PRODUCTIVITY OF MAIZE/SORGHUM MIXTURE AS AFFECTED BY CROP PROPORTION, STAND ARRANGEMENT AND MAIZE VARIETY

BY

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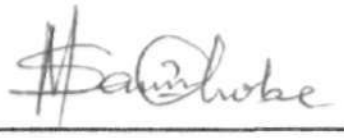
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DECLARATION

I hereby declare that this thesis has been written by me and that it is a record of my own research work. It has not been presented before in any previous application for a higher degree.



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CERTIFICATION

This thesis entitled "PRODUCTIVITY OF MAIZE/SORGHUM MIXTURE AS AFFECTED BY CROP PROPORTION, STAND ARRANGEMENT AND MAIZE VARIETY" by Sani Mohammed Chobe meets the regulations governing the degree of Master of Science of Ahmadu Bello University Zaria and is approved for its contribution to scientific knowledge and literary presentation.

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DEDICATION

This work is dedicated to my parents Late Mohammed Chobe Usman and Asma'u and my guardian Alhaji Mohammed Abdullahi for giving me a sound footing to my educational career.

ACKNOWLEDGEMENT

First of all, I want to express my thanks to the Almighty Allah for the courage and endurance bestowed on me in starting and completing this work.

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- S.M. CHOBE (1987)

ABSTRACT

A field experiment was conducted at Samaru farm of the Institute for Agricultural Research in the 1984 and 1985 wet seasons with the objective of studying the effect of different proportions of component crops, stand arrangement and maize variety on the productivity of maize/sorghum mixture.

Factorial combinations of three proportions (50:50; 67:33 and 95:25 of maize and sorghum respectively), two stand arrangements (alternate and within ridge) and two maize varieties of different maturity (TZB and TZE-SR-W) were laid out in a randomized complete block design (RCBD) with four replications.

Increasing maize proportion in the mixture from 50:50 to 75:25 significantly increased the grain yield of maize, while that of sorghum reduced significantly. The effect of stand arrangement on the grain yield of maize was not consistent. Maize in the within ridge arrangement outyielded those in alternate ridges in the 1985 wet season but not in 1984. The performance of sorghum in alternate ridges appeared better than in the within ridge arrangement.

Although, there was no significant difference in yield between TZB and TZE-SR-W either in mixture or sole crops, crop proportion 67:33 with TZE-SR-W as maize component gave the highest yield advantage of *25%* in 1984. In 1985, TZE-SR-W at crop proportion 67:33 again produced the highest yield advantage of 39%. Generally row arrangement did not seem to affect yield advantage. In monetary terms only maize/sorghum mixture at crop proportion 67:33 and 75:25 produced gross returns that were consistently good as for sole maize but superior to that of sole sorghum.

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Chapter 1

INTRODUCTION

Mixed cropping is a traditional cropping pattern among small scale farmers in the tropics. Essentially, it involves the growing of two or more crops simultaneously on the same parcel of land at the same time with or without regard to row arrangement (Andrews and Kassam, 1976; Okigbo, 1976).

Effort by research and extension workers to convince tropical small scale farmers to emphasize sole cropping have proved abortive (Abalu, 1976). However, research interest on mixed cropping is relatively recent (Okigbo, 1976). Crops could be found in complex combinations in mixtures (Norman, 1972), but of prime importance in decreasing order are cereal/cereal, cereal/legume and cotton/legume mixtures (Okigbo and Greenland, 1976 and Fisher, 1982). In the Guinea savanna ecological zone of Nigeria, maize (Zea mays L.) is gradually replacing millet (Pennisetum americanum (L) Leeke) as a component of mixture with sorghum (Sorghum bicolor (L) Moench). This development could probably be traced to the higher yield potential of maize and its less predisposition to bird damage, in addition to being better responsive to cultural management than millet.

Relatively limited research work has been conducted on maize/sorghum mixture. The increased grain yield in mixture of sorghum cultivar SK5912 with early maize variety Bomo local and late maize variety S-123 was attributed by the

Institute for Agricultural Research (I.A.R.) workers as being caused by the better utilization of light since the canopy structure and maturity period of the component crops differ appreciably (Anon. 1976). Fisher (1984) in a multi-locational fertilizer trial with maize/sorghum mixture, suggested fertilizer rates of 60:30:30 and 90:45:45 kg/ha ($N:P_2O_5:K_2O$) for the southern and northern Guinea savanna respectively. Anon (1976) also found that the maize yields from mixture were not affected by sorghum population, although sorghum yields showed consistent decline as the population of maize in the mixture increased. Lere (1985) reported better grain yield with crop proportion 2:1 (67:33) of maize/sorghum than the 1:2 (33:67). Nevertheless, Lere's work on the mixture could not go further than the crop proportion 2:1(67:33) maize: sorghum and only maize variety TZB was used. With the recent release of relatively early maturing maize varieties such as TZE-SR-W, their response in mixture with sorghum needs also be investigated. This study was therefore conducted to:

i) determine the effect of component crop proportion on the production of maize/sorghum mixture;

ii) compare the alternate ridge arrangement of the component crops with the within ridge arrangement;

iii) evaluate the influence of two maize varieties on the productivity of the mixture.

Chapter 2

LITERATURE REVIEW

Mixed cropping as defined by Andrews and Kassam (1976) is the growing of two or more crop species simultaneously on the same piece of land without regard to row arrangement. Ruthenberg (1980) described intercropping as the growing of two or more crops by simultaneously intermingling on the same piece of land with distinct row arrangement. The component crops are not necessarily sown or harvested at the same time but grown simultaneously with significant interaction between species for a greater part of their life span (Andrews and Kassam, 1976; Whilley, 1979). However, mixed cropping and intercropping are sometimes used interchangeably (Andrews and Kassam, 1976).

2.1 Maize/Sorghum Mixture

Little work has been done to date on maize/sorghum mixture. This mixture is of widespread and growing importance in northern Nigeria (Fisher, 1984). Perhaps, this could be due to the advantages of its production in terms of better response to added inputs such as fertilizer and high grain yield than millet/sorghum. In the northern Guinea savanna the two crops are usually sown at about the same time with maize replacing millet in the traditional millet/sorghum mixture (Anon., 1980; Fisher, 1984). In the southern Guinea savanna, maize is usually planted early in the season and sorghum intersown about four weeks later (Fisher, 1984).

2.1.1 Effects of maize varieties on maize/sorghum mixture

The increase in grain yield as a result of growing crops in mixture has been associated with differences in maturity of the component crops (Andrews, 1972). Varieties of maize of different maturity have been found to influence the grain yield of associated sorghum in different ways (Anon., 1976). In an experiment with two varieties of maize (Bomo local with 90 days maturity and S-123 with 110 days maturity) in mixture with sorghum (SK5912 with 160 days maturity at Samaru), Anon (1976) reported 8% increase in grain yield with Bomo local but 14% with S-123 over their respective sole crops in a 1:1 (50:50) mixture arrangement. Yields of the component sorghum were found to be higher in mixture with Bomo local than S-123. It was reported (Anon., 1976) that the higher yield of component sorghum with Bomo local was as a result of the early maturity of the latter. Baker and Yusuf (1976), while relating yield advantage to differences in maturity concluded that yield advantage could only occur when there was approximately 30-40 days maturity difference between the components of a mixture.

2.1.2 Effect of crop proportion on maize/sorghum Mixture

I.A.R. workers found that component sorghum grain yield increased as the proportion of maize in the mixture decreased (Anon., 1976). Lere (1985) reported better grain yield with 2:1 (67:33) maize:sorghum proportion than the 1:1 (50:50), irrespective of row arrangement.

2.1.3 Effect of stand arrangement on component crops

Since maize is relatively early maturing and faster growing than sorghum, it is likely that the yield of sorghum will be affected by plant arrangement in mixture. Lere (1985) reported that alternate row arrangement gave higher yield of maize and sorghum at Samaru than within row arrangement, while at Saminaka it was the within row arrangement that performed better.

2.2 Millet/Sorghum Mixtures

Millet/Sorghum is the dominant cereal-based mixture in northern Nigeria, apparently because of its superiority in productivity over the sole crops (Andrews, 1972; Okigbo and Greenland, 1976; Norman, 1972). Both crops play predominant roles in the diet of the people. It is common for millet to be sown early and later intersown with the traditional long-season sorghum. The mixture is often in the proportion of 1:2 (33:67) millet to sorghum in the southern area of the northern Guinea savanna while the ratio is 1:1 (50:50) in the northern part as well as in the sudan savanna. A yield advantage of 20-30% in the millet/sorghum mixture over sole crops was reported by Fisher (1982). Andrews (1972), Kassam and Stockinger (1973) associated productivity of millet/sorghum mixture to the ability of the intercropped sorghum to recover from the effect of competition with millet. Consequently, grain yield of sorghum in the mixture was as good as in the sole crop since sorghum fully recovered after the harvesting of millet.

It was concluded that the increased grain yield obtained from millet/sorghum mixture was as a result of better utilization of environmental resources (Anon., 1981 and Andrews, 1972). For instance, the different canopy structure of the mixture allowed for better penetration of light into the millet canopy. Baker (1979) also attributed the yield advantage in intercrops to the efficient canopy structure attained by mixing early and later maturing crops together since no single component crop could alone utilize the growth resources of the entire wet season efficiently. However, IAR workers suggested that cereal mixture should be so arranged in such a way that part of the plant contributing to the grain (above the ear in maize or the upper leaves for sorghum and millet) should be free of shading during the period of grain formation (Anon. 1977). Fisher (1982) working with millet/sorghum mixture found alternate ridge arrangement better than the within ridge arrangement as it is easier to apply the fertilizer inputs to the components.

2.3 Other Cereal-Based Mixtures

Fisher (1977) found that yield of beans was depressed due to shading as proportion of maize in the mixture with beans increased. Similar finding was made by Aidar and Vierra (1979). Yunusa (1985) while working on maize/soyabean mixture reported that reducing soyabean proportion to 33% lowered yields significantly.

Various studies have been carried out on the effect of stand arrangement on component crops. Evans (1960) found no stricking advantage from growing maize or sorghum with groundnut in alternate rows as compared with the uniform distribution within the row. Dalal (1974) found that the combined dry matter yield and nutrient uptake of both maize and pigeon peas were better in alternate rows than in mixed stands. In another study, Galal et al.(1981) experimenting on maize and soyabean under different cropping patterns found that intercropping on alternate ridges increased the per cent of harvested maize plants, number of ears per plant and grain weight, pod number and seed number per plant, but reduced the seed yield of soyabean. Fulman and Herbert (1982) found that yields were slightly reduced in soyabean intercropped in alternate rows with maize, and further reduced when grown in the same row with maize. Yunusa (1985) on the other hand, found that maize in mixture with soyabean was less affected by plant arrangement, but that soyabean was sensitive to maize. Alternate ridge arrangement was found to minimize both the competitive effect of maize on soyabean thus resulting in better yields than the within ridge arrangement.

Chapter 3

MATERIALS AND METHODS

3.1 Experimental Sites

A field experiment was conducted on the farm of the Institute for Agricultural Research at Samaru, Zaria (latitude $11^{o}11'N$, longitude $07^{o}38'E$ and 685m above mean sea level) in the northern Guinea savanna ecological zone of Nigeria during the 1984 and 1985 wet seasons. Details of the physico-chemical properties of the furrow-slice are summarized in appendix 1.

The rainfall and evapotranspiration data collected from the agrometeorological station located about 500 m from the experimental sites in 1984 and 1985 respectively are presented in figure 1. The climate at Samaru is characterized by unimoda rainfall pattern. Rains start, normally, by mid-May reaching its peak in August and ending by early or mid-October (Kowal an Knabe, 1972). At this time, crops such as traditional sorghum varieties remain in the field until November when ready for harvest.

