

BOT/91/001  
Field Document 8

Land Use Planning for Sustainable Agricultural Development

B O T S W A N A

**ON-FARM CROP TRIALS CROPPING SEASON 1994/1995**

**RESULTS AND EVALUATION**

Food & Agriculture  
Organization of the  
United Nations

Republic of  
Botswana

United Nations  
Development  
Programme

SEPTEMBER 1995

Land Use Planning for Sustainable Agricultural Development

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**ON-FARM CROP TRIALS CROPPING SEASON 1994/1995**

**RESULTS AND EVALUATION**

*by*

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## SUMMARY

*A series of 43 on-farm crop trials was programmed in the Agricultural Regions of Central, North East, North West and Southern during the cropping season 1994/1995. The main objectives of the trials were to demonstrate the scope for improvements in rainfed arable crop production to farmers through their participation, to collect information on management operations and to compare trial yields with CYSLAMB predictions.*

*A standard management system with local variations was adopted. Sorghum Segaolane was grown as crop, ploughing/planting was scheduled for the first occasion that a minimum of 20 mm of effective rainfall was recorded, from the third dekad of November onwards. Seeds were row planted at calculated target plant densities; farmers were encouraged to carry out timely weeding and bird scaring operations. The effect of the application of fertilizer on grain yields and gross margins was studied.*

*Soil and climatic characteristics of the trial sites are described, as well as observations on management operations and crop development stages.*

*One third of the trials succeeded, while two third failed, due to unfavorable climatic conditions, unsatisfactory crop management or insufficient supervision. From the successful dryland plots the actual yield of the ten control plots varied from 170-1290 kg/ha, while the CYSLAMB predictions ranged from 430-1070 kg/ha. For the twelve successful fertilized plots the achieved yields varied from 300-1010 kg/ha, against 670-1600 kg/ha for the CYSLAMB simulations, respectively.*

*The average grain weight per harvested head was for the control plots 26.4 g, ranging from 6.9-60 g and for the fertilized plants 29.4 g, varying from 8.3-78 g.*

*If assumed, that a difference between actual and predicted yield of at least 20 % is significant, in 35 % of the cases no difference was observed, while in the remaining 65 % a large discrepancy occurred. Several reasons for the discrepancy between trial yields and CYSLAMB predictions are discussed.*

*From the nine trials with successful control and fertilized plots, in one case the control plot yielded 41 % higher, in two cases the yield was virtually equal (2 % and 4 % discrepancy) and in 6 instances the fertilized plot yielded on average 97 % (43 - 181) higher than the control plot.*

*To assess the financial viability of the executed production systems, a gross margin analysis was carried out. If the cost of on-farm labour is ignored, the ten successful control plots achieved a positive gross margin ranging from Pula 58-474/ha without and from Pula 228-644/ha with government drought relief subsidy. If no residual effect from the fertilizer is assumed, and the costs are written off in one year, eleven trials achieved a positive gross margin varying from Pula 9-265/ha without, and from Pula 179-435/ha with drought relief subsidies. Only one out of the twelve fertilized trials obtained a slightly negative gross margin. If the fertilizer costs would be divided over three years, all twelve gross margins would be positive, and range from Pula 75-341/ha without to Pula 245-511/ha with drought relief subsidies.*

*When comparing the dryland plots where both control and fertilized plots were harvested, the use of fertilizer did only pay off in 22 % of the cases, if no residual effect of the fertilizer was taken into account in the gross margin analysis. When the fertilizer costs were divided over three years (the residual effect of single superphosphate fertilizer), the use of fertilizer was financially attractive in 56 % of the trials.*

*Finally, an evaluation of the trials is done, both from the farmers' and from the supervision's point of view, in order to identify fields for improvement, which might increase the success rate of future trials. Suggestions are formulated for recommendations concerning importance of timeliness and accurateness of operations, area ploughed and planted per planting opportunity, target plant densities, and the use of fertilizer.*

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## **1 INTRODUCTION**

Traditional rainfed arable crop production is a widespread economic activity in Botswana, in which approximately 75% of the population is involved on a yearly basis.

The prevailing semi-arid conditions in Botswana make arable farming an enterprise with variable success, resulting in average grain yields of 2-4 bags/ha (150-300 kg/ha); barely enough to sustain an average household's needs.

The National Land Suitability Map for Rainfed Crop Production shows a fairly high potential for the crops maize, sorghum, millet, cowpeas and groundnuts in most of the north and east of Botswana. The yields reflected on the map have been generated with help of the *Crop Yield Simulation and Land Assessment Model for Botswana (CYSLAMB)*. This computer model evaluates the crop performance under different management systems on selected land units typified by soil and climatic characteristics.

Simulations based on improved management operations result in considerable yield increases as compared to traditional management scenarios. To demonstrate innovations to farmers and to show the strength of the model for the generation of extension recommendations, a set of on-farm crop trials following the CYSLAMB proposals, was carried out during the cropping season 1994/1995.

### **1.1 Objectives**

The trials had as main objective to show farmers the scope for improvement of rainfed arable crop production by following improved management techniques and timely operations, mainly based on CYSLAMB simulations. The trials were production oriented, rather than focussing on different crops and varieties or on alternative farming practices.

The second aim of the on-farm experiments was to gain more insight in rainfed arable crop production systems in general and in its individual management operations in particular. Through close observations of time and labour requirements and costs involved in each management operation, an impression could be obtained of the major constraints and opportunities in five agricultural regions in Botswana.

Additionally, the yield data resulting from the trials could be compared to the CYSLAMB predicted yields and possible discrepancies could be explained.

### **1.2 Organization of the trial programme**

#### **1.2.1 Logistics and costs**

The preparation of the trial programme was coordinated from the Land Use Planning Section at the Ministry of Agriculture (MoA). Man power was financed through the recurrent budget. One technical assistant and a driver were seconded from MoA to the Kanye and Maun offices for the duration of the cropping season.

RAOs and Farming Systems Research (FSR) financed fertilizer, while seeds were supplied by the Seed Multiplication Unit.

Topsoil samples taken before and after the trials were analyzed by the Soil Laboratory of the Department of Agricultural Research (DAR) on their phosphorus content. The pre-trial samples results formed the basis for the calculation of the height of the fertilizer applications. The post-trial results were supposed to give an idea of the phosphorus levels achieved by fertilizing and the amount of fertilizer uptake by the plants.

Although budgeted for by the Senior Land Use Officer of MoA, no use was made of casual labour to assist farmers in performing operations as weeding and birdscairing. It was felt to be more valuable, to observe on-farm management decisions and labour use.

### **1.2.2 Preparation and monitoring**

A Preparation Protocol was drafted and used as a checklist for the pre-planting activities (see Appendix I). To facilitate standardized monitoring and execution of the trials a Monitoring Protocol was compiled (see Appendix II). In addition a Checklist was used to record climatic, management and agronomic observations (see Appendix III).

Information was collected on the following topics:

- \* soil characteristics and rainfall data
- \* use of labour, draught power and inputs
- \* plant densities and crop growth stages
- \* weed cover and signs of pests, diseases and deficiencies
- \* yield figures

### **1.2.3 Dissemination of extension messages**

For each trial site two farm-walks were scheduled during the course of the growing season, in order to acquaint as many neighbouring farmers as possible with the recommended practices and results: one 4-5 weeks (early vegetative stage) and one 14-15 weeks (yield formation stage) after planting.

## **1.3 Selection and location of trial-farms**

Participating farmers were generally chosen in consultation with the Agricultural Demonstrators (AD) of the concerned Agricultural Extension Area (AEA). In the Southern Region (Kanye) a pre-selection of 20 farmers was made by the District Crop Production Officers (CPO); the final selection was done by the ALUP team in cooperation with the ADs. In Mahalapye the choice was made by Farming Systems Research (FSR).

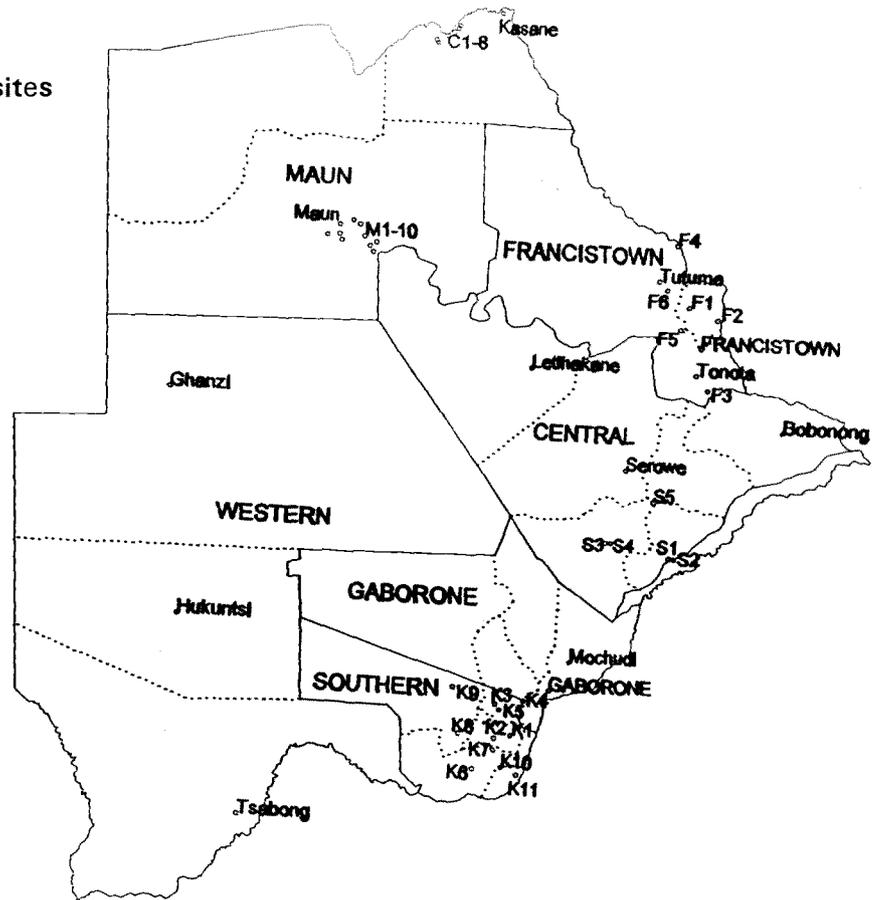
The trial farmers were selected on basis of their labour and draught power potential, availability and state of implements, motivation and preparedness to act swiftly at the first planting opportunity.

Table 1 gives an overview of the location data, while Figure 1 shows the approximate position of the trial sites. More detailed regional location maps are inserted in Appendix IV.

### **Table 1. Location data of trial sites**

CODE	REGION	DISTRICT	AEA	VILLAGE
C1	North West/Kasane	Chobe	Kachikau	Kachikau
C2	North West/Kasane	Chobe	Kachikau	Kachikau
C3	North West/Kasane	Chobe	Mabele/Kavimba	Kavimba
C4	North West/Kasane	Chobe	Mabele/Kavimba	Kavimba
C5	North West/Kasane	Chobe	Mabele/Kavimba	Kavimba
C6	North West/Kasane	Chobe	Mabele/Kavimba	Kavimba
C7	North West/Kasane	Chobe	Mabele/Kavimba	Mabele
C8	North West/Kasane	Chobe	Mabele/Kavimba	Mabele
C9	North West/Kasane	Chobe	Mabele/Kavimba	Mabele
C10	North West/Kasane	Chobe	Mabele/Kavimba	Mabele
F1	North East/Francistown	Masunga	Makaleng	Sechele
F2	North East/Francistown	Masunga	Siviya	Siviya
F3	North East/Francistown	Tonota	Tonota East	Tapaladipoo
F4	North East/Francistown	Tutume	Maitengwe	Maitengwe
F5	North East/Francistown	Tutume	Mathangwane	Mathangwane
F6	North East/Francistown	Tutume	Matobo	Matobo
F7	North East/Francistown	Tutume	Nata	Nata
K1	Southern/Kanye	Ngwaketse Central	Lotlhakane East	Gamoswana
K2	Southern/Kanye	Ngwaketse Central	Twsidi	Ramonedi
K3	Southern/Kanye	Ngwaketse North	Lotlhakane	Lotlhakane West
K4	Southern/Kanye	Ngwaketse North	Manyana	Manyana
K5	Southern/Kanye	Ngwaketse North	Moshupa South	Polokwe
K6	Southern/Kanye	Ngwaketse South	Kanngwe	Kanngwe
K7	Southern/Kanye	Ngwaketse South	Mmathethe North	Mmathethe
K8	Southern/Kanye	Ngwaketse West	Gasita	Gasita
K9	Southern/Kanye	Ngwaketse West	Sese	Sese
K10	Southern/Kanye	Barolong	Goodhope	Mongwalale
K11	Southern/Kanye	Barolong	Pitsane	Pitsane
M1	North West/Maun	Ngamiland East	Chanuga	Chanuga
M2	North West/Maun	Ngamiland East	Chanuga	Xhana
M3	North West/Maun	Ngamiland East	Komana	Komana
M4	North West/Maun	Ngamiland East	Komana	Nxaraga
M5	North West/Maun	Ngamiland East	Matlapaneng	Matlapaneng
M6	North West/Maun	Ngamiland East	Matlapaneng	Matlapaneng
M7	North West/Maun	Ngamiland East	Shashe/Maun	Thamalakane West
M8	North West/Maun	Ngamiland East	Shashe/Maun	Tsanakuna
M9	North West/Maun	Ngamiland East	Tatamoga/Makalamabedi	Segoro
M10	North West/Maun	Ngamiland East	Tatamoga/Makalamabedi	Xwee
S1	Central/Serowe	Machaneng	Makwate	Makwate
S2	Central/Serowe	Machaneng	Makwate	Makwate
S3	Central/Serowe	Mahalapye	Soshong East	Dihate
S4	Central/Serowe	Mahalapye	Soshong East	Dihate
S5	Central/Serowe	Palapye	Makoro	Makoro

Figure 1. Location map of trial sites



#### 1.4 Production systems and management systems

The on-farm crop trial programme was mainly focussing on rainfed arable crop production systems with sorghum *var. Segalane* as crop. However, in Chobe District some trials were set up with maize *var. Kalahari Early Pearl* as crop, based on the traditional preference of the participating farmers. Also in Chobe the opportunity was taken to conduct two trials under flood recession or molapo farming conditions with maize *var. Kalahari Early Pearl* as crop.

A standard management system was proposed, which at times was adapted to local circumstances. The experiments were conducted on a field of 0.5 hectare. One half of the field was cultivated under natural conditions (the **control plot**), whilst the other half was treated with single superphosphate fertilizer, to raise available P levels to 10 ppm (the **fertilized plot**). In Chobe, a third plot was fertilized with 3:2:1 compound NPK fertilizer in six cases.

In principle, ploughing was done with animal draught power provided by the host farmer. The planting opportunity was identified by the ALUP and was defined by a minimum of 20mm of effective rainfall in one dekad, from the dekad NOV3 onwards. Seeds, supplied by the Seed Multiplication Unit, were planted using a row planter. The targeted plant density was determined by CYSLAMB, at 50,000 plants/ha in all regions except for Maun, where 15,000 plants/ha was aimed for. A thinning operation (if necessary) was carried out concurrently with the first weeding operation. The first weeding operation was scheduled for approximately 20 days after planting, either by hand hoe or with a cultivator; a second operation was carried out if considered necessary. Farmers were encouraged to minimize crop damage by properly fencing their fields and carrying out bird scaring operations.

## **2 OBSERVATIONS**

All discussions in this chapter are based on remarks and observations from the ALUP teams in Francistown, Kanye, Kasane, Maun and Serowe. The author visited the majority of the trial sites in May 1995, in order to compare the crop performance in the different regions. A second visit was made in August 1995 to collect final results and comments.

### **2.1 Soil observations**

#### **Reliability of soil analyses**

Before planting, samples were taken from the topsoil of all 43 trial sites, to analyze the phosphorus content. The initial phosphorus level was used by CYSLAMB to simulate the yield of the control plots and to calculate the amount of fertilizer to use in order to reach a financial optimum level of 10 ppm on the fertilized plots. After the harvest, samples were taken again from the topsoil of the Kanye and the Maun trial sites, in order to study the effectiveness of the fertilizer uptake by the crop and the residual effect of fertilizer after one cropping season.

The outcome of the soil analyses is of crucial importance for above exercises. The pre-season sample analyses showed irregular results for some of the Kanye and Kasane trials. Repeats carried out on the Kanye samples gave more realistic values. Unfortunately the post-season samples from Kanye and Maun demonstrate such large discrepancies with the pre-season samples, that the results could not be used for further interpretation.

#### **Erosion**

Severe wind erosion and deposition affected germination, establishment and development of plants on several trial sites located on sandy soils in the Kanye and Maun Regions. At the control plot of the Gasita trial site (K8), wind erosion uprooted seedlings and re-deposited sand buried others. In addition to moisture stress, a very low plant density resulted and the surviving plants were stunted and did not form heads. A similar situation occurred at the Xhana (M2) site. The fertilized plot was so affected by wind erosion, that a very low plant density was obtained; the remaining plants, however, established very well and the yield was high. The control plot on the other hand was completely covered by a thin layer of fine sand, preventing plants to establish. Both plots of the Matlapaneng trial site M6, planted after the first identified opportunity, were affected by wind erosion and deposition to the extent, that no germination took place.

At some trial sites in the Kanye and Serowe Regions with slopes greater than 2 %, signs of sheet and rill erosion were observed, due to run-off of adjacent hill sides after relatively large rainfall amounts. Damage to crops, however, was limited, probably due to the low intensity of the processes and the occurrence after plant establishment.

#### **Workability**

In the Chobe Enclave, in the Kasane Region, soils with high clay contents (up to 50 %) occur frequently. The workability of these soils formed a serious constraint for traditional ploughing/planting operations with draught animals. Many farmers relied on tractor hire for the ploughing of their fields used for rainfed crop production (see section 2.3 Ploughing).

## **Soil burning**

In the Chobe Enclave, soil burning or "Fumbawe" is frequently observed. This phenomenon mainly occurs on molapo fields, after burning of the fields to remove reeds. Due to the high organic matter content of the topsoil, underground burning proceeds at a depth of 0-50 cm. The burning is usually stopped by high floods. Signs of burning are visible on the surface or in pits; the soil has a whitish colour and a high content of ash. The effect is detrimental on the nutrient status of the soil. On burned soil, no effect of phosphorus fertilizer was observed, suggesting nitrogen to be the limiting factor. This hypothesis is confirmed by the gaps in the crop stand on the burned patches of the plot fertilized with single superphosphate, while plants performed better (more homogeneous stand) on the burned patches in the plot fertilized with 3:2:1 compound NPK fertilizer.

## **Groundwater level**

A rapid dropping of the groundwater level at Mabele (Kasane Region), was the cause of the failure of one of the molapo trial sites (C10).

## **Termite activity**

At several trial sites in the Kanye Region past and present termite activity may have attributed to bare patches, uneven crop stands and low yields.

## **2.2 Climatic observations**

The term dekad is introduced to indicate a 10-day period; a dekad is identified by the first three letters of the month and its order in time, e.g. DEC1, meaning the period between 1-10 of December. The dekad is used for rainfall totals and to indicate when certain crop management operations take place.

### **Synoptic data**

Tables 2a-e show monthly average, extreme maximum and minimum temperatures, relative humidity, sunshine, wind speed, rainfall, evapotranspiration and frost days, based on multiple year ranges stored in the METEO database for the synoptic stations of Francistown, Kanye, Kasane, Mahalapye and Maun.

### **Rainfall data**

The 1994/95 rainfall season was characterized by a late start in the Southern and North East Regions (first planting rains in DEC3), a slightly earlier start in Central Region and North West Region/Chobe (DEC1) and a statistically expected onset in NOV3 in the North West Region around Maun. The total amount of rain received on the trial sites (from OCT1-MAY1) was in all five regions less than the long-term averages as compared to the nearest rainfall station and had an erratic distribution with one or more dry spells. Table 3 shows the mean percentage of average rainfall per region. The area around Maun received very little rainfall (42 %), North East and Southern Region were slightly better off (58-59 %), and in Central Region and North West/Chobe a close to average rainfall season was recorded (84-90 %). The figures 2a and 2b show the rainfall totals of the 1994/95 season for 13 well recorded trial sites, located in the 5 trial regions.

Table 2a-e. Synoptic data

STATION		LONGITUDE			LATITUDE			ELEVATION								
33 FRANCISTOWN		2729 E			2109 S			968								
month	temperature				% relative humidity			cloud cover			sunshine hrs/day	wind km/h	rain mm	PET mm	frostdays	
	mean	max	min	extreme	08.00	14.00	20.00	08.00	14.00	20.00					per month	air
September	29.8	12.3	37.0	1.5	51	27		0.0	0.0	0.0	9.6	8.2	6	162	0.0	0.6
October	31.5	16.2	40.2	4.0	56	32		0.0	0.0	0.0	9.0	9.2	27	188	0.0	0.0
November	31.0	16.9	41.1	4.1	59	41		0.0	0.0	0.0	8.1	8.0	60	182	0.0	0.0
December	30.3	18.5	39.5	8.8	68	44		0.0	0.0	0.0	7.4	7.3	90	181	0.0	0.0
January	30.7	19.0	40.6	10.6	69	48		0.0	0.0	0.0	8.0	6.9	100	180	0.0	0.0
February	29.5	18.2	38.4	10.5	74	50		0.0	0.0	0.0	8.2	6.8	83	161	0.0	0.0
March	29.3	16.9	38.8	4.0	72	46		0.0	0.0	0.0	8.2	6.8	59	155	0.0	0.0
April	27.7	13.7	35.6	4.0	74	41		0.0	0.0	0.0	8.5	5.8	25	128	0.0	0.1
May	25.6	8.5	34.0	-1.0	72	32		0.0	0.0	0.0	9.4	5.0	6	107	0.0	3.0
June	23.0	5.3	31.1	-4.5	67	34		0.0	0.0	0.0	8.9	5.0	3	89	3.7	12.0
July	23.1	4.8	30.6	-5.0	70	29		0.0	0.0	0.0	9.6	5.5	0	98	3.3	12.0
August	25.1	7.7	35.5	-4.2	60	26		0.0	0.0	0.0	9.9	6.5	1	127	0.8	4.2
											yeartotal rain : 460					

2a. Francistown

STATION		LONGITUDE			LATITUDE			ELEVATION								
61 KANYE		2522 E			2458 S			1372								
synoptic data interpolated based on station numbers : 0 0 0																
month	temperature				% relative humidity			cloud cover			sunshine hrs/day	wind km/h	rain mm	PET mm	frostdays	
	mean	max	min	extreme	08.00	14.00	20.00	08.00	14.00	20.00					per month	air
September	27.8	10.3	36.6	-2.9	51	24	33	0.0	0.0	0.0	9.6	7.8	15	148	0.3	0.2
October	29.9	14.4	39.0	2.1	53	29	40	0.0	0.0	0.0	9.3	9.1	43	178	0.0	0.0
November	30.4	16.2	39.1	6.2	59	34	50	0.0	0.0	0.0	8.8	8.2	67	187	0.0	0.0
December	31.2	17.3	41.5	6.4	64	39	53	0.0	0.0	0.0	8.6	7.2	82	196	0.0	0.0
January	31.4	18.1	41.3	8.6	67	41	56	0.0	0.0	0.0	8.5	6.9	99	187	0.0	0.0
February	30.2	17.6	38.8	8.3	72	44	60	0.0	0.0	0.0	8.5	5.9	87	161	0.0	0.0
March	29.3	16.1	38.3	6.3	74	45	65	0.0	0.0	0.0	8.1	5.0	72	147	0.0	0.0
April	26.4	11.6	34.2	-2.3	77	41	65	0.0	0.0	0.0	8.3	4.8	40	115	0.1	0.0
May	23.6	6.4	32.4	-3.8	75	34	59	0.0	0.0	0.0	9.1	5.1	12	88	0.8	0.5
June	21.1	2.8	29.1	-6.6	74	30	53	0.0	0.0	0.0	8.5	4.8	6	72	5.6	11.4
July	21.2	2.6	28.4	-7.8	69	28	47	0.0	0.0	0.0	9.7	5.0	3	81	5.4	10.3
August	24.3	5.4	32.4	-5.9	58	24	37	0.0	0.0	0.0	9.9	6.4	3	110	1.9	3.7
											yeartotal rain : 530					

2b. Kanye

STATION		LONGITUDE			LATITUDE			ELEVATION								
64 KASANE		2509 E			1749 S			960								
month	temperature				% relative humidity			cloud cover			sunshine hrs/day	wind km/h	rain mm	PET mm	frostdays	
	mean	max	min	extreme	08.00	14.00	20.00	08.00	14.00	20.00					per month	air
September	31.5	12.7	37.8	3.5	44	21		0.0	0.0	0.0	10.4	5.0	2	170	0.0	0.0
October	32.9	16.8	38.4	7.7	46	26		0.0	0.0	0.0	9.0	5.7	22	191	0.0	0.0
November	31.9	18.0	38.7	10.4	59	36		0.0	0.0	0.0	7.9	4.8	70	175	0.0	0.0
December	30.0	18.1	38.1	11.8	74	49		0.0	0.0	0.0	7.1	4.2	148	166	0.0	0.0
January	29.5	18.3	38.0	10.0	80	55		0.0	0.0	0.0	7.3	3.9	159	158	0.0	0.0
February	29.2	18.0	36.7	10.9	82	54		0.0	0.0	0.0	7.6	3.9	138	145	0.0	0.0
March	29.3	17.1	36.9	10.3	79	51		0.0	0.0	0.0	8.1	4.2	96	152	0.0	0.0
April	28.6	14.0	34.3	6.2	74	42		0.0	0.0	0.0	8.9	3.8	25	138	0.0	0.0
May	26.9	9.4	32.3	-0.3	69	33		0.0	0.0	0.0	9.5	3.6	3	117	0.0	0.2
June	24.4	5.6	30.4	-3.9	70	31		0.0	0.0	0.0	9.6	3.7	2	99	0.0	1.0
July	24.5	5.4	30.7	-2.7	67	28		0.0	0.0	0.0	9.8	3.8	0	108	0.0	1.7
August	27.5	8.0	34.2	-3.4	54	24		0.0	0.0	0.0	10.5	4.5	0	138	0.0	0.0
											yeartotal rain : 665					

2c. Kasane

STATION	LONGITUDE						LATITUDE			ELEVATION					
106 MAHALAPYE	2650 E						2307 S			1006					
month	temperature				% relative humidity			cloud cover		sunshine hrs/day	wind km/h	rain mm	PET mm	frostdays	
	max	mean	min	extreme	max	min	08.00	14.00	20.00					08.00	14.00
September	29.2	12.6	37.6	1.7	50	30	0.0	0.0	0.0	8.8	3.8	8	136	0.0	0.1
October	29.8	15.6	39.3	6.2	52	38	0.0	0.0	0.0	8.4	4.4	31	159	0.0	0.0
November	30.4	18.0	38.6	8.6	60	47	0.0	0.0	0.0	7.6	4.0	68	164	0.0	0.0
December	30.6	19.0	37.9	11.6	60	44	0.0	0.0	0.0	8.6	3.6	79	180	0.0	0.0
January	30.9	19.1	40.5	12.5	58	47	0.0	0.0	0.0	6.8	3.4	88	172	0.0	0.0
February	30.2	19.2	36.6	13.5	64	54	0.0	0.0	0.0	7.1	2.9	83	149	0.0	0.0
March	28.6	16.6	36.5	9.8	68	54	0.0	0.0	0.0	7.8	2.7	68	136	0.0	0.0
April	26.5	13.2	34.6	4.5	64	44	0.0	0.0	0.0	8.6	2.4	26	110	0.0	0.0
May	24.4	8.1	33.0	1.0	62	35	0.0	0.0	0.0	8.7	2.2	9	89	0.0	1.0
June	22.1	4.9	28.9	-5.4	64	42	0.0	0.0	0.0	8.7	2.4	3	72	2.2	11.1
July	22.3	3.9	29.8	-4.0	54	33	0.0	0.0	0.0	9.7	2.2	2	80	0.9	10.8
August	25.1	7.1	34.1	-6.0	55	31	0.0	0.0	0.0	9.1	2.9	2	105	0.5	3.4
yeartotal rain : 468															

