INTENSIVE CROP ROTATIONS TO IMPROVE AGRICULTURAL PRODUCTION IN MIDDLE EGYPT

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Abstract

A Long-term field trial was conducted at Mallawi Agric. Res. St. (Middle Egypt), on clay loamy soil. It started in 2001/2002 to 2007/2008 seasons. The objective of this study was to compare different rotations i.e one prevailing rotation and two proposed intensive rotations that are assumed to be more productive, sustainable and less weedy. The results showed that yield of crops in the two proposed rotations were higher than those in prevailing rotation in both cycles. The NPK of soil contents and organic matter (OM) percentages were more improved under the two proposed rotations as compared with the prevailing rotation in both cycles. The results also revealed that the increase in soil contents of NPK and OM were higher in the latter year (after the second cycle) as compared with the first cycle. The intensification index in the proposed (I) and proposed (II) was 2.50 and 2.60, respectively as compared with the prevailing rotation 2.05. The density of associated annual weeds was more reduced which reached only 50% of the prevailing rotation. The values of both total revenue and net return in the proposed rotations were also greater than those in the prevailing rotation. The increases in yields and soil contents of nutrients, intensification index and reduction in weeds might be due to the inclusion of legumes in rotation and intercropping systems which was more productive and sustainable, and conserve soil NPK content and OM.

Keyword: Crop rotation, intercropping, weeds and crop sequence

INTRODUCTION

Egypt faces a growing imbalance between agriculture production and population increase. Vertical expansion and horizontal expansion should be taken into consideration to achieve a balance between population and agricultural production. However, vertical expansion includes many activities more productive and tolerant to pest and diseases, optimizing cultural practices and selection of pertinent crop rotation.

Crop rotations have a positive effect on yields combat diseases, pests and weeds. Rotations avoid yield depressions under monoculture which increase populations of microorganisms that are pathogenic and decrease population of antagonistic microorganisms in the crop root rhizoshere (Cook 1984) and reduce production of phytoxic allelopathic chemicals and improve physical and chemical conditions of soil (Barber, 1972). Several investigators studied effect of crop sequence and crop rotation on crop productivity and soil characteristics. Shafshak et al (1983), Abou-Keriasha (1998), Arsheal et al (1998) and Dogan and Bilgili (2010) they showed that those grown cereal crops (wheat or maize) after legume crops produced more grain yield than those grown after non legume crops Abou-Keriasha (1998) and Farghly and Zohry (2002) found that cotton sown after legume crops gave the highest seed cotton yield, while the lowest yield was obtained when cotton was grown after cereal crops. Toaima et al (2007) found that seed cotton per plant and faddan in the intercrop treatment (wheat/cotton) when grown after fahl berseem was superior to other treatments. Abd El-Hadi et al (2000) showed that available NPK and organic matter were higher in second cycle than that of zero time and the first cycle of the crop rotation.

Crop rotation helps in reducing the weed population by interrupting their life cycle and suppressing their growth development and dispersion (Anderson 2004). Shafshak et al (1983) found that maize after clover contained 76% of the total fresh weight of weed in comparison of maize after wheat. Altieri and Liebman (1988) noticed that cropping patterns selected in management systems can also act to reduce weed densities and cause shifts in composition, density and spatial distribution of weed species in fields. Zohry (2005) and Toaima et al (2007) concluded that berseem as a preceding crop reduced weeds in wheat or maize compared with those grown after non legume crops.

In cereal-legume rotation or intercropping systems, the cereal benefits from the nitrogen fixed by the legume and the decomposition of the nutrient–vies biomass, root and nodules of legume which help to increase soil organic matter as well as reduces weeds population density and biomass production (Liebman and Dyck 1993, Gregorich et al 2001 and Chen et al 2004)

Several researchers who studied intercropping systems found that yield of one or all of the crops in the intercrop were lower than the total of their pure stands, but the combined yield from the intercropping crops was higher than the total yield of any crop as pure stands (Fininsa 1997 and Abou-Keriasha et al 2009). Whereas, (Khan et al 2002) showed that cereal crops grain yield increased or remain unaffected by intercropping systems compared with sole crop, but yields of legume crops, were decreased. Massawe et al (2001) and Abou-Keriasha et al (2011) showed that maize + bean or maize + cowpea intercropping reduced weeds manifest by 20-50% compared to pure stands. The main objective of this study is to examine some intensive crop rotations more productive and sustainable in middle region of Egypt.

