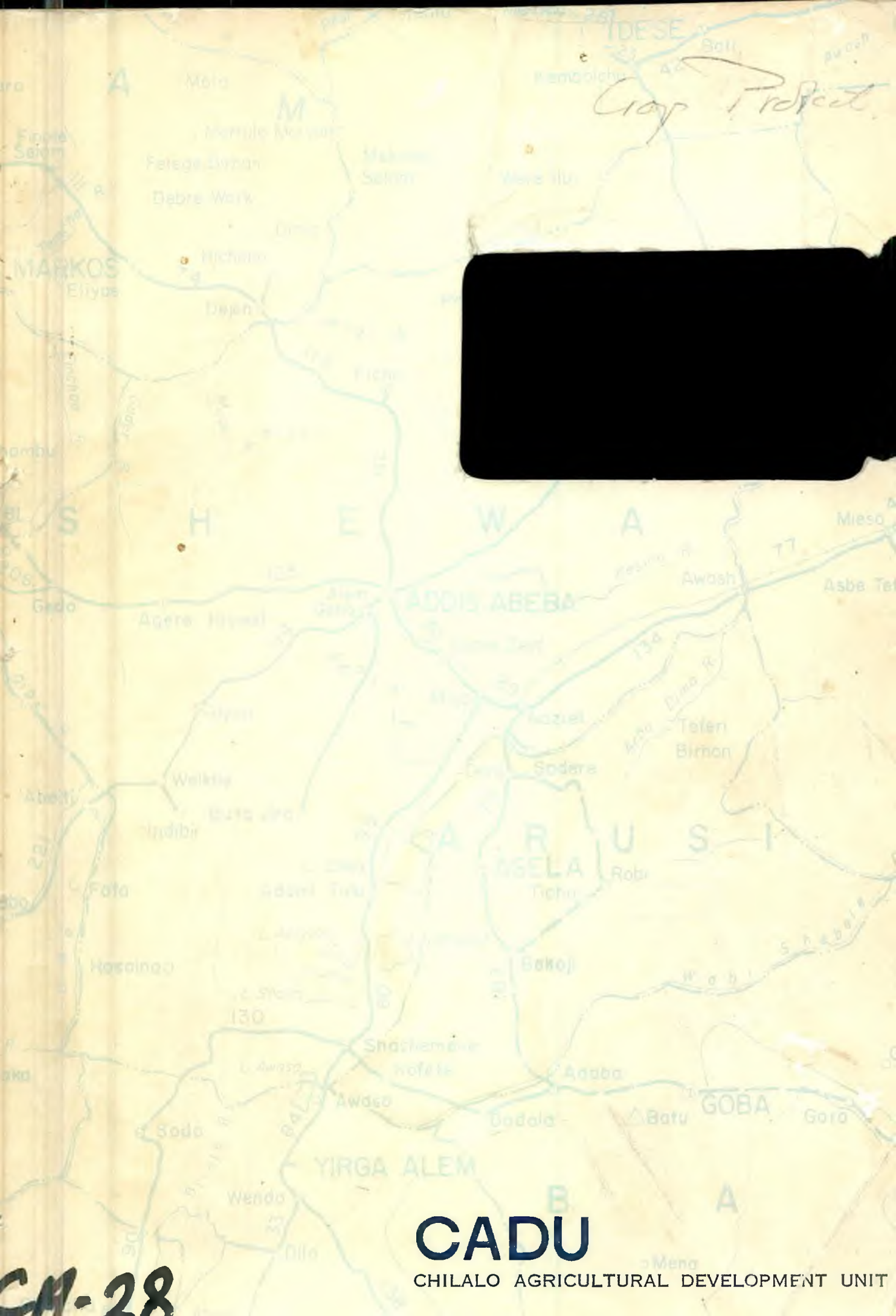
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CM-28

RESULTS OF TRIALS AND OBSERVATIONS 1968/69

Crop Production Department

Addis Ababa, April, 1969

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PART I

1. INTRODUCTION

A summary of the results of trials and observations on field and forage crops carried out at Kulumsa and on the Demonstration and Livestock Farms (Asella), in 1968, together with some observations and recommendations, are presented in part I of this report. The detailed data are found in part II.

2. METEOROLOGICAL OBSERVATIONS

Meteorological observations were made at Kulumsa (elevation = 2200m) by the crop production Department, at Asella (el= 2400m) by the Swedish Mission, and at Dighelu (el =2700m) by the Commerce and Industry Dept. The weather records are presented in Tables A - C.

At Kulumsa there was 82 mm more rain in 1968 than in 1967, while the reverse was true in Asella. However, the total rain fall during the big rains was actually less in 1968 than in 1967 at Kulumsa. In 1967 there was 132 mm of rain in October and November, whereas during the same period in 1968, there was only 33 mm of rain. The dry October coupled with the dry North-easterly wind was unfavorable for crops. Apparently this dry wind is a major factor limiting yields of crops . Crops or varieties that succumb easily to this October - November dry wind should be considered undesireable.

The total rainfall at Kulumsa in 1968 was only 62% (54% in 1967) of that at Asella and 92% of that at Digelu.

Table A. Temperature, humidity, precipitation, hours of sunshine, evaporation, and soil temperature at Kulumsa during 1968.

Month	Air Temperature						Precipitation				Relative humidity			Evaporation	Hours of sunshine	Soil temperature	
	Mean		Extremes														
	Max °C	Min °C	Max °C	Date	Min °C	Date	Total mm	Max mm	Date	No. of rainy days	At 6 a.m. %	At 12 noon %	At 6 p.m. %			50 cm	100 cm
January	22.0	6.3	25.0	24,25 28,31	0.5	13	2.5	2.5	31	1	52.4	38.3	37.2	-	-	-	-
February	19.8	6.6	25.5	1	7.5	1,8	163.8	32.0	1	22	85.3	62.9	60.4	-	-	-	-
March	21.2	9.2	25.5	20	3.0	17	58.0	46.0	22	5	59.4	47.8	40.0	-	-	-	-
April	20.4	10.9	24.5	1	9.0	13,15 22,24	157.6	26.7	4	22	81.0	64.4	59.6	-	-	-	-
May	24.2	11.0	26.5	30	8.5	2,3	14.8	12.0	1	3	75.6	49.6	43.9	-	-		
June	21.9	10.7	23.5	9	8.5	15	91.5	39.3	6	17	83.0	57.7	47.3	-	-	-	-
July	20.2	10.9	22.0	6,21	9.0	16	163.7	63.0	18	20	82.3	71.7	54.5	-	-	-	-
August	19.3	10.4	22.0	3	8.5	17	143.0	29.6	18	28	82.7	76.1	65.5	-	-	-	-
September	19.6	10.3	22.0	27	8.5	12	138.7	24.2	2	25	84.6	71.2	64.3	-	-	-	-
October	20.2	10.5	22.5	13	6.5	29	11.0	9.4	2	3	62.2	46.3	43.9	-	-	-	-
November	17.2	9.7	21.0	14	5.0	12	22.0	9.0	18	7	69.5	50.6	52.8	5.1	6.9	19.5	19.5
December	21.8	8.2	24.3	8	5.0	2,3	-	-	-	-	72.8	50.7	51.1	5.6	7.8	19.2	19.0
Total	-	-	-	-	-	-	966.6	-	-	153	-	-	-	-	-	-	-
Mean	20.7	9.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table B. Temperature and precipitation at Asella (Swedish Mission) in 1968

Month	Air temperature						Precipitation			
	Mean		Extremes							
	Max °C	Min °C	Max °C	Date	Min °C	Date	Total mm	Max mm	Date	No. of rainy days
January	21.7	3.8	24.8	29	0.9	7	10.0	10.0	31	1
February	20.1	9.0	25.9	3	6.0	8	125.5	32.0	22	19
March	21.2	7.2	24.9	26	1.5	18	50.0	24.0	1	10
April	19.9	9.8	23.4	1	6.6	23	278.5	37.0	20	28
May	21.8	9.4	24.0	29	6.8	4,5	101.0	48.0	3	7
June	19.8	9.8	22.7	1	7.7	20	199.0	35.0	6	24
July	19.6	10.1	22.7	20	7.4	25	212.0	35.0	24	22
August	19.1	9.7	22.0	1	7.6	9	267.5	35.0	22	20
September	19.5	9.7	22.0	17	7.5	28	270.5	25.0	11,6, 8,21	22
October	20.6	8.1	23.0	13	1.5	30	20.0	20.0	1	1
November	20.3	4.6	22.2	13	0.6	22	15.0	4.0	20	7
December	20.7	3.7	22.9	27	0.3	27	17.0	11.0	28	3
Total	-	-	-	-	-	-	1,566.0	-	-	164
Mean	20.4	7.9	-	-	-	-	-	-	-	-

Table C. Precipitation at Digelu during 1968

Month	Precipitation			
	Total, mm	Max/day	No. of rainy days	No. of rainy days, ≥5 mm.
January	0.0	0.0	0	0
February	132.2	19.9	24	9
March	38,0	16.5	13	2
April	247.8	39.7	27	13
May	52.1	16.2	11	5
June	77.2	28.6	23	3
July	216.4	32.5	29	14
August	150.4	19.5	25	11
September	75.7	9.8	24	6
October	39.8	15.5	7	4
November	2.3	1.9	3	0
December	16.6	8.8	6	1
Total	1,048.5		192	68

SUMMARY AND CONCLUSIONS

Variety trials and observations

Wheat: Varieties such as (LRX N 10-B) An^3, 8156, and Penjamo 62 have the potential for doubling the low yields given by Kenya 1 and local varieties. These varieties give high yields especially on fertile or fertilized soil. Even the varieties presently under multiplication at Kulumsa namely, Romany, Kentana Frontana X Mayo 48, Yaktana 54, and Supremo Kenya X Yaqui 48 are superior to Kenya 1 and the tested local varieties. Since Kenya 1 is a poor yielder and has become susceptible to stripe rust, it should be replaced by the above varieties.

Barley: In 1968 barley did very poorly at Kulumsa, partly due to attack by barley fly. In almost all trials the local varieties (DZ-02- 72 and Aruso) performed better than introduced varieties. Since barley appears to be a poor competitor with wheat in the Kulumsa area, future trials on barley should be concentrated in the barley growing areas South of Asella.

Maize: Hybrids and composite varieties from Kenya again showed their high yield potential under the conditions of Kulumsa. H613B, the outstanding Hybrid, gave 121 qt/ha, followed by kitale synthetic E with 106 qt/ha.

Teff: Varieties DZ-01-354, DZ-01-386, DZ-01-200, and A-44 appear to be very promising, with yields of 25 to 29 qt/ha. DZ-01-354 and DZ-01-196 grown at Kulumsa make good "injera", contrary to testimonies of some people.

Pulses: Among different species of grain legumes tested in one trial, lupin (21 qt/ha), horse beans (17 qt/ha), and a variety of dry bean (14 qt/ha) did satisfactorily. Yields of chickpeas, lentils, peas, and especially Soybeans were rather low in this trial. Among chickpea varieties tested, No. 170-1, DZ-10-10 and C 410, with yields of 22 to 24 qt/ha, appear to be very promising. Horsebeans, chickpeas, and lupins should make good rotation crops.

Oil seed Crops: Flax varieties Dakota and Redwood outyielded local selections mainly because of their resistance to wilt. Since the disease is common in the flax growing areas of Chilalo, susceptible local varieties should be replaced with Dakota or Redwood.

Among different species of oil seed crops tested, rape and sunflower, when fertilized, have given good yields, Crambe and safflower appear promising. Flax is a good oil crop on poor soils, while noog obviously is unproductive under Kulumsa conditons. Rape, sunflower, and safflower should make good rotation crops.

Miscellaneous crops: Oats cannot compete with wheat or even barley in the Kulumsa area. However, oats appear promising as a fodder crop. Quinoa again performed quite well (4400 kg/ha) and seems to be a good crop if some use can be found for it.

Vegetables: Potatoes, cabbage, and carrots give high yields on good soils. Some potato varieties (e.g. B-4972- M1) will be increased and distributed to model farmers.

Fertilizer trials: Several feritilizer trials were carried out in order to determine the optimum levels of nitrogen and phosphate and to find out the best source and time of application of nitrogen and the most effective method of application phosphate.

Maize, teff, and flax gave no significant positive response to nitrogen and phosphate. Some NP combinations actually reduced the yield of teff. Nitrogen failed to give a significant increase in yield of wheat. Phosphate increased the yield of Kentana Frontana X Mayo 48 by 33 %. But the yield increase of Romany was not significant. The yield of barley was markedly increased by phosphate (by 222%). The yield increase due to nitrogen was negligible.

Urea, ammonium sulfate nitrate, and nitro-chalk were found to be equally good sources of nitrogen for wheat. Application of nitrogen at planting time was as good or better than split or late application. Nitrogen (Urea) applied at different times on maize failed to give significant yield increases.

The most effective way of applying phosphate on wheat was band application. Forty kilos of $P_2 O_5$ applied in the drill row were euqivalent to broadcasting 60 Kg/ha. Mixing the phosphate with the soil was superior to leaving it on the surface of the soil. Lime and the trace elements copper, boron, manganese, and zinc failed to increase yield of wheat when applied with phosphate.

The results of fertilizer trials and observations and of other trials in which fertilizers were applied on parts of the plots have now clearly revealed that failures to demonstrate good yield responses from fertilizer applications at Kulumsa have been largely due to the heterogeneity of the soil. It has been repeatedly shown in 1968 that whenever trials were situated on poor (average) sites the response to phosphate has been remarkable. The only exception was the NP trial on flax. However, on naturally rich sites, the response has been poor. Furthermore, the fixation of phosphate by the soil does not appear to be as great as anticipated. Phosphate must be applied on most soils in the Kulumsa areas in order to get good yields of most crops. However, nitrogen should be applied with caution and always incombination with phosphate.

Cultural practices

Seeding date: Seeding date trials showed that most crops did better when planted early. Thus maize did best when planted in early April; flax, barley and sunflower did best when planted in late June or early July. Even teff (July 12) and chickpeas (Aug. 2) did best when planted early. Wheat varieties reacted differently to time of planting. Romany did best when planted early (June 28), whereas the yields of Kenya 1 and Kent. Fr X Mayo 48 were not influenced much by time of planting. However, their test weights increased with the later plantings . It seems that varieties susceptible to leaf diseases will do better if planted late, whereas resistant varieties should be planted early.

Seeding rate and spacing: It appears that a seeding rate of 125 Kg/ha is sufficient for some wheat varieties while others may benefit from higher seeding rates. The optimum seeding rate for barley (variety Beka) was 125 Kg/ha. Maize gave the highest yield with a spacing of 75X30 cm, sunflower with a spacing of 80x40 cm. and broadbeans with a spacing of 20x5 cm. However, it is questionable if spacing of 20x5 cm.should be recommended for broadbeans, since this would impede cultivation and might accentuate the loss from chocolate spot.

Weed Control

Different hand weeding intensities were compared in wheat, teff, maize, broad-beans and flax. In maize three weedings were most profitable. In wheat, teff, and flax two weedings were profitable, whereas weeding did not pay at all in broad-beans due to the low fertility of the soil. The main advantage of row planting seems to be facilitating early hand weeding.

Most herbicides applied on wheat paid well, the most profitable one (in this trial) being linuron. In barley, due to the low price of barley, only linuron yielded an appreciable profit.

In maize both tested chemicals (atrazine and 2, 4-D ester) were highly profitable and yielded a net profit of $154-173/ha, about the same as for intensive hand weeding.

Due to poor yield, no chemicals applied on broad-beans were profitable. In flax, the yield increase obtained from application of dalapon was highly profitable, although the yield was low. The result demands further investigations on the use of grass herbicides on flax.

TCA reduced the amount of weeds in rape by 85%. The profitability of the treatment cannot be estimated, since the trial was not harvested. Chemical control of Avena species is not profitable at the present level of Avena infestation on Kulumsa farm. The wild oats problem is serious in the project area, however, and every possible measure should be taken to reduce the population of wild oats by careful seed cleaning, cultivation and hand weeding.

Insect Control

Observations indicated that fair control of cutworms on maize can be achieved by post-emergent treatments with DDT or dieldin. The yield reduction caused by cutworms is not known, however.

Four applications of DDT for control of stalkborers yielded a good profit. Fewer applications might be sufficient and more profitable.

Seed-dressing of barley with aldrin reduced the attack from barley fly but did not increase the yield. Barley varieties differ considerably in susceptibility to barley fly attack. Some local varieties seems to have fair resistance.

Disease control

In a seed dressing trial on wheat, remarkably high yield increases were obtained from treatment with mercury. Four different seed lots of different origin were used, among them a purple wheat infested with bunt spores. This disease was controlled completely. The yield increase as an average for all varieties was 32%. The result is surprising, since no seedling or root disease was observed in the field.

In barley, on the other hand, only introduced varieties responded profitably to seed dressing. Mercury-aldrin treatment seemed to have reduced the yield of the local barley more than pure fungicide treatment.

Seed-dressing of maize with mercury caused a yield reduction in Jimma maize and an insignificant yield increase in Asella maize.

Chickpea seeds are prone to rot in wet soils. Seed-dressing with mercury, thiram or quintozen seemed to control the disease to a certain extent.

Forage Crops: Among the perennial forage legumes tested, lucerna(alfalfa) and especially Desomodium appear promising. Alfalfa must be fertilized with phosphate in the Kulumsa area. Among the grasses tested, Nandi Setaria , Colored Guinea (Panicum coloratum), Rhodes grass and Columbus grass have done well. Fodder beet is also well adapted and has given high yields. Among the native grasses tested only Kikuyu grass, Bermuda grass and a Hyparrhenia sp. merit further studies.

Nitrogen and phosphate have given good results on natural pastures. Forty kg. P_2O_5 and 80 to 120 kg. nitrogen per hectare can increase the yield of natural pastures by 200 to 300 %.

RECOMMENDATIONS FOR THE EXTENSION DEPARTMENT

Experiences gained so far indicate that several innovations would greatly help to increase the yield and improve the quality of crops grown in the Chilalo Awraja. These innovations should be disseminated or demonstrated to farmers.

A. Improved varieties to be demonstrated

Wheat: Kentana Frontanax Mavo 48, "Laktana 54", Romany, (LRXN 10-B) An^3, 8156. Farmers should be advised to replace Kenya 1 and their local varieties with the first 2 varieties.

Barley: Zephyr, Proctor, Unitan, Beka, Kenya Research.

Maize: Kitale Hybrids 613B and 632, kitale composite E. The first two are recommended for production.

Teff: DZ-01-354, A-44, DZ-01-386

Flax: Dakota, Redwood

Fodder crops: Fodder beets

B. Fertilizers

Phosphate is generally recommended for areas of north Asella. Nitrogen is used cautiously with phosphate, and also be profitable. Both phosphate and nitrogen must be used south of Asella.

The fertilizer demonstrational trials should be expanded so as to cover as wide an area and soil types as possible.

C. Crop protection

1. The use of clean seed helps in avoiding infestations with noxious weeds and in increasing yields.

2. When current varieties fall susceptible to rusts, they should be replaced with new resistant varieties.

3. Bunt or stinking smut can be controlled by planting healthy seed or by treating the seed with thiram.

4. Flax varieties susceptible to wilt should be replaced with resistant varieties.

5. A good crop rotation is an essential feature of weed control. If grain crops are grown continuously, grass weeds are almost impossible to control. Crop rotation also helps in reducing losses from diseases such as leaf blotch (Septoria trici) of wheat.

6. Proper weeding is a "must" for getting reasonable yields. Maize should be weeded at least three times, which will increase the yield by at least 100% compared to poor weeding. Other crops should be weeded twice.

7. Row planting facilitates the most important first weeding, since weeding can be done by hoe and earlier than plucking by hand. Row planting of maize, sorghum, and beans should be especially encouraged.

8. Herbicides show promise for the future. At present, 2,4-D and atrazine may be recommended for use in maize, MCPA in small grains, and MCPA + dalapon in flax. MCPA and 2,4-D do not control grass weeds.

9. Grain legumes readily fall victims to different insects attacking flower buds, flowers, and pods. Care should be exercised so that adults and larvae of American bollworm and possibly other insects can be detected and treated with DDT before it is too late.

10. If army-worms or locust swarms appear, they should be reported immediately, through the agents to the weed and pest specialist.

PART II DETAILED DATA AND RESULTS OF TRIALS AND OBSERVATIONS

A. Varieties, fertilizers and cultural practices

1. Variety trials and observations

1.1 Wheat

1.1.1 National wheat variety trial

The 1968 national wheat variety trial consisted of 16 varieties - 8 from the 1967 trial, 7 new entries, and one local check. Since the replications were not (inadvertently) randomized, the results could not be analysed statistically. Nevertheless the varietal differences are very striking (Table 1). (LR X N10-B) An^3 was the outstanding variety, followed by 8156 (red grain). The four top varieties are dwarf, Mexican varieties. The new entries performed much better than the entries from the 1967 trial. Azizia which was in first place in 1967 was the worst variety in 1968. This was due to heavy attack by rusts in 1968. This emphasizes the point that one should not rely too much on a single test. Kenya and Setakuri, the local check, performed very poorly, again illustrating that Kenya 1 is a poor variety, actually no better than the local varieties. The trial demonstrates the potential for increasing yield through varietal selection.

1.1.2 Wheat variety trial A

This trial consisted of, mainly, the better varieties tested by the Debre Zeit experiment station for several years. The differences between the varieties are not very striking (Table 2). This is thought to be due to lack of fertilizers (the top-dressing with phosphate did not give good results). Varieties such as 8156, Penjamo 62, and Sonora 63 which give high yields on fertilized soil, did not perform better than Kentana Frontana X Mayo 48 when tested on poor soil. This emphasizes the need for fertilizing experimental plots inorder to reveal the real potential of outstanding varieties.

There was no significant difference in the yields of the first 6 varieties. From this trial and previous observations, Catcher, Fanfare, No. 43, Setakuri, and Prins do not appear to be promising varieties for the Kulumsa area. Although Salmayo has done well in previous trials, it was found to be very easily damaged by dry wind.

1.1.3 Wheat variety trial B

In this trial, promising new entries were compared with varieties that have been tested for several years by the Debre Zeit station. The outstanding variety was (LR X N10-B) An^3. This variety yielded significantly higher than all other varieties except Fr-KAD-Gb. (Table 3). There is no significant difference in the yields of Fr-KAD-Gb, ES, Romany and Nainari 60.

(LR X N10-B) An^3 appears to be a promising variety. It holds first place in the national trial. It was also the second best variety in the 1967 Debre Zeit trial at Kulumsa. The only defects it has are its small seed size and moderate susceptibility to leaf rust.

