number of Plants Selected		
		Alemaya	Arsi Negele	Nazreth
2751	(NES 712xAwash 1050)x (PP_6xETS 179)	0	1	0
2753	(NES 712xAlemaya 70)x (IS 9618xAlemaya 70)	0	1	0
2759	(NES 843xJijidasola)x (IS 9618xAlemaya 70)	0	1	0
2773	MSH 21xETS 651	0	1	0
2775	Gambella 1107xETS 2947	4	4	1
	Total Number of Crosses Selected	61	82	37
	Total Number of Plants Selected	119	129	37
	Selected Crosses as % of Total Crosses Evaluated	7.9	16.6	4.8

Table A3 F_3 populations out of which individual plant or plants were selected at Alemaya and/or Arsi Negele in the 1977 Keremt season.

1977 Brdg Nrsy No.	Pedigree	Number of Plants Selected	
		Alemaya	Arsi Negele
3001	ETS 1993xDalecho Kondel	0	2
3002	" "	0	2
3006	ETS 1486xETS 2625	0	1
3008	" xETS 2416	0	1
3010	" xIS 11758	0	2
3016	" xETS 2623	1	0
3017	" x "	0	1
3019	" xETS 137	0	2
3020	" "	0	1
3022	" xETS 2113	0	2
3023	" x "	0	1
3024	" x "	0	1
3024D	IS 9243xWhite Marchuke	0	1
3026	ETS 1486xETS 396	0	1
3027	" "	0	1
3028	" "	0	1
3029	" "	0	2
3030	" xWS 1763	1	0
3033	" "	0	1
3034	" "	1	1
3035D	IS 9618xETS 2416	0	1
3036D	P-721xETS 2416	2	0
3041	ETS 1486xNetch Keteto	0	1
3042	" "	3	0
3043	" xDalecho Kondel	0	1
3044	" "	0	1
3045	" "	1	1
3046	" "	0	1

Table A3 continued

1977 Brdg Nrsy No.	Pedigree	Number of Plants Selected	
		Alemaya	Arsi Negele
3047	ETS 1486xDalecho Kondel	0	1
3049	" "	2	1
3050	" xETS 2111	0	1
3051	" "	0	1
3052	" "	0	1
3056D	NES 635xAlemaya 70	0	1
3057	ETS 1486xETS 2112	0	2
3058	" "	0	1
3059	" "	0	2
3070	ALAD 502xIS 11758	0	1
3073	" xETS 2270	0	2
3074	" "	1	0
3076	" "	2	1
3077	" xNetch Fendisha	1	2
3078	" "	0	1
3079	" "	1	0
3080	" "	0	1
3083	" "	0	1
3085	" xAlemaya 70	0	1
3086	" "	0	3
3087	" "	0	2
3090	" "	0	1
3093	" xETS 2113	0	2
3095	" "	0	1
3096	" "	1	2
3097	" "	0	1
3098	" xETS 396	0	4
3100	" "	0	1
3100H	IS 9243xETS 137	0	1
3101	ALAD 502xWS 1763	0	1
3103	" "	1	2

Table A3 continued

1977 Brdg Nrsy No.	Pedigree	Number of Plants Selected	
		Alemaya	Arsi Negele
3104	ALAD 502xWS 1763	0	1
3105	" "	2	6
3106	" "	1	0
3107	" "	1	1
3112-1	ALAD 502xFafam-Pearl	0	1
3112-2H	P-721xETS 2623	0	1
3114	ALAD 502xFafam-Pearl	0	1
3115	" xWhite Marchuke	0	2
3116	" x "	0	1
3118	" "	0	1
3119	" "	0	2
3120	" "	0	2
3123	" xDirb Keteto	2	0
3124	" "	0	1
3126	" "	1	0
3128	" "	2	0
3129	" "	1	0
3130	" "	2	0
3131	" "	1	0
3135	" "	0	1
3138	" xMashila Baria	0	1
3140	" xAwash 1050	1	4
3142	" x "	0	1
3143	" "	0	1
3144	" "	2	0
3144-1	" "	0	1
3144-2	" "	0	1
3144-3	" "	0	1
3147	ALAD 691xETS 2416	2	0
3147-1	" "	0	1
3147-2	" "	0	1

