Table (9): Effect of intercropping on maize grain yield and stand at harvest in 1987 and 1988 seasons.

Second experiment: planting maize after 21 days from cotton planting date

Cropping systems	Grains yield / plant (g)		Grain yield kg/fad. (actual yield)		Grain yield kg/ fad. (adjusted yield)		% of surviving plants	
	1987	1988	1987	1988	1987	1988	1987	1988
Cotton 100 % + Maize 100 %	173	103	3156.97	1678.96	6313.94	3357.92	78.0	68.5
Cotton 100 % + Maize 75 %	171	91	2871.75	1370.91	5743.50	2741.82	93.8	84.4
Cotton 100 % + Maize 50 %	310	127	3169.44	1344.98	6338.88	2689.96	93.9	89.4
Cotton 75 % + Maize 100 %	187	91	3539.45	1364.43	7078.90	2728.86	81.1	63.9
Cotton 75 % + Maize 75 %	192	96	3293.11	1221.89	6586.22	2443.78	94.6	69.6
Cotton 50 % + Maize 50 %	296	119	3370.37	1264.08	6740.74	2528.16	91.6	91.1
Cotton 50 % + Maize 100 %	191	90	3597.78	1662.63	7195.56	3325.26	80.5	79.4
Cotton 50 % + Maize 75 %	245	97	3500.55	1393.73	7001.10	2787.46	85.1	80.4
Cotton 50 % + Maize 50 %	320	145	3494.07	1481.12	6988.14	2962.24	94.4	87.2
Sole maize	205	134	4627.77	2660,93	4627.77	2660.93	96.3	85.0
LSD 5 %	41.62	32.56	498	720	926	NS	9.89	11.22
1 %	56.23	NS	674	815	1252	NS	13.37	15.17

Higher values were recorded when maize was intercropped at lower densities and lower values with intercropping at higher densities and grain yield/ plant in sole maize cropping was in between.

In both seasons, the highest value was recorded with intercropping cotton and maize at 50 % : 50 % with an increase of 56 and 8 % over pure stand maize in 1987 and 1988 seasons, respectively. The lowest value was recorded in both seasons by intercropping cotton and maize at 100 % : 75 %, which was lower than grain yield/ plant in pure stand by 17 and 32 % in 1987 and 1988, respectively.

It could be concluded that maize grain yield/plant significantly increased by intercropping at lower densities due to the reduction in intraspecific competition, but under higher densities intercropping reduced maize grain yield/ plant. It is worthy to note that grain yield/plant followed the same trend of response of ear weight to intercopping.

Results reported by Abdel- Aal and Mohamad (1988) showed that intercropping maize and cotton increased yield components of maize.

2- Grain yield (kg/ faddan):

Results presented in Tables (8) and (9) showed that maize grain yield/ fad. estimated either as the "actual" yield or "adjusted" per unit area was affected by intercopping with significant differences in most cases and in both experiments .

a- "Actual" yield :

Concerning the "actual" grain yield produced from intercropped plots, a significant effect was detected for intercropping in both experiments as well as in both seasons.

Results of the first experiment showed that intercropping significantly reduced maize grain yield/ faddan in both seasons. In 1987 seasons, the reduction in grain yield ranged between 24 and 32 % compared with sole cropping. The highest intercropped yield was obtained by intercropping cotton and maize at 50 %: 100 % of pure stand density, respectively, and the lowest intercropped yield was produced when 75 % of the pure stand density of both crops was used. Yield differences were significant.

In 1988 season, a similar trend was observed where pure stand maize produced significantly higher grain yield than intercropped maize. The reduction in maize grain yield due to intercropping was from 37 to 59 % compared with

sole maize. The lowest intercropped yield was obtained by intercropping cotton and maize at 100 % : 100 % and the highest yield was produced with intercropping 50 % cotton : 100 % maize.

Concerning the second experiment, a similar trend was observed as with the first one. Sole maize cropping outyielded all intercropping treatments with highly significant differences in both seasons.