297, which was an outstanding variety in 1967, is occupying a mediocre position because of susceptibility to stripe rust and dry wind. Kenya 1 again demonstrated its poor performance.

Table 1. Results of the national wheat variety trial, Kulumsa, 1968.

Design: Not randomized, 4 reps
Seeding date: July 15
Seeding rate: 100 kg/ha
Fertilizer: 46 kg/ha P_2O_5 banded, 23 kg/ha N at planting; 46 kg/ha N on Aug. 28
Plot size: 2 m^2

Variety *		Days to maturity	Height cm	Lodging 0–10	Shattering %	Reaction to diseases: Stripe r. %	Leaf r. %	Leaf blotch 0–5	Weight of: 1000 seeds g	1 hectoliter kg.	Yield kg/ha
(LR X N10-B) An^3	(1)	136	86	0	1	-	25	3	26.0	82.8	5920
8156 (red grain)	(1)	120	91	0	3	-	-	3	29.1	78.2	4700
Sonora 63	(1)	114	102	0	5	30	-	4	30.9	77.2	4170
Penjamo 62	(2)	113	105	0	1	10	-	4	30.6	77.0	4160
Tezanos Pintos 57-2830	(1)	112	125	2	3	-	-	2	29.1	76.0	4010
36896 - Ci 542 X yt 54A	(1)	121	110	1	4	25	-	4	28.2	82.4	3810
8156 (white grain)	(2)	114	93	0	5	-	-	4	27.0	74.6	3720
Kenya Frontana X Mayo 48	(1)	134	126	3	0	-	5	2	23.5	78.0	3400
Pitic 62	(1)	126	111	1	0	-	-	4	22.2	76.6	3220
Kentana Frontana X Mayo 48	(2)	120	125	0	1	-	5	3	23.4	73.2	3170
Supremo Kenya X Yaqui 48	(2)	120	126	0	3	-	-	3	30.8	74.6	3160
Salmayo	(2)	114	130	0	2	-	-	2	22.0	69.0	2590
Yaktana 54	(2)	123	123	3	3	-	-	3	21.8	74.2	2330
Kenya 1	(2)	120	125	0	0	75	-	2	26.9	77.0	1950
Setakuri	(3)	115	129	5	0	10	90	2	24.5	60.6	1160
Azizia	(2)	118	120	1	2	-	100	1	18.0	60.4	480

* 1 = new entry, 2 = old entry (1967), 3 = local check

Table 2. Yield, test weight, and agronomic characteristics of 12 varieties of wheat

Design: Randomized blocks, 4 reps
Seeding date: July 15
Seeding rate: 100 kg/ha
Fertilizer: 100 kg/ha triple super Po_4 top dressedon reps I, II, III.
Plot size: 27.3 m^2

Variety	Days to maturity	Height cm	Lodging %	Shattering %	Reaction to diseases			Weight of		Yield 90% DM kg.
					Stripe r. %	Leaf r. %	Leaf blotch (0-5)	1000 seeds g	1 hecto-liter kg	
Sonora 63	120	96	0	4	25	-	5	28.2	79.4	2310
Kentana Frontana Mayo 48	123	118	0	0	-	5	3	30.2	79.6	2300
36896-Ci 542 [illegible] yt 544	135	103	1	6	40	-	4	31.5	82.6	2290
Penjamo 62	119	85	0	3	25	-	4	27.7	79.6	2200
8156 (white grain)	120	84	0	1	-	-	5	23.8	77.8	2200
Pezanos Pintos - 57 - 2830	113	115	0	0	-	-	2	27.2	80.0	2090
Prins	165	107	0	5	-	25	1	34.2	76.5	2050
Catcher	120	108	0	15	-	30	3	27.5	77.4	1960
Salmayo	118	102	0	10	-	-	3	24.6	78.4	1950
Fanfare	121	116	1	12	-	5	3	28.6	76.2	1670
No. 43	120	124	1	13	-	-	4	29.8	77.4	1530
Setaluri	122	127	5	0		100	2	24.9	74.0	1080

Standard error = 0.774, Lsd 5% and 1% = 220 290 kg, CV = 7.7 %

Table 3. Yield, test weight, and agronomic characteristics of 12 varieties of wheat

Design: Randomized blocks, 4 reps
Seeding date: July 15
Seeding rate: 100 kg/ha
Fertilizer: Top dressed with 100 kg/ha triple superphosphate
Plot size: 27.3 m^2

Variety	Days to maturity	Height cm	Lodging (0-10)	Shattering %	Reaction to diseases			Weight of		Yield 90% DM kg/ha
					Stripe r. %	Leaf r. %	Leaf blotch (0-5)	1000 seeds g.	1 hectoliter kg.	
(LR X N10-B) An^3	126	80	0	0	-	35	2	25.6	82.4	3020
Fr-KAD-Gb-514c 4b - 2t - 1b -1t	108	102	0	15	-	tr	4	33.8	77.8	2680
ES	108	115	0	0	-	25	2	31.2	76.6	2490
Romany	123	112	1	0	-	-	1	32.3	81.8	2480
Nainari 60	125	115	0	0	35	5	2	29.2	80.2	2350
Kentana Frontana X Nayo 48	122	113	1	0	-	5	2	24.3	79.4	2180
297	149	106	1	5	50	tr	1	33.4	81.6	1990
Supremo Kenya X Yaqui 48	122	114	0	13	-	-	3	32.6	81.0	1990
Yaktana 54	122	108	1	0	-	-	4	27.0	75.2	1400
Setakuri	123	129	4	0	-	100	2	25.2	73.0	1320
Fronthatch	156	115	1	8	-	-	tr	35.0	74.4	1240
Kenya 1	127	109	1	0	65	5	3	30.0	82.6	1160

Standard error = 1.349, Lsd 5 & 1% = 390 & 510 kg, CV = 13.5 %

1.1.4 Comparison of local with introduced varieties of wheat

In this trial, 5 of the better introduced varieties of wheat were compared with 5 of the more commonly cultivated varieties in Chilalo Awraja. The results show that in general the introduced varieties have a much higher potential of yielding capacity and better resistance to diseases (especially leaf rust) and lodging (Table 4). The Ethiopian wheats (Setakuni, Tikur sindes, and Netch sinde) yielded only about one half as much as the better introduced varieties (only about a third of the best variety - 8156), lodged badly, and were heavily infected by leaf rust.

It is of interest to note that in this trial, which was carried out on a fertile piece of land (note lodging), 8156 performed much better than Kent. Fr X My 48, whereas in another trial (2.1.2) carried out on poorer soil, there was no difference between the two varieties.

1.1.5 Kenya wheat varieties

Seventy one varieties, consisting of commercial varieties and pedigree and mother crops - the cream of the Kenyan wheat selection and breeding work - were obtained from the Institute of Agricultural Research and planted in observation plots. The results are given only for the best 15 varieties (Table 5). Most of the other varieties did not appear promising for the Kulumsa area. Many were extremely late in maturity. Others were tall and lodged badly. Yaqui 50, Primex, No. 43, and Bounty have been tested previously and did not appear especially outstanding. Besides Primex and Bounty have poor quality. Several of the varieties shown in the table did not yield better than Kentona Frontana X Mayo 48, a variety to be released in 1968.

1.1.6 Observation of wheat varieties

Twenty four varieties from Debre Zeit and 3 varieties from Kulumsa were planted in observation plots. Most of these varieties had shown outstanding qualities in the Debre Zeit tests, and it was hoped that some would be advanced to future yield trials. The results, however, were not encouraging (Table 6). With the exception of Humantla Rojo X Pi 62^2, the varieties were not better than varieties already in yield trials, such as Yaktana 54, Romany, and Kent. Fr. X My 48. Even the best variety, Humantla R X Pi 62^2... does not appear promising because of its susceptiility to stripe rust.

1.2 Barley

1.2.1 National barley variety trial

The 1968 national barley variety trial consisted of 6 new entries, 8 old entries, and 2 checks (Table 7). The top 3 varieties were of Ethiopian origin. There is no significant difference in the yields of the first four varieties, thus making Egypt 20 the only introduced variety to stand on a level with the best variety, EZ-02-72.

In spite of heavy fertilization, the yields were generally low. This was partly due to heavy attack by barley fly (Delia arambourgi). 1968 has generally been an unfavourable year for barley at Kulumsa.

Table 4. Comparison of yield and agronomic characteristics of some introduced and local varieties of wheat

Design: Randomized blocks, 4 reps
Seeding date: July 18
Seeding rate: 100 kg/ha
Fertilizer: None
Plot size: 26.6 m^2

Variety 1/		Days to maturity 2/	Height cm	Lodging 0-10	Reaction to 3/ Stripe r. %	Leaf r. %	blotch 0-5	Weight of: 1000 seeds g	1 hectoliter kg	Yield 90 DM kg/ha
8156 (White grain)	(I)	123	86	0	-	tr	4	27.2	79.2	3760
Romany	(I)	121	129	6	-	-	1	30.2	81.6	2610
Kentana /Pont. K Mayo 48	(I)	126	128	3	-	5	2	25.0	80.8	2530
English	(I)	160	137	5	-	25 mr	tr	47.6	74.9	1690
Fronthatch	(I)	153	110	1	-	-	tr	34.7	74.3	1690
Kenya 1	(I)	128	127	5	65	25	1	30.6	82.6	1680
Setakari	(L)	125	131	8	-	100	2	27.0	75.2	1370
Fetch sinde	(L)	125	132	3	-	100	2	26.9	76.4	1320
Filur sinde	(L)	128	124	7	-	100	2	24.3	72.8	1270
Bawde	(L)	155	123	4	65	-	-	38.3	76.5	1260

1/ I = Introduced, L = Local varieties

2/ No. of days from planting to maturity

3/ mr = moderately risistant, tr = trace, - = not observed.

Table 5. Yield, test weight, and agronomic characteristics of the best 15 wheat varieties from Kenya

Seeding date: July 18
Fertilizer: None
Plot size: 5.6 m^2 .1 replicate for the first 4 varieties, 2 reps for the others.

Variety	Maturity 1/	Lodging (0-10)	Stripe rust	Hectoliter weight, kg.	Yield kg/ha
Yaqui 50	E	0	5	78.0	4320
Primex	E	7	tr	78.0	4430
No. 43	E	0	tr	78.0	4140
Bounty	M	0	0	77.8	4460
Trophy	M	0	10	78.6	4150
II - 47-26[2] X No. 58 X II-46-13, II - 58-59. Sel. A	M	1	10	77.8	4060
LR 64 X Son 64, 19008-83E-100 Y - 100M	E	0	0	79.6	4610
Nenco X (Kis. 245-Supr. 51) X (Fr -Fn/Y)2 - 4496 L.S	E	5	0	80.2	4650
Nemax (Kis 245 - Supr.51) X (Fr - Fn/Y)[2]	E	6	0	76.6	3940
Pol. 53 X Lf - Ky, 13019.C	E	5	0	76.6	4040
Expo 63	E	5	0	76.2	3930
CI 8154 - Fr[2]	VE	5	0	75.8	4570
Y 48[2] X K58 X F X Fr X K 350-A.D.9.C.24 X Cb, II-12388-3r-3m-5r. Sel.	M	6	5	77.8	4050
PI 178383 X Omar[3], Cre 7-35, Sel.	E	7	0	76.6	4660
D.58 - 25	M	1	5	81.0	3950
Lentana Frontana X Mayo 48 (check)	M	4	0	79.6	3950

1/ E = early, VE = very early, M = medium

Table 6. Yield and reaction to diseases of 27 varieties of wheat planted in nursery rows
Plot size: 3.2 m^2, one replication

Varieties	Reaction to: Stripe rust	Septoria (Leaf Bl 0-5	eight of 1000 seeds g	Yield g /plot
Humantla Rojo ... Pi 62[2] ... Penjamo 62, II - 11052 - 3[illegible] - 2R - 7[illegible]	85	2	28.6	1264
'Yaktana 54'	-	4	30.7	1149
Romany	-	-	34.6	1132
Kentana Frontana ... Yaqui 48	-	2	25.4	1113
Kenya Frontana ... Yaqui 48	-	2	24.9	1104
Bonza 63	-	1	27.5	1071
Penjamo 62	25	4	29.0	1054
Soncra 64 ... TEPPANainari 60, II - 1889 - 3M - 4T -2Y - 3C	65	2	36.5	1042
Frocor 24 ... Coneta[2] ... Penthatch X Kentana[3] ... Penkenen, 9808 - 4b-4t	-	2	27.6	1024
Tezanos Pintos 57-...830	-	2	27.3	999
8625 (Rio Negro[2]-Redman ...gypt ... Yaqui 50) X Lee Frontana	40	3	33.1	992
Crespo 63	-	3	25.0	979
Tacuari	-	2	25.5	953
Salmayo	-	2	21.6	932
Supremo Kenya ... Yaqui 48	-	2	23.3	922
Fronthatch	-	4	31.0	857
Gaboto	-	1	33.6	816
Carazinho	-	1	22.0	784
Fanfare	25	-	25.8	760
M.M.B. 184	-	-	26.9	669
Humantla Rojo	-	-	32.4	633
DL-04-649	-	5	22.5	629
Kenya 1	-	1	20.8	627
Nadadores 63 II-850-7...-10... 2R-II -2Y	65	2	28.3	623
Pi 62 - Chris sib ... Son 64	65	3	27.6	603
(Ly 54 ... P 10-B) Y54	85	2	22.3	593
	85	2	19.8	553

Table 7. Result of the national barley variety trial, Kulumsa, 1968.

Design: Randomized blocks, 4 reps.
Seeding date: July 12
Seeding rate: 100 kg/ha
Fertilizer: 46 kg/ha P_2O_5 planting time, 46 kg/ha N on Aug. 16
Plot size: 4 m^2

Variety 1/		Days to maturity	Height cm	Lodging 0-10	Reaction to: Scald 0-5	Reaction to: Barley-fly 2/ %	Weight of: 1000 seeds g.	Weight of: 1 hectoliter kg	Yield kg/ha
DL-02-72	(N)	105	114	7	5	2.3	38.1	66.0	2690
DL-02-305	(N)	104	108	9	3	5.8	35.5	62.8	2410
Aruso	(C)	107	107	7	5	3.6	32.1	62.8	2350
Egypt 20	(O)	102	77	4	1	2.1	34.2	59.2	2240
Atlas Kindred 2	(O)	105	89	2	tr	2.8	26.2	56.4	2090
Arzo F_4	(N)	104	98	6	3	5.7	24.3	55.2	2010
Firlbecks III	(O)	110	88	0	3	5.7	23.1	63.8	1750
Unitan	(O)	112	111	2	1	1.2	26.6	60.0	1700
Egypt 5	(O)	106	104	4	2	6.8	28.9	53.6	1500
Beka	(O)	107	90	1	3	2.4	23.0	62.4	1460
Bonus	(N)	113	84	0	3	7.5	22.6	64.4	1220
DO	(N)	103	103	5	2	2.6	30.4	60.6	1220
Egypt 9	(O)	104	107	4	3	3.6	30.6	60.0	1080
Hannchen	(N)	122	86	1	4	5.7	18.8	61.4	930
Erie	(O)	108	90	1	4	2.7	22.9	62.0	600
Birgitta	(C)	117	81	1	5	5.9	24.6	63.4	1230

Standard error = 1.931, Lsd 5 & 1% = 550 & 730 kg, CV = 23.4%

1/ N = New entry, O = Old entry, C = Checks

2/ % of plants attacked.

1.2.2 Barley variety trial A

Eleven of the best varieties of barley from previous tests were again tested in one trial. The differences in yield were not impressive (Table 8). With the exception of the last variety, Saxonia, there was no significant difference in the yields of the different varieties. This trial again demonstrates that under the environmental conditions of 1968, the introduced varieties were not superior to the local check - Aruso.

1.2.3 Malting barley micro-trial

Several trials have demonstrated that as a feed grain barley may not be able to compete with wheat in the Kulumsa area. It is worthwhile, however, to search for high yielding, malting barley varieties which may be more profitable than feed barley.

Fifteen varieties of malting barley, supplied by the Institute of Agricultural Research, were compared (Table 9). The outstanding variety was Atlas 57, which yielded significaly higher than all other varieties. Mosane, Research and Cambrinus were the poorest varieties. The other varieties were not significantly different from one another.

1.2.4 Comparison of local with introduced varieties of barley.

Four of the better introduced varieties of barley were compared with 4 of the more commonly cultivated barley varieties in Chilalo Awraja. This trial again demonstrated that the introduced varieties were not superior to the two-row local variety - Aruso (Table 10). However, Aruso and the introduced varieties (all except Unitan two-row) were better than the six-row local varieties - muga, black and white barley. These latter varieties are normally grown at higher altitudes.

1.3 Teff

1.3.1 National teff variety trial

Fifteen varieties were tested in the national teff variety trial. Four of these were old entries, 10 were new entries, and one was a local check. The best varieties were DZ-01-354, A-44, DZ-01-200 and DZ-01-386 (Table 11). Since there is no significant difference in the yields of these varieties, and since A-44 and DZ-01-386 are purple-seeded varieties (hence of lower value), the outstanding variety was DZ-01-354 . DZ-01-200 did not yield significantly higher than the next 4 varieties in the table.

1.4 Maize

1.4.1 Eastern African maize variety trial

This co-operative, uniform trial, organized by the Maize Breeding Station, Kitale, Kenya, was again carried out at Kulumsa. The trial consisted of 15 hybrids and varieties from Eastern Africa and from Ethiopia. The results are presented in Table 12.

Because of great variation from plot to plot, the trial failed in providing critical comparision among the hybrids and varieties. Thus there was

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Table 8. Yield, test weight and agronomic characteristics of 11 varieties of barley.

Design: Randomized blocks, 4 reps
Seeding date: July 17
Seeding rate: 100 kg/ha
Fertiliser: None
Plot size: 26.6 m^2

Variety	Days to maturity	Height cm	Lodging 0-10	Reaction to: Scald 0-5	Reaction to: Leaf rust %	Weight of: 1000 seeds g.	Weight of: 1 hectoliter kg.	Yield kg/ha
Beka	114	90	0	4	5	29.3	63.4	2320
Unitan	126	118	0	1	5	33.8	59.4	2300
Aruso	106	109	5	5	10	32.9	60.8	2270
Zephyr	117	92	0	5	-	27.0	62.6	2160
Firlbecks III	121	97	0	5	5	28.9	65.4	2090
Mari	95	69	1	5	-	30.7	69.4	2060
Birgitta	118	84	0	5	-	29.9	62.2	2040
5650	115	85	0	5	5	30.5	61.6	1980
Kenya Research	123	101	3	1	-	33.2	63.8	1940
Proctor	126	93	1	4	tr	26.9	63.0	1920
Saxonia	123	88	0	5	tr	24.2	63.4	1850

Standard error = 1.559, Lsd 5% & 1% = 450 & 610 kg, CV = 15%

1.2.3 Barley variety trial B

Eight promising varieties from the 1967 Debre Zeit trials at Kulumsa (mostly introductions from Mexico) and four other check varieties were tested in a second trial. The varieties tested were: P 401, 1922, 56387, Athenais, 071, P 425, Dickson, Aromesa, Beka, Birgitta, D2-02-72, and Aruso. The Ethiopian varieties D2-02-72 and Aruso again did much better than the introduced varieties, most of which did extremely bad under the heavey attack from barley fly and the poor fertility of the plot. However, these varieties should be tested again under better conditions.

Table.9. Results of the national malting barley micro trial, Tulumsa, 1968

Design: Randomized blocks, 3 reps
Seeding date: July 23
Seeding rate: 100 kg/ha
Fertilizer: 46 kg/ha P_2O_5 banded at planting time
Plot size: 2 m^2

Variety	Days to 1/ maturity	Height cm	Lodging (0-10)	Reaction to diseases:			Weight of		Yield kg/ha
				Scald (0-5)	Net blotch (0-5)	Leaf rust %	1000 seeds g	1 hectoliter kg	
Atlas 57	111	100	2	-	tr	25	35.5	60.8	4470
Bido	114	90	0	5	-	-	29.2	65.2	3350
Pallas	114	86	0	3	1	15	24.0	58.4	3350
Zephyr	110	95	0	4	2	tr	27.8	59.6	3250
Paris Waldric	110	90	0	2	2	5	26.2	62.2	3090
Aika	115	90	0	5	-	-	25.6	61.4	2990
Johnna	113	87	0	5	-	-	26.5	61.6	2990
Beka	104	95	0	5	tr	-	26.9	61.2	2700
Kenya Research	112	102	2	1	2	5	29.2	59.4	2690
Proctor	112	90	0	2	-	10	29.4	60.8	2530
Europa	112	84	0	tr	1	-	25.7	60.6	2520
Saxonia	110	87	1	4	0	0	25.6	59.8	2510
Rosine	111	89	0	5	0	tr	24.0	62.4	2474
Research	112	106	1	2	1	-	27.8	58.0	2320
Cambrinus	111	95	0	3	2	-	26.8	58.6	2110

Standard error = 2.923, Lsd 5% & 1%=850 & 1140 kg, CV = 7.5%

1/ Number of days from planting to maturity

Table 10. Comparison of introduced and local varieties of barley for yield, test weight, and agronomic characteristics

Design: Randomized blocks, 3 reps
Seeding date: July 17
Seeding rate: 100 kg/ha
Fertilizer: None
Plot size: 26.0 m^2

Variety 1/		Days to 2/ heading	Reaction to:		Weight of		Yield
			Scald (0-5)	Leaf rust %	1000 seeds g	1 hectoliter kg	kg/ha
Aruso	(L)	64	2	30	36.5	65.6	2230
Unitan	(I)	83	tr	25	32.9	64.4	2170
Beka	(I)	87	3	40	31.8	71.4	2110
Zephyr	(I)	87	2	10	28.5	70.2	1630
Birgitta	(I)	87	4	25	31.0	69.2	1460
Muga	(L)	86	1	40	36.4	64.8	1190
Black barley	(L)	83	tr	50	34.2	67.6	1140
White	(L)	86	-	85	33.6	65.4	880

1/ I = Introduced, L = Local

2/ No. of days from planting to heading

Table 11. Results of the national teff variety trial, Mulumsa, 1968

Design: Randomized blocks, 4 reps
Seeding date: July 25
Seeding rate: 20 kg/ha
Fertilizer: 40 kg/ha P_2O_5 + 40 kg/ha N at planting time
Plot size: 10 m^2

Variety 1/	Days to heading	Height cm	Lodging (0-10)	Weight of: 1 hectoliter kg	Weight of: 2/ straw kg/ha	Grain Yield kg/ha
DZ-01-354 (N)	62	94	8	84.4	6470	2890
A-44 (O)	53	75	7	84.2	7650	2660
DZ-01-200 (N)	67	98	8	85.2	7110	2570
DZ-01-386 (N)	50	66	8	83.6	5770	2530
DZ-01-257 (N)	61	97	6	85.4	5930	2320
A-170 (N)	61	94	5	85.2	6160	2300
DZ-01-238 (N)	65	102	5	85.6	6320	2230
Local check (C)		99	5	85.6	6770	2060
DZ-01-196 (O)	71	94	5	85.8	7530	1790
DZ-01-248 (N)		100	4	85.6	6250	1700
DZ-01-146 (N)		97	4	86.4	7400	1610
DZ-01-186 (O)	52	81	2	84.8	7590	1530
A-49 (N)		100	5	84.4	6390	1420
DZ-01-197 (N)		97	5	86.8	6530	1360
A-53 (O)		97	4	84.0	6530	1010

Standard error = 1.314, Lsd 5% & 1% = 370 & 500 kg, CV = 13.1%

1/ N = new entries, O = 1967 entries

2/ Rep. I only

Table 12. Results of the Eastern African maize variety trial, Mulumsa, 1968

Design: Simple lattice, 3 reps
Seeding date: April 11
Spacing: 80 X 25 cm
Fertilizer: 60 kg/ha P_2O_5 on April 11, 80 kg/ha N (urea) on June 26.
Plot size: 4 m^2

Variety	Days to maturity 1/	Ear height cm	No. of lodged plants/ plot	No. of plants/ plot	No. of usable ears/ plot	Weight of: 1000 seeds g	Weight of: hectoliter kg	Yield 90% DM kg/ha
Kitale Hybrid 613 B	235	156	4	24	27	454	73.4	12,170
Kitale composite E	240	159	2	23	27	486	68.0	10,690
Ukiriguru composite A	245	141	2	26	29	467	66.8	10,680
Kitale Hybrid 632	235	139	4	24	30	379	70.1	10,620
Kitale Hybrid 511	230	96	6	22	27	440	74.8	9,500
Zambia local composite	227	129	4	29	29	462	67.8	8,200
Jimma (Jimma)	227	138	3	24	28	385	73.5	8,180
Jimma (Alemaya)	226	130	6	24	23	388	71.2	8,080
Local (Uteya)	218	109	5	26	34	313	74.5	7,950
Embu composite I	225	99	4	23	25	325	73.7	7,900
S.R. 52	218	108	3	22	22	462	63.8	7,800
Embu composite II	218	96	3	22	28	335	76.0	7,150
White star	216	81	7	22	24	302	72.9	6,290
Illonga composite	243	110	4	24	27	322	73.6	5,940
Katumani V X Kat. VI	189	61	5	25	26	376	74.5	5,500
Ashari composite	220	124	4	24	24	301	68.6	5,120

1/ Number of days from planting to maturity

Lsd 5% = 2960 kg. (analysed as randomized blocks), CV = 21.3%

no significant difference in the yields of the first 5 entries. Even if the trial lacks precision, it is worthwhile pointing out that H 613 B is again outstanding in its yielding capacity, that some composite varieties, such as Kitale Composite E, may compete favourably with the best hybrids, and that under proper husbandary maize is highly productive under the conditions of the Kulumsa area. The tall, late hybrids and varieties gave the highest yields.

