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Technical Report

Adaptation Technologies in Agriculture: Adoption and Impact Assessment of Raised Bed Farming System Technology (RFST) in Egypt

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1 Introduction

Water scarcity for agriculture in Egypt has been, and will continue to be, a profound problem. The water scarcity has crossed the threshold value of 1,000 m3/capita/yr, and tend to be down to 500 m3/capita/yr in 2025 if there is no significant improvement in management (Swelam, 2016). Moreover, negative effects of climate change on agricultural production further asserts problems associated with water allocation for agriculture. According to a 2013 report by the United Nations Development Programme (UNDP) in association with the Egyptian Government and various other UN agencies, agricultural production could decrease by 8-47% by 2060, with employment losses of up to 39% (Swelam, 2016). Thus, the current and future challenge in Egypt is how to produce more food with less water resources. The benefits of each drop applied could be maximized by adopting appropriate irrigation scheduling and adapted irrigation practices.

Research on water management to achieve higher productivity in irrigated agriculture has identified mechanized raised bed technology (MRBT) as an important component of improved crop production package (Karrou et al., 2011; Swelam, 2016). Raised bed technology has been proven to increase crop yields in both winter and summer crops and improve water use efficiency through decreasing irrigated areas, shortening the time needed for irrigation, and reducing water volume needed for a same amount of crops.

Applying this practice can help to spend less money for irrigation, while achieving higher yields and increasing the farm income. The technology has been technically tested and validated by ICARDA projects over the last 10 years in Egypt. In the experimental farms, the application of this technique with the main winter crops has shown that up to 25% of water could be saved, while crop production increased by 10%. Net benefits increased by 40% in, and additionally, it reduced variable costs by 30% (Karrou et al., 2011). This technology was disseminated for promoting sustainable agricultural intensification in 22 Egyptian governorates, as part of a nation-wide campaign by the Egyptian Government on self-sufficiency in wheat production (Swelam, 2016).

Although a great deal of knowledge on the proven role of MRBT in improving water use efficiency given by irrigation, agronomic and economic studies, too few studies seek to understand (1) drivers affecting farmers' adoption of MRBT, (2) multi-aspects efficiency of MRBT (technically, economically and ecologically/environmentally), (3) impacts of MRBT on whole farms' performance and households' livelihoods. Proven knowledge on these issues will be essential for informing policies and development practices that aim disseminating the technology towards achieving food security, water resources saving, and thereby better resilience to climate change.

Drivers of farmers' MRBT adoption: So far there has been a few studies on raised bed adoption in Egypt, such as the study of Dessalegn et al. (2016) conducted in Sharkia Governorate. As many other adoption analyses, the drivers of raised bed adoption were inferred from the analysis of one household/farm sample selected for the study area, hence the revealed cause-effect relationships are also applied uniformly over the study area. Indeed, the causal relationships defined in that way (one sample for the study area) is validly applied for an 'average household/farm' of the area (located in the centroid of the multi-variate sample). The more diversity in livelihood context/setting in the area would lead to the less representativeness of this average household/farm, thus weakening the plausibility of applying the causal relationship over the whole area. An improved method would be

the stratification the studied population in according to functional livelihood contextual types, then conduct multi-variate adoption analysis for each strata to additionally infer adoption drivers in specific to the livelihood context type (Thiombiano and Le, 2016a). Adoption analysis in this way requires the identification of plausible livelihood contextual types beforehand. The livelihood contextual typology is also important as it can shape the efficiency assessment of the considered technology/intervention (Thiombiano and Le, 2015; Thiombiano and Le, 2016b).

Efficiency assessment of MRBT: So far, most of efficiency assessments for raised bed technology in Egypt have done in a straightforward way, which were about the partial agronomic efficiency – with respect to crop output, i.e. water productivity index (water volume needed / unit of crop yield), or to water input (crop yield response / unit of water input) - and irrigation cost (cost of irrigation / unit of cropping area, or cost of irrigation / unit of crop yield). However, at the same time crop yield is also influenced by other side conditions (e.g. soil quality) and other inputs (e.g. fertilizers and labor). Variation of these factors can make the comparison of the above indicators over the studied population inadequate. Moreover, it is important to know the ceiling of water use efficiency the MRBT can bring about (i.e. the efficiency frontier) as a reference for setting realistic goals and pathway towards to achieve the goals. Next, it would be useful to understand how MRBT shape the productivity-risk relationship. The meaningful hypothesis would be the implementation of MRBT can improve water productivity and yield while reduce, or not to increase risk for crop production. All of these issues have remained a gap in knowledge.

Impact assessment of MRBT: In current literature, effects of MRBT on what beyond crop yields, such as performance of whole farm, community livelihoods and irrigated agricultural landscape in Egypt have been speculative anticipations or hopes rather than scientific proofs or science-based projections. Efforts on filling this gap is important to realize impact pathways from interventions in MRBT toward achieving development goals in national and international programs and policies.

In line with the knowledge gaps above-justified, the following objectives are proposed to be considered:

(i) Identify and characterize main livelihood types of smallholders in terms of their farms' biophysical and socioeconomic characteristics.

(ii) Identify determinants, both common and livelihood type-specific, of farmers' adoptions of MRBT over ICARDA's studied area in Egypt.

(iii) Evaluate impacts of MRBT on whole farm productivity and profit, household livelihoods, irrigated community-landscape (multi-scale impacts).

2 Methodological Framework

2.1 Sample size and Characterization

The study has been conducted in Sharkia (6 districts) and Assiut (3 districts) governorates, A random sample of 360 individuals have been selected from several districts in the two governorates, 80 farmers were practicing traditional farming methods, while the remaining 180 were adopters of the Mechanized Raised Bed farming system (MRB).

2.2 Sample Classification

2.2.1 Traditional Farmers

Data presented in Table 1 reveal that individuals belonging to traditional farmers at the level of Sharkia comprise 14 from Zaqaziq, 30 from Awlad Saqr, 5 from Menia Al-Qamh, 15 from Hehia, 21 from Abo-Ahmed and 5 from Faqos district. Out of the total samples, the small farmers represent 91%, graduates represent 3% and tenants represent 6%. Farmers who own lands located on the head of Mesqa account for 38%, those who own lands located on the middle of Mesqa account for 33% and those who own lands located on the tail of Mesqa account for 29%.

At the level of Assiut, The traditional farmers include 45 from Manfalot and 45 from Al-Fat'h district, all of which are small farmers (100%). whereas, farmers who own lands located on the head of Mesqa account for 30%, those who own lands located on the middle of Mesqa account for 54% and those who own lands located on the tail of Mesqa account for 16%.

2.2.2 Adopters of Mechanized Raised-bed Farming

It can be noted from table (1) that adopters of MRB farming at the level of Sharkia include 14 from Zaqaziq, 29 from Awlad Saqr, 5 from Menia Al-Qamh, 15 from Hehia, 20 from Abo-Ahmed and 7 from Faqos district. All of the sample individuals are small farmers. Farmers here either own lands on the middle of Mesqa (43%), or on the tail of Mesqa (57%).

In regards adopters of MRB farming at the level of Assiut, data indicate that sample individuals include 60 from Al-Fat'h district and 30 from abnob district, all of whom are small farmers. In addition, 19% of them own lands on the middle of Mesqa, 64% own lands on the middle of Mesqa and 17% own lands on the tail of Mesqa.

3 Cropping Pattern

Area under summer crops at the level of the study sample area is estimated at 426.12 acres, whereas area under winter crops is estimated at 533.11 acres, as shown in table 2. Cotton, maize, rice and sorghum are the main crops grown in the summer season, while wheat, clover and sugar beet are the main crops grown in the winter season.

Table 1. Sample Classification

Governorate	District	Traditional Farming							MRB Farming System						
		No. of Individuals	Category			Land Location on "*Mesqa*"			No of Interviewers	Category			Land Location on "*Mesqa*"		
			Small farmer Beneficiary	Graduates	Other (Investors)	Head	Middle	End		Small farmer Beneficiary	Graduates	Other (Investors)	Head	Middle	End
Sharkia	Zaqaziq	14	13	-	1	5	5	4	14	14	-	-	-	5	4
	Awlad Saqr	30	29	-	1	12	5	13	29	29	-	-	9	15	5
	Menia Al-Qamh	5	2	3	-	2	2	1	5	5	-	-	2	2	1
	Hehia	15	15	-	-	4	7	4	15	15	-	-	6	7	2
	Abo-Hammad	21	18	-	3	9	9	3	20	20	-	-	7	7	6
	Faqos	5	5	-		2	2	1	7	7	-	-	3	3	1
Total		90	90	82	3	5	34	30	26	90	90		-	-	39
Assiut	Manfalot	45	45	-	-	19	18	8	-	-	-	-			
	AL-Fat'h	45	45	-	-	8	31	6	60	60	-	-	9	44	7
	Abnob	-	-	-	-	-	-		30	30	-	-	8	14	8
Total		90	90	90		-	27	49	14	90	90		-	17	58

3.1 Summer Crops

Rice: rice is grown in Sharkia only. Area under rice at the level of the study sample is estimated at 179.8 acres representing around 42% of the total area under summer crops at the level of the study sample. Farmers who grow rice under MRB and traditional farming systems are almost equivalent. Total number of plots from where data have been collected is 125.

Cotton: area under cotton at the level of the study sample is estimated at 80.6 acres representing 19% of the total area under summer crops at the level of the study sample. Farmers who grow cotton under MRB system represent 55%, while those who grow the crop under traditional farming system represent 45%. Total number of plots from where data have been collected is 51.

Maize: area under maize grown in Sharkia and Assiut represent 12% and 25% of the total area under summer crops at the level of the study sample, respectively. It can be noted that, in Sharkia, farmers who grow maize under MRB system represent 62% compared 38% who grow the crop under traditional farming system. By contrast, farmers who grow maize under MRB farming system in Assiut represent only 30%, whereas those who grow the crop under traditional farming system represent 70%. Total number of plots from where data have been collected is 124.

Sorghum: is grown in Assiut only, with total area estimated at 113.12 acres representing 27% of the total area under summer crops at the level of the study sample. Farmers who grow sorghum under

MRB and traditional farming systems are almost similar, where they represent 52% and 48%, respectively. Total number of plots from where data have been collected is 107.