3.2 Varietal Characteristics

Two maize varieties: TZB and TZE-SR-W maturing in 120 and 90 days respectively, were used in this study. TZE-SR-W apart from being early maturing is also resistant to streak virus disease and smaller seeded than TZB variety. Sorghum variety SK5912, maturing in 160 days, was the other component crop of the mixture. TZB and SK5912 were obtained from the National Seed Service at Samaru while TZE-SR-W were obtained from the Kano Agricultural and Rural Development Station at Kadawa.

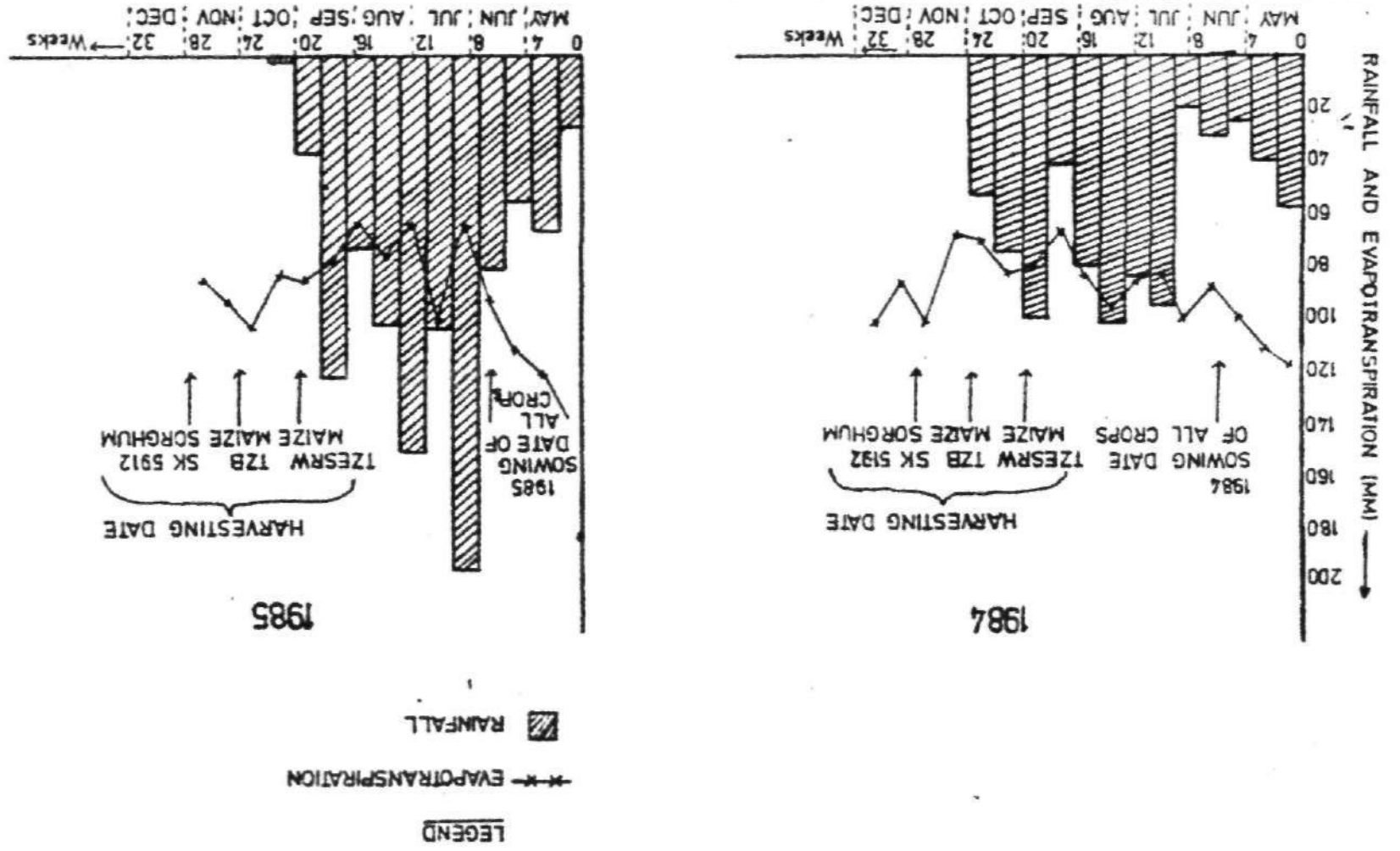


FIG. 1 MEAN FORTNIGHTLY RAINFALL AND EVAPOTRASPIRATION FOR SAMARU (1984 AND 1985 WET SEASONS)

3.3 Experimental Treatment and Design

There were 15 treatments comprising three sole crops (TZB, TZE-SR-W maize varieties and SK5912 sorghum variety) and 12 crop mixture treatments obtained by factorial combinations of three crop proportions (1:1. 2:1 and 3:1 maize:sorghum), two stand arrangements (alternate ridge and within ridge) and two maize varieties (TZB and TZE-SR-W). For the alternate ridge stand arrangement, the three crop proportions were achieved by alternating one ridge of sorghum with one, two and three ridges of maize for the 1:1, 2:1 and 3:1 maize:sorghum proportions respectively. For the within ridge stand arrangement, one, two and three stands of maize were alternated with a stand of sorghum to achieve the maize:sorghum proportions 1:1, 2:1, and 3:1 respectively.

The experiment was laid out in a randomized complete block design (RCBD) with four replicates. The gross plot was made up of 12 ridges spaced 75 cm apart and 6 m long (area of 54 m^2). The six inner ridges with an area of 14.4 m^2 constituted the net plot while the remainder formed the discard from where the samplings were made.

3.4 Crop Management

The experimental area was ploughed, harrowed and ridged. Fertilizer was applied at planting at the rate of 45 kg N/ha, 45 kg P_2O_5/ha, and 45 kg K_2O/ha (as 300 kg compound 15:15:15/ha) to the mixture treatments. Calcium ammonium nitrate (CAN) at

the rate of 45 kg N/ha was side dressed (as 173 kg CAN/ha) to both component crops at five weeks after planting. For sole crops, a rate of 60 kg/ha each of N, P_2O_5 and K_2O for maize (as 400 kg compound 15:15:15/ha) and 30 kg/ha each of N, P_2O_5 and K_2O for sorghum (as 200 kg compound 15:15:15/ha) was applied at planting respectively. Calcium ammonium nitrate at the rate of 60 kg and 30 kg/ha (as 230 kg CAN/ha and 115.4 kg CAN/ha respectively) for maize and sorghum was side-dressed five weeks after planting respectively.

Maize and sorghum were both planted on 14 June in 1984 and on the 17 and 18 June 1985. About four seeds of sorghum and two seeds of maize were sown per hole and later thinned to one plant per stand at a distance of 20 cm to give a total plant population of 66,666 plants/ha.

Gardoprim A 500 FW (containing terbuthylazine and atrazine at 250 gm/l each) was sprayed as pre-emergence herbicide. A rate of 3 l/ha or 1.5 kg a.i./ha in 200 litres of water per hectare was applied using a knapsack sprayer. Supplementary hoe-weeding was carried out five weeks later. Insect pest, particularly stem borer, was controlled by spraying cabaryl (Vetox 85) at the rate of 1.5 kg a.i./ha in 200 litres of water per hectare with also a knapsack sprayer.

3.5 Collection and Processing of Data

3.5.1 Plant height

The height of 5 plants of maize and of sorghum were taken per plot at 12 weeks after planting. The measurements were taken from the ground level to the tip of foliage at vegetative stage and the panicles or tassel at the reproductive stage.

3.5.2 Plant girth

Girth of 5 plants of maize and of sorghum were taken at 12 weeks after planting. The measurements were taken at about 30 cm from the bottom of each plant. A thread was tied round the stem and later measured using a ruler.

3.5.3 Dry weight of five plants

Five plants of maize and of sorghum were removed from each plot by cutting at ground level and oven-dried at $85^{o}C$ for 24 hours and weighed.

3.5.4 Lodging

Plants that lodged were counted in each plot and expressed as percentage of total plants in the plot. A plant was considered lodged when it inclined more than 45^{o} from the vertical normal position.

3.5.5 Number of plants per square metre at maturity

Number of plants of maize and sorghum was counted per plot. This was then converted to square metre. The counting was done prior to harvesting.

3.5.6 Number of cobs per square metre

Number of cobs per net plot was taken after harvest and expressed on square metre basis.

3.5.7 Cob weight per plant

The weight of harvested cobs was recorded and later converted into per plant basis.

3.5.8 Number of panicles per square metre

The number of panicles of sorghum per net plot was taken after harvest. The number was then expressed into per square metre basis.

3.5.9 Panicle weight per plant

The weight of harvested panicles was taken per net plot and converted into per plant basis.

3.5.10 Grain yield

The harvested cobs of maize and panicles of sorghum from the net plots were shelled and threshed, and later winnowed. The grains were then weighed before converting it into hectare basis.

3.5.11 Grain weight

Grain samples of maize were collected from each net plot and 100 grain weight taken. Also grain samples of sorghum were collected from each net plot and 1000-grain weight taken.

3.5.12 Shelling percentage

The shelling percentage of maize from each plot was calculated as given below:

$$\text{Shelling percent (\%)} = \frac{\text{Grain weight after shelling}}{\text{Cob weight (unshelled)}} \times 100$$

3.5.13 Threshing percentage

The threshing percentage of sorghum from each plot was calculated as below:

$$\text{Threshing percent (\%)} = \frac{\text{Grain weight after threshing}}{\text{Panicle weight (unthreshed)}} \times 100$$

3.5.14 Land equivalent ratio

Land equivalent ratio (LER) was calculated for maize based on the corresponding variety in sole and crop mixture. Also that of sorghum was calculated based on sorghum in sole and crop mixture. The combined LER for maize/sorghum was also calculated by summation of LER for maize and sorghum in the mixture:

$$\text{LER (maize)} = \frac{\text{Grain yield of maize in mixture}}{\text{Grain yield of maize in sole}}$$

$$\text{LER(sorghum)} = \frac{\text{Grain yield of sorghum in mixture}}{\text{Grain yield of sorghum in sole}}$$

$$\text{Combine (LER) (mixture)} = \text{LER (maize)} + \text{LER (sorghum)}$$

3.5.15 Gross return

The gross return was calculated using the grain yields per hectare of maize and sorghum in sole and mixture. The grain prices offered by the Nigerian Grains Board for 1984/85

and 1985/86 seasons were used. The prices for maize for the 1984/85 and 1985/86 seasons were ₦400/ton and ₦450/ton, respectively. That of sorghum for the corresponding seasons were ₦450/ton and ₦500/ton, respectively.

3.6 Data Analysis

The data collected were subjected to statistical analysis of variance and the treatments means compared by least significant difference (LSD) or Duncan's multiple range test (DMRT) at five percent level of probability.

Correlation between grain yields and plant characters of both maize and sorghum was also calculated and compared at five percent level of probability.

Chapter 4

RESULTS

4.1 Grain Yield, Shelling Percent and 100-grain Weight of Maize

4.1.1 Grain yield of maize

Results of the effect of component crop proportion on grain yield of maize in mixture with sorghum in the 1984 wet season, which was the only treatment effect significant is presented in Table 4.1. Maize/sorghum proportion of 67:33 and 75:25 gave statistically similar grain yield in the mixture but these were more than for proportion 50:50.

In 1985 wet season maize grain yield response to crop proportion, however, almost followed similar trend as in 1984 (Table 4.1). Crop proportion 75:25 gave the highest grain which was even significantly higher than for 67:33 and 50:50.

Within ridge arrangement of the component crops produced significantly higher maize grain yield than the alternate ridge arrangement (Table 4.1).