MATERIALS AND METHODS

A Long-Term Trial (LTT) was initiated in 2001/2002 growing season and lasted to 2007/2008 season at Mallawi Agriculture Research Station (Middle Egypt). The main objective of this study was to compare intensive two rotations with the common rotation in middle Egypt. The comparison included three forms of three-year crop rotation i.e. one prevailing rotation (control) and two intensive rotations. The proposed rotations assumed to be more productive and sustainable with less weed. The three crop rotations were as shown in (figure 1).

The experimental design was strip plot in randomized complete block with three replicates and plot area was 42 m^2.

Soil analysis: soil surface samples (0-30 cm.) were collected from each plot individually before planting (0-time) and after first and second cycle of the 3-year crop rotations. The sowing and harvesting dates of winter; summer; autumn and intercrop crops and their area per faddan were recorded in Tables (1 and 2). The main crops (berseem, wheat, F.bean, maize and cotton) were sown as recommended (solid or intercroped). Onion + cotton intercrop: four onion rows (100%) were transplanted on bed of wide ridge (120cm) and cotton was sown on the two sides of all ridges (100%). Wheat + cotton intercrop: four wheat (Giza 168) rows (75%) were sown on bed of wide ridges (90cm) and cotton (Giza 80) was sown on the two sides of ridges (100%).

Area of onion + cotton as about 11816fad (Agricultural Statistics (2007))

Area of wheat + cotton as about 301 fad (Agricultural Statistics (2007))

Figure (1)