1.5 Oats

1.5.1 Oats variety trial

Eight varieties of oats were included in this trial. All Swedish varieties were so thoroughly devastated by crown rust that they were not worth harvesting. Suregrain from Kenya gave the highest yield, 2810 kg/ha (Table 12a). However, it does not seem that even Suregrain can compete with wheat in the Kulumsa area.

The Swedish varieties which failed to give measurable yield were Nina, Linda, Sorbo, No. 16648 and No. 16646. Some Swedish varieties(Oats Nip, No. W 16090) had done fairly well previously when attack by crown rust was not so severe.

Since oats cannot compete with wheat or even barley as a grain crop, they should in the future be tested only as a fodder crop.

Table 12a. Yield and other data for 3 varieties of oats.

Design: Randomized blocks, 4 reps.
Seeding date: July 18
Seeding rate: 100 kg/ha
Fertilizer: None
Plot size: 26.6 m^2

Variety	Days to maturity 1/	Height cm.	Weight of: 1000 seeds g	Weight of: Hectoliter kg	Yield kg/ha
Suregrain	155	114	34.9	53.8	2,810
Lampton	153	138	26.7	44.4	1,890
Alamo	148	143	25.2	46.0	1,090

1/ Number of days from planting to maturity

1.6 Sorghum

1.6.1 National sorghum variety trial

The national sorghum variety trial consisted of 21 entries - 20 selections from the college of Agriculture, Alemaya, and one local selection from Kulumsa. Most of the varieties proved to be too late and unproductive under the conditions of Kulumsa. The highest yield was obtained from the local check (6890 kg/ha). Only three other selections gave more than 40 quintals per hectare (Table 13). Thirteen selections gave less than 10 qt/ha, 8 of which yielded less than 3 qt/ha.

With favourable moisture during the small rains, hybrid maize appears to be a better crop than sorghum for the Kulumsa area. Bird damage is an additional deterrent to the production of sorghum.

Table 13. Result of the national sorghum variety trial Kulumsa 1968

Design: Randomized blocks, 4 reps
Seeding date: April 3, 1968
Spacing: 75 cm. X 15 cm
Fertilizer: 160 kg/ha of 18:47·0 at planting, 57 kg/ha N on June 29
Plot size: 9 m^2

Variety/selection	Days to heading	Height cm	Weight of 1000 seeds	Yield kg/ha
Local Kulumsa	150	232	22.2	6,890
67-AS Adv. 0-10	138	210	22.7	5,670
67-AS Adv. 0-122	137	206	21.0	5,170
67-AS Adv. 0-125	167	325	22.0	4,580
67-ASO-A-D-5	165	192	21.3	3,900
67-AS Adv. 0-60	167	285	23.3	3,870
67-AS Adv.0-32	169	305	20.4	3,070
67-ASO-A-D-73	174	176	19.2	2,420
67-AS Adv.0-44	173	267	40.4	940
67-ASO-A-D-9	157	245	20.7	380
67-ASO-A-D-77	180	273	23.3	340
67-ASO-A-O-69	156	271	25.1	320
67-ASO-A-O-78	157	240	25.8	320

1.7 Pulses

1.7.1 Comparison of different grain legumes

Different species and varieties of grain legumes were compared in one trial in order to identify the most productive or valuable grain legumes for use in rotations in the Kulumsa area. The results are presented in Table 14 a.

The most productive legume was lupine. This legume has given good results in previous tests, too. Unfortunately, its monetary value is low at present because it is not used either as a grain legume (although it is used as such in Gojam) or as a fodder crop by Chilalo farmers. The next highest yield (1730 kg/ha) was given by horse-bean. In terms of monetary value the bean, Bure Boloke, gave the highest return, followed by horse-bean and lentils.

Two replications were fertilized with phosphate (46 kg P_2O_5/ha applied in the row). The different species (even varieties) of pulses gave varying responses to the phosphate. Bean, soya-bean, lentil #2, and lupine gave fair, although not impressive, positive responses (Table 14 b). On the other-hand, the fertilizer markedly reduced the yields of peas, #4, and vetch both of which lodged badly. Due to the small number of replications nothing definite can be said about the response of the different pulses to phosphate.

Table 14a. Comparison of different pulses for yield and other characterstics

Design: Split plot, 4 reps. Main plots species, subplots = varieties
Seeding date: Chickpeas, Aug. 2, others July 16
Fertilizer: 46 kg/ha banded on reps II & IV
Plot size 18 m^2

Crop and variety	Days to maturity 1/	Hectoliter wt., kg	Yield kg/ha	Value $/100kg	Value $/ha
Chickpea					
Grao preto	141	75.0	1,270	12	152.40
IZ-10-8	129	77.8	1,160	14	162.40
Bean (Bure Boloke)	108	78.0	1,400	20	280.00
Horse bean (CS 42/66)	126	78.6	1,730	13	224.90
Soyabean (X B/2)	134	73.0	670	30	201.00
Lentils					
# 2	110	81.0	570	25	142.50
# 3, Alemaya	164	82.8	890	25	222.50
Lupin-white giant	-	74.4	2,110	10	211.00
Peas					
# 4, Asella	127	77.6	1,210	15	181.50
CS 70/66	122	77.8	1,460	15	219.00
Vetch	-	83.6	1,560	13	202.80

1/ Number of days from planting to maturity.

Table 14b. The effect of phosphate on yield of different pulses.

Fertilizer: 46 kg/ha P_2O_5 applied in the row with seeds.
Replications: 2 fertilized, 2 unfertilized.

Crop & variety	No fertilizer (a) kg/ha.	Fertilized (b) kg/ha	Difference b-a kg/ha
Chickpeas			
Grao Preto	1,387	1,446	+ 59
LL-10-8	1,094	1,218	+124
Bean, bure boloke	1,296	1,504	+208
Horse bean, CS 42/66	1,769	1,680	-109
Soybean, X b/2	532	804	+272
Lentils			
# 2	415	732	+317
# 3, Alemaya	975	805	-170
Lupin, white giant	1,970	2,253	+283
Peas			
# 4, Asella	1,512	1,011	-501
CS 70/66	1,486	1,437	- 49
Vetch	1,927	1,188	-739

1.7.2 Chickpea variety trial

Eleven varieties were tested in this trial. There were no big differences in the yields of most of the varieties. There is no significant difference in the yields of the first six varieties, all of which appeared to be good varieties. No. 170-1, LL-10-10, and C410 appear especially promising varieties (Table 15). Grao Preto, a late variety, did not do well in 1968 because of shortage of rain in October. Two of the replications were fertilized with phosphate at planting time. There was no response to the fertilizer. The average yield of the fertilized replications was higher by only 24 kg than the average of the unfertilized replications.

1.8 Oil seed crops

1.8.1 Comparison of different oil seed crops

Different species and varieties or selections of oil seed crops were compared in one trial in order to determine the best oil seed crop that could be used in rotations in the Kulumsa area (Table 16).

Since the plot on which the trial was carried out turned out to be very unfertile, the plants were stunted and the yields were generally low. Nevertheless the trial was very informative with respect to revealing the comparative performance of the oil crops on poor soil. Thus flax, safflower, and oil radish did fairly well on the poor soil, and their yields were not increased by top dressing with phosphate. On the otherhand, rape and crambe obviously cannot be grown profitably on poor soil. Noog was generally poor and cannot compete with the other oil seed crops in the Kulumsa area.

Table 15. Yield and other data for 10 varieties of chickpeas

Design: Randomized blocks, 4 reps

Seeding date: August 2

Spacing: 40 x 10 cm

Fertilizer: 46 kg/ha P_2O_5 on reps I & III

Plot size: 23.6 m^2

Variety	Days to maturity 1/	Weight of:		Yield kg/ha
		1000 seeds g	hectoliter kg	
No.-170 ≠ 1 (Alemaya)	128	343.4	78.2	2380
DZ-10-10 (Debre Zeit)	140	277.2	76.6	2260
No.-102 - ≠ 3 (Alemaya)	123	160.7	78.8	2260
No. 11-67 (local)	129	139.8	79.0	2250
C 217/3 (Pakistan)	138	151.8	79.0	2200
C 410 (Pakistan)	132	163.9	78.8	2200
DZ-10-8 (D.Z.)	136	239.4	75.6	1810
Grão Preto (F.A.O)	150	271.2	74.4	1750
DZ-10-3 (D.Z.)	125	148.8	79.0	1600
DZ-10-2 (D.Z.)	130	131.5	78.4	1250

Standard error = 1.385, Lsd 5% & 1% = 400 & 540 kg, CV = 13.9%

1/ Number of days from planting to maturity

The trial demonstrated that flax is definitely the choice for poor soils. Safflower may also be considered as another useful crop. Rape and crambe, if planted on naturally rich or fertilized soils, are expected to give high yields. Another promising oil crop, not included here because of its size, is sunflower.

Table 16. Yield of different oil seed crops tested in one trial

Exptl. design: Randomized blocks, 4 reps
Seeding date: July 19
Spacing: Flax 20 cm, others 40 and 60 cm between rows
Seeding rate: 25 kg/ha
Fertilizer: Reps I & IV top dressed with 46 kg/ha P_2O_5 on August 7
Plot size: 10.9 m^2

Crop	Variety	Yield			
		Rep. I & IV (a) (fertilized) kg/ha	Rep. II & III (b) (unfertilized) kg/ha	Difference a - b kg/ha	Average of 4 reps kg/ha
Flax	CS 26/66	825	840	15	830
	Redwood	970	940	30	960
Rape	Local	700	-	700	350
Noog	No. 3-67	240	430	-190	330
	No. 1-67	355	340	15	350
Crambe	from Debre Zeit	865	100	765	480
Safflower	Asella	800	900	-100	850
	Aklilu	810	880	-70	850
Oil raddish	from Germany	670	750	-80	710

1.8.2 Flax variety trial

Three introduced varieties and five local selections of flax were tested (Table 17a). Although there was no really outstanding variety, the trial helped to point out a significant difference between the introduced varieties and the local selections. Many plants among the local selections wilted and died in replicates 1 and 2. The introduced varieties Dakota, Redwood, and Marine 62 proved to be highly resistant to the disease - presumably Fusarium wilt. Thus when the yields were compared over the four replications, the varieties or selections that showed resistance tended to yield higher than those that were susceptible (Table 17a & b). However, comparison of the varieties in only replicates 3 and 4, where there was almost no incidence of disease, reveals that the introduced varieties were not superior to some of the local selections.

Since the disease has been observed to be common south of Asella, where most of the flax in Chilalo is grown, the resistant varieties, Redwood and Dakota, may have a distinct advantage over the local, susceptible flax "varieties".

Table 17a. Yield, test weight, and agronomic characteristics of 8 varieties and selections of flax

Design: Randomized blocks, 4 reps
Seeding date: July 19
Seeding rate: 25 kg/ha
Fertilizer: None
Plot size: 28.4

Variety	Days to maturity 1/	Height cm	Wilt 2/ 0-10	Weight of: 1000 seeds g	Weight of: hectoliter kg	Yield kg/ha
Dakota	128	74	0.0	4.7	68.6	870
Redwood	129	72	0.0	4.9	65.4	790
'Local flax'	132	50	3.5	3.8	67.8	730
Marine 62	126	75	0.0	5.0	67.4	720
DZ-07-6	128	72	0.0	4.5	67.8	710
CS 36-66	136	53	4.5	4.3	67.0	670
CS 26-66	130	47	7.5	4.5	66.0	470
CS 38-66	131	47	8.5	4.0	68.0	390

1/ No. of days from planting to maturity

2/ Average of worst 2 replications. 0 = no wilt, 10 = all plants wilted.

Table 17 b. Comparison of yields of flax varieties and selections when grown on Fusarium - free and infested plots

Reps I&II Infested with Fusarium
III&IV not infested with Fusarium

Variety	Reps I&II (1) kg/ha	Reps III&IV (2) kg/ha	Difference (2-1) kg/ha	Wilt rating (0-10)
Dakota	780	959	179	0
Redwood	747	834	87	0
Local flax	716	978	262	3.5
Marine 62	663	778	115	0
DZ-07-6	684	742	58	0
CS 36-66	387	962	575	4.5
CS 26-66	146	801	655	7.5
CS 38-66	136	640	504	8.5

1.8.3 a Sunflower variety trial

Among the 10 varieties tested, three - Hesa, population 158, and Nazera improved - did fairly well with yields of above 1800 kg/ha (Table 18). However, the yields of the first 6 varieties were not significatly different from each other.

Although the sunflowers grew luxuriantly, they did not yield as high as expected due to abundant stem breaking caused by stem rot (Sclerotinia Sclerotiorum) and probably also due to the strong, dry November wind. The Kenyan varieties performed poorly.

Table 18. Yield, test weight, and agronomic characteristics of 10 varieties of sunflower

Design: Randomized blocks, 4 reps
Seeding date: July 3
Spacing: 80 x 20 cm, 4 rows
Fertilizer: 47 kg/ha P_2O_5 on July 3
Plot size: 64 m^2

Variety	Days to maturity 1/	Height cm	Lodging %	Weight of 1000 seeds g	Yield kg/ha
Hesa (Balo)	153	207	15.6	49.8	1860
Population 158 (Germany)	160	207	26.4	56.3	1820
Nazera improved (FAO)	166	233	32.9	79.8	1800
Yugoslavia grey	156	208	19.3	50.4	1550
No. 4 (Alemaya)	180	260	20.0	61.9	1520
? (Alemaya)	168	243	22.7	75.4	1510
Russian black	170	244	31.8	48.0	1380
Kenya black	177	288	28.7	65.3	1280
Kenya grey striped	182	285	15.8	71.4	1190
Kenya white	180	308	10.9	61.4	1080

Standard error = 1.528 Lsd 5% & 1% = 440 & 600 kg, CV = 20.4,
1/ Number of days from planting to maturity

1.8.3 b. Observation of sunflower varieties

A total of 110 varieties (62 from Germany, 26 from Russia, 13 from the U.S.A, and 9 from Awasa farm), originating from most of the major sunflower growing countries, were planted in nursery rows to test their adaptability to the Kulumsa area. Most of them appeared to be of little value for commercial production. Many had very small heads; others were too late or too early to be productive. Several had nice heads, but the seeds were only empty shells. Seed was saved only from the nineteen promising varieties listed in Table 19.

Table 19. Names and origin of sunflower varieties selected from observation plots.

Variety		Source
D 329/67	Advance	Canada
D 335/67	Slovenska Siva	Kosice, CSR
D 405/67	Szabolcsi	" "
D 405/65	Intermedius	" "
D 339/67	Barnaul'skij 1501	USSR
D 351/67	Saratovskij 169	"
D 336/65	Vniimk 1646	"
D 436/65	Cernjanka 66	"
D 441/66	Kustanajskij 91	"
K 736	Rostov region	"
K 2096	Kustanajskij 91	"
D 346/67	-	Portugal
D 363/66	Iregi Naproforgo	Hungary
D 383/65	S-R	"
D 1066/67	Mezohegyesi Cirmos	"
D 365/67	Ostsonne	Germany
D 371/66	D - 4/1	Yugoslavia
D 428/67	Fuksinka 10	Romania
8975/64	Idanov 8281	"

1.8.4. Observation of soya-bean varieties

Five of the best varieties from the 1967 trials were tested in 1968 (Table 20). Even though they were fertilized, the yields were again low, 750 kg/ha being the highest yield. This is a slight improvement over the results obtained in 1967 when the yields of these varieties ranged from 400 - 560 kg/ha.

Five other German varieties were tested in observation plots. Two varieties, Gaterslebener Stamm No. 8915/67 and 9166/67, yielded 420 kg/ha each. The other varieties yielded less than 400 kg/ha.

Table 20. Yields of 5 varieties of soya-bean planted in observation plots at Kulumsa in 1968

Seeding date: July 11
Spacing: 50 cm X 5 cm
Fertilizer: 46 kg P_2O_5/ha in the row
Plot size: 15.2 m^2, 1 rep of Hardee, 2 reps of the other varieties.

Variety	1000 seed weight g	Hectoliter wt. kg	Yield kg/ha
Hardee-U.S.A.	149.3	65.6	750
X B/2 - Kenya	144.2	-	670
B 7/4 - Kenya	142.9	-	450
Hill - U.S.A.	110.9	71.6	440
H 1/3 - Kenya	167.6	-	380

1.9 Observation of different crops

Yields obtained from observation or multiplication plots of some crops are presented in Table 21. Quinoa (Chenopodium quinoa) seems to be well adapted, giving yields upto 44 quintals per hectare. An observation plot of row-drilled and broadcast teff showed some advantage in favour of row-drilling. It seems that there is no harm in row-drilling teff as long as the rows are narrow (15-20 cm) and the seeds are not covered too deep.

Table 21 Yields of some crops planted in observation plots.

Seeding date: 1 and 2, August 2; 3, July 26; 4, August 1.

Crop	Variety	Size of plot m^2	Yield kg/ha
1. Quinoa, white	509	368	3890
" , white	653	252	2220
" , red	531	276	4490
2. Fenugreek	Local	344	1480
3. Crambe	from Debre Zeit	461	780
4. Teff			
row-drilled	A-44	280	2190
broadcast	A-44	286	2000
5. Oats	Alamo	355	2870
"	Local sel.	51	830
6. Chickpeas	Grao Preto	210	1810
"	D2-10-12	325	1690

1.10 Vegetables

1.10.1 Observation of different vegetables

Several vegetables were planted in observation plots in order to test their adaptation to the Kulumsa area (Table 22). Potatoes, cabbage, carrots, beans and peas did remarkably well. Potatoes (B-4972-M1) and cabbage (Copenhagen)

gave more than 50 tons per hectare. One variety of cauliflower – Snowdrift – did quite well, while two other varieties – Super Snowball and especially Gt. St. Valentine–were not well adapted. Tomatoes were directly seeded in July, and in spite of the dry October, variety Moneymaker produced a substantial amount of small fruits. The beans and peas appeared so promising that they were harvested for seed.

Table 22. Yields of some vegetables planted in observation plots at Kulumsa in 1968.

Planting date: 1, June 27; 2 and 3, July 10; 4-9, July 4.
Spacing: 1, 80 x 50 cm; 2 and 3, 40 x 25 cm,
Fertilizer: None

	Vegetable	Variety	Fresh weight kg/ha
1.	Potatoes	B - 4972 - 11	52,440
		B - 5517 - B_1	41,560
		B - 5513 - L_1	37,250
		B - 5504 - B4	47,580
		B - 4972 - L	32,120
2.	Cabbage	Copenhagen	52,270
		Danish Ballhead	20,670
		Jersey Wakefield	26,720
3.	Cauliflower	Snowdrift	4,590
4.	Onion	-	7,050
		Early Yellow Cape Flat	2,970
5.	Chives		4,080
6.	Carrots	Chantenay	19,590
		Early Market	23,940
7.	Cucumber	Cool & Crisp	6,770
8.	Beans	Bosch	1,640 1/
		The Prince	5,200 1/
9.	Peas	Senator	2,674 1/

1/ Weight of dry seed

2. FERTILIZER TRIALS

2.1 Rate of phosphate and nitrogen application

2.1.1 Rate of phosphate and nitrogen application on wheat

Since nitrogen and especially phosphate are the two major nutrients which limit yields of wheat in Chilalo Awraja a trial was carried out to ascertain the optimum combination of the two nutrients. The results are presented in Table 23 a. A summary of the nigrogen and phosphate effects are presented in Table 23 b.