Table A3 continued

1977 Brdg Nrsy No.	Pedigree	Number of Plants Selected	
		Alemaya	Arsi Negele
3151	ALAD 691xAsfaw White	3	1
3152	" "	2	3
3153	" "	0	2
3156	" "	0	2
3157	" "	6	2
3158	" xNetch Fendisha	0	1
3161	" "	2	0
3167	" xAlemaya 70	0	1
3169	" "	1	0
3170	" "	0	1
3175	" "	1	0
3176	" xETS 2113	1	0
3177	" "	3	1
3179	" xETS 651	3	1
3179N	NB 635xWS 1763	0	1
3182	ALAD 691xETS 651	0	1
3183	" xETS 396	2	1
3185	" "	1	0
3186	" "	0	1
3187	" "	1	1
3189	" xFafam-Pearl	0	1
3191	" "	0	1
3192	" "	0	1
3194	" "	0	1
3204	" xWollo Red Giant	0	1
3206	" "	0	1
3208	" xKormie	1	1
3210	" "	0	2
3214	" "	0	1
3216	" "	0	1
3220	" xDalecho Kondel	0	2

Table A3 continued

1977 Brdg Nrsy No.	Pedigree	Number of Plants Selected	
		Alemaya	Arsi Negele
3222	ALAD 691xDalecho Kondel	0	1
3223	" "	0	1
3226	" "	1	2
3230	" xAwash 1050	0	2
3234	" "	0	1
3241	Miscellaneous	0	1
3244	"	0	1
3248	IS 9243xETS 2625	0	1
3255	" xETS 2416	1	0
3259	" xETS 2623	0	1
3262	" xAsfaw White	1	1
3264	" x "	0	1
3270	" xETS 137	0	1
3271	" "	0	1
3274	" xETS 2113	0	2
3276	" "	0	3
3278	" "	0	2
3283	" xETS 651	0	1
3284	" x "	0	1
3285	" "	1	1
3289	" "	0	2
3300	" xETS 396	0	1
3302	" "	0	3
3305	" xWS 1763	1	0
3311	" "	2	0
3330	IS 8534xETS 2416	1	0
3341	" xAlemaya 70	6	2
3342	" x "	0	1
3345	" xETS 396	4	1
3346	" x "	0	3
3347	" "	2	1

Table A3 continued

1977 Brdg Nrsy No.	Pedigree	Number of Plants Selected	
		Alemaya	Arsi Negele
3353	IS 8534xETS 396	1	0
3358	" xAbdelot	2	0
3359	" xDalecho Kondel	1	0
3360	" "	1	1
3363	" "	1	1
3364	" "	1	0
3365	" "	1	0
3366	" "	0	1
3370	" "	1	0
3373	" "	0	1
3375	" xAwash 1050	4	0
3380	" "	0	1
3383	IS 9618xETS 2416	0	1
3384	" "	0	1
3392	" xETS 2270	1	0
3396	" xAlemaya 70	0	1
3400	" "	1	0
3402	" "	0	1
3406	" xETS 2113	0	1
3407	" "	0	1
3416	P-721xETS 651	2	0
3418	NB 691xETS 137	1	0
3430	" xKemisse Compact	0	1
3434	" xAwash 1050	0	1
3436	" x "	1	1
3439	Miscellaneous	1	3
3443	NB 635xETS 2625	1	0
3452	" xAlemaya 70	1	0
3455	" "	0	1
3456	" xETS 2113	1	0
3463	" xETS 651	2	0

Table A3 continued

1977 Brdg Nrsy No.	Pedigree	Number of Plants Selected	
		Alemaya	Arsi Negele
3464	NB 635xWS 1763	1	0
3471	" xMiscellaneous	1	0
3508	MSH 21xETS 651	1	0
3532	" xNetch Keteto	1	0
3540	" "	1	0
3542	" xETS 2113	1	0
3543	" "	2	0
3547	" "	0	1
3552	" xAwash 1050	0	2
3559	SwarnaxETS 2113	1	0
3567	" xWS 1763	3	0
3576	" xDirb Keteto	0	1
3581	LuluxNetch Fendisha	4	0
3589	" xETS 651	0	1
3609	NES 635xAlemaya 70	0	1
3613	" x "	0	1
3645	NES 1533xFafam-Pearl	0	2
3657	NES 1533xDirb Keteto	0	1
3659	" "	0	1
3676	IS 3673xYusuf Muyra	3	0
3684	" "	0	2
3692	NES 1773xETS 2390	0	1
3698	" xETS 2113	0	2
3735	ETS 2111xYusuf Muyra	0	1
3738	" xAlemaya 70	0	1
3739	" "	0	1
3741	ETS 2112xYusuf Muyra	2	1
3742	" "	1	0
3743	" xAlemaya 70	0	1
3744	" xETS 2113	0	2
3746	" xKormie	0	1