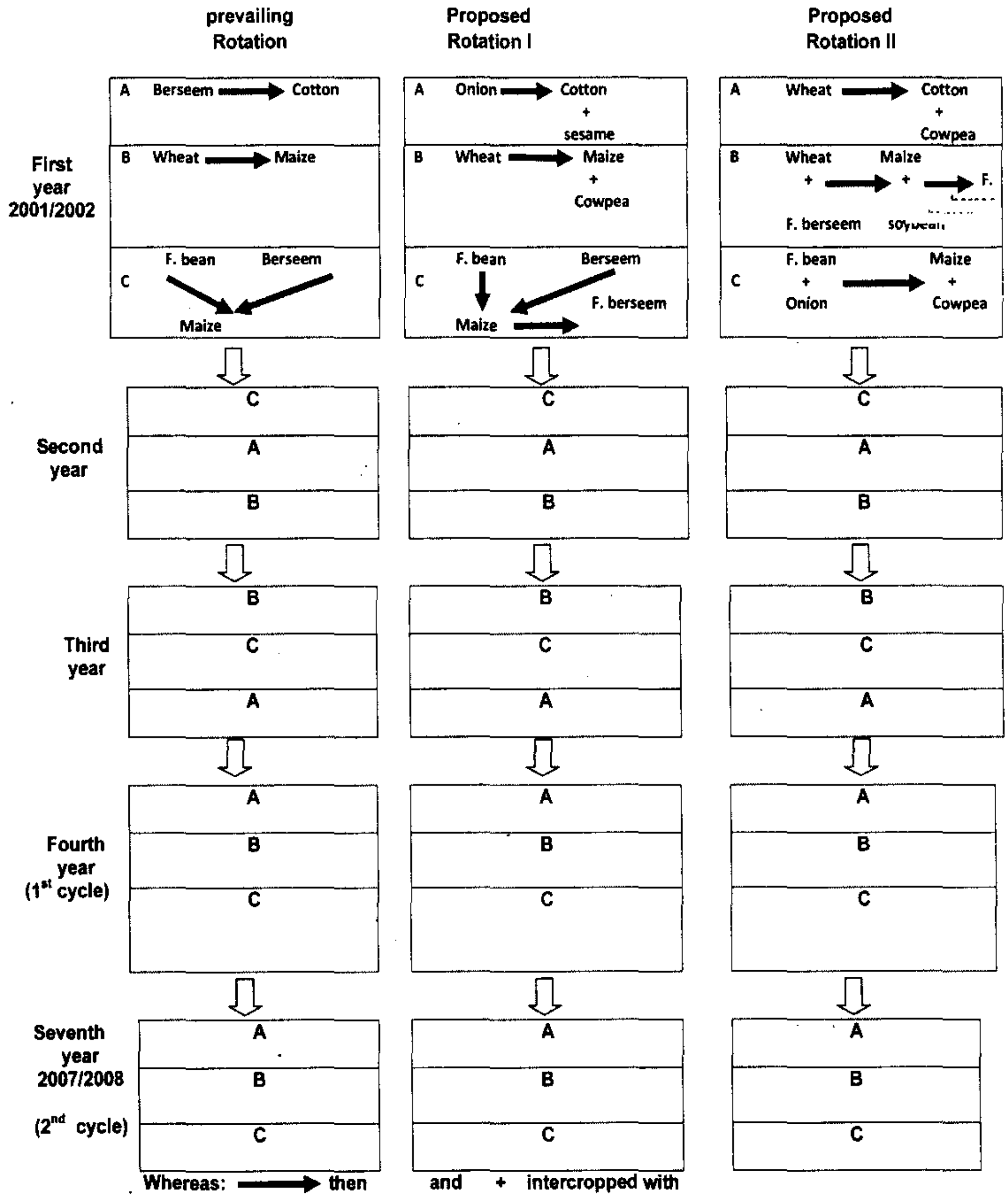
prevailing Rotation
Proposed Rotation I
Proposed Rotation II
First year 2001/2002
A Berseem Cotton
B Wheat Maize
C F. bean Berseem Maize
A Onion Cotton + sesame
B Wheat Maize + Cowpea
C F. bean Berseem F. berseem Maize
A Wheat Cotton + Cowpea
B Wheat + F. berseem Maize + soybean F.
C F. bean + Onion Maize + Cowpea
Second year
C
A
B
Third year
B
C
A
Fourth year (1st cycle)
A
B
C
Seventh year 2007/2008 (2nd cycle)
A
B
C
Whereas: then and + intercropped with

Table 1. Date of planting and harvesting of crops during prevailing, proposed (I) and proposed (II) rotations.

Rotation	Date of planting, Harvesting / Crop sequences	Winter crops		Summer crops		Intercropped crops		Autumn crops (relay intercropping)	
		planting	harvesting	planting	harvesting	planting	harvesting	planting	harvesting
Prevailing	A	28/10	3/3	28/3	25/9	-	-	-	-
	B	18/11	12/5	25/5	20/9	-	-	-	-
	C	28/10	22/4	25/5	20/9	-	-	-	-
Proposed I	A	18/11	22/4	28/3	25/9	Sesame 20/5	Sesame 5/9	-	-
	B	18/11	15/5	25/5	25/9	Cowpea 2/6	Cowpea 10/8	-	-
	C	28/10	15/5	25/5	25/9	-	-	F. berseem 15/9	F. berseem 5/11
Proposed II	A	18/11	15/5	28/3	25/9	Cowpea 20/5	Cowpea 20/7	-	-
	B	18/11	22/4	10/5	10/9	Soybean 18/5	Soybean 10/9	F. berseem 15/9	F. berseem 10/11
	C	25/10	22/4	10/5	25/9	Cowpea 10/6; Onion 25/11	Cowpea 11/8; Onion 15/5	-	-

Table 2. Crops area percentage per rotation area during prevailing, proposed (I) and proposed (II) rotations