In 1987 season, the reduction in maize grain yield due to intercropping was 23- 39 % compared with maize in pure stand. The highest intercropped yield was produced when cotton was intercropped with maize at 50 % : 100 % of the pure stand density, respectively. The lowest intercropped yield was recorded with intercropping cotton and maize at 100 % : 75 % , respectively.

In 1988 season, the reduction in maize grain yield due to intercropping ranged from 38 to 54 % compared with pure stand yield. The best intercropping treatment concerning maize grain yield was with intercropping 50 % cotton : 100 % maize, and the lowest yield was with intercropping both crops at 75 % of the pure stand density.

It could be concluded that intercropping cotton with maize markedly reduced maize grain yield estimated

as the "actual" yield harvested per intercropped plots. It was clear that reducing cotton population density as well as increasing maize density led to a considerable reduction in maize grain yield in both experiments as well as in both seasons. The highest intercropped yield was produced with intercropping cotton and maize at 50% : 100 % of their pure stand density, respectively.

The present result is expected since the actual area occupied with intercropped maize was only 50 % of the pure stand area.

b- "Adjusted" yield :

"Adjusting the grain yield in accordance with the area grown by doubling the "actual" yield data is more appropriate for better evaluation.

Results showed that intercropping significantly affected the "adjusted" maize grain yield per unit area, in the first growing season in both experiments.

Concerning the first experiment, intercropping increased maize grain yield compared with pure stand yield with few exceptions.

In 1987 season, intercropping increased maize grain yield compared with sole cropping with highly

significant differences. Increases of 33 to 52 % in maize grain yield were obtained with intercropping. The highest yield was of the intercropping treatment 50 % cotton: 100 % maize.

In 1988 seasons, increase in maize grain yield due to intercropping reached a maximum of 26 %, but in two intercropping systems namely, 50 %: 50 % and 100 %: 100 %, a reduction of 7 and 12 % in grain was recorded compared with sole maize growing.

However, all yield differences in that season were below the level of significance.

With regarded to the second experiment, a similar trend was observed where intercropping significantly increased maize grain yield in the first season, but an insignificant effect was found in the second one.

In 1987 season, intercropping increased maize grain yield from 24 to 56 % over the pure stand yield with highly significant differences.

In 1988 season, the effect of intercropping on grain yield was not significant in spite of some considerable differences.

Increases in grain yield from 1 to 26 % were obtained with 7 intercropping systems, but a reduction of 5

and 8 % was obtained by intercropping cotton and maize at 75 % : 50 % and 75 % : 75 % , respectively. All these differences were below the level of significance.

It could be concluded that maize can be intercropped with cotton and higher grain yields could be expected. The vigorous growth of maize compared with cotton led to a reduction in competition with intercropping. The reduced competition was expressed in an increase in maize grain yield per unit area.

The present result is also due to the encouraging effect of intercropping on number of ears/ plant, and ear weight.

Results reported by Murno (1960), Chowdhury and Singh (1982) and Abdel Aal and Mohamad (1988) showed that maize grain yield was increased by intercropping with cotton.

On the other hand, Ghaly et al. (1989) and Hosny et al. (1989) found that intercropping reduced maize grain yield.

3- Percentage of surviving plants at harvest :

Results in Tables (8) and (9) showed that the percentage of surviving maize plants at harvest were significantly affected by intercropping.

Concerning the first experiment, where maize and cotton were planted on the same date, intercropping at higher population densities reduced percentage of surviving plants at harvest compared with intercropping at lower densities.

In 1987 season, the effect of intercropping on maize stand was not significant. The highest percentage of surviving plants was 94.4 % recorded when cotton and maize were intercropped at 100 % : 50 % , respectively, and the lowest percentage was 81.9 % of the pure stand.

In 1988 season, a different trend was found where intercropping at higher densities significantly reduced percentage of surviving plants at harvest. Intercropping cotton and maize at 100 % : 100 % led to a serious reduction in maize stand at harvest where 30.9 % of the plants were lost compared with a reduction of 12.5 % with sole maize cropping.