Table A3 continued

1977 Brdg Nrsy No.	Pedigree	Number of Plants Selected: Alemaya	Number of Plants Selected: Arsi Negele
3747	ETS 2112xKormie	0	1
3750	" xMiscellaneous	0	1
3752	Awash 1050xETS 2113	0	1
3753	" "	0	1
3758	GambellaxWS 1763	4	1
3768	" xWhite Marchuke	0	2
3772	" "	0	1
3798	NK 300xYusuf Muyra	3	1
3819	" xAdele Muyra	1	0
3828	" xDalecho Kondel	1	0
3834	HafukagnexIS 9243	1	0
3838	" xLulu	1	0
3840	CK-60xALAD 651	0	1
3856	" xAwash 1050	1	0
3876	Mersa White (2)xWofetel	1	1
3881	ETS 1993xETS 2283	0	2
3887	ALAD 502xAsfaw White	0	1
3888	" "	1	1
3894	NB 691xMiscellaneous	0	2
3906	MSH 21xAsfaw White	1	0
3942	GambellaxBati Compact	1	0
3943	" "	1	1
3953	HafukagnexNB 635	0	1
3966	IS 2230xETS 2390	0	2
3974	ALAD 691xAsfaw White	0	1
	Total Number of Families Selected	92	181
	Total Number of Plants Selected	147	241
	Selected Families as % of Total Families Evaluated	7.7	15.2

Table A4. Current list of and some agronomic data at Nazreth on A and B lines being maintained by ESIP.

ESIP Code#	Identification	Days to head	Leaf dis.*	Overall Appearance**	Remarks
1	CK-60	77	2	3	White; used as female C in 77 MW
2	Kafinam	80	2	3	White
3	Maldandi	92	3	4	Pearly
4	Martin	76	3	5	Red
5	RCF	92	3	5	White, not uniform
6	IS 187-1	82	2	5	Mixed (white & red)
7	IS 187-2	78	2	5	White
8	IS 219	78	2	4	White
9	IS 418-1	73	3	4	Red
10	IS 418-2	75	4	4	Red
11	IS 534	78	-	3	Yellow
12	IS 855-1				
13	IS 855-2				
14	IS 896	72	3	4	Red, used as female D in 77 MW
15	IS 2219	72	2	2	Pearly, used as female E in 77 MW
16	IS 2375	59	4	5	Red
17	IS 2830-1	62	5	5	Brown
18	IS 2830-2	65	5	5	Brown
19	IS 3659	75	2	2	White, threshes poorly
20	IS 3677	73	2	1	Yellow, selected as female M for 78 MW
21	IS 7822	59	5	5	Brown
22	IS 8361	71	3	5	Brown
23	IS 10238	74	2	4	White
24	IS 10240	76	2	3	White
25	IS 10242	71	2	4	White
26	IS 10244	73	3	4	Pearly

Table A4 continued

ESIP Code#	Identification	Days to head	Leaf dis.*	Overall Appearance**	Remarks
27	IS 10248	75	5	4	White, very susceptible to rust
28	IS 10250	75	2	4	White
29	IS 10252	75	2	3	White
30	IS 10254	68	3	5	White
31	IS 10256	76	2	1	White, selected as female N for 78 MW
32	IS 10258	74	3	3	White
33	IS 10262	76	3	3	White
34	IS 10264	77	3	3	White
35	IS 10288	68	4	4	Red
36	IS 10315	67	3	4	Red
37	IS 10316	76	3	3	White
38	IS 10317	76	2	1	White, selected as female F for 77 and 78 MW
39	IS 10318	73	4	5	Red
40	IS 10348	70	4	4	White
41	IS 10350	76	4	4	Red
42	IS 10354	74	4	3	White
43	IS 10360	78	2	1	White, selected as female G for 77 and 78 MW
44	IS 10362	72	2	3	White
45	IS 10364	74	3	3	White
46	IS 10366	76	2	3	White
47	IS 10368	74	2	3	White, used as female H in 77 MW
48	IS 10376	67	3	4	Red, used as female I in 77 MW
49	IS 10378	69	3	4	Red
50	IS 10380	72	3	5	Red
51	IS 10382	74	3	5	Red
52	IS 10384	74	2	3	White
53	IS 10386	71	4	5	Red
54	IS 10388	73	3	4	White

Table A4 continued

ESIP Code#	Identification	Days to head	Leaf dis.*	Overall Appearance**	Remarks
55	CK 11D				
56	IS 10396	82	3	5	White, too tall & poor agronomically
57	IS 10398	72	3	4	White
58	IS 10402	76	3	4	Red
59	IS 10404	72	3	5	White
60	IS 10408	73	3	4	White
61	IS 10410	72	3	4	Red
62	IS 10414	72	3	3	White
63	IS 10416	69	3	3	White
64	IS 10418	73	3	3	White
65	IS 10420	73	3	2	White
66	IS 10428	72	3	3	White
67	IS 10430	71	3	3	White, used as female J in 77 MW
68	IS 10434	72	2	3	White
69	IS 10436	67	3	4	Red
70	IS 10438	74	3	3	Red
71	IS 10440	74	4	3	Red
72	IS 10446	78	2	2	Yellow
73	IS 10448	75	3	2	White
74	IS 10450	77	4	4	Red
75	IS 10454	83	2	1	Yellow, selected as female Q for 78 MW
76	IS 10456	73	2	3	Yellow
77	IS 10460	77	2	1.5	Yellow, selected as female R for 78 MW
78	IS 10462	81	2	4	Yellow
79	IS 10464	73	3	1.5	Yellow, selected as female S for 78 MW
80	IS 10468	77	3	1.5	Yellow, selected as female T for 78 MW
81	IS 10473	74	4	4	White, selected as female K for 77 and 78 MW
82	IS 10475	72	4	4	Red