Table 2. Cropping Pattern

Governorate	Season	Crop	Traditional Farming						MRB Farming System					
			Plot No. 1			Plot No. 2			Plot No. 1			Plot No. 2		
			No	Area		No	Area		No	Area		No	Area	
				Acre	Qerat*		Acre	Qerat*		Acre	Qerat*		Acre	Qerat*
Sharkia	Summer	Rice	65	86	22	2	2	12	53	82	-	5	7	22
		Maize	7	6	10	13	14	-	14	21	-	15	12	-
		Cotton	18	23	6	9	13	-	23	43	-	1	1	-
		Total	90	116	14	24	29	12	90	146	0	21	20	22
	Winter	Wheat	90	126	6	-	-		90	139	14	-	-	-
		Clover	-	-	-	20	16	16	-	-	-	27	21	10
		Sugar Beet	-	-	-	2	-	7	-	-	-	4	6	-
		Total	90	126	6	22	16	23	90	139	14	31	27	10
Assiut	Summer	Rice	-	-	-	-	-	-	-	-	-	-	-	-
		Maize	46	76	12	-	-	-	29	33	7	-	-	-
		Cotton	-	-	-	-	-	-		-	-	-	-	-
		Sorghum	44	56	17	2	2	12	61	54	7	-		-
		Total	44	56	17	2	2	12	61	54	7	-	-	-
	Winter	Wheat	90	134	17	-	-	-	90	87	1	-	-	-
		Clover	-	-	-	2	1	12	-	-	-	-	-	-
		Total	90	134	17	2	1	12	90	87	1	-	-	-

* One qerat = 0.0417 acre

3.2 Winter Crops

Wheat: Is grown in Sharkia and Assiut on a total area estimated at 487.14 acres or 95% of the total area under winter crops at the level of the study sample. Number of farmers who grow wheat under traditional and MRB systems represent 54% and 46%, respectively. Total number of plots from where data have been collected is 360.

Clover: Is grown in Sharkia and Assiut on a total area estimated at 39.14 acres or 7% of the total area under winter crops at the level of the study sample. Farmers who grow clover under MRB system represent 55%, whereas those who grow the crop under traditional system represent 45%. Total number of plots from where data have been collected is 49.

Sugar Beet: Is grown in Sharkia on an area representing 1% of the total area under winter crops at the level of the study sample. Total number of plots from where data have been collected is 6.

4 Production costs

4.1 Production Cost For Summer Crops

Data in table 3 present the production costs of summer crops classified by farming system in Sharkia and Assiut. The following can be inferred from the table:

Cotton: In Sharkia, total variable cost per acre of cotton grown under traditional farming system in plots 1 and 2 amount to LE 7348 and LE 6882, respectively, while fixed cost account for 60% and 63% of the total cost of cotton production, respectively. Costs of seeds, manure, chemical fertilizers and pesticides account for 40% and 37% of the total variable costs of cotton grown in the two plots, respectively. In regard to cotton grown under MRB system, total variable cost per acre at the level of plot 1 and 2 amount to LE 5947 and LE 8652, while fixed cost account for 72% and 52% of the total cost of cotton production, respectively.

Maize: In Sharkia, total variable cost per acre of maize grown under traditional farming system in plots 1 and 2 reached LE 5679 and LE 5815, respectively, while fixed cost accounts for 60% in both cases. In regards to maize grown under MRB system, total variable cost per acre reached LE 5344 and LE 6589 for plots 1 and 2, respectively, while fixed cost accounts for 62% and 53%, respectively. In Assiut, total variable cost per acre of maize grown under traditional farming system amounts to LE 4924, while fixed cost accounts for 62%. As for maize grown under MRB farming system, variable cost per acre amounts to LE 5655, while fixed cost accounts for 54% of the total cost of maize production.

Rice: In Sharkia**,** total variable cost per acre of rice grown under traditional farming system in plots 1 and 2 amount to LE 5770 and LE 5035, respectively, while fixed costs account for 60% and 66% of the total production cost, respectively. In regard to rice grown under MRB system, total variable cost per acre at the level of plots 1 and 2 amount to LE 5542 and LE 4756, respectively, while fixed costs account for 62% and 74% of the total production cost, respectively.

Sorghum: In Assiut, total variable cost per acre of sorghum grown under traditional farming system amounts to LE 5039, while fixed cost accounts for 60% of the total cost of sorghum production. As for sorghum grown under MRB system, total variable cost per acre amounts to LE 6334, while fixed cost accounts for 49% of the total cost of sorghum production.
It can be noted that rent per acre is one of the main reasons for the obvious increase in production cost, where it represents 45% to 74% of the total production cost.

4.2 Total revenue from summer crops

Total revenues from summer crops grown under traditional and MRB farming systems at the level of Sharkia and Assiut governorates are presented in table 4. It can be noted that:

Cotton: In Sharkia, total revenue per acre of cotton grown in plots 1 and 2 under traditional farming system reached LE 25240 and LE 26725, respectively, where average yield per acre reached 1.26 and 1.38 tons, respectively, and average price per ton reached LE 19464 and LE 18756, respectively. Revenue from byproducts reached LE 796 and LE 905 per acre, respectively.

Table 3. Cost of Production Inputs for Summer Crops

Plot No.	Gover.	Input	Unit	Traditional Farming												MRB System											
				Cotton			Maize			Rice			Sorghum				Cotton			Maize			Rice			Sorghum		
				Q	p	V	Q	p	V	Q	p	V	Q	p	V		Q	p	V	Q	p	V	Q	p	V	Q	p	V
1	Sharkia	Seeds	Kg/Fed	24	10	240	11	32	330	75	4	300					24	7	168	11	40	440	73	3	219			
		Manure	m3/Fed	23	36	828	15	27	357	18	35	630					21	25	525	14	30	420	20	25	510			
		Urea (46.5%)	Kg/Fed	4	130	520	4	150	600	4	130	481					4	90	360	4.2	85	530	4	112	426			
		Phosphate	Kg/Fed	5	48	240	4	60	250	4	48	178					4	40	160	4	40	160	4	42	160			
		Potassium	Kg/Fed	2	290	580			0	1	270	270					1	170	170			0	1	245	319			
		Other Fertilizer	Kg/Fed			0			0			0							0			0			0			
		COTAINERS	Kg/Fed	10	17	170	58	3	174	53	2	106					8	13	104	60	2	120	56	2	112			
		Pesticides	Liter/Fed	3	90	270	4	85	360	2	80	160					3	60	180	1.7	78	133	2	73	161			
		Transportation	L.E/Fed	1	120	120	1	160	160	1	140	140					1		0	1	180	180	1	150	150			
		Rent	L.E/Fed			4380			3400			3455							4280			3310			3440			
		Tax	L.E/Fed			50			53			50										50			47			
		Total Cost	L.E/Fed			7348			5679			5770							5947			5344			5542			
	Assiut	Seeds	Kg/Fed				11	35	368				5	79	411					11	58	615				5	115	610
		Manure	m3/Fed				12	25	290				10	35	347					15	40	608				17	48	806
		Urea (46.5%)	Kg/Fed				6	118	708				5	140	686					5	150	750				5	190	969
		Phosphate	Kg/Fed				4	43	168				3	55	190					4	50	180				4	76	312
		Potassium	Kg/Fed						0						0							0						0
		Other Fertilizer	Kg/Fed						0						0							0						0
		COTAINERS	Kg/Fed				37	2	73				38	2	77					38	2	76				37	3	110
		Pesticides	Liter/Fed				1	70	77				2	82	139					2	120	204				2	133	293
		Transportation	L.E/Fed				1	160	160				1	120	120					1	120	120				1	110	110
		Rent	L.E/Fed				1		3030				1		3020					1		3050				1		3075
		Tax	L.E/Fed						50						50							52						50
		Total Cost	L.E/Fed						4924						5039							5655						6334
2	Sharkia	Seeds	Kg/Fed	24	9	216	12	40	480	60	4	240					24	13	312	11	45	495	78	4	311			
		Manure	m3/Fed	24	31	744	10	30	300			0					25	40	1000	22	40	880			0			
		Urea (46.5%)	Kg/Fed	4	165	693	5	140	700	4	140	560					6	165	990	5	160	800	4	99	396			
		Phosphate	Kg/Fed	4	44	185	6	60	240	4	52	187					5	65	325	5	70	350	4	41	176			
		Potassium	Kg/Fed	1	268	268			0	1	400	320					2	275	550			0			0			
		Other Fertilizer	Kg/Fed			0			0			0							0			0			0			
		COTAINERS	Kg/Fed	9	14	126	35	2.9	105	49	2	98					10	20	200	48	3	144	57	2	114			
		Pesticides	Liter/Fed	3	78	226	3	111	333	2	84	202					6	110	660	2	120	240	2	76	137			
		Transportation	L.E/Fed	1	96	67	1	142	142	1	100	80					1	100	100	1	132	132	1	126	76			
		Rent	L.E/Fed			4310			3465			3300							4500			3500			3500			
		Tax	L.E/Fed			47			50			48							45			48			46			
		Total Cost	L.E/Fed			6882			5815/			5035							8682			6589			4756			

Total revenue per acre of cotton grown in plots 1 and 2 under MRB system reached LE 24323 and LE 26850, respectively, where average yield per acre reached 1.23 and 1.42 tons, while average price per ton reached LE 19072 and LE 18154, respectively. Revenue earned from byproduct reached LE 851and LE 1200 per acre, respectively.

It can be noted that, contrary to plot 2, yield realized from plot 1 under traditional farming is higher compared to MRB system. In addition, price per ton of cotton produced under MRB is higher than that produced under traditional farming.

Maize: In Sharkia, total revenue per acre of maize grown under traditional farming system in plots 1 and 2 reached LE 10389 and LE 8726, respectively, where average yield per acre from plots 1 and 2 reached 3.1 and .28 tons, respectively, while average price per ton reached LE 3184 and LE 2982, respectively. Revenue from byproducts of maize grown in plots 1 and 2 reached LE 519 and LE 376 per acre, respectively. In Assiut, total revenue per acre reached LE 13965, where average yield per acre reached 3.1 tons and average price per ton reached LE 4179. Revenue from maize byproduct reached LE 592 per acre.

As for maize grown under MRB system, total revenue per acre of maize grown in plots 1 and 2 in Sharkia under traditional farming system reached LE 10749 and LE 9034, respectively, where average yield per acre reached 3.5 tons and 3 tons, respectively, while average price per ton reached LE 2893and LE 2936, respectively. Revenue from byproducts of maize grown in the two plots reached LE 623 and LE 226 per acre, respectively. In Assiut, total revenue per acre of maize grown under MRB system reached LE 13563, where average yield reached 3.1 tons and average price per ton reached LE 4157. Revenue from byproduct reached LE 676 per acre.