Result of the analysis of maize grain yield in sole and crop mixture with sorghum in different combination (Table 4.2) show that in 1984, sole crop of TZB maize gave statistically similar grain yield as sole crop of TZE-SR-W, but significantly outyielded mixed TZB and TZE-SR-W. However, grain yield of

sole TZE-SR-W was statistically similar with those obtained in the crop mixtures with both maize varieties at crop proportions 67:33 and 75:25. In the 1985 wet season, maize grain yields were not significantly different in both sole and mixture except where maize was grown in alternate ridges with sorghum at crop proportion 50:50 which gave significantly lower yields than the sole crops.

4.1.2 Shelling percent of maize

Result obtained in 1984 on maize shelling percent revealed that neither maize variety, stand arrangement, crop proportion nor their interactions significantly influenced the shelling percent of maize (Table 4.1).

On the contrary, the 1985 data showed that the shelling percent of TZE-SR-W was significantly higher than for TZB (Table 4.1). Furthermore, crop proportion 67:33 gave lower shelling percent than 75:25 proportion but similar to 50:50 proportion (Table 4.1).

Table 4.1 The grain yield, shelling percent and 100-grain weight of maize in mixture with sorghum as affected by maize variety, crop proportion and stand arrangement (1984 and 1985 wet seasons)

Treatments	Grain Yield (kg/ha)		Shelling Percent (%)		100-grain weight (gm)	
	1984	1985	1984	1985	1984	1985
Maize Variety (V)						
TZB	2722.80	2323.50	76.55	61.89b	25.77	24.50
TZE-SR-W	2576.52	2317.71	76.97	67.08a	25.74	24.17
Mean	2649.66	2320.61	76.76	64.49	25.76	24.34
SE ±	184.36	91.134	0.397	0.967	0.298	0.418
LSD (5%)	NS	NS	NS	2.80	NS	NS
Crop Proportion (maize:sorghum)(P)						
50:50	2304.69b	2187.50c	77.05	63.68ab	24.99	23.69
67:33	3432.29a	2947.92b	77.18	62.99b	26.11	24.31
75:25	3801.79a	3218.75a	76.05	66.78a	26.17	25.00
Mean	3179.59	2784.72	76.76	64.48	25.76	24.33
SE ±	225.79	106.351	0.486	1.186	0.366	0.51
LSD (5%)	652.04	153.56	NS	3.43	NS	NS
Stand Arrangement (A)						
Alternate ridge	2653.36	2671.88b	76.88	65.13	25.96	23.63b
Within ridge	2645.96	2897.57a	76.63	63.84	25.55	25.04a
Mean	2649.66	2784.73	76.76	64.49	25.75	24.34
SE ±	184.36	86.835	0.397	0.967	0.298	0.418
LSD (5%)	NS	125.36	NS	NS	NS	1.21
Interactions						
VxP	NS	NS	NS	NS	**	NS
VxA	NS	NS	NS	NS	NS	NS
PxA	NS	NS	NS	NS	NS	NS
PxVxA	NS	NS	NS	NS	NS	NS

NS = Not significant. *Significant at 5% level of probability.
**Significant at 5% level of probability.

Table 4.2 Effect of proportion, stand arrangement and maize variety on grain yield (kg/ha)* of maize in mixture with sorghum (1984 and 1985 wet seasons)

Treatment***	Maize grain yield (kg/ha)**	
	1984	1985
Sole TZB (V_1)	5604.17a	4468.75a
Sole TZE-SR-W	4423.75ab	4552.08a
$P_1V_1A_1$	2552.08c-e	2062.50b
$P_1V_1A_2$	2166.67e	2415.67ab
$P_1V_2A_1$	2354.17de	2041.67b
$P_1V_2A_2$	2145.79e	2229.17ab
$P_2V_1A_1$	3645.60bc	2750.00ab
$P_2V_1A_2$	3593.75bc	3208.34ab
$P_2V_2A_1$	3250.00b-e	2875.00ab
$P_2V_2A_2$	3239.59b-e	2958.34ab
$P_3V_1A_1$	3437.50b-d	3093.75ab
$P_3V_1A_2$	4208.33b	3197.92ab
$P_3V_2A_1$	3864.58b	3208.33ab
$P_3V_2A_2$	3696.75bc	3372.00ab
Mean	3441.62	3031.07
SE ±	447.715	779.460

* Means of four replications

**Means followed by same letter in a column are not significantly different at 5% level of probability (DMRT)

*** P_1 = 50:50 maize:sorghum
P_2 = 67:33 maize:sorghum
P_3 = 75:25 maize:sorghum
A_1 = Alternate ridge arrangement
A_2 = Within ridge arrangement
V_1 = TZB maize variety
V_2 = TZE-SR-W maize variety

4.1.3 The 100-grain weight of maize

In 1984, there was significant interaction between crop proportion and maize variety (Table 4.3). As proportion of TZB increased in the mixture from 50:50 to 67:33 (maize: sorghum), the 100-grain weight increased. Further increment of maize proportion to 75:25 did not influence the 100-grain weight. On the other hand, increasing the proportion of TZE-SR-W maize variety in the crop mixture did not affect the 100-grain weight.

Table 4.3 The 100-grain weight (gm)* of maize in mixture with sorghum as affected by crop proportion, and maize variety (1984 wet season)

Crop proportion (maize:sorghum)	Maize Variety **		
	TZB	TZE-SR-W	Mean
50:50	24.37b	25.61ab	24.99
67:33	26.82a	25.41ab	26.12
75:25	26.13ab	26.22ab	26.18
Mean	25.17	25.75	
SE ±	0.518		

*Means of four replications

**Means followed by same letter in both row and column are not significantly different at 5% level of probability (DMRT)

However, only the main effect of stand arrangement was significant in 1985 where the within ridge arrangement gave heavier 100-grain weight than in the alternate ridges (Table 4.1).

4.2 Number of Component Maize Plants, Lodging Percent and Number of Cobs of Maize

4.2.1 Number of component maize plants per square metre

Number of maize plants per square metre harvested significantly increased as the crop proportion of maize increased from 50:50 to 75:25 through 67:33 in both years (Table 4.4).

4.2.2 Lodging percent of maize

Results obtained on the lodging incidence of maize in both seasons are presented in Table 4.4. Only the effect of maize variety was significant. There was more lodging with TZE-SR-W than with TZB.

4.2.3 Number of cobs per square metre

Number of cobs per square metre of maize increased as the proportion of maize in the mixture increased in both years (Table 4.4). However, variety and stand arrangement had no significant effect on the number of cobs per square metre in both years.

Table 4.4 The number of plants per metre square, loding percent and number of cobs per metre square of maize in mixture with sorghum as affected by maize variety, crop proportion and stand arrangement (1984 and 1985 wet seasons).

Treatment	No. of plants/m^2		Loding percent (%)		No. of cobs/m2	
	1984	1985	1984	1985	1984	1985
Maize Variety (V)						
TZB	3.97	4.07	31.52b	33.65b	4.68	4.13
TZE-SR-W	4.06	4.05	37.72a	40.72a	4.70	4.05
Mean	4.02	4.06	34.50	37.19	4.69	4.09
SE ±	0.043	0.04	1.871	1.572	0.117	0.039
LSD (5%)	NS	NS	5.40	4.54	NS	NS
Crop Proportion (maize:sorghum) (P)						
50:50	2.99c	3.10c	32.16	38.02	3.76c	3.10c
67:33	4.22b	4.27b	33.70	35.26	4.80b	4.27b
75:25	4.83a	4.90a	37.62	38.28	5.51a	4.90a
Mean	4.01	4.049	34.49	37.19	4.69	4.09
SE ±	0.054	0.14	2.29	1.876	0.143	0.049
LSD (5%)	0.15		NS	NS	0.412	0.141
Stand Arrangement (A)						
Alternate ridge	4.03	4.07	36.37	36.88	4.66	4.07
Within ridge	4.01	4.11	33.62	37.49	4.72	4.11
Mean	4.07	4.09	35.00	27.19	4.69	4.09
SE ±	0.043	0.04	1.871	1.572	-0.117	0.039
LSD (5%)	NS	NS	NS	NS	NS	NS
Interactions						
VxP	NS	NS	NS	NS	NS	NS
VxA	NS	NS	NS	NS	NS	NS
PxA	NS	NS	NS	NS	NS	NS
PxVxA	NS	NS	NS	NS	NS	NS

NS = not significant

4.3 Cob Weight Per Plant, Plant Height, Plant Girth and Straw Yield of Maize

4.3.1 Cob weight of maize per plant

In both years, cob weight per plant was only affected by maize variety (Table 4.5). TZB maize variety produced significantly heavier cobs than the TZE-SR-W.

4.3.2 Plant height of maize at 12 weeks after planting

For the plant height of maize at 12 weeks after planting in 1984 there was significant interaction between maize variety and crop proportion on one hand and maize variety and stand arrangement on the other (Tables 4.6 and 4.7). The plant height of TZB and TZE-SR-W was statistically similar at crop proportions 50:50 and 67:33. TZB at 75:25 produced significantly taller plants than the other treatments except for TZB at 67:33 crop proportion (Table 4.6). Maize variety TZE-SR-W produced shorter plants in the within ridges. There was no significant difference between plant height of TZB maize at both stand arrangement (Table 4.7).

In 1985 wet season, the plant height of maize was the same irrespective of maize variety, crop proportion and stand arrangement (Table 4.5).

Table 4.5 The cob weight per plant, plant height, plant girth and straw yield of maize in mixture with sorghum as affected by maize variety, crop proportion and stand arrangement in the 1984 and 1985 wet seasons.

Treatment	Cob weight/plant 1984	1985	Plant height at 12 WAP 1984	1985	Plant girth at 12 WAP 1984	1985	Straw yield at 12 WAP 1984	1985
Maize variety (V)								
TZB	0.043a	0.184a	164.96	212.29	7.25a	7.09	167.17	353.94
TZE-SR-W	0.038b	0.174b	155.21	212.96	6.56b	7.25	163.58	315.12
Mean	0.041	0.179	160.09	212.63	6.91	7.17	165.38	334.53
SE ±	0.002	0.005	2.870	4.980	0.134	0.084	2.541	5.731
LSD (5%)	1.05×10^{-5}	0.014	NS	NS	0.39	NS	NS	NS
Crop Proportion (maize:sorghum)(P)								
50:50	0.039	0.190a	154.56	212.06	7.03	7.18	190.54	313.31
67:33	0.039	0.181ab	160.25	213.94	6.95	7.17	151.50	349.07
75:25	0.041	0.165b	165.44	211.88	6.74	7.17	154.08	341.20
Mean	0.040	0.171	160.08	212.63	6.91	7.17	165.37	334.53
SE ±	0.002	0.005	3.517	6.100	0.164	0.103	3.112	7.019
LSD (5%)	NS	0.01	NS	NS	NS	NS	NS	NS
Stand Arrangement (A)								
Alternate ridge	0.040	0.171b	164.46a	212.29	6.72	7.17	164.31	342.28a
Within ridge	0.040	0.187a	155.71b	212.96	7.10	7.18	166.44	326.77b
Mean	0.040	0.179	160.09	212.63	6.91	7.18	165.38	334.53
SE ±	0.002	0.005	2.87	4.980	0.134	0.084	2.541	5.731
LSD	NS	0.014	NS	NS	NS	NS	NS	16.55
Interactions								
V x P	NS	NS	*	NS	NS	NS	NS	*
V x A	NS	NS	*	NS	NS	NS	NS	NS
P x A	NS	NS	NS	NS	NS	NS	NS	NS
P x V x A	NS	NS	NS	NS	NS	NS	**	NS

* NS = Not significant *Significant at 5% level of probability **Significant at 1% level of probability.

Table 4.6 The plant height (cm)* of maize in mixture with sorghum at 12 WAP** as affected by crop proportion and maize variety (1984 wet season).