Crops / area/fad	Green forage		Wheat	Faba bean	Maize	Seed cotton	onion	Oil crops	
	Berseem	cowpea						sesame	soybean
prevailing	50	---	33	16.5	66	33	-----	----	-----
Proposed I	50	33	33	16.5	66	33	33	16.5	----
Proposed II	33	66	66	33	50	33	16.5	----	16.5

onion intercrop: Four fababean (Giza 2) rows (100%) were sown on the bed of wide ridge (120cm). Onion (Giza 6) was transplanted on the sides of all the wide ridges (50%). Maize + soybean: maize (TWC 310) was sown at 2 ridges : 2 soybean (Crawford) ridge (50%:50%). Cotton + sesame intercrop: one sesame (Giza 2) row was sown after onion harvested on the bed of half cotton ridges, 40cm between hill (25%). While, cotton + cowpea intercrop: two cowpea (cream) rows were sown on the bed of half cotton ridges (50%) after wheat harvested. Maize + cowpea intercrop: one cowpea row was sown on the side of all maize ridges (100%) 20cm between and two plants/hill

Fertilizers (NPK), irrigation, pests and diseases control were practiced as recommended for each crop. At harvesting the yield of each crop was determined on plot basis and converted to one faddan (in ton). Weed studies (annual weeds) were hand pulled from each plot after 60-90 days from planting and recorded the weight on dry weight basis (gm/m^2).

Farmer's Benefit

1- Intensification index: The intensification index was calculated as followed formula :

Intensification index = Σ(crop area / land area)

or Σ(LER)

2- Cereal unit: The yield of crops for each rotation were changed to units of cereal according to (Brockhaus, 1962) for judicious comparison between 100kg for each crop as follow: maize & wheat =1, berseem =0.14, cowpea =0.12, fababean seeds = 1.20, soybean =1.50, sesame =2.00, straw of cereal crops =0.10, onion= 0.30, straw of legume crops =0.25, seed berseem =5.00 and seed cotton (kentar)= 5.55.

3- Economic evaluation: To calculate the net return during the three crop rotations at first year (before rotation) , first and second cycles, the average market prices of as fallow: 1166 LE/ ton of wheat, 1571 L.E/ton for maize grain ,1900 L.E./ton soybean , 5833 L.E/ton sesame, 2258 LE/ton faba bean, 870 L.E/kentar seed cotton, 330 L.E/ton straw of cereal, 200 L.E/ton fababean straw, 1227 L.E/one cut berseem and 600 L.E/ton onion

Total cost (Rent + Total variable cost) as followed: 2600 LE for maize, 1800L.E for soybean, 3400L.E for cotton, 2400L.E for wheat, 2290Le for fababean, 1200Le for berseem and 2800 L.E for onion (Agricultural Statistics (2007))

The statistical analysis was carried out for each crop separately according to Snedecor and Cochran (1982) and treatment means were compared by least significant differences test (LSD) at 5% level was used between treatments.

RESULTS AND DISCUSSION

A- Crop rotations effect on crops productivity during two cycles in prevailing and proposed rotations:

Data in Table (3) indicated that the yield of the main crops (berseem, wheat, fababean, maize and cotton) were significantly affected by crop rotation duration (prevailing and proposed) at the three times (first, fourth and seventh years). The results indicated that the values of crop productivity in the proposed rotations were relatively higher than those obtained from the prevailing rotation except the green forage in proposed rotations. These increases were due to an improved crop sequence and inclusion of legume crops within the proposed rotations. Proposed (I) and proposed (II) rotations outyielded those grown in prevailing by 3.71 and 101.86% for wheat, 5.66 and 39.62% for faba bean and 4.50 and 8.45% for seed cotton, respectively. The proposed (I and II) rotations also recorded the highest values of by production (wheat, fababean and cotton) as compared with the prevailed rotation. The increases of wheat in proposed (II) was due to the area of wheat in this rotation (66% faddan) compared with other rotations (Table 2). Maize grain yield was higher in proposed (I) by 2.72% but in proposed (II) was less by 9.34% than prevailing rotation. Also green forage yield reduced by 1.10% in proposed (I) and 38.22% in proposed (II) than prevailing respectively. The reduction in proposed (II) for green forage yield and maize grain yield was due to the area of forage and maize was less than those grown in prevailing (Table 2). These observations are in accordance with those obtained by Shafshak et al 1983, Abou-Keriash 1998. Faraghaly and Zohry 2002 and Toima et al 2007. These results, revealed also that the yield of all crops in the prevailing, proposed (I) and proposed (II) rotations in the first cycle (fourth year) surpassed in first year and also in second cycle (seventh year) surpassed first cycle. The increases in first and second cycles were estimated to 17.83 and 20.70% for green forage, 31.16 and 63.77% for wheat 16.33 and 57.14% for fababean, 50.73 and74.34% for maize and 19.49 and 52.68% for seed cotton over first year, respectively. Also, the first and second cycles recorded increasing in by product by 23.30 and 26.10% for straw wheat, 28.50 and 50.80% for straw fababean, 39.30 and 36.40% for straw maize and 26.00 and 48.50% for cotton, respectively. These observations might be due to the sustainable effect of rotation which improved macro. and micro environment of factors that led to soil improvement in latter year. These results are in agreement with those obtained by Cook (1984), and Barber (1972). They noticed that increased yield at latter year of rotation was due to the accumulative amendments resulted from following crop rotation.