It can also be noted that yield realized under MRB system is higher than that realized under traditional farming. In addition, average price per ton of maize produced under traditional farming is higher compared to that produced under traditional farming.

Rice: In Sharkia, total revenue per acre of rice grown under traditional farming system in plots 1 and 2 reached LE 15286 and LE 14927, respectively, where average yield reached 3.97 and 3.8 tons, respectively, and average price per ton reached LE 3718 and LE 3775, respectively. Revenue from byproduct of maize grown in the two plots reached LE 525 and LE 582per acre, respectively.
Total revenue per acre of rice grown under MRB system in plots 1 and 2 reached LE 15326 and 16936, where average yield reached 3.99 and 4 tons, respectively, and average price per ton reached LE 3710 and 4050, respectively. Revenue from byproducts of rice produced from the two plots reached LE 534 and LE 573per acre, respectively.

It can be noted that total revenue per acre from plot 2 under MRB is higher due to higher yield and average price per ton.

Sorghum: In Sharkia, total revenue per acre of sorghum grown under traditional farming system reached LE 12103, where average yield per acre reached 2.5 tons and average price per ton reached LE 4690. Revenue from byproduct of sorghum grown reached LE 378 per acre. In Assiut, total revenue per acre of sorghum grown under MRB system reached 13840, where average yield reached 2.8 tons and average price per ton reached 4785. Revenue from sorghum byproducts reached: LE 442 per acre.

Table 4. Total Revenue Per Acre Under Summer Crops

Part	Govern	Crop	Traditional							MRB						
			Main Product			Byproduct			Total Revenue	Main Product			Byproduct			Total Revenue
			Q (Ton)	P (LE)	R (LE)	Q (Ton)	P (LE)	R (LE)	(TR) (LE)	Q (Ton)	P (LE)	R (LE)	Q (Ton)	P (LE)	R (LE)	(TR) (LE)
1	Sharkia	Cotton	1.26	19464	24444	8.8	90	796	25240	1.23	19072	23819	8.9	96	851	24323
		Maize	3.1	3184	9870.4	12.4	42	519	10389	3.5	2893	10126	13.5	46	623	10749
		Rice	3.97	3718	14761	2.22	236	525	15286	3.99	3710	14792	2.2	237	534	15326
	Assiut	Maize	3.2	4179	13373	12.6	47	592	13965	3.1	4157	12887	14.5	47	676	13563
		Sorghum	2.8	4690	13132	14	27	378	13510	2.5	4785	11963	17	26	442	12405
2	Sharkia	Cotton	1.38	18756	25820	9.7	93	905	26725	1.42	18154	25650	12	100	1200	26850
		Maize	2.8	2982	8349.6	12.7	47	376	8725.6	3	2936	8808	8.9	47	226	9034
		Rice	3.8	3775	14345	2.4	243	582	14928	4.0	4050	10125	2.3	244	573	10698

It can be noted that total revenue per acre from plot 2 under MRB is higher due to higher yield and average price per ton.

4.3 Production Cost for Winter Crops

Data in table 5, which presents the production costs for winter crops classified by farming system at the level of Sharkia and Assiut governorates, reveal that:

Wheat: In Sharkia, total production cost per acre of wheat grown under traditional farming in plot 1 amounts to LE 6677. Rent per acre reached LE 4355, indicating that fixed cost accounts for 65% of the total production cost. In Assiut, total production cost per acre reached LE 7874 and fixed cost accounts for 68% of the total production cost. As for wheat grown under MRB system, total production cost per acre in Sharkia amounts to LE 6379 and fixed cost accounts for 69% of the total production cost. In Assiut, total production cost per acre amounts to LE 7881 and fixed cost accounts for 68% of the total production cost.

Clover: In Sharkia, total production cost per acre of clover grown under traditional farming in plot 2 amounts to LE 6603. Rent per acre reached LE 4410, indicating that fixed cost accounts for 67% of the total cost of production. In Assiut, total production cost per acre reached LE 6330 and fixed cost accounts for 67% of the total production cost. In regard to clover grown under MRB system in plot 2 in Sharkia, total production cost per acre amounts to LE 6909, while fixed cost accounts for 60% of the total cost of production.
Given the limited data on clover in Assiut, neither production cost nor revenue are calculated.

Sugar Beet: Is grown in Sharkia. Total production cost per acre of sugar beet grown in plot 2 under traditional farming amounts to LE 6588. Rent per acre reached LE 4500, indicating that fixed cost accounts for 68% of the total cost of production. As for sugar beet grown in plot 2 under MRB system, total production cost per acre amounts to LE 7347, while fixed cost accounts for 61% of the total production cost.

It is worth mentioning that rent per acre during the winter season is higher compared to the summer season, which resulted in increasing its share in total production cost to reach 61%-69%.

4.4 Total Revenue From Winter Crops

Data in Table 6 present total revenue per acre for winter crops grown under traditional and MRB system in Sharkia and Assiut. The following can be inferred from the table:

Wheat: In Sharkia, total revenue per acre of wheat grown under traditional farming system reached LE 12256, where average yield reached 2.5 tons and average price per ton reached LE 3817, while revenue from wheat byproduct reached LE 2880per acre. In Assiut, total revenue per acre reached LE 13864, where average yield reached 2.5 tons and average price per ton reached LE 3860, while revenue from wheat byproduct reached LE 4281per acre.

Table 5. Cost of Production Inputs for Winter Crops

Plot No.	Govern	Inputs	Unit	Traditional Farming									MRB System								
				Wheat			Clover			Sugar Beet			Wheat			Clover			Sugar Beet		
				Q	p	V	Q	p	V	Q	p	V	Q	p	V	Q	p	V	Q	p	V
1	Sharkia	Seeds	Kg/Fed	78	5	407							44	5	208						
		Manure	m^3/Fed	16	34	556							17	31	533						
		Urea (46.5%)	Kg/Fed	4	127	521							4	115	460						
		Phosphate	Kg/Fed	4	46	202							4	42	168						
		Potassium	Kg/Fed	1	245	196							1	207	166						
		Other Fertilizer	Kg/Fed			0									0						
		COTAINERS	Kg/Fed	38	2	79							37	2	67						
		Pesticides	Liter/Fed	2	81	186							2	75	158						
		Transportation	L.E/Fed	1	125	125							1	195	195						
		Rent	L.E/Fed			4355									4375						
		Tax	L.E/Fed			50									50						
		Total Cost	L.E/Fed			6677									6379						
	Assiut	Seeds	Kg/Fed	81	5	379							46	7	338						
		Manure	m^3/Fed	12	32	388							17	46	777						
		Urea (46.5%)	Kg/Fed	5	126	605							5	175	858						
		Phosphate	Kg/Fed	4	46	189							4	70	273						
		Potassium	Kg/Fed																		
		Other Fertilizer	Kg/Fed																		
		COTAINERS	Kg/Fed	441	2	705							45	3	118						
		Pesticides	Liter/Fed	1	73	102							1	110	143						
		Transportation	L.E/Fed	1	150	150									5374						
		Rent	L.E/Fed			5357									54						
		Tax	L.E/Fed			51															
		Total Cost	L.E/Fed			7874									7881						
2	Sharkia	Seeds	Kg/Fed				32	33	1056	4	20	86				31	36	1105	4	20	80
		Manure	m^3/Fed						0	33	33	1109						0	35	33	1166
		Urea (46.5%)	Kg/Fed				2	218	523	4	122	488				3	232	580	7	125	913
		Phosphate	Kg/Fed				5	77	370	5	43	228				5	83	415	7	43	301
		Potassium	Kg/Fed															0			
		Other Fertilizer	Kg/Fed															0			
		COTAINERS	Kg/Fed															0			
		Pesticides	Liter/Fed							2	77	177				3	158	395	4	90	342
		Transportation	L.E/Fed				1	203	244			0				1	190	247			0
		Rent	L.E/Fed						4410			4500						4167			4500
		Tax	L.E/Fed						50			48						47			46
		Total Cost	L.E/Fed						6603			6588						6909			7301

On the other hand, total revenue per acre of wheat grown under MRB system in Sharkia reached 13470, where average yield reached 2.7 tons and average price per ton reached LE 3837, while revenue from byproduct reached LE 1890 per acre. In Assiut, total revenue per acre reached LE 14567, where average yield reached 2.8 tons and average price per ton reached LE 3914, while revenue from byproduct reached LE 3663per acre.

It can be noted that revenue per acre cultivated under traditional farming in Sharkia and Assiut is higher due to the higher yield and average price per ton.

Clover: Is grown in Sharkia. Total revenue per acre of clover grown under traditional farming system reached LE 13528, where average yield reached 27.5 tons and average price per ton reached LE 490. On the other hand, total revenue per acre of clover grown under MRB system reached LE 13325, where average yield reached 27.2 tons and average price per ton reached LE 490.
It can be noted that average yield realized from clover grown under traditional farming is higher than that realized under MRB system.

Sugar Beet: In Sharkia, total revenue per acre of sugar beet grown under traditional farming system in plot 2 reached LE 18010, where average yield reached 25 tons and average price per ton reached LE 662, while revenue from byproduct reached LE 1467per acre, respectively. Total revenue per acre of sugar beet grown under MRB system reached LE 18040, where average yield reached 25.3 tons and average price per ton reached LE 670, while revenue from byproduct reached LE 1067per acre.
It can be noted that revenue per acre of sugar beet grown under MRB system is higher compared to revenue per acre under MRB system due to the higher yield and average price per ton.

4.5 Labor Cost

Cotton: Is grown in Sharkia. Labor cost classified by farm operation and farming system is presented in table 7. Total number of labor engaged in cotton cultivation under traditional farming amounts to 124 workers, of which 62% is family labor. Female labor reached 54 or 33% of the total number of labor. Total labor cost reached LE 8030/acre, of which machine usage cost is LE 813/acre or 10% the total cost of labor work, while average work time is estimated at 31 hours. Harvesting operation accounts for 80% of the total labor cost.

In regards to cotton grown under MRB system, total number of labor engaged in cultivation amounts to 112. Female workers amount to 49 or 44% of the total number of labor work, whereas family labor accounts for 20%. Total labor cost reached LE 7645/acre, of which machine usage costs LE 1072 per acre or 14%, with average work time estimated at 37 hours. Harvesting operation accounts for 61% of the total labor cost.

It can be noted that the number of labor under MRB system is less compared to traditional farming, which helps reduce production cost.