2d. Mahalapye

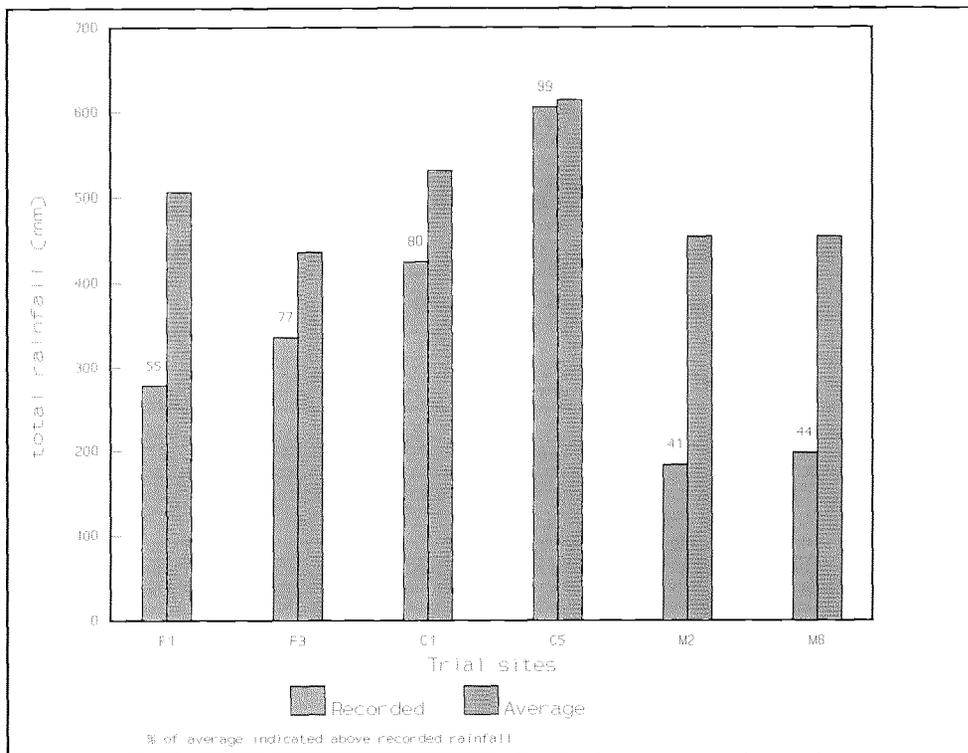
STATION	LONGITUDE						LATITUDE			ELEVATION					
130 MAUN	2325 E						1959 S			945					
month	temperature				% relative humidity			cloud cover		sunshine hrs/day	wind km/h	rain mm	PET mm	frostdays	
	max	mean	min	extreme	max	min	08.00	14.00	20.00					08.00	14.00
September	32.2	14.8	38.6	3.9	40	19	0.0	0.0	0.0	10.1	7.8	3	184	0.0	0.0
October	34.1	18.6	41.4	9.0	44	23	0.0	0.0	0.0	9.5	8.8	16	207	0.0	0.0
November	33.0	19.4	41.7	9.4	57	32	0.0	0.0	0.0	8.6	7.7	47	199	0.0	0.0
December	32.1	19.4	40.6	8.4	69	42	0.0	0.0	0.0	8.3	6.8	81	193	0.0	0.0
January	31.6	19.5	40.0	9.2	76	48	0.0	0.0	0.0	8.0	6.0	106	179	0.0	0.0
February	31.4	18.9	37.2	10.6	78	48	0.0	0.0	0.0	8.1	5.7	99	159	0.0	0.0
March	31.3	17.8	39.5	6.2	75	42	0.0	0.0	0.0	8.5	6.0	70	161	0.0	0.0
April	29.9	15.0	35.0	-4.4	70	36	0.0	0.0	0.0	9.1	5.7	26	140	0.0	0.0
May	27.5	9.6	33.0	-1.1	64	27	0.0	0.0	0.0	10.0	5.5	4	123	0.0	0.2
June	25.0	6.9	30.6	-5.8	64	27	0.0	0.0	0.0	9.5	5.8	1	105	0.0	7.8
July	25.1	6.9	31.3	-3.6	62	25	0.0	0.0	0.0	9.8	6.1	0	114	0.0	1.7
August	28.3	9.8	35.2	3.5	52	20	0.0	0.0	0.0	10.3	6.6	0	147	0.0	0.1
yeartotal rain : 454															

2e. Maun

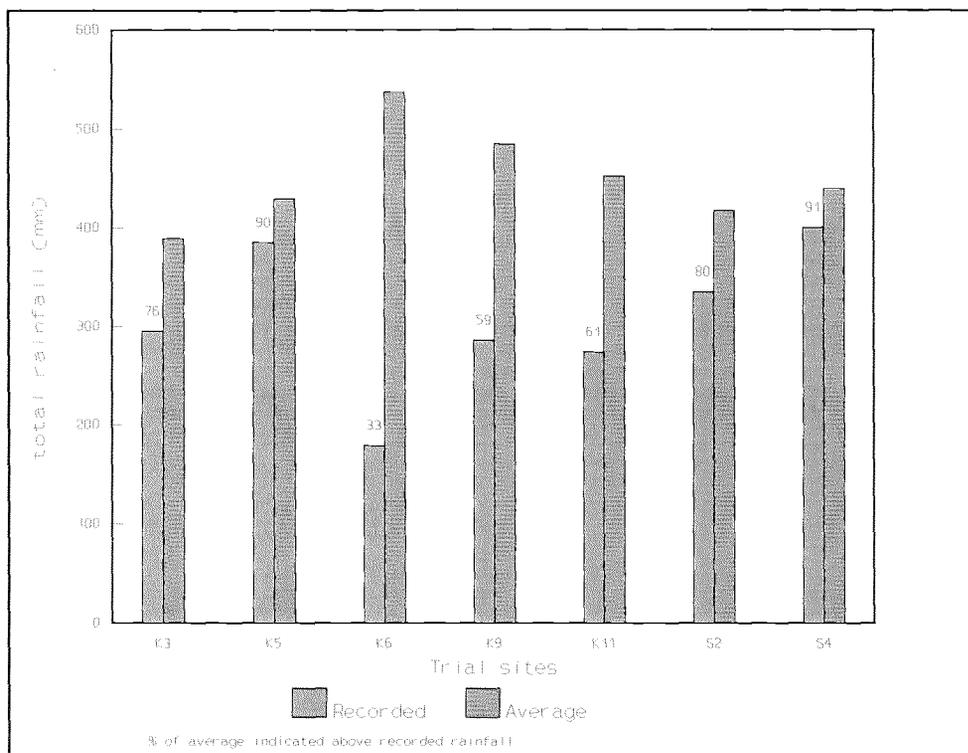
Table 3. Mean percentage of average rainfall in trial regions

REGION	MEAN % of AVERAGE	RANGE	No. of STATIONS
North West/Chobe	90	80-99	2
North East/Francistown	58	54-77	4
Southern/Kanye	59	33-90	11
North West/Maun	42	41-44	2
Central/Serowe	84	78-89	2

**Figure 2a. Recorded and average rainfall for North West and North East**



**Figure 2b. Recorded and average rainfall for Central and Southern**



At various places in the Southern Region a hailstorm was recorded on 06/02/95, which totally shredded leaves of sorghum plants. As the heads were not yet exposed, the plants made a full recovery and yielded well.

### Dry spells

At all trial sites, one or more dry spells were recorded during the 1994/95 rainfall season. It should be remarked, that dry spells have been the cause of crop failure on those trial sites, where no germination took place or where no planting opportunity was identified. A dry spell in this study is defined as a period of at least 14 days of no or not effective rainfall (rainfall less than the evapotranspiration). Some observations can be made concerning types and number of dry spells, and their effect on the grain yield. Considered were those trial sites, where seeds germinated, plants established, the crop growth was well monitored and which had complete rainfall records.

19 from the 43 trial sites met the above requirements for an analysis of dry spells. Of three sites either the fertilized or the control plot failed due to a reason other than a dry spell (wind erosion or weeds). In one case the fertilized plot was planted 23 days earlier than the control plot. For this analysis they were considered as two different trial sites, making a total of 20 sites.

The number of dry spells observed, varied from 1-4 all over the country. One single dry spell mainly occurred around Maun and the 4 dry spells were recorded around Mahalapye. In the majority of cases 2 or 3 dry spells were observed (see table 4).

**Table 4. Number of dry spells**

DRY SPELLS	SITES	% of TOTAL
1	4	20
2	10	50
3	4	20
4	2	10

A classification is made of the first dry spells, as they often fall in an early stage of the crop growth cycle, and can be most decisive for further crop development. Two main groups were recognized according to the length of the dry spells:

1. short dry spells: 14-21 days
2. long dry spells: 22 days or longer.

Sub-groups were distinguished based on the time of planting and the occurrence of the first dry spell (in days) after planting:

- a. 0-14 days after early planting in NOV3 or DEC1
- b. 0-14 days after late planting in DEC3 or JAN
- c. 15-30 days after planting
- d. more than 30 days after planting

From the 20 sites two showed an atypical behavior and could not be classified. Trial K1 mainly failed due to bird damage. And M2 yielded very well despite a dry spell of 53 days, that started at planting. From the 18 classified trials 12 achieved a yield and 6 did not. From the 6 trials that did not yield, 3 probably failed due to the timing of a dry spell, 2 due to livestock and 1 because of bird damage. Table 5 shows the classification of the first dry spells of the 18 trials and their impact on the yield.

**Table 5. Classification of first dry spells**

TYPE	No of TRIALS	% of TOTAL	IMPACT *	TRIALS **
1a	3	16.7	+/-	M9, S3, S4F
1b	2	11.1	-	C5, S4C***
1c	2	11.1	+	K5, K10
1d	1	5.5	+	K11
2a	1	5.5	-	M1
2b	2	11.1	+/-	K2, M8
2c	5	27.9	+/-	K3, K7, K8F, M7, S2
2d	2	11.1	+	K6, K9

\* - fatal; the dry spell probably caused crop failure  
 +/- moderate; some restriction in growth, still yielding reasonably well  
 + minimal; no obvious signs of growth restriction, yielding well

\*\* F - fertilized plot; C - control plot

\*\*\* Trial S4C had a short dry spell 18 days after planting, but fits best in 1b.

44.4 % of the sites was affected by a short first dry spell (type 1), while 55.6 % suffered from a long first dry spell (type 2). Of all 18 classified trials 72.3 % had a first dry spell that affected the crop growth: 16.6 % fatally and 55.7 % moderately. No obvious damage was caused by the first dry spell in 27.7 % of the trials.

Fatal seemed the short dry spells, that occurred within two weeks after planting in DEC3 or later (group 1b) and the long dry spells taking place shortly after planting at the first planting opportunity in NOV3 or DEC1 (group 2a). In both cases seeds had the chance to germinate, but soil moisture conditions were not favorable enough to support the young plants through the dry spell.

Some moisture stress and stunting was observed in case of a short dry spell, shortly after planting, when planting was done in NOV3 or DEC1 (group 1a), and in case of long dry spells, that happened shortly after late planting in JAN (group 2b) or 15-30 days after planting (group 2c). In general the plants were in their early vegetative stage and/or late planted in relatively moist soils and sustained some set back in their development. These dry spells did not cause a crop failure, however, and the sites had reasonably high yields.

No serious damage could be detected in the case of short first dry spells occurring 15-30 days (group 1c) or more than 30 days (group 1d) after planting and when long dry spells were recorded more than 30 days after planting (group 2d). In these instances plants were

in their middle to late vegetative stage, well developed and resistant enough to stand a period without (sufficient) rainfall.

The impact of (second, third or fourth) dry spells (after a first dry spell of either type 1 or 2) during the grain filling stage of the crop did not seem to be vital for the final yield. At most, a slight reduction in grain weight was found, the more dry spells occurred.

Based on the above analysis, the limited number of observations and bearing in mind, that the rainfall season 1994/95 was below average, no conclusions can be drawn on the ideal time of planting in order to minimize the risk of crop damage or failure due to dry spells. However, after characterizing the first dry spell, some predictions could perhaps be done concerning the crop performance, considering optimal crop husbandry.

## **2.3 Management observations**

### **General**

The cropping season 1994/95 was characterised by below average total rainfall, and consequently low farmers' yields. Dryland maize failed nearly everywhere, while sorghum, cowpeas and melons were harvested throughout the country in amounts of 1-2 (70 kg) bags/ha. The number of farmers that obtained a yield was very low in the North West Region, both around Maun and in Chobe < 10 %. In Chobe the rainy season started late and was the first planting rain used to loosen up the (relatively heavy) soils before ploughing, hence postponing planting to the second opportunity. In the North East and Central Regions some 50 % of the farmers achieved a yield. Rainfall was just below average and other income generating activities seemed to get priority. In the Southern Region approximately 75 % of the farming households harvested, despite the late start of the rains. Perhaps the farmers in that Region were more inclined to arable farming and to conducting proper crop husbandry.

### **Draught power**

Of all trial sites 85 % was ploughed with draught animals; in 72.5 % of the cases donkeys were used and in 12.5 % oxen. A tractor was used in the remaining 15 %.

Often in Botswana, farmers give as excuse for late planting the reason that their draught animals are in a bad shape at the beginning of the rainy season. From the trials that were ploughed with animal draught power, it appeared that the vast majority was ploughed within six days after the identified planting rain. In many cases part of the farmer's own field was ploughed during the same period as well. It is hard to accept the argument of weak draught power as cause for a delay in starting to plough/plant based on this observation. Additionally it could be stated, that grasses (fodder for the draught animals) need at least 20 days to germinate and produce some edible biomass. This would mean that ploughing/planting should earliest be taking place some three weeks after the first identified planting rainfall event, which does not seem to happen in practice. It should be remarked, however, that due to the weakness of the draught animals, ploughing and planting operations take more time in the beginning of the season, than later on. Frequently only the morning is used for ploughing/planting at the beginning of the season, leaving the animals enough time to recuperate, feed and drink. Later in the season, however, the animals are also used in the late afternoon.

**Labour**

When use is made of draught animals, the ploughing operation is often carried out by 3-4 people and harrowing (if done) and planting with 3. The necessary minimum, however, is 2 people for all three operations; one to control the implement and one to control the draught animals.

Recordings show, that in the Maun trials on average 109.4 manhrs/ha was spent on fertilizing, harrowing, ploughing and planting. If the actual hours spent on these operations is calculated for 2 people, then an average of 75.4 manhrs/ha should be spent. Assuming a working day of 6 hours (from 6 am to noon), it would take 2 people 6.3 working days to finish one hectare. For the Kanye trials 107 manhrs/ha were used for fertilizing, ploughing and planting (against 96.9 manhrs/ha in Maun without harrowing). More time was spent per operation (especially ploughing) in Southern Region, and calculated for 2 people 93 manhrs/ha were used, which would take them 7.8 days/ha. From Serowe and Kasane is reported that ploughing takes 48 manhrs/ha on average (2 people finish 0.25 ha in 6 hours). See table 6 for more detailed labour hours spent per operation.

**Table 6. Labour time used per management operation \***

REGION	FERTILIZING	PLOUGHING	HARROWING	PLANTING	TOTAL
Kasane		48			
Maun	8.4	63.5	12.5	25	109.4
Kanye	2	77	n/a	28	107
Serowe		48			

\* All labour time used is converted to manhrs/ha

Apart from one or two lost days for looking for draught animals, the long time spent per hectare on land preparations explains the delay between the end of the rainfall event and the day of planting. A further delay was sometimes caused by the fact, that farmers did not work on the lands on either Friday, Saturday or Sunday, due to traditional/religious reasons. Time was also lost due to social obligations as meetings, marriages and funerals.

It was noted in several regions that labour shortages occurred, especially in female headed households, for ploughing/harrowing/planting and in most types of households for the time consuming activities of weeding and birdscaring.

**Fertilizing**

Four farmers in the Southern Region used a planter with a mounted fertilizer hopper. Through the hopper 50 kg (corresponding to 200 kg/ha) of single superphosphate fertilizer was applied next to the seeds and the balance was broadcasted before ploughing. At all other trial sites the fertilizer was broadcasted and ploughed in. Because of inaccurate ploughing at some sites, fertilizer particles were still observed on the surface after planting.

In Chobe a standard dose of 50 kg (corresponding to 200 kg/ha) of single superphosphate and 3:2:1 were applied; no more accurate amounts could be given, due to the uncertainty about the phosphorus levels as a result of the soil tests.

## **Ploughing**

Some farmers seem to believe, that they should wait with ploughing for one or two days after a sufficient rainfall event, in order to allow the rainwater to infiltrate and wet the soil properly. This practice could also attribute to delayed planting (see under Labour). In the Central Region it was observed, that the (sandy) topsoil had dried out by the time of planting, due to some delay in the start of ploughing.

In the Central Region on trial site S2, an experiment was done with a planter mounted on a double mouldboard plough. This combination was preferred by the farmer above the single mouldboard plough and single row planter, because of the time gain; only one pass through the field is required. On the plot where the plough/planter combination was used, a poor germination and consequently gaps in the plant stand were observed. The single plough/planted plot had a more uniform crop stand. Perhaps the difference in crop stand can be attributed to an uneven planting depth. Certainly, no harrowing could be carried out using the combined implement.

Amongst several of the trial farmers in the Southern Region an awareness is noted about the risks of shallow ploughing. This allows rainwater only to infiltrate to a certain depth, could create a pan and obstruct a deep penetration and proper development of the plant roots.

All trial plots (molapo and dryland fields) in the Chobe Enclave were situated on the floodplain. The soils of the floodplain have a high clay content: 30-50 %. Often farmers use the first planting rain (20-30 mm) to loosen up the topsoil. Only after the second rainfall event ploughing/planting with animals is carried out. Ploughing of the heavy soils breaks the surface of the soils into big massive clods. Some of the farmers plough twice or harrow to reduce the clods in size. In the Chobe Enclave four trial sites were ploughed by tractor. Generally the ploughing was inefficiently done: very superficial and often weed tufts were still left on the surface.

## **Harrowing**

In most instances no harrowing was carried out on the trial sites in the Chobe Enclave, resulting in very irregular surfaces and uneven planting depth.

Only on the trial sites around Maun harrowing was carried out as a standard practice. The soils were generally sandy (Arenosols), and a smoother planting surface, relatively free of weed tufts was achieved, as compared to farmers' fields that had not been harrowed. The harrowing operation created a good condition for uniform planting depths.

## **Planting and seed rates**

Planting is a crucial operation and the use of a row planter demands special care and accurateness of the operator. Several ALUPs reported problems with the Sebele row planters used by the trial farmers. The main constraints were temporary blockage of the seed outlet and hence uneven seed droppings. Often grass tufts and damp soil clods were dragged along by the planter for a couple of meters, blocking the seed outlet and thus attributing to an uneven plant stand. Uneven surfaces caused by furrows, also led to varying speed and direction of the planters, resulting in uneven seeding rates. At times, high amounts of seed were planted, e.g. seeding rates up to 40 seeds/m<sup>2</sup> have been

observed, which would have resulted in a plant density of 400,000 plants/ha, if all seeds would have emerged.

DAR recommended a seeding rate of approximately 3 kg/ha in order to achieve a plant density of 15,000 plants/ha (for the Maun trials) and 5 kg/ha to obtain 50,000 plants/ha (for the other regions). Converted to quarter hectare trial plots, this resulted in 750 gram/plot for Maun and 1250 gram/plot in Kanye. In both cases almost all farmers used all distributed seed. Nevertheless it seemed very difficult to achieve the target plant densities. Most trial around Maun reached plant densities below 5000 plants/ha, while in the other regions plant densities between 15,000-30,000 plants/ha were achieved.

The DAR recommendations include a germination rate of 80 %. However, based on seed counts, 3 kg of sorghum seed should be enough to reach a plant density of 100,000 plants/ha (including 80 % germination rate). This discrepancy of 6.6 times might be caused by factors such as:

- \* improper seedbed preparation (irregular ploughing, no harrowing), leading to uneven planting depth
- \* planter problems; uneven dropping of seeds, causing a competition for soil moisture of clusters of seeds
- \* no thinning operation carried out, maintaining the competition for soil moisture, restricting growth of individual plants and possibly leading to lesser grain yield per plants or failure to develop heads at all
- \* bird/insect damage to seed, just after planting
- \* damaged seeds
- \* poor germination potential (less than the guaranteed 80 %)

In the Chobe Enclave, the recommended Sebele row planter can not be used. Because of the big soil clods, the wheel of the planter does not function properly. No other row planter has been developed so far, that is suitable for the soils in the Chobe Enclave. Most farmers practice a type of third furrow planting by following the plough (in some cases a tractor) and drop the seeds by hand in each third furrow made by the plough. On the way back the plough covers the furrow with the next slice of soil.

The control plot of trial site S2, Makwate Central Region, was dry planted on 27-28/12/94, followed by good rains on 29/12/94.

In the majority of cases the first planting opportunity of the season was used to plant the trial plots. Sometimes the topsoil had dried out within 4-6 days after the rainfall event and before ploughing was finished, so that planting had to be held up until the next opportunity. As mentioned above, in the Chobe Enclave, planting generally took place at the second planting opportunity due to the soil conditions.

### **Pest and disease control**

In the Southern Region three farmers were assisted by the Plant Protection Division of MoA with spraying against armyworm, stalk borers and corn crickets. Alphametryon was used in knapsack sprayers. Half of the trial plots S3, Dihate Central Region, were sprayed with "Sherpa" against bollworm by FSR. A concentration of 7.5 ml/15 l was used. The bollworm disappeared, but no difference was observed between the treated and the non treated sections of the plots.

In Maun, one trial site was sprayed with Decis ULV against aphids.

Aphid attacks were reported from most regions. They mainly occurred during the late vegetative stage and were usually washed off the plants by a good shower. In Lotlhakane West (K3) near Kanye the trial site was not treated against aphids, and no timely rain occurred, resulting in dying off of the first developed heads. Despite the black heads plants did develop some tillers with secondary heads.

Bird scaring during the crop's grain filling stage formed the farmers' main activity since MAR3. Where a shortage of labour occurred a large portion of heads was damaged (up to 100 %).

Cattle entering the trial sites and severely damaging the crop was observed in a few cases.

On the molapo trial plots in the Chobe Enclave bird scaring was not necessary, because of the well protected maize crop. However, as fields are traditionally not fenced, damage by wildlife is a constant threat. Farmers are living on lands during the cropping season, prepared for full time vigilance.

### **Weeding**

In general most farmers, whose trial crop established well, conducted a weeding operation. The first weeding operation usually took place between 30-40 days after planting and was carried out in approximately 10 days. A second weeding operation (mainly conducted on the Kanye trial sites, due to the use of fertilizer) happened 50-65 days after planting and took around 1-5 days. The number of days spent on the weeding operations strongly depended on the amount of labour available and whether the trial plots formed part of an operation on the entire farmer's field or whether they were treated separately.

Farmers in the Chobe Enclave were reluctant to weed their fields after a poor germination. They reckoned, it was a waste of time to engage themselves in an activity, which they thought was not economically viable. The crops from those who did weed, remained stunted (30-50 cm) for the whole season and did not yield.

Some farmers in the Southern Region were hesitant to conduct a timely weeding operation, because as they stated, a dry spell had reduced the soil moisture and increased the soil temperature. The farmers explained, that weeding at that moment would damage plants, as hot soil would be pushed against them.

Another farmer near Kanye, in Sese (K9), had delayed weeding his trial plots, as he said to protect the seedlings against wind erosion until they were a bit stronger. It seemed to have made a positive impact on the plant establishment, because an adjacent field was practically free of weeds, but had a very poor establishment rate.

A lack of knowledge was detected, when one farmer admitted, that she did not know that weeds compete with crops for soil nutrients and fertilizer. She was very motivated to start weeding after obtaining this information.

The farmer in Polokwe (K5) conducted weeding with a cultivator and was enthusiastic about the results of proper weeding.

## **Harvesting**

In the Central Region and around Maun, it was observed that many sorghum growers are not interested in small immature heads or in heads with only partially filled grains (so called "mothallane"). After approximately two weeks of harvesting mature heads, they stopped and left the immature heads behind. In the Southern Region most farmers harvested all immature/partially filled heads and dried and threshed them separate from the mature heads and used the grains to feed their chickens.

In the Southern Region the sorghum crop is often left to dry on the stem, out of tradition, until the first cold (winter) winds arrive to finalize the drying of the grains. Consequently, lodging may occur and some of the grain may be lost due to wind or rodent action.

At the successful molapo trial in the Chobe Enclave (C9), it was remarked that the farmer delayed the harvest until all maize cobs had fully ripened on the stems. This was done, as the farmer was reluctant to spend too much time in harvesting; due to probably the way of planting, the plant stand had developed rather unevenly. Instead of harvesting the mature cobs and let them dry near the hut, a crop damage of approximately 10% occurred, due to termite and other insect attacks and fungi. The obtained yield figure from this trial could well be underestimated, due to home consumption of green mealies by the farm family.

## **2.4 Agronomic observations**

### **Germination and plant establishment**

On most trial sites in the Southern Region, 80 % of the established plants germinated within 6-7 days after planting. The remaining 20 % of the seeds germinated, approximately 4-5 days after the next major rainfall event. Both groups of plants established and continued developing (see Photograph 1, Appendix VI). The older plants usually formed proper heads and yielded fully filled grains, whilst the later germinated plants never finished their grain filling stage and ended up as "mothallane". This "second germination phase" was also observed around Maun and is known from the North East Region. Irregular planting depth and long dry spells shortly after planting might cause this phenomenon.

At the Maun trials, germination normally took place around 10 days (7-11) after planting. At one occasion germination occurred 26 days after planting, but 5 days after a second rainfall event of 28 mm.

From some trials in the Central Region poor germination was reported, due to a delay between the planting rainfall event and the actual planting. The prolonged dry spell and the high temperatures and the low moisture content of the topsoil may have caused the low establishment rates.

Those dryland farmers in the Chobe Enclave, who managed to plough and plant, had very poor germination and crop establishment. This can be attributed to the uneven rainfall distribution, resulting in high moisture stress during the cropping season. Farmers, whose crop had not germinated three weeks after a dry spell in January, abandoned their fields and left for Kasane to look for employment.

## Effect of fertilizer

Generally the use of fertilizer seemed to have a positive effect on plant growth in the vegetative stage. As compared to the plants on the control plots, fertilized plants were slightly taller, had more and greener leaves and thicker stems (see Photographs 2 and 3, Appendix VI). The Photographs 2 and 3 show a clear difference in plant development between the control and the fertilized plot of the Gamoswana trial site (K1) at 26 and 60 days after planting, respectively. As the fertilized plants were stronger than the non-fertilized, they were more resistant against wind erosion and dry spells. Often the fertilized plants had developed 1-2 tillers more than the non-fertilized.