Crop proportion (maize:sorghum)	Maize variety***		Mean
	TZB	TZE-SR-W	
50:50	154.75b	154.38b	154.47
67:33	163.75ab	156.75b	146.75
75:25	176.38a	154.50b	165.44
Mean	164.96	155.21	
SE ±	4.973		

*Means of four replications

**Weeks after planting

***Means followed by same letter in both raw and column are not significantly different at 5% level of probability (DMRT).

Table 4.7 The plant height (cm)* of maize in mixture with sorghum at 12 WAP** as affected by stand arrangementand maize variety (1984 wet season).

Stand Arrangement	Maize Variety***		Mean
	TZB	TZE-SR-W	
Alternate ridge	166.33a	163.58a	164.96
Within ridge	162.58a	147.83b	155.21
Mean	164.46	155.71	
SE±	4.061		

*Means of four replications

**Weeks after planting

***Means followed by same letter in both row and column are not significantly different at 5% level of probability (DMRT).

4.3.3 Plant girth of maize at 12 weeks after planting

Only the main effect of maize variety was significant in 1984 wet season. TZE-SR-W produced plants with significantly thinner stems than TZB at 12 weeks after planting (Table 4.5).

In 1985 wet season, however, no significant difference was observed within and between crop proportion, variety and stand arrangement.

4.3.4 Straw yield of maize at 12 weeks after planting

The interaction between maize variety, crop proportion and stand arrangement regarding the straw yield was significant in 1984 (Table 4.8). There was tendency for the straw yield of maize to decrease with increased crop proportion for TZB in alternate ridge. Nevertheless, no such difference was observed with TZE-SR-W in alternate ridge and TZB in the within ridge arrangement.

In 1985, better straw yield was obtained in alternate ridge than with the within ridge arrangement (Table 4.5). There was also significant interaction between maize variety and crop proportion (Table 4.9). TZE-SR-W at crop proportion 50:50 produced significantly lower straw yield than at the other proportions.

Table 4.8 The straw yield (kg/ha)* of maize in mixture with sorghum at 12 WAP** as affected by crop proportion stand arrangement and maize variety (1984 wet season).

Crop proportion (maize:sorghum)	Stand Arrangement***				
	Alternate Ridge		Within Ridge		
	TZB	TZE-SR-W	TZB	TZE-SR-W	Mean
50:50	197.73b	156.02cd	155.34cd	250.09a	190.55
67:33	186.10bc	155.10d	152.78d	112.04e	151.51
75:25	144.69d	146.20d	163.38cd	162.04cd	154.08
Mean	176.17	152.44	157.17	174.72	
SE ±	6,224				

*Means of four replications

**Weeks after planting

***Means followed by same letter in both row and column are not significantly different at 5% level of probability (DMRT)

Table 4.9 Straw yield (kg/ha)* of maize in mixture with sorghum at 12 WAP** as affected by crop proportion and maize variety (1985 wet season).

Crop proportion (maize:sorghum)	Maize Variety***		Mean
	TZB	TZE-SR-W	
50:50	345.14a	281.48b	313.31
67:33	358.33a	339.81a	331.94
75:25	358.33a	324.07a	341.20
Mean	353.93	315.12	
SE ±			

*Means of four replications

**Weeks after planting

***Means followed by same letter in both row and column are not significantly different at 5% level of probability (DMRT)

4.4 Grain Yield, Threshing Percent and 1000-Grain Weight of Sorghum

4.4.1 Grain yield of sorghum

In 1984, grain yield of sorghum was highly influenced by crop proportion (Table 4.10). There was significantly lower sorghum grain yield as sorghum proportion was decreased from 50:50 to 75:25 (maize:sorghum).

Stand arrangement also influenced sorghum grain yield (Table 4.10). Yields obtained in alternate ridge arrangement were significantly higher than the within ridge arrangement.

In 1985, there was interaction between crop proportion, variety and stand arrangement (Table 4.11). At 50:50 crop proportion. Sorghum grain in mixture with TZE-SR-W within ridge produced inferior grain yield to TZB and TZE-SR-W in alternate ridge.

Comparison of grain yield of sorghum in sole and mixture with maize for both years is presented in Table 4.12. Grain yield of sorghum was significantly higher in sole than in mixture in 1984. Mixtures at crop proportion 67:33 and 75:25 (maize:sorghum) gave statistically similar sorghum yields.

In 1985, sorghum grain yield in mixture with TZB and TZE-SR-W in alternate ridge at crop proportion 50:50, and with TZE-SR-W in alternate ridge arrangement at 67:33 proportion were statistically similar to the sole crop yield (Table 4.12).

Table 4.10 The grain yield, threshing percent and 1000-grain weight of sorghum in mixture with maize as affected by maize variety, crop proportion and stand arrangement (1984 and 1985 wet seasons)

Treatment	Grain yield (kg/ha)		Threshing %		1000-grain weight (gm)	
	1984	1985	1984	1985	1984	1985
Maize variety (V)						
TZB	1692.71	1710.07	66.77	77.80	41.67	43.29
TZE-SR-W	1921.30	1834.49	70.59	74.07	41.50	42.38
Mean	1807.01	1772.28	68.68	75.94	41.59	42.34
SE ±	79.510	76.264	1.461	1.947	0.825	0.745
LSD	NS	NS	NS	NS	NS	NS
Crop Proportion (maize:sorghum)(P)						
50:50	2426.29a	1983.51	69.09	74.60	40.51	43.10
67:33	1818.58b	1875.00	70.71	78.32	41.21	42.39
75:25	1176.21c	1458.33	66.25	74.89	43.03	43.02
Mean	1807.03	1772.28	68.68	75.94	41.58	42.84
SE ±	97.377	93.404	1.789	2.384	1.010	0.912
LSD	281.21	NS	NS	NS	NS	NS
Stand Arrangement (A)						
Alternate ridge	1924.19a	2013.89	70.05	78.83	41.99	41.57b
Within ridge	1689.81b	1530.67	67.31	73.04	41.18	44.10a
Mean	1807.00	1772.28	68.68	75.94	41.59	42.84
LSE ±	79.51	79.264	1.461	1.947	0.825	0.745
LSD	229.61	NS	NS	NS	NS.	2.15
Interactions						
V x P	NS	NS	NS	NS	NS	NS
V x A	NS	NS	*	NS	NS	NS
P x A	NS	NS	NS	NS	NS	NS
P x V x A	NS	*	NS	NS	NS	NS

NS = Not significant

*Significant at 5% level of probability

Table 4.11 The grain yield* (kg/ha) of sorghum in mixture with maize as affected by crop proportion, stand arrnagement and maize variety (1985 wet season).

Crop proportion (maize:sorghum)	Stand Arrangement**				
	Alternate Ridge		Within Ridge		
	TZB	TZE-SR-W	TZB	TZE-SR-W	Mean
50:50	2378.47a	2326.39a	1909.72ab	1319.44bc	1983.51
67:33	1822.92ab	2222.22a	1545.14abc	1909.72ab	1875.00
75:25	1666.67abc	1666.68abc	937.50c	1562.60abc.	1458.34
Mean	1956,02	2071.76	1464.12	1597.22	
SE ±	186.807				

* Means of four replications

**Means followed by same letter in both row and column are not significantly different at 5% level of probability (DMRT).

Table 4.12 Effect of crop proportion, stand arrangement and maize variety on the grain yield (kg/ha)* of sorghum in mixture with maize with maize (1984 and 1985 wet seasons).

Treatment***	Grain yield (kg/ha) ** 1984	1985
Sole sorghum	4322.92a	3107.64a
$P_1V_1A_1$	2517.36bc	2378.47ab
$P_1V_1A_2$	1909.72b-e	1909.72bc
$P_1V_2A_1$	2812.50b	2326.39ab
$P_1V_2A_2$	2465.28bc	1319.44cd
$P_2V_1A_1$	1909.72b-e	1822.92b-d
$P_2V_1A_2$	1510.42cde	1545.14bcd
$P_2V_2A_1$	1718.75b-e	2222.22abc
$P_2V_2A_2$	2135.42bcd	1902.72b-c
$P_3V_1A_1$	1215.28de	1667.67cd
$P_3V_1A_2$	1093.75de	937.50d
$P_3V_2A_1$	1371.53de	1666.67cd
$P_3V_2A_2$	1024.31e	1562.50bcd
Mean	2000.54	1874.54
SE ±	226.750	204.290

*Means of four replications

**Means followed by same letter in a column are not significantly different at 5% level of probability (LMRT)

*** P_1 = 50:50 maize:sorghum
P_2 = 67:33 maize:sorghum
P_3 = 75:25 maize:sorghum
A_1 = Alternate ridge arrangement
A_2 = Within ridge arrangement
V_1 = TZB maize variety
V_2 = TZE-SR-W maize variety

4.4.2 Threshing percent of sorghum

In 1984, the threshing percent of sorghum showed interaction between maize variety and stand arrangement (Table 4.13). The threshing percent of sorghum in mixture with TZE-SR-W maize was statistically similar irrespective of stand arrangement. Similar result was obtained with TZB. However, the threshing percent of sorghum in the within ridge arrangement was significantly lower with TZB than TZE-SR-W.

Table 4.13 The threshing percent*(%) of sorghum in mixture with maize as affected by stand arrangement and variety (1984 wet season).

	Maize Variety**		
Stand Arrangement	TZB	TZE-SR-W	Mean
Alternate ridge	69.75ab	70.53a	70.14
Within ridge	63.79b	70.83a	67.31
Mean	66.77	70.63	
SE ±	2.066		

*Means of four replications

**Means followed by same letter in both row and column are not significantly different at 5% level of probability (LSD)

Result obtained in 1985 (Table 4.10) showed no significant interaction between variety, proportion and stand arrangement.

4.4.3 The 1000-grain Weight of Sorghum

The effect of maize variety, crop proportion, stand arrangement or their interactions was not significant in 1984 for the 1000-grain weight of sorghum (Table 4.10). In 1985 however, only stand arrangement significantly influenced the 1000-grain weight of sorghum (Table 4.10). Sorghum intercropped with maize within ridge produced heavier grains than in alternate ridges.

4.5 Number of component Sorghum Plants, Lodging Percent and Number of Panicles of Sorghum

4.5.1 Number of component sorghum plants per square metre

The number of plants per square metre of sorghum in mixture with maize was significantly influenced by the crop proportion in 1984 and 1985 wet seasons (Table 4.14). Number of sorghum plants decreased as the proportion of sorghum in the mixture decreased.

4.5.2 Lodging Percent of sorghum

There was significant interaction between crop proportion, maize variety and stand arrangement in 1984 regarding the lodging percent of sorghum (Table 4.15). At crop proportion 50:50, sorghum mixed with TZE-SR-W on alternate ridges did not lodge as much as those mixed with TZB or TZE-SR-W intercropped within ridges. On the other hand, at crop proportion 67:33, sorghume mixed with TZB in alternate ridges did not lodge as much as those mixed with TZB and TZE-SR-W within ridge.

Table 4.14 The number of plants per metre square, lodging percent and number of panicles per metre square of sorghum in mixture with maize as affected by crop proportion, stand arrangement and maize variety (1984 and 1985 wet seasons).