Table 3. Crop rotations effect on yields of the main crops; forage, wheat, faba bean, maize and seed cotton at first year, fourth year (first cycle) and seventh year (second cycle)

Crops yield /fad.		Green forage			Wheat (ton)		Faba bean (ton)		Maize (ton)		Seed cotton (kentar)		Onion (ton)	Oil	
		Berseem		Cow-pea (ton)	Mean	By product	Mean	By product	Mean	By Product`	Mean	By product		sesame (kg)	Soybean (ton)
Rotations		forage (ton)	Seeds (kg)												
First year															
Prevailing		33.66		-----	2.15	2.83	0.44	0.58	3.75	1.55	4.58	5.13	------	------	------
Proposed I		32.66		4.50	2.28	3.53	0.46	0.57	4.23	1.75	4.63	5.00	15.60	91.00	-----
Proposed II		21.66	20.00	10.00	3.85	4.50	0.59	0.78	3.80	1.57	4.81	5.60	7.80	-------	0.78
LSD 5%		2.16			0.25	0.90	0.05	0.05	0.35	0.08	0.16	0.35			
Mean		29.33			2.76	4.29	0.49	0.63	3.43	1.62	4.67	5.24			
Fourth year (first cycle)															
Prevailing		40.50		-----	2.60	3.00	0.49	0.92	5.39	2.16	5.63	6.58	-	----	----
Proposed I		40.10		4.80	2.80	4.10	0.55	0.67	5.12	2.15	5.33	6.45	15.40	90.00	----
Proposed II		23.10	25.00	11.60	5.47	8.70	0.66	0.85	5.02	2.10	5.80	6.78	8.40	----	0.75
LSD 5%		2.77			0.16	0.40	0.05	0.17	0.23	0.03	0.36	0.08			
Mean		34.56			3.62	5.29	0.57	0.81	5.17	2.30	5.58	6.60			
Seventh year (second cycle)															
Prevailing		39.66		----	3.32	3.25	0.66	0.81	6.29	2.82	6.46	7.24	-	---	----
Proposed I		39.80		4.80	3.30	4.63	0.68	0.84	6.50	2.62	7.46	8.15	17.56	100.00	----
Proposed II		25.55	23.00	12.50	6.96	8.35	0.98	1.16	5.17	2.11	7.48	8.18	8.50	----	0.83
LSD 5%		6.18			0.05	0.80	0.07	0.41	0.10	0.15	0.51	0.71			
Mean		35.40			4.52	5.41	0.77	0.95	5.98	2.52	7.13	7.86			
Mean	Prevailing	37.94			2.69	3.05	0.53	0.75	5.14	2.21	5.56	6.32			
	Proposed I	37.52			2.79	4.08	0.56	0.70	5.28	2.34	5.81	6.53			
	Proposed II	23.44			5.43	7.45	0.74	0.93	4.66	1.93	6.03	6.68			

The data in Table (3) show also that using intercropping system render help the inclusion of more crops as cowpea, onion, sesame and soybean and follow intensive systems as tri crop sequence in proposed (I) and (II) rotations and resulted in increased production as compared to prevailing rotation.