Rice: Is grown in Sharkia. Data in table 8 indicate that total number of labor engaged in rice cultivation under traditional farming amounts to 58, of which 38 or 65% is family labor. Female

Table 6. Revenue from Winter Crops (LE/ acre)

Part No.	Govern	Crop	Traditional							MRB						
			Main Product			Byproduct			Total Revenue	Main Product			Byproduct			Total Revenue
			Q (Ton)	P (LE)	R (LE)	Q (Ton)	P (LE)	R (LE)	(TR) (LE)	Q (Ton)	P (LE)	R (LE)	Q (Ton)	P (LE)	R (LE)	(TR) (LE)
1	Sharkia	Wheat	2.5	3817	9376	10.4	278	2880	12256	2.7	3837	10550	10.5	278	2919	13470
	Assiut	Wheat	2.5	3860	9583	11.7	367	4281	13864	2.8	3914	10904	10.6	346	3663	14567
2	Sharkia	Clover	27.5	490	13528				13528	27.2	490	13325				13325
		Sugar Beet	27	662	17888	7.3	200	1467	19354	25.3	670	16974	5.3	200	1067	18040
	Assiut	Clover	26	450	11700				11700							

Table 7. Cost of Farm Operations for Cotton Grown in Sharkia

	Traditional System											MRB System										
	Hired Labor LE/day						Family Labor LE/day			Machine Usage		Hired Labor LE/day						Family Labor LE/day			Machine Usage	
	Men	Cost	Women	Cost	Boy/Girl	Cost	Men	Women	Boy/Girl	hours	Cost LE/hr	Men	Cost	Women	Cost	Boy/Girl	Cost	Men	Women	Boy/Girl	hours	Cost LE/hr
Organic Fertilizer		0		0		0	1.3			0.8	72		0		0		0.0	0.6			0.6	36
Land Preparation		0		0		0	0.9			2.8	266		0		0		0	0.8			2.0	170
Agricultural Gypsum		0		0		0					0		0		0		0					0
Land Leveling	1.9	143		0		0	1.4			1.2	180		0		0		0	0.6			2.3	334
Planting	4.3	387	4.8	336		0	1.1	1.5	1.5		0	4.2	395	3.9	273		0	1.0				0
Irrigation		0		0		0	5.5		32.0	22	0	4.8	360		0		0	5.1			30	443
Fertilizing	1.5	113	3.9	273		0	1.5				0	1.2	90	1.0	70		0	1.4				0
Weeding/Hoeing	4.6	405	3.1	233		0	1.4				0	4.2	378	2.7	189		0	1.2				0
Replanting		0		0		0	1.2	0.8	0.8		0		0		0		0	1.0				0
Pest Control		0		0		0	1.1		1.5	2.8	70		0		0		0	0.8			2.9	90
Harvesting	21.7	1628	38.0	2660	12.6	756	1.9	1.5	1.3		0	20	1400	40	2720	8.8	528	1.7	1.8	1.3		0
Threshing & Winnowing		0		0		0					0		0		0		0					0
Residual Removing	3.0	285		0		0	1.6				0	1.7	170		0		0	1.6				0
Transportation		0		0		0	0.9		0.8	1.5	225		0		0		0	1.0				0
Total	37	2959	50	3502	13	756	20	4	38	31	813	36	2793	48	3252	9	528	17	2	1	37	1072

Table 8. Cost of Farm Operations for Rice Grown in Sharkia

Farm Operation	Traditional System											MRB System										
	Hired Labor LE/day						Family Labor LE/day			Machine Usage		Hired Labor LE/day						Family Labor LE/day			Machine Usage	
Organic Fertilizer	0.7	70		0		0	1.5			0.8	841	0.6	45		0		0	0.8			0.6	60
Land Preparation	0.7	56		0		0	0.9		0.7	3.0	390	0.6	45		0		0	0.8		0.6	3.2	410
Agricultural Gypsum		0		0		0					0		0		0		0					0
Land Leveling	2.6	221		0		0	1.0			0.9	135	2	176		0		0	0.8			0.9	131
Planting	1.9	152	5.4	351	1.4	70	1.0	1.2	0.9		0	1.2	96	4.5	293	2.5	125	0.9	0.6	0.6		0
Irrigation		0		0		0	13.7		3.0	81.0	2187	3.2	320		0		0	13.4		3.4	80.0	2080
Fertilizing	1.2	90		0		0	1.4		0.9		0	0.9	68		0		0	1.2		0.8		0
Weeding/Hoeing		0		0		0					0		0		0		0					0
Replanting		0		0		0					0		0		0		0					0
Pest Control		0		0		0	0.8		1.5	2.2	59		0		0		0	0.8		0.6	2.2	64
Harvesting	1.0	75		0		0	1.0		0.7	3.0	705	0.7	53		0		0	0.9	0.6	0.6	2.9	754
Threshing & Winnowing	1.3	98		0		0	1.3	0.9	0.9		0	0.9	68	1.6	112		0	1.3		0.8	3	390
Residual Removing	2.2	220		0		0	1.3	1.5	0.7		0		0		0		0	0.9		0.6		0
Transportation	2.2	90					1				140									1		140
Total	14	1072	5	351	1	70	25	4	9	91	4457	10	870	6	405	3	125	22	1	9	92	4028

workers amount to 9 or 15% of the total number of labor work. Total labor cost reached LE 5950/acre, of which machine usage costs LE 4457 or 75% of the total cost of labor and average work time is 91 hours.

In regard to rice grown under MRB system, total number of labor engaged in cultivation amounts to 51, of which 32 or 6% is family labor. Female labor amounts to 7 workers or 14% of the total number of labor. Total cost of labor reached LE 5427/acre, of which machine usage cost is estimated at LE 4028 or 75% of the total cost of labor and average work time is 92 hours.

It can be noted that labor work under MRB system is less the case of traditional farming, which helps reduce production cost.

Maize: Data in table 9 indicate that total number of labor engaged in maize cultivation under traditional farming system in Sharkia amounts to 54 workers, of which 46 or 85% is family labor. Female labor accounts for 24% of the total number of labor. Total labor cost reached LE 2232/acre, of which machine usage costs LE 1583 per acre or 70% of the total cost of labor work and average work time is 30 hours.

In regard to maize cultivated under MRB system, total number of labor engaged in cultivation amounts to 32, of which family labor represents 47%. Female labor amounts to 2 representing 8% of the total number of labor. Total labor cost reached LE 2065/acre, of which machine usage cost is LE 1397 per acre or 67% of the total cost of labor and average work time is estimated at 28 hours.

Despite the lower number of labor under MRB system, production cost is higher compared to traditional farming.

At the level of Assiut, data in table 10 indicate that total number of labor engaged in maize cultivation under traditional farming amounts to 34 workers, of which 16 or 46% is family labor. It can be noted that female labor is absent. Total labor cost reached LE 2381/acre, of which machine usage costs LE 1164 per acre representing 49% of the total cost of labor work, while average work time is estimated at 25 hours.

In regards to maize grown under MRB system, total number of labor engaged in cultivation amounts to 35 workers, of which 19% is family labor. Total cost of labor reached LE 2608/acre, of which machine usage costs LE 1284/acre representing 49% of the total cost of labor work, while average work time is estimated at 28 hours.

It can be noted that labor work under MRB system is less compared to traditional farming, which helps reduce production cost.

Sorghum: Data in table 11 indicate that total number of labor engaged in sorghum cultivation under traditional farming in Assiut amounts to 35 workers, of which 17 is family labor. Total cost of labor reached LE 2451/acre, of which machine usage costs LE 1096 or 45% of the total cost of labor, while average work time is 27 hours.

In regard to sorghum grown under MRB system, total number of labor engaged in cultivation amounts to 34, of which 19 is family labor. Total cost of labor reached LE 2439/acre, of which

Table 9. Cost of Farm Operations for Maize Grown in Sharkia

Farm Operation	Traditional System											MRB System										
	Hired Labor LE/day						Family Labor LE/day			Machine Usage		Hired Labor LE/day						Family Labor LE/day			Machine Usage	
	Men	Cost	Women	Cost	Boy/Girl	Cost	Men	Women	Boy/Girl	hours	Cost LE/hr	Men	Cost	Women	Cost	Boy/Girl	Cost	Men	Women	Boy/Girl	hours	Cost LE/hr
Organic Fertilizer	1.1	99	1.1	77			1.3	2.2	1.1	1.9	187	0.7	50		0		0	0.8			1.5	152
Land Preparation							1.3		1.1	3.3	428	0.7	54		0		0	0.7			2.9	342
Agricultural Gypsum																						0
Land Leveling							1.1			1.1	148							0.7			1.4	165
Planting							2	1	1									0.9		0.7		
Irrigation							3.9			20.6	547		0		0		0	3.8			20.2	472
Fertilizing							2.2	2.2	1.6		0	1.3	100					1.1		0.7		0
Weeding/Hoeing							1.9				0						0	1.1		1.0		0
Replanting		0		0			1.8	1.5	1.1		0		0		0		0	1.1	1.1	1.0		0
Pest Control		0		0			1.9		2.2	3.6	134		0		0		0	0.7			1.9	56
Harvesting	5.6	474					2.0	1.1			0	5.4	464		0		0	1.2	1.3	0.7		0
Threshing & Winnowing							1.4	1.6	1.4		0						0	1.2	1.0	1.0		0
Residual Removing							1.7	1.5	1.1		0		0		0		0	0.8				0
Transportation							1	1			138		0		0		0	1				210
Total	7	573	1	77	0	0	24	12	11	31	1582	8	668	0	0	0	0	15	3	5	28	1397

Table 10 Cost of Farm Operations for Maize Grown in Assiut

Farm Operation	Traditional System											MRB System										
	Hired Labor						Family Labor			Machine Usage		Hired Labor						Family Labor			Machine Usage	
	LE/day						LE/day					LE/day						LE/day				
	Men	Cost	Women	Cost	Boy/Girl	Cost	Men	Women	Boy/Girl	hours	Cost LE/hr	Men	Cost	Women	Cost	Boy/Girl	Cost	Men	Women	Boy/Girl	hours	Cost LE/hr
Organic Fertilizer	0.6	52.6					0.6			0.6	63	0.9	70					1.2			1	96
Land Preparation	0.7	63.1					0.7			3.2	319	0.9	73					1.2			4	438
Agricultural Gypsum		0									0		0									0
Land Leveling	0.7	50.5					0.6				0		0									0
Planting	2.2	164.8					1.2				0	2.3	203					1.7				0
Irrigation		0					3.7			20.6	593		0					3.9			21	583
Fertilizing	0.9	69.3					1				0	1.6	124					1.2				0
Weeding/Hoeing	4	181					1				0	5.3	427					1.3				0
Replanting		0					1				0		0					1.4				0
Pest Control		0					0.6			1.1	33		0					0.9			2	52
Harvesting	6	448.2					1.9				0	3.3	265					1.4				0
Threshing & Winnowing	1.5	119.7					1.9				0	2.2	163					2.7				0
Residual Removing	0.9	68.2					0.7				0		0					1.2				0
Transportation		0					0.8				156		0					1				115
Total	18	1217	0	0	0	0	16	0	0	25	1164	16	1325	0	0	0	0	19	0	0	28	1284