Kentana Frontana X Mayo 48 gave no significant response to nitrogen. However, it gave very good response to phosphate, 40 kg P_2O_5/ha yielded 820 kg/ha (33.2%)more than without phosphate. In this trial there was no increase in yield by raising the phosphate level over 40 kg/ha. Romany was adversely affected by the higher rates of nitrogen. There was a gradual decrease in yield as the level of nitrogen was increased. The reduction in yield was significant with 80 kg/ha N. Although Romany showed some response to phosphate, the increase in yield was not significant. There was no nitrogen x phosphate interaction. It is of interest to note that Romany yields much better than Kt.Fr. X My 48 in the absence of phosphate, whereas the yields of the two varieties are comparable when fertilized with phosphate.

One replication was not harvested because of extremely bad lodging even in the unfertilized plots. The plots could not be separated apart.

Table 23 a. The effect of phosphate and nitrogen on yield and test weight of wheat.

Design: Split - split plot, 4 reps. Main plot = varieties, subplot . P04, sub- subplot = nitrogen
Seeding date: July 12
Seeding rate: 100 g/ha
Plot size: 15.6 m^2 (net)

Treatment		KENTANA FRONT X MAYO 48			ROMANY		
P_2O_5 kg/ha	N kg/ha	Lodging 0-10	1000 seed weight, g	Yield kg/ha	Lodging 0-10	1000 seed weight, g	Yield kg/ha
0	0	0	28.1	2580	0	35.3	3370
0	40	0	28.2	2470	0	34.2	3030
0	60	0	27.6	2470	0	34.0	3020
0	80	0	27.3	2300	0	38.5	2900
40	0	0	29.0	3360	1	32.3	3390
40	40	0	29.1	3420	2	34.1	3460
40	60	0	30.0	3070	3	33.7	3360
40	80	1	28.1	3320	2	33.7	3270
60	0	0	29.7	2850	1	32.0	3510
60	40	0	28.0	3040	1	32.9	3310
60	60	1	27.7	3070	2	32.6	3210
60	80	2	28.2	3030	3	33.4	3180
80	0	0	29.7	3120	1	34.8	3320
80	40	2	28.3	3400	5	32.5	3340
80	60	2	26.3	2950	5	33.7	3080
80	80	2	27.9	3340	6	31.7	2880

Table 23 b. Average yields of Romany & Kent Fr. X Mayo 48 at one level of P_2O_5 or N and at all levels of the other nutrient.

Treatment		Lodging	1000 seed	Yield	Yield difference from no treatment	
P_2O_5 kg/ha	N kg/ha	0–10	weight, g.	kg/ha	kg/ha	%
		R O M A N Y				
-	0	1	33.6	3400	-	-
-	40	2	33.4	3290	-110	-3.2
-	60	2	33.6	3170	-230	-7.3
-	80	3	34.3	3060	-340	-10.0
0	-	0	35.5	3080	-	-
40	-	2	33.5	3370	290	+9.4
60	-	2	32.7	3300	+220	+7.1
80	-	4	32.2	3160	+ 80	+2.6
		[illegible]				
-	0	0	29.1	2980	-	-
-	40	0	28.4	3080	+100	+3.4
-	60	1	27.9	2890	-90	-3.0
-	80	1	27.9	3020	+40	+1.3
0	-	0	27.8	2470	-	-
40	-	0	29.1	3290	+820	+33.2
60	-	1	28.4	2990	+520	+21.1
80	-	1	28.5	3200	+730	+29.6

For Romany: Lsd 5% for : phosphate = 500 kg, nitrogen = 240 kg.

2.12 Rate of phosphate and nitrogen application on barley

Beka barley did very poorly in 1968. Most plants even in fertilized plots remained stunted; many plants (especially in unfertilized plots) died before maturity due to unknown causes. Consequently yields were generally depressed (Table 24).

The barley did not respond to the nitrogen. On the other hand phosphate, at 60 and 80 kg/ha P_2O_5, gave very good results. There was no yield increase by going over 60 kg/ha P_2O_5.

Table 24. The effects of phosphate and nitrogen on yield of barley.

Design: Split plot(P04, N), 4 reps
Variety: Bek
Seeding date: July 12
Seeding rate: 100 kg/ha
Fertilizer: Triple S. P04 on July 11, urea on Aug. 8
Plot size: 20 m^2

Rates of P_2O_5 kg/ha	Rates of nitrogen, kg/ha				Ave.- for P04
	0 kg/ha	40 kg/ha	60 kg/ha	80 kg/ha	
0	321	455	336	349	360
40	498	408	462	447	450
60	1118	1179	1134	1231	1160
80	1107	895	792	1188	990
Ave. for N	760	730	680	800	

2.1.3 Rate of phosphate and nitrogen application on teff

The yield of teff was adversely affected by most combinations of phosphate and nitrogen (Table 25). Four of the combinations (0:60, 40:0, and 60:60) reduced the yield significantly. No definite conclusion can be made from this trial concerning fertilization of teff, other than caution in the use of fertilizers on similar naturally fertile soils. The teff grew luxuriantly on all plots. The straw yield was somewhat increased(by 8 to 16) in the fertilized plots - nitrogen giving most of the increase.

Table 25. The effect of phosphate and nitrogen on yield and test weight of teff.

Design: Randomized blocks, 4 reps
Variety: A-71
Seeding date: July 31
Seeding rate: ca. 30 kg/ha
Fertilizer: applied on July 31
Plot size: 15m^2

Fertilizer P_2O_5 kg/ha	Fertilizer N kg/ha	Straw yield kg/ha	Hectoliter weight kg/ha	Grain yield kg/ha	Difference from no fertilizer, kg/ha
0	0	6310	87.8	1830	-
0	40	6760	87.4	1640	-190
0	60	7140	87.0	1450	-380
40	0	6250	87.2	1620	-210
40	40	6280	86.8	1590	-240
40	60	7160	87.8	1640	-190
60	0	6940	87.2	1730	-100
60	40	7340	87.4	1720	-105
60	60	6860	87.0	1480	-350

Standard error = 0.701, Lsd 5% & 1% = 200 & 280 kg, CV = 8.6%

2.1.4 Rate of phosphate and nitrogen application on flax

No significant response was obtained by fertilizing flax with nitrogen or/and phosphate at the rates shown in Tables 30 a & b. In no case was the value of the increase in yield sufficient to cover the cost of the fertilizer. Since the seeding rate was far below optimum (15 kg/ha) and the planting date was rather late (rf. 3.25) the full potential of response to fertilizer may not have been realized in this trial

Table 30 a. The effect of phosphate and nitrogen on yield and test weight of flax.

Variety: Redwood
Design: Randomized blocks, 4 reps
Seeding date: July 19
Seeding rate: 15 kg/ha
Fertilizer: Applied July 17
Plot size: 18 m^2

Fertilizer P_2O_5 kg/ha	Fertilizer N kg/ha	eight of hectoliter kg	Yield kg/ha
0	0	64.0	620
0	30	64.4	640
0	50	62.6	650
40	0	64.8	720
40	30	70.0	710
40	50	62.2	760
60	0	65.8	680
60	30	61.8	670
60	50	61.4	690

Table 30 b. Average yield of Redwood flax at different levels of P_2O_5 or N and at all levels of the other fertilizer.

N, Kg/ha	P_2O_5, Kg/ha	Yield, Kg/ha	Yield diff. from no N or P_2O_5 Kg/ha
0	–	670	–
30	–	670	0
50	–	700	+30
–	0	640	–
–	30	730	+90
–	50	680	+40

Table 31. The effects of phosphate and nitrogen on yield, test weight, and agronomic characteristics of hybrid maize.

Variety: H 613 B
Design: Randomized blocks, 4 reps.
Seeding date: April 12 and 13
Spacing: 80 X 30 cm
Fertilizer: Triple S. PO4 on April 12, Urea on June 26
Plot size 16 m^2 (net)

Treatment		No of ears	Relative degree of lodging	Weight of:		Yield	Yield difference from no fertilizer
P_2O_5 kg/ha	N kg/ha			1000 seeds g	hectoliter kg/ha	kg/ha	kg/ha
0	0	85	100	421.3	75.8	9630	-
0	40	77	74	425.8	75.4	8160	-1470
0	60	80	68	411.2	74.8	7920	-1710
0	80	80	93	450.7	75.6	9260	- 370
40	40	84	68	420.7	75.8	9050	- 580
40	60	80	61	433.5	75.6	8210	-1420
40	80	79	84	429.7	75.4	8620	-1010
60	40	84	81	435.6	75.2	8530	-1100
60	60	83	71	451.8	75.0	9020	- -610
60	80	75	77	425.3	75.4	8600	-1030
80	40	78	90	427.3	75.8	8630	-1000
80	60	74	71	443.8	75.4	8340	-1290
80	80	77	68	432.1	75.4	8260	-1370

Standard error = 386, Lsd 5% = 1120 kg, CV = 7.1%

2.1.5 Rate of phosphate and nitrogen application on maize

In this trial the check plots (without phosphate and nitrogen) gave the highest yield, 9630 kg/ha (Table 31). This high yield reflects on the high natural fertility of the trial plot, which was later found out to be an old farmyard. Nevertheless, it is not clear why some of the fertilizer combinations (0:40, 0:60, 40:60, 80:60, and 80:80) actually reduced the yield of the maize. The number of ears per plot was highest in the check plot, whereas several of the fertilized plots had considerably less ears.

2.2 Rate of phosphate application

2.2.1 Rate of phosphate application on sunflower

This trial combined rate of phosphate applications with different populations (spacings). The results are summarized in Table 32. There was no significant response to phosphate. This was surprising because earlier in the season there was marked difference between the fertilized and unfertilized plots. However, as the season progressed the difference in vegetative growth became less and less noticeable. The differences in spacings were significant. In this trial 80 X 40 cm was significantly better than 80 X 20 cm, but not better than 80 X 60 cm.

There was no interaction between fertilizer and spacing. Nitrogen was applied on two replications, but no response was observed.

Table 32. The effects of phosphate and spacing on yield of sunflower.

Variety: From Alemaya
Design: Split-plot. Main plots = P04, sub-plot = spacing
Seeding date: July 3
Fertilizer: Triple SPO_4 on July 3, urea on reps. I and IV on August 8
Plot size: 16 m^2

Fertilizer P_2O_5, kg/ha	Spacing			Average for phosphate kg/ha
	80X20 cm kg/ha	80X40 cm kg/ha	80X60 cm kg/ha	
No P04	1300	1430	1230	1320
47	1170	1450	1420	1350
94	1380	1380	1370	1380
Average for spacing	1290	1420	1340	

Lsd 5 % for: fertilizer = 320 kg, spacing = 100 kg, two spacings in one fertilizer = 180 kg.

2.3 Time and source of nitrogen application

2.3.1 Time and source of nitrogen application on wheat

Because of high transport cost, urea is the cheapest source of nitrogen in Ethiopia. However, its effectiveness as compared to other sources of nitrogen as well as the best time of application for obtaining the highest response should be ascertained.

Three sources of nitrogen were tested at two levels (54 and 80 kg/ha) and at three different stages of application. Although this was a split-split plot experiment, only data from the 80 kg/ha application was subjected to analysis as a split-plot experiment (Tables 33 a & b).

Unfortunately since there were no plots without nitrogen, the exact response of the wheat to the different sources of nitrogen cannot be known. A rate of phosphate and nitrogen trial situated next to this trial failed to show any response of Kt. Fr. A My 48 to urea.

Urea, ammonium sulfate nitrate, and nitrochalk behaved similarly in their overall effects on yield of Kt. Fr. X Iy 48. The effects of urea and ammonium sulfate nitrate were not influenced by time of application. Nitro chalk gave a significantly higher yield when spread in two applications than when applied on August 6. But two applications were not significantly different from one application at planting time. According to this trial, therefore, application of nitrogen at planting time is to be preferred, since both nitrogen and phosphate can be applied all at once. Because of its cheaper cost urea is the preferred source of nitrogen.

Table 33 a. The effects of sources and time of application of nitrogen on yield of wheat.

Design : Split-split plot (source, rate, time), 4 reps.
Seeding date : July 12
Seeding rate : 100 kg/ha
Plot size : 15.6 m^2 (net)

Fertilizer source	Time of application	Rate of Nitrogen		Yield difference (80-54) kg/ha
		54 kg/ha kg/ha	80 kg/ha	
Urea (46% N)	1. July 12	2940	2920	- 20
	2. ½ July 12, ½ August 6	2770	2800	+ 30
	3. August 6	2930	2840	- 90
	Average	2880	2850	- 26
Ammonium Sulfate nitrate (26% N)	1. July 12	2880	2880	0
	2. ½ July 12 ½ Aug. 6	2710	2930	+220
	3. August 6	2580	2740	+160
	Average	2720	2850	+127
Nitro chalk (21% N)	1. July 12	2750	2870	+120
	2. ½ July 12, ½ Aug. 6	2630	3120	+490
	3. August 6	2670	2620	- 50
	Average	2680	2870	+187
	Grand average	2760	2860	+100

Table 33 b. Summary of the yields (kg/ha) of Kent. Fr. A Hoyo 48 for the different sources of nitrogen and time of application, when nitrogen was applied at 80 kg/ha

Source of N	Time of application			Average for source of N kg/ha
	July 12	½ July, ½ August	August 6	
Urea	2920	2800	2840	2870
Amm. Sulf				
No_3	2880	2930	2740	2850
Nitro chalk	2870	3120	2620	2870
Average for time	2890	2950	2730	

Lsd 5% for: Source of N = 430 kg, Time of Appl. = 170 kg,

2 times for one source = 290 kg.

2.3.2 Time of nitrogen application on maize

Since maize is planted during the small rains, information is needed as to the best time of applying nitrogen. Nitrogen (as urea) was applied half at planting time, half at the beginning of the big rains, and all of it at the beginning or in the middle of the big rainy season. The plot was uniformly fertilized with 50 kg/ha P_2O_5 at planting time. Nitrogen, under any method of application tried here, failed to give a significant increase in yield (Table 34). This may be due inpart to the fact that urea is not a good source of nitrogen for maize, as some workers claim.

2.4 Observations on response of different crops to fertilizers

2.4.1 Fertilizer observation plots on Kulumsa farm

Results of fertilizer trials have shown variable results at Kulumsa. Some of the results have been contrary to expectations. In order to ascertain whether or not failure of some crops to respond to fertilizers, especially phosphate, may be due to location effects or deficiency of other essential nutrients, fertilizer observation plots were established in different fields on Kulumsa farm. Besides nitrogen and phosphate, potassium and the trace elements boron, manganese, copper, zinc and molybdenum were tested (Table 35).

On wheat nitrogen by itself had no marked effect on yield. Nitrogen when combined with phosphate increased yield in one location. In the second location the yield was depressed due to excessive shattering of the wheat. Shattering was heaviest in the best plots. Phosphate gave a remarkable increase in yield. For the two locations phosphate increased the yield by 95% over the checks and by 73% over the nitrogen fertilized plots. Potassium increased yield in one location. However, it is questionable if this is an actual effect. The trace elements had no influence on yield of wheat.

Table 34. The effect of time of application of nitrogen on yield and other characteristics of hybrid maize.

Variety : H 613 B
Seeding date : April 12
Spacing : 80 X 30 cm
Fertilizer : 60 kg/ha P_2O_5 on April 12
Plot size : 16 m^2

Treatment	No. of ears	Relative degree of lodging	Weight of: 1000 seeds g	Weight of: hectoliter kg	Yield kg/ha
No nitrogen	82	100	397.7	75.6	7660
20 kg at planting 20 kg June 26	79	100	424.5	75.4	8230
30 kg at planting 30 kg June 26	82	119	403.7	74.8	7810
40 kg on June 21	76	119	423.7	75.0	7920
60 kg on June 26	78	136	424.2	75.2	8130
40 kg on August 2	78	86	416.6	75.6	7920
60 kg on August 2	83	86	427.6	75.4	7860

Standard error = 4.84, Lsd 5% = 1440 kg, CV = 12.2%

The barley responded in much the same way as the wheat, except that the results were not as clear-cut as those of the wheat due to great variation in the plots.

Broadbeans did not respond to phosphate as expected. The phosphate seemed to have worked better in the presence of nitrogen as can be seen from the yields of the NP and NPK plots. The nitrogen by itself did not raise yield. It is doubtful if the yield was actually influenced by the trace elements. Since the observation was carried out in only one location, it is difficult to make conclusions from the available data.

Table 35. The effects of different fertilizers on yields of different crops.

Design : Observation plots, 1 replication
Fertilizer : Source: nitrogen from urea, phosphate from triple SP, NPK from nitrophos 15:15:15. Trace elements: Borax, 20 kg/ha; Mn SO4, 30 kg/ha; Cu SO4, 5 kg/ha; Zn SO4, 5 kg/ha, sodium molybdate 2.5 kg/ha.

Crop / variety	Yield from different fertilizers (kg/ha)					
	None kg/ha	N (50) kg/ha	P_2O_5 (50) kg/ha	N : P (50:50) kg/ha	N:P:K (50:50:50) kg/ha	NPK + Trace elements (50:50:50) kg/ha
Wheat						
1. Supremo						
K.XY.48	940	950	1830	2100	2030	1880
2. "	670	860	1290	1280	1410	1370
Average	800	900	1560	1690	1720	1620
Barley, Beka	480	610	1590	1770	990	1260
Broadbeans, local	930	690	980	1130	1130	1220

2.5.1 Rate and method of application of phosphate on wheat

The results of phosphate trials on wheat and other crops were disappointing, in 1967, in that phosphate failed to give economic levels of yield increase, in spite of the fact that the soil at Kulumsa is very deficient in phosphate. An experiment was designed to find some possible clues to the problem. Phosphate was applied broadcast, then mixed with the soil or left on the surface. In other plots phosphate was applied in the row with the seed. Furthermore phosphate was applied alone and in combination with lime and some trace elements. Nitrogen (46 kg/ha N) was applied on all plots. The questions that were hoped to be answered by this experiment were: 1) Are trace elements limiting factors? 2) Is most of the phosphate fertilizer fixed by the clay? If so could it be made more available by applying it in bands or by liming? The results are presented in Table 36.

All methods and combinations of phosphate application gave substantially higher yields than the check plots. Sixty kilograms P_2O_5 per ha. when applied in the seed row gave the highest yield (1920 kg/ha), although not significatly higher than either 40 kg/ha banded or 60 kg/ha broadcast and hoed in. The best methods, according to this trial, are either broadcasting 60 kg/ha and mixing thoroughly with the soil or applying 40 kg/ha in bands. There was no advantage in using lime or the trace elements used in this experiment. The lime actually reduced yield. When the phosphate was 1 ft on the surface of the soil, the yield of the wheat was significantly less than when the phosphate was mixed with the soil.

This trial revealed that on sites of low fertility (as was the site of this trial as confirmed by the low yield of the check plots and as further confirmed by soil analysis), the response of wheat to phosphate is excellent. The evidence so far at hand indicates that the variability of, and in some cases the failure of the phosphate trials, is due to location effects. Trials carried out on pockets of naturally rich soil give little response to phosphate.

Table 36. The effect of method of application of phosphate, alone and in combination with lime and trace elements, on the yield of wheat

Design : Randomized blocks, 3 reps
Variety : S156 (white)
Seeding date : July 26
Seeding rate : 100 kg/ha
Fertilizer : Quick lime, 2 tons/ha, Borax, 20 kg/ha; Mn SO4, 30 kg/ha; Cu SO4, 5 kg/ha; Zn SO4, 5 kg/ha
Plot size : 11.2 m^2

Treatment	Weight of 1000 seeds g	Yield kg/ha	Yield difference from check	
			kg/ha	%
1. Check (no PO4)	32.1	1200	-	-
2. PO4 broadcast, hoed in (60 kg/ha)	31.3	2980	1780	148
3. PO4 + lime broadcast, hoed in (60 kg/ha)	31.4	2570	1370	114
4. PO4 + trace elements broadcast, hoed in (60 kg/ha)	31.3	2630	1430	119
5. PO4 broadcast, not hoed in (60 kg/ha)	32.2	2530	1330	111
6. PO4 (40 kg P_2O_5) applied in the row	32.0	2910	1710	142
7. PO4 (60 kg P_2O_5) applied in the row	31.0	3120	1920	160

Standard error = 1.312 Lsd 5% and 1% = 400 and 570 kg.

3. CULTURAL PRACTICES

3.1 Seeding rates and spacings

3.1.1 Seeding rate of wheat

Seeding rates ranging from 50 to 200 kg/ha were tested on Romany and Supremo Kenya X Yaqui 48 (Tables 37a &b). For the two varieties (also for each variety) 50 kg/ha gave significantly less yield than all other seeding rates. One hundred and fifty kg/ha gave barely significantly higher yield than 100 kg/ha but was not better than 125, 175, or 200 kg/ha. For Supremo, 100 kg/ha was as good as the higher rates of seeding. For Romany, 125 kg/ha gave a significantly higher yield than 100 kg/ha but was not better than the higher seeding rates. It appears that it is more economical to use a higher rate of seeding on Romany than on Supr. K X Y. 48. According to this trial a seeding rate of over 125 kg/ha is not beneficial to Supremo, whereas Romany may benefit from 125 kg/ha or even slightly higher seeding rates.

Two of the 4 replications were fertilized with phosphate and nitrogen. Table 37 c presents interesting contrast of the fertilized and unfertilized blocks. For both varieties, the optimum seeding rate for fertilized blocks was about 25 kg/ha higher than for unfertilized blocks. This was unexpected.

It is interesting to note again that the difference in performance between Romany and Supremo was much more pronounced on the unfertilized blocks (2040 vs 1210 kg/ha) than on the fertilized blocks (2390 vs 2070 kg/ha).