B – Crop rotations effect on soil contents of N, P and K and organic matter after first and second cycles.

Data presented in Table (4) showed that the available soil N P K contents and O.M were increased in proposed (I) and proposed (II) in both cycles as compared with the prevailing. These increases in proposed (I) over the prevailing were 56.03 and 41.42% for N, 27.17 and 38.80% for P and 24.34 and 31.30% for K, respectively. These increases in proposed (II) reached 83.19 and 42.88% for N, 48.91 and 45.30% for P and 54.40 and 35.10% for K, respectively. These increases could be attributed to the inclusion of legume crops and proper crop sequence which led to more soil improvement in proposed rotations than in prevailing rotation. Results also revealed that the available soil N, P and K contents increased after first and second cycles than that before starting rotation. These increases in first cycles were 77.85% for N, 115.30% for P and 42.64% for K over those before rotation. These increases in second cycle were 130.73% for N, 179.48% for P and 68.80% for K as compared to first cycle. The increases of NPK after the first cycle and more increases after second cycle may be due to the effect of proper and more favourable allelopathy and crop sequence, decomposition of plant debris. These observations are in agreement with those obtained by Abd El-Hadi et al (2000).

Data also observed that the soil organic matter content slightly increased in proposed rotations than prevailing rotation in both cycles. This increases of organic matter in proposed (I) and proposed (II) rotation were 10.62 and 37.17% in first cycle, respectively. While increases in the second cycle were 22.31 and 38.02% than prevailing rotation, respectively. The soil organic matter contents after first cycle was higher than those before rotation, those after second cycle was more improved as compared to first cycle. The increasing of organic matter at latter year of rotation indicate rotation advantage due to the effect of crop sequence and inclusion of legume crops in the proposed rotations (Abd El-Hadi et al 2000, Gregorich et al 2001and Chen et al 2004).

Table 4. Effect of crop rotations on N, P and K contents and organic matter after first and second cycles

Chemical analysis	Before Planting (0-time)	1st cycle				2nd cycle			
		Prevailing rotation	Proposed I	Proposed II	Mean	Prevailing Rotation	Proposed I	Proposed II	Mean
Available N ppm	19.100	23.200	36.200	42.500	33.970	34.400	48.650	49.150	44.070
Available P ppm	2.6800	4.6000	5.8500	6.8500	5.7700	5.8500	8.1200	8.5000	7.4900
Available Kppm	241.80	273.20	339.70	421.80	344.90	334.20	438.90	451.50	408.20
Organic Matter %	1.10	1.13	1.25	1.55	1.31	1.21	1.48	1.67	1.45

C- Crop rotation effect on intensification index:

Data in Table (5) indicated clearly that intensive crop rotation had significantly effect on intensification index. The intensification index in proposed (I), proposed (II) and prevailed rotations were 2.50, 2.64 and 2.05, respectively This increasing in proposed (I) and proposed (II) were 19.10 and 26.40% in first cycle, respectively, whereas increases were 25.71 and 34.76% in second cycle as compared to prevailing rotation. The intensification index at latter year (second cycle) was higher than those at first years. The increases were estimated 8.64% and 13.20% in proposed (I) and proposed (II) respectively. However these increases in prevailing rotation was

Table 5. Effect of crop rotations on intensification index

Crop rotation	1st year	after 1st cycle	after 2nd cycle	Mean
Prevailing	2.00	2.04	2.10	2.05
Proposed I	2.43	2.43	2.64	2.5
Proposed II	2.50	2.58	2.83	2.64
LSD 5%	0.10	0.43	0.14	----
Mean	2.31	2.35	2.50	-----

less value as compared to proposed rotation. These observations might be due to that cereal- legume rotation and intercropping systems had more effectiveness which helps to increase soil

NPK contents and organic matter levels, thereby enhancing soil fertility as well as having the additional benefit of the improved macro and micro environmental condition. (Chen et al, 2004 and Gregorich et al 2001).