Table 11. Cost of Farm Operations for Sorghum Grown in Assiut

Farm Operation	Traditional System											MRB System										
	Hired Labor LE/day						Family Labor LE/day			Machine Usage		Hired Labor LE/day						Family Labor LE/day			Machine Usage	
	Men	Cost	Women	Cost	Boy/Girl	Cost	Men	Women	Boy/Girl	hours	Cost LE/hr	Men	Cost	Women	Cost	Boy/Girl	Cost	Men	Women	Boy/Girl	hours	Cost LE/hr
Organic Fertilizer	1.0	80					0.8			0.8	84	1.0	75					1.3			1.0	78
Land Preparation	1.0	75					0.8			3.4	340	1.0	80					1.6			4.1	410
Agricultural Gypsum	0.8	56					0.8				0		0									0
Land Leveling	2.6	195					1.6			21.4	621	2.7	243					2.0				0
Planting		0					4				0		0					4.0			21.5	624
Irrigation	1.1	88					1				0	1.7	128					1.2				0
Fertilizing	4.0	300					2				0	4.4	352					1.5				0
Weeding/Hoeing		0					1				0		0					1.6				0
Replanting		0					1			2	51		0					1.4			2	66
Pest Control	6.2	465					2				0	3.7	296					1.7				0
Harvesting		0									0		0									0
Threshing & Winnowing	1.2	96					1				0	1.1	88					1.3				0
Residual Removing		0					1				0		0					1.1				0
Transportation																						
Total	18	1355	0	0	0	0	17	0	0	27	1096	16	1262	0	0	0	0	19	0	0	29	1178

machine usage costs LE 1178 or 48% of the total cost of labor work, while average work time is estimated at 29 hours.

Wheat: as shown in table 12, total number of labor engaged in wheat cultivation under traditional farming in Sharkia amounts to 47 workers, of which 27 or 57% is family labor. Female labor amounts to 17 or 37% of the total labor. Total cost of labor reached LE 3660/acre, of which machine usage costs LE 2062 or 56% of the total cost of labor, while average work time is 32 hours. As for wheat grown under MRB system, total number of labor engaged in cultivation amounts to 44, of which 20 is family labor. Female labor amounts to 11 representing 25% of the total labor. Total cost of labor reached LE 3915/acre, of which machine usage costs LE 2089 or 53% of the total cost of labor work, while average work time is estimated at 29 hours.

Turning to Assiut, data in table 13 indicate that total number of labor engaged in wheat cultivation under traditional farming amounts to 31 workers, of which 14 or 45% is family labor. Total cost of labor reached LE 3122/acre, of which machine usage costs LE 1348 representing 56% of the total cost of labor work, while average work time is 13 hours. Regarding wheat grown under MRB system, total number of labor engaged in cultivation amounts to 30, of which 16 or 53% is family labor. Total labor cost reached LE 2813/acre, of which machine usage costs LE 1465 per acre representing 52% of the total cost of labor work, while average work time is 25 hours.

Clover: As shown in table 14, total number of labor engaged in clover cultivation under traditional farming in Sharkia amounts to 55 workers, of which 51 or 89% is family labor. Total cost of labor reached LE 1797/acre, of which machine usage costs LE 1209 representing 67% of the total cost of labor work, while average work time is estimated at 27 hours.
Total number of labor engaged in clover cultivation under MRB system amounts to 48, of which 42 is family labor. Total cost of labor reached LE 1743/acre, of which machine usage costs LE 1295 representing 74% of the total cost of labor work, while average work time is estimated at 33 hours.

Sugar Beet: Data in table 15 indicate that total number of labor engaged in cultivating sugar beet under traditional farming in Sharkia amounts to 57 workers, of which 18 or 32% is family labor. Total cost of labor reached LE 3984/acre, of which machine usage costs LE 1357 representing 34% of the total cost of labor work, while average work time is estimated at 33 hours.
Under MRB system, total number of labor engaged in cultivation amounts to 55 workers, of which 16 or 29% is family labor. Total cost of labor reached LE 4192/acre, of which machine usage costs LE 1381 or 33% of the total cost of labor work, while average work time is estimated at 38 hours.

5 Crop Budget

Data in table 16 present crop budgets for all of the study crops at the level of Sharkia and Assiut, classified according to farming system. It is clear that net revenue realized from wheat grown under MRB system in Assiut is higher compared to that realized from wheat grown under traditional farming. However, net revenues realized from wheat, clover and sugar beet grown under traditional farming in Sharkia are higher compared to MRB system.

In addition, net revenues realized from cotton, maize and rice grown under MRB system in Sharkia

Table 12. Cost of Farm Operations for Wheat Grown in Sharkia

Farm Operation	Traditional System											MRB System										
	Hired Labor LE/day						Family Labor LE/day			Machine Usage		Hired Labor LE/day						Family Labor LE/day			Machine Usage	
	Men	Cost	Women	Cost	Boy/Girl	Cost	Men	Women	Boy/Girl	hours	Cost LE/hr	Men	Cost	Women	Cost	Boy/Girl	Cost	Men	Women	Boy/Girl	hours	Cost LE/hr
Organic Fertilizer	0.7	57	0.7	50			0.8	1.1		0.9	100	0.6	51		0			0.7		0.6	1	132
Land Preparation	1.0	84		0			0.9			3.1	424	0.8	67		0			0.8		0.6	3	398
Agricultural Gypsum		0		0							0		0		0							0
Land Leveling		0		0			0.9	0.7		0.7	91		0		0			0.6			1	146
Planting	0.8	66		0			1.1	0.7	0.7		0		0		0			0.7			1	175
Irrigation		0		0			3.4		0.7	18.6	543	2.6	133		0			3.0		1.3	15	404
Fertilizing	0.9	49		0			1.1	0.7	0.7		0	0.8	65		0			1.0		0.8		0
Weeding/Hoeing		0		0							0		0		0							0
Replanting		0		0							0		0		0							0
Pest Control	1.0	50		0			0.8	1.8	0.9	2.7	83	1.1	61		0			0.8		1.0	2	60
Harvesting	3.4	304	4.9	339			1.0	1.3	1.1	2.9	386	4.9	449	4.9	342			1.0	1.0	1.1	3	357
Threshing & Winnowing	2.6	249	3.6	263			1.2	0.9	1.0	3.4	434	2.8	285	4.0	308			1.1	1.0	0.9	3	417
Residual Removing	0.9	87		0			1.0	0.9	0.7		0	0.6	64		0			0.9		0.6		0
Transportation		0		0			0.9				0		0		0			0.9				0
Total	11	946	9	652	0	0	13	8	6	32	2062	14	1175	9	651	0	0	12	2	7	29	2089

Table 13. Farm Operations for Wheat Grown in Assiut

Farm Operation	Traditional System											MRB System										
	Hired Labor LE/day						Family Labor LE/day			Machine Usage		Hired Labor LE/day						Family Labor LE/day			Machine Usage	
	Men	Cost	Women	Cost	Boy/Girl	Cost	Men	Women	Boy/Girl	hours	Cost LE/hr	Men	Cost	Women	Cost	Boy/Girl	Cost	Men	Women	Boy/Girl	hours	Cost LE/hr
Organic Fertilizer	0.7	53					0.7			0.5	47	1.0	83					1.1			1	83
Land Preparation	1.4	107					0.9			2.9	338	1.2	104					1.4			3	372
Agricultural Gypsum		0									0		0									0
Land Leveling	0.9	65					0.8				0		0									0
Planting	1.7	128					1.0				0		0					1.0			1	211
Irrigation	1.2	99					3.0			18.7	514		0					2.8			14	400
Fertilizing	0.8	66					0.8				0	1.0	86					1.1				0
Weeding/Hoeing		0									0		0									0
Replanting		0									0		0									0
Pest Control		0					0.7			1.4	35		0					1.0			1	38
Harvesting	6.6	551					2.5			4.0	481	7.1	735					3.8				0
Threshing & Winnowing	3.0	241					1.6			3.3	332	2.9	258					1.6			4	362
Residual Removing	0.8	63					1.0				0	1.0	83					1.2				0
Transportation		0					0.7				0		0					1.1				0
Total	17	1374	0	0	0	0	14	0	0	31	1748	14	1348	0	0	0	0	16	0	0	25	1465

Table 14. Farm Operations for Clover Grown in Sharkia

Farm Operation	Traditional System											MRB System										
	Hired Labor LE/day						Family Labor LE/day			Machine Usage		Hired Labor LE/day						Family Labor LE/day			Machine Usage	
	Men	Cost	Women	Cost	Boy/Girl	Cost	Men	Women	Boy/Girl	hours	Cost LE/hr	Men	Cost	Women	Cost	Boy/Girl	Cost	Men	Women	Boy/Girl	hours	Cost LE/hr
Organic Fertilizer		0								0.6	72		0									0
Land Preparation	1.2	96					1.7			3.0	360	1.3	104					1.9			3.1	310
Agricultural Gypsum		0									0		0									0
Land Leveling	3.0	300					1.4			1.2	144		0								1.3	156
Planting	1.2	96					1				0	3.0	240					1.4				0
Irrigation		0					4			22.6	633		0					4.5			26.0	754
Fertilizing	1.2	96					1				0	1.3	104					1.5				0
Weeding/Hoeing		0									0		0									0
Replanting		0									0		0									0
Pest Control		0									0		0								2.5	75
Harvesting		0					40				0		0					32.0				0
Threshing & Winnowing		0									0		0									0
Residual Removing		0									0		0									0
Transportation		0					1				0		0					1				0
Total	7	588	0	0	0	0	51	0	0	27	1209	6	448	0	0	0	0	42	0	0	33	1295