	No. of plants/m^2		Lodging %		No. of panicles /m^2	
Treatment	1984	1985	1984	1985	1984	1985
Maize variety(V)						
TZB	2.12	2.17	41.56	27.95	2.03	1.99
TZE-SR-W	2.18	2.20	33.71	28.04	2.05	1.98
Mean	2.15	2.19	37.67	28.00	2.04	1.99
SE ±	0.041	0.058	2.37	2.450	0.048	0.038
LSD (5%)	NS	NS	NS	NS	NS	NS
Crop Proportion (maize:sorghum) (P)						
50:50	2.93a	2.94a	29.26	30.73	2.81a	2.75a
67:33	2..02b	2.06b	36.33	29.30	1.91b	1.87b
75:25	1.49c	1.55c	47.40	23.96	1.40c	1.33c
Mean	2.15	2.18	37.66	28.00	2.04	1.98
SE ±	0.051	0.071	2.90	2.998	0.058	0.047
LSD (5%)	0.146	2.31	NS	NS	0.17	0.135
Stand Arrangement (A)						
Alternate ridge	2.18	2.05	25.79	20.79	2.03	1.96
Within ridge	2.12	2.18	49.53	35.20	2.05	2.01
Mean	2.15	2.12	37.66	28.00	2.04	1.99
SE ±	0.041	0.058	2.370	2.450	0.048	0.038
LSD (5%)	NS	NS	NS	NS	NS	NS
Treatment Interactions						
V x P	NS	NS	NS	NS	NS	NS
V x A	NS	NS	NS	NS	NS	NS
P x A	NS	NS	NS	*	NS	NS
P x V x A	NS	NS	*	NS	NS	NS

NS = Not significant * Significant at 5% level of probability
** Significant at 1% level of probability.

Table 4.15 The loding percent* (%) of sorghum in mixture with maize as affected by crop proportion, stand arrangement and maize variety (1984 wet season)

Crop proportion (maize:sorghum)	Stand Arrangement**				
	Alternate Ridge		Within Ridge		
	TZB	TZE-SR-W	TZB	TZE-SR-W	Mean
50:50	24.27bcd	17.71d	38.07bc	38.07bc	29.26
67:33	21.88cd	24.22bc	48.44ab	48.44ab	36.33
75:25	37.50bc	29.17bcd	79.19a	79.17a	47.40
Mean	27.34	23.70	55.23	55.22	
SE ±	5.808				

* Means of four replications

**Means followed by same letter in both row and column are not significantly different at 5% level of probability (DMRT)

Significant interaction was found between crop proportion and stand arrangement in 1985 (Table 4.16). Lodging was significant when sorghum was intercropped with maize in the within ridge arrangement as compared to the alternate ridges at crop proportion 50:50 and 67:33, such difference was not observed at crop proportion 75:25.

Table 4.16 The lodging percent (%) of sorghum in mixture with maize as affected by crop proportion and stand arrangement (1985 wet season)

Crop proportion (maize:sorghum)	Stand Arrangement**		
	Alternate Ridge	Within Ridge	Mean
50:50	21.25b	39.59a	30.42
67:33	17.58b	41.02a	29.30
75:25	22.92b	25.00ab	23.96
Mean	20.58	35.20	
SE±	3.84		

* Means of four replications.

** Means followed by same letter in both row and column are not significantly different at 5% level of probability (DMRT)

4.5.3 Number of sorghum panicles per square metre

In both 1984 and 1985 wet seasons, only the main effects of crop proportion produced significant difference on the number of sorghum panicles (Table 4.14). There was significant decrease in number of panicles per square metre as the proportion of sorghum in the mixture decreased.

4.6 Panicle Weight Per Plant, Plant Height, Plant Girth and Straw Yield of Sorghum

4.6.1 Panicle weight of sorghum per plant

Results obtained in 1984 (Table 4.17) showed that neither maize variety, crop proportion, stand arrangement nor their interactions had effect on the panicle weight per plant of sorghum.

In 1985 wet season, significant interaction was observed between maize variety, crop proportion and stand arrangement (Table 4.18). Only sorghum mixed with TZB in both stand arrnagements and with TZE-SR-W in the within ridge arrangements at 50:50 proportion produced significantly lower panicle weight than TZE-SR-W in the within ridge arrangement at 75:25 proportion. Other treatments were statistically similar.

Table 4.17 The panicle weight per plant, plant height, plant girth and straw yield of sorghum in mixture with maize as affected by maize variety, crop proportion and stand arrangement (1984 and 1985 wet seasons).

Treatment	Panicle weight/ plant		Plant height at 12 WAP		Plant girth at 12 WAP		Straw yield at 12 WAP	
	1984	1985	1984	1985	1984	1985	1984	1985
Maize Variety (V)								
TZB	0.187	0.101	101.04	179,33b	7.34	8.44	86.26	184.59
TZE-SR-W	0.151	0.124	104.42	190.42a	7.33	8.03	95.89	192.52
Mean	0.169	0.113	102.73	184.88	7.34	8.24	91.08	188.56
SE±	0.038	0.007	3.711	3.124	0.164	0.223	2.090	5.725
LSD (5%)	NS	NS	NS	9.02	NS	NS	NS	NS
Crop Proportion (maize:sorghum)(P)								
50:50	0.118	0.088	102.88	191.31a	7.77a	7.90	102.36	186.95
67:33	0.178	0.112	106.69	190.13a	7.08b	8.29	80.36	183.45
75:25	0.211	0.137	98.63	173.19b	7.17b	8.52	90.50	195.26
Mean	0.169	0.112	102.73	184.88	7.34	8.24	91.07	188.55
SE ±	0.046	0.008	3.214	3.83	0.201	0.225	2.57	7.012
LSD (5%)	NS	NS	NS	11.05	0.58	NS	NS	NS
Stand Arrangement (A)								
Alternate ridge	0.123	0.118	100.13	179.17b	7.36	10.31a	92.27	212.89a
Within ridge	0.214	0.107	105.33	190.42a	7.34	6.17b	89.88	164.22b
Mean	0.169	0.113	102.73	184.80	7.35	8.24	91.08	188.56
SE±	0.038	0.007	3.711	3.124	0.164	0.223	2.090	5.725
LSD (5%)	NS	NS	NS	9.02	NS	0.65	NS	16.53
Interaction								
V x P	NS	NS	NS	NS	NS	NS	*	NS
V x A	NS	NS	*	NS	NS	NS	*	NS
P x A	NS	NS	NS	NS	NS	NS	NS	NS
P x V x A	NS	*	NS	*	NS	NS	NS	NS

NS = Not significant *Significant at 5% level of probability

Table 4.18 The panicle weight (kg/plant)*of sorghum in mixture with maize as affected by crop proportion, stand arrangement and maize variety (1985 wet season).

Crop proportion (maize:sorghum)	Stand Arrangement **			
	Alternate Ridge		Within Ridge	
	TZB	TZE-SR-W	TZB	TZE-SR-W
50:50	0.093b	0.108ab	0.088b	0.063b
67:33	0.108ab	0.130ab	0.085b	0.128ab
75:25	0.133ab	0.138ab	0.100ab	0.178a
Mean	0.111	0.125	0.091	0.123
$SE_{\pm}$	0.016			

* Means of four replications

**Means followed by same letter in both row and column are not significantly different at 5% level of probability (DMRT)

4.6.2 Plant height of sorghum at 12 weeks after planting

In 1984, data on the height of sorghum at 12 weeks after planting showed the only significant interaction between variety and stand arrangement (Table 4.19). Sorghum mixed with maize variety TZB in the within ridge arrangement grew significantly taller than same variety in alternate ridges. Nevertheless, plant height of sorghum mixed with TZE-SR-W produced plants with statistically similar height to those with TZB.

Table 4.19 The plant height (cm)* of sorghum in mixture with maize at 12 WAP** as affected by stand arrangement and maize variety (1984 wet season)

Stand Arrangement	Mixed Variety***		
	TZB	TZE-SR-W	Mean
Alternate ridge	95.50b	104.75ab	100.13
Within ridge	106.58a	104.08ab	105.33
Mean	101.04	104.42	
SE ±	3.711		

*Means of four replications

**Weeks after planting
***Means followed by same letter in both row and column are not significantly different at 5% level of probability (LSD)

Results obtained in the 1985 wet season showed significant interaction between variety, crop proportion and stand arrangement (Table 4.20). Generally, at all the three levels of proportion, the plant height of sorghum was statistically similar irrespective of maize variety and stand arrangement. An exception was TZB at 75:25 proportion in the within ridge arrangement where sorghum plants were significantly shorter than in other treatments.

Table 4.20 The plant height (cm)* of sorghum in mixture with maize at 12 WAP** as affected by crop proportion, stand arrangement and maize variety (1985 wet season)

Crop proportion (maize:sorghum)	Stand Arrangement***				
	Alternate Ridge		Within Ridge		
	TZB	TZE-SR-W	TZB	TZE-SR-W	Mean
50:50	185.50a	187.25a	198.50a	194.00a	191.31
67:33	168.50a	189.25a	198.50a	204.25a	190.13
75:25	174.25a	170.25a	150.75b	197.50a	173.19
Mean	176.08	182.25	182.58	198.58	
$SE_{\pm}$	7.658				

*Means of four replications
**Weeks after planting
***Means followed by same letter in both row and column are not significantly different at 5% level of probability (DMRT)

4.6.3 Plant Girth of sorghum at 12 weeks after planting

Results of the main effect of crop proportion on the plant girth of sorghum in mixture with maize in the 1984 wet season are presented in table 4.17. Crop proportion 50:50 produced significantly thicker plants of sorghum than these at 67:33 and 75:25. Proportions 67:33 and 75:25 produced statistically similar plant girth.

In 1985 wet season, only the main effect of stand arrangement was observed (Table 4.17). Sorghum plants in mixture with maize were significantly thicker in alternate ridge arrangement than those in the within ridge.

4.6.4 Straw yield of sorghum at 12 weeks after planting

Data obtained in the 1984 wet season on the straw yield of sorghum at 12 weeks after planting showed significant interaction between variety and crop proportion (Table 4.21). While there was no significant difference in the straw yield of sorghum in mixture with maize varieties in the 50:50 and 67:33 proportions, crop proportion 75:25 gave significant difference with sorghum grown with TZB producing significantly lower straw yield at 67:33 and 75:25 proportions than at 50:50 proportion. With TZE-SR-W maize variety, however, crop proportion 50:50 and 75:25 gave significantly higher straw yield than 67:33 proportion.

Table 4.21 The straw yield(kg/ha)* of sorghum in mixture with maize at 12 WAP as affected by maize variety and crop proportion (1984)

Crop proportion (maize:sorghum)	Maize variety ***		Mean
	TZB	TZE-SR-W	
50:50	98.24a	106.48a	102.36
67:33	80.39b	80.32b	80.36
75:25	80.14b	100.86a	90.50
Mean	86.26	95.89	
SE±	3.628		

*Means of four replications

**Weeks after planting

***Means followed by same letter in both row and column are not significantly different at 5% level of probability (DMRT).

Significant interaction was also found between maize variety and stand arrangement in 1984 wet season (Table 4.22). Results showed that sorghum intercropped with maize in alternate ridge arrangement produced significantly higher straw yield. On the other hand, significantly higher straw yield of sorghum was obtained with TZE-SR-W maize variety than TZB in the within ridge arrangement.

Table 4.22 The straw yield (kg/ha)* of sorghum in mixture with maize at 12 WAP** as affected by maize variety and stand arrangement (1984 wet season)

Stand Arrangement	Maize Variety ***		
	TZB	TZE-SR-W	Mean
Alternate ridge	89.80abc	94.74ab	92.27
Within ridge	82.72c	97.04a	89.88
Mean	86.26	95.89	
SE ±	2.962		

*Means of four replications

**Weeks after planting

***Means followed by same letter in both row and column are not significantly different at 5% level of probability (LSD)

In 1985 wet season, only the main effect of stand arrangement was significant (Table 4.17). Result showed that sorghum intercropped with maize in the alternate ridge arrangement produced significantly higher straw yield than in the within ridge arrangement.

4.7 Association Among Plant Characters

4.7.1 Correlation among plant characters of maize

In the 1984 wet season, maize grain yield was highly associated with the number of plants and cobs per metre square and also the cob weight per plant and one hundred-grain weight (Table 4.23). The number of plants per square metre was significantly and positively correlated with number of cobs per square metre. The one hundred-grain weight was also positively correlated with the cob weight per plant and the shelling percent.