D- Crop rotation effect on dry weight of annual weeds (gm/m^2) associated with wheat, maize and cotton crops:

Data presented in Table (6) showed that dry weight (gm/m^2) of annuals weeds associated with wheat, maize and cotton crops were significantly affected by crop rotations. The results indicated that dry weight of annual weeds (gm/m^2) in wheat, maize and cotton crops were more reduced in proposed (I) and proposed (II) rotations in both cycles as compared as the prevailing rotation. This reduction in proposed (I) was 34.62, 52.95 and 56.56% for wheat, maize and cotton compared with the prevailing, respectively. The reduction in proposed (II) was 50.80, 69.93 and 66.31% for wheat, maize and cotton respectively. This reduction could be attributed to growing understory crops in the intensive rotation by intercropping and proper crop sequence which resulted in reduced density of weeds. Similar results were observed by Shafshak et al (1983), Altieri and Liebman (1988), Zohry (2005) and Toaima et al (2007). The results also, revealed that the density of associated weeds were reduced after first and second cycles more than before rotation (first year). This reduction were 21.01 and 34.21% for wheat, 13.00 and 32.43% for maize and 19.12 and 33.95% for cotton, respectively. This observation is in accordance with those obtained by Shafshak et al (1983), Altieri and Liebman (1988) and Anderson (2004). They noticed that the apparent reduction in weed density at latter year of rotation resulted as a rotation advantage.

Table 6. Crop rotations effect on dry weight of annual weeds (gm/m^2) associated with wheat, maize and cotton

	Wheat				Maize				Cotton			
	1st year	After		Mean	1st year	After		Mean	1st year	After		Mean
		1st cycle	2nd cycle			1st cycle	2nd cycle			1st cycle	2nd cycle	
Prevailing	53.00	41.00	36.00	43.33	84.00	71.00	64.50	73.17	171.00	142.50	115.40	142.97
Proposed I	36.00	27.00	22.00	28.33	41.00	37.00	25.30	34.43	81.00	57.80	47.50	62.10
Proposed II	25.00	22.00	17.00	21.33	24.60	26.60	14.80	22.00	55.60	48.60	40.30	48.17
LSD 5%	9.88	5.70	8.48		4.21	4.95	8.00		2.83	1.72	2.37	----
Mean	38.00	30.00	25.00		51.50	44.80	34.80		102.50	82.90	67.70	----

E- Crop rotation effect on crop productivity of cereal unit

Data in Table (7) revealed that the values of cereal units were increased in proposed (I) and proposed (II) as compared to prevailing rotation in both cycles. These increases were estimated in proposed (I) by 21.3 and 35.00% over the prevailing, respectively. The increases in proposed (II) were estimated to 24.0 and 34.4% for cereal unit, respectively. The excesses in both proposed rotations was due to the use of legume in rotation or intercropping systems, hence could benefit from the nitrogen fixed by the legume, increase soil organic matter levels and add additional benefit of crop sequences which led to more yields in both proposed rotation than in prevailing. These results also revealed that the values of cereal unit was increased after first and second cycles than before rotation (first year). These increases in first and second cycles were 46.0 and 66.0% for cereal unit and than that before starting rotation, respectively.

Table 7.Crop rotations effect on cereal unit at first year, first cycle and second cycle

Crop rotations \ Cereal unit	Cereal unit			
	1st year	1st cycle	2nd cycle	Mean
Prevailing	151.72	192.74	223.99	189.48
Proposed I	160.83	249.25	279.77	229.95
Proposed II	165.36	255.72	289.39	236.82
LSD 5%	5.28	11.18	5.30	
Mean	159.30	232.57	264.38	

F- Crop rotation effect on the average of net return during the three crop rotations at first year (before rotation), first and second cycle crop productivity :

Data in Table (8) revealed that the values of total revenue and net return were increased in proposed (I) and proposed (II) as compared to the prevailing rotation in both cycles. These increases were estimated in proposed (II) by 11.10 and 20.20% for total revenue and net return over the prevailing, respectively. While the increases in proposed (II) were estimated to 24.00 and 32.00% over the prevailing for total revenue and net return, respectively. The excess in both proposed rotations was due to the use of legume in the rotation, or intercropping system and hence could benefit from the nitrogen fixed by legume, increase soil organic matter levels and add additional benefit of crop sequences which led to more yields in both proposed rotations than the prevailing. These results also revealed that the values of total revenue and net return were increased after first and second cycles more than first year (before rotation). The increases in first and second cycles were 9.40 and 36.50% for total revenue and 44.40 and 151.00% for net return over the first year (before rotation), respectively. The increasing of total revenue and net return at latter year of rotation (after second cycle) indicate rotation advantage due the effect of crop rotation on production and net return.