## Plant stands and crop development

The trial sites in the Southern Region showed the most homogeneous plant stands. Soil preparations and planting had been carried out well; straight rows with relatively few gaps. The extra time spent on ploughing and planting (as compared to Maun area) seems to have paid off. In the other regions more heterogeneous plant stands have been observed, with plants in different development stages on one plot. Possible causes for this uneven plant development have been discussed above: improper land preparations, malfunctioning planters and rainfall/soil moisture conditions.

In general the highest plant densities were achieved around Kanye. Often, however, where target plant densities of approximately 30,000 plants/ha were achieved, plants had thin stems and only 2-3 tillers per plant. On trial plots with extremely low plant densities around Maun, the surviving plants developed very well and generally formed 3-6 tillers per plant (see Photograph 5, Appendix VI).

It took the successful trials in all regions on average 71 days (55-87) from planting to 50 % flowering (see Photograph 6, Appendix VI). Flowering continued for approximately 10-20 days. The grain filling lasted for about 30-35 days (see Photographs 4 and 7, Appendix VI), while ripening took around 25 days.

The average length of the growing season (from planting till harvest) amounted 128 days (112-146) in all regions except Southern. There the crop was left to dry on the stems for 1-1.5 month after reaching physiological maturity, resulting in an average season of 160 days (150-176).

The slightly longer growing season of 128 days, than the average of 120 days for sorghum *Segalana*, could have been caused by the relatively late start of the rainy season and consequently late planting. Dry spells, moisture stress and low temperatures in June/July may also have led to a prolongation of the crop cycle.

Farmers in the Southern Region observed, that the amount of fully developed heads and "mothlane" depends on the rainfall situation. In a season with early rains, no "mothlane" occurs. In case of late planting, due to late rains, the optimal growing conditions are shortened and not all heads get the chance to grain fill properly, leading to a certain percentage of "mothlane" heads (see Photograph 8, Appendix VI). Additionally a number of secondary shoots of the main tillers may also develop "mothlane" heads. The proportion of fully developed heads and "mothlane" was around 80 %-20 % in the 1994/95 growing season. The fully developed heads attributed on average 97 % of the grain weight, while the "mothlane" made up for the remaining 3 %.

## **Pest and disease factors**

Type and damage factors of pests and diseases vary per region and time of observation.

In the Southern Region army worm, stalk borers, corn crickets, termites, birds, baboons, rodents and cattle have been observed affecting crop yields. At Gamoswana (K1), termites seemed to attack plants during the season and past activity (anthills) may be the cause of patches of poorly developed plants. Due to poor fencing cattle damaged most of the crop at the Ramonedi trial site (K2).

In Central Region minor aphid and African Bollworm infestations have been recorded on some trial sites. Quelea (immature grains) and pigeons (ripe grains) formed a threat to the harvest on most of the Serowe trials.

Aphids, birds and livestock have been affecting some of the trials around Maun. At Segoro (M9), a promising crop failed for 100 %, due to bird damage. As the farmers' own crops had already failed due to dry spells, motivation was lacking to carry out bird scaring on the trial plots. At Xhana (M2), the harvested fertilized heads were approximately 10 % damaged by birds; despite bird scaring activities the remaining secondary heads were severely affected by birds, upto 90 % damage. Cattle ate around 75 % of the well established plants on the Thamalakane West site (M7).

Sorghum plants are most prone to bird damage during the grain filling and early ripening stages, when the grains still contain a high moisture content. Bird damage depends generally on the amount of effort put into scaring. If well controlled, bird damage can be kept to a maximum of 10% of the grains of each mature sorghum head. Several methods have been observed throughout the country: scare crows, plastic bags on the stems or covering the heads, strings with tins around the field, and people residing in or next to the field, scaring birds with stones, sticks or voice. Where not enough labour was available, or when other activities got priority, considerable damage occurred; observations showed 80-100% of the grains on individual heads had been picked towards the end of the ripening time.

Only early planted crops (NOV3-DEC3) could possibly ripen before the beginning of April, generally the start of the quelea infestations. But in a poor rainfall year like the 1994/95 season, an additional hazard is formed by local birds (like pigeons), which attack crops as soon as seeds have formed, due to the lack of seed bearing grasses and berry forming shrubs in the surrounding bush.

## **Molapo farming**

Two trials were conducted under the molapo (flood recession) farming system at Mabele in the Chobe Enclave. The two fields were adjacent to each other, situated in a river channel. Trial site C9 was located in the lowest part of the channel, where the plots of site C10 were positioned slightly higher on a bank of the channel.

Both farmers ploughed and planted in the decade SEP2. Due to the higher position of site C10 and a fast drop of the groundwater table, crop establishment was very poor and finally the trial failed.

Trial C9 had a good establishment rate and plants developed well. The plants at the fertilized plots looked stronger and were slightly taller than those on the control plot. The fertilized plots had a higher weed burden than the control. The dominant weed was *Sesbania bispinosa*, a leguminous weed. When uprooted, it was noticed that the roots of the weed plants on both fertilized plots showed more nitrogen fixating nodules than those of the control plot. The fertilized plants flowered two weeks earlier than the control plot. On average one cob was formed per plant.

During the last two months of the crop cycle, a humid micro climate established on the trial sites due to the prolific growth of the leguminous weed. Most of the cobs were affected by insects and fungi. The infestation resulted on the fertilized plots in a grain loss of approximately 40-50 %; on the control plot the loss was somewhat lower 30-40 %. Harvesting was done in the dekad FEB1/95.

### 3 RESULTS

#### 3.1 Trial yields

In total 43 on-farm trials were programmed for the 1994/95 cropping season. Of this total 14 trials (33 %) were successful and 29 (67 %) failed. The three main reasons for failure were:

- climate            5 trials (11%)
- farmer            15 trials (35%)
- supervision      9 trials (21%)

No identified timely planting opportunity and dry spells were the main adverse climatic reasons for trial cancellation or failure. Shortage of labour, slow preparation for the ploughing season, negligence and other activities (cattle, building, social obligations) attributed to farmers missing the first planting opportunity or carrying out improper crop husbandry, leading to sub-optimal crop yields or even failure. Logistical and communication problems of the supervising teams have led to missed planting opportunities, wrong fertilizer applications or mixtures of *Segaolane* seeds and local varieties, making trial results unsuitable for comparison.

The yield figures for the successful trials are reflected in Table 7. Trial C9 in Mabele was conducted under molapo farming conditions and with two types of fertilizer. The control plot yielded 1770 kg/ha of maize, while the plot treated with 3:2:1 compound NPK fertilizer yielded 42 % higher (2520 kg/ha) and the single superphosphate plot harvested 55 % higher than the control (2750 kg/ha).

**Table 7. Yield figures and discrepancies control - fertilized plots**

CODE	REGION	VILLAGE	YIELD (kg/ha)		DIFFERENCE %
			CONTROL	SSP *	
C9	North West/Chobe	Mabele **	1770	2750	+ 55
K3	Southern	Lotlhakane West	210	300	+ 43
K5	Southern	Polokwe	270	760	+ 181
K6	Southern	Kanngwe	460	1010	+ 120
K7	Southern	Mmathethe	170	350	+ 106
K8	Southern	Gasita	failed	480	
K9	Southern	Sese	660	670	+ 2
K10	Southern	Mongwalale	470	870	+ 85
K11	Southern	Pitsane	1290	760	- 41
M2	North West/Maun	Xhana	failed	590	
M8	North West/Maun	Tsanakuna	560	failed	
S2	Central	Makwate	700	730	+ 4
S3	Central	Dihate	670	1000	+ 49
S4	Central	Dihate	failed	670	

\* SSP - single superphosphate

\*\* molapo farming

Of the 10 dryland trials with successful control plots, the yields vary from 170-1290 kg/ha, while the range for the 12 fertilized plots is 300-1010 kg/ha.

Nine of the above thirteen dryland sites, had both successful control and fertilized plots. In one instance (K11), the control plot yielded considerably more (41 %) than the fertilized plot. In section 3.3.1 possible explanations for the deviating outcome of this trial are given. In two cases (K9 and S2), both control and fertilized plots yielded almost the same; the fertilized yields were 2 % and 4 % higher, respectively. On the remaining six sites (K3, K5, K6, K7, K10 and S3), the fertilized plot yielded significantly higher than the control plot; on average 97 %, ranging from 43-181 %.

The results from the Southern Region trials K5, K7, K9, K10 and K11 included fully developed grains and "mothalane". The harvested "mothalane" varied from 1-48 kg/ha and contributed 0.6-4.7 % to the control plot yields and 0.3-7.2 % to the fertilized yields, respectively. The highest amounts of "mothalane" were recorded in Sese (K9): 31 kg/ha (4.7 %) on the control plot and 48 kg/ha (7.2 %) on the fertilized plot.

It is suspected, that the yields from the Serowe trials are underestimated, since early harvested and immature heads have not been included. In addition, the used scale seemed to give rather round figures.

From the trials around Kanye, Maun and Serowe the average seed weight of harvested mature heads has been recorded (see Table 8). The average seed weight of heads of non-fertilized plants was 26.4 g, varying from 6.9-60 g and of fertilized plants 29.4 g, ranging from 8.3-78 g. "Mothalane" in the Southern Region produced on average 8 g of seed per head.

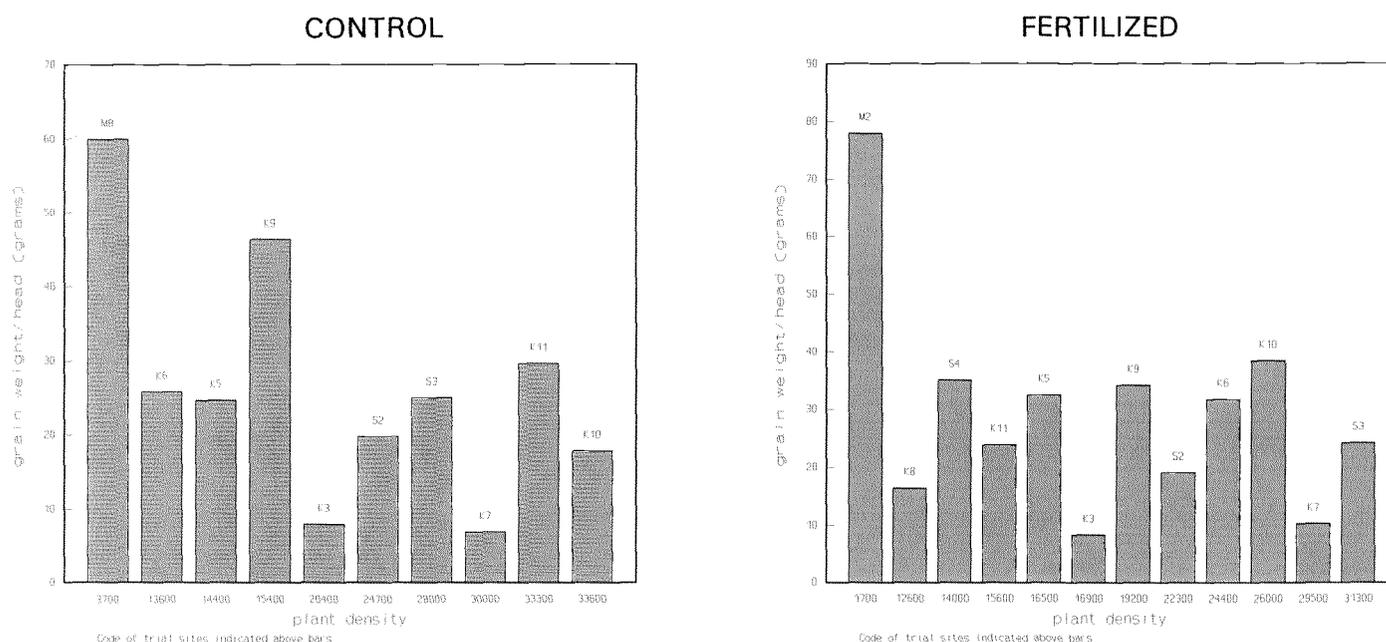
**Table 8. Seed weight of sorghum heads**

CODE	REGION	VILLAGE	GRAIN WEIGHT/HEAD (gram)	
			CONTROL	SSP *
K3	Southern	Lotlhakane West	8.0	8.3
K5	Southern	Polokwe	24.7	32.5
K6	Southern	Kanngwe	25.8	31.8
K7	Southern	Mmathethe	6.9	10.3
K8	Southern	Gasita	failed	16.4
K9	Southern	Sese	46.4	34.2
K10	Southern	Mongwalale	17.8	38.5
K11	Southern	Pitsane	29.6	23.9
M2	North West/Maun	Xhana	failed	78.0
M8	North West/Maun	Tsanakuna	60.0	failed
S2	Central	Makwate	19.8	19.1
S3	Central	Dihate	25.0	24.2
S4	Central	Dihate	failed	35.1

\* SSP - single superphosphate

The relationship between grain weight of harvested heads and actual plant density is depicted in Figure 3, for both control and fertilized plots. Although based on very few observations, a downward trend seems to exist in the grain weight/head with increasing plant density in the results of the control plots. On the other hand, the results of the fertilized plots show no obvious relationship between grain weight/head and plant density.

**Figure 3. Relationship between grain weight/head and plant density**



### 3.2 CYSLAMB yields

The CYSLAMB simulations were based on trial observations as reflected in Appendix IV. Where a raingauge was placed on trial sites, recorded rainfall data were used. If no site records were kept, data from the nearest rainfall station were used instead. For synoptic data reference was made to the nearest synoptic station.

On most trial sites a soil pit was described and often (topsoil) samples were taken and analyzed. The necessary soil characteristics to run CYSLAMB are: textural class, drainage class, effective soil depth, available water holding capacity.

The simulated management factors are the dates of planting and the first weeding operation, the plant density and the weed infestation rate.

The predicted yields for the successful trials and the discrepancy with the actually achieved yields are shown in Table 9. Under rainfed conditions, the CYSLAMB simulations for the control plots vary from 430-1070 kg/ha; for the fertilized plots the CYSLAMB yields range from 670-1600 kg/ha. Due to the unreliable soil analysis, only the control situation of molapo trial C9 could be simulated (a phosphorus content of 6 ppm has been taken).

The simulated yields under fertilized circumstances are on average 89 % (35-126) higher than the simulations for the control plots.

**Table 9. CYSLAMB yields and discrepancy with actual trial yields**

CODE	PREDICTED YIELD (kg/ha) and DISCREPANCY (%)			
	CONTROL		SSP *	
C9 **	2340	- 24 %	n/a	n/a
K3	560	- 63 %	1190	- 75 %
K5	960	- 72 %	1330	- 43 %
K6	430	+ 7 %	970	+ 4 %
K7	1070	- 84 %	1440	- 76 %
K8	failed	failed	920	- 48 %
K9	710	- 7 %	1470	- 54 %
K10	760	- 38 %	1600	- 46 %
K11	440	+ 191 %	990	- 23 %
M2	failed	failed	670	- 12 %
M8	500	+ 12 %	failed	failed
S2	810	- 14 %	1280	- 43 %
S3	710	- 6 %	1320	- 24 %
S4	failed	failed	810	- 17 %

\* SSP - single superphosphate      \*\* molapo farming

NB: The discrepancy columns reflect the trial yields (see Table 7): e.g. a discrepancy of - 38 %, means the actual yield was 38 % less than the by CYSLAMB predicted yield.

### 3.3 Comparisons

#### 3.3.1 Trial versus CYSLAMB yields

The achieved trial yields are generally lower than the simulated CYSLAMB yields. From all comparisons of the control plots, in 73 % of the cases the actual yield was less than the CYSLAMB yield; the discrepancy varies from 6-84 %. On 27 % of the control plots, the achieved yield was higher than the CYSLAMB prediction; the discrepancy varies between 7-191 % (see Figure 4a). From the fertilized plots, 92 % yielded lower and 8 % higher than the CYSLAMB simulations; the ranges of differences were 12-76 % less and 4 % more, respectively (see Figure 4b).

It is assumed, that  $\geq 20$  % difference between actual and simulated yield can be considered as significant. In that case, from all 23 comparisons, both control and fertilized, 35 % is not significantly different; 65 %, however, shows a large discrepancy.

A number of reasons for sub-optimal crop yields, and hence for the discrepancy between actual and predicted yields can be mentioned, derived from the management and agronomic observations described in the sections 2.3 and 2.4.:

- \* uneven distribution of fertilizer
- \* due to low rainfall, fertilizer not fully available to plants
- \* improper land preparations
- \* irregular planting depths, leading to poor emergence
- \* wind and sheet erosion
- \* uneven plant stands, gaps and no thinning
- \* dry spells
- \* improper weeding
- \* pests and diseases
- \* lodging and damage by wind, rain/hail storms

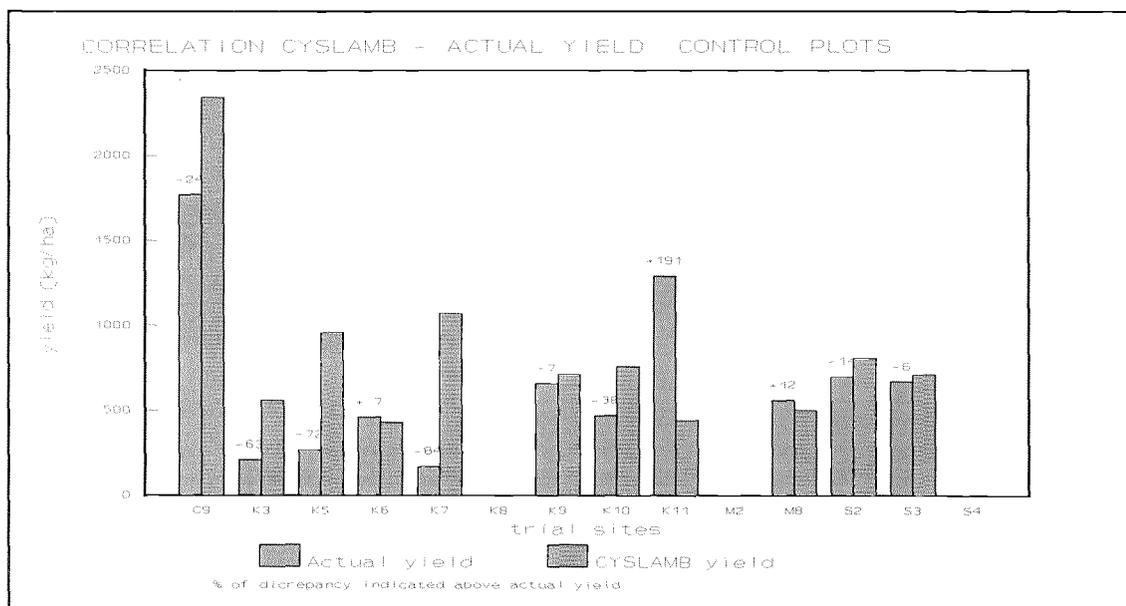
The large discrepancies of trial K3 Lotlhakane West (-63 % control and -75 % fertilized) can be attributed to an aphid attack, that wiped out the first developed heads; only secondary heads produced grain to harvest.

Planting of trial K5 Polokwe was done along the plough furrows, causing some irregularities in plant development. Additionally, capping of the topsoil occurred later in the season, leading to some sheet and rill erosion and discrepancies of -72 % for the control and -43 % for the fertilized plot.

The large differences in actual and predicted yield (-84 % for the control and -76% for the fertilized plot) at trial K7 Mmathethe, might be attributed to past and present termite activities. Several flattened termite mounds were observed in the field, which may have been the cause for the poor performance of clusters of plants. During the vegetative stage termites attacked plants all over the trial plots.

The fact that the control plot of trial K11 Pitsane produced 191 % more than CYSLAMB predicted might be attributed to an inaccurately determined phosphorus level. It is also known, that the farmer has used kraal manure on the trial plot in the past. Perhaps the

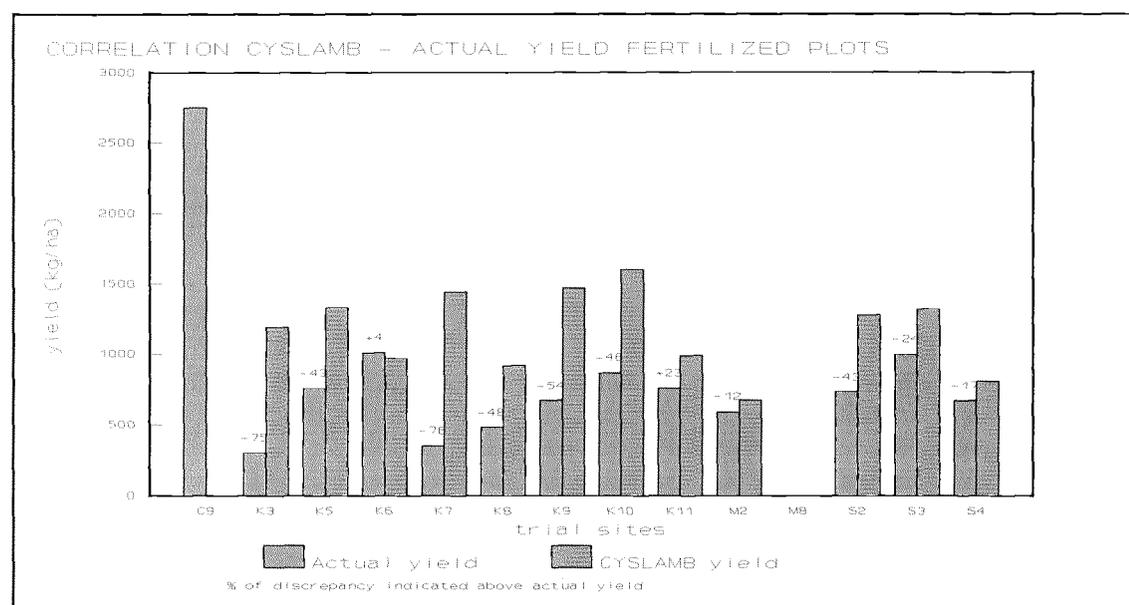
**Figure 4a. Trial and CYSLAMB yield for control plots**



nutrient status of especially the control plot is much more favorable than simulated by CYSLAMB. The relatively low yield of the fertilized plot is probably caused by shallow ploughing and subsequently the formation of a pan at approximately 20-30 cm below the surface. This observation is supported by a high germination rate and a promising early vegetative stage, but a further hampering of the plant development, due to shallow root penetration. The result of the fertilizer trial was 23 % less than the CYSLAMB prediction.

Both control and fertilized yields of trial K6 Kanngwe show a very good correlation with the CYSLAMB prediction: the trial yields were 7 % (control) and 4 % (fertilized) higher than the CYSLAMB simulations.

**Figure 4b. Trial and CYSLAMB yield for fertilized plots**



### 3.3.2 Trial versus farmers' yields

In most regions no yield data was collected of farmers' yields. Either different varieties of sorghum or a mixture of crops were planted, or farmers' crop had failed. In the Southern Region most of the trial farmers grew sorghum *Segaolane* as monocrop on their own fields and managed to obtain a yield (see Table 10). In all but one cases, the trial control plots yielded higher than the farmers' own fields. The positive differences vary between 17-625 %. The main reasons for the better performance of the trial plots is caused by proper crop husbandry. Labour shortage resulted often in improper weeding and birdscaring on the sometimes large farmers' fields, while enough attention was paid to the small trial plots.

**Table 10. Trial and farmer yields (kg/ha) and discrepancy in Southern Region**

SITE	K3	K5	K6	K7	K9	K10	K11
farmer	180	220	260	220	100	160	600
control	210	270	460	170	660	460	1290
%	+ 17 %	+ 23 %	+ 77 %	- 23 %	+ 625 %	+ 188 %	+ 115 %

### 3.4 Gross margin analysis

It is difficult to obtain a clear picture of the use of all available household labour. In some instances a competition between arable farming and other (income generating) activities was observed, like livestock rearing and building. Unless known what the financial returns of rainfed cropping are, nothing can be said about its feasibility.

The financial evaluation of the successful trials has been done through a gross margin analysis, which compared input costs with the value of the produce. On the cost side of the equation, the cost of seed and fertilizer was taken into account. It can be debated, whether farm labour for land preparations, weeding and birdscaring should be included in the gross margin analysis. Initially farm labour was excluded from the calculations. The effect of Drought Relief Subsidies for ploughing and row planting on the gross margin has been compared; see Table 11 for the parameters of the gross margin analysis per region.

**Table 11. Costs, prices and subsidies used in the gross margin analysis**

Costs, prices and subsidies	KANYE	MAUN/KASANE	SEROWE
seed P/kg	2.50	2.50	2.50
SSP* P/50 kg	27.50	28.55	28.55
3:2:1 P/50 kg		34.95	
labour P/ha	150.00	150.00	150.00
BAMB producer price '94/95 P/kg	0.34	0.45	0.38
DRS** - ploughing P/ha	120.00	120.00	120.00
- row planting P/ha	50.00	50.00	50.00

\* SSP - single superphosphate

\*\* DRS - drought relief subsidy

The results of the gross margin analysis are shown in Table 12. If no farm labour is taken into consideration in the analysis, the 10 successful control plots of the dryland trials achieved a positive gross margin varying from Pula 58-474/ha without and from Pula 228-644/ha including drought relief subsidies. If Pula 150/ha for farm labour was accounted for, 3 out of the 10 control plots would have resulted in a negative gross margin.

When the fertilizer costs are written off in one year and no farm labour is considered, 1 out of the 12 fertilized dryland plots would have had a slightly negative gross margin. The other 11 obtained a positive gross margin, varying from Pula 9-265/ha without, to Pula 179-435/ha with drought relief subsidies. Assuming Pula 150/ha is included for farm labour, 9 out of the 12 fertilized plots would have had a negative gross margin.

A factor complicating the comparison of crop performance is the risk of crop failure, which should be studied over a range of years. From the scheduled trials for the 1994/95 cropping season 67 % failed (see also section 3.1). The costs and efforts put into these failed trials have not been returned. On the fertilized trial plots a residual effect might still be seen the next two seasons.

If the cost of fertilizer is divided over three years in order to simulate the residual effect, the gross margins of the 12 successful fertilized plots would be all positive, varying from P 75-341/ha without, to P 245-511/ha including drought relief subsidies.

**Table 12. Gross margins in pula/ha**

CODE	CONTROL		FERTILIZED (single superphosphate)			
	GM	GM + DRS *	GM	GM + DRS	GM - SSP/3 **	GM - SSP/3 + DRS
C9***	795	965	1122	1292	1198	1368
K3	72	242	19	189	75	245
K5	91	261	147	317	222	392
K6	158	328	178	348	289	459
K7	58	228	9	179	83	253
K8	failed	failed	- 3	167	108	278
K9	226	396	62	232	174	344
K10	158	328	103	273	233	403
K11	474	644	92	262	203	373
M2	failed	failed	108	278	212	382
M8	251	421	failed	failed	failed	failed
S2	265	435	145	315	232	402
S3	253	423	265	435	341	511
S4	failed	failed	139	309	215	385

\* GM - gross margin      DRS - drought relief subsidy

\*\* GM - SSP/3, gross margin assuming a residual effect of 3 year, dividing fertilizer costs by 3 (without/with DRS)

\*\*\* molapo farming

It is considered, that a difference of 20 % or more in gross margin between the control and fertilized plots is significant. When comparing the 9 trials with both successful control and fertilized plots (see columns 2 and 4 of Table 11), the use of fertilizer written off in one season would pay off in 22 % of the cases. In another 22 % no considerable difference is obtained and in 56 % of the cases the use of fertilizer is not profitable.

If, however, the cost of fertilizer is spread over three years (the residual effect), in 56 % of the trials the fertilized plot has a significantly better gross margin than the control plot. In 22 % no significant difference is achieved and in the remaining 22 % the fertilizer was not lucrative.