Table A4 continued

ESIP Code#	Identification	Days to head	Leaf dis.*	Overall Appearance**	Remarks
83	IS 10487	74	3	4	Red
84	IS 10489	68	4	4	White
85	IS 10491	75	3	3	White, B line partial sterile
86	IS 10493	74	4	4	White, B line partial sterile, used as female L in 78 MW
87	IS 10495	70	4	4	Red
88	IS 10511	70	4	3	Red, A & B not similar
89	IS 10558	73	3	4	White
90	IS 10560	73	3	3	White
91	IS 10562	74	3	2	White
92	IS 10564	74	3	3	White
93	IS 10566	74	3	3	White
94	IS 10568	75	3	3	White
95	IS 10570	75	3	3	White
96	IS 10572	78	3	3	White
97	IS 10574	79	4	3	White
98	IS 10576	79	2	3	White
99	IS 10578	77	3	3	White
100	IS 10582	76	3	3	White
101	IS 10584	75	3	3	White
102	IS 10586	74	3	3	White
103	IS 10588	76	2	3	White
104	IS 10590	76	3	2	White
105	IS 10594	73	4	3	White
106	IS 10596	70	4	4	Red
107	IS 10598	65	4	4	Red
108	IS 10600	69	4	4	Red
109	IS 10602	71	4	5	Red
110	IS 10604	71	3	5	Red
111	IS 10606	69	3	5	Red, good early vigor, B partial sterile

Table A4 continued

ESIP Code#	Identification	Days to head	Leaf dis.*	Overall Appearance**	Remarks
112	IS 10610	69	3	3	White
113	IS 10612	71	3	3	White
114	IS 10614	71	3	3	White
115	IS 10618	65	3	4	Red
116	IS 10620	70	3	3	White
117	IS 10622	73	3	3	White
118	IS 10626	74	3	3	White
119	IS 10628	75	3	3	White
120	IS 10630	73	3	3	White
121	IS 10632	71	3	3	White
122	IS 10634	56	3	4	Brown
123	IS 10638	75	3	3	White
124	CK 74				
125	IS 10652	70	4	4	Red
126	IS 10654	71	3	2	White
127	IS 10658	64	4	4	Red
128	IS 10662	73	3	4	Red
129	IS 10664	65	3	3	White
130	IS 10668	68	3	3	White
131	IS 10674	69	3	4	Red
132	IS 10676	77	2	3	White
133	IS 10678	83	3	4	White
134	IS 10680	--	-	4	White
135	IS 10686	66	3	4	Red
136	IS 10688	71	3	4	Brown
137	IS 10690	83	3	4	Pearly, poor panicle exertion
138	IS 10694	87	3	4	White
139	IS 10696	64	3	4	Red
140	P 932127-1	59	4	4	Brown, poor pollen shedder
141	HK I				
142	ND I				
143	P 932233-1	58	4	5	Brown

Table A4 continued

ESIP Code#	Identification	Days to head	Leaf dis.*	Overall Appearance**	Remarks
144	1005				
145	1006				
146	1007				
147	1009				
149	P 93242-2	80	3	4	Red, not uniform
151	P 954066-1	73	2	1	Pearly, Kobomash 76 type, large panicle, selected as female P for 78 MW
152	ISNI				
153	Tx 384				
154	Tx 607				
155	P 954149-1	63	3	5	White
156	Tx 615				
157	7701				
158	7602				
159	P 954149-5	62	4	5	Brown, poor pollen shedding
160	Bulk Y-4	84	3	-	Pearly, not uniform
161	Tx 622	77	3	1	White pearly, selected as female U for 78 MW
162	Tx 623	77	3	1	White pearly, selected as female V for 78 MW
163	Tx 624	77	3	1	White pearly, selected as female W for 78 MW
164	Redlan				Red
165	A2 Tx 2753				White
166	2077			1	Pearly

*1 Very little leaf disease ..... 5 Severely diseased

**1 Best as female parent ..... 5 Worst as female parent