Table 15. Farm Operations for Sugar Beet Grown in Sharkia

Farm Operation	Traditional System											MRB System										
	Hired Labor LE/day						Family Labor LE/day			Machine Usage		Hired Labor LE/day						Family Labor LE/day			Machine Usage	
	Men	Cost	Women	Cost	Boy/Girl	Cost	Men	Women	Boy/Girl	hours	Cost LE/hr	Men	Cost	Women	Cost	Boy/Girl	Cost	Men	Women	Boy/Girl	hours	Cost LE/hr
Organic Fertilizer		0		0		0	1.3			0.7	70		0		0		0	1.3			0.7	70
Land Preparation	0.7	56		0		0	1.7			3.3	330	0.7	56		0		0	1.0			3.0	375
Agricultural Gypsum		0		0		0					0		0		0		0					0
Land Leveling		0		0		0					0		0		0		0					0
Planting	2.3	184	2.3	161		0	1				0	2.7	216	2.4	168		0	0.9				0
Irrigation		0		0		0	5			32.3	888		0		0		0	5.2			31.0	853
Fertilizing	0.7	56		0		0	1				0	0.7	56		0		0	1.0				0
Weeding/Hoeing	8.3	664		0		0	2				0	7.3	577		0		0	1.8				0
Replanting	1	56	4	26		0	1				0	1	64	2.8	196		0	1.3				0
Pest Control		0		0		0	1			2.3	69	0.7	56		0		0	0.9			3.1	84
Harvesting	5.3	424	10.0	700	5	300	4				0	4.2	336	10.2	714	6.2	372	2.5				0
Threshing & Winnowing		0		0		0					0		0		0		0					0
Residual Removing		0		0		0					0		0		0		0					0
Transportation		0		0		0					0		0		0		0					0
Total	18	1440	16	887	5	300	18	0	0	39	1357	17	1361	15	1078	6	372	16	0	0	38	1381

Table 16. Crop Budget (LE)

Season			winter				Summer				
Govern			Sharkia			Assiut	Sharkia			Assiut	
Crop			Wheat	Clover	Sugar Beet	Wheat	Cotton	Maize	Rice	Maize	Sorghum
Traditional System	FC		4355	4410	4500	5357	4380	3400	3455	3030	3020
	VC	In put	2322	2193	2088	2517	2968	2279	2315	1894	2019
		laborer	2062	3122	3984	1797	8030	4077	5950	2381	2451
	TC		8739	9725	10572	9671	15378	9756	11720	7305	7490
	Main Product	Q	2.5	27.5	25	2.5	1.26	3.1	3.97	3.2	2.8
		P	3817	490	662	3860	19464	3184	3718	4179	4690
	Byproduct	Q	10.4		7.3	11.7	8.8	12.4	2.22	27	14
		P	278		200	367	90	42	236	47	27
	Total	Revenue	12256	13528	18010	13864	25317	10391	15284	14642	13510
	Net profit		3517	3803	7438	4193	9939	2480	3564	7337	6020
MRB System	FC		4375	4167	4500	5374	4280	3310	3440	3050	3075
	VC	In put	2004	2742	2801	2507	1667	2034	2102	2605	3259
		laborer	3915	2813	4192	1743	7645	3422	5427	2608	2439
	TC		10294	9722	11493	9624	13592	8766	10969	8263	8773
	Main Product	Q	2.7	27.2	25.3	2.8	1.23	3.5	3.99	3.1	2.5
		P	3837	490	670	3914	19072	2893	3710	4157	4785
	Byproduct	Q	11.5		5.3	10.6	9	13.5	2.2	14.5	17
		P	278		200	346	96	46	237	47	26
	Total	Revenue	13470	13325	18040	14567	24323	10747	15324	13568	12405
	Net profit		3176	3603	6547	4943	10731	3338	4355	5305	3632

are higher compared to traditional system, whereas net revenue from maize grown under traditional farming in Assiut is higher compared MRB system. Moreover, net revenue from sorghum grown under traditional farming in Assiut is higher compared MRB system.

5.1 Irrigation Cost

5.1.1 Sharkia

Detailed irrigation cost items are presented in table 17. It can be noted that irrigation pumps used have horsepower ranging between 3.4 and 10 hp and cost ranging between LE 6350 and LE 20345. Usage and maintenance costs differ according to planted crop and farming system, as clarified below:

Table 17. Irrigation Costs at the Level of Sharkia

Season				Summer			Winter		
Crop				Rice	Maize	Cotton	Wheat	Clover	Sugar Beet
Traditional	Plot 1	Model type	Dwets	16	4	6			
			Shubra	7	1	3			
			Hindi	14		1			
			Peter	28	2	8			
		Discharge Capacity		27	41	41			
		Horsepower		6	8.2	10			
		Price		12530	17415	20345	82360	12941	18495
		Diesel &Oil		522	118	305	37	38	54
		Maintenance &Replacement		153	41	103			
	Plot No. 2	Model Type							
		Discharge Capacity	Dwets						
			Shubra						
			Hindi						
			Peter						
		Horsepower							
		Price		15356	3980	18500			
		Diesel &Oil		43	114	46			
		Maintenance &Replacement							
MRB	Plot No. 1	Model Type	Dwets	18	8	3			
			Shubra	8		5			
			Hindi	1	3	1			
			Peter	26	3	3			
		Discharge Capacity		23	26.5	15.6			
		Horsepower		5	5.2	3.4			
		Price		9866	9582	6350		14794	15510
		Diesel &Oil		450	113	158		43	45
		Maintenance &Replacement		129	37	46			
	Plot No. 2	Model Type	Dwets						
			Shubra						
			Hindi						
			Peter						
		Discharge Capacity							
		Horsepower							
		Price					10254	14940	
		Diesel &Oil					30	43	
		Maintenance &Replacement							

Rice: cost of fuel and oil for rice grown in plot 1 under traditional and MRB farming systems reached LE 522 and LE 450 per acre, respectively, whereas maintenance cost reached LE 153 and LE 450 per acre, respectively. As for the cost of fuel and oil for rice grown in plot 2 under traditional system, it reached LE 43 per acre.

Maize: cost of fuel and oil for maize grown in plot 1 under traditional and MRB farming systems reached LE 118 and LE 113 per acre, respectively, whereas maintenance cost reached LE 41 and LE 37 per acre, respectively. The cost of fuel and oil for maize grown in plot 2 under traditional system reached LE 114 per acre.

Cotton: cost of fuel and oil for cotton grown in plot 1 under traditional and MRB farming systems reached LE 305 and LE 158 per acre, respectively, whereas maintenance cost reached LE 103 and LE 46 per acre, respectively. The cost of fuel and oil for maize grown in plot 2 under traditional system reached LE 46 per acre.

Wheat: cost of fuel and oil for wheat grown in plot 1 under traditional farming system reached LE 37 per acre, while reached LE 30 per acre for wheat grown in plot 2 under MRB system reached LE 46 per acre.

Clover: cost of fuel and oil for clover grown in plot 1 under traditional and MRB farming systems reached LE 38 and LE 43 per acre, respectively. The cost of fuel and oil for clover grown in plot 2 under MRB system reached LE 43 per acre.

Sugar Beet: cost of fuel and oil for clover grown in plot 1 under traditional farming systems reached LE 54 and LE 45 per acre, respectively.

5.1.2 Assiut

Data in table 18 presents irrigation cost items classified by planted crop and farming system:

Sorghum: cost of fuel and oil for sorghum grown in plot 1 under traditional and MRB farming systems reached LE 122 and LE 119 per acre, respectively, whereas maintenance cost reached LE 36 and LE 35 per acre, respectively. As for the cost of fuel and oil for sorghum grown in plot 2 under MRB system, it reached LE 32 per acre.

Maize: cost of fuel and oil for maize grown in plot 1 under traditional and MRB farming systems reached LE 113 and LE 122 per acre, respectively, whereas maintenance cost reached LE 33 and LE 36 per acre, respectively.

Wheat: cost of fuel and oil for wheat grown in plot 1 under traditional and MRB farming systems reached LE 38 and LE 27 per acre, respectively.

Clover: cost of fuel and oil for clover grown in plot 2 under traditional and MRB farming systems reached LE 45 and LE 49 per acre, respectively.

Table 18. Irrigation Costs at the Level of Assiut

Season				Summer Crops			Winter Crops		
Crop				Sorghum	Maize	Cotton	Wheat	Clover	Sugar Beet
Traditional	Plot 1	Model Type	Rosten	10	23				
			marshal	4	2				
			Peter	27	5				
			Electrical Motor	3					
		Discharge Capacity		15	21				
		Power							
		Price		13162	12000		95705		
		Diesel & Oil		122	113		28		
		Maintenance & Replacement		36	33				
	Plot 2	Type & Model							
		Discharge Capacity	Rosten						
			marshal						
			Hired						
			Electrical Motor						
		Power							
		Price						15253	
		Diesel &Oil						45	
		Maintenance & Replacement							
MRB	Plot 1	Type & Model	Peter	55	39				
			marshal		1				
			Hired	6					
			Electrical Motor		4				
		Discharge Capacity		9	15				
		Power							
		Price		10853	13162		93368		
		Diesel & Oil		119	122		27		
		Maintenance & Replacement		35	36				
	Plot 2	Type & Model	36						
			marshal						
			Hired						
			Electrical Motor						
		Discharge Capacity							
		Power							
		Price		10725				16702	
		Diesel &Oil		32				49	
		Maintenance & Replacement							

5.2 Irrigation Sources and Systems

5.2.1 Sharkia

As shown in table 19, the majority of sample farmers in Sharkia (88%) use flood irrigation during the summer and winter seasons, while the remaining 12% use mixed irrigation (flood and ground water). Comparing irrigation shifts and average irrigation time for crops grown under traditional and MRB systems reveals the following:

Cotton: under **traditional farming,** cotton is irrigated 7 to 8 times using flood irrigation in the two plots, and 3 times using ground water. Average irrigation time is 4.8 to 5.2 hours. Under **MRB**

system, cotton is irrigated 7 to 8 times using flood irrigation in the two plots, and 4 times using ground water. Average irrigation time is 4.8 to 6.2 hours.