In 1985 as in 1984, the grain yield of maize was significant and highly correlated with the number of plants per square metre, number of cobs per square metre, cob weight per plant and the one hundred-grain weight (Table 4.24) Similarly, the number of plants per square metre was also positively and highly correlated with the number of cobs per square metre and cob weight per plant. But unlike in 1984, the one hundred-grain weight was negatively associated with plant girth while the straw yield was positively associated with the number of plants per square metre.

Table 4.23 Correlation matrix for maize plant characters (1984 wet season)

	GY	PH	PG	SY	NP	CN	CW	GW	SP	LP
GY	1.000									
PH	0.219	1.000								
PG	-0.099	0.301*	1.000							
SY	-0.339*	-0.199	0.231	1.000						
NP	0.703**	0.255	-0.113	-0.404**	1.000					
CN	0.721**	0.101	-0.056	-0.448**	0.751**	1.000				
CW	0.548**	0.004	0.033	0.016	-0.031	0.261	1.000			
GW	0.606**	0.061	0.117	-0.052	0.239	0.211	0.340*	1.000		
SP	0.110	0.035	-0.072	-0.021	-0.193	-0.135	-0.095	0.334*	1.000	
LP	0.135	0.018	-0.310*	-0.235	0.181	0.143	-0.008	0.155	0.70	1.000

GY = Grain Yield (kg/ha)
PH = Plant height at 12 WAP
PG = Plant girth at 12 WAP
SY = Straw yield at 12 WAP
NP = Number of plants/m^2
CN = Number of cobs/m^2
CW = Cob weight /plant
GW = 100-grain weight (gm)
SP = Shelling percent
LP = Lodging percent
* = Significant at 5% level of probability
** = Significant at 1% level of probability

Table 4.24: Correlation matrix for maize plant characters (1985 wet season)

	GY	PH	PG	SY	NP	CN	CW	GW	SP	LP
GY	1.000									
PH	0.102	1.000								
PG	0.024	0.215	1.000							
SY	0.268	-0.203	-0.199	1.000						
NP	0.804**	-0.006	-0.043	0.407**	1.000					
CN	0.852**	0.075	0.014	0.275	0.878**	1.000				
CW	0.448**	0.077	0.001	-0.197	-0.470**	0.214	1.000			
GW	0.439**	-0.002	-0.314*	-0.187	0.238	0.266	0.267	1.000		
SP	0.169	0.191	0.222	-0.150	0.199	0.111	-0.520**	-0.081	1.000	
LP	0.059	0.141	0.124	-0.165	-0.049	0.053	-0.126	-0.046	0.534**	1.000

GY = Grain yield (kg/ha)
PH = Plant height at 12 WAP
PG = Plant girth at 12 WAP
SY = Straw yield at 12 WAP
NP = Number of plants/m^2
CN = Number of cobs/m^2
CW = Cob weight/plant
GW = 100-grain weight (gm)
SP = Shelling percent
LP = Lodging percent

* = Significant at 5% level of probability

** = Significant at 1% level of probability

4.7.2 Correlation among plant characters of sorghum

In the 1984 wet season, sorghum grain yield was positively and highly correlated with the number of plants and number of panicles per square metre and also with the panicle weight per plant, and threshing percent (Table 4.25). The plant girth was also positively correlated with the number of plants per square metre, while straw yield at 12 weeks after planting was positively correlated with number of plants and number of panicles per square metre. The number of plant per square metre was highly correlated with the number of panicle.

In 1985 as in 1984, the grain yield of sorghum was significant and highly associated with the number of plants, number of panicles per square metre with threshing percent (Table 4.26). Unlike 1984, the grain yield of sorghum was positively correlated with plant height and girth at 12 weeks after planting, while plant girth was highly and positively correlated with straw yield. On the other hand, plant girth was negatively correlated with the one-thousand-grain weight and lodging percent, while straw yield was also negatively correlated with lodging percent.

Table 4.25: Correlation matrix for sorghum plant characters (1984 wet season)

	GY	PH	PG	SY	NP	PN	PNW	GW	TP	LP
GY	1.000									
PH	0.045	1.000								
PG	0.272	0.179	1.000							
SY	0.180	0.143	0.174	1.000						
NP	0.761**	0.093	0.347*	0.385**	1.000					
PN	0.724**	0.062	0.247	0.402**	0.895**	1.000				
PNW	0.300**	-0.105	0.112	-0.141	-0.193	-0.286	1.000			
GW	0.029	0.087	0.096	-0.047	-0.224	-0.250	0.178	1.000		
TP	0.503**	-0.147	-0.058	-0.116	0.115	0.055	-0.091	0.192	1.000	
LP	-0.416**	0.090	0.090	-0.300	-0.376	-0.398**	0.342*	0.062	-0.357*	1.000

GY = Grain yield (kg/ha)
PH = Plant height at 12 WAP
PG = Plant girth at 12 WAP
SY = Straw yield at 12 WAP
NP = Number of plants/m^2
PN = Number of panicles/m^2
PNW= Panicle weight/plant
GW = 1000-grain weight (gm)
TP = Threshing percent
LP = Lodging percent

* = Significant at 5% level of probability

** = Significant at 1% level of probability

Table 4.26 Correlation matrix for sorghum plant characters (1985 wet season)

	GY	PH	PG	SY	NP	PN	PNW	GW	TP	LP
GY	1.000									
PH	0.288*	1.000								
PG	0.331*	-0.237	1.000							
SY	0.030	-0.005	0.362*	1.000						
NP	0.486**	0.250	0.064	-0.136	1.000					
PN	0.345*	0.345*	-0.119	-0.185	0.835**	1.000				
PNW	0.193	-0.058	0.172	0.111	-0.522**	0.528**	1.000			
GW	-0.293*	-0.112	-0.370*	-0.125	-0.042	0.084	-0.148	1.000		
TP	0.457**	0.049	0.218	0.102	0.028	-0.047	-0.167	-0.078	1.000	
LP	-0.056	0.122	-0.486	-0.046	0.027	0.193	-0.314*	0.020	0.082	1.000

GY = Grain yield (kg/ha)
PH = Plant height at 12 WAP
PG = Plant girth at 12 WAP
SY = Straw yield at 12 WAP
NP = Number of plants/m^2
PN = Number of panicles/m^2
PNW = Panicle weight/plant
GW = 1000-grain weight (gm)
TP = Threshing percent
LP = Lodging percent

* = Significant at 5% level of probability

** = Significant at 1% level of probability

4.8 Land Equivalent Ratio (LER)

4.8.1 Land equivalent ratio for the 1984 wet season

The LER for component maize in mixture for the 1984 wet season are presented in table 4.48. The LER of sole TZB and TZESRW were not significantly different from all mixture treatments at 75:25 crop proportion with the exception of TZB grown with sorghum in alternate ridge arrangement. TZESRW maize variety grown with sorghum in alternate ridge at crop proportion 67:33 also gave statistically similar LER to sole maize. There was no significant difference in LER among treatments within and between 50:50 and 67:33 crop proportions. An exception was TZESRW variety in both stand arrangements at 67:33 crop proportion which were significantly higher than treatments within 50:50 crop proportion.

All the mixture treatments produced significantly lower LER for sorghum relative to the sole crop (Table 4.48). There was no significant difference in LER of sorghum between 50:50 and 67:33 crop proportions. However, treatments within 50:50 proportion gave significantly higher LER than those of at 75:25.

Results of the combined LER for maize and sorghum in the 1984 wet season (Table 4.48) showed no significant difference between the sole crop and the various crop mixtures. TZB maize variety in the within ridge at crop proportion 50:50 nevertheless, gave a statistically less LER than the 25% given by TZESRW in the within ridge arrangement at crop proportion 57:33.

Table 4.27 Land equivalent ratio (LER)* for maize/sorghum based on the corresponding maize variety in sole and crop mixture (1984 wet season)

Treatments	LER for** maize	LER for** sorghum	Combined LER** for maize/ sorghum
Sole TZB (V_1)	1.00a	-	1.00ab
Sole TZE-SR-W (V_2)	1.00a	-	1.00ab
Sole sorghum	-	1.00a	1.00ab
$P_1V_1A_1$	0.47ef	0.60bc	1.07ab
$P_1V_1A_2$	0.38f	0.50b-e	1.88ab
$P_1V_2A_1$	0.53ef	0.67b	1.20ab
$P_1V_2A_2$	0.49ef	0.58b-d	1.07ab
$P_2V_1A_1$	0.65b-e	0.47b-f	1.12ab
$P_2V_1A_2$	0.64b-e	0.36c-f	1.00ab
$P_2V_2A_1$	0.75a-d	0.42b-f	1.17ab
$P_2V_2A_2$	0.74b-d	0.51b-e	1.25a
$P_3V_1A_1$	0.61c-e	0.30ef	0.91ab
$P_3V_1A_2$	0.77a-c	0.25f	1.02ab
$P_3V_2A_1$	0.89ab	0.34d-f	1.24ab
$P_3V_2A_2$	0.85a-c	0.25f	1.10ab
Mean	0.70	0.48	1.07
se ±	0.050	0.50	0.070

*Means of four replications

**Means followed by same letter in a column are not significantly different at 5% level of probability (DMRT)

P_1 = 50:50 maize:sorghum

P_2 = 67:33 maize:sorghum

P_3 = 75:25 maize:sorghum

A_1 = Alternate ridge arrangement

A_2 = Within ridge arrangement

V_1 = TZB

V_2 = TZE-SR-W

4.8.2 Land equivalent ratio for the 1985 wet season

In the 1985 wet season, there was significant difference between sole maize and mixture treatments (Table 4.49). While there was no significant difference among treatments within and between 67:33 and 75:25 crop proportions, mixtures with the alternate ridge arrangement at 50:50 crop proportion gave significantly lower maize LER than at the other crop proportions.

Sorghum grown in the mixture with both maize varieties in alternate ridge arrangement at crop proportion 50:50 together with sorghum grown with TZESRW in alternate ridge at 67:33 were the only crop mixtures that gave LER comparable to sole sorghum.

The combined LER for the mixture in 1985 (Table 4.49) showed that TZESRW arranged in alternate rows at crop proportion 67:33 gave the highest LER of 39% which was superior to those of sole crops.

Table 4.28 Land equivalent ratio(LER)* for maize/sorghum mixture based on the corresponding maize variety in sole crop and in mixture (1985 wet season).

Treatment	LER for maize**	LER for sorghum**	Combined LER for maize/ sorghum**
Sole TZB (V_1)	1.00a	-	1.00bc
Sole TZE-SR-W (V_2)	1.00a	-	1.00bc
Sole Sorghum	-	1.00a	1.00bc
$P_1V_1A_1$	0.47e	0.79ab	1.26ab
$P_1V_1A_2$	0.54c-e	0.62b-d	1.16a-c
$P_1V_2A_1$	0.45e	0.77ab	1.22a-c
$P_1V_2A_2$	0.50de	0.45d	0.94c
$P_2V_1A_1$	0.62b-d	0.60b-d	1.22a-c
$P_2V_1A_2$	0.72b	0.52cd	1.25a-c
$P_2V_2A_1$	0.64b	0.75a-c	1.39a
$P_2V_2A_2$	0.65bc	0.64b-d	1.30ab
$P_3V_1A_1$	0.70bc	0.55b-d	1.25a-c
$P_3V_1A_2$	0.72b	0.31e	1.03a-c
$P_3V_2A_1$	0.71b	0.57b-d	1.27a-c
$P_3V_2A_2$	0.74b	0.52cd	1.26a-c
Mean	0.68	0.62	1.17
SE ±	0.030	0.050	0.070

*Means of four replications

**Means followed by same letter in a column are not significantly different at 5% level of probability (DMRT)

P_1 = 50:50 maize:sorghum

P_2 = 67:33 maize:sorghum

P_3 = 75:25 maize:sorghum

A_1 = Alternate ridge arrangement

A_2 = Within ridge arrangement

V_1 = TZB

V_2 = TZE-SR-W

4. 9 Gross Returns of Maize and Sorghum in Sole and Mixed Crop

In the 1984 wet season, amongst the sole crops, sole TZB gave the highest gross return, followed by TZESRW while the least gross return was obtained from sole sorghum (Table 4.50). All the crop mixture treatments gave gross returns which were statistically similar to that of sole TZB. An exception is the within ridge arrangement of the component crop with TZB and TZESRW at the 50:50 crop proportion.