Table 37 a. Summary of the yield data of the seeding rate trial on wheat

Variety	Seeding rate (kg/ha)						Average for varieties
	50 kg/ha	100 kg/ha	125 kg/ha	150 kg/ha	175 kg/ha	200 kg/ga	kg/ha
Supremo K.	1420	1680	1670	1660	1680	1750	1640
Romany	2030	2120	2280	2370	2300	2200	2220
Ave. for dates	1720	1900	1970	2010	1990	1970	

Lsd 5% for: varieties = 520 kg, seeding rates = 120 kg, 2 rates for 1 variety = 160 kg

Table 37 b. The effect of seeding rate on yield and test weight of wheat

Design : Split-plot, 4 reps. Main plots = varieties, sub-plot = seeding rates.
Seeding date : July 19
Fertilizer : 2 blocks received 92 kg/ha P_2O_5 at planting 46 kg/ha N 6 weeks later
Plot size : 28.21 m^2

Seed rate kg/ha	1000 seed weight g	Yield kg/ha	Difference from 100 kg/ha kg/ha
	Supremo Kenya X Yaqui 48		
50	30.9	1420	-260
100	27.2	1680	-
125	26.9	1670	- 10
150	28.6	1660	- 20
175	28.0	1680	0
200	27.7	1750	+ 70
Average		1640	
	Romany		
50	32.8	2030	- 90
100	32.0	2120	-
125	31.5	2280	+160
150	31.7	2370	+250
175	30.4	2300	+180
200	31.9	2200	+ 80
Average		2220	

Table 37 c. The effect of fertilizers on seeding rate of wheat

Seeding rate kg/ha	Fertilized		Unfertilized	
	Yield kg/ha	Difference from 100 kg/ha	Yield kg/ha	Difference from 100 kg/ha kg/ha
	Supremo - Kenya X Yaqui 48			
50	1900	-110	940	-420
100	2010	0	1360	0
125	2110	+100	1230	-130
150	2130	+120	1190	-170
175	2120	+110	1240	-120
200	2170	+160	1330	- 30
	2070		1210	
	Romany			
50	2350	+ 50	1720	-220
100	2300	0	1940	0
125	2340	+ 40	2230	+290
150	2580	+280	2160	+220
175	2400	+100	2190	+250
200	2360	+ 60	2030	+ 90
	2390		2040	

3.1.2 Seeding rate of barley

Seeding rates ranging from 50 to 200 kg/ha were tested on Bela barley (Table 38). The yield increased as the rate was increased from 100 to 200 kg/ha. Rates of 125, 175, and 200 kg/ha gave significatly better yields than either 50 or 100 kg/ha. For an unknown reason 150 kg/ha did not yield better than either 50 or 100 kg/ha. Since the yields from 175 and 200 kg/ha were not significatly higher than from 125 kg/ha, the latter rate seems to be the optimum planting rate for barley according to the trial.

Table 38. The effect of seeding rate on yield and test weight of barley

Design : Randomized blocks, 4 reps
Variety : Bela
Seeding date : July 19
Fertilizer : 200 kg/ha P_2O_5 and 46 kg/ha N on 2 reps
Plot size : 28.21 m^2

Seeding rate kg/ha	1000 seed weight g	Yield kg/ha	Difference from 100 kg/ha kg/ha
50	31.6	1190	+ 20
100	33.4	1170	-
125	32.6	1540	+370
150	32.3	1210	+ 40
175	32.7	1700	+570
200	32.1	1850	+680

Standard error = 1.235, Lsd 5% & 1% = 370, 510 kg, CV = 17.2%

3.1.3 Spacing of maize (see 3.2.3)

3.1.4 Spacing of sunflower (see 2.2.1)

3.1.5 Spacing of broadbeans

A spacing trial was carried out on broadbeans as shown in Table 39. The closest spacing, 20 X 5 cm, gave the highest yield - 2420 kg/ha. This yield was significantly higher than all other yields. Yields of the following spacings were not significantly different from each other: 20 X 10 cm, 20 X 15 cm, 40 X 5 cm, and 60 X 5 cm. The lowest yields were given by 40 X 10 cm and 60 X 10. Although the closest spacing gave the highest yield it is questionable if 20 X 5 cm is the best practical spacing. With this spacing mechanical cultivation will be difficult, losses from lodging and also probably from chocolate spot (Botrytis fabae) would be expected to be higher than with the wider spacing. The closer spacings also reduced seed size. Until further confirmation of these results, a spacing of 50 X 5 cm should be recommended.

In an adjoining area two plots, each 6 4.8 m^2, were planted to the same broadbeans used in the spacin trial by broadcasting 120 and 240 kg/ha, corresponding to spacings of 40 X 10 cm and 40 X 5 cm, rspectively. The yields were 2070 and 1880 kg/ha, rspectively. The corrsponding yields for the above spacings (40 X 10 and 40 X 5 cm) were 1360 and 1930. kg/ha. According to this observation (although only 1 replicate for broadcasting), row drilling did not increase yield over broadcasting.

Table 39. The effect of plant population (spacing) on yield and test weight of horse beans.

Variety : Local selection
Design : Randomized blocks, 4 reps.
Seeding date: June 28
Fertilizer : None
Plot size : 12 m^2

Spacing		Weight of 1000 seeds g	Yield kg/ha
Between rows cm	In the row cm		
20	5	382.3	2420
20	10	408.8	1820
20	15	413.6	1750
40	5	358.1	1930
40	10	414.1	1360
40	15	437.0	1300
60	5	406.2	1560
60	10	431.9	1360

Standard error = 1.386, Lsd 5% & 1% = 410 & 570 kg, CV = 16.4%

3.2 Seeding date

3.2.1 Seeding date of wheat

The results of the seeding date trial on wheat are presented in Tables 40 a and 40 b. Since Kenya 1 was not planted on the last date and since its performance on the different dates was similar to Kt. Fr. X My 48, only data from Kt. Fr. X My 48 and Romany were analyzed (Table 40 b).

For the two varieties, the first two dates (June 28 and July 12) gave significantly higher yields than later dates of planting. For Kt.Fr. X My 48, planting dates from June 28 to August 4 were not significantly different from each other. For Romany the first date, June 28 gave significantly higher yield than later dates of planting. Although July 12 also gave good yield, it was not significantly better than planting on July 22 and August 4. August 15 was evidently too late for all varieties tested.

As can be inferred from the above comparison of Kt. Fr. X My 48 and Romany, there was variety X date interaction. In additon to the better performance of Romany on the first date, it was also much more superior to Kt. Fr. X My 48 when planted on June 28, whereas the two varieties were not significantly different from each other at later dates of planting.

Although the first four dates of planting had little effect on the yield of Kt. Fr. X My 48 (also Kenya 1), they had a remarkable effect on their test weight. The 1000 seed and hectoliter weights gradually increased from the first to the last date of planting. This increase is not so marked in the case of Romany. The almost constant test weight of Romany and its higher yield when planted early seem to derive from the high degree of resistance of this variety to leaf deseases (leaf blotch and rusts, Table 40a).

This trial seems to indicate that varieties resistant to leaf diseases would benefit from early planting (July 1-10), whereas varieties susceptible to leaf diseases (if early varieties) should be planted rather late (July 20 - 30).

Table 40 a. The effect of seeding date on yield and other characteristics of 3 wheat varieties.

Design : Split plot, 4 reps. Main plots = dates, sub-plots = varieties
Seeding rate: 100 kg/ha
Fertilizer : None
Plot size : 23.8 m^2

Variety and date of planting	Lodging 0-10	Reaction to: stripe r. %	Reaction to: blotch 1/ 0-5	Weight of: 1000 seeds g	Weight of: 1 hectolitre kg	Yield Kg/ha
Kenya 1						
June 28	8	85	2	26.6	78.2	1390
July 12	6	85	2	29.6	81.8	1480
July 22	1	65	1	29.4	84.4	1490
August 2	1	65	1	31.4	85.6	1260
Kentana Fr.XKuyo 48						
June 28	6	-	3	23.9	76.6	2590
July 12	4	-	2	24.3	80.0	2700
July 22	tr	-	1	24.2	80.6	2210
August 2	0	-	1	29.1	84.0	2500
August 15	tr	-	1	34.5	84.8	1720
Average	2.0		1.6	27.2	81.2	2340
Romany						
June 28	3	-	1	35.0	81.2	3650
July 12	4	-	tr	30.0	81.0	2930
July 22	2	-	tr	28.4	82.6	2280
August 2	0	-	tr	30.2	83.2	2280
August 15	tr	-	0	38.4	82.8	1650
Average	1.8		tr	32.4	82.2	2560

1/ 0 = no blotch, 5 = 100% infection, tr = trace, - = not detected

Table 40 b. Summary of the yield data of the seeding date trial on wheat

Variety	Seeding date					Average for variety kg/ha
	June 28 kg/ha	July 12 kg/ha	July 22 kg/ha	August 2 kg/ha	August 15 kg/ha	
Kenya 1	1390	1480	1490	1260	-	1400
KentanaXFrontanaX Kayo 48	2590	2700	2210	2500	1720	2340
Romany	3650	2930	2280	2280	1650	2560
Average for dates	2540	2370	1990	2010	-	
Ave. for Kt.Fr.& Romany	3120	2810	2240	2390	1680	

For Kt. Fr. X Ky 48 and Romany: Lsd 5% for: dates = 440 kg, varieties = 150 kg, 2 varieties for 1 date = 330 kg
2 dates for 1 variety = 700 kg.

3.2.2 Seeding date of barley

The seeding date trial on barley did not turn out to be very informative because of heavy damage to seedlings by the barley fly and because of poor fertility of the plot. However, some comments may be made on the results (Table 41). The local variety, Aruso, did much better than the introduced variety, Beka. Aruso gave the highest yield on the earliest planting date, June 28. Planting date had little influence on the poor performance of Beka.

This and other trials on barley showed that under the conditions of 1968, the local barley varieties performed better than the introduced varieties. This emphasizes the need for thorough and repeated testing under different conditons before releasing exotic varieties for large scale production.

Table 41. The effect of seeding date on yield and test weight of 2 barley varieties

Design : Split plot, 4 reps.
Seeding rate: 100 kg/ha
Fertilizer : None
Plot size : 23.8 m^2

Variety and date	Weight of 1000 seeds g	Yield kg/ha
June 28		
Aruso	36.2	1290
Beka	28.2	390
		840
July 11		
Aruso	35.6	970
Beka	31.9	480
		720
July 22		
Aruso	36.0	500
Beka	29.8	420
August 2		
Aruso	36.2	420

3.2.3 Seeding date of maize (with different spacing)

The cultural practices trial on maize comprised seeding date, spacing, and varieties. The second and third planting dates failed because of heavy damage by cutworms and other insects. The third date was used as a second date and a fourth planting was made on the site of the second planting date. Since plant population was very variable in the second planting date only results from the first and last dates are presented in Table 42 a and summarised in Table 42 b.

For the three varieties as a whole the first planting (April 2) was much better (by 246 %) than the late planting (June 5). The yield reduction from the late planting was higher for the hybrid and Jimma maize (72 and 80%) than for the local variety (55%). The number of plants (stalks) was higher in the early planting because of higher production of suckers.

As far as spacing for the three varieties is concerned, 75 x 30 cm was someewhat better than 75 x 40 cm, and these two spacings were decidedly better than 75 x 60 cm which apparently is too wide a spacing. The performance of the individual varieties was also in line with the above conclusion, although for H 632 spacings of 75 x 40 cm and 75 x 30 cm seemed to be equally good. The wider spacings reduced the yield of the small-sized local variety more than of either the hybrid or the Jimma selection.

The hybrid performed much better than the other two varieties under all conditions, giving a yield increase of 82 and 116% over the Jimma and local selections, respectively.

Table 42 a. Results of the cultural practices trial on maize.

Design: Split-plot, 4 reps.
Fertilizer: 160 kg 18:47:0 at planting, 45 kg/ha N on June 27.
Plot size: 9.4 m^2.

Planting time and variety	Spacing	No. of stalks per plot	No. of cobs per plot	1000 seed weight g	Yield 90% DM kg/ha
Early (April 2)					
H 632	75x30 cm	55	83	424.1	11,700
	75x40 cm	60	77	421.5	11,230
	75x60 cm	52	68	434.3	9,560
					10,830
Jimma	75x30 cm	48	56	376.5	6,410
	75x40 cm	48	51	383.4	6,530
	75x60 cm	49	55	392.3	6,060
					6,330
Local	75x30 cm	61	91	224.7	5,290
	75x40 cm	52	65	243.1	3,992
	75x60 cm	46	62	244.4	4,000
					4,420

Table 42 a (continued)

Planting time and variety	Spacing	No. of stalks per plot	No. of cobs per plot	1000 seed weight g	Yield 90% DM kg/ha
Late (June 5)					
H 632	75x30 cm	43	32	367.6	2,660
	75x40 cm	33	33	362.0	3,370
	75x60 cm	24	27	333.5	2,990
					3,000
Jimma	75x30 cm	50	27	306.1	1,600
	75x40 cm	35	14	-	1,110
	75x60 cm	24	16	342.8	1,140
					1,280
Local	75x30 cm	52	52	201.8	2,280
	75x40 cm	41	44	177.0	2,230
	75x60 cm	28	28	216.9	1,400
					1,970

Table 42 b. Summary of the yield data for the practices trial on maize, 1968.

Spacing cm	Variety	Time of planting		Average for kg/ha
		Early (April 2) kg/ha	Late (June 5) kg/ha	
75 x 30	H 632	11700	2660	7180
	Jimma	6410	1600	4000
	Local	5290	2280	3780
	Average	7800	2180	4980
75 x 40	H 632	11230	3370	7300
	Jimma	6530	1110	3820
	Local	3990	2230	3110
	Average	7250	2240	4740
75 x 60	H 632	9560	2990	6270
	Jimma	6060	1140	3600
	Local	4000	1400	2700
	Average	6540	1840	4190
	Grand Average	7200	2080	

3.2.4 Seeding date of teff

Since teff straw is an important fodder, a seeding date trial was designed with the aim of finding out the best time of planting for maximum return in terms of straw and grain. Another objective was to find out if, after cutting teff for hay or fodder in early September, it would be possible to have a second harvest for seed. The results are presented in Table 43.

Contrary to expectations, the highest grain yield was produced from the first date of planting, July 11. It was reasoned that heavy lodging would reduce the yield of the earliest planting. The straw yield was also highest from the earliest planting. Therefore, the value of seed and straw was highest for the first planting (Table 43). A-44 produced 5400 kg of air dry hay per hectare when harvested on September 18. The yield of grain from the second growth was about 600 kg/ha for the 3 varieties. There was great variation from plot to plot, the best plots giving as much as 1000 kg/ha. The total amount of fodder produced from the two cuttings (for hay and seed) was less than that produced by the first date of planting. However, the fodder from the September cutting had a much higher nutritive value than the straw obtained after thrashing.

The results obtained in 1968 may vary from those obtained in a year with a different rainfall pattern. If it had rained in October, the first planting may not have fared so well. On the other hand the second growth might have done much better.

It was found difficult to make hay in September. If the yield from the second cutting can be improved, the first cutting would have to be used as green fodder or silage.

Table 43. The effect of seeding date on grain and straw yield of teff.

Design : Split plot, 4 reps.
Seeding rate: 25 kg/ha
Fertilizer : 15 kg/ha N & 23½ kg/ha P_2O_5 at planting + 35 kg/ha N 5 weeks later on reps I & IV
Plot size : 10 m^2

Date of planting and variety	Height cm	Lodging 0-10	Weight of straw air dry kg/ha	Hectoliter weight kg	Weight of seed kg/ha	Value ₰/ha
July 11, harvested for seed						
A-44	100	10	8630	84.0	2590	733
A-71	109	10	7420	85.8	2600	809
DZ-01-186	107	10	8310	84.4	1800	675
July 11, 1st cut for hay						
A-44	-	-	5480	-	-	223
A-71	-	-	4610	-	-	224
DZ-01-186	-	-	4300	-	-	172
July 11, 2nd cut for seed						
A-44	48	0	1870	86.4	580	163
A-71	66	0	2530	87.2	640	217
DZ-01-186	61	0	2230	87.0	660	228
July 25, for seed						
A-44	91	8	8100	85.2	2150	632
A-71	105	4	6710	87.6	2000	648
DZ-01-186	93	4	8150	85.6	1460	584
August 13, for seed						
A-44	76	4	6820	86.6	1660	502
A-71	89	3	6500	87.8	1790	592
DZ-01-186	74	0	7070	87.0	1350	528

1/ Cost of grain = A-44 = ₰20/100 kg, A-71 = ₰24/100 kg, DZ-01-186 = ₰26/100 kg
Cost of hay = ₰4/100 kg, cost of straw = ₰2.5/100 kg.

3.2.5 Planting date of chickpeas

A trial on different dates of planting chickpeas contradicted the farmers' conception that chickpeas should be planted late. In fact, only the first planting (August6 gave a fair yield (Table 44). The two later plantings failed almost completely due to insufficient rainfall in October.

Table 44. Data from planting date trial on chickpeas.

Variety : DZ-10-4
Spacing : 20 cm between rows
Seed rate : 50 kg/ha
Plot size : 45 m^2
No. of replications: 4
Dates of harvest : Planted August 6 - January 10, 1969
Planted August 28 - February 6, 1969

Planting date	Yield kg/ha	No. of plants/ha	Weight of: 1000 seeds g	1 hecto-liter kg
August 6	520	182,000	111.4	77.6
August 28	140	142,000	98.4	77.8
Sept. 17) Not harvested	-	52,000	-	-
Oct. 9)	-	25,000	-	-

3.2.6 Seeding date of flax

Dakota and a local selection of flax were used in a seeding date trial (Table 45). For the two varieties the earliest planting (July 2) gave a significantly higher yield than later plantings. According to this trial flax should be planted the first week of July in the Kulumsa area. There was no significant difference between Dakota and the local flax. There was no significant variety X seeding date interaction, although Dakota seemed to have done better compared to the local variety when planted early than with later plantings.

Table 45. Results of a seeding date trial on flax

Design : Split plot (dates, varieties) 4 reps
Seeding rate: 25 kg/ha
Fertilizer : None
Plot size : 24.50 m^2

Variety	Seeding date July 2 kg/ha	July 12 kg/ha	July 22 kg/ha	Average for variety
Local	992	855	812	890
Dakota	1188	827	804	940
Ave. for dates	1090	840	810	

Lsd 5% for: dates = 100 kg, varieties = 80 kg.

3.2.7 Seeding date of sunflower

The results of the trial on seeding date of sunflower are presented in Table 46. The first two dates (July 2 & 12) yielded much better than the last date, July 29. Sunflower should be planted during the first week of July.

Table 46. The effect of seeding date on yield and test weight of sunflower

Variety : Hazera improved
Design : Randomized blocks, 4 reps.
Spacing : 80 X 20 cm
Fertilizer : None
Plot size : 28.8 m^2 (net)

Date	Weight of:		Yield kg/ha
	1000 seeds g	hectoliter kg	
July 2	87.9	33.4	2790
July 12	101.9	32.8	2690
July 29	93.1	29.8	1010

3.2.8 Observation of seeding date of soybean

Soybean yields have been low at Kulumsa. It was felt that planting soybeans early when the temperature is higher and the day length longer may give better results. Hill and B 7/2 were planted on May 3, June 5, and July 12. Unfortunately the plants from the May planting were almost completely defoliated by rabbits. However, new leaves were produced. Because of this it is difficult to compare the yields at the different planting dates (Table 47). The last planting (July 12) seemed to have done at least as well, if not better, than the earlier plantings.

Table 47. The effect of seeding date on yield of soybean

Design : 1 plot observation
Spacing : 50 X 5 cm
Fertilizer : None
Plot size : 24 m^2

Variety	Seeding date			Average for varieties kg/ha
	May 3 kg/ha	June 5 kg/ha	July 12 kg/ha	
B 7/4	688	927	1300	972
Hill	651	656	885	731
Ave. for dates	669	791	1092	

B. CROP PROTECTION

The weed and pest situation in 1968

Weeds

A comprehensive report of the weed situation is given in CADU publication No. B 10.

The composition of the weed population, which in the beginning of the growing season mainly consists of rapidly growing broadleaved weeds, is gradually changing into a grass-dominated flora. Chemical weed control with phenoxyacetic acids is no remedy for the grass problem, and hand weeding is a poor one. A better solution is offered above all by a better crop rotation, but also some chemicals are promising.

Insect pests

Agrotis segetum (cutworm) attacked late-planted maize seriously on Kulumsa farm. Three weeks after planting, 14% of the seedlings were killed. The yield decrease is probably not so great, most attacked plants being out of competition at an early stage.

Busseola fusca (stalkborer) was probably the most destructive maize pest. About 15% of the plant population was attacked. The plants survive but give poor yield or no yield at all. More work should be devoted to this pest.

Delia arambourgi (barley fly) seems to be able to cause substantial losses although its significance in the area is not yet fully investigated. However, the local barley varieties seem to be more resistant than introduced ones.

Phyllotreta sp. (flea-beetles) attacked newly emerged rape but did not cause damage justifying control measures.

Brevicoryne brassicae and Dactynotus compositae (aphids) were abundant on rape and safflower respectively, and control measures will probably be necessary if the crops are introduced on a large scale.

Rhopalosiphum maidis (the maize aphid) was observed on maize but most probably it did not cause any appreciable harm.

Plusia spp. and Athalia sp. caused some damage on rape, mainly at the edge of the field. The attack was moderate, however, and it is doubtful whether control measures were economic.

Heliothis armigera (American bollworm) causes substantial yield losses to different crops. From investigations in different areas was concluded that the pest was particularly bad at Kulumsa farm, where the attack was most serious on pulses. The larvae also attacked sunflowers and tomatoes, and to a lesser extent maize and wheat.

Termites (not identified) were observed attacking roots of broad beans and chick-peas. The attack had no effect upon the yield.

Diseases

Wheat

Puccinia striiformis (stripe rust), Puccinia graminisf f. sp.tritici (stem rust) and Puccinia recondita (leaf rust) are very important diseases in the wheat growing areas, and severe attacks mainly of stripe rust were observed also in 1968.

Tilletia foetida (bunt or stinking smut) caused a great deal of quality deterioration but also yield losses at altitudes above 2,400 m, i.e. mainly south of Asella.

Septoria tritici (leaf blotch) is a devastating disease in the major part of the wheat growing area, although the attack was not particularly severe in 1968.

The best way of avoiding the above mentioned diseases is to buy new seed of a resistant variety. Bunt can also be controlled by seed-dressing.

Barley

The main leaf diseases on barley were Puccinia hordei (leaf rust) and Rhyncosporium secalis (scald). Other important diseases found in the project area are Ustilago hordei (covered smut), Ustilago nuda (loose smut) and Erysiphe graminis f. sp. hordei (powdery mildew). There is a great variation in susceptibility, and risistant varieties should be planted. Covered smut can be controlled by seed-dressing.

Oats

The Swedish varieties grown in trials were badly damaged by Puccinia coronata (crown rust) and also Puccinia graminis f. sp. avenae (stem rust) occurred.

Maize

Puccinia sorghi (rust) was noticed but did no severe harm.

Field pea

Erysiphe polygoni (powdery mildew) was observed on light soil but caused no appreciable yield reduction.

Chick pea

A root rot (not identified) has been observed to cause bad losses on small-seeded white varieties, whereas the big-seeded dark varieties seem to be resistant.

Broad bean

Botrytis fabae (chocolate spot) caused some damage during the rainy season.

Flax

Fusarium oxysporum f. lini seems to be a common disease where flax is grown at too short intervals.

Sunflower

Sclerotinia sclerotiorum, stem rot, caused yield losses of unknown magnitude, probably rather severe.

Safflower

The attack from Ramularia carthami (leaf spot) was not very severe due to the dry weather in October and November.