Table 19. Irrigation Sources, Systems and Durations in Sharkia

Farming System	Plot No.	Season	Crop	Area		Source of Irrigation					Irrigation System (Flood)	No of Irrigation Times				Average Time (Mixed Water)
				F	Q	Nile (Fresh)	Ground Water	Drainage Water	Mixed Water	Other (fresh &		Fresh Water	Ground Water	Drainage Water	Mixed Water	
Traditional	1	Summer	Cotton	23	6	11				7	18	7	3			4.8
			Maize	6	9	7					7	6				2.9
			Rice	86	21	45				20	65	25	13			3.6
			Sorghum													
		Winter	Wheat	126	6	90					90	5	1			5.2
	2	Summer	Cotton	12		8					8	8				5.6
			Maize	14		13					13	7				3.5
			Rice	2	12	2					2	31				2.5
			Sorghum													
		Winter	Clover	16	18	20					20	6				3.1
			Sugar Beet	3		2					2	10				5.5
MRB	1	Summer	Cotton	42	22	14				9	23	7	4			6.2
			Maize	21		14					14	7				4.5
			Rice	82	4	38				15	53	26	13			4.2
			Sorghum													
		Winter	Wheat	139	15	90					90	5	2			5
	2	Summer	Cotton	2		2					2	8				4
			Maize	12		15					15	7				2.9
			Rice	7	22	3				2	5	25				4.7
			Sorghum													
		Winter	Clover	41	10	27					27	6				3
			Sugar Beet	6		4					6	9	4			6.3

Maize: under traditional farming, maize is irrigated 6 to 7 times using flood irrigation in the two plots. Average irrigation time is 2.9 to 3.5 hours. Under MRB system, maize is irrigated 7 times using flood irrigation, with average irrigation time estimated at 4 to 4.5 hours. Ground water is not used in irrigation given the fact that maize is sensitive to salinity.

Rice: under traditional farming, rice is irrigated 25 to 31 times using flood irrigation and 13 times using ground water in the two plots. Average irrigation time is estimated at 2.5 to 3.6 hours. Under MRB system, rice is irrigated 25 to 26 times using flood irrigation and 13 times using ground water. Average irrigation time is estimated at 4.2 to 4.7 hours.

5.2.2 Assiut

Data in table 20 indicates that the most of sample farmers in Assiut (72%) use flood irrigation, 16% use ground water, 55% use a mixed irrigation (flood and ground water), and 2% use drainage water

during the summer and winter seasons. Comparing irrigation shifts and average irrigation time for crops grown under traditional and MRB systems reveals the following:

Maize: under traditional farming, maize is irrigated 6 times using flood irrigation in plot 1, with average irrigation time estimated at 7 hours. Under MRB system, maize is irrigated 7 times using flood irrigation, and 8 times using ground water, with average irrigation time estimated at 3.9 hours.

Sorghum: under traditional farming, sorghum grown in plot 1is irrigated 6 times using flood irrigation and 8 times using drainage water, with average irrigation time estimated at 4.9 hours. Under MRB system, sorghum grown in the two plots is irrigated 6 to 8 times using flood irrigation and 8 times using ground water in plot 1, with average irrigation time estimated at 2.8 to 5 hours.

Wheat: under **traditional farming,** wheat grown in plot 1is irrigated 5 times using flood irrigation and 6 times using drainage water, with average irrigation time estimated at 4.6 hours. Under MRB system, wheat is irrigated 5 times using flood irrigation and 6 times using ground water, with average irrigation time estimated at 2.7 hours.

Clover: under **traditional farming,** clover grown in plot 2 is irrigated 6 times using flood irrigation, with average irrigation time estimated at 3.1 hours.

Table 20. Irrigation Sources, Systems and Durations in Assiut

Farming System	Plot No.	Season	Crop	Area		Source of Irrigation					Irrigation System (Flood)	No of Irrigation Times				Average Time Mixed Water
				F	Q	Nile (Fresh)	Ground Water	Drainage Water	Mixed Water	Other (fresh & ground)		Fresh Water	Ground Water	Drainage Water	Mixed Water	
Traditional	1	Summer	Cotton													
			Maize	54	23	30					30	6				6.1
			Rice													
			Sorghum	45	6	22	4	4			30	6	8	8		4.9
		Winter	Wheat	134	17	71	25	4			90	5	6	6		4.6
	2	Summer	Maize													
			Rice													
			Sorghum													
		Winter	Clover	1	12	2					2	8				2.7
			Sugar Beet													
MRB	1	Summer	Cotton													
			Maize	54	20	17				28	45	7	8			3.9
			Rice													
			Sorghum	65	18	49				26	75	6	8			2.8
		Winter	Wheat	87	2	68	31			1	90	5	6			2.7
	2	Summer	Maize													
			Rice													
			Sorghum	2	12	2					2	8				5
		Winter	Clover													
			Sugar Beet													

It can be noted that number of irrigation times is almost similar, but irrigation duration under MRB system is less than traditional system by 56% in case of maize, 75% in case of sorghum and 70% in case of wheat.

5.3 Irrigation Shifts

The state of *Mesqa* and irrigation shifts at the level of the study sample is described below. It can be noted that:

- All of the sample individuals mentioned that *Mesqas* are not improved and irrigation shifts last for less than 10 days.
- In regard to drainage systems, Sharkia outperforms Assiut, where all of the MRB system adopters in Sharkia sample mentioned that drainage system exists, while those in Assiut mentioned that it is absent. At the level of traditional farming, findings reveal that drainage system serves 84 farms in Sharkia, while the one available in Assiut serves only 29 farms.
- Farmers in Sharkia sample mentioned that two types of drainage systems are available, tile drainage and surface/open drainage. In Assiut, 29 of the sample farmers mentioned that only surface/open drainage exists.
- Asking the farmers about availability of irrigation water revealed that 67 and 73 farmers in Assiut mentioned that it is available during the summer, while 69 and 68 farmers in Sharkia mentioned that it is not available during the summer. Generally speaking, the period from May to August is characterized by insufficiency of irrigation water.
- As for the reasons for insufficiency of irrigation water during the summer, 92 of the sample farmers said that water level is high at the head of *Mesqa*, while 63 and 27 of the farmers said the reasons are the lengthy irrigation shifts at the head of Mesqa and the short distance between *Mesqa* and the main canal.
- Exploring the methods followed to face shortage in irrigation water revealed that: 61 of the sample farmers in Sharkia said that lining *Mesqas*, laser leveling of lands and covering *Marwas*. On the other hand, 61 farmers in Sharkia and Assiut said they adopt rationalization of water use, in addition to using ground water wells.
- In regard to quantity of water used, 219 farmers said they believe that holders of lands at the head of Mesqa overuse water, while 141 farmers denied this belief.

5.4 Farmers Opinions Regarding Improving Water Use Efficiency

In Sharkia, farmers suggested participating in projects aiming to execute covering of main canals, applying laser leveling of lands, covering pipelines, digging of groundwater wells, night irrigations, early irrigation, disinfection of *Marwa* and canals, in addition to organizing and increasing irrigation shifts.

In Assiut, farmers suggested applying laser leveling of lands and adopting modern farming methods.

Exploring farmers' opinions regarding problems related to quantity and quality of water indicates that 89 traditional farmers and 90 MRB adopters in Sharkia believe there are problems. Likewise, 42

traditional farmers and 68 MRB adopters in Assiut believe there are problems. They think the reasons behind these problems include Nahda Dam, low water level in main canals and low quantity of water released into canals. They suggested finding political solutions for the problem of Nahda Dam, rationalizing water use, organizing water shifts and regular disinfection of *Mesqas* and *Marwas*. In addition, 119 farmers said they irrigate at night during the summer and winter seasons. Average irrigation times reached 8 during the summer and one during the winter. According to 119 of the sample farmers, the reason for irrigating at night is water shortage early during the day due to irrigations shifts, whereas 12 of the farmers said the reason is water shortage early during the day, in addition to appropriateness of night irrigation to the cultivated crops.

6 Animal Production Activities

6.1 Cows

Data in table 21, which illustrates the number of cows owned by sample farmers, indicates that average number of cows' traditional farmers and MRB adopters in Sharkia own is estimated at 2 heads, respectively, while is estimated at 2.8 and 2.3 heads in Assiut, respectively. It is also clear that average number of dairy cows' traditional farmers and MRB adopters in Sharkia own is estimated at 1.6, while reached 1.8 and 1.9 in Assiut, respectively.

As for the average market value of cows, it ranged between LE 48632 and LE 76929. Average daily quantity of milk production from traditional and MRB farms in Sharkia reached 14.9 kg and 15 kg, respectively, while reached 15.3 kg and 14.6 kg in Assiut, respectively. Annual average milk production is estimated at 2250 kg, of which 95% is sold at a price ranging between LE 6.1 and LE 6.4 per kg, generating an average income of LE 13950 per annum. Results indicate that sold to owned cows is 50%:90%, and average price ranges between LE 20000 and LE 30429 per head.

Table 21. Number of Cows and Quantities and Values of Milk and Meat Production

Governorate	Sharkia		Assiut	
Category	Traditional Farmers	MRB Adopters	Traditional Farmers	MRB Adopters
Total No. (Heads)	2	2	2.8	2.3
No of Owned Dairy Buffaloes (Heads)	1.6	1.6	1.8	1.9
Average Market Value (L.E)	49528	48632	76929	51885
Milk production (Kg/day)	14.9	15	15.3	14.6
Sold Milk (Kg/day)	14	14	14.2	14
Average price (L.E/Kg)	6.1	6.3	6.4	6.3
No. of Sold Cows (Head)	1.1	1.9	2.2	1
Average Price (L.E/Head)	25615	30429	25308	20000
No of Slaughtered Cows for Own Consumption (Heads/HH)		1		
Average Value of (L.E/Head)		30000		

6.2 Buffalo

Data in table 22 indicates that average number of buffaloes' traditional farmers and MRB adopters in Sharkia own amounts to 1.7 and 1.8 heads, respectively, while amounts to 2.4 and 1.7 heads in Assiut, respectively. It can also be noted that average number of dairy buffaloes' traditional farmers and MRB adopters in Sharkia own is estimated at 1.5 and 2.2 heads, respectively, while reached 2.2 and 1.5 in Assiut, respectively.

As for the average market value of buffaloes, it ranged between LE 36160 and LE 59042. Average daily quantity of milk production from traditional and MRB farms in Sharkia reached 14.2 kg and 13.6 kg, respectively, while reached 18.3 kg and 10.9 kg in Assiut, respectively. Annual average milk production is estimated at 2730 kg, of which 80% is sold at a price ranging between LE 8 and LE 9 per kg, generating an average income of LE 23200 per annum. Results indicate that sold to owned buffaloes is 72%:100%, and average price ranges between LE 22611 and LE 29500 per head.