At the molapo farming trial in Mabele (C9) two types of fertilizer were tested. The gross margins of the single superphosphate plot have been included in Table 12. The gross margins for the plot treated with 3:2:1 compound NPK fertilizer turned out approximately 10 % lower: Pula 993/ha without and Pula 1163/ha with drought relief subsidies. If the fertilizer costs are spread over 3 years, the gross margins are Pula 1086/ha excluding and Pula 1256/ha including drought relief. The use of the compound fertilizer did not prove to be more successful than the use of single superphosphate. The yield of the former was slightly lower (not significantly) and the costs slightly higher, resulting in a somewhat lower gross margin.

## 4 EVALUATION OF TRIALS

### 4.1 Lessons learned from farmers' point of view

Based on observations discussed in section 2.3 some general constraints met by groups of trial farmers can be listed:

- \* poor preparation for cropping season
- \* labour shortages, especially in female headed households
- \* dependence on tractors for ploughing, making operations not flexible
- \* problems with planters
- \* not conducting of thinning operation (tradition or labour problem)
- \* negligence in fence maintenance, causing damage by livestock

From the management observations, the draught power argument (animals too weak to plough after the first rains) can be refuted. Most of the trial farmers managed to plough and plant the trial plots within six days after the first planting rainfall event. In the beginning of the season, draught animals are only used during the morning. They can recuperate in the afternoon. In some cases draught animals are already used for ploughing of molapo fields as early as September.

Taking account of the large amount of manhrs/ha spent on fertilizing, ploughing, harrowing and planting, future trial plots should be reduced in size. To achieve timely completion of operations, instead of the 1/4 hectare plots, 1/8 hectare plots should be used. However, the 1/4 hectare plots showed clearly what the farmers' main constraints were.

Specific problems, based on confusion, inexperience or local traditions were the following:

- \* wrong fertilizer dosage given
- \* mixture of distributed seeds and local varieties used
- \* other occupations more important than arable farming
- \* first planting rain in Chobe Enclave used for loosening up of topsoil; second considerable shower used for ploughing/planting; farmers consider season as failed, if no shower of 50 mm or more has fallen by the end of December

On initiative of the CPO and the DAO in Ngwaketse North a Farm Walk was organized on the Polokwe trial site (K5) in April. Around 40 farmers mainly from the Moshupa South extension area turned up. Although most of the innovations tested during the on-farm trials were known, it appeared very motivating to the farmers participating in the walk, to see the results with their own eyes and discuss with the farmer responsible for the site. A similar positive response was received from the participants to the Farmers' Day, held in May on the same trial site. Approximately 100 people from all extension areas in the Ngwaketse North District attended the event.

The ALUP team in Kanye conducted end-of-season interviews with those eight farmers, who participated in the trials and obtained a harvest. The following section is based on the farmers' impressions of the trials. Five of the eight respondents were of the opinion, that the sorghum *Segaolane* had yielded poorly this past season, mainly due to the late start of the rains and the consequently late planting date in combination with the low rainfall amounts received. In addition wind erosion, bird damage, rodent and aphid attacks were mentioned as hazards, that influenced the crop yield. Three of the eight interviewed

farmers considered the yield as medium high.

The farmer at Lotlhakane West (K3) blamed the two dry spells, which occurred at the beginning and at the end of the vegetative stage for the moderate yield. Most farmers mentioned insufficient labour for proper weeding and birdscaring on their own fields as a cause for partial failure. Fields of upto 15 ha were ploughed and planted with sorghum. The trial plots were generally given priority, when it came to conducting timely and proper crop husbandry activities.

When asked, which management operation was the most difficult to perform well, seven out of the eight farmers answered: bird (and baboon) scaring. It is the most time consuming activity, because it requires a continuous presence in the field during daytime, from dawn to dusk. One farmer at Mmathethe (K7) did not consider birdscaring as that complicated. He had made a device, consisting of strings with cans filled with pebbles around the sides of his field, which would rattle when the strings were pulled. As damage due to birds was very limited on most trial sites, credit should be given to the farmers' efforts.

In response to the question, which management operation conducted for the trials was considered the most important to obtain a good yield, the farmers in Polokwe (K5) and Sese (K9) mentioned proper weeding. In Polokwe, weeding with a cultivator had virtually eliminated all weeds on the plots.

The farmer in Lotlhakane West (K3) stated that no results of improved management operations could be noticed the past season, due to the insufficient rainfall. His field received 76 % of the average rainfall amount and suffered from two dry spells.

The farmers were finally asked, if they would adopt any of the improved management operations in their production system next year. All eight declared that they would try to fertilize (a part of) their own field, as they has appreciated the yield increase on the fertilized plots. Six farmers intend to buy inorganic fertilizer and two would use kraal manure, as they could probably not afford the purchase single superphosphate. The other management operations (row planting, weeding and birdscaring) were all carried out on the farmers' own fields as well as on the trial plots the past season. Either a labour shortage or too high a hectarage under cultivation must have caused inefficient crop husbandry on the farmers' fields and most farmers have the intention to improve this situation next season.

#### **4.2 Lessons learned from supervision's point of view**

From all 43 scheduled on-farm trials, 21 % failed due to poor supervision and 35 % due to unfortunate farmers' decisions. The latter group could maybe have been reduced by more extension and discussions with the concerned farmers. In future, the high failure rate can perhaps be limited with help of the following reflections.

The main constraint in the execution of the trial program was a lack of logistical support. For proper farmer preparation and monitoring each trial region should have been provided with a motivated and well qualified Technical Officer with a vehicle and driver at his/her disposal. The past season this situation was created in Kanye and Maun. From these two stations the most detailed observations were collected. To prevent mistakes and to be able

to act swiftly, when necessary, two visits of each trial site per week are an absolute minimum.

On several occasions fertilizing did not take place according to the specifications, planting was done when topsoil moisture was too low, or where the distributed seed was mixed with local varieties, or fertilized and control plant heads were not separated at harvest. The final results of these sites could not be compared to properly conducted trials and this type of failure is basically due to insufficient supervision.

Although some flexibility should be allowed, depending on local conditions, it should be tried to follow one method for the measurement of plant densities, weed cover and harvesting and yield calculation and presentation for all trial sites in the program.

In the Chobe Enclave the choice of crop was left to the farmers. Almost all opted for maize, which failed on all dryland trials. In order to use a more drought resistant crop and to facilitate countrywide comparison of results, it is advisable to use sorghum in the Chobe Enclave in future trials.

The Kasane ALUP team felt, that too much time was spent in travelling to and from trial sites for a relatively short time of observations. Their suggestion was to reduce the number of participating farmers, and increase the number of plots and experiments per farmer.

The Preparation and Monitoring Protocols (Appendix I and II) served their purpose of to-do lists well. The Checklist (see Appendix III) to record trial and farmers' activities was found a bit too elaborate and time consuming to fill out at each visit to a trial site. This despite the fact, that the lessons learned from the comparison of the farmers' performance on the trial sites and on their own field were very valuable. Experience has proven, that the more time spent on data collection, the more conclusions could be drawn concerning farmers' constraints. Unfortunately, the collected agronomic data (concerning timing of the different crop growth stages) are rather poor. There is no factual basis to give recommendations for the validation of CYSLAMB in that respect.

The scheduled farm walks (two at each trial sites) were a bit too ambitious. In the first place, a farm walk should offer the farmers new developments, secondly budgets should be available to organize meals for the participants and thirdly the logistics should be in place for the organization of the events (e.g. transport of farmers). As not all conditions could be met in many trial sites this season, more effort should be made in future to convey trial results first hand to neighbouring farmers' households. Certainly one farm walk at each successful trial site should be scheduled and could perhaps be combined with a field day or farm walk organized in the same Extension Area by the AD or the CPO.

The post-season interviews as conducted in the Southern Region should be standardized and carried out at all trial sites in future.

## 5 CONCLUSIONS & RECOMMENDATIONS

The concluding remarks presented here must be appreciated in the framework within, which they were achieved. Firstly they are based on the results of only one trial season. Secondly, that season was generally characterized by poor to moderate rainfall, both in terms of quantity and in distribution over the season. The intention of this chapter is to share the experiences obtained and to formulate suggestions for possible (regional) sets of extension recommendations for the improvement of the rainfed arable crop production in Botswana.

### Land preparations

From the observations in Kanye and Maun it appears, that a lot of time is spent on the operations fertilizing, ploughing, harrowing and planting: 107 and 109.4 manhrs/ha respectively. Converted in working days of six hours, this corresponds for two people to 7.8 and 6.3 days/ha. When too much time is spent on the land preparations, the topsoil moisture decreases and consequently a poor germination results or the planting opportunity is missed altogether. Timeliness of operations is crucial and the most optimal ways should be found to make use of the available soil moisture as soon after the rainfall event as possible. Several alternatives can be thought of:

- \* better preparation of implements and draught animals before the cropping season
- \* the use of two spans of draught animals, in order to be able to alternate them and to carry out operations in the morning and in the late afternoon
- \* a reduction of the time used for land preparations through the use of (small) mechanized draught power
- \* concentration on a small hectareage per planting opportunity
- \* spreading of operations

At each planting opportunity, farmers should concentrate on a small area; for the time being 0.5 ha seems to be a portion of land, that can well be managed with draught animals within 3-4 days. In future a relationship should be established between the amount and the timing of rainfall, potential evapotranspiration and soil moisture, and the corresponding maximum hectareage to plough and plant per agro-ecological region.

Especially on sandy soils a spreading of the land preparation operations could be carried out. In the North Western Region, certainly around Maun, CYSLAMB identifies the first planting opportunity in NOV3 or DEC1 in approximately 80 % of the years. Operations as fertilizing and ploughing can be started from NOV2 onwards. Immediately after the first planting opportunity fields can be harrowed, followed by planting, thus gaining valuable time and creating optimal conditions for germination and plant establishment.

The option of dry "ploughing/planting" on sandy soils brings all operations forward, including planting, and creates more flexibility to the farmer. This method of ploughing and planting before the first planting rain is practiced all over the country, but at a very limited scale. By ploughing, possible weeds should die and do not re-emerge during the dry period before the first planting rain. If seeds are planted evenly at approximately 10 cm below the surface, they should withstand the high topsoil temperatures and germinate after the first rainfall event of at least 20 mm. Planting done from NOV2 onwards, will provide the seeds optimal advantage of the rain of the first planting opportunity of the season. Planting too early (before NOV2) might lead to crop failure due to a lack of soil moisture.

In any case, farmers should try to utilize the first planting opportunity of the season, normally occurring in NOV3 or in December. Germination and early vegetative stage should then take place in December, providing the plants with the best protection against dry spells in January and February, and hence creating the highest chance for good survival rates and reasonable yields.

It is recommended, that more research should be done on the functioning of row planters, in order to minimize the occurrence of uneven plant stands.

### **Crop development**

Although the trials aimed for plant densities of 15,000 plants/ha around Maun and 50,000 plants/ha in the other regions, considerably lower plant densities were achieved. The used seeding rates conformed to the recommendations of the Department of Agricultural Research. However, low germination rates were observed, due to various reasons (see section 2.3 Planting and seed rates).

In general, it is recommended to keep plant densities low (possibly 10,000-30,000 plants/ha). Even in below average rainfall years, plants in a small population will have the chance to develop properly and produce large heads and consequently a high grain weight per head or per plant. It is imperative to strive for a homogeneous plant stand. An even row spacing and in-row plant spacing will reduce competition for available soil moisture. Accurateness in planting, and where necessary a thinning operation, should be carried out. Even to achieve low plant densities, enough seed should be used to compensate for losses during planting and germination. The 10 kg seed pockets/ha, distributed under the drought relief scheme, seem too much, but must be based on similar experiences.

It was observed, that plants from the plots with the highest plant densities, developed the lowest number of tillers. For the control plots the grain weight from harvested heads decreased with increasing plant populations. An extreme example occurred on trial site Xhane (M2), where a plant density of only 1700 plants/ha was achieved, and a mean of 3-6 tillers developed per plant, yielding on average 78 g/head.

All trials that yielded well (> 450 kg/ha, corresponding to 6.5 (70kg) bags), received a minimum amount of 20 mm of rain during the establishment phase of the crop. This ten day period just after germination, seems to be crucial for the crop development. When established well, the small plants are more resistant to possible dry spells.

A simple classification of first dry spells of the season was made (see section 2.2). The analysis made was too superficial to advise the best time of planting for the limitation of crop damage or failure due to dry spells. Dry spells can not be avoided, as they are inherent to agro-ecological conditions in Botswana. Farmers can only try to minimize the impact of dry spells on their crop yield by a good preparation, swift action and concentration on small areas per planting opportunity. After characterization of the first dry spell, a prediction could perhaps be made concerning the final crop performance, indicating which crop management operations are still advisable.

Considering the low to average rainfall received during the trial season, the use of single superphosphate fertilizer was rather successful. From the nine trial sites, where both control and fertilized plots reached harvest stage, in six instances the fertilized plot yielded higher than the control. The average yield increase due to fertilizer use was 97 %, ranging

from 43-181 %. In two cases the fertilized and the control yield did not significantly differ; the fertilized yield was 2 % and 4 % higher respectively. At one trial, however, the control plot yielded 41 % higher than the fertilized. To investigate the financial viability of the used production systems, a gross margin analysis was carried out. When assuming a difference in gross margin of 20 % as significant, fertilizer use would be attractive in 22 % of the cases, when paid off in one year. In another 22 % no financial difference is achieved and in 56 % fertilizer is not profitable. If, however, the cost of fertilizer is spread over three years (assuming a residual effect), in 56 % of the trials the fertilized plot has a significantly better gross margin than the control plot. In 22 % no significant difference is achieved and in the remaining 22 % the fertilizer did not pay off.

For proper plant development, effective and timely weeding and bird scaring are highly recommended. Weeding with a cultivator proved to be successful, as in some instances delayed weeding to protect seedlings against wind erosion seemed important. Extension efforts should be increased concerning the explanation of the relationship between fertilizer and increased weed growth. More attention should be given to the development of bird scaring techniques (like at the Mmathethe trial, K7) in order to alleviate this important task for farmers.

After swift action, spraying by the Plant Protection Division against several insects has proven to be effective. It is recommended, that farmers contact this Division as soon as pest or diseases have been observed. On the other hand, insecticides and pesticides should be made more widely available to the farming community through government or private outlets, so that timely action can be undertaken by farmers themselves and the reliance on government officers can be decreased.

As traditionally grain yields in Botswana are low, it can be recommended to harvest "mothlane" heads, which in the Southern Region formed up to 7.2 % of the yield.

The yields achieved on the successful control plots in the Southern Region are in 6 out of the 7 cases higher than the yields of the farmers' fields. The positive differences vary from 17-625 %. The main reasons for the better performance of the trial plots must be sought in better crop husbandry. Labour shortage resulted often in improper weeding and birdscaring on the sometimes large farmers' fields, while enough attention was paid to the small trial plots.

For a more sound correlation of trial yields and CYSLAMB predictions, it is imperative to have proper soil analysis results. An effort should be made to achieve a higher degree of reliability in soil laboratory output in Botswana.

Despite the poor to moderate rainfall season and the high amount of crop failure and not realized trials, certainly in the Southern Region the main objective of the trials (to show farmers the scope for improvement) has been met. The recommendations as generated by CYSLAMB regarding timing of operations and the use of fertilizer can be adopted by motivated and meticulous farmers. Not all the obtained yield figures can be used for the validation of the program, due to the impact of not modeled factors on the yield. The trials definitely provided more insight in rainfed cropping in general and in individual management operations in particular. Future trials are recommended, especially to collect data under more favorable rainfall conditions. Future trials may bridge gaps between farmers on the one hand and researchers and policy makers on the other, in order to jointly increase outputs of the arable crop production sector in Botswana.

## APPENDIX I PREPARATION PROTOCOL

### ON-FARM CROP TRIALS - SEASON 1994/1995

#### PREPARATION PROTOCOL

- \* **Consultation** of concerned officers in Extension and Research (RAO, DAO, DAS, AD, CPO, RARO and others)
- \* **Selection** of farmers in cooperation with AD  
criteria:     - access to draught power, implements and labour  
              - prepared to experiment  
              - representative
- \* **Selection** of trial sites  
criteria:     - 1/2 hectare sites  
              - plots for fertilized and control on similar positions  
                  (altitude, slope and soil types)
- \* **Check**, if applicable, the condition of the fence of the field and encourage farmer to take appropriate action, where necessary
- \* **Verify** cultivation history of the trial sites (crops grown, rotation, fertilizer use)
- \* **Take** soil samples of the top 25 cm for routine analyses (including pH, N, P, K)
- \* **Run CYSLAMB** with following parameters set: - rainfall 20 mm or  
  - soil moisture 20 mm  
  - phosphorus rate as analyzed  
  - phosphorus rate of 10 ppm  
**in order to simulate:** - optimal planting date  
                                  - optimal plant density  
                                  - optimal time of weeding (30-50 days after planting)
- \* **Calculation** of phosphorus application rate for fertilized plots.  
Use Single Superphosphate (SSP) fertilizer and raise initial phosphorus level to 10 ppm.  
Use following table and formula to calculate the amount of fertilizer required:  
  
bulk densities (in gm/cc): Arenosol     1.50 - 1.55  
                                  Luvisol ferric 1.50 - 1.65  
  light     1.45 - 1.55  
  heavy    1.40 - 1.50  
                                  Calcisol    1.55 - 1.70  
                                  Vertisol    1.00 - 1.30  
                                  Gleysol    1.10  
  
formula:     **kg P needed =  $2.5 \times 10^6 \times \text{bulk density} \times \text{portion of hectare} / 10^6$**   
              **kg single superphosphate needed = kg P needed  $\times 100/10.5$**  to raise the phosphorus level  
              of the topsoil of the trial plot with 1 ppm  
(N.B. for topsoil is taken 2.5 dm,  $10^6$  is surface of 1 ha in  $\text{dm}^2$ , portion of hectare is the surface of  
the fertilized plot, P content of single superphosphate is 10.5 %)  
  
For Arenosols and Luvisols an application of 35 kg SSP corresponds with 1 ppm increase in P level.
- \* **Set out** trial plots:   - two 1/4 hectare plots, preferably 50x50 m per site  
                                  one plot fertilized, one control  
                                  - mark corners with (white) pegs
- \* **Install** a rain gauge close to the trial site and instruct AD/farmer/TO how to record

- \* **Distribute** seeds and fertilizer to participating ADs
- \* **Collect and prepare** draught animals
- \* **Inspect, prepare, organize** implements: plough, chains, harnesses, planter, harrow, cultivator
- \* **Organize access to threshing machine and scale**
- \* **Identify** the planting opportunity after 20 mm of effective rainfall in a given decade.

N.B.: Daily falls greater than the potential evapotranspiration (PET) are considered effective and summed. As soon as the total effective rainfall in a dekad exceeds 20 mm, planting can take place. **Farmers should be informed and mobilized !** The average dekadal PET values can be retrieved from the synoptic station databases in CYSLAMB.

- \* **Broadcasting** of fertilizer by the farmer under supervision
- \* **Ploughing and harrowing (if required)**
- \* **Planting** in rows, as closely to the required optimal plant density as possible

## APPENDIX II MONITORING PROTOCOL

### ON-FARM CROP TRIALS - SEASON 1994/1995

#### MONITORING PROTOCOL

- \* **Recording** of rainfall as soon as rain gauge has been installed
- \* **Make** a sketch map of the trial sites depicting topography, possible soil differences, number of rows and location of fertilized and control plots for observations on crop performance
- \* **Make** a rough estimate of the plant density and **do** observations on the homogeneity of the crop stand (show possible irregularities on the sketch map), 4 weeks after planting
- \* **Mind** replanting/gap filling by farmers; if signaled try to eradicate plants and/or map concerned spots
- \* **Estimate** the weed coverage (% ground cover) just before weeding
- \* **Conduct** a thinning operation, to reach the optimal plant density, concurrently with a first weeding operation at the optimal time of weeding (simulated with CYSLAMB)
- \* **Estimate** the exact plant density, three weeks after the first weeding operation, by counting the number of plants in randomly chosen, 2m long sections of 10 rows
- \* **Estimate** the weed coverage (% ground cover) three weeks after the first weeding operation
- \* **Make** observations of:
  - infestation of pest/diseases, including rate of affected plants
  - nutrient deficiencies
  - dry spells, flooding/ponding water, hail/night frost (number of days)
- \* **Contact** Plant Protection Unit and **spray** appropriate chemical, when more than 20-30% of plants affected by pest/decease
- \* **Organize** possibly two farm walks; one 4-5 weeks and one 14-15 weeks after planting. All farmers from the extension area, where the trial is taking place, should be invited.
- \* **Conduct** a second weeding operation, if considered necessary, 4-5 weeks after the first weeding operation
- \* **Organize** bird scaring activities for approximately 4 weeks during week 11-15 after planting
- \* **Harvest** after 120 days all cobs/heads of plants in randomly chosen, 2m long sections of 10 rows. **Count** total number of plants and cobs/heads harvested and **observe** cob/head quality and grain filling.
- \* When maize, **dry** at ADs office for 2-3 weeks
- \* **Threshing**
- \* **Weighing and yield calculation**
- \* **Comparison** of achieved yield with CYSLAMB results, using actual (field) plant density

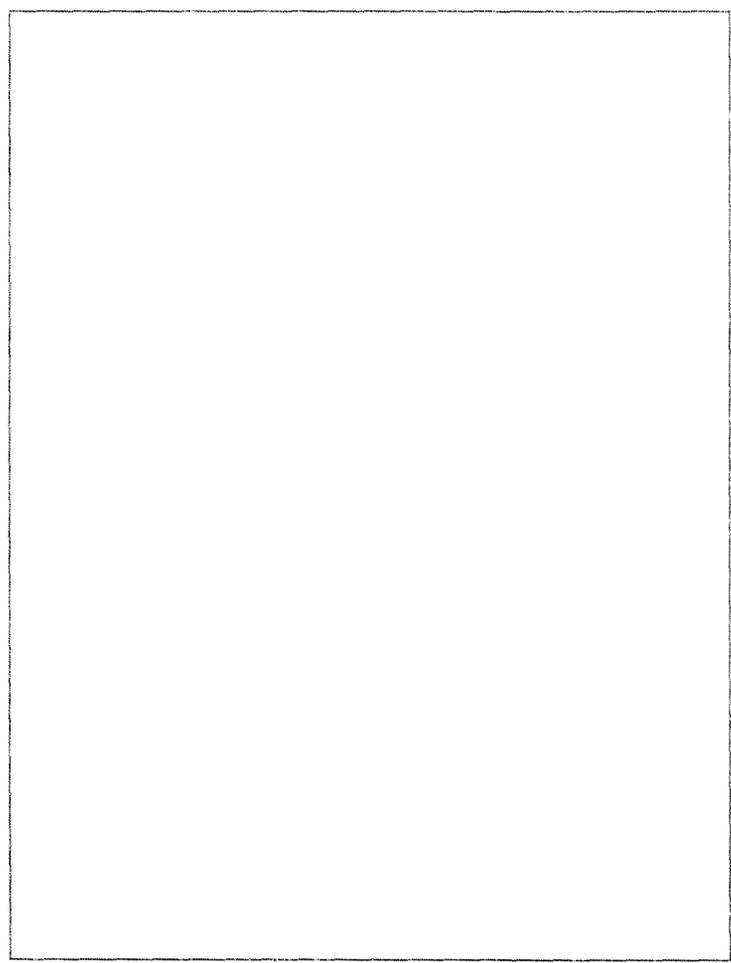
## APPENDIX III CHECKLIST

**CHECKLIST**

SITE: \_\_\_\_\_ DATE: \_\_\_\_\_  
FARMERS NAME: \_\_\_\_\_ TRIAL PLOT SIZES: \_\_\_\_\_ HA  
P-CONTENT IN SOIL: \_\_\_\_\_ PPM FERTILIZER TYPE: \_\_\_\_\_  
FERTILIZER/HA: \_\_\_\_\_ KG/HA FERTILIZER AMOUNT USED: \_\_\_\_\_ KG  
NUMBER OF ROWS: \_\_\_\_\_ FERTILIZED PLOT/ \_\_\_\_\_ NON-FERTILIZED PLOT

**INSTRUCTIONS:**

1. Make a sketch map of field. Show location of trial plots in field and mention landmarks to identify location of plots (distance from identifiable fenceposts to corners, etc). Indicate which plot is fertilized. Show direction of North. Show which direction rows are running.
2. Show "high" and "low" areas in field and differences in soiltype (sandy, loamy, etc) on the map.
3. Make a rough estimate of plant density of crop **JUST BEFORE WEEDING** and show possible uneven density on sketch map (do 4 2m sections in each plot, see page 5 for instructions).



**INSTRUCTIONS:** The following observations should be done at visits to trials:  
**EVERY VISIT:** 1) Check rainfall records, ensure that farmer is doing correct recording and figures are reliable and enter into:

- RAINFALL SHEET (p.3)
- 2) Record management operations carried out since last visit in:
- LABOUR CALENDAR (p.7)
- DRAUGHT POWER CALENDAR (p. 11)
- use of INPUTS (p.12)
- and CROP OBSERVATIONS (p.13)

Make comments about quality of work, special problems expressed by farmer, farmers opinion about trials, comparison with own crop, etc., in the section "comments" at the bottom of relevant pages.

- 3) In case of any attacks by pests and diseases: fill in CROP OBSERVATIONS (p.13) and advice supervisor immediately, so proper action may be taken.

- 4) Estimate if farmer needs assistance for weeding and birdscaring.

**AT APPROXIMATELY 30 DAYS AFTER PLANTING:**

- 5) Measure percentage ground cover by weeds, record in WEED COVER (1) (p.4).

- 6) Estimate plant density, indicate on sketch map (p.2) and determine if thinning is required to achieve optimal plant density.

**AT 50 DAYS AFTER PLANTING:**

- 7) Measure plant density, record in PLANT DENSITY (p.5)

**AT 60 DAYS AFTER PLANTING:**

- 8) Measure percentage ground cover by weeds, record in WEED COVER (2) (p.6). Estimate if second weeding operation is necessary. Note if this might conflict with other work by farmer.

**AT 90 DAYS AFTER PLANTING:**

- 9) Take soil sample from both plots. Samples should be taken FROM PLANT ROWS.

**AT APPROXIMATELY 120 DAYS AFTER PLANTING:**

- 10) Measure yield from plots and record in HARVEST ASSESSMENT (p.15 and 16).

**COMMENTS:**

## RAINFALL SHEET

SITE: \_\_\_\_\_

INSTRUCTIONS: If farmer keeps rainfall records: transfer data from his/her record to rainfall sheet, after assessing if it is correct. If you do reading: enter figure. If no data available: contact nearest AD and obtain figure.

DATE	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
21								
22								
23								
24								
25								
26								
27								
28								
29								
30								
31								
TOTAL								

## WEED COVER (1)

SITE: \_\_\_\_\_

DATE: \_\_\_\_\_

INSTRUCTION: Estimate percentage weed cover using 10 quadrats **JUST BEFORE WEEDING** (Approx. 30 days after planting). Use the following method to identify the rows to sample: Count the total number of rows in a plot, divide by three, and sample each row representing a third of the width (eg. in case of 66 rows, sample between row number 22 and 23 from both borders (66/3=22)).

Sample distance: - 19 m in case of 100 m long plots and 9 m in case of 50 m long plots

Place first quadrat: - 4.5 m from the end.