Prices used in profitability calculations:

Hired labour	Eth. $ 1,- /day
Seed cleaning +)	1,75/ql.
Seed-dressing +)	1,75/ql.
Transport for cleaning or seed-dressing	1,25/ql.
Hire of tractor and sprayer +)	8,-
Wheat	20,- /ql.
Barley	12,- /ql.
Teff	25,- /ql.
Maize	10,- /ql.
Chick-peas	17,- /ql.
Broad beans	13,- /ql.
Flax	20,- /ql.

Costs for chemicals are March 1969 prices in Addis Ababa whenever possible. Prices for chemicals not available in Ethiopia are estimates.

4. WEED CONTROL

4.1 Clean seed

4.1.1 Seed purity - manual weeding in wheat

Wheat seed was purchased at the local market in Asella, and the yield from uncleaned and cleaned seed was compared at the same seed rate, 100 kg/ha. Two different weeding intensities were applied, one and two weedings.

From last year's trials was concluded that one weeding raised the wheat yield by 17 %. This trial indicates that by a second weeding the yield can be raised by another 9%.

+) exclusive of chemicals

The difference in seed quality was too slight to cause any difference in yields. In fact, also the uncleaned seed was better than the average seed used by farmers. The value of the yield increase obtained from seed cleaning and a second weeding is just sufficient to cover the extra cost involved.

Seed:	Cleaned seed, purity 100 % Uncleaned " " 95.5%
Variety:	"Nech sinde"
Spacing:	20 cm.
Seed rate:	100 kg/ha., drilled
Date of seeding:	July 19
Plot size:	24 m^2
No. of replications:	4
Dates of weeding:	Sept. 17 (one weeding), Aug. 29 and Sept. 17 (two weedings)
Date of harvest:	Dec. 26

Table 48. Different purity levels and weedin intensities in wheat

Seed Purity No. of weedings	Yield kg/ha	Yield increase		Weight of		Value of yield incr. kg/ha	Cost over check /ha	Profit g/ha
		kg/ha	%	1000 Seeds gm.	1 hl. kg.			
Uncleaned Seed								
Seeding once	1,410			32.2	79.0			
Seeding twice	1,450	80	6	32.1	78.8			
Cleaned Seed								
Seeding once	1,390			33.7	79.8			
Seeding twice	1,560	170	12	32.2	79.2			
Uncleaned Seed	1,450			32.2	78.9			
Cleaned Seed	1,480	30	2	33.0	79.5	6	3	3
Seeding once	1,400			33.0	79.4			
Seeding twice	1,520	120	9	32.2	79.0	24	24	0

4.1.2 Seed Purity - manual weeding inflex

Also in this trial, the yield increase from cleaned seed compared to Uncleaned Seed was more than sufficient to pay for the cleaning procedure.

The second seeding was greatly facilitated by the work done earlier, and the two seedings could be done in less time than one late weeding.

Seed: Cleaned seed, purity 100%
Uncleaned seed purity 92.6%
Variety: Local flax from Asella market
Spacing: 20 cm
Seed rate: 25 kg/ha
Date of seeding: July 24
Plot size: 24 m^2
No. of replications: 4
Dates of weeding: Oct. 3 (one weeding); Aug. 28, Oct. 3 (two weedings)
Date of harvest: Dec. 2

Table 49. Different purity levels and weeding intensities in flax

Seed purity, No. of weedings	Yield kg/ha	Yield incr. kg/ha	Yield incr. %	Weight of 1000 seeds gm	Weight of 1 hl kg.	Value of yield incr. $/ha.	Cost over check $/ha	Profit $/ha
Market seed								
Weeding once	870			3.68	70.2			
" twice	1110	240	28	3.68	72.2	48		
Clean seed								
Weeding once	980			3.77	72.4			
" twice	1150	170	17	3.74	71.2	34		
Market seed	990			3.68	71.2			
Clean seed	1070	80	7	3.76	71.8	16	1	15
Weeding once	920			3.73	71.3			
Weeding twice	1130	210	23	3.71	71.7	42	0	42

4.2 Intensified hand weeding in broadcast and row-planted crops

Although at present all seed is broadcast, row planting offers obvious advantages in facilitating weeding. Generally, early weeding proves especially beneficial, but since it requires a hoe, it is difficult to accomplish in broadcast crops. Additionally, row planting as such has proved to increase yields, particularly in large seeded crops like maize and broad beans.

4.2.1 Teff

Teff requires intensive weeding and is consequently from this point of view an expensive crop. The trial reported indicates that there is certainly a substantial yield increase from a more efficient weeding than is normally practised. Actually, a poor weeding has proved not to pay for the labour involved, but as the weeding standard improves, the economics also improve.

The main reason for the poor result of drilling is that the seed was covered too deep.

Spacing: 20 cm (drilled)
Seed rate: 25 kg/ha (drilled), 35 kg/ha (broadcast)
Date of seeding: July 19
Plot size: 24 m^2
No. of replications: 4
Weeding dates: Oct. 2 (one weeding), Aug. 29, Oct. 2 (two weedings)
Date of harvest: Dec. 11 (broadcast), Dec. 19 (drilled)

Table 50. Hand weeding in broadcast and drilled teff

Treatment	Yield kg/ha	Yield increase kg/ha	Yield increase %	Hecto-litre weight kg	Value of yield increase */ha	Cost for weeding */ha	Profit */ha
Broadcast							
No weeding	1010			86.4			
Hand weeding once	1230	220	22	85.8	55	91	-36
Hand weeding twice	1410	400	40	85.8	100	100	0
Drilled							
No weeding	270			86.6			
Hand weeding once	590	320	119	86.6	80	81	- 1
" " twice	690	420	256	85.4	105	80	25
No weeding	640			86.5			
Hand weeding once	910	270	42	86.2	68	86	-18
Hand weeding twice	1050	410	64	85.6	103	90	13
Broadcast	1220			86.0			
Drilled	520	-700	-58	86.2			

4.2.2 Maize

Three different standards of weeding were compared in a trial with local and hybrid maize, row planted and broadcast. The most important factor influencing yield turned out to be the weeding standard, but it should be observed that hybrid maize more than doubled the yield compared to the local variety. The yield raising effect of row planting compared to broadcasting of local maize was negative, mainly due to irregularities in the soil fertility state of the trial area. The hybrid maize plots were more uniform and the yield increase from row planting of hybrid maize - 14% - seems to give a more reliable information.

Since the local maize does not grow tall, the population should also be increased considerably.

Varieties : Local maize from Asella market; Hybrid maize H 613 B
Spacing : 80 x 25 cm (row planted)
Seed rate : A, row planted 17 kg/ha
A, broadcast, and B 25 kg/ha
Date of planting : April 11
Plot size : 19.2 m^2
No. of replications: 3
Weeding dates : Two weedings June 7, Aug. 30
Three weedings May 14, July 11, Aug. 30
Dates of harvest: Local maize Dec. 10
Hybrid " " 27

Table 51 a. Frequency of weeding in local and hybrid maize, broadcast and row planted.

Variety treatment	Yield kg/ha	Yield incr. kg/ha	Yield incr. %	Weight of 1000 seeds gm	Weight of 1 hl. kg	Plants/ ha	Cobs/ ha	Cobs/ plant	yield Cob, gm.
Local maize									
Broadcast									
No weeding	660			255	74.6	50,300	21,700	.43	30
Two weedings	1490	830	125	245	75.0	43,700	32,600	.75	46
Three "	2540	1880	285	249	75.8	40,500	47,200	1.17	54
Row planted									
No weeding	250			231	74.0	24,700	8,000	.32	31
Two weedings	1440	1190	476	260	75.2	34,200	26,200	.77	55
Three "	2370	2120	848	260	74.8	43,600	39,200	.90	60
Hybrid maize									
Broadcast									
No weeding	1130			309	73.6	25,300	17,500	.69	65
Two weedings	3220	2090	185	393	75.0	28,800	31,100	1.08	104
Three "	4540	3410	302	461	75.2	25,700	27,800	1.08	163
Row planted									
No weeding	1750			313	73.4	41,100	25,300	.62	69
Two weedings	3720	1970	113	379	74.2	42,500	35,900	.85	104
Three "	4620	2870	164	379	75.6	42,200	42,200	1.00	109
No weeding	950			-	73.9	35,400	18,100	.51	52
Two weedings	2470	1520	160	-	74.9	37,300	31,500	.84	78
Three weedings	3520	2570	271	-	75.4	38,000	39,100	1.03	90
Local maize	1460			250	74.9	39,500	29,200	.74	50
Hybrid "	3160	1700	117	373	74.5	34,300	30,000	.87	92
Broad cast	2260			-	74.9	35,700	29,700	.83	76
Row planted	2360	100	4	-	74.5	38,000	29,400	.77	80

Table 51 b. Economics of different weeding intensities in local and hybrid maize, broadcast and row planted.

Treatment, variety	Yield increase kg/ha	Value of yield increase $/ha	Cost over check $/ha	Profit $/ha
No weeding				
Two weedings	1520	152	67	85
Three "	2570	257	72	185
Local maize				
Hybrid "	1700	170	26	144
Broadcast				
Row planted	100	10		

4.2.3 Broad beans

Row planting by itself seems to raise the yield of broad beans considerably in comparison with broadcasting. It has another great advantage in facilitating weeding. A proper weeding alone has brought about the same yield increase as row planting.

From the economics point of view, weeding broad beans at this low yield level seems to bring a low profit. Normally, farmers plant beans on their most fertile land, close to the dwellings, and consequently weeding should be tested on better land to obtain a proper idea of the economics of weeding. Nevertheless, if a farmer is short of cash and has no alternative employment but sufficient labour, an intensified weeding might be an advisable measure. If he has to hire labour at the rate of one dollar a day, however, the additional weeding will not be profitable.

Spacing: 40 cm
Seed rate: 100 kg/ha
Date of planting: July 11
Plot size: 16 m²
No. of replications: 4
Dates of weeding: weeding once - Sept. 4
" twice - Aug. 12, Sept. 4
Date of harvest: Nov. 14

Table 52. Hand weeding in broadcast and row planted broad beans

Treatment	Yield kg/ha	Yield increase kg/ha	%	Weight of: 1000 seeds gm	1 hl. kg	Value of yield increase ₹/ha	Cost for weeding ₹/ha	Profit ₹/ha
Broadcast								
No weeding	550			392	76.8			
Hand weeding once	750	200	36	404	79.2	26	77	-51
Hand weeding twice	740	190	35	371	78.6	25	96	-71
Row planted								
No weeding	780			407	78.2			
Hand weeding once	840	60	8	392	78.2	8	51	-43
Hand weeding twice	890	110	14	372	79.4	14	77	-63
Broadcast	680			389	78.2			
Row planted	840	160	24	390	78.8	21	-	-
No weeding	670			399	77.5			
Hand weeding once	790	120	18	398	79.0	16	64	-48
Hand weeding twice	820	150	22	371	79.0	20	87	-67

4.2.4 Flax

One reason for the extremely poor flax yields obtained by the farmers in the area is that the weeding is not properly done. From this trial can be concluded that the yield can be raised substantially and with a good profit by application of better weeding practices. It is also obvious that row drilling not only facilitates weeding but also provides for a substantial yield increase.

Variety : Local flax from Asella market
Spacing : 20 cm
Seed rate : 25 kg/ha
Date of seeding : July 24
Plot size : 24 m^2
No. of replications: 4
Dates of weeding : Oct. 8 (one weeding)
Aug. 29, Oct. 8 (two weedings)
Date of harvest : Dec. 3

Table 53. Hand weeding in broadcast and drilled flax

Treatment	Yield kg/ha	Yield increase kg/ha	Yield increase %	Weight of 1000 seeds gm	Weight of 1 hl kg	Value of yield increase ₹/ha	Cost for weeding ₹/ha	Profit ₹/ha
Broadcast								
Hand weeding once	810			3.59	69.8			
Hand weeding twice	1010	200	25	3.55	67.8	40	12	28
Drilled								
Hand weeding once	990			3.62	70.6			
Hand weeding twice	1070	80	8	3.55	70.0	16	-12[x]	28
Hand weeding once	900			3.61	70.2			
" " twice	1040	140	16	3.55	68.9	28	0	28
Broadcast	910			3.57	68.8			
Drilled	1030	120	13	3.59	70.3	24		

x Time required for two weedings 12 hours less than for one weeding

4.3 Herbicidal weed control

Since no chemical weed control has been applied in Chilalo up to now and consequently no selection of weeds has taken place, most common broadleaved weed species are susceptible to the herbicides widely used in other countries. The grasses on the other hand are a more serious problem, since grain crops occupy 75% of the arable area, and it is very difficult to control grasses by herbicides in grain crops. The results from the herbicide trials clearly demonstrate that there is an urgent need for grass herbicides. The yield increase from this type of herbicides will probably pay well for the extra cost and labour put in, whereas the profit from application in small grains of herbicides only controlling broadleaved weeds is not so obvious. This is somewhat surprising since the effect on the broadleaved weeds is excellent in terms of weed weight, some 80-95% for most herbicides. The explanation seems to be that the broadleaved weeds predominant in the beginning of the growing season, are later more or less replaced by a second flush of weeds, mainly grasses. The effect of the herbicide will then mainly be to provide space of grasses.

4.3.1 Chemical weed control in wheat and barley

Two trials were laid out in which exactly the same chemicals were used, in wheat and barley. They are recorded together below.

As was expected, the effects on weeds and yields were more or less the same in both trials. The barley was slightly more susceptible to the phenoxyacetic acids. Although it is widely assumed that grain crops should not be treated with this type of herbicides until the 5-leaf stage, the damage in these trials was negligible. As far as 2, 4-D - amine is concerned, however, a somewhat later stage should be preferred to avoid any risk of damage.

From an economic point of view, there is a profit from all treatments in wheat except 2,4-D-amine. Treatments b and f - h seem to be the most profitable ones. In barley, on the other hand, no treatment except linuron yields an appreciable profit, due to the lower product price.

The area where the trials were located was less infested with weeds, than the average of Kulumsa farm.

Variety : Kenya 1, Beka
Spacing : 20 cm
Seed rate : 100 kg/ha
Date of seeding : July 16
Plot size : 22.5 m^2
No. of replications: 4
Dates of treatment : July 30 (linuron), Aug. 6 (the rest)
Dates of harvest : Nov. 13 (barley), Nov. 28 (wheat)

Table 54 a. Chemical weed control in wheat and barley, yields and test weights.

Treatment	Kg of active ingredient/ha	Yield kg/ha		1000 seed weight gm		Hectolitre weight kg	
		Wheat	Barley	Wheat	Barley	Wheat	Barley
a Check		1870	1880	30.0	28.6	83.0	69.2
b MCPA	1.0	2030	1850	31.5	31.1	84.2	72.4
c 2,4-D amine	.8	1870	2010	32.0	29.6	83.0	69.8
d MCPA+ Mecoprop+ TBA	.4/.85/.1	2020	1920	31.6	31.9	82.8	68.8
e MCPA+dicamba	1.0/.07	2000	1960	30.6	30.7	82.6	69.6
f Dichlorprop	1. 9	2080	2090	31.8	30.4	83.8	68.8
g MCPA+ dichlorprop+ ioxinil	1.05/.45/.27	2090	2150	30.2	31.3	83.6	69.2
h Linuron	. 3	2080	2080	30.7	31.0	83.2	70.8

Linuron applied at the 2-leaf stage, the rest at the 3-leaf stage.

Table 54 b. Chemical weed control in wheat and barley, economics

Treatment	Yield increase over check					Value of yield increase			Profit	
	kg/ha		%							
	heat	Barley	Wheat	Barley	Mean	Wheat	Barley	cost	Wheat	Barley
a Check										
b MCPA	160	-30	9	-2	4	32	-4	19	13	-23
c 2,4-D amine	0	130	0	7	4	0	15	14	-14	1
d MCPA+ Mecoprop+ TBA	150	40	8	2	5	30	5	26	4	-21
e MCPA+dicamba	130	80	7	4	6	26	10	22	4	-12
f Dichlorprop	210	210	11	11	11	42	25	29	13	- 4
g MCPA+ dichlorprop+ ioxinil	220	270	12	14	13	44	32	29	15	3
h Linuron	210	200	11	11	11	42	24	14	28	10

Table 54 c. Chemical weed control in wheat and barley. Weights of weeds, gm/m^2, % weed control, and percentage of ear deformities.

Treatment	Weight, gm / m^2					Total, gm/m^2	% weed control	Deformed ears %	
	Polygonum nepalense	Guizotia scabra	Oxalis obliquifolia	Amaranthus angustifolius	Various broadleaved weeds			Wheat	Barley
a Check	702.4	15.9	7.7	46.8	80.7	853.5	0	.02	.00
b MCPA	18.4	7.4	6.4	9	6.3	39.4	95.4	.02	.13
c 2,4-D amine	10.8	-	6.6	-	10.2	27.6	96.8	.27	.28
d MCPA+ Mecoprop+ TBA	38.3	2.7	4.1	11.1	11.5	67.7	92.1	.02	.20
e MCPA+dicamba	5.3	.6	6.9	-	4.7	17.5	97.9	.01	.08
f Dichlorprop	27.3	5.8	9.4	16.7	12.8	72.0	91.6	.01	.00
g MCPA+ dichlorprop+ ioxinil	24.3	.2	7.2	-	11.0	42.7	95.0	.00	.05
h Linuron	107.3	4.2	10.1	7.7	22.9	152.2	82.2	.04	.03

4.3.2 Chemical weed control in teff

Post-emergent application of phenoxyacetic acids, mecoprop and dicamba did not cause any visual growth depression in the crop. Because the infestation of grasses, mainly Phalaris paradoxa, was so high, the crop was not harvested. Only the scores of broadleaved weeds are given below.

Table 55. Chemical weed control in teff. eights of weeds, gm/m^2, and % weed control.

Treatment	kg of a.i./ha	Weights of weeds gm/ m2						Total gm/m^2	% weed control
		Polygonum nepalense	Guizotia scabra	Oxalis obliquifolia	Corrigiola capensis ssp. africana	Amaranthus angustifolius	Various broad leaved		
No treatment		361	105	7	8	29	8	519	0
MCPA	1.0	67	17	5	4	6	6	105	80
2,4-D-amine	.8	22	24	9	4	6	4	69	87
MCPA+ dicamba	1.0+.07	20	15	17	2	2	2	58	89
Mecoprop	1.56	38	22	7	7	8	4	86	83

4.3.3 Chemical weed control in local and hybrid maize

Since weed problems are very serious in maize, the need for good weed control practices is urgent. Like manual weeding, herbicides have given a very good response and proved highly economical to use. Whilst unweeded maize has yielded extremely poorly, good hand weeding and chemicals have produced a yield increase in the range of 114-146%. It is also interesting to note that the hybrid maize outyields the local variety by no less than 117%, exactly the same as in the hand weeding trial. This indicates that the local maize should be replaced by better varieties as soon as possible.

From the economics point of view the chemicals have performed well compared to manual weeding, if the labour has to be hired at the rate of one dollar a day. If cheaper labour is available, hand weeding might be a more attractive alternative. The trial was carried out in row-planted maize which allows early weeding by hoe. The comparison would probably be more in favour of herbicides in broadcast maize, where early hand weeding is impracticable.

Varieties : Local maize from Asella market
Hybrid maize H 613 B

Spacing : 8 x 25 cm

Seed rate: Local maize 17 kg/ha
Hybrid maize 25 kg/ha

Date of seeding: April 16

Plot size: 28 m^2

No of replications : 3

Dates of treatment: Hand weeding May 14, July 11, Aug. 30
Atrazine April 24
2,4-D ester May 14

Dates of harvest: Local maize Nov. 14
Hybrid maize Dec. 11-12

Table 56 a. Chemical weed control in maize. Yields and agronomic data

Variety, treatment	Yield kg/ha	Yield increase kg/ha	Yield increase %	Weight of 1000 seeds gm	Weight of 1 hl. kg	No. of Plants/ha	No. of Cobs/ha	Cobs/plant	Yield/cob gm
Local maize									
No treatment	400			199	71.2	31,100	17,100	.55	23
Proper hand weeding	3170	2770	693	249	74.0	28,100	51,900	1.48	61
Atrazine, 2.2 kg a.i./ha pre-em	2950	2250	638	255	75.0	29,500	48,600	1.65	61
2.4-D ester, 0.9 kg a.i./ha postem	1690	1290	323	256	74.4	30,800	34,200	1.11	49
Hybrid maize									
No treatment	2890			350	75.0	34,000	37,100	1.09	80
Proper hand weeding	4430	1540	53	371	75.4	36,900	49,000	1.33	90
Atrazine, 2.2 kg a.i./ha pre-em	5150	2260	78	372	75.8	34,200	51,700	1.51	100
2,4- D ester, 0.9 kg a.i./ha postem	5340	2450	85	391	75.2	35,700	51,300	1.44	104
No treatment	1640			-	73.1	32,600	27,100	.83	61
Proper hand weeding	3800	2160	131	-	74.7	36,000	50,500	1.40	75
Atrazine	4050	2410	146	-	75.4	31,800	50,100	1.57	81
2,4-D ester	3520	1880	114	-	74.8	33,300	42,700	1.28	82
Local maize	2050			240	73.7	31,600	37,900	1.20	54
Hybrid maize	4450	2450	117	371	75.3	35,200	47,300	1.34	94

Table 56 b. Economics of different weed control measures in maize

Entry	Treatment	Value of yield increase ₹/ha	Cost ₹/ha	Profit ₹/ha
a	No treatment	-		
b	Proper hand weeding	216	68	148
c	Atrazine, 2.2 kg. a.i./ha pre-em	241	87	154
d	2,4-D ester, 0.9 kg a.i./ha postem	188	15	173

Table 56 c. Chemical weed control in maize. Weights of weeds, gm/m^2 and % weed control

Treatment	Broadleaved weeds		Grasses		Total	
	gm/m^2	% control	gm/m^2	% control	gm/m^2	% control
No treatment	142	0	87	0	229	0
Proper hand weeding	0	100	2	98	2	99
Atrazine, 2.2 kg a.i./ha pre-em	0	100	11	87	11	95
2,4-D- ester, 0.9 kg a.i/ ha postem	40	72	167	0	207	10

4.3.4 Chemical weed control in broad beans

Five chemicals were applied pre-emergent and tested for weed control in broad beans. All showed surprisingly poor results. Since the yield was also poor, no profit was obtained from any of the treatments.

Spacing: 40 cm
Seed rate: 100 kg/ha
Date of seeding: July 13
Plot size: 27 m^2
No. of replications: 4
Date of treatment: July 20
Date of harvest: Nov. 15

Table 57a. Yield and test weights from a herbicide trial in broad beans.