With regard to the second experiment, in which cotton planting preceded maize planting by 3 weeks, a significant effect for intercropping on survival percentage was also detected in both seasons.

It was quite clear that the lowest survival percentages were where maize was intercropped at 100 % of pure stand density.

In 1987 season, the highest percentage of survival was 94.4 % recorded with intercropping at 50 % : 50% and the lowest percentage was 78.0 % recorded with intercropping at 100 % : 100 %, while with pure stand maize , 96.3 % of the grown plants reached maturity and were harvested.

In 1988 season, the highest survival percentage was 91.1 %, recorded with intercropping cotton and maize at 75 % : 50 %, respectively, and the lowest percentage was 68.5 % recorded with intercropping system 100% : 100 %, and sole maize cropping was in between with a survival percentage of 85 %.

It could be concluded that a great lost in maize stand is expected when intercropping is followed under higher population densities due to the increase in intraspecific competition among maize plants.

V- Effect of Intercropping on Some Agronomic Characters in Maize :

1- Percentage of barren plants :

Results in Tables (10) and (11) showed that intercropping had no significant effect on the percentage of barren plants in both experiments as well as in both seasons.

Table (10): Effect of intercropping on some agronomic characters in 1987 and 1988 seasons

First experiment: planting maize with cotton at the same date.

Cropping systems	% of barren plants		% of lodged and broken plants		% of smut infested plants		% of late wilt infested plants	
	1987	1988	1987	1988	1987	1988	1987	1988
Cotton 100 % + Maize 100 %	5.82	8.63	1.85	2.31	0.83	0.81	--	1.40
Cotton 100 % + Maize 75 %	6.68	8.08	1.69	2.39	0.90	0.68	--	0.90
Cotton 100 % + Maize 50 %	5.93	7.20	1.43	2.25	0.56	0.50	--	0.80
Cotton 75 % + Maize 100 %	4.95	6.93	1.21	2.59	0.65	0.50	--	0.90
Cotton 75 % + Maize 75 %	4.73	7.38	1.25	2.24	0.60	0.60	--	0.90
Cotton 75 % + Maize 50 %	5.88	6.75	1.14	2.41	0.50	0.50	--	0.95
Cotton 50 % + Maize 100 %	4.40	6.83	1.05	2.35	0.60	0.50	--	0.75
Cotton 50 % + Maize 75 %	5.55	6.95	1.11	2.14	0.50	0.40	--	0.40
Cotton 50 % + Maize 50 %	5.00	6.70	1.04	2.11	0.50	0.50	--	0.45
Sole maize	5.55	6.15	1.01	2.71	0.50	0.44	--	0.95
LSD 5 %	NS	NS	NS	NS	NS	NS	---	NS
LSD 1 %	NS	NS	NS	NS	NS	NS	--	NS

Table (11): Effect of intercropping on some agronomic characters in 1987 and 1988 seasons.

Second experiment: planting maize after 21 days from cotton planting date.

Cropping systems	% of barren plants		% of lodged and broken plants		% of smut infested plants		% of late wilt infested plants	
	1987	1988	1987	1988	1987	1988	1987	1988
Cotton 100 % + Maize 100 %	4.33	6.95	3.78	3.00	0.80	1.49	--	1.13
Cotton 100 % + Maize 75 %	3.60	7.28	2.35	2.48	10.68	1.10	--	0.90
Cotton 100 % + Maize 50 %	4.93	7.28	3.60	3.20	0.50	0.98	--	0.90
Cotton 75 % + Maize 100 %	3.10	7.80	2.68	3.65	0.70	0.71	--	0.86
Cotton 75 % + Maize 75 %	3.68	7.15	2.88	3.13	0.50	0.85	--	0.93
Cotton 75 % + Maize 50 %	3.18	6.33	2.18	2.23	0.50	0.64	--	0.75
Cotton 50 % + Maize 100 %	3.53	6.53	2.78	2.70	0.50	0.75	--	0.34
Cotton 50 % + Maize 75 %	2.60	7.33	2.40	2.43	0.50	0.75	--	0.50
Cotton 50 % + Maize 50 %	2.75	6.65	1.95	2.70	0.45	0.70	--	0.55
Sole maize	3.48	7.68	2?13	2.58	0.50	0.95	--	0.82
LSD 5 %	NS	NS	NS	NS	NS	NS	--	NS
1 %	NS	NS	NS	NS	NS	NS	--	NS