In the 1985 wet season (Table 4.50) sole TZB again produced significantly higher returns than sole sorghum but statistically similar to that of TZESRW. All the mixture treatments except TZESRW in both alternate and within ridge arrangement in crop proportion 50:50 produced gross returns that were as good as for sole TZB as for either of the maize variety.

Table 4.29 Gross Returns (₦)* of grain yield of maize and sorghum in sole and **mixture.**

Treatment	Gross Return(₦)** 1984 Wet season	1985 Wet season
Sole TZB (V_1)	3736.20a	3413.88a
Sole TZE-SR-W (V_2)	2949.20b	3351.49a
Sole sorghum	1815.77c	1553.88c
$P_1V_1A_1$	2758.77ab	2693.90ab
$P_1V_1A_2$	2443.37bc	2767.36ab
$P_1V_2A_1$	2750.65ab	2399.76bc
$P_1V_2A_2$	2465.51bc	2331.49bc
$P_2V_1A_1$	3222.20ab	2974.20ab
$P_2V_1A_2$	3030.21ab	3178.88a
$P_2V_2A_1$	2888.58ab	3267.30a
$P_2V_2A_2$	3026.51ab	3173.48a
$P_3V_1A_1$	2802.10ab	3153.69ab
$P_3V_1A_2$	3264.87ab	2867.01ab
$P_3V_2A_1$	3043.37ab	3239.53a
$P_3V_2A_2$	3804.49a	3312.51a
Mean	2933.45	2911.86
SE ±	226.77	147.257

* Means of four replications.
**Means followed by same letter in a column are not significantly different at 5% level of probability (DMRT)

P_1 = 50:50 maize:sorghum
P_2 = 67:33 maize:sorghum
P_3 = 75:25 maize:sorghum
A_1 = Alternate ridge arrangement
A_2 = Within ridge arrangement
V_1 = TZB
V_2 = TZE-SR-W

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Minimum guaranteed prices offered by Nigerian Grains Board were used for maize and sorghum. The prices for maize and sorghum for the 1984/85 and 1985/86 seasons were ₦400/ton, ₦450/ton and **₦450/ton**, ₦500/ton, respectively.

Chapter 5

DISCUSSION

5.1 Effect of Component Crop Proportion on the Maize/Sorghum Mixture

The grain yield of maize and sorghum increased significantly as their proportion in the mixture increased in both years. As expected, the number of plants per square metre increased as the proportion of a particular component crop increased. Increasing crop density has been found to result into higher grain yield upto a point after which further increase resulted into lower grain yields (Holliday, 1960 and Andrews, 1976). Ologunde and Ogunlela (1984) also reported that grain yield of maize responded curvilinearly to increase in plant density. Yunusa (1985) while working on maize/soyabean mixture observed that maize grain increased significantly with increase in its proportion in the mixture, while that of soyabean reduced with reduction in its proportion. In maize/sorghum mixture, Lere (1985) reported that the grain yield of both maize and sorghum was significantly influenced by their respective crop proportion in the mixture.

Highest productivity of the mixture was recorded with crop proportion 67:33 with a yield advantage of 25% amd 39% in 1984 and 1985 wet seasons, respectively. This agrees with Lere (1985) who reported better yield advantage with 2:1 (67:33) crop proportion.

Comparison of grain yield of maize showed that sole crop yields were similar to the mixture yields in 1985 wet season. The good performance of the mixture may be as a result of better rainfall which was recorded in 1985 than in 1984 wet season.

Plants of TZB maize variety grew taller as the crop proportion increased from 50:50 to 67:33. Such difference was not however observed with TZE-SR-W. The effect of crop proportion might be due to competition among maize plants that affected TZB maize variety resulting in taller plants' (Kumar et al. 1983). The effect of crop proportion on maize straw yield has been found to be influenced by variety. In 1984, straw yield decreased as the proportion of TZB in the mixture in alternate ridge decreased. Such decrease was observed with TZE-SR-W only in the within ridge arrangement. Straw yield of TZE-SR-W increased as its proportion increased from 50:50 to 67:33 in 1985. But TZB was not affected

The plant girth of sorghum was affected by change in sorghum proportion in the mixture. Thinner sorghum plants were observed where maize proportion was higher, especially in the within ridge arrangement, probably due to competition offered by maize. It was obvious that late maturing sorghum offered little competition to early maturing cereal such as maize (Andrews, 1972).

5.2 Effect of Maize Variety on Maize/Sorghum Mixture

Maize grain yield in sole as well as in mixture was not influenced by variety in both years. This agrees with Baker (1979) who found no significant difference in the yields of Bomo local and S-123 maize when both were grown in mixture or as sole crops. But contraty to this, Sayfikar (1980) found later maturing hybrid to produce higher grain yield than early maturing one.

Comparison of the LER of the mixture treatments showed that in both years, highest yield advantage was obtained where TZE-SR-W maize variety was the associate crop in the mixture. This was because TZE-SR-W which is the early maturing variety was harvested earlier than the late maturing TZB thus reducing the period of competition with sorghum.

Result of plant height of the two maize varieties was not consistent. In the within ridge arrangement, TZE-SR-W was taller than TZB, while TZB grew taller as the crop proportion increased from 50:50 to 67:33. Such difference was not observed with TZE-SR-W. The difference in height could be associated to intra-specific competition with increased proportion of maize. This result was not in line with the finding of Lucas (1981). He reported no difference between two maize varieties, (Farz 23 and Farz 27) with increase in population.

In the 1984 and 1985 wet seasons, the plant girth of the two maize varieties was not consistent. While TZE-SR-W produced thinner stems than TZB in 1984, such difference was not observed in 1985. Result of 1984 wet season was not in line with what was reported by Lucas (1981). However, such difference in 1984 was possible as a result of accumulation of dry matter by the late maturing variety (Goldsworthy, 1969).

In one of the years, sorghum mixed with TZE-SR-W produced more straw yield than TZB in the within ridge arrangement. Perhaps, this was due to early maturity of TZE-SR-W which probably compete less with sorghum as compared to TZB. Studies by Kassam and Stockinger (1973), Anon. (1976), Baker and Yusuf (1976) and Baker (1979) showed that removal of early crop freed sorghum from competition and allowed for light interception thereby resulting in increase in yield per plant.

5.3 Effect of Stand Arrangement on Maize/Sorghum Mixture

In 1985, within ridge arrangement produced higher maize grain yield than alternate ridge. The difference between the two stand arrangements may be related to intra-specific competition among maize plants in alternate ridges which was greater than inter-specific competition between the component crops in the within ridge arrangement. It was also possible that the competition offered by sorghum in the within ridge was less as has been reported by Andrews (1974). Similar results was reported by Koli (1975). Willey and Osiru (1972)

reported higher maize yield per plant in mixture than in pure stand because of reduced intra-specific competition. Kumar et al. (1983) reported 14% reduction in maize grain yield when maize was planted in alternate double rows with associated intercrops as compared to single rows, and attributed the reduction to intra-plant competiting among maize plants.

Alternate ridge arrangement produced higher sorghum grain yield than the within ridge arrangement in the 1984 wet season. The variation in grain yield could be as a result of competition between the two component crops in the within ridge arrangement which was greater and detrimental to sorghum, thereby reducing its yields. However, Lere (1985) reported no such difference.

In the 1985 wet season, even though less number of sorghum was harvested in the within ridge, no significant difference was observed in grain yield between the two stand arrangement possibly due to better rainfall as compared to what was recorded in 1984 wet season.

Result of the total grain yield of the mixture showed that yield advantage was not affected by stand arrangement and this corroborates the finding of Lere (1985). But in the present study, plant height of sorghum was influenced by stand arrangement. Sorghum mixed with maize variety TZB in the within ridge arrangement grew taller than with same variety in alternate ridges, most probably as a result of competition from maize in the within ridge arrangement due to their close proximity. Similar observation was made by Lere (1985) on the same mixture.

Chapter 6

SUMMARY AND CONCLUSION

A field experiment was conducted on Samaru farm of the Institute for Agricultural Research during the 1984 and 1985 wet seasons to investigate the productivity of maize/sorghum mixture as affected by crop proportion, stand arrangement and maize variety.

There were fifteen treatments comprising three sole crops (TZB, TZE-SR-W maize varieties and SK5912 sorghum variety) and twelve treatments obtained by factorial combinations of three crop proportions, two stand arrangements and two maize varieties. The experiment was laid out in a randomized complete block design (RCBD) with four replications.

Grain yield of both maize and sorghum was affected significantly by their respective crop proportions in the mixture in 1984 and 1985 wet seasons. Crop proportion 67:33 maize:sorghum gave the highest yield advantage over the other proportions in both seasons.

There was no significant difference in grain yield between the two maize varieties either in sole or in mixture. However, the performance of sorghum was better where TZE-SR-W was the associate intercrop. Highest yield advantage was obtained with TZE-SR-W as component crop in both years.

The effect of stand arrangement on maize was inconsistent. While there was no significant difference in grain yield between the two stand arrangements in the 1984

wet season, the performance of maize in terms of grain yield was better in the within ridge arrangement as compared to alternate ridge in 1985. Contrary to this, the performance of sorghum in alternate ridges was better than in the within ridge arrangement.

Correlation between maize grain yield, number of plants, number of cobs, cob weight and grain weight was positively and highly significant in both years. Similar result was obtained with sorghum in the corresponding years.

Based on these findings, the mixture can be grown at 67:33 (2:1) maize:sorghum proportion (3:1) with more probably TZE-SR-W as the component crop.

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APPENDICES

Appendix 1 Physico-chemical properties of the surface soil on the experimental sites.

Physical Properties		1984	1985
Particle size			
Clay (%)		16.00	12.00
Silt (%)		50.00	50.00
Sand (%)		34.00	38.00
Textural class		Sandy loam	Sandy loam
Chemical Properties			
Organic carbon (%)		0.42	0.24
pH (1:1 water)		4.50	4.60
Nitrogen (%)		0.035	0.02
Available P (ppm)		4.90	4.90
Ca	Meq/100g soil	4.11	2.30
Mg	"	1.25	0.70
K	"	0.24	0.12
Na	"	0.09	0.08
CEC	"	7.10	4.40

Appendix 2 Mean squares from analysis of variance for grain yield of maize and sorghum in 1984 and 1985 wet seasons.