Entry	Treatment	kg of a.i./ha	Yield kg/ha	Yield increase		Weight of 1000 seeds, gm	1 hl, kg
				kg/ha	%		
a	No treatment	.75	610			77.2	488
b	Metobromuron	.75	550	-60	-9	77.8	460
c	Atrazine	.75	650	40	8	77.8	488
d	CIPC	1.0	560	-50	-8	77.0	470
e	Linuron	.75	570	-40	-5	77.0	484
f	Dinoseb	2.0	550	-60	-9	77.4	490

Table 57 b Chemical weed control in broad beans. Weights of weeds.

Entry (see table 57a)	Polygonum nepalense	Commelina latifolia	Corrigiola capensis ssp. africana	Guizotia scabra	Weights of weeds gm./m^2			
					Various broad-leaved weeds	Setaria pallide-fusca	Lolium temulentum	Avena strigosa
a	376	118	88	115	273	908	165	453
b	135	47	47	9	298	657	54	433
c	204	52	23	177	217	783	47	602
d	194	62	54	262	175	840	0	344
e	354	1	19	12	149	696	52	280
f	88	50	27	129	138	414	72	645

gm./m^2. and % weed control.

Broad leaved weeds		Grasses		Total	
gm/m^2	%Control	gm/m^2	%Control	gm/m^2	%Control
970	0	1526	0	2496	0
536	45	1144	25	1680	33
673	30	1432	6	2105	16
747	23	1184	23	1931	23
535	45	1028	32	1563	37
432	55	1131	26	1563	37

4.3.5 Chemical weed control in flax

Due to a purposely bad seedbed preparation, the trial area was badly infested with gramineous weeds, mainly Phalaris paradoxa. Since grasses constitute the most serious part of the weed problem, this condition corresponds well to the general situation in the project area. Although the flax yield in the trial was low, due to the serious competition from weeds, the result is interesting, since it indicates a good potentiality for yield increase by use of grass herbicides such as dalapon. All herbicides were applied post-emergent.

Variety: Local flax from Asella market
Spacing: 20 cm.
Seed rate: 25 kg/ha
Date of seeding: July 17
Plot size: 30 m^2
No. of replications: 4
Date of treatment: Aug. 13 Height of flax 5 - 6 cm.
Date of harvest: Nov. 25.

Table 58 a Chemical weed control in flax. Yield, test weights and profitability.

Treatment	Kg of a.i./ ha.	Yield kg/ha	Increase over check kg/ha	Increase over check %	Weight of 1000 seeds gm	Weight of 1 hl. kg	Value yield increase $/ha	Cost $/ha	Profit $/ha
No treatment		250			31.9	70.0			
MCPA	.25	330	80	32	30.7	69.6	16:-	16:-	0
Linuron	.4	280	30	12	31.4	70.2	6:-	16:-	-10:-
Dalapon	1.7	610	360	144	33.6	70.0	72:-	20:-	52:-

Table 58 b Chemical weed control in flax. Weights of weeds, gm./m^2 and % weed control

Treatment	Polygonum nepalense	Guizotia scabra	Various broadleaved	Broadleaved weeds gm/m^2	Broadleaved weeds % control	Grasses (estimated) gm/m^2	Grasses (estimated) % control	Total gm/m^2	Total % control
No treatment	356	33	24	413	0	1040	0	1453	0
MCPA	104	13	3	120	71	1040	0	1160	20
Linuron	87	21	18	126	69	1080	0	1206	17
Dalapon	188	28	28	244	41	360	65	604	58

4.3.6 Chemical weed control in rape.

Oil rape is a very interesting crop for the project area, not only because it is a high yielding crop but also from the weed control aspect. It has a lush and rapid growth and competes successfully with both broadleaved and gramineous weeds. Even better control will be achieved if TCA is applied before planting, which this trial was designed to establish. The major question is whether, or at what dosage, an economic yield increase will be obtained from the herbicide treatment. Unfortunately no answer to this question could be given by the trial since it was destroyed before harvest. Therefore only the weed scores can be given here.

Variety: Local rape from the Swedish Mission, Asella
Spacing: 40 cm.
Seed rate: 6 kg/ha
Date of treatment: July 9
Date of seeding; July 15
Plot size: 45 m^2
No. of replications: 4

Table 59 Weed score from TCA treatments of rape, gm./m.^{2} and % control.

Treatment	Avena strigosa	Setaria pallidefusca	Polygonum nepalense	Weights of weeds, gm/m.^{2} Commelina latifolia	Oxalis obliquifolia	Various grasses	Various broadleaved	Grasses gm/m^2	Grasses %control	Broadleaved weeds gm/m^2	Broadleaved weeds %control	Total gm/m^2	Total %control
No treatment	751	223	2202	27	19	76	7	1050		2255		3305	0
10 kg TCA/ha	165	19	181	40	48	0	76	184	82	345	85	529	84
20 kg TCA/ha	79	9	342	22	18	0	36	88	92	418	81	506	85

4.4 Chemical control of Avena species in wheat and teff.

The two commercially available products for control of wild oats, Avadex BW and Carbyne, were tried at different sites on Kulumsa farm. The Avena species occurring on Kulumsa farm are mainly A. strigosa and, to a much lesser extent, A. abyssinca.

4.4.1 Wheat

The effects of the chemicals were good, the best treatment causing a weight decrease of the weeds in the range of 80 percent. The frequency of weeds, however, was so low that the yields from the different entries were not significantly affected by the treatments. No yield decreases due to harmful effects caused by the chemicals can be detected.

Variety: Supremo Kenya x Yaqui 48

Spacing: 20 cm.

Seed rate: 100 kg/ha

Date of seeding: July 13

Plot size: 27 m^2

No. of replications: 4

Dates of treatments: July 16 (Avadex), July 31 (Carbyne), Oct. 10 (hand weeding)

Date of harvest: Nov. 21

Table 60 Chemical control of Avena species in wheat

Treatment	Yield kg/ha	Yield increase over check		Weed control, %of weights	Weight of	
		kg/ha	%		1000 seeds gm	1 hl kg
Check	1310			0	27.8	81.4
Hand weeding	1290	-20	-2	100	28.6	81.6
Avadex BW, 2 l/ha	1380	70	5	63	29.3	81.4
" " 3 l/ha	1210	100	-8	76	28.3	81.0
" " 4 l/ha	1360	50	4	81	27.9	81.6
" " 3 l/ha	1290	-20	-2	75	28.9	81.0

4.4.2 Teff

By mistake the whole trial area was hand weed, and therefore no weed counts were made. The yield figures are interesting, however, since it seems likely that the higher doses of Avadex BW have decreased the yield. From this information can be concluded that Avadex BW should not be used in teff until further knowledge on its harmful properties is available.

Since the price of Avadex and Carbyne is about $15:- /lit., it is obvious that the treatments are not profitable either in wheat or teff at this level of weed infestation.

Spacing: 20 cm.
Seed rate: 30 kg/ha
Date of seeding: Aug. 7
Plot size: 27 m²
No. of replications: 4
Dates of treatments: July 19 (Avadex), Aug. 29 (Carbyne), Oct. 20 (hand weeding)
Date of harvest: Dec. 25

Table 61 Chemical control of Avena species in teff.

Treatment	Yield kg/ha	Yield increase over check		Hectoliter weight kg
		kg/ha	%	
Check	1370			87.4
Hand weeding	1520	150	11	87.6
Avadex BW 2 l/ha	1550	180	13	87.4
Avadex BW 3 l/ha	1250	-120	-9	87.8
Avadex BW 4 l/ha	1180	-190	-14	87.6
Carbyne, 3 l/ha	1340	-30	-2	87.8

5. INSECT CONTROL

5.1 Observation plots with different chemicals for control of cutworms on maize

The treatment was done when the attack was well under way, that is, too late from a practical point of view. However, although the attack was rather severe, a good control was obtained. The best treatment seemed to be dieldrin worked into the soil.

The maize was planted on May 10 and the treatments were carried out on May 29. Data about the observation plots:

	% surviving plants as percentage of surviving plants on check plot
No treatment	100
DDT, 10 kg. of 5% dust/ha	111
Dieldrin, 20 kg. of 2% dust/ha	113
" 100 " " " " " worked into the soil	123
Malathion, 1.5 l. of 50% E.C./ha	107

5.2 Control of stalk-borers on maize.

Cutworms and stalkborers caused severe yield losses on maize crops in the Kulumsa area in 1968. In two estimations, carried out partly on farmers' fields around Kulumsa, partly on Kulumsa farm, the number of plants attacked from each pest was 12-15% of the total plant population. In the stalkborer trial the percentage was somewhat higher, and the insecticide treatment reduced the number of attacked plants per hectare by 72%. This reduction caused a substantial yield increase which pays well for the cost of the treatment. It might be profitable, however, to decrease the number of treatments from four to two or three.

Variety: Local maize from Asella market
Spacing: 80 x 25 cm.
Seed rate: 17 kg/ha
Date of Planting: April 16
Plot size: 33.6 m^2
No. of replications: 4
Dates of treatment: June 11, 20, 27, July 4
Chemical: DDT, 25% M.L., 0.5 kg a.i./treatment
Date of harvest: Dec. 24

Table 62 Control of stalk-borers on maize.

Treatment	Yield kg/ha	Increase over check kg/ha	%	Weight of 1000 seeds gm	1 hl. kg	plants/ ha
No treatment	2390			275	77.0	30,600
DDT dust	3160	770	32	259	76.0	26,900

No of Cobs/ ha	Cobs/ plant	Yield /cob, gm	Attacked plants, %	Value of yield increase	Cost	Net profit
38,800	1.27	62	16.9	-	-	-
46,600	1.73	68	4.7	77:-	46:-	31:-

6. DISEASE CONTROL

6.1 Seed-dressing

6.1.1 Seed-dressing of Wheat

Two seed-dressing trials were carried out to establish whether seed-borne diseases on wheat are of any significance in the Kulumsa area. Bunt or stinking smut (Tilletia foetida) is a bad problem at altitudes above 2,400m. in Chilalo.

It is not known if there are other important seed-borne diseases, and therefore, one trial was laid out with four different wheat varieties, underessed and dressed with mercury. Kentana Frontana x Mayo 48 proved a very good yielder outyielding the poorest variety, Kenya 1, by 86%. The seed-dressing caused a yield increase of 32% irrespective of variety. This is remarkably high, and it is not known what disease caused the difference.

The purple wheat ("Tikur") seed was badly infested by bunt, but the attack on the crop was not very severe. It was bad enough to lower the quality, however, but this has not been taken into consideration in the return calculations.

Spacing:	20 cm.
Seed rate:	100 kg/ha
Date of seeding:	July 19
Dressing:	Mercury (200 gm. of Agrosan GN/100 kg. of seed)
Plot size:	18 m^2
No. of replications:	4
Date of harvest:	Dec. 2

Table 63 Control of seed-borne diseases on wheat.

Variety	Treatment	Yield kg/ha	Yield increase kg/ha	Yield increase %	Weight of 1000 seeds gm	Weight of 1 hl. kg	No of smut ears/ ha	Value of yield increase £/ha	Cost for dressing £/ha	Profit £/ha
Kenya 1	undressed	1100			28.0	83.0	0	-	-	-
	dressed	1320	220	20	29.4	80.8	0	44:-	3:-	41:-
K.F.xMayo 48	undressed	1900			24.4	78.0	0	-	-	-
	dressed	2630	730	38	26.2	81.6	0	146:-	3:-	143:-
"Tikur sinde"	undressed	1140			25.9	71.8	28,000	-	-	-
	dressed	1530	390	34	25.6	73.6	0	78:-	3:-	75:-
"Bawnde"	undressed	1080			22.1	68.2	0	-	-	-
	dressed	1390	310	29	23.2	74.2	0	62:-	3:-	59:-
All varieties	undressed	1310			25.1	75.3		-	-	-
	dressed	1720	410	32	26.1	77.6		82:-	3:-	79:-
Kenya 1		1210			28.7	81.9				
K.F.xMayo 48	undressed and dressed	2260	1050	86	25.3	79.8				
"Tikur sinde"		1330	120	10	25.8	72.7				
"Bawnde"		1240	30	2	22.7	71.2				

6.1.2 Seed-dressing of barley

Seed-dressing of barley was tested in order to estimate the yield losses from attacks of seed-borne diseases and barley fly. As far as diseases are concerned, only a very slight attack from loose smut was observed on the Arusso variety. The local varieties responded to seed-dressing with a yield decrease, whereas some improvement of yields was achieved in the introduced varieties, which paid for the treatment. There is an interesting difference in resistance to barley fly attack, since the introduced varieties seem to be more susceptible than the local ones. The attack from barley fly was somewhat mitigated by aldrin dressing.

Spacing: 20 cm.
Seed rate: 100 kg/ha
Date of seeding: July 19
Dressings: Mercury (200 gm. of Agrosan GN/100 kg of seed)
Mercury + aldrin (100 gm. of Aldrex M/100 kg of seed)
Plot size: 18 m^2
No. of replications: 4
Dates of harvest: Oct. 28 (Mari), Nov. 6 (Arusso),
Nov. 25 ("Tikur gebs," Beka).

Table 64 Seed-dressing of barley.

Variety	Treatment	Yield kg/ha	Yield increase kg/ha	Yield increase %	Weight of 1000 seeds gm	Weight of 1 hl. kg	% Barley fly attack
Arusso	undressed	2800			40.9	65.0	1.19
	Hg	2440	-360	-13	40.4	61.8	.63
	Hg + aldrin	2300	-500	-18	41.2	65.4	.21
Mari	undressed	1480			32.9	69.8	3.64
	Hg	1580	+100	7	32.0	69.2	4.17
	Hg + aldrin	1490	+ 10	1	33.3	70.2	1.23
"Tikur gebs"	undressed	990			34.5	60.4	2.45
	Hg.	800	-190	-19	32.7	59.2	2.92
	Hg + aldrin	610	-380	-38	30.3	59.0	1.31
Beka	undressed	1770			33.9	69.2	5.27
	Hg	1900	130	7	33.0	69.2	8.33
	Hg + aldrin	1890	120	7	33.1	69.4	5.63
Arusso	undressed and dressed	2510			40.8	64.1	.68
Mari		1520	-990	-39	32.7	69.7	3.01
"Tikur gebs"		800	-1710	-68	32.5	69.5	2.23
Beka		1850	-660	-26	33.3	69.3	6.41
All Varieties	undressed	1760			35.6	66.1	3.14
	Hg	1680	-80	- 5	34.5	64.9	4.01
	Hg + aldrin	1570	-190	-11	34.5	66.0	2.10

6.1.3 Seed-dressing of maize

Whereas the local Asella maize yielded about the same when treated as untreated, in Jimma maize there was a considerable yield decrease from seed-dressing with mercury. Obviously the toxic effect from the chemical had a greater impact on the yield than the fungicidal action. The number of cobs per plant was signficantly higher on the untreated plots.

Spacing: 80 x 25 cm.
Seed rate: 24 kg/ha (hybrid), 18 kg/ha (Jimma), 14 kg/ha (local)
Date of planting: April 11
Plot size: 11.2 m^2
No. of replications: 3
Dates of harvest: Nov. 13 (local), Dec. 11 (hybrid + Jimma)

Table 65 Control of seed-borne diseases of maize.

Variety, treatment	Yield, kg/ha	Yield increase kg/ha	Yield increase %	Weight of 1000 seeds gm	Weight of 1 hl. kg	No of Plants/ ha	No of Cobs/ ha	Cobs/ plant	Yield/ cob, gm
Hybrid H 613B dressed with thiram + lindane	8530			474	76.8	49,100	57,700	1.18	148
Jimma maize, untreated	5720			370	75.0	37,800	52,400	1.39	109
Jimma maize, dressed with Hg	4190	-1530	27	357	74.2	35,400	38.700	1.09	108
Local maize, untreated	5010			271	75.8	34,500	69,600	2.02	72
Local maize, dressed with Hg	5190	80	2	273	75.6	39.300	71,400	1.82	73
Jimma + local maize:									
Untreated	5370			321	75.4	36,200	61,000	1.69	88
Seed-dressed	4690	-680	-13	315	74.9	37,400	55,100	1.47	85
Jimma maize	4960			364	74.6	36,600	45,500	1.24	109
Local maize	5100	140	3	272	75.7	36,900	70,500	1.91	72

6.1.4 Seed-dressing of chickpeas

It is commonly stated in the area that chickpeas should be planted late to get an acceptable yield. It was suspected that the substantial yield decreases reported from early planting might be due to heavy attacks from some disease. The trial was designed to find out whether the yield from a moderately early planting could be raised by seed-dressing. The variety used has small white seeds and turned out to be very susceptible to seed rot. As indicated by the plant count, seed-dressing raised the population considerably, and also the yields are very much in favor of seed-dressing.

Although seed dressing raised the yield and is profitable, even in the best entry the number of plants surviving two months after seeding represent only a little more than 50% of the seed rate per hectare. Since there are better yielding varieties, which are more or less resistant to root rot, these varieties should have preference, although they might not be popular due to their dark seed colour.

Variety: DZ 10-4
Spacing: 20 cm.
Seed rate: 50 kg/ha
Date of seeding: Aug. 8
Dressings: Aldrin, 40%, 100 gm/100 kg. of seed
Brassicol, (75% quintozen) 100 gm/100 kg of seed+Aldrin, 40% 100 gm/100 kg of seed
Aldrex T (25% thiram + 25% aldrin) 400 gm/100 kg of seed
Aldrex M (2% Hg + 40% aldrin) 100 gm/100 kg of seed
Plot size: 26.4 m^2
No. of replications: 4
Date of harvest: Jan. 1, 1969

Table 66 Control of seed-borne diseases on chickpeas

Treatment	Yield kg/ha	Yield increase kg/ha	Yield increase %	Weight of 1000 seeds gm	Weight of 1 hl. kg	No of plants/ ha Oct. 9	Value of yield increase $/ha	Cost for dressing $/ha	Profit $/ha
No seed-dressing	430			89.8	77.0	177,000	-	-	-
Aldrin	530	100	23	89.5	76.4	209,000	17:-	2:-	15:-
Brassicol + Aldrin	520	90	22	84.5	76.0	317,000	15:-	2:-	13:-
Aldrex T	560	130	31	82.6	76.0	355,000	22:-	3:-	19:-
Aldrex M	610	180	44	84.4	76.8	311,000	31:-	2:-	29:-

C. FORAGE CROPS

In Chilalo awraja, the grasslands are grazed intensively. Overgrazing is common. No fodder is specially grown, therefore, it is inevitable that there is no forage rotation. Because of this the vegetation cover is severely damaged.

In order to improve the existing condition, different forage crops from various parts of the world have been seeded at the Kulumsa farm. An introductory experiment with collected seeds of indigenous grass and leguminous species has been carried out at the Kulumsa farm in order to study their value for grazing and cutting.

Experiments for studying grazing and production of complementary fodder on natural grassland have been laid out at the Livestock farm to find out the possibilities of increasing the total fodder production and improving the quality of the fodder. In these trials, the botanical compositon is analysed to see if there are any changes in regard to different managements.

The results of the 1967 fertilizer trial on the Demonstration farm showed that natural grassland gave high response to phosphate and nitrogen application. This has been confirmed by the results of this year's trials.

7. OBSERVATION OF FODDER CROPS.

7.1 Observation of different introduced forage crops at the Kulumsa farm

Some of the fodder crops that were planted in 1966 and 1967 were kept and harvested during 1968. New observation plots were established to give some additional information about suitable fodder crops for the Kulumsa area. Approximately 40 different fodder crops were observed. The most promising ones were harvested. Generally no fertilizer has been applied.

7.1.1 Observation plots planted in 1966

From the observation plots planted in 1966, it is worth mentioning that the legumes alfalfa (Medicago sativa) and esparsett (Onabrychis sativa) have been doing quite well. Red clover (Trifolium arvense), which was mentioned in last year's report as promising and even this year yielded very well (declined after) having been harvested and most of the plants died during the dry season. Birdsfoot trefoil (Lotus corniculatus) was growing well but has not been harvested.

Table 67. Results of observations of various legumes planted in 1968.

Planting date: July 28, 1968

Spacing: 30 cm.

Seeding rate: Clover 25 kg. per hectare. The other fodder crops were sown by hand.

Fertilizer: No fertilizer

Plot size: 4.8 m^2

Crop/Variety	Stages	Height cm	Harvesting date	Yield, kg/ha	
				Green matter	Dry matter
Onabrychis sativa					
Esparsett	After flowering seed formed	70	22/10/1968	28330	8360
Lupinella No.13.667	After flowering Seed formed	75	22/10/1968	22290	7290
Trifolium pratense					
Red clover Markense	—	—	18/ 9/1968	30920	8410
	Flowering	55	22/10/1968	18130	4900
			Total	49050	13310
Red clover Qudensgard	Flowering	60	22/10/1968	13540	5000
Medicago sativa					
Alfalfa Hairy peruvian	—	—	6/ 9/1968	14730	4010
	Beg. flowering		22/10/1968	14420	3890
	Budding	50	26/ 3/1969	16670	4430
			Total	45820	12330
Alfalfa Cape province	—	—	6/ 9/1968	11100	3120
	Beg. flowering		22/10/1968	7710	2070
	Budding	35	26/ 3/1969	11460	3210
			Total	30270	8400
Alfalfa Africana	—	—	6/ 9/1968	8080	2500
	Beg. flowering		22/10/1968	8960	2700
	Budding	40	26/ 3/1969	10630	2340
			Total	27670	7540

As the plots are very small there are very big border effects and the figures give only an approximate idea about the production capacity.

7.1.2 Observation plots planted in 1967.

From the observation plots planted in 1967, alfalfa and silverleaf desmodium (Desmodium uncinatum) seem to be the most promising perennial legumes. Kenya white clover has been found to be the best one among the tested white clovers, but still it gave no substantial yield this year.

Among the tested grass species, nandi setaria (Setaria sphacelata) and rhodes grass (Chloris gayana) seem to be very productive. These grasses as well as sudan grass (Sorghum sudanese) and columbus grass (Sorghum almum) are drought resistant and stood green almost throughout the whole dry season.

Crop such as white clover (Trifolium repense and Trifolium semipolisum), tall fescue (Festuca arundinacea), cooks foot (Dactylis glomerata) perennial ryegrass (Lolium perenne), westerwolths ryegrass (Lolium multiflorum var. westerwoldicum) and Italian ryegrass (Lolium multiflorum) were growing but did not give any substantial yield.

Table 68 shows the results of some alfalfa varieties.

Table 68. Observation of some alfalfa varieties

Planting date: July 21, 1967

Spacing: 20 cm.

Seeding rate: 25 kg per hectare

Fertilizer application: Half of each plot was fertilized with 300 kg superphosphate (20% P_2O_5) per hectare.