Table 8. Average of net return for the three crop rotations at first year, first and second cycle x1000

	1st year			1st cycle			2nd cycle			Mean		
	Total revenue	Total cost	Net return	Total revenue	Total cost	Net return	Total revenue	Total cost	Net return	Total revenue	Total cost	Net return
Prevailing	17.21	13.59	3.63	19.52	13.59	5.94	23.61	13.59	10.02	20.11	13.58	6.53
Proposed I	19.45	14.57	4.89	20.79	14.56	6.23	27.00	14.56	12.44	22.41	14.56	7.85
Proposed II	21.88	16.35	5.54	23.73	16.33	7.11	29.30	16.35	12.96	24.97	16.35	8.60
Mean	19.51	14.72	4.70	21.35	14.72	6.79	26.63	14.72	11.80	22.50	14.72	----

CONCLUSION

The results on crop yields and soil contents under different crop rotations after first and second cycles revealed the following:

The use of cereal-legume rotation or intercropping systems in both proposed rotations increased the values of grain yields, cereal unit and net product, as well as the available soil contents of NPK levels and organic matter percentage and reduced weed population density.

Generally, under Middle Egypt the use of cereal- legume rotation or intensive rotation (intercropped) increased agriculture production

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دورات زراعية مكثفة لزيادة الانتاج الزراعى فى مصر الوسطى

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أجريت تجربة طويلة الأمد فى محطة بحوث ملوى (فى مصر الوسطى) فى أرض طينية طمييـــة. وقد بدأت التجربة فى عام ٢٠٠٢/٢٠٠١ واستمرت حتى ٢٠٠٨/٢٠٠٧. كان الهدف مـــن هـــذه الدراســـة مقارنة دورتين مقترحتين مكثفتين بفرض أنهما أكثر انتاجا وتنمية مستدامة وأقل اصابة بالحـــشائش عـــن الدورة السائدة. وقد أوضحت النتائج أن المحاصيل الناتجة فى كلا من الدورتين المقترحتين كانت أفضل من المحاصيل الناتجة من الدورة السائدة. كذلك أظهرت النتائج أن محتويات التربة من النتروجين والفوســـفور والبوتاسيوم ومحتوى المادة العضوية كانت فى حالة تطبيق الدورتين المقترحتين المكثفين أكبر من محتـــوى هذه العناصر فى التربة فى حالة تطبيق الدورة السائدة. كما أوضحت النتائج أن محتوى التربة مـــن هـــذه العناصر والمادة العضوية فى نهاية الدورة الثانية كانت أكبر من هذه المحتويات بعد تطبيق الدورة الأولـــى وجاء معدل التكثيف فى الدورة المقترحة الأولى٢,٥ وفى الثانية٢,٦بالمقارنة بالدورة السائدة حيث كان معدل التكثيف بها ٢,٠٥.كما قلت نسبة الحشائش الحولية بالدورات المقترحة بـــ٥٠% عن الدورة السائدة. كما أن العائد النقدى الكلى وصافى الربح عن الدورات المقترحة كان

أكبر عنها فى الدورة السائدة. وقد فسرت الزيادة فى كمية الحاصل ومحتوى التربة من العناصـــر ومعدل التكثيف والنقص فى كثافة الحشائش بادخال المحاصيل البقولية ونظم التحميل مما يزيد الانتاج فـــى وحدة المساحة ويحافظ على محتوى العناصر بالتربة ويزيد من خصوبتها ويزيد من المادة العضوية.