Quadrat number	Percentage groundcover by weeds in quadrat	
	Fertilized plot	Non-fertilized plot
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
Percentage ground cover (mean)		

2) If weed cover is very uneven in plots, make sketch of different areas (indicate average weed cover in each area in %)

2) SKETCH OF PLOTS WITH AREAS OF DIFFERENT % WEED COVER

COMMENTS: (any dominant weeds, very noxious weeds...): \_\_\_\_\_

## PLANT DENSITY

SITE: \_\_\_\_\_ DATE: \_\_\_\_\_

INSTRUCTIONS: Count the number of live plants in 10 sections each measuring 2m in each plot **THREE WEEKS AFTER WEEDING**. Count the number of plants in 5 2m long sections in two rows and record below. Use the following method to identify the rows to sample: Count the total number of rows in a plot, divide by three, and sample each row representing a third of the width (eg. in case of 66 rows, sample on row number 22 from both borders (66/3=22)).

Sample distance: - 18 m in case of 100 m long plots and 8 m in case of 50 m long plots

Sample first 2m section: - 4 m from the end.

Section number	Number of plants in section	
	Fertilized plot	Non-fertilized plot
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
Total no. of plants		
Plot length		
Plot width		
Rows sampled (eg. number 22 and 44)		
No. of rows		
Plant density (mean)		

COMMENTS (evenness of plant density, reasons, etc): \_\_\_\_\_

## WEED COVER (2)

SITE: \_\_\_\_\_ DATE: \_\_\_\_\_

INSTRUCTION: Estimate percentage weed cover using 10 quadrats **4 WEEKS AFTER WEEDING** (Approx. 60 days after planting). Use the following method to identify the rows to sample: Count the total number of rows in a plot, divide by three, and sample each row representing a third of the width (eg. in case of 66 rows, sample between row number 22 and 23 from both borders (66/3=22)).

Sample distance: - 19 m in case of 100 m long plots and 9 m in case of 50 m long plots

Place first quadrat: - 4.5 m from the end.

Quadrat number	Percentage groundcover by weeds in quadrat	
	Fertilized plot	Non-fertilized plot
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
Percentage ground cover (mean)		

2) If weed cover is very uneven in plots, make sketch of different areas (indicate average weed cover in each area in %)

2) SKETCH OF PLOTS WITH AREAS OF DIFFERENT % WEED COVER

COMMENTS: (any dominant weeds, very noxious weeds....): \_\_\_\_\_

LABOUR CALENDAR

SITE: \_\_\_\_\_

1. TRIAL PLOTS

ACTIVITY	Period(s): Record dates	Area (ha)	Time spent on activity. Record in hours or half or full days	Labour force used		
				Household name	age no.	Hired age gender
PLOUGHING						
FERTILIZING						
PLANTING						
WEEDING method:	1					
	2					
BIRDSCARING						
OTHER:						
OTHER:						
HARVESTING						

COMMENTS: \_\_\_\_\_

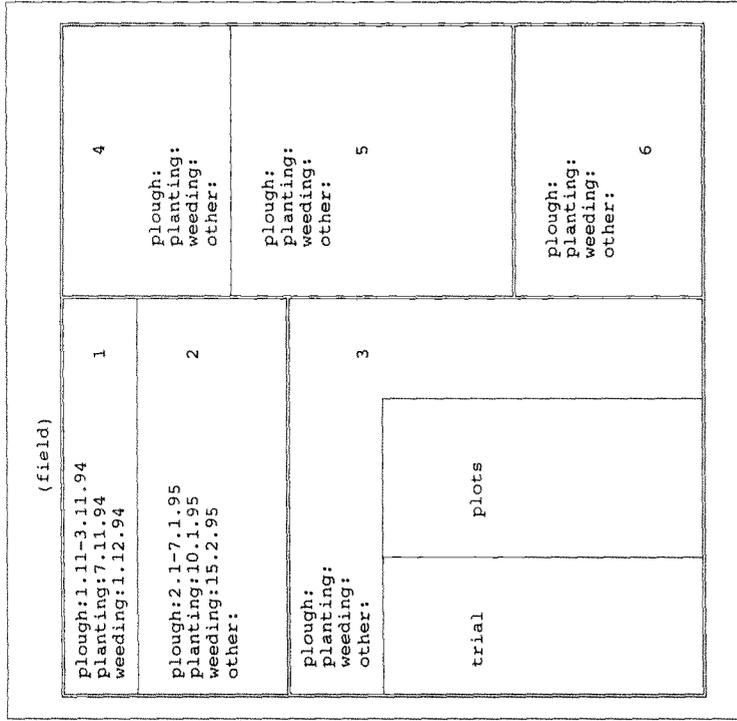
LABOUR CALENDAR (continued)

2. FIELD

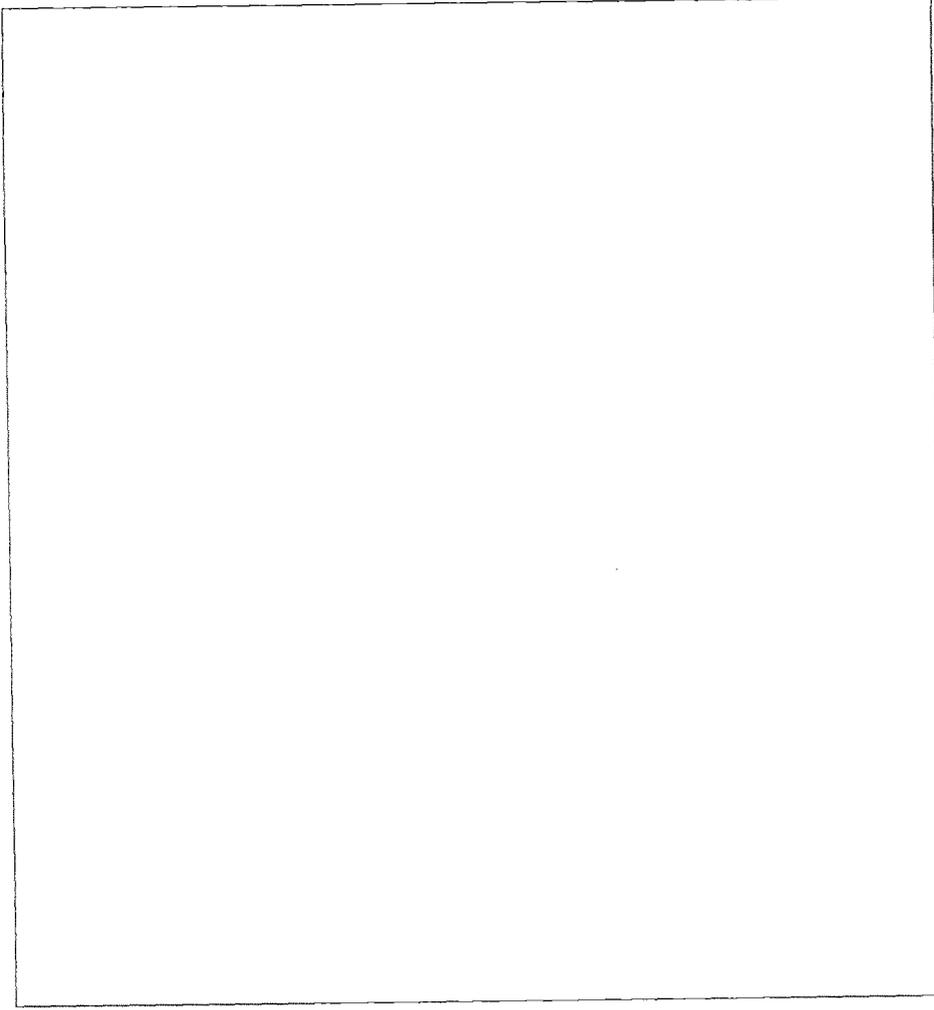
ACTIVITY	Period(s): Record dates	Area (ha)	Time spent on activity. Record in hours or half or full days	Labour force used		
				Household name	age no.	Hired age gender
PLOUGHING						
FERTILIZING						
PLANTING						
WEEDING method:	1					
	2					
BIRDSCARING						
OTHER:						
OTHER:						
HARVESTING						

COMMENTS: \_\_\_\_\_

EXAMPLE OF SKETCH MAP OF FIELD SHOWING WHEN OPERATIONS TOOK PLACE IN DIFFERENT PARTS OF FIELD.



INSTRUCTIONS: Show on sketch map when activities took place at different areas of field (see example on following page).



- Area 1: 2 Ha (approx.) Crop: MAIZE
- Area 2: 1 Ha (approx.) Crop: MAIZE
- Area 3: 1 Ha (approx.) Crop: COMPEA
- Area 4: 0.5 Ha (approx.) Crop: SORGHUM
- Area 5: 3 Ha (approx.) Crop: SORGHUM
- Area 6: 0.5 Ha (approx.) Crop: SUNFLOWER

- Area 1: \_\_\_\_\_ Ha (approx.) Crop: \_\_\_\_\_
- Area 2: \_\_\_\_\_ Ha (approx.) Crop: \_\_\_\_\_
- Area 3: \_\_\_\_\_ Ha (approx.) Crop: \_\_\_\_\_
- Area 4: \_\_\_\_\_ Ha (approx.) Crop: \_\_\_\_\_
- Area 5: \_\_\_\_\_ Ha (approx.) Crop: \_\_\_\_\_
- Area 6: \_\_\_\_\_ Ha (approx.) Crop: \_\_\_\_\_

COMMENTS: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

COMMENTS: \_\_\_\_\_



### CROP OBSERVATIONS (1)

SITE: \_\_\_\_\_ DATE: \_\_\_\_\_

INSTRUCTIONS: Record the date that crop (more than 90% of all plants) have reached development stage. Also calculate number of days from planting. Repeat for same crop in field as in trials (sorghum or maize).

**1. TRIALS**

CROP STAGE	DATE		DAYS FROM PLANTING	
	fertilized	non-fertilized	fertilized	non-fertilized
planting				
plant emergence				
flowering				
seed formation				
maturity (harvest)				

**2. FIELD**

CROP STAGE	DATE	DAYS FROM PLANTING
planting		
plant emergence		
flowering		
seed formation		
maturity (harvest)		

COMMENTS: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

### CROP OBSERVATIONS (2)

SITE: \_\_\_\_\_

INSTRUCTIONS: Record any effect of pests, diseases, dry spells, nutrient deficiencies, hail damage, standing water, frost. For field: Record only MAJOR attacks!

**1. TRIAL**

TYPE (Name of disease, etc)	PLOT (fert/ no fert.)	DATE OF OCCURRENCE	AFFECTED PLANT POPULATION (%)	COMMENTS (treatment, dosage, dates)

**2. FIELD**

TYPE	CROP	DATE OF OCCURRENCE	AFFECTED PLANT POPULATION (%)	COMMENTS (treatment, dosage, dates)

COMMENTS: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_



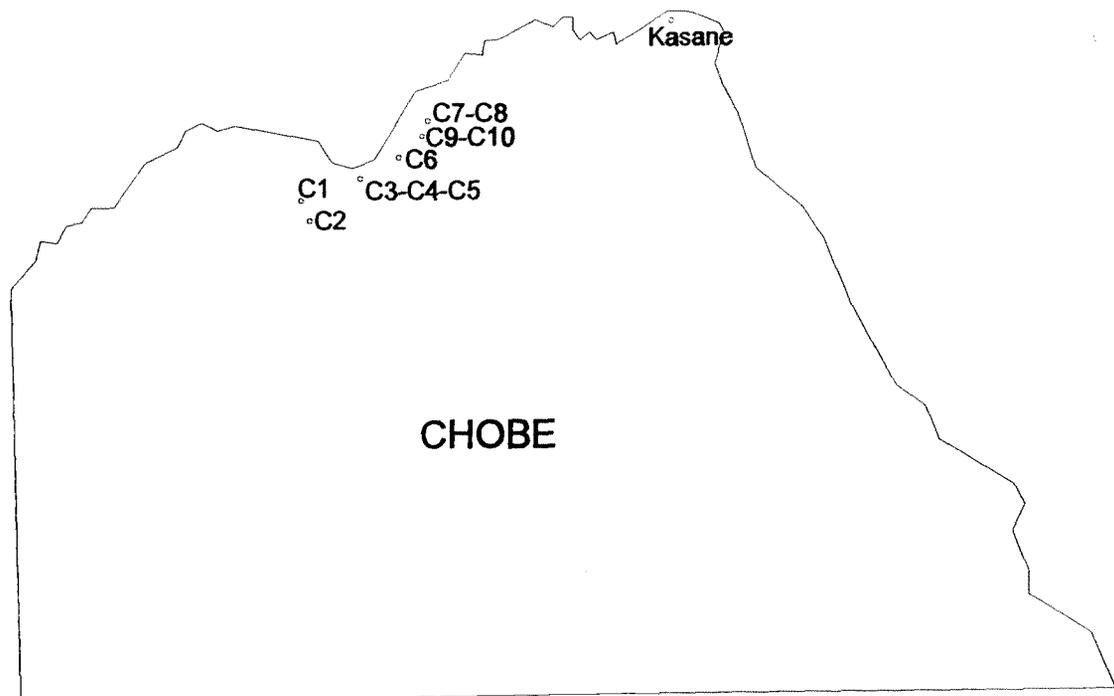
## APPENDIX IV TRIAL PROGRESS

The soil analysis results for the CEC, Ca, Mg, K and Na levels are expressed in the unit  $\text{cmol}^+/\text{kg}$ . The pH results for the Chobe, Francistown and Serowe trials are expressed as  $\text{pH-CaCl}_2$ , while for the Kanye and Maun trials the  $\text{pH-H}_2\text{O}$  results are given.

### NORTH WEST REGION / CHOBE

Trial sites:

- C1 Kachikau
- C2 Kachikau
- C3 Kavimba
- C4 Kavimba
- C5 Kavimba
- C6 Kavimba
- C7 Mabele
- C8 Mabele
- C9 Mabele
- C10 Mabele



TRIAL SITE	C5 Kavimba	C1 Kachikau
SYNOPTIC STATION	Kasane	Kasane
RAINFALL STATION	Kavimba	Kachikau
yearly average	614 mm	532 mm
01 Dec	19	20
02 Dec	1.6	2
09 Dec	1.5	5
11 Dec	2.1	10
22 Dec	30	3
23 Dec	2	
24 Dec		5
28 Dec		10
29 Dec	28	21
30 Dec		19
31 Dec	21	2
09 Jan	20.5	
10 Jan		14
12 Jan	15	
13 Jan	25.5	29
19 Jan		5
27 Jan		11
31 Jan		1
03 Feb		1
04 Feb	10	6
05 Feb	3	
06 Feb		5
09 Feb		7
11 Feb	10	5
12 Feb		6
13 Feb		4
14 Feb	18.5	10
19 Feb		8
20 Feb		1
22 Feb	28.5	11
23 Feb	20	7
27 Mar	150.5	100
28 Mar	120	3
29 Mar	15	
02 Apr	65	60
10 Apr		1
25 Apr		2
26 Apr		1
23 May		30
<b>TOTAL</b>	606.7	425
% of AVERAGE	99 %	80 %

**C1 KACHIKAU****Mr H. Lungera****ALDEP model II**

plot size: 0.25 ha  
 soiltype: Luvi-Stagnic Phaeozem  
 AWHC: unknown  
 fertilizer type 1:  
 fertilizer type 2:

slope: 0-1°  
 UTM position: 231067E 7994856N  
 Phosphorus content topsoil: 2 ppm  
 single superphosphate application rate: 200 kg/ha  
 3:2:1 application rate: 200 kg/ha

topsoil analysis control plot:

pH-CaCl <sub>2</sub>	org C	CEC	Ca	Mg	K	Na
7.1	0.9	5.92	15.16	1.25	0.36	0.20

crop: sorghum *Segaolane***result:** Trial failed.

Farmer fertilized plots in the dekad JAN1/95 and ploughed the same dekad with his own donkeys. He incurred a delay in planting (done in dekad JAN2/95), due to repair of the row planter. A slight misunderstanding with the AD caused the delay in repair. Finally the crop did not establish.

**C2 KACHIKAU****Ms A. Mothoka****ALDEP model I**

plot size: 0.25 ha  
 soiltype: Sodi-Luvic Calcisol  
 AWHC: unknown  
 fertilizer type 1:  
 fertilizer type 2:

slope: 0-1°  
 UTM position: 233710E 7990894N  
 Phosphorus content topsoil: 1 ppm  
 single superphosphate application rate: 200 kg/ha  
 3:2:1 application rate: 200 kg/ha

topsoil analysis control plot:

pH-CaCl <sub>2</sub>	org C	CEC	Ca	Mg	K	Na
7.2	0.4	3.24	9.9	1.06	0.77	0.44

crop: sorghum *Segaolane***result:** Trial failed.

The plots were fertilized in the dekad JAN1/95. Farmer was delayed in ploughing/planting, because she had to wait for a hired tractor until JAN2/95. Germination was very poor. The trial plots were located on a sodic soil; salt was observed on the surface.

**C3 KAVIMBA****Mr G. Lekokoto****ALDEP model III**

plot size: 0.25 ha  
 soiltype: Stagnic Luvisol  
 AWHC: unknown  
 fertilizer type 1:  
 fertilizer type 2:

slope: 0-1°  
 UTM position: 242687E 7999227N  
 Phosphorus content topsoil: 7 ppm  
 single superphosphate application rate: 200 kg/ha

topsoil analysis control plot:

pH-CaCl <sub>2</sub>	org C	CEC	Ca	Mg	K	Na
4.1	2.1	24.24	23.9	3.69	0.28	0.96

crop: maize *Kalahari Early Pearl***result:** Trial failed.

The plots were fertilized and ploughed by a hired tractor in the dekad DEC1/94. Ploughing took place that early, because the farmer had booked the tractor for that dekad. Planting was done straight after ploughing in the same dekad. Germination was poor and plants stunted; the plots were weeded, but no harvest was obtained.

**C4 KAVIMBA****Ms E. Mazunga****ALDEP model I**

plot size: 0.25 ha  
 soiltype: Stagnic Luvisol  
 AWHC: unknown  
 fertilizer type 1:  
 fertilizer type 2:

slope: 0-1°  
 UTM position: 243141E 7998249N  
 Phosphorus content topsoil: 9 ppm  
 single superphosphate application rate: 200 kg/ha  
 3:2:1 application rate: 200 kg/ha

topsoil analysis control plot:

pH-CaCl <sub>2</sub>	org C	CEC	Ca	Mg	K	Na
7.0	0.9	4.16	177.6	2.07	0.32	0.12

crop: maize *Kalahari Early Pearl***result:** Trial failed.

The plots were fertilized and ploughed by a hired tractor in the dekad DEC3/94. Farmer did not plant; she abandoned her field and went to Kasane because of social circumstances.

C5 KAVIMBA

Mr Sankwasa

ALDEP model III

plot size: 0.25 ha  
soiltype: Eutric Gleysol  
AWHC: unknown  
fertilizer type 1:  
fertilizer type 2:

UTM position: 240719E 7996740N  
Phosphorus content topsoil: 35 ppm  
single superphosphate  
application rate: 200 kg/ha  
3:2:1

topsoil analysis control plot:

pH-CaCl <sub>2</sub>	org C	CEC	Ca	Mg	K	Na
6.8	1.9	20.16	140.8	33.6	1.98	10.43

crop: maize *Kalahari Early Pearl*

result: Trial failed.

Plots were fertilized in the dekad DEC3/94. A delay in ploughing by hired tractor and planting occurred (done in JAN1/95), due to occupations with cattle. Germinated very poor and finally crop failed to yield.

C7 MABELE

Mr N. Nkumba

ALDEP model III

plot size: 0.25 ha  
soiltype: Mollic Gleysol  
AWHC: unknown  
fertilizer type 1:

slope: 0-1 °  
UTM position: 250309E 8010552N  
Phosphorus content topsoil: 11 ppm  
single superphosphate  
application rate: 200 kg/ha

topsoil analysis control plot:

pH-CaCl <sub>2</sub>	org C	CEC	Ca	Mg	K	Na
4.0	1.8	21.28	18.5	3.76	0.77	0.76

crop: maize *Kalahari Early Pearl*

result: Trial failed.

Plot was fertilized in the dekad DEC1/94. After having waited for a tractor, the farmer decided to plough with his own oxen in DEC3/94. Planting was done immediately after ploughing. Germination was very poor and as a result no harvest was obtained.

C6 KAVIMBA

Mr Kanyenvu

ALDEP model III

plot size: 0.25 ha  
soiltype: Eutric Gleysol  
AWHC: unknown  
fertilizer type 1:

UTM position: (next to site C5)  
Phosphorus content topsoil: 27 ppm  
single superphosphate  
application rate: 200 kg/ha

topsoil analysis control plot:

pH-CaCl <sub>2</sub>	org C	CEC	Ca	Mg	K	Na
6.0	1.8	19.4	24.8	5.27	1.58	1.12

crop: maize *Kalahari Early Pearl*

result: Trial failed.

Plot was fertilized in the dekad DEC1/94. A long delay in ploughing by hired tractor and planting occurred (done in JAN2/95), due to occupations with cattle. No germination took place.

C8 MABELE

Mr P. Mabuku

ALDEP model II

plot size: 0.25 ha  
soiltype: Mollic Gleysol  
AWHC: unknown  
fertilizer type 1:

slope: 0-1 °  
UTM position: 249958E 8010394N  
Phosphorus content topsoil: 8 ppm  
single superphosphate  
application rate: 200 kg/ha

topsoil analysis control plot:

pH-CaCl <sub>2</sub>	org C	CEC	Ca	Mg	K	Na
5.4	2.4	32.84	28.9	4.7	1.01	0.72

crop: maize *Kalahari Early Pearl*

result: Trial failed.

Fertilizing was done in the dekad DEC1/94. The farmer was reluctant to plough on recommendation of ALUPs and did not identify a proper planting opportunity for himself until mid January and subsequently left the lands to look for employment in Kasane. He judged "late" planting not financially viable.

**C9 MABELE**

Ms E. Chiswaniso

ALDEP model III

molapo farming trial

plot size: 0.25 ha  
 soil type: Mollic Gleysol  
 AWHC: 130 mm/m  
 fertilizer type 1:  
 fertilizer type 2:

slope: 0-2°  
 Phosphorus content topsoil: 6 ppm  
 single superphosphate  
 application rate: 200 kg/ha  
 application rate: 200 kg/ha

plot size: 0.25 ha  
 soil type: Mollic Gleysol  
 AWHC: unknown  
 fertilizer type 1:  
 fertilizer type 2:

slope: 2°  
 Phosphorus content topsoil: 6 ppm  
 single superphosphate  
 application rate: 200 kg/ha  
 application rate: 200 kg/ha

topsoil analysis control plot:

pH-CaCl <sub>2</sub>	org C	CEC	Ca	Mg	K	Na
4.7	3.4	37.44	27.4	4.51	0.81	0.96

top soil texture: fine

drainage: imperfectly

soil depth: 100 + cm

crop: maize *Kalahari Early Pearl*

fertilized plot 1:

number of rows: 55

plant density: 41,800 pl/ha

fertilized plot 2:

number of rows: 42

plant density: 29,400 pl/ha

control plot:

number of rows: 51

plant density: 24,500 pl/ha

**yield fertilized plot 1: 2750 kg/ha****yield fertilized plot 2: 2520 kg/ha****yield control plot: 1770 kg/ha****CYSLAMB prediction: 2340 kg/ha**

Farmer fertilized in SEP1/94 and ploughed/planted with own oxen in SEP2/94. The plants in the two fertilized plots developed better, than those from the control plot. The fertilized plots, however, were more infested with weeds. The main weed was *Sesbania bispinosa*, a leguminous weed. When the weed was uprooted, it was observed that the roots of the weed plants on both fertilized plots had more nitrogen fixing nodules than those of the control plot.

The fertilized plants flowered 2 weeks earlier than the control plot. On average one cob was formed per plant.

During the last two months quite a lot of insects were found and at harvest most of the cobs were affected. The infestation resulted on the fertilized plots in a yield loss of approximately 40-50 %; on the control plot it was somewhat lower 30-40 %. Harvesting was done in the dekad FEB1/95.

**C10 MABELE**

Mr M. Samosojo

ALDEP model III

molapo farming trial

plot size: 0.25 ha  
 soil type: Mollic Gleysol  
 AWHC: unknown  
 fertilizer type 1:  
 fertilizer type 2:

slope: 2°  
 Phosphorus content topsoil: 6 ppm  
 single superphosphate  
 application rate: 200 kg/ha  
 application rate: 200 kg/ha

topsoil analysis control plot:

pH-CaCl <sub>2</sub>	org C	CEC	Ca	Mg	K	Na
5.8	1.8	20.36	22.5	3.89	0.65	0.88

crop: maize *Kalahari Early Pearl***result:** Trial failed.

Fertilizing was done in the dekad SEP1/94. Farmer could only plough/plant with his own oxen, one week after fertilizing (SEP2/94), due to the obligatory vaccination against F&MD of his oxen. The animals were not allowed to do any heavy physical labour for two weeks after the job.

As the farmer's field was situated on the slope of a channel and since the ground water table dropped quickly, germination was very poor and no yield was achieved.