Date of fertilizer application: April, 1968

Plot size: From 19 m^2 to 45 m^2

Replications: 2

Harvest date	Yield, kg dry matter per hectare		
	"Italian" from Casa Agricola	"Alfa" from Weibullsholm	"Isreal" from Simlaw's
Unfertilized			
Sept. 6,1968	3,310	1,400	2,050
Oct.22,1968	4,290	2,000	2,700
March 26,1968	2,100	800	2,000
Total yield	9,700	4,200	6,750
Fertilized			
Sept. 6,1968	3,580	2,030	3,410
Oct. 22,1968	4,240	2,250	3,280
March 26,1969	2,770	1,250	3,640
Total yield	10,590	5,530	10,330

7.1.3. Observation plots planted 1968.

In the observation plots planted in 1968, very satisfactory results have been obtained from fodderbeets (Beta vulgaris). The beets stood green throughout the dry season (October - February) and if the farmers cultivate this crop they can "store" the roots in the ground and harvest according to their needs. The fodderbeets increased in yield from November 12 to February 3 by more than 100%.

Table 69. Results of observation plots of fodder beets and mangolds at Kulumsa farm.

Planting date: July 18, 1968

Spacing: 60 cm.

Fertilizers: Parts of the plots where fertilized with 100 kg triple superphosphate (46 % P_2O_5) and 20 kg borax per hectare (July 18,1968) and 200 kg urea per hectare (October 22, 1968).

Plot size: 43.2 m^2 of which 28.8 m^2 were fertilized.

Crop/variety	Harvesting date	Yield of green matter, kg/ha		%DM of roots
		Leaves	Roots	
Fodder beet, Red Otofte				
Unfertilized	November 12	4,900	3,540	
- " -	February 3	6,870	13,160	
Fertilized	November 12	19,900	22,970	18
- " -	February 3	15,350	58,330	18
Mangold, long Red Mammoth				
Unfertilized	November 12	4,900	2,500	
- " -	February 3	15,830	12,920	
Fertilized	November 12	18,000	19,530	15
- " -	February 3	12,940	45,070	19

Among other forages tested marrow stemmed kale (Brassica oleracea), rape (Brassica napus var. oleifera) for fodder, oats (Avena sativa) cultivated alone or in combination with vetches (Vicia sativa) or lupins (Lupinus sp.) yielded well. Nandi setaria, rhodes grass and coloured guinea (Panicum coloratum) seem very promising although they did not give any substantial yield.

The annual legume subteranean clover (Trifolium subterraneum) was grown, but gave no yield. Another legume cow peas (Vigna sp.) failed.

Table 70. Results of observation plots of forage crops at the Kulumsa farm, 1968

Planting date: July 31, 1968

Spacing: Marrow stemmed kale 60 cm. Other crops 20 cm.

Seeding rate: Legumes 25 - 30 kg/ha. Oats, vetches 150 kg/ha.

Fertilization: Parts of the plots with marrow stemmed kale and rape where fertilized with 100 kg triple superphosphate (46% P_2O_5) and 20 kg borax per hectare (July 18,1968) and 200 kg. urea (46% N) per hectare (October 22, 1968).

Plot size: Marrow stemmed kale, rape and oats 43.2 m^2. Other crops 28.8 m^2

Crop/variety	Stages	Harvesting date	Yield, kg/ha		Remarks
			Green matter	Dry matter	
Marrow stemmed kale					
Unfertilized	20 cm.	Nov. 12	2,640	480	
Fertilized	60 cm.	Nov. 12	22,740	3,890	Attacked by cabbage moth
Rape, grand essex					
Unfertilized	10 cm.	Nov. 12	12,630	1,960	
Fertilized	30 cm.	Nov. 12	29,720	3,840	
Oats					
Alamo	Heading	Oct. 30	13,910	3,590	
-"-	End of heading	Nov. 12	16,410	4,480	
Suregrain	Heading	Oct. 30	15,640	4,070	
- " -	End of heading	Nov. 12	16,280	4,710	
Lampton	Beg. of heading	Oct. 30	20,380	5,650	
- " -	End of heading	Nov. 12	19,420	6,390	
Sorghum					
Sudan grass	Just bef. heading	Oct. 30	6,020	1,260	
- " -	Regrowth	Dec. 10	4,500	1,080	
		Total	10,520	2,340	

Table 70 continued.

Sudan grass	Beg. of heading	Nov. 12	6,850	1,660
- " -	Flowering	Dec. 10	8,210	2,700
Columbus grass	Beg. of heading	Oct. 30	6,570	1,450
- " -	Beg. of heading	Nov. 12	6,850	1,624
- " -	Flowering	Dec. 10	10,520	3,120
1/3 vetches 2/3 Lampton		Oct. 30	19,620	5,470
- " -		Nov. 12	17,820	5,770
1/3 Lupin 2/3 Lampton		Oct. 30	19,290	4,260
Vetches	Beg. maturity	Oct. 30	10,610	2,820
Lupin	Beg. maturity	Oct. 30	18,270	3,090
Cow peas	Growing but no yield very short.			

Tabor clover (single cut) was grown for seed production. The seed was planted July 24. Spacing 20 cm and seeding rate 25 kg per hectare. Part of the plot was fertilized with 100 kg triple superphosphate and 20 kg borax per hectare, applied in July 24. Suprisingly the fertilized and unfertilized parts gave the same yield, 580 kg per hectare.

7.2 Observation of indigenous grasses and legumes.

7.2.1 Observation of teff as fodder crop.

Some teff (Eragrostis tef) varieties were compared as fodder crop on small plots. According to table 71, big differences were detected in the capacity of the different varieties to produce fodder.

Table 71. Results of observation plots of teff as a fodder crop at the Kulumsa farm, 1968.

Planting date: August 8, 1968

Spacing: 20 cm.

Fertilizer: 0

Plot size: 6 m^2

Harvesting date: Oct. 30, 1968

Stages: Bef.- beg. of maturity

Variety	Yield, kg/ha		Dry matter relative numbers
	Green matter	Dry matter	
A-53	5,060	1,780	100
A-39	7,170	2,390	134
A-63	3,960	1,420	80
A-44	8,350	3,160	177
DZ-01-354	12,180	4,570	256
DZ-01-238	8,400	2,980	167
DZ-01-239	7,120	2,610	146
DZ-01-186	8,400	2,630	147
DZ-01-200	11,870	4,070	228
DZ-01-248	7,870	2,630	147
DZ-01-197	9,710	3,450	193
DZ-01-146	8,220	2,520	141
DZ-01-196	9,280	3,140	176
DZ-01-362	11,340	4,300	241
DZ-01-257	8,530	2,900	163
Zenge	8,700	2,820	153
A-128	13,010	4,180	243
A-170	13,280	5,140	288
A-71	13,230	4,630	260

7.2.2 Observations of different indigenous grass and leguminous species.

Seeds were collected during the last part of 1967 and planted in 1968 at the Kulumsa farm. The laboratory tests showed that some of the seeds had low germination capacity. Snowdenia polystachya (annual) which yielded quite well, emerged one and a half weeks after planting , July 11, 1968. Weeds were a serious problem Phalaris paradoxa and Setaria acromelana were the predominating ones.

Table 72. Results of the germination test of indigenous grass and leguminous species.

No.	Species	Germinated %	Hard %	Fresh ungerminated %	Nunviable seed %
3	Andropogon abyssinicus	18		31	51
4	Andropogon chrysostachys	78		15	94
10	Hyparrhenia hirta	3		15	82
6	Hyparrhenia sp.	39		12	49
7	Hyparrhenia sp.	8		32	60
8	Hyparrhenia sp.	6			94
12	Hyparrhenia sp.	22		32	46
11	Themeda triandra	13		43	44
9	Trifolium sp.	10	90		
5	Snowdenia polystachya	4		35	61

Some remarks concerning the indigenous grasses and legumes are presented in Table 73.

Pennisetum clandestium, Cynodon dactylon and one of the Hyparrhenia

Sp. (No. 12) seems to be the most promising species.

Table 73. Observation of some indigenous grasses and leguminous species at Kulumsa in 1968.

No.	Species	Planting date	Germination	Seed production	REMARKS
1.	Andropogon abyssinicus	July 25	Planted vegetatively	Matured Nov. 2 Good	Very little yield. After the seed was harvested the plants wilted. Seems annual.
2.	Pennisetum clandestinum	July 25	Planted vegetatively	No seed	The plants spread by stolons rather rapidly and at the end of January 1969 about 50% of the area was covered. During the small rains the plants spread and in the end of March they covered almost the whole plot. No substantial yield. Much fungys on the leaves on the fertilized plot.
3.	Andropogon abyssinicus	July 11	Good	Matured Dec. 10 Good	Very little yield. After the seed was harvested the plant wilted. Seems annual.
4.	Andropogon chrysostachyus	July 11	No seed germinated		
5.	Snowdenia polystachya	July 11	Very good		Rather good growth. Harvested Sept. 9. 4300 kg dry matter per hectare. On the fertilized plot good growth March 31, 1969. On the unfertilized plot most of the plants were dead March 31.
6.	Hyparrhenia sp.	July 11	Rather good	Matured end of March 1969 Good	No substantial yield. Flowering Jan. 22, 1969.
7.	Hyparrhenia sp.	July 11	Bad	Matured beg, of Jan. 1969 V.good	Very little yield. After the seed was harvested the plants wilted. Seems annual.
8.	Hyparrhenia sp.	July 11	Very bad		Only a few plants. Flowering Feb, 1969.
9.	Trifolium sp.	July 11	No. seed germ		

Table 73, continued

No	Species	Planting date	Germination	Seed production	REMARKS
10	Hyparrhenia hirta	July 11 first sprouting Jan. 1969	Very bad		Only a few plants. No substantial yield. Flowering Feb. - March 1969.
11	Themeda triandra	July 11	Few seed germinated		Only a few plants. No substantial yield. Flowering April 1969.
12	Hyparrhenia sp.	July 11	Good	Matured end of Jan. 1969	No substantial yield. On the fertilized plot good growth by March 31, 1969. The best Hyparrhenia.
13.	Cynodon sp.	July 25	Planting veg.		The plants spread by long stolons(up to 3m) At the end of Jan. 1969, about 30% of the area was covered by March 31st, 50-60%. Much better growth on the fertilized plot.
14.	Cynodon dactylon	July 25	Planted veg.	Matured end of Jan. few racemes	The plants spread by long stolons (up to 2m). At the end of Jan. about 40% of the area was covered. Much better growth on the fertilized plot.
15.	Pennisetum glabrum	July 25	Planted veg.	Matured end of Jan. 1969 few racemes	No substantial yield. Short stolons.

8.1 Fertilizer trials.

8.1.1 Rate of phosphate and nitrogen application on natural grassland

On the demonstration and the livestock farms at Asella, two fertilizer trials with phosphorous and nitrogen were carried out on natural grassland. Very good response was given to these nutrients. It seems that the application of fertilizers to natural grassland is important for future production of fodder.

Table 74 and 75 show the effect of phosphate and nitrogen on yield of drymatter. The tables give also an idea about the costs of fodder production by fertilizer applications. According to these trials a fertilizer application of 40 kg P_2O_5 and 120 kg N per hectare seems reasonable. Production cost for the yield increase for the above mentioned fertilizers would be about 3 cents per kg dry matter.

Table 74. The effect of phosphate and nitrogen on yield of hay from natural grassland.

Location: Asella, Demonstration farm

Started: 1967

Date of fertilizer application: Superphosphate (20% P_2O_5) April 9, 1968
Urea (46%N) May 8,1968

Harvesting date: October 15, 1968

Plot size, gross: 48 m^2

net: 48 m^2

Replications: 4

Amount of		Yield, kg. per ha.					
P_2O_5 kg/ha	N kg/ha	Green matter	Dry matter	D.M Increase over control	Relative numbers	Fertilizer cost Eth. $/ha	Fertilizer cost per kg. yield increase in ¢
0	0	5,460	1,900	—	100	-	-
40	0	8,470	2,740	+0,840	144	40	4,8
40	80	16,850	5,940	+4,020	312	106	2,6
40	120	20,020	7,270	+5,370	383	139	2,6
80	0	9,360	3,210	+1,310	169	80	6,1
80	80	17,830	6,510	+4,610	343	146	3,2
80	120	20,680	7,340	+5,440	386	179	3,3

Table 75. The effect of phosphate and nitrogen on the yield of dry matter - natural grassland.

Location: Asella, Livestock farm

Started: 1968

Date of fertilizer application: Superphosphate (20% P_2O_5) April 10, 1968
Urea (46% N) April 10, 1968

Harvesting dates: Parts of the plots were harvested on May 16, June 13, June 31 and August 15. The same parts were finally harvested Oct. 17th.

Plot size: 24 m^2. Each part harvested was about 6 m^2.

Replications: 4

Amount kg/ha		Total yield in kg/ha dry matter at different dates of the first harvest					Increase over control	Relative numbers	Fertilizer cost Eth. $/ha	Fertilizer cost per kg yield increase in ¢
P_2O_5	N	Cut May 16	Cut June 13	Cut June 31	Cut Aug. 15	Average				
0	0	2,730	2,560	1,800	3,120	2,550	-	100	-	-
80	0	3,690	2,830	2,570	4,050	3,290	740	129	80	10,8
80	40	5,130	4,300	3,530	6,910	4,970	2,420	195	133	4,7
80	80	5,860	5,570	5,270	9,430	6,530	3,980	256	146	6,3
80	120	8,260	7,510	6,260	12,100	8,530	5,980	335	179	3,0
160	0	3,900	2,920	2,630	3,940	3,350	800	131	160	20,0
160	40	4,210	4,350	4,000	8,170	5,180	2,630	203	193	7,3
160	80	6,020	5,710	5,880	10,570	7,050	4,500	276	226	5,0
160	120	8,360	7,120	7,340	13,440	9,070	6,520	356	259	4,0

Price of the fertilizers:

Superphosphate, 20% P_2O_5 Eth. $20.0 per 100 kg.

Urea, 46% N Eth. $38.0 per 100 kg.

8.1.2 The effect of different nitrogen fertilizers on natural grassland.

Four different nitrogen fertilizers were compared in one trial at the Livestock farm. According to table 76 no difference could be found between nitrochalk, ammonium sulphate nitrate and nitrophose. On the other hand urea showed less response than the other nitrogen fertilizers.

Table 76. The effect of different nitrogen fertilizers on naturl grassland

Location: Asella, Livestock farm.

Started: 1968

Amount of fertilizer applied: 40 kg N as nitrochalk (21 %N), urea, (46%N), ammonium sulphate nitrate (26%N) and nitrophose(NP 20:20) per hectare. All plots were treated with 200 kg. superphosphate (20% P_2O_5) per hectare except those fertilized with nitrophose.

Date of fertilizer: application: April 10, 1968

Harvesting dates: Parts of the plots were harvested on June 14, August 15 and October 16. The parts which were harvested on June 14 were again harvested on October 16. The regrowth on the plots harvested Aug. 15 was too little to be cut.

Plot size: 24 m^2. Each part harvested varied from 5 to 12 m^2

Replications: 4

Nitrogen fertilizer	Amount, kg/ha		Yield (dry matter, kg/ha)				
	P_2O_5	N	Two harvests 14/6 & 16/10	One harvest 15/8	One harvest 16/10	Average	Relative numbers
Nitrochalk	40	40	4,430	3,530	4,970	4,310	100
Urea	40	40	4,290	2,950	4,050	3,760	87
Ammonium sulphate nitrate	40	40	4,820	3,670	4,110	4,200	97
Nitrophose	40	40	5,020	3,000	3,960	3,990	93

8.1.3 Date of fertilizer application on natural grassland.

Five different dates of application of nitrogen and phosphate fertilizers were compared in one trial on the Livestock farm. As can be seen in table 77, the yields were about the same for the first four dates of applications. July 1st seems too late.

Table 77. Date of fertilizer application on natural grassland

Location: Asella, Livestock farm.

Started: 1968

Amount fertilizer applied: Superphosphate (20% P_2O_5) 200 kg per hectare.
Nitrochalk (21% N) 381 kg per hectare.

Harvesting date: October 18, 1968

Plot size, gross: 48 m^2
net: 19,2 m^2

Replications: 4

Date of fertilization	Amount of		Yield, kg per ha.		
	P_2O_5 kg / ha	N kg /ha	Dry matter	DM Increase over control	Relative numbers
No fertilization	0	0	4,130	--	100
April 10	40	80	8.830	4,700	214
May 1	40	80	8,460	4,330	205
May 23	40	80	8,880	4,750	215
June 12	40	80	8,460	4,330	205
July 1	40	80	6,800	2,670	165

The first fertilized plots had a much better growth in the beginning of the rainy season than the later fertilized ones and the yield might have increased if it had been possible to harvest them twice, in the beginning of June and in October.

9.1 Experiments for studying grazing and production of complementary fodder on natural grassland.

Various trials related to these problems were carried out at the Livestock farm. The objective was to improve the yield and quality of natural grassland by applying fertilizers and also to see the possibilities of using grassland for production of hay or silage in order to solve some of the fodder shortage during the dry season. Another objective was to study the grazing intensity and the effect of grazing during the dry season on the production during the rainy season. It is important to see whether or not the flora will change through these different management practices, but it will take a number of years to get sound results. At this stage it is only possible to present the effect of the fertilizers.

Table 78. Production and development of the vegetation in grassland used in various ways at different fertility levels.

Location: Asella, Livestock farm

Started: 1968

Amount and date fertilizer applied: 200 kg. nitrophose (NP 20:20) per hectare applied April 12, 1968 and 100 kg ammonium sulphate nitrate (26%N) per hectare applied Aug. 27, 1968.

Harvesting date: June 18–22 and October 22–24, 1968.

Plot size:
gross: 48 m^2
net: 30 m^2

Replications: 6

Numbers of trials: 4

	Yield, kg dry matter per hectare						
	Unfertilized			Fertilized			
Trial numb.	1st harvest	2nd harvest	Total	1st. harvest	2nd harvest	Total	Relative numbers. Unfertilized 100
4.1.1a	1,260	1,100	2,360	2,070	1,870	3,940	167
4.1.1b	840	550	1,390	1,370	870	2,240	164
4.1.1c	960	380	1,340	1,860	1,060	2,920	218
4.1.1d	1,120	690	1,810	2,670	1,440	4,110	227
Average	1,040	680	1,720	1,990	3,310	3,300	193

According to the plan the plosts should have been harvested in various ways. Some of them should for e.g. have been cut up to four times instead of two. Unfortunately it was not possible to do so the first year.

Table 79. Production and development of the vegetation in grassland used for grazing and cutting in various combinations at different fertility levels.

Location: Asella, Livestock farm

Started: 1968

Amount and date fertilizer applied: 200 kg nitrophose (NP 20:20) per hectare applied May 1st, 1968 and 100 kg ammonium sulphate nitrate (26% N) per hectare applied August 27, 1968.

Harvesting date: October 24, 1968

Plot size: 48 m^2

Replications: 2

Treatment	Yield, kg dry matter per ha		Relative numbers
	Unfertilized	Fertilized	Unfertilized 100
No grazing	3,220	6,550	203
Grazed until July 1	2,320	4,000	172
Grazed until July 25	2,510	4,730	188
Grazed until Aug. 20	2,400	5,240	218

Table 82. The effect of grazing of permanent pasture during the dry season on its production during the rainy season.

Location: Asella, Livestock farm

Started: 1968

Fertilization: No fertilizer applied

Harvesting date: June 24 and October 29, 1968. After the 2nd harvest half of the plots were opened for grazing.

Plot size: 48 m^2

Replications: 2

Treatment	Yield, kg dry matter per hectare		
	1st harvest	2nd harvest	Total
Fenced in throughout the year	450	800	1,250
Opened for grazing during the dry season and the small rains	420	620	1,040

As the trial was carried out just before the 1968 rainy season, there should be no difference between the fenced plots and the ones opened for grazing. The higher yield from the fenced plots must, therefore, be due to uneven distribution of the vegetation.

IMPLEMENTS RESEARCH SECTION

A report on the findings of this section is to be issued in July 1969. This report will contain the results from trials and studies on:

1. Soil preparation
2. Storage
3. Treshing
4. Transportation

LIST OF CADU PUBLICATIONS

A. Project Preparation Period

1. Report No. I on the establishment of Regional development project in Ethiopia, October 1966
   Part I General Background
   Part II Project Outline
   Part III Appendices
   (A reprint of the Summary is also available)
2. Report No. II on the establishment of a regional development programme in Ethiopia, May 1967. (The building programme appears under separate cover)
3. Trials and demonstration plots at Kulumsa in 1966, July 1966
4. Reconnoitering survery of the water resources in Chilalo Awraja, March 1967.
5. Creation of a forestry administration in Arussi province, March 1967
6. Crop sampling in the Chilalo Awraja 1966, May 1967
7. Results of trials and observation plots at Kulumsa 1966/67, May 1967
8. Sagure, a market village, June 1967
9. Forest nursery and planning techniques, June 1967
10. Trials and demonstration plots at Kulumsa and Swedish Mission Asella in 1967, July 1967
11. Grain Marketing experiments 1967, August 1967

B. Implementation Period

1. Government Agreement on Plan of Operation
2. Some reflections on water erosion in Chilalo awraja, October 1967
3. The Taungya afforestation method, Novermber 1967
4. Grow better Bahr-Zaaf in Ethiopia, January 1968
5. CADU Semi-annual report 1967/68, January 1968

6. Census in Sagure-Yeloma 1967, February 1968
7. The changing rural society in Arussiland: Some findings from a field study 1966-67, March 1968
8. CADU (Pamphlet in English and Amharic)
9. CADU plan of work and budget 1968/69 (with preliminary estimates for 1969/70)
10. Cultivation practices and the weed, pest and disease situation in some parts of the Chilalo awraja, March 1968
11. Introductory agro-botanical investigations in grazed areas in the Chilalo awraja, June 1968.
12. Results of trials and observations on fields forage crops at the Kulumsa farm and in Asella 1967/68, June 1968.
13. Crop sampling in the Chilalo awraja, Arussi province 1967, June 1968
14. General agricultural survey, August 1968
15. CADU statistical digest, May 1968
16. Descriptions of agricultural demonstrations 1968
17. Field trials and observations 1968/69
18. Feasibility study on a farm for breeding of grade cattle at Gobe, Arussi province, September 1968
19. Feasibility study on the electrification of Sagure town, September 1968
20. CADU, Annual report 1967/68, September 1968
21. Census in Dighelu village, May 1968
22. A case study of peasant farming in Dighelu and Yeloma areas, Chilalo awraja, Ethiopia
23. CADU semi-annual report 1968/69, February 1969
24. Results of demonstrations 1968/69
25. CADU plan of Work and Budget 1969/70
26. Tentative CADU Programme 1970/75, Addis Ababa March 1969
27. Feasibility study on sunflower protein concentrate and fafa mixing plant
28. Results of trials and observations, 1968/69