Concerning the first experiment, it was clear in both seasons that very slight differences were observed in barren plants percentage with no specific trend. All differences were too slight to reach the level of significance.

Regarding the second experiment, intercropping had also no significant effect on this trait in both seasons. The differences observed in this character had no specific trend and were too slight.

It could be concluded that under the conditions of the investigation intercropping had no significant effect on barren plants percentage.

Results reported by El- Aishy et al. (1978) showed that intercropping maize and soybean in alternate single rows decreased percentage of barren plants.

Also Galal et al. (1983) reported that intercropping corn and soybean in alternate ridges increased prolificacy of maize plants.

Other investigators reported that intercropping maize and soybean had no significant effect on barren plants percentage (Ahmed, 1983), whereas El-Habbak (1985) found that percentage of barren plants increased when maize and soybean were intercropped at higher densities.

2- Percentage of lodged and broken plants :

Results in Tables(10) and (11) showed that intercropping at different densities had no significant effect on percentage of lodged and broken maize plants in both experiments and in both seasons as well.

Concerning the first experiment, it was observed that slight differences in lodging and breakage in maize among the different treatments occurred.

In 1987 season, the highest percentage of lodging and breakage was 1.85 %, recorded with intercropping system 100 % : 100 % and the lowest percentage was 1.01 % of pure stand maize.

In 1988 season, the highest percentage was 2.71 % recorded with sole maize cropping, and the lowest percentage was 2.11 % recorded with intercropping both crops at 50 % : 50 % .

As for the second experiment, very slight differences were also observed, where at higher intercropping densities the percentage of lodging and breakage was increased,but decreased at lower intercropping densities, and sole maize cropping was in between.

All differences in the percentage of lodged and broken plants were, however, below the level of significance.

It could be concluded that increasing maize population density in intercropping systems slightly icrcreased lodging and breakage in maize as a result of increasing the intraspecific competition.

Results obtained by Frances et al, (1978) indicated that lodging was less in the intercropped culture of maize with beans with an average of 16.4 % in intercropping compared with 28.1 % in sole cropping.

3- Percentage of smut infested plants :

Results in Tables(10) and (11) showed that intercropping had no significant effect on the percentage of smut infested maize plants in both experiments as well as in both growing seasons.

The differences in percentage of smut diseased plants observed in both experiments were too slight to reach the significant level and also had no specific trend.

It could be concluded that intercropping maize with cotton did not adversely affect smut infestation in maize.

Willey (1979) reported that intercropping allows better control of weeds, pests or diseases. He added that many instances of better control of diseases with intercropping have been quoted but there have also been instances of poorer control.

4- Percentage of late wilt infested plants :

Results in Tables (10) and (11) showed that intercropping at different densities had no effect on the percentage of late wilt infested plants in both experiments as well as in both seasons.

It was observed that in the first season and in both experiments no late wilt diseased plants were detected in all treatments. Slight infection percentages were recorded in the second season with the highest percentage with intercropping system 100 % : 100 % and the lowest percentages with intercropping systems with lowest population dinsities . But all differences were too slight to reach the level of significance.

It could be concluded that intercropping had no adverse effect on maize infestation with late wilt disease.

In this respect Willey (1979) reported that intercropping allows better control of weeds, pests and diseases .

IV- Effect of Intercropping on Weed Density :

1- Weed density after 35 days from planting :

Results presented in Tables (12) and (13) showed that intercropping cotton and maize had no significant effect on weed density after 35 days from planting in both experiments as well as in both seasons.