## NORTH EAST REGION / FRANCISTOWN

Trial sites:

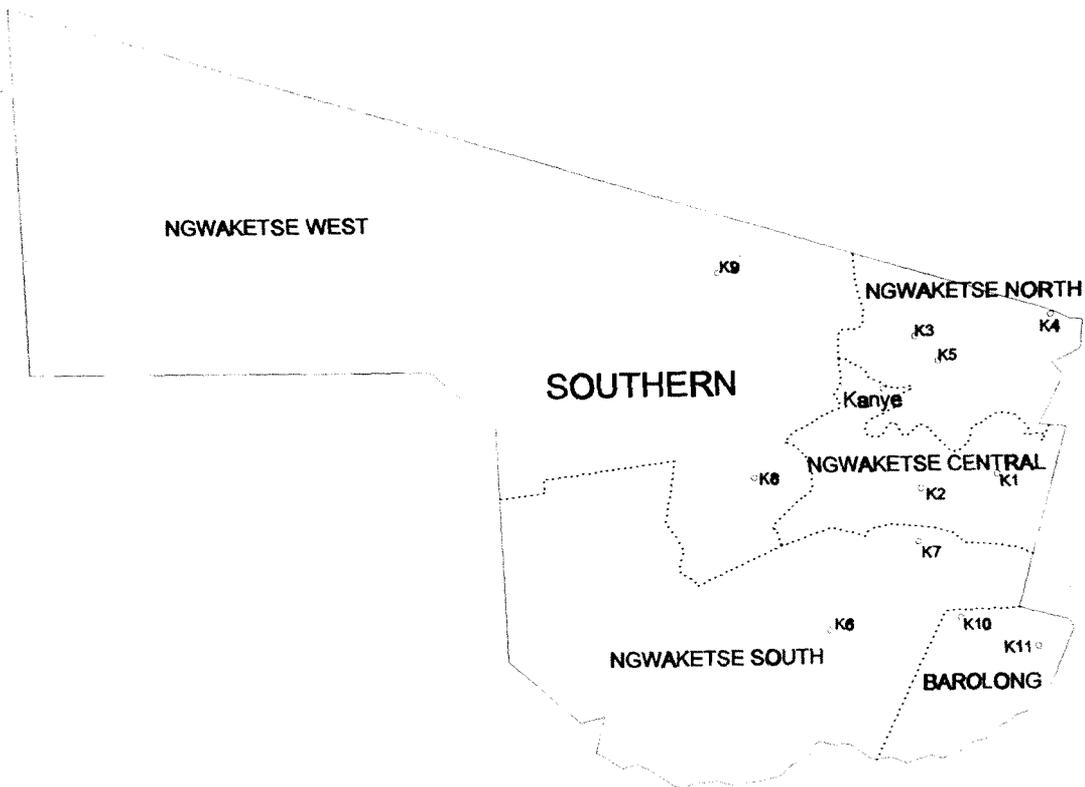
- F1 Sechele
- F2 Siviya
- F3 Tapaladipoo
- F4 Maitengwe
- F5 Mathangwane
- F6 Matobo
- F7 Nata



## SOUTHERN REGION / KANYE

Trial sites:

- K1 Gamoswana
- K2 Ramonedi
- K3 Lotlhakane West
- K4 Manyana
- K5 Polokwe
- K6 Kanngwe
- K7 Mmathethe
- K8 Gasita
- K9 Sese
- K10 Mongwalale
- K11 Pitsane



Rainfall data trial sites

TRIAL SITE	F1 Sechele	F2 Siviya	F3 Tapaladipoo	F6 Matobo
SYNOPTIC STATION	Francistown	Francistown	Francistown	Francistown
RAINFALL STATION	Tshesebe	Tshesebe	Tonota	Tutume
yearly average	506 mm	506 mm	436 mm	520 mm
31 Oct				2
01 Nov	11.3			6.3
21 Nov	3.1			17.3
23 Nov	7.8			
30 Nov	6			4
01 Dec				1.6
08 Dec	10			21
10 Dec	11.5			10.5
19 Dec			12	
20 Dec		3.1		
23 Dec		8.1		6.2
25 Dec	15.8	17	10	31.6
26 Dec	13			8
27 Dec				1.2
28 Dec		10	5	
09 Jan		10		
10 Jan	11			
11 Jan		1		
12 Jan		2.5		17
13 Jan		5.5		
14 Jan		50	6	
15 Jan			5	67.2
16 Jan	70.9	10	58	
30 Jan			12	
16 Feb		27		
18 Feb	9.5		12	18.9
19 Feb	45.3	35	24	6.5
20 Feb	8	27	40	
21 Feb	8	5	50	49.7
22 Feb			6	
28 Feb		28		
18 Mar			38	
20 Mar			15	
21 Mar			10	
22 Mar			8	

continued:

23 Mar			25	
24 Mar	10			
25 Mar	15.9			
26 Mar	11.4			7.5
27 Mar		5.5		3.5
28 Mar	4.6			
29 Mar				4
30 Mar	5	10.3		
31 Mar		17		
03 May				3
<b>TOTAL</b>	<b>278.1</b>	<b>272</b>	<b>336</b>	<b>287</b>
<b>% of AVERAGE</b>	<b>55 %</b>	<b>54 %</b>	<b>77 %</b>	<b>55 %</b>
<b>TRIAL SITE</b>	<b>F1 Sechele</b>	<b>F2 Siviya</b>	<b>F3 Tapaladipoo</b>	<b>F6 Matobo</b>

**F1 SECHELE**

**Ms. K. K. Sechele** ALDEP model II

plot size: 0.5 ha slope: 1° UTM position: 537080E 7705966N  
 soil type fertilized plot: Vertisol  
 AWHC: unknown  
 fertilizer type: Phosphorus content topsoil: 7 ppm application rate: 50 kg/ha  
 soil type control plot: Chromic Luvisol, petric phase  
 AWHC: unknown Phosphorus content topsoil: unknown

topsoil analysis control plot:

pH-CaCl <sub>2</sub>	org C	CEC	Ca	Mg	K	Na
4.9	0.4	54.01	1.61	1.11	1.50	6.48

**result:** The results are not suitable for comparison, due to different soil types of the plots and a mixture of seeds.

visit 15/05/95

**FERTILIZED PLOT**

The farmer owns a plough, but ploughing was done by hired tractor, after broadcasting of seed in the dekad NOV3. A mixture of varieties was planted: red sorghum 75 %, white hairy sorghum 15 %, *Segoalane* 10 %, maize and a few melons.

The achieved plant density is approximately 30,000 plants/ha; the crop stand uneven with many gaps. The red sorghum plants were 1.00-1.40m high, with 2-3 tillers per plant and medium to large maturing heads; bird damage 1%. *Segoalane* plants are stunted < 1.00m and thin, in grain filling stage.

**CONTROL PLOT**

Broadcasted and ploughed by hired tractor in NOV3. Also a mixture of seeds, and similar plant density as on fertilized plot; plants in general taller, better developed, probably due to the lighter textured soil.

**F2 SIVIYA**

**Mr. Lameck Bacheche** ALDEP model I

plot size: 0.5 ha slope: 1-2° UTM position: 568445E 7693639N  
 soil type: Cambic Arenosol  
 AWHC: 65 mm/m  
 fertilizer type: Phosphorus content topsoil: 4 ppm application rate: 50 kg/ha  
 single superphosphate

topsoil analysis control plot:

pH-CaCl <sub>2</sub>	org C	CEC	Ca	Mg	K	Na
4.0	0.03	1.98	1.29	0.43	0.69	0.09

fertilized plot plant density: 11,000 pl/ha  
 control plot plant density: unknown

**result:** Due to a mixture of varieties, great caution is required with the interpretation of the results.

Fertilized plot: sorghum *Segoalane* - 105 kg/ha  
 sorghum local variety - 45 kg/ha  
 Control plot: failed

Ploughing was done on 24-25/12/94 with a span of 4 donkeys. No harrowing operation was carried out. Planting was done with 1 donkey on 28/12/94. Fertilizer was applied as a top dressing on 07/01/95. A weeding operation was conducted 4-5 weeks after planting.

visit 15/05/95

**FERTILIZED PLOT**

A mixture of varieties was observed: sorghum *Segoalane* formed 70 % of the plant stand, white hairy sorghum 30 %. Top half of field had an even and rather homogeneous plant stand; the majority of the plants was 1.20-1.50m high, thin stems and few tillers. Plants were in grain filling to ripening stage, with medium sized heads. Bottom half of field had a poor stand; plants stunted and thinly stemmed, perhaps due to shallow soil. No bird problem. Harvesting was done around beginning of June.

**CONTROL PLOT**

Plot was infested by army worm; in order to control the pest, the farmer decided to plough the plot. The spreading of pest was stopped, but the control plot was not replanted.

**F3 TAPALADIPOO****Mr. Daniel Francis****ALDEP model II**

plot size: 0.5 ha  
 soiltype: Chromic Luvisol  
 AWHC: unknown  
 fertilizer type:

slope: 1°  
 UTM position: 560640E 7614313N  
 Phosphorus content topsoil: 7 ppm  
 single superphosphate application rate: 50 kg/ha

topsoil analysis control plot:

pH-CaCl <sub>2</sub>	org C	CEC	Ca	Mg	K	Na
5.2	0.09	9.9	7.32	1.16	0.65	0.08

fertilized plot plant density: 10,000 pl/ha  
 control plot plant density: 5,000 pl/ha

**result:** The results are not suitable for comparison, due to the use of local varieties.

visit 16/05/95

Plots tractor ploughed and rowplanted much later (JAN2) than farmer's field (NOV3); farmer not too interested. Poor germination, no weeding nor birdscaring done. Uneven plant stands. 100 % local red sorghum variety used; weed cover approximately 40 %.  
 Farmer spent time on birdscaring on his own field and neglected trial plots, resulting in approximately 10 % bird damage on heads of trial plots.

Farmer's field looked very uniform, relatively high plant density 30,000 +, with thin stemmed plants; already harvested.

**FERTILIZED PLOT**

Uniform plant height of 1.30m; plants that germinated are medium-well developed and having upto 6 tillers; heads medium to large for the variety and maturing.

**CONTROL PLOT**

Plants slightly less developed than fertilized plot.

The total yield obtained from both the fertilized and the control plot was approximately 120 kg/ha red sorghum.

**F4 MAITENGWE**

**result:** No planting opportunity was identified and no ploughing was done. Trial was terminated.

**F5 MATHANGWANE**

**result:** This trial was supposed to have been carried out under supervision of the Department of Agricultural Research; however, fertilizer was not available in time and hence no ploughing has been undertaken. The trial was terminated.

**F6 MATOBO****Mr. Fadzani Mmusi****ALDEP model I**

plot size: 1 ha  
 soiltype: unknown  
 AWHC: unknown  
 fertilizer type:

slope: 1°  
 UTM position: 511125E 7724278N  
 Phosphorus content topsoil: unknown  
 single superphosphate application rate: 25 kg/ha

**result:** Results not suitable for comparison, due to wrong fertilizer application and use of local variety.

This trial was carried out and monitored by the Department of Agricultural Research Francistown, which also provided the farmer with a row planter. By mistake all fertilizer was applied on 1 ha, including both the fertilized and the control plot. Hence no control plot on this trial site. The trial was planted with red sorghum, local variety (probably be sorghum 80) in January 1995. No harrowing was done, but a weeding operation was conducted. No bird problems occurred. Already harvested by May 15th, so site not visited. The yield of red sorghum amounted 40.5 kg/ha.

**F7 NATA**

topsoil analysis control plot:

pH-CaCl <sub>2</sub>	org C	CEC	Ca	Mg	K	Na
6.3	0.1	5.53	4.44	0.75	0.89	0.08

**result:** The fertilizer was not available in time and no planting opportunity was identified in time, so no ploughing took place. The trial was terminated.

Rainfall data trial sites K1-K6

TRIAL SITE	K1 Gamoswana	K2 Ramonedi	K3 Lotlhakane	K4 Manyana	K5 Polokwe	K6 Kanngwe
SYNOPTIC STATION	Kanye	Kanye	Kanye	Kanye	Kanye	Kanye
RAINFALL STATION	Kanye	Pelotshetla	Moshupa	Moshupa	Polokwe	Pelotshetla
yearly average	490 mm	537 mm	389 mm	389 mm	429 mm	537 mm
23 Oct				1		
28 Oct	2					
03 Nov	4.5	7	5			
05 Nov			20			
06 Nov		3				
12 Nov	5			7		
13 Nov	10			4	6	
05 Dec						2
07 Dec		4.4	10	10		
08 Dec	10		5	2	4	
09 Dec	4					15
10 Dec					4	
15 Dec	4					
18 Dec				1		7
23 Dec						2
24 Dec	34					
26 Dec		13	30		44	
27 Dec	18	10		60		22
28 Dec				3	8.5	
31 Dec				2	6	
01 Jan			10			
03 Jan			7			
08 Jan	12					
11 Jan						3
12 Jan		12			6	20
13 Jan	20			36		20
14 Jan	2				3	14
15 Jan			14	4.5	7	
18 Jan						5
29 Jan					21	
31 Jan	18	24	25			30
02 Feb					32	
03 Feb				4		
05 Feb	7					
22 Feb					20	

continued:

25 Feb	4.5		20		15	8
26 Feb		12			11	6
27 Feb		3	22		6	
01 Mar	7	40			3	
04 Mar		3				
05 Mar		1				
13 Mar					2	
14 Mar					10	
22 Mar					31	
23 Mar		30	16		30	
24 Mar	30		21	24	4	20
25 Mar		3	4	30		
26 Mar			38	27	46	
27 Mar		4	4	23		5
28 Mar	6					
29 Mar	13					
30 Mar	19	21	4		29	
28 Apr	7.5		10	4.5	22	
29 Apr			15	13.5	12	
30 Apr			10	10	3	
03 May			5			
<b>TOTAL</b>	237.5	190.4	295	266.5	385.5	179
<b>% of AVERAGE</b>	48 %	35 %	76 %	68 %	90 %	33 %
<b>TRIAL SITE</b>	K1 Gamoswana	K2 Ramonedi	K3 Lotlhakane	K4 Manyana	K5 Polokwe	K6 Kanngwe

## Rainfall data trial sites K7-K11

TRIAL SITE	K7 Mmathethe	K8 Gasita	K9 Sese	K10 Mongwalale	K11 Pitsane
SYNOPTIC STATION	Kanye	Kanye	Kanye	Kanye	Kanye
RAINFALL STATION	Pelotshetle	Jwaneng	Jwaneng	Pitsane	Pitsane
yearly average	537 mm	485 mm	485 mm	452 mm	452 mm
27 Oct				6	8
28 Oct				3	
29 Oct	2				
02 Nov				4	
03 Nov	3				
04 Nov	2				
05 Nov				9	
06 Nov	1	6			
10 Nov	3		7		
12 Nov				3	9
13 Nov	3			4	11
05 Dec		4		15	
08 Dec			2		11
09 Dec				6	
10 Dec			10	2	
17 Dec			5		22
18 Dec				13	6
23 Dec					6
24 Dec		3			
26 Dec				28	20
27 Dec	20	22.5	19		
28 Dec	2				
29 Dec		5	10		10
31 Dec				15	4
07 Jan					2
08 Jan	1		2		
09 Jan	4				
11 Jan		6	5		1
12 Jan	2	28	10		5
13 Jan	7				10
14 Jan	31	9		3	4
15 Jan	3	30	13	4	11
16 Jan			3	10	
17 Jan					1
24 Jan			3.5		

continued:

25 Jan	1				
26 Jan		6			
31 Jan	24	28	32	32	24
02 Feb		5	5		
07 Feb					30
08 Feb			10		3
09 Feb				4	
18 Feb				22	
20 Feb	4				
26 Feb	18			24	12
28 Feb		18			
01 Mar	52	11	62	9	
06 Mar	6	4.5		26	
08 Mar					3
10 Mar		5			8
11 Mar			3		
23 Mar	12	24		20	
24 Mar	14	6	34	10	21
25 Mar	2	3			
26 Mar				5	4
27 Mar	23			36	
28 Mar	11				5
30 Mar	12			20	4
31 Mar	2		40		
07 Apr		9			
08 Apr	5			2	
21 Apr				3	11
27 Apr				9	
28 Apr					5
30 Apr			11		
01 May				5	
02 May		5			
04 May		5			
05 May					3
<b>TOTAL</b>	270	243	286.5	352	274
<b>% of AVERAGE</b>	50 %	50 %	59 %	78 %	61 %
<b>TRIAL SITE</b>	<b>K7 Mmathethe</b>	<b>K8 Gasita</b>	<b>K9 Sese</b>	<b>K10 Mongwalale</b>	<b>K11 Pitsane</b>

**K1 GAMOSWANA****Mrs M. Modutlwa****ALDEP model I**

plot size: 0.25 ha  
 soil type: Chromic Luvisol  
 AWHC: 140 mm/m  
 fertilizer type:

slope: 1°  
 Phosphorus content topsoil: 1.5 ppm  
 single superphosphate  
 application rate: 299 kg/ha

UTM position: 348036E 7220230N

topsoil analysis control plot:

pH-H <sub>2</sub> O	EC	org C	CEC	Ca	Mg	K	Na	PBS	carbo
6.5	0.1	0.8	8.6	4.4	1.4	0.8	0.0	77	4.8

top soil texture: medium

drainage: well drained

soil depth: 100 + cm

fertilized plot:

number of rows: 24

plant density: 20,100 pl/ha

control plot:

number of rows: 18

plant density: 16,900 pl/ha

**result:** Trial failed.

Ploughing poorly done by tractor on 04/01/95 after 52 mm of rain on 26-28/12/94, leaving big ridges and furrows. Subsequently, planting done on 06/01/95, not very straight and with a wide row spacing, resulting in relatively low plant densities. Germination was even and plant development quite good at the beginning. The fertilized plants looked greener, bigger and more advanced than the plants in the control plot. Especially in the fertilized plot, oval shaped, bare patches encountered. The farmer gave differences in soil as reason, possibly caused by a high termite activity on the bare patches. Termites seemed to have attacked plants. In general the crop looked healthy, but started suffering from moisture stress after 30/01/95. The weed cover was low and a weeding operation took only a few days. Crop finally attacked by birds, leading to a 100 % damage of 80 % of the (mature) heads; only 20 % of the heads were harvested as "mothaiane".

**K2 RAMONEDI****Mr Lekau Selebaleng****ALDEP model I**

plot size: 0.25 ha  
 soil type: Petri-Chromic Luvisol  
 AWHC: 140 mm/m  
 fertilizer type:

slope: 1°  
 Phosphorus content topsoil: 1.1 ppm  
 single superphosphate  
 application rate: 312 kg/ha

UTM position: 328616E 7216714N

topsoil analysis control plot:

pH-H <sub>2</sub> O	EC	org C	CEC	Ca	Mg	K	Na	PBS	carbo
6.9	0.0	0.5	5.1	3.5	0.4	0.3	0.0	82	0.0

top soil texture: medium

drainage: well drained

soil depth: 80 cm

fertilized plot:

number of rows: 58

plant density: 13,000 pl/ha

control plot:

number of rows: 58

plant density: 11,600 pl/ha

**result:** Trial failed.

Cattle and house construction took most of the farmers time. The farmer missed the first planting opportunity. Poor plot fence allowed cattle to enter and damage crop.

visit 04/05/95

Trial plots planted in dekad JAN3. Plant stands poor; no obvious difference between fertilized and control plants; plants 80 cm high. Weed coverage approximately 15 %, no weeding operation carried out. Plants with thin stems, some tillering occurred. Plants in grain filling stage; bird problem (not taken care of). Due to farmers negligence no harvest was achieved.

**K3 Lothakane WEST****Mr Kgari Difemo****ALDEP model I**

plot size: 0.125 ha  
 soil type: Chromic Luvisol  
 AWHC: 140 mm/m  
 fertilizer type:

slope: 3°  
 Phosphorus content topsoil: 1.7 ppm  
 single superphosphate  
 application rate: 291 kg/ha

plot size: 0.25 ha  
 soil type: Rhodi-Chromic Luvisol  
 AWHC: 130 mm/m  
 fertilizer type:

Mr Kgolego Letlole  
 slope: 1°  
 Phosphorus content topsoil: 1.2 ppm  
 single superphosphate  
 application rate: 308 kg/ha

**ALDEP model II**

UTM position: 327953E 7294675N

UTM position: 362000E 7260000N

topsoil analysis control plot:

pH-H <sub>2</sub> O	EC	org C	CEC	Ca	Mg	K	Na	PBS	carbo
6.5	0.0	1.2	8	3.5	1.8	0.2	0.2	71	0.0

top soil texture: medium

drainage: well drained

soil depth: 100+ cm

fertilized plot:

number of rows: 32

plant density: 16,900 pl/ha

control plot:

number of rows: 30

plant density: 20,400 pl/ha

**yield fertilized plot:****300 kg/ha****CYSLAMB prediction: 1190 kg/ha****yield control plot:****210 kg/ha****CYSLAMB prediction: 560 kg/ha**

Field located adjacent to a steep slope; only a few signs of water erosion in the field. First planted in dekad NOV1 and no germination occurred; a dry spell of 4-5 weeks followed and replanting was done on 11/01/95.

Fertilizer not everywhere ploughed in well; it was observed on the surface at places. Seeds dropped unevenly from planter.

A portion of the control plot is located in a depression, collecting run-off from most of the field. Plants looked better there than in other parts of the plot. However, a clear difference between fertilized and control plants has been noticed all the time, with fertilized plants looking greener, bigger and further developed than control plot plants. Tillering started when plants were only 10 cm high; flowering occurred in some cases when plants were only 20-30 cm.

visit 04/05/95

Rather uneven plant stands; control plot plants were slightly shorter and had thinner stems than fertilized plot. On average 2-3 tillers per plant; fertilized plants seemed to be affected more severely by army worm than control plants. Aphids generally attacked first tillers, which were dying and black at the time of the visit. New tillers developed later; mostly flowering now, some grain filling occurred and probably harvested as "mothalane".

Low yields were achieved, due to aphid infestation and small developed secondary and tertiary heads.

topsoil analysis control plot:

pH-H <sub>2</sub> O	EC	org C	CEC	Ca	Mg	K	Na	PBS	carbo
6.0	0.0	0.8	7.9	0.3	0.8	0.6	0.0	22	0.0

top soil texture: medium

drainage: well drained

soil depth: 100+ cm

**result:** Trial failed, due to the use of a local variety.

Ploughing was done on 08/01/95 after 60 mm of rain on 28/12/94 and planting was further delayed until 16/01/95. The farmer claimed the planter was wrongly adjusted and all the seeds poured out in big heaps, which was confirmed at germination. The farmer then reploughed and replanted (on 26/01/95) the trial plots, using a local sorghum variety. Germination occurred 6 days later on 02/02/95.

**K5 POLOKWE****Mr and Mrs Mogorosi Kgopiso****ALDEP model II**

plot size: 0.25 ha

slope: 2°

UTM position: 333580E 7248554N

soil type: Areni-Ferri-District Regosol

Phosphorus content topsoil: 3.6 ppm

AWHC: 60 mm/m

single superphosphate

application rate: 224 kg/ha

fertilizer type:

topsoil analysis control plot:

pH-H <sub>2</sub> O	EC	org C	CEC	Ca	Mg	K	Na	PBS	carbo
6.0	0.0	0.4	1.9	0.3	0.0	0.2	0.0	26	0.0

top soil texture: coarse

drainage: well drained

soil depth: 60 cm

fertilized plot:

number of rows: 33

plant density: 16,500 pl/ha

control plot:

number of rows: 33

plant density: 14,400 pl/ha

**yield fertilized plot:****760 kg/ha****CYSLAMB prediction: 1330 kg/ha****yield control plot:****270 kg/ha****CYSLAMB prediction: 960 kg/ha**

Field located on footslopes of Polokwe Hills, sloping towards the North, with evidence of sheet and rill erosion. The trial plots were located in a flat part of the field. The soil is loamy and capping occurred later in the season. The farmer was not able to respond as quickly as others to the first planting opportunity (44 mm on 26/1/2/94). Ploughing (with 8 oxen) and planting were delayed for about 14 days (11/01/95 and 12/01/95 respectively). The farmer planted along plough furrows, which reduced accuracy, making row distance unnecessarily wide (1-1.40 m). The large row spacing affected the plant density, which was relatively low.

A clear difference in plant development between fertilized and control plot was observed: fertilized plants looked greener, bigger and further in development than control plants.

When requested to start weeding, the farmer was reluctant at the time, as a dry spell had reduced the soil moisture and increased the soil temperature. The farmer explained, that weeding at that moment would damage plants if hot soil was pushed against plants. She was unaware of the fact, that weeds also consume fertilizer, and was very motivated when told that weeds compete with the crops for nutrients (this might be a general knowledge gap, which could explain the low rate of adoption of fertilizer amongst farmers). Weeding was done with hoe and cultivator and was efficient (06/03/95). The use of the cultivator was facilitated by the wide row spacing. The Plant Protection Division sprayed against corn crickets and army worm on 13/04/95, using alphamethrin.

visit 04/05/95

On 27/04/95 a hailstorm occurred, which caused hardly any damage to the crop. Plants on the fertilized plot looked slightly better than the control plot: more leaves and thicker stems. The crop stand on the control plot was rather open. Plants on both plots were somewhat stunted, approximately 1 m high. Moisture stress must have occurred during the vegetative stage, because hardly any tillering observed

and only one medium sized head was formed per plant. Most heads were in grain filling and ripening stages. Bird scaring done by the farmer, was so far effective; all heads had a maximum of 5 % damage. Birdscaring stayed effective until harvesting; the bird damage did not increase. At harvest, the plants on the fertilized plot were taller than the control plot.

**K6 KANNGWE**

plot size: 0.25 ha  
 soil type: Chromic Luvisol  
 AWHC: 60 mm/m  
 fertilizer type:

**Mr Keelediwe Kosiwe**

slope: 0-1°  
 Phosphorus content topsoil: 0.7 ppm  
 single superphosphate

**ALDEP model II**

UTM position: 304750E 7181760N  
 application rate: 325 kg/ha

topsoil analysis control plot:

pH-H <sub>2</sub> O	EC	org C	CEC	Ca	Mg	K	Na	PBS	carbo
6.2	0.0	0.3	3	1.7	0.5	0.3	0.0	83	0.0

top soil texture: coarse

drainage: well drained

soil depth: 60 cm

fertilized plot:

number of rows: 61

plant density: 24,400 pl/ha

control plot:

number of rows: 53

plant density: 13,600 pl/ha

yield fertilized plot:

1010 kg/ha

CYSLAMB prediction: 970 kg/ha

yield control plot:

460 kg/ha

CYSLAMB prediction: 430 kg/ha

The farmer carried out an early ploughing operation to loosen the soil, on half of both trial plots. Ploughing was done on 13/12/94 after 15 mm of rain on 09/12/94. Ploughing was poorly done and a lot of stover was left on the surface. The topsoil was only moist enough for planting on 30/12/94, after a rainfall event of 22 mm on 27/12/94. Germination took place 7 days after planting.

A fertilizer hopper mounted on the planter was used, which initially did not function well, and fertilizer was spilled through cracks and was visible on the surface at the start of some of the rows.

Plant development was fairly uneven, with plants in different stages of development. This and quite uneven in-row plant spacings may be attributed to poor planting; seeds dropped in groups or not at all over a few meters, and irregular planting depths occurred. Uneven germination of seeds due to different soil moisture and temperature conditions resulted from planting at irregular depths. A first germination was observed after 54 mm of rain on 11-13/01/95; a second germination phase was noted after 30 mm of rain on 30/01/95. The farmer explained the uneven in-row plant spacings as a result of moisture stress, which killed seedlings which had actually germinated in the gaps. The dead seedlings have since been swept away by wind and water erosion. This explanation seems quite likely, because of the dry spells in January of 2 weeks and in February of 3 weeks.

The weed burden was less in the non-fertilized plot (2-3 %), than in the fertilized plot (10 % at places). The farmer started weeding 30 days after planting on 01/02/95 and finished the first operation on 10/02/95. A second weeding operation was conducted from 01-07/03/95. The farmer hired labour to weed his own field. Finally, a very even ripening was observed; plants had large heads and only 1 % of "alane" was harvested.

**K7 MMATHE THE**

plot size: 0.25 ha  
 soil type: Areni-Ferri-Dystric Regosol  
 AWHC: 60 mm/m  
 fertilizer type:

**Mr Ngaka Kgotlaetsho**

slope: 1°  
 Phosphorus content topsoil: 4.0 ppm  
 single superphosphate

**ALDEP model I**

UTM position: 327692E 7203558N  
 application rate: 210 kg/ha

topsoil analysis control plot:

pH-H <sub>2</sub> O	EC	org C	CEC	Ca	Mg	K	Na	PBS	carbo
5.5	0.0	0.3	1.8	0.5	0.1	0.2	0.0	44	0.0

top soil texture: coarse

drainage: well drained

soil depth: 60 cm

fertilized plot:

number of rows: 59

plant density: 29,500 pl/ha

control plot:

number of rows: 59

plant density: 30,000 pl/ha

yield fertilized plot:

350 kg/ha

CYSLAMB prediction: 1440 kg/ha

yield control plot:

170 kg/ha

CYSLAMB prediction: 1070 kg/ha

A motivated farmer, who lives next to his field. He has participated in the National Tillage Trials and in ADs variety experiments. No rainfall received in November; he only recorded 20 mm on 27/12/94. He ploughed and planted soon hereafter on 02/01/95 and 04/01/95, respectively. The 5 days between rainfall and ploughing were spent on working on his own field. Germination was quite even and took place 14 days after planting. This may be attributed to a low soil moisture content, as the next substantial rainfall event was 31 mm on 14/01/95. This rain seems to have triggered germination on 18/01/95.

Fertilized plants looked greener, bigger and more advanced in development than the control plants throughout. The first weeding operation was finished on 18/02/95, 45 days after planting. The farmer was hesitant to weed too early, when the soil was dry and the temperature high, in order to avoid scorching plants with hot soil. So a few more showers were awaited. The weed burden was higher in the fertilized plot, probably due to the use of fertilizer and a second weeding operation was deemed necessary and conducted from 04-11/03/95.