Source	Df	1984		1985	
		Maize	Sorghum	Maize	Sorghum
Block	3	$1.0x10^{-6}$	128702	326592	35466.2
Proportion	2	$2.70x10^{7}$**	$6.25x10^{6}$**	$1.27x10^{7}$**	$1.24x10^{6}$**
Variety	1	$1.03x10^{6}$ NS	627032**	1608.18N	185768NS
Arrangement	1	2625.56NS	659189**	$1.70x10^{6}$**	$2.80x10^{6}$**
Interaction					
Proportion x variety	2	344045 NS	46283 NS	199332 NS	600506**
Proportion x arrangement	2	998760 NS	236304 NS	67918.5 NS	209274NS
Variety x arrangement	1	479892 NS	241230 NS	212592 NS	904.35NS
Proportion x variety x arrangement	2	$1.03x10^{6}$NS	271668 NS	133022 NS	340295*
Error (P.V.A.-1) (b-1)	33	815703	151718	80967	139588

* F test significant at (P=0.05)
** F test significant at (P=0.01)
NS = not significant

Appendix 3 Mean squares from analysis of variance for number of plants per square metre and number of cobs per metre square of maize in 1984 and 1985

Source		1984		1985	
		No. of plants/m^2	No. of cobs/m^2	No. of plants/m^2	No. of cobs D/m^2
Block	3	$6.44x10^{-2}$NS	$3.65x10^{-2}$NS	$4.56x10^{-2}$NS	$6.35x10^{-2}$
Proportion	2	13.93**	12.44**	13.29**	10.64**
Variety	1	$9.65x10^{-2}$NS	$2.51x10^{-3}$NS	0.06NS	0.34NS
Arrangement	1	$8.14x10^{-3}$NS	0.04NS	$1.22x10^{-2}$NS	$1.52x10^{-5}$NS
Interaction					
Proportion x variety	2	$2.09x10^{-2}$NS	0.33NS	$1.61x10^{-3}$NS	$7.21x10^{-2}$NS
Proportion x arrangement	2	0.034NS	0.29NS	$7.64x10^{-3}$NS	$2.93x10^{-2}$NS
Variety x arrangement	1	$4.43x10^{-2}$NS	0.03NS	$2.51x10^{-3}$NS	$1.52x10^{-5}$NS
Proportion x variety x arrangement	2	$3.74x10^{-2}$NS	0.66NS	$1.49x10^{-2}$NS	$3.68x10^{-2}$NS
Error (P.V.A.-1)(b-1)	33	$4.64x10^{-2}$NS	0.33NS	$3.81x10^{-2}$NS	$7.38x10^{-2}$NS

* F test significant at (P=0.05)

** F test significant at (P=0.01)

NS = not significant

Appendix 4 Mean squares from analysis of variance for cob weight per plant and 100-grain weight of maize in 1984 and 1985 wet seasons.

Source	Df	1984		1985	
		Cob weight per plant	100-grain weight	Cob weight per plant	100-grain weight
Block	3	0.00NS	13.01	7.11×10^{-4}NS	3.22
Proportion	2	1.87×10^{-5}NS	7.10**	2.49×10^{-3}**	6.90NS
Variety	1	0.003**	0.009NS	0.001*	1.33NS
Arrangement	1	8.33×10^{-6}NS	2.03NS	3.04×10^{-3}**	24.08**
Interaction					
Proportion x variety	2	8.12×10^{-5}NS	7.09**	7.46×10^{-5}NS	10.15*
Proportion x arrangement	2	1.27×10^{-4}NS	3.64NS	5.57×10^{-5}NS	0.27NS
Variety x arrangement	1	8.33×10^{-6}NS	0.39NS	0.00NS	6.75NS
Proportion x variety x arrangement	2	1.46×10^{-5}NS	1.25NS	2.89×10^{-4}NS	1.94NS
Error (P.V.A.-1)(b-1)	33	6.21×10^{-5}	2.24	5.64×10^{-4}	4.19

* F test significant at (P=0.05)

** F test significant at (P=0.01)

NS = not significant

Appendix 5 Mean squares from analysis of variance for shelling percent, germination percent and lodging percent of maize in 1984 and 1985 wet seasons.

Source	Df	1984			1985		
		Shelling %	Germ. %	Lodging %	Shelling %	Germ. %	Lodging %
Block	3	6.86	262.60	81.70NS	12.61	98.22	14.06
Proportion	2	6.15NS	324.43*	126.38NS	65.04**	738.44**	45.01NS
Variety	1	2.19NS	70.20NS	425.31**	322.82**	137.91NS	599.25**
Arrangement	1	0.67NS	215.94NS	36.54NS	20.10NS	45.63NS	4.55NS
Interaction							
Proportion x variety	2	2.69NS	58.03NS	53.44NS	29.68NS	275.13*	14.79NS
Proportion x arrangement	2	6.38NS	48.98NS	81.93NS	37.23NS	78.56NS	55.31NS
Variety x arrangement	1	1.69NS	458.49**	100.23NS	7.15NS	504.27**	14.32NS
Proportion x variety x arrangement	2	4.40NS	34.37NS	43.69NS	0.04NS	37.22NS	10.62NS
Error (P.V.A. -1)(b-1)	33	3.78	120.55	84.05	22.52	113.24	59.33

* F test significant at (P=0.05)

** F test significant at (P=0.01)

NS = not significant

Appendix 6 Mean squares from analysis of variance for number of plants per square metre and number of panicles per metre square in 1984 and 1985 wet seasons.

Source	Df	1984		1985	
		No. of plants /m^2	No. of panicles /m^2	No. of plants /m^2	No. of panicles/m^2
Block	3	$1.51x10^{-2}$NS	$5x50x10^{-2}$	$5.34x10^{-2}$NS	$3.17x10^{-2}$NS
Proportion	2	8.51**	8.10**	7.95**	8.21**
Variety	1	$3.63x10^{-2}$	$8.14x10^{-3}$NS	$1.22x10^{-2}$NS	$4.02x10^{-4}$NS
Arrangement	1	$5.31x10^{-2}$NS	0.19*	0.80**	$2.57x10^{-2}$NS
Interaction					
Proportion x variety	2	$9.11x10^{-2}$*	$2.51x10^{-2}$NS	0.04NS	$4.92x10^{-3}$NS
Proportion x arrangement	2	$1.40x10^{-2}$NS	$3.90x10^{-2}$NS	0.16NS	$2.51x10^{-3}$NS
Variety x arrangement	1	$8.45x10^{-2}$NS	$9.66x10^{-2}$NS	$8.14x10^{-3}$NS	$1.45x10^{-}$NS
Proportionxvariety x arrangement	2	0.02NS	0.16**	0.15NS	$3.92x10^{-3}$NS
Error (P.V.A.-1) (b-1)	33	$4.09x10^{-2}$	$5.48x10^{-2}$	$8.09x10^{-2}$	3.53

* F test significant at (P=0.05)

** F test significant at (P=0.01)

NS = not significant

Appendix 7 Mean squares from analysis of variance for panicle weight per plant and 1000-grain weight of sorghum in 1984 and 1985 wet seasons.

Source	DF	1984		1985	
		Panicle wt/plant	1000-grain weight	Panicle wt/ plant	1000-grain weight
Block	3	$1.25x10^{-2}$NS	29.90	$8.69x10^{-4}$NS	3.35
Proportion	2	$3.51x10^{-2}$NS	27.05NS	$9.75x10^{-2}$**	2.38NS
Variety	1	$1.54x10^{-2}$NS	0.35NS	$6.30x10^{-3}$**	9.82NS
Arrangement	1	$9.90x10^{-2}$*	7.76NS	$1.52.10^{-3}$NS	77.14**
Interaction					
Proportion x variety	2	$8.79x10^{-3}$NS	24.85NS	$2.41c10^{-3}$*	10.76NS
Proportion x arrangement	2	$3.60x10^{-2}$NS	2.62NS	$8.31x10^{-4}$NS	3.31NS
Variety x arrangement	1	$1.14x10^{-2}$NS	3.05NS	$9.19x10^{-4}$NS	
Proportion x variety x arrangement	2	$9.75x10^{-3}$NS	5.09NS	$3.17x10^{-3}$**	5.87NS
Error (P.V.A.-1(b-1)	33	$3.38x10^{-2}$	16.32	$1.02x10^{-3}$	13.31

* F test significant at (P=0.05)

** F test significant at (P=0.01)

NS = not significant

Appendix 8 Mean squares from analysis of variance for shelling percent, germination percent and loding percent of sorghum in 1984 and 1985 wet seasons.

Source	Df	1984			1985		
		Shelling %	Germ.%	Lodging %	Shelling %	Germ.%	Lodging %
Block	3	89.51	126.22	105.89	93.58	371.18	102.16
Proportion	2	81.45NS	204.99NS	1337.3**	68.56NS	28.91NS	190.58NS
Variety	1	174.96**	163.25NS	727.43**	166.96NS	37.51NS	0.18NS
Arrangement	1	90.31NS	364.65*	6764.48**	401.83**	284.55**9	2564.2**
Interaction							
Proportion x variety	2	46.47NS	122.67NS	633.61**	68.98NS	34.54NS	53.42NS
Proportion x arrangement	2	128.78*	12.26NS	158.19NS	255.58*	428.80**	497.54**
Variety x arrangement	1	124.10*	107.64NS	155.66NS	70.18NS	27.74NS	6.37NS
Proportion x variety x arrangement	2	50.26NS	171.468NS	303.79*	24.79NS	122.42NS	1.60NS
Error (P.V.A.-1) (b-1)	33	51.23	155.45	134.93	90.94	97.13	118.06

* F test significant at (P=0.05)

** F test significat at (P=0.01)

NS = not significant

Appendix 9 Mean squares from analysis of variance for plant height, girth and straw yield of maize at 12 weeks after planting in 1984 and 1985 wet seasons.

		1984			1985		
Source	Df	Plant height	Plant girth	Straw yield	Plant height	Plant girth	Straw yield
Block	3	547.39	1.63	74.51	696.14	0.05	221.51
Proportion	2	473.40**	0.37	7628.82NS	20.81NS	0.002NS	5650.36**
Variety	1	1140.75**	5.81**	154.48NS	5.33NS	0.30NS	18077.3**
Arrangement	1	918.75**	1.73**	54.81NS	5.33NS	0.001NS	2886.87**
Interaction							
Proportion x variety	2	484.94*	0.28NS	3748.75**	3034.65**	0.13NS	2099.62*
Proportion x arrangement	2	338.688NS	0.21NS	4980.68*	491.02NS	0.13NS	139.52NS
Variety x arrangement	1	432.00*	0.23NS	4870.86NS	216.75NS	0.008NS	52.06NS
Proportion x variety x arrangement	2	102.56NS	0.49	6523.47**	246.94	0.06NS	378.71NS
Error (P.V.A.-1) (b-1)		197.90	0.43	154.96**	595.41	0.17	788.23

* F test significant at (P=0.05)

** F test significant at (P=0.01)

NS = not significant

Appendix 10 Mean squares from analysis of variance for plant height, girth and straw yield of sorghum at 12 weeks after planting in 1984 and 1985 wet seasons.

Source	Df	1984			1985		
		Plant height	Plant girth	Straw yield	Plant height	Plant girth	Straw yield
Block	3	765.35	0.54	102.68	213.36	1.88	1309.73
Proportion	2	260.27NS	2.27**	1939.91**	1644.81**	1.57NS	588.41NS
Variety	1	136.69NS	0.00NS	1113.81**	1474.08*	2.00NS	754.62NS
Arrangement	1	325.52NS	0.02NS	68.74NS	1564.08*	205.84**	28426.2
Interaction							
Proportion x variety	2	546.06**	0.78NS	438.12NS	531.65NS	0.04NS	1609.32NS
Proportion x arrangement	2	151.40NA	0.09NS	100.246NS	432.52NS	0.61NS	216.71NS
Variety x arrangement	1	414.19*	1.40*	263.58*	490.08	0.24NS	5.52NS
Proportion x variety x arrangement	2	264.94NS	.73NS	118.76NS	1274.77**		17.64NS
Error (P.V.A. -1)(b-1)	33	165.26	0.65	105.30	234.29		786.72

* F test significant at (P=0.05)

** F test significant at (P=0.01)

NS = not significant

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School of Preliminary Studies, Kano	1976	1978	I.J.M.B.
Ahmadu Bello University Zaria	1978	1982	B.Sc (Agriculture)

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Organization	From	To	Position
College of Agric, Yandev	1982	1983	Teacher (NYSC)
AERLS/ABU Zaria	1983	To-date	Grad. Asst.

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