Concerning the first experiment where cotton and maize were planted on the same date, no marked difference were observed in weed density, expressed as dry weight of weed (gm/m^2) after 35 days from planting, among the different treatments in both seasons. Also, sole cotton as well as sole maize were nearly similar with regard to weed density compared with all intercropping treatments in both seasons.

With the second experiment, data were collected after 35 days from cotton planting. It is also clear that no significant differences were found among the different treatments.

2- Weed density after 50 days from planting:

Results in Tables (12) and (13) showed that intercropping had no significant effect on weed density in both experiments as well as in both seasons.

Concerning the first experiment, slight differences were observed showing that higher weed density was recorded at lower intercropping densities and vice versa.

In 1987 season, the highest weed density was 19.65 gm/m^2 recorded with intercropping treatments 50% : 50% and the lowest density was 10.77 gm/m^2 recorded with intercropping cotton and maize at 100 %: 50 %, respectively, and sole cropping was in between with 14.32 and 14.82 gm/m^2 for cotton and maize, respectively.

Table (12): Effect of intercropping on dry weight of weeds after 35 and 50 days from planting in 1987 and 1988 seasons.

First experiment, planting maize with cotton at the same date .

Cropping systems	Dry weight of weeds (g/ m^2)			
	After 35 days from sowing		After 50 days from sowing	
	1987	1988	1987	1988
Cotton 100 % + Maize 100 %	13.70	11,75	15.70	14.35
Cotton 100 % + Maize 75 %	13.70	12.60	14.25	13.97
Cotton 100 % + Maize 50 %	11.90	10.52	10.77	14.52
Cotton 75 % + Maize 100 %	13.12	12.00	14.00	14.55
Cotton 75 % + Maize 75 %	12.40	11.90	12.82	14.97
Cotton 75 % + Maize 50 %	13.87	11.67	16.67	16.97
Cotton 50 % + Maize 100 %	13.75	13.82	16.62	14.37
Cotton 50 % + Maize 75 %	15.55	16.65	18.67	16.52
Cotton 50 % + Maize 50 %	14.55	14.02	19.65	15.95
Sole cotton	13.67	11.82	14.32	14.90
Sole maize	14.52	14.02	14.82	18.32
LSD 5 %	NS	NS	NS	NS
1 %	NS	NS	NS	NS

Table (13): Effect of intercropping on dry weight of weeds after 35 and 50 days from planting in 1987 and 1988 seasons.

Second experiment, planting maize after 21 days from cotton planting date

Cropping systems	Dry weight of weeds (g / m^2)			
	After 35 days from planting cotton		After 50 days from planting cotton	
	1987	1988	1987	1988
Cotton 100 % + Maize 100 %	8.50	7.70	11.90	11.37
Cotton 100 % + Maize 75 %	9.80	6.12	13.10	10.15
Cotton 100 % + Maize 50 %	7.90	8.07	12.20	10.20
Cotton 75 % + Maize 100 %	8.40	7.12	14.00	11.05
Cotton 75 % + Maize 75 %	9.40	7.77	14.70	13.85
Cotton 75 % + Maize 50 %	8.30	8.70	15.50	10.45
Cotton 50 % + Maize 100 %	8.90	6.20	13.10	15.80
Cotton 50 % + Maize 75 %	8.50	8.15	14.50	16.17
Cotton 50 % + Maize 50 %	9.70	9.82	16.60	12.10
Sole cotton	10.10	8.35	12.80	11.40
Sole maize	11.90	9.75	15.20	17.30
LSD 5 %	NS	NS	NS	NS
LSD 1 %	NS	NS	NS	NS

In 1988, the highest weed density was 18.32 gm/m^2 recorded with maize in pure stand and the lowest density was 13.97 gm/m^2 recorded with intercropping system 100 % cotton: 75 % maize.

With regard to the second experiments, data were collected after 50 days from cotton planting. It was also clear that some differences were found among the different treatments.