Around 09/03/95 a big difference in crop stand had developed. Especially in the fertilized plot, patches of plants in depressions were stunted and under moisture stress. The farmer attributed this to differences in soil type.

The Plant Protection Division sprayed the trial plots and the farmer's field against corn crickets and army worm with alaphametricin on 02/04/95.

visit 04/05/95

The fertilized plants were higher (approximately 1.0 m) and had thicker stems than the control plot (plants 60-80 cm high). The fertilized plants had developed on average two tillers per plant. Bird problems were still limited (3 % damage) and controlled by strings with empty tins filled with pebbles.

**K8 GASITA**

**Mr R. Taunyana ALDEP model II**

**K9 SESE Mr John Seamokwena ALDEP model I**

plot size: 0.25 ha  
soil type: Luvic Arenosol  
AWHC: 70 mm/m  
fertilizer type:

slope: 1°  
UTM position: 286683E 7219996N  
Phosphorus content topsoil: 0.6 ppm  
single superphosphate application rate: 329 kg/ha

slope: 2°  
UTM position: 278657E 7271526N  
Phosphorus content topsoil: 1.5 ppm  
single superphosphate application rate: 299 kg/ha

topsoil analysis control plot:

pH-H <sub>2</sub> O	EC	org C	CEC	Ca	Mg	K	Na	PBS	carbo
6.8	0.0	0.3	2	1.6	0.0	0.1	0.0	85	1.9

top soil texture: coarse

drainage: s. exc.

soil depth: 70 cm

fertilized plot:

number of rows: 47  
number of rows: 47

plant density: 12,600 pl/ha  
plant density: 3,600 pl/ha

yield fertilized plot:

480 kg/ha  
CYSLAMB prediction: 920 kg/ha

yield control plot:

failed  
CYSLAMB prediction: 440 kg/ha

The farmer has been living on the field since the start of the cropping season. The field is very sandy and wind erosion was a major constraint. Ploughing was done from 30/12/94-03/01/95, following a rainfall event of 22 mm on 26/12/94. The topsoil moisture content was too low for planting. Planting was done on 14/01/95, following a 34 mm of rain on 11-12/01/95. Germination was recorded on 20/01/95, 6 days after planting.

A dry spell of 21 days in combination with wind erosion was detrimental to plant growth. Seedlings were buried under sand, soil temperatures increased and roots were exposed; most plants in the control plot died and were swept away by the wind, causing a very low plant density. On 01/02/95 wind deposition made the plot look not ploughed. The few surviving plants were behind in development in comparison to the plants on the fertilized plot, which seemed to have been strengthened by the fertilizer. The survival rate in the fertilized plot was 4 times as high as on the control plot. Cattle entered the field and damaged approximately 12.5 % of the plants.

topsoil analysis control plot:

pH-H <sub>2</sub> O	EC	org C	CEC	Ca	Mg	K	Na	PBS	carbo
8.2	0.1	0.7	4.7	16.1	0.6	0.2	0.0	> 100	0.0

top soil texture: coarse

drainage: well drained

soil depth: 85 cm

fertilized plot:

number of rows: 47  
number of rows: 47

plant density: 19,200 pl/ha  
plant density: 15,400 pl/ha

yield fertilized plot:

670 kg/ha  
CYSLAMB prediction: 1470 kg/ha

yield control plot:

660 kg/ha  
CYSLAMB prediction: 710 kg/ha

The farmer lives next to the field; the trial plots are located on the edge of a pan with a petrocalcic horizon at approximately 80 cm. Ploughing/planting was done on 29-30/12/94, immediately after a rainfall event of 29 mm on 27-30/12/94. Wind erosion and deposition was severe, and made the field look not ploughed. The weed cover (compared to other trials in Southern Region) was high and amounted 8 % on the fertilized and 5 % on the control plot. The most dominant weeds were *Cynodon dactylon* (in patches, clearly benefitting from fertilizer), *Heliotropium steudneri* ("whitehead") and some *Tylosema esculentum* ("morama bean"). The farmer did a good first weeding job from 01-14/02/95 and conducted a second operation from 13-23/03/95. The trial site was only cultivated during the cropping season 1992/93, which could explain the high weed burden. The farmer had delayed weeding, to protect the seedlings against wind erosion. An adjacent field, which was weeded earlier, was practically free of weeds, but had very poor germination/establishment rates, due to wind erosion. Due to the weed pressure, open patches were observed in both fertilized and control plots. However, a clear difference between fertilized and control plants was noticed all the time, with fertilized plants looking greener, bigger and further developed than the control plot plants. The plant density of the fertilized plot was higher, than that of the control plot.

visit 04/05/95

The fertilized plants were 1-1.60 m high, were slightly better developed and had thicker stems than the control plants. An average of 3 tillers had developed per plant on the fertilized plot and occasionally tillering occurred on control plot. Fertilized heads were medium-large, flowering, grain filling and some ripening. Control plants had medium size heads, and were flowering to grain filling. Some corn crickets were observed, but they caused minimal damage to the developed heads. Although this site received a low amount of total rainfall (59 % of the average), a relatively good yield was achieved. Two phenomena may have played a role: due to the slope of the field some run-on may have occurred and the combination of a sandy soil texture and a petro-calcic horizon may have kept soil moisture longer available for the plant roots.

**K10 MONGWALALE****Mrs Keboetse Mosea****ALDEP model I**

plot size: 0.25 ha  
 soil type: Ferric Luvisol  
 AWHC: 130 mm/m  
 fertilizer type:  
 slope: 1 °  
 UTM position: 337792E 7184398N  
 Phosphorus content topsoil: 0.2 ppm  
 application rate: 342 kg/ha

topsoil analysis control plot:

pH-H <sub>2</sub> O	EC	org C	CEC	Ca	Mg	K	Na	PBS	carbo
6.7	0.0	0.6	9.2	2.2	1.3	1.2	0.0	82	1.9

top soil texture: medium drainage: well drained soil depth: 60 cm

fertilized plot: number of rows: 56 plant density: 26,000 pl/ha  
 control plot: number of rows: 56 plant density: 33,600 pl/ha

yield fertilized plot: 870 kg/ha CYSLAMB prediction: 1600 kg/ha

yield control plot: 470 kg/ha CYSLAMB prediction: 760 kg/ha

The field is situated approximately 1-2 km away from the farmer's house. Ploughing was done from 31/12/94-05/01/95 after a rainfall event of 43 mm during 26-30/12/94. Due to the poor condition of the donkeys and the fact that the farmer ploughed a larger area than just the trial plots, ploughing took 6 days. Germination occurred 6 days after planting and plant development was relatively even. Initially the fertilized plants looked better, later a high weed burden and possibly a difference in soil type slowed down the development in the fertilized plot. Plants in the control plot were looking more healthy and the plant stand was denser.

This picture changed after a weeding operation was conducted; the main weed in the fertilized plot, with at places a ground cover of 10 % was *Cynodon dactylon*. On 06/03/95 the plants of the fertilized plot looked more developed than the control plot.

[visit\\_04/05/95](#)

The fertilized plants were 0.80-1.20 m high, and had developed 2-4 tillers per plant. The heads were well formed, some were 30-40 cm long; the majority was flowering and grain filling, some ripening. On the control plot, plants were slightly thinner, 60-80 cm high, less well developed and hardly any tillering occurred. Bird scaring by the farmer seemed effective, no damage was noticed.

**K11 PITSANE****Mr Petrus Chidi****ALDEP model II**

plot size: 0.25 ha  
 soil type: Ferric Luvisol  
 AWHC: 130 mm/m  
 fertilizer type:  
 slope: 1 °  
 UTM position: 357174E 7177028N  
 Phosphorus content topsoil: 1.3 ppm  
 application rate: 303 kg/ha

topsoil analysis control plot:

pH-H <sub>2</sub> O	EC	org C	CEC	Ca	Mg	K	Na	PBS	carbo
6.6	0.0	0.7	5.6	2.4	0.8	0.8	0.0	71	0.0

top soil texture: medium drainage: well drained soil depth: 60 cm

fertilized plot: number of rows: 26 plant density: 15,600 pl/ha  
 control plot: number of rows: 26 plant density: 33,300 pl/ha

yield fertilized plot: 760 kg/ha CYSLAMB prediction: 990 kg/ha

yield control plot: 1290 kg/ha CYSLAMB prediction: 440 kg/ha

The field is well fenced, about 2 km from the farmer's house. The farmer traditionally uses compost. He ploughed both plots on 24/12/94 in the first planting opportunity, after a rainfall event of 22 mm on 16/12/94. Ploughing and planting took a while, as donkeys were weak (and the farmer, who is VDC chairman, was away for meetings). Initially germination and plant development looked very even. Later, the fertilized plants looked greener, bigger and more developed than control group. A hailstorm on 06/02/95 totally shredded leaves of plants, but they recovered. Fortunately the heads were not damaged, as they were not yet exposed at the time. A number of bare patches in the fertilized plot reduced the plant density and from 21/02/95 the plants in the control plot looked more healthy. The farmer attributed the bare patches to soil differences and to poor ploughing, which he would have liked to do twice in those areas. He seemed to notice the same differences every year.

An aphid attack was controlled by rain and the hail storm. The trial plots and the farmer's field were sprayed against stalk borers. This operation was carried by 2 people from the Plant Protection Division, using knapsack sprayers and alphasol at a concentration of 1:1000 (120 ml/120 l). Birds became a major problem as from 01/03/95, especially since the farmer's crop was one of the first in the area to reach the grain filling stage. The farmer, however, was not able to dedicate all his time to birdscairing, due to other commitments.

[visit\\_04/05/95](#)

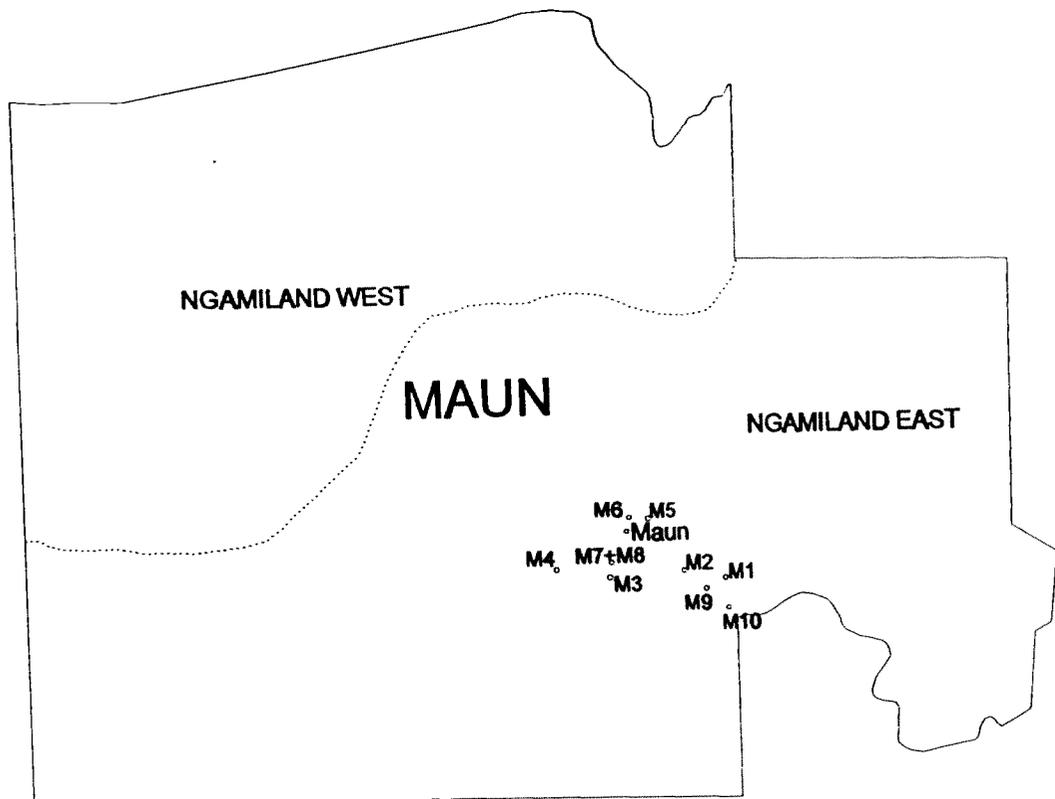
The fertilized plants looked worse than control group; 80 cm high and 4-5 tillers per plant. The heads were grain filling and ripening. On the control plot, the plants looked very healthy, varying in height from 60/100-150 cm and having 3-4 tillers per plant. They developed medium sized heads of 25-35 cm, of which 90 % was ripening.

The yield of the fertilized plot seems to be severely affected by the poor plant development on the bare patches.

# NORTH WEST REGION / MAUN

Trial sites:

- M1 Chanuga
- M2 Xhana
- M3 Komana
- M4 Nxaraga
- M5 Matlapaneng
- M6 Matlapaneng
- M7 Thamalakane West
- M8 Tsanakuna
- M9 Segoro
- M10 Xwee



Rainfall data trial sites M2, M7-M9

TRIAL SITE	M2 Xhana	M7 Thamalakane	M8 Tsanakuna	M9 Segoro
SYNOPTIC STATION	Maun	Maun	Maun	Maun
RAINFALL STATION	Maun	Maun	Maun	Maun
yearly average	454 mm	454 mm	454 mm	454 mm
01 Nov	1		7	10
02 Nov	10			
16 Nov	4		21	12
17 Nov		20	6	15
18 Nov		10		
20 Nov	5			
21 Nov		1		
23 Nov		2		
28 Nov	30		3	9
29 Nov	10	7	5	5
30 Nov	8	2	14	12
01 Dec			2	
27 Dec				10
28 Dec				18
12 Jan	6	10		8
14 Jan		5	10	
17 Jan		24	25	
18 Jan				13
27 Jan				5
30 Jan	9			3
02 Feb	9	10	16	3
05 Feb	5			4
08 Feb	6			
10 Feb	3	38	41	
21 Feb	28			22
23 Feb		2		
22 Mar	18			
23 Mar	4	20	30	8
24 Mar	1			2
26 Mar		1	2	
27 Mar	16	2	2	75
29 Mar	11	1		13
30 Mar		16	14	7
<b>TOTAL</b>	<b>184</b>	<b>171</b>	<b>198</b>	<b>254</b>
<b>% of AVERAGE</b>	<b>41 %</b>	<b>38 %</b>	<b>44 %</b>	<b>56 %</b>

**M1 CHANUGA****Mr. Gaatadiwe Modise****ALDEP model II**

plot size: 0.25 ha  
 soiltype: Luvis Arenosol  
 AWHC: 65 mm/m  
 fertilizer type:

slope: 0.5°  
 UTM position: 777987E 7771945N  
 Phosphorus content topsoil: 2.0 ppm  
 application rate: 280 kg/ha

topsoil analysis control plot:

pH-H <sub>2</sub> O	EC	org C	CEC	Ca	Mg	K	Na	PBS	carbo
7.0	0.1	0.8	4.0	1.7	0.6	0.5	0.1	72	1.0

top soil texture: coarse drainage: well drained soil depth: 100 + cm

fertilized plot: number of rows: 66 plant density: 2,000 pl/ha  
 control plot: number of rows: 66 plant density: 2,150 pl/ha

result: Trial failed.

visit [31/10/94](#)

A rain gauge was installed; donkeys (5) and cattle (5) were on the field.

visit [02/12/94](#)

34 mm of rain on 28-30/11/94; fertilizing done on 02/12/94; ploughing started on 02/12/94.

visit [17/01/95](#)

Some seeds germinated shortly after planting; plants 10 cm high. Start of second, more general, germination phase: plants approximately 0.5 cm high.  
 Cowpeas planted on 02/12/95 on the farmer's own field germinated well; maize planted 06/12/94 reached 10-20 cm, but died after a dry spell of 3 weeks.

visit [31/01/95](#)

Germination on both plots poor, around 20 %; plant stands looking poor, not much difference in plant density between fertilized and control plot. Plants on fertilized plot slightly taller. Some damage by small antelopes. Both the fertilized and the control plot have 9 % ground cover of weeds (*Tribulus terrestris*, *Commelina benghalensis*, *Gisekia pharnaceoides* and "delele", a kind of vegetable).

visit [14/02/95](#)

Goats have damaged 70 % of crop; the rest was severely moisture stressed. The weed cover was upto 25 %. No more substantial rainfall received in the following weeks, hence plants wilted and trial failed.

**M2 XHANA****Mr. Segotisa Makhi****ALDEP model II**

plot size: 0.25 ha  
 soiltype: Haplic Arenosol  
 AWHC: 65 mm/m  
 fertilizer type:

slope: 0°  
 UTM position: 795629E 7768639N  
 Phosphorus content topsoil: 2.2 ppm  
 application rate: 273 kg/ha

topsoil analysis control plot:

pH-H <sub>2</sub> O	EC	org C	CEC	Ca	Mg	K	Na	PBS	carbo
7.5	0.1	0.3	1.8	1.3	0.3	0.2	0.0	> 100	3.8

top soil texture: coarse drainage: s. exc. soil depth: 100 + cm

fertilized plot: number of rows: 57 plant density: 1,700 pl/ha  
 control plot: number of rows: 57 plant density: 150 pl/ha

**yield fertilized plot:** 100 heads (max 10% damaged) - 7.8 kg; seedweight 1 head 78 gram  
 1 head (undamaged) weighs 78 x 10/9 = 86.5 gram  
 3 heads/plant x 1700 plants/ha = 441.15 kg/ha (6.3 bags)  
 4 heads/plant x 1700 plants/ha = **588.2** kg/ha (8.4 bags)

**CYSLAMB prediction: 670** kg/ha

**yield control plot:** failed

In order to compare the trial yield with a CYSLAMB simulation, the yield of the damaged heads was converted into undamaged weight and an average of 4 heads per plant was taken.

visit [25/10/94](#)

A rain gauge was installed.

visit [02/12/94](#)

48 mm of rain on 28-30/11/94; farmer ready to start; the Technical Officer judged the soil too wet and made the farmer wait; fertilizing was done on 01/12/94; ploughing started on 02/12/94.

visit [28/12/94](#)

Poor germination due to the deposit of 5 cm of sand blown on the plots. On the control plots only a few plants were observed, while the fertilized plot had a slightly higher plant density with well looking plants.

The section of the farmer's field planted around 01/12/94 with sorghum "goose-neck" variety (short stemmed, 90 day variety), millet and melons looked more uniform and higher plant density.

visit 31/01/95

Plants on the fertilized plot looked healthy, varying in height from 15-55 cm. Some leaves affected by possibly an insect eating the chlorophyll of the leaves, leaving dry tissue behind. Plot had a 3 % weed cover; mainly melon type weeds. Control is a mere failure; very few plant of 10-20 cm.

visit 09/02/95

Farmer's local sorghum variety is flowering.

visit 20/02/95

Plants approximately 1 m high, looking healthy, abundant tillering. Around 40 % started to flower.

visit 06/03/95

90 % of plants flowering on 21/02/95. Fertilized plot had 30 % weed cover, while the control plot had 20 % weed cover.

visit 23/03/95

Heads grain filling; bird problem since 14/03/95. Farmer's wife and children tried to do bird scaring from 6am to 6pm, but had also other household duties to fulfill.

visit 28/03/95

Fertilized plot: plants are about 1.20 m high, heads are large (largest of all trial sites visited), 10 % damaged by birds. Approximately 20 % of the heads are ripening, grains not milky anymore and less prone to bird damage.

visit 07/04/95

Despite the bird scaring efforts, 50 % of the plants for 100 % damaged. As reason for the influx of local species (no queleas) given by farmer's wife was the shortage of flowering grasses and berry-forming shrubs (like *Grewia* and *Ziziphus*) around the field this year, due to the low rainfall. The farmer's wife had started harvesting and drying mature heads (with 10 % bird damaged) from trial plot on 04/04/95. An average of 4 heads per plant is counted. Grain filling and ripening still continued for the later formed heads.

visit 20/04/95

Earlier ripened heads severely damaged by birds, upto 100 %. Last heads still grain filling and ripening. Birds seem less active at the time of this visit; they seemed to have spread. Harvested and dried (10 % damaged) heads were kept in a drum, and were threshed on 22/04/95.

**M3 KOMANA**

plot size: 0.25 ha  
soil type: Haplic Arenosol  
AWHC: 65 mm/m  
fertilizer type:

**Mr. Loabo Johannes**

slope: 4-5°  
Phosphorus content topsoil: 6.0 ppm  
single superphosphate  
application rate: 210 kg/ha

**ALDEP model II**

UTM position: 745666E 7773643N

topsoil analysis control plot:

pH-H <sub>2</sub> O	EC	org C	CEC	Ca	Mg	K	Na	PBS	carbo
6.8	0.1	0.4	2.8	2.0	0.3	0.3	0.1	96	0.0

top soil texture: coarse

drainage: s. exc.

soil depth: 100+ cm

**result:** Trial failed.

visit 01/11/94

A raingauge was installed.

visit 02/12/94

22 mm of rain on 28-30/11/94; the farmer had to be located in Maun by the AD.

visit 05/12/94

The farmer was on the lands, looking for his donkeys at the time of the visit. He fertilized on 13/12/94 and ploughed from 13-15/12/94. The soil moisture conditions were unfavorable for planting, so the next opportunity had to be awaited.

visit 18/01/95

19 mm of rain on 12-13/01/95; the farmer harrowed with *Acacia* tree on 13/01/95 and planted on 14/01/95.

visit 31/01/95

Although 78 mm of rain between 12/01-10/02/95 no germination took place and the trial failed. No germination took place on the farmer's own field either. The trial plots were covered by 3 % of weeds.

**M4 NIXARAGA**

plot size: 0.25 ha  
 soiltype: Haplic Arenosol  
 AWHC: 65 mm/m  
 fertilizer type:

**Ms. Renosi Motsamai**

slope: 1 °  
 Phosphorus content topsoil: 4.6 ppm  
 single superphosphate

**ALDEP model I**

UTM position: 723320E 7773022N  
 application rate: 189 kg/ha

topsoil analysis control plot:

pH-H <sub>2</sub> O	EC	org C	CEC	Ca	Mg	K	Na	PBS	carbo
5.8	0.1	1.7	3.8	2.6	0.3	0.2	0.0	82	1.0

top soil texture: coarse

drainage: s. exc.

soil depth: 100+ cm

**result:** Trial terminated.

visit 24/10/94

Female headed household. A raingauge was installed; donkeys were on the field. The trial plots were ploughed with hired labour on 12-14/12/94.

visit 18/01/95

20 mm of rain on 12/01/95; the children went back to school, the sister of the farmer was breast feeding, so she hired two men to plough her own field.

Harrowing was done by hired labour on 18-19/01/95; the AD judged the soil moisture as too low and advised farmer not to plough and plant (this against the instructions of the ALUP team). No planting opportunity occurred anymore before the end of January, so the trial was terminated.

**M5 MATLAPANENG**

plot size: 0.25 ha  
 soiltype: Haplic Luvisol  
 AWHC: 72.5 mm/m  
 fertilizer type:

**Mr. Selawe Sawete**

slope: 1-2°  
 Phosphorus content topsoil: 9.2 ppm  
 single superphosphate

**ALDEP model III**

UTM position: 762434E 7793844N

application rate: 28 kg/ha

**result:** Trial terminated.

visit 26/10/94

A raingauge was installed.

visit 02/12/94

21 mm of rain on 28-30/11/94; farmer was reluctant to start.

visit 06/12/94

Farmer was organizing donkeys to borrow; he did not manage in time and failed to benefit from this first planting opportunity.

visit 18/01/95

Although awaiting enough rainfall, farmer hired two men to plough a part of his own field and the two trial plots on 16-18/01/95. No planting opportunity occurred anymore before end of January, so the trial was terminated.

**M6 MATLAPANENG**

Mr. Kadisa Kadisa

ALDEP model II

plot size: 0.25 ha  
 soiltype: Haplic Arenosol  
 AWHC: 65 mm/m  
 fertilizer type:

slope: 1-2°  
 UTM position: 754386E 7794390N  
 Phosphorus content topsoil: 3.0 ppm  
 single superphosphate  
 application rate: 245 kg/ha

topsoil analysis control plot:

pH-H <sub>2</sub> O	EC	org C	CEC	Ca	Mg	K	Na	PBS	carbo
7.0	0.1	0.5	3.2	1.7	0.4	0.2	0.0	72	0.0

top soil texture: coarse

drainage: s. exc.

soil depth: 100 + cm

**result:** Trial failed.visit 26/10/94

A was raingauge installed.

visit 02/12/94

22 mm of rain on 29-30/11/94; the farmer started looking for his donkeys on 01/12/94; found four on 02/12/94 and fertilized on 02/12/94. He ploughed from 04-07/12/94, harrowed on 08/12/94 and planted on 09/12/94.

visit 18/01/95

No germination had occurred; moderate wind erosion and deposition observed on the trial plots. The farmer had not ploughed yet on his own field.

visit 31/01/95

The trial plots were covered by a thin layer of sand (approximately 5 cm); no germination; weed cover 10 %. Trial failed. Portion of farmer's field ploughed by tractor, no germination observed there either.

**M7 THAMALAKANE WEST**

Ms. S. Dikole

ALDEP model I

plot size: 0.25 ha  
 soiltype: Haplic Arenosol  
 AWHC: 65 mm/m  
 fertilizer type:

slope: 1-2°  
 UTM position: 746589E 7775699N  
 Phosphorus content topsoil: 1.2 ppm  
 single superphosphate  
 application rate: 308 kg/ha

topsoil analysis control plot:

pH-H <sub>2</sub> O	EC	org C	CEC	Ca	Mg	K	Na	PBS	carbo
6.2	0.0	0.3	2.6	1.6	0.3	0.2	0.0	81	4.8

top soil texture: coarse

drainage: s. exc.

soil depth: 100 + cm

fertilized plot:

number of rows: 56

plant density: 3,950 pl/ha

control plot:

number of rows: 56

plant density: 4,150 pl/ha

**result:** Trial failed.visit 09/12/94

Female headed household. A waiting sufficient rain, the farmer did fertilize on 06/12/94 and the plots were ploughed from 07-09/12/95 by her sons.

visit 18/01/95

24 mm of rain on 17/01/95; harrowing was done on 18-19/01/95 and planting on 20/01/95.

visit 31/01/95

Germination took place on 27/01/95. Plants 2-6 cm high and looking reasonable. Weed cover was 1 %. Cowpeas on the trial of the Crop Production Officer (CPO) had not yet germinated, whilst they were planted a day after our trial. Farmer's sorghum, planted before Christmas, was severely moisture stressed.

visit 14/02/95

Plants looked healthy on both plots, but slightly smaller on the fertilized plot; maybe due to lateral subsurface flow of water from fertilized to control plot (situated slightly lower). Weed cover was 30 %; a weeding operation was conducted on 13, 15-16/02/95.

Farmer's sorghum and beans seemed recovered from moisture stress, and looked well; however, weed cover 60 %. Cowpea trial of the CPO germinated on 07/02/95; the plants were well established.

visit 20/02/95

Plants approximately 20 cm high, moderately moisture stressed and slightly affected by aphids.

visit 28/03/95

Livestock had entered the field and damaged trial crops for approximately 75%. The plants on the control plot were approximately 70 cm high and looked affected by long dry spell; weed cover of 15%. The fertilized plot had many gaps, plants were 70 cm high, and affected by dry spell; weed cover 35%.

visit 10/04/95

The remaining plants did not survive the long dry spell of 6 weeks and the aphid attack. Trial failed. Farmer's own crop died as well.

**M8 TSANAKUNA**

plot size: 0.25 ha  
soil type: Haplic Arenosol  
AWHC: 65 mm/m  
fertilizer type:

**Mr. B. Kebiditswe**

slope: 2°  
Phosphorus content topsoil: 3.5 ppm  
single superphosphate  
application rate: 227.5 kg/ha

**ALDEP model II**

UTM position: 748021E 7778324N

topsoil analysis control plot:

pH-H <sub>2</sub> O	EC	org C	CEC	Ca	Mg	K	Na	PBS	carbo
6.3	0.0	0.3	3.0	5.5	0.5	0.3	0.0	> 100	0.0

top soil texture: coarse

drainage: s. exc.

soil depth: 100 + cm

fertilized plot:

number of rows: 32

plant density: 100 pl/ha

control plot:

number of rows: 32

plant density: 3,700 pl/ha

**yield fertilized plot:** failed.

**yield control plot:**

200 heads (not damaged) - 12 kg; seedweight 1 head 60 gram

1.5 heads/plant x 3700 plants/ha = 333 kg/ha (4.8 bags)

2 heads/plant x 3700 plants/ha = 444 kg/ha (6.3 bags)

2.5 heads/plant x 3700 plants/ha = 555 kg/ha (7.9 bags)

3 heads/plant x 3700 plants/ha = 666 kg/ha (9.5 bags)

**CYSLAMB prediction: 500 kg/ha**

In order to compare the trial yield with a CYSLAMB simulation an average of 2.5 heads per plant was taken.

visit 01/11/94

A rain gauge installed; soil slightly moist at 25 cm after few mm of rain on 31/10/94.

visit 11/11/94

*Cynodon dactylon* germinated and spreading over fertilized plot and partly over control plot.

visit 02/12/94

19 mm of rain on 29-30/11/94; the farmer was looking for the last donkey; fertilizing done on 02/12/94.

visit 09/12/94

Farmer finished ploughing; however, soil moisture too low for planting and the next planting opportunity had to be awaited. Ploughing finished late due to other occupations (looking for cattle, building hut, in town). The farmer used *Acacia mellifera* to harrow the field and to reduce the weed cover between 08/12-20/12/94.

visit 18/01/95

25 mm of rain on 17/01/95; the farmer broadcasted maize and ploughed his own field on 18/01/95. He did not have time for the trial plots.

visit 31/01/95

Harrowing done on 26/01/95 and planting on 27/01/95, 10 days after effective rainfall event. The average row spacing was 1.60 m (probably, farmer wanted to finish quickly). *Cynodon dactylon* forms severe problem on fertilized plot and moderate problem on the control plot.

visit 14/02/95

Apart from *Cynodon dactylon* problem (covering 25 % of control plot and 60 % of fertilized plot) germination and establishment OK, plants upto 8 cm high and relatively evenly spaced.

visit 28/03/95

Around 90% of the plants were flowering; plants looked remarkably well after a dry spell of 6 weeks, slightly stunted, approximately 80 cm. Farmer's wife did conduct a weeding operation of three days between 03-07/03/95 and controlled the *Cynodon dactylon* around the plants on the control plot. On the fertilized plot, however, only a few plants were left. The farmer's own maize failed, and his sorghum looked very thin, while the cowpeas were doing well.

visit 19/04/95

Grain filling had started on 11/04/95, no bird problems so far.

visit 10/05/95

Farmer's wife residing in shelter on the field for bird scaring. On the fertilized plot only a few strong plants with 3-4 tillers left; heads medium sized, grain filling and ripening. The plants on the control plot had a uniform height of 1.20-1.40 m, looked healthy, on average 2-3 tillers/plant had developed and often a secondary head at one of the three tillers. Heads grain filling and ripening. Large gaps in the stand, due to uneven germination. Where plants were close to each other, only one tiller had developed and the stems stayed thin. The plants looked better developed than those on the farmer's own field. Hardly any bird damage (1-3 %) observed.

visit 23/05/95

Mature heads were harvested on 19/05/95 and were dried on rack off the ground in cone shaped pile covered by grass on the time of this visit. The harvested heads from the fertilized and control plot were mixed; as only a few fertilized heads were harvested and no obvious difference was observed between the control and the fertilized heads, the yield figure was not seriously affected. Several heads were still ripening, a slight damage by cattle and birds was observed (1-3 %).

**M9 SEGORO**

plot size: 0.25 ha

soil type: Haplic Arenosol

AWHC: 65 mm/m

fertilizer type:

**Mr. Fanabi Sasa**

slope: 3-4°

Phosphorus content topsoil: 4 ppm  
single superphosphate

application rate: 245 kg/ha

**ALDEP model II**

UTM position: 787496E 7764204N

topsoil analysis control plot:

pH-H <sub>2</sub> O	EC	org C	CEC	Ca	Mg	K	Na	PBS	carbo
6.6	0.1	0.6	1.6	1.3	0.2	0.3	0.1	> 100	

top soil texture: coarse

drainage: s. exc.

soil depth: 100+ cm

fertilized plot:

plant density: 2,100 pl/ha

control plot:

plant density: 2,250 pl/ha

**result:** Trial failed.

visit 31/10/94

A raingauge was installed.

visit 11/11/94

*Cynodon dactylon* germinated and was spreading over the fertilized plot.

visit 02/12/94

26 mm of rain on 28-30/11/94; fertilizing was done on 02/12/94; ploughing started on 02/12/94.

visit 18/01/95

Germination on 03/01/95, 26 days after planting and 5 days after two rainfall events of 28 mm in total. Germination seemed to be slightly better on the fertilized plot, than on the control plot. A weeding operation was started by the farmer's wife on 11/01/95 and carried on in small portions over 15 days (5 events) until both plots were finished.

visit 31/01/95

Plants on both plots were reasonably well established. *Cynodon dactylon* becoming a problem on the fertilized plot; many termites around the roots of the plants as well.

visit 14/02/95

The plants were 50-70 cm high, slightly moisture stressed; no obvious difference between fertilized and control plot. Majority of plants tillering profusely; upto 6-8 tillers per plant. Aphids affecting approximately 85 % of the crop on the trial plots. The farmer's cowpeas next to the trial plots looked well developed, but were for approximately 25 % affected by aphids. A spraying operation was conducted (including farmers cowpeas) with knapsack sprayer by the Plant Protection Division on 16/02/95; the chemical used was Decis (Ultra Low Volume) with a rate of 12 l/ha.

visit 20/02/95

The spraying was effective, plants looked more healthy, but still some moisture stress. Heads were developing.

visit 28/03/95

Around 90 % of the plants were flowering on 06/03/95. Severe moisture stress for 5-6 weeks. Plants 80-100 cm high and upto 8 heads per plant were observed (on average 4-5 heads per plant). At the time of the visit 80 % of heads were grain filling and birds form a problem. The plant stand of the control plot is slightly more uniform than the fertilized plot (maybe due to *Cynodon dactylon* in fertilized plot). On farmer's own field all crops failed, except the cowpeas, which were still looking good and in the grain filling stage.

visit 07/04/95

Farmer's family was not interested in birdscaring for the trials plots only; the crop 100 % damaged by birds. Trial failed.

**M10 XWEE**

plot size: 0.25 ha  
soil type: Haplic Arenosol  
AWHC: 65 mm/m  
fertilizer type:

**Ms. T. Sejagomo**

slope: 0°  
Phosphorus content topsoil: 3.5 ppm  
single superphosphate  
application rate: 227.5 kg/ha

**ALDEP model III**

UTM position: 798478E 7753829N

topsoil analysis control plot:

pH-H <sub>2</sub> O	EC	org C	CEC	Ca	Mg	K	Na	PBS	carbo
6.2	0.0	0.2	1.9	0.9	0.3	0.1	0.0	68	0.5

top soil texture: coarse

drainage: s. exc.

soil depth: 100+ cm

**result:** Trial terminated.

visit 31/10/94

Female headed household. A raingauge was installed.

visit 02/12/94

37 mm of rain on 28-30/11/94; the farmer waited for her children to finish school on 02/12/94 to assist her in debushing part of field.

visit 08/12/95

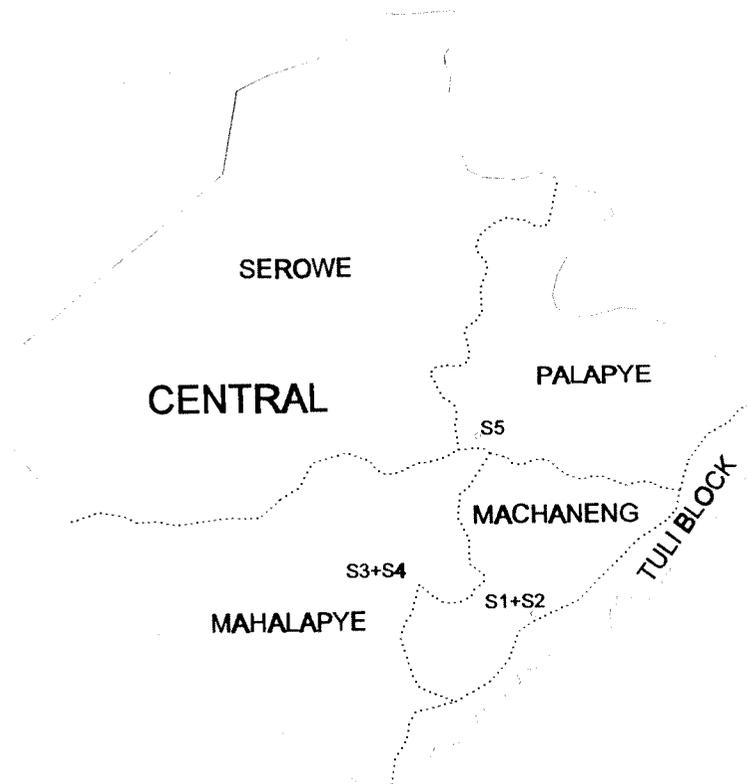
Farmer and children debushed trial plots on 03-04,06/12/94. Fertilizing was done on 05/12/94 and ploughing from 06-08/12/94. Soil moisture at the time of the visit too low for planting, so planting opportunity missed.

By the end of January not enough rain for a planting opportunity had been recorded, so trial was terminated.

## CENTRAL REGION / SEROWE

Trial sites:

- S1 Makwate
- S2 Makwate
- S3 Dihate
- S4 Dihate
- S5 Makoro



Rainfall data trial sites S1/2, S3/4, S5

TRIAL SITE	S1/S2 Makwate	S3/S4 Dihate	S5 Makoro
SYNOPTIC STATION	Mahalapye	Mahalapye	Mahalapye
RAINFALL STATION	Machaneng	Kalamare	Palapye
yearly average	417 mm	439 mm	403 mm
15 Oct		9.3	5.7
16 Oct		7.1	14
24 Oct			3
02 Nov			1
03 Nov	6.6	21.1	11
04 Nov			2
08 Nov	1.5		
12 Nov		5.6	20
13 Nov			9
17 Nov	16	42	7
18 Nov	8	22	1
24 Nov		4	
30 Nov	0.6	14	5
01 Dec	3.3	9	16
09 Dec	11	0.3	
10 Dec	29.8	10	30
11 Dec	9		
28 Dec		12.3	14
29 Dec	18		
03 Jan	12		
09 Jan			10
10 Jan		11	
13 Jan		18	30
14 Jan		12	
15 Jan			4
16 Jan	5	7	
03 Feb		20	
10 Feb			10
18 Feb	70		5
19 Feb	60		
20 Feb	1.5	100 +	100 +
21 Feb			30
14 Mar	3	9	
24 Mar	26	24	40
25 Mar	4	1.5	20

continued:

26 Mar	27.5		5
27 Mar			30
28 Mar	1.4		
31 Mar		26	20
10 Apr	6	6.1	
<b>TOTAL</b>	323.2	391.3 +	442.7 +
<b>% of AVERAGE</b>	78 %	89 %	110 %
<b>TRIAL SITE</b>	<b>S1/S2 Makwate</b>	<b>S3/S4 Dihate</b>	<b>S5 Makoro</b>

**S1 MAKWATE**

**Mr. Peter Garabaitse**

visit 15/03/95

plot size: 0.33 ha  
soil type: Chromic Luvisol  
AWHC: 110 mm/m  
fertilizer type:

slope: 0-1 °  
UTM position: 531400E 7425400N  
Phosphorus content topsoil: 3 ppm  
single superphosphate  
application rate: 50 kg/ha

topsoil analysis control plot:

pH-CaCl <sub>2</sub>	org C	CEC	Ca	Mg	K	Na
5.0	0.3	4.0	2.2	1.0	0.3	0.04

top soil texture: coarse

drainage: well drained

soil depth: 80 cm

fertilized plot:

plant density: 16,000 pl/ha

control plot:

plant density: 6,700 pl/ha

**result:** Because of mistakes with fertilizer and variety, this trial is not suitable for further analysis.

visit 14/11/94

Initially three trial plots were laid out: 1 for the superphosphate fertilizer, 1 for a kraal manure application and a control plot. Due to transport problems, the kraal manure could not be applied in time, so the idea was left.

The farmer lives in Makwate, and has a (summer) homestead near the field. No activity yet on 14/11/94. Rain gauges installed previously, but no recording at site so far.

visit 14/12/94

By accident 50 kg superphosphate distributed over 1 ha, including the two trial plots of 0.33 ha. The plots were ploughed on 13/12/94 with a double mouldboard plough and donkeys. At the time of the visit planting had not been done yet, will start planting on 15/12/94. There are no tractors available in the area; they have left because of the late rains.

visit 18/01/95

The farmer owns a span of mules and harness. The two fertilized plots were planted on 14-15/12/94; the control plot was planted on 27-28/12/94, due to the low soil moisture content mid December, a new shower had to be awaited. The plant density was relatively low, and a poor alignment of rows was observed. The plots had already been weeded.

visit 15/02/95

Plants at knee-height and in fairly good condition; patches of the field showed moisture stress; plants unevenly distributed (in-row clusters), few plants were flowering. Few plants were affected by aphids.

The variety planted is not *Segaolane*, but the "gooseneck" or "Raigop". The farmer had used the distributed *Segaolane* seeds somewhere else. No weeds, few watermelon in the field. No pests observed.

visit 12/04/95

Crop was still in a good condition; the majority of plants had not yet matured. No major pests observed. Farmer had picked few heads of plants, which were lying on the ground. These heads are stored on a platform under a tree.

**S2 MAKWATE****Mr. Ogomoditse Martin**

plot size: 0.33 ha  
 soil type: Chromic Luvisol  
 AWHC: 115 mm/m  
 fertilizer type:

slope: 0-1°  
 UTM position: 531400E 7425400N  
 Phosphorus content topsoil: 2 ppm  
 application rate: 230 kg/ha (to 8 ppm)  
 single superphosphate

topsoil analysis control plot:

pH-CaCl <sub>2</sub>	org C	CEC	Ca	Mg	K	Na
4.9	0.3	4.0	2.0	1.0	0.3	0.04

top soil texture: medium

drainage: well drained

soil depth: 100+ cm

fertilized plot:

plant density: 22,300 pl/ha

control plot:

plant density: 24,700 pl/ha

**yield fertilized plot:****730 kg/ha****CYSLAMB prediction: 1280 kg/ha****yield control plot:****700 kg/ha****CYSLAMB prediction: 810 kg/ha**visit 14/11/94

Initially three trial plots were laid out: 1 for the superphosphate fertilizer, 1 for a kraal manure application and a control plot. Due to transport problems, the kraal manure could not be applied in time, so the idea was left.

The farmer lives in Makwate, and has a (summer) homestead near field. He was present at the field on 14/11/94 and ready to plough with the first rain. He lives at lands most of the time. He used donkeys for ploughing. Some fertilizer was applied on the trial site 5 years ago (gift from MoA). Rain gauge installed previously, but no recording at site so far.

visit 14/12/94

Fertilized plot was ploughed on 13-14/12/94, first with a single mouldboard plough and single planter, later with a double mouldboard plough/planter. Ploughing was done at approximately 7 cm deep. The topsoil was already dry, compacted and crusted, more so than soils of other trial sites.

visit 18/01/95

The fertilized plot was characterized by a moderate plant density with many gaps. The area planted with the Sabele single row planter had a higher plant density than the area planted with the double mouldboard plough/planter. Few weeds were observed. The control plot was planted on 27-28/12/94, due to low soil moisture content, hence a the next shower had to be awaited. The control plot showed a somewhat better stand than the fertilized plot.

visit 15/02/95

The fertilized plot looked slightly better than the control plot (the plants were slightly higher on the fertilized plot). Most plants reached knee-height, and showed signs of slight moisture stress. Both plots were free of weeds (weeded on 06-10/02/95). Many gaps and in-row clusters observed. Farmer acknowledged, that planter often got blocked.

The sorghum (local variety "gooseneck" or "Raigop") planted at later date (around 05/01/95) adjacent to trial site looked better than *Sego/ane* on the trial sites. The farmer had also a good single stands of cowpea, jugo bean and tepary bean. Cowpea was a good inter-crop, because of its spreading nature.

visit 15/03/95

Crop had done relatively well since 15/02/95. Few African Bollworm observed. The developed heads were small, due to the moisture stress before 19/02/95. No (visual) differences between fertilized and control plot to be seen. None of the plants were ripe yet; some were only forming heads. The plots were free of weeds.

Jugobean and cowpea were doing very well in the adjacent plot. Also the maize looked promising, considering the low rainfall received this season.

visit 12/04/95

Crop kept performing well and was about 1.50 cm high. A few plants were attacked by pigeons (ripe grains); also damage by quelea (immature grains) was observed. Weeds covered a few percent; watermelon planted on the trial plots. Minor occurrence of bollworm observed.

**S3 DIHATE****Mr. Kotame Batiang**visit 15/03/95

plot size: 0.5 ha

soil type: Chromic Luvisol

AWHC: 105 mm/m

fertilizer type:

slope: 2°

UTM position: 455600E 7440700N

Phosphorus content topsoil: 1 ppm

single superphosphate application rate: 200 kg/ha (to 6 ppm)

topsoil analysis control plot:

pH-CaCl <sub>2</sub>	org C	CEC	Ca	Mg	K	Na
4.5	0.3	2.8	1.0	0.5	0.2	0.04

top soil texture: coarse

drainage: well drained

soil depth: 100 + cm

fertilized plot:

plant density: 31,300 pl/ha

control plot:

plant density: 28,000 pl/ha

**yield fertilized plot:****1000 kg/ha****CYSLAMB prediction: 1320 kg/ha****yield control plot:****670 kg/ha****CYSLAMB prediction: 710 kg/ha**visit 14/11/94

The farmer lives in Soshong and has a (summer) homestead near his field. No activity yet on 14/11/94, despite good rains and soil moist up to a depth of 100 cm.

First planting opportunity on 03/11/94; perhaps somewhat early. Sparse green weeds in farmer's field. Week-old grass regrowth in the surrounding area.

No rain recording at trial site. Farmer owns a tractor and a planter.

visit 14/12/94

Both plots were ploughed by tractor on 05/12/94 and planted on 08/12/94. Crop just emerged.

visit 18/01/95

Some thinning was carried out on 11/01/95. Many gaps in the rows (due to poor planting); the plants were approximately 30 cm high. The growth in the fertilized plot looked better than in the control plot. A weed count was carried out in both plots; the main weed was *Urochloa* spp., a grass and easy to remove. The farmer was advised to weed.

visit 15/02/95

A reasonable plant stand was observed, but no proper thinning was done; many in-row clusters and gaps. 50 % of the plants was flowering; nearly all plants were affected by aphids. Slight moisture stress was observed. Few weeds (2 %). Not much difference to be seen between the fertilized and the control plot.

No (visual) difference between the fertilized and the control plot observed. Rain of mid February washed away the aphids. Both plots attacked by African Bollworm; also few corn crickets seen. Some heads were ready for harvesting. Few weeds (mainly *Sesamum alatum*, "wild sesamum") observed. Signs of sheet and rill erosion in the field, caused by the heavy rain from mid February.

visit 12/04/95

Half of each plot was sprayed by FSR against Bollworm on 20/03/95 with "Sherpa" concentration 7.5 ml/l. No noticeable difference between sprayed and not sprayed sections observed; the Bollworm had disappeared throughout. The crop continued to do well, and was almost mature. Some stalks had fallen down because of strong wind. Some attack by pigeons and quelea observed. The weed cover was a few percent. The farmer was trying to fight a obnoxious weed (*Sesamum alatum*) by pulling it up and collecting it in piles.

visit 16/05/95

On the trial plots sorghum was mixed with melons; the plant density of the sorghum amounted on both fertilized and control plot approximately 30,000 plants/ha; the melons reached an approximate density of 5,000/ha.

The plant stand on the fertilized plot was rather homogeneous; the plants were 1.10-1.30 high, thinly stemmed, and upto 3 tillers had developed (mainly 1 though). The plants on the control plot were slightly thinner and lower than the fertilized plants, only 1 tiller had developed. The main mature heads were harvested in APR3; the harvested heads were medium-large, and were drying at the time of the visit. Some 3 % bird damage was done to the harvested heads; the small immature second and third heads were left by the farmer; they were not worth the effort to harvest.

**S4 DIHATE****Mr. Mpoloking Lesele**

plot size: 0.5 ha  
 soil type: Chromic Luvisol  
 AWHC: 105 mm/m  
 fertilizer type: single superphosphate

UTM position: 455600E 7440700N  
 slope: 2°  
 Phosphorus content topsoil: 1 ppm  
 application rate: 200 kg/ha (to 6 ppm)

topsoil analysis control plot:

pH-CaCl <sub>2</sub>	org C	CEC	Ca	Mg	K	Na
4.8	0.4	3.3	1.1	0.6	0.3	0.04

top soil texture: coarse      drainage: well drained      soil depth: 100+ cm

fertilized plot:      plant density before thinning: 14,000 pl/ha

**yield fertilized plot:**      670 kg/ha      **CYSLAMB prediction: 810 kg/ha****yield control plot:**      failedvisit 14/11/94

The site was situated on the footslope, liable to sheet erosion; contour was ploughing done. In an adjacent field, previously experiments were carried out with broad ridging along the contour and maize production; locally hills had broken through the ridges.

The farmer lives in Soshong and has a (summer) homestead near his field. No activity yet on 14/11/94, despite good rains and soil moist up to a depth of 100 cm.  
 First planting opportunity on 03/11/94; perhaps somewhat early. Sparse green weeds observed in the farmer's field. Week-old grass regrowth in surrounding area.

Farmer owns donkeys and a plough-planter.

visit 12/12/94

The fertilized plot was ploughed and planted on 05-06/12/94. Emergence took place on 14/12/94.

visit 18/01/95

The control plot was plough-planted on 28-29/12/94, due to the low soil moisture in mid December, a new shower had to be awaited. Very few plants had emerged. A few weeds were observed: *Urochloa* spp and *Tribulus terrestris* ("mosetlho").

On the fertilized plot a very low plant density and many gaps were found. The farmer was advised to fill in the gaps. Few weeds were observed.

visit 15/02/95

The farmer was at the cattle post, and did not seem very interested in cropping (anymore). Plants were 1 m high and flowering on the fertilized plot. Most plants were affected by aphids. Weed covered approximately 5%. The plant density was around 15,000 plants/ha, but many in-row gaps and clusters were seen. The control plot was a complete failure.

visit 15/03/95

The fertilized plot was weeded on 05/03/95. A few plants were attacked by the African Bollworm. A few heads were ready for harvesting.

visit 12/04/95

Considerable damage was done by pigeons and quelea. A few scarecrows were erected, but they did not seem very effective. The Bollworm had disappeared. A few plants had fallen on the ground. A portion of field was well weeded, the remaining part was covered by many grasses (up to 20%); the control plot was covered by *Sesamum alatum*.

visit 16/05/95

On the fertilized plot, sorghum was mixed with melons; the plants were stunted and poorly developed. Harvested heads, medium sized and < 3% bird damage, were dried at the time of the visit.

**S5 MAKORO**

Mr. L. Tshupelo

plot size: 0.5 ha

slope: 0-1° UTM position: 497500E 7488500N

soil type: Chromic Luvisol

Phosphorus content topsoil: 1 ppm

AWHC: 115 mm/m

single superphosphate

application rate: 200 kg/ha (to 6 ppm)

fertilizer type:

topsoil analysis control plot:

pH-CaCl <sub>2</sub>	org C	CEC	Ca	Mg	K	Na
4.7	0.2	4.3	1.6	1.0	0.4	0.04

top soil texture: medium

drainage: well drained

soil depth: 100 + cm

**result:** Trial failed.visit 14/11/94

Farmer lives in Serowe and has a (summer) homestead near the field. No activity yet on 14/11/94, despite good rain on 13/11/94.

First planting opportunity on 13/11/94. No rain recorded yet at trial site.

visit 14/12/94

The farmer recorded 30 mm on 10/12/94; the topsoil was already dry on 14/12/94. A very uneven distribution of fertilizer was observed. The fertilized plot was planted with plough/planter on 14/12/94 with 8 donkeys. Approximately 30-40 seeds were planted per meter, row distance 75 cm, planting depth 10 cm; the seeds were covered loosely with almost dry sandy topsoil.

visit 17/01/95

The fertilized plot was a near-failure. The farmer was advised to replant (broadcast and harrow), which was done on 15/01/95. Possible reason for failure: high (soil) temperatures after planting (as suggested by Mr Modiakgotia). The control plot partly planted on 16/01/95.

visit 12/04/95

The replanting of the fertilized plot on 15/01/95 and the planting of the control plot on 16/01/95 both failed. Some plants emerged, but at a very late date. Some plants of the original planting on the fertilized plot (14/12/95) did survive; a very low plant density was observed. Many plants were eaten by goats. The field was left unattended for a period in March/April, because the farmer passed away mid March 1995. Few plants were affected by African Bollworm. A weed cover of 10-15 % was observed. The plots had not been weeded since they were ploughed.

## **APPENDIX V          EXAMPLE OF A BAR-CHART**

An easy way of monitoring and comparing the progress of several trial sites is a bar-chart like the following:







Photograph no. 1



Photograph no. 2



Photograph no. 3



Photograph no. 4

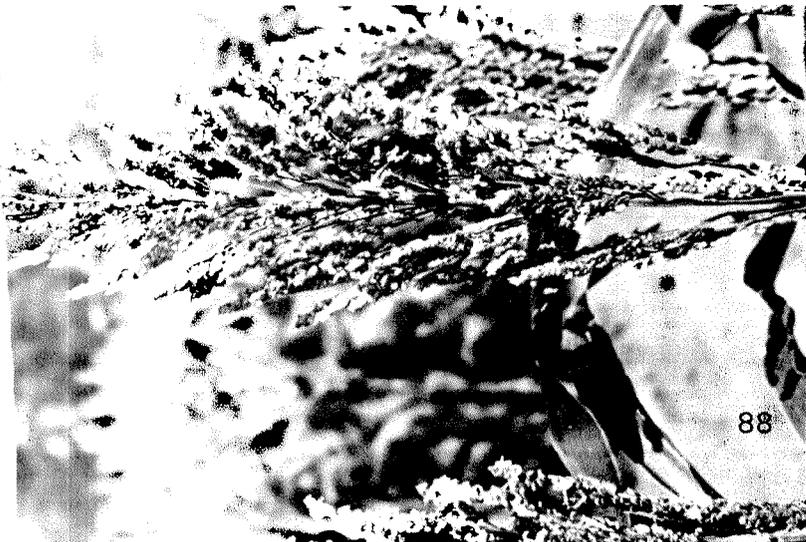
Photographs 5-8



Photograph no. 8



Photograph no. 5



Photograph no. 6