In 1987, season, the highest weed density was 16.60 gm/m^2 recorded with intercropping 50% : 50%, and the Lowest density was 11.90gm/m^2 for the intercropping system 100%: 100%.

In 1988, season, the highest weed density was 17.30 gm/m^2 recorded with maize in pure stand and the lowest density was 10.15 gm/m^2 of the intercropping system 100% cotton: 75 % maize.

It could be generally concluded that intercropping at higher population densities slightly reduced weed infestation, whereas at lower densities slight increases in weed density were observed.

The smothering effect of the higher intercropping densities depressed weed growth and reduced weed density.

Results obtained by Kamel et al. (1979) indicated that dry weight of annual weeds was significantly affected by intercropping corn and soybean. They found that intercropping both crops on the same ridges depressed weed growth compared with alternate ridges of corn and soybean.

VII- Effect of Intercropping on Competitive Relationships and Yield Advantage :

1- Land equivalent ratio :

Results in Tables (14) and (15) showed the LERs obtained for the different intercropping systems in both experiments in 1987 and 1988 growing seasons.

a- First experiment:

Concerning the first experiment, where maize and cotton were planted on the same date, results indicated that intercropping increased land productivity with all systems in the first season and with three systems out of of nine in the second one.

In 1987 season, all intercropping systems increased land usage from 10 to 19 % . The highest LER (1.19) was obtained by intercropping cotton and maize at 100 % : 50% respectively. It is worth mentioning that the best results were obtained with higher cotton densities combined with lower maize densities.

Maize produced higher yields than the expected , where "Lm" values ranged between 0.68 and 0.76 showing a great competitive ability. On the other hand, cotton produced lower yields than the expected where "Lc" ranged

Table (14): Competitive relationships of intercropping cotton and maize in 1987 and 1988 seasons .

First experiment: planting maize with cotton at the same date.

Cropping systems	Land equivalent ratio (LER)						Relative crowding coefficient K						Aggressivity (A)			
	1987			1988			1987			1988			1987		1988	
	Lc	Lm	LER	Lc	Lm	LER	Kc	Km	K	Kc	Km	K	Ac	Am	Ac	Am
Cotton 100 % + Maize 100 %	0.42	0.74	1.16	0.41	0.44	0.85	0.73	2.79	2.03	0.69	0.79	0.54	-0.63	+0.63	-0.06	+0.06
Cotton 100 % + Maize 75 %	0.43	0.72	1.15	0.42	0.57	0.99	0.76	2.57	1.95	0.71	1.36	0.96	-0.58	+0.58	-0.32	+0.32
Cotton 100 % + Maize 50 %	0.44	0.75	1.19	0.50	0.54	1.04	0.78	2.94	2.29	1.00	1.15	1.15	-0.61	+0.61	-0.07	+0.07
Cotton 75 % + Maize 100 %	0.42	0.75	1.17	0.40	0.59	0.99	0.71	3.15	2.23	0.67	1.44	0.96	-0.69	+0.69	-0.38	+0.38
Cotton 75 % + Maize 75 %	0.42	0.68	1.10	0.41	0.52	0.93	0.72	2.08	1.49	0.69	1.09	0.75	-0.51	+0.51	-0.23	+0.23
Cotton 75 % + Maize 50 %	0.41	0.76	1.17	0.48	0.54	1.02	0.69	3.15	2.17	0.94	1.19	1.11	-0.70	+0.70	-0.12	+0.12
Cotton 50 % + Maize 100 %	0.39	0.76	1.15	0.40	0.63	1.03	0.63	3.18	2.00	0.64	1.70	1.08	-0.74	+0.74	-0.48	+0.48
Cotton 50 % + Maize 75 %	0.40	0.74	1.15	0.38	0.52	0.90	0.67	2.89	1.93	0.61	1.06	0.64	-0.68	+0.68	-0.27	+0.27
Cotton 50 % + Maize 50 %	0.41	0.74	1.15	0.44	0.47	0.91	0.68	2.87	1.95	0.78	0.87	0.67	-0.67	+0.67	-0.05	+0.05