Table 22. Number of Buffaloes and Quantities and Values of Milk and Meat Production

Governorate	Sharkia		Assiut	
Category	Traditional Farmers	MRB Adopters	Traditional Farmers	MRB Adopters
Total No. (Heads)	1.7	1.8	2.4	1.7
No of Owned Dairy Buffaloes (Heads)	1.5	2.2	2.2	1.5
Average Market Value (L.E)	57872	55094	59042	36160
Milk production (Kg/day)	14.2	13.6	18.3	10.9
Sold Milk (Kg/day)	11.1	10.9	15.7	9.6
Average price (L.E/Kg)	8.3	9	8.3	8
No. of Sold Cows (Head)	1.6	1.3	2.4	
Average Price (L.E/Head)	29500	26733	22611	
No of Slaughtered Cows for Own Consumption (Heads/HH)		1		
Average Value of (L.E/Head)		32500		

6.3 Sheep

Data in table 23 indicates that average number of sheep traditional farmers and MRB adopters in Sharkia own amounts to 2.8 and 6.1 heads, respectively, while amounts to 6.8 and 4.4 heads in Assiut, respectively. Average market value of sheep ranges between LE 10697 and LE 22400. Results indicate that sold to owned sheep is 15%:40% and that average price ranges between LE 2833 and LE 4962 per head.

6.4 Goats

Data in table 24 indicates that average number of sheep traditional farmers and MRB adopters in **Sharkia** own amounts to 3.3 and 5.6 heads, respectively, while amounts to 3.7 and 2.8 heads in **Assiut**, respectively. As for the average market value of goats, it ranges between LE 4480 and LE 11816. Results indicate that sold to owned goats is 30% and that average price ranges between LE 1500 and LE 2645 per head.

Table 23. Number and Values of Sheep

Governorate	Sharkia		Assiut	
Category	Traditional Farmers	MRB Adopters	Traditional Farmers	MRB Adopters
Total Number of Owned Sheep (Heads)	2.8	6.1	6.8	4.4
Average Market Value (L.E)	10697	22400	18727	12100
No of Sold Sheep (Head)	1.6	2.4	2	1
Average Price (L.E/Head)	4000	4932	2200	2800
No of Slaughtered Sheep for Own Consumption (Heads/HH)	1.2	1.1	1	1.5
Average Value (L.E/Head)	4962	4246	2833	4167

Table 24. Number and Values of Goats

Governorate	Sharkia		Assiut	
Category	Traditional Farmers	MRB Adopters	Traditional Farmers	MRB Adopters
Total Number of Owned Goats (Heads)	3.3	5.6	3.7	2.8
Average Market Value (L.E)	8274	11816	6071	4480
No of Sold Goats (Head)	1.9	3.9		1
Average Price (L.E/Head)	2310	4250		1500
No of Slaughtered Goats for Own Consumption (Heads/HH)	1.4	1.1	1	1
Average Value (L.E/Head)	2645	2357	1550	1500

6.5 Home Poultry

Data in table 25 indicates the average number of poultry sample farmers own. It can be noted that pigeon and chicken are the main types of poultry reared in house. Ducks, geese, turkey and rabbits followed in terms of relative importance. It is worth mentioning that rabbits are only reared in Assiut. The average market value of home poultry ranges between LE 409 and LE 1710.

Table 25. Number and Values of Poultry

Governorate	Sharkia		Assiut	
Category	Traditional Farmers	MRB Adopters	Traditional Farmers	MRB Adopters
No. of Home Poultry	30.8	31.5	35	21.6
Value (L.E)	1510	1542	1709	1049
No. of Ducks	16.6	15.9	14.4	6.6
Value (L.E)	1606	2310	1106	529
No. of Geese	8.2	7.5	9	2.7
Value (L.E)	889.6	1710	770	483
No. of Turkey		6	7.4	1.5
Value (L.E)		1267	780	205
No. of Pigeon	45.7	52.6	29.9	17.3
Value (L.E)	1148	1455	705	409
No. of Rabbits			23.3	4.67
Value (L.E)			1057	386

6.6 Cost of Animal Production

Data in table 26 presents the cost of family labor, where no labor is hired to perform this work. Results indicate that number of labor at the level of traditional farmers and MRB adopter in Sharkia amounts to 83 and 84, respectively, while amounts to 81 and 71 in Assiut, respectively.

Table 26. Cost of Family Labor

Governorate		Sharkia		Assiut	
Category		Traditional Farmers	MRB Adopters	Traditional Farmers	MRB Adopters
No. of Males		45	46	58	53
Wage	(LE/man)	65	64	63	66
Value	(LE)	1,660	2,005	1,409	1,128
No. of Females		25	17	11	13
Wage	(LE/Woman)	53	52	55	54
Value	(LE)	858	644	327	314
No. of Boys/	Girls	13	21	12	5
Wage	(LE/Boy or Girl)	41	42	43	45
Value	(LE)	144	454	102	115

6.7 Cost of Inputs Used in Animal Production

Data in table 27 presents the cost of inputs used animal production activity at the level of the study sample. Results indicate that sample farmers use different kinds of animal feed, including clover, *darawa*, straw, *dreese*, Faba beans, bran and concentrated feed. Average quantities used in traditional and MRB farms in Sharkia reached 48 worth LE 33 thousand and 36.5 tons worth 25.6 thousand, respectively, while reached 40 worth LE 30.5 thousand and 28.6 tons worth LE 22 thousand in Assiut, respectively.

6.8 Production and Revenues Realized from the Study Crops

6.8.1 Summer Crops

Table 28 presents the quantities of summer crops produced by traditional farmers and MRB adopters in Sharkia and Assiut, quantities sold from each crop and total revenue. Results indicate that, in Sharkia, the entire production of cotton, maize and sorghum is sold, while 4% and 5% of the rice produced in plot 1 by traditional farmers and MRB adopters is kept for own consumption, respectively. As for rice produced in plot 2, traditional farmers and MRB adopters keep around 11% and 5% for own consumption, respectively.

6.8.2 Winter Crops

Table 29 presents the quantities of winter crops produced by traditional farmers and MRB adopters in Sharkia and Assiut, quantities sold from each crop and total revenue. Results indicate that, in Sharkia, traditional farmers and MRB adopters keep around 8% and 7% of wheat produce for own consumption, respectively, while those in Assiut keep around 8% and 11% for own consumption,

respectively. The low quantity of wheat kept for own consumption can be attributed to the currently implemented bread distribution system. Results also reveal that wheat consumption is higher in Assiut, especially among MRB adopters. In regards to sugar beet planted in plot 2 in Sharkia, the entire produce is sold.

Table 27. Cost of Inputs Used in Animal Production

Governorate		Sharkia		Assiut	
Category		Traditional Farmers	MRB Adopters	Traditional Farmers	MRB Adopters
Concentrated Feed (Ton)	Q	0.8	0.8	1.1	0.9
	P	6896	6931	6454	6767
	V	5517	5545	7099	6090
Bran (Ton)	Q	0.8	0.6	0.8	0.8
	P	3993	3960	3842	3903
	V	3194	2376	3074	3122
Seeds and Grain (Ton)	Q	0.4	0.3	0.4	0.4
	P	6766	6553	6933	
	V	2706	1966	2773	0
Clover (Qerat/Cut) (Ton)	Q	17.4	16.2	10.8	8.7
	P	519	514	538	550
	V	9031	8327	5810	4785
Darawa (Qerat/Cut) (Ton)	Q	9		6	6.3
	P	450		476	467
	V	4050	0	2856	2942
Straw (Ton)	Q	0.7	0.6		
	P	1917	2008		
	V	1342	1205	0	0
Straw (Heap)	Q	18.9	17.6	20.8	11.2
	P	314	257	372	343
	V	5935	4523	7738	3842
Veterinary Care quantity	Q	274	241	236	240
	P	1	1	1	1
	V	274	241	236	240
Dasheesha (Ton)	Q	0.3	0.4	0.3	0.3
	P	4218	4179	3983	4014
	V	1265	1672	1195	1204

One Qerat of farm land = 1/24 acre One cut of clover = 5 tons; One cut of darawa = Heap of Straw = 250 kg Concentrated Feed for Poultry

7 Institutional Framework for Social Participation

Institutional framework of cooperative societies and associations working in Sharkia and Assiut is presented is table 30. The following can be inferred from the table:

Table 28. Production and Utilization of Summer Crops

Plot No.	Crop	Governorate	Category	Main Product (Ton)	Price (LE/Ton)	Byproduct (Ton)	Price (LE/Ton)	Quantity Sold from Main Product	Quantity of Byproduct Sold (Ton)	Household Consumption
1	Cotton	Sharkia	Traditional Farmers	1.26	19464	8.80	90	1.26	8.80	0
			MRB Adopters	1.23	19072	9.00	96	1.23	9.00	0
	Maize	Sharkia	Traditional Farmers	3.10	3184	12.40	42	3.10	12.40	0
			MRB Adopters	3.50	2893	13.50	46	3.50	13.50	0
		Assiut	Traditional Farmers	3.20	4179	27.00	47	3.20	27.00	0
			MRB Adopters	3.10	4157	14.50	47	3.10	14.50	0
	Rice	Sharkia	Traditional Farmers	3.97	3718	2.22	236	3.81	2.22	0.07
			MRB Adopters	3.99	3710	2.20	237	3.79	2.20	0.05
	Sorghum	Assiut	Traditional Farmers	2.8	4690	14.00	27	2.50	14.00	0
			MRB Adopters	2.5	4785	17.00	26	2.80	17.00	0
2	Cotton	Sharkia	Traditional Farmers	1.38	18756	9.70	93	1.38	9.70	0
			MRB Adopters	1.42	18154	12.00	100	1.42	12.00	0
	Maize	Sharkia	Traditional Farmers	2.80	2982	12.70	47	2.80	12.70	0
			MRB Adopters	3.00	2936	8.90	47	3.00	8.90	0
	Rice	Sharkia	Traditional Farmers	3.80	3775	3.00	243	3.38	3.00	0.11
			MRB Adopters	3.80	3775	2.40	243	3.61	2.40	0.05
	Sorghum	Assiut	Traditional Farmers	4.00	4050	2.30	244	4.00	2.30	0

1. **Cooperative Societies:** All of the sample farmers mentioned that cooperative societies exist and play an active role in Sharkia, while are less active in Sharkia, where 30 and 45 of the sample farmers are not members in any cooperative society.
2. **Water Users Associations (WUA):** 25 and 17 of the traditional farmers and MRB adopters in Sharkia mentioned that WUAs exist, but none of the farmers joined them.
3. **Agricultural Marketing Cooperatives:** all of the sample farmers in Assiut mentioned that such cooperatives exist, but none of them has membership. In Sharkia, 66% of the traditional farmers and 90% of MRB adopters mentioned that such cooperatives exist, and 87% and 78% mentioned that they play an active role.

Table 29. Production and Utilization of Winter Crops

Plot No.	Crop	Governorate	Category	Main Product (Ton)	Price (LE/Ton)	Byproduct (Ton)	Price (LE/Ton)	Quantity Sold from Main Product	Quantity of Byproduct Sold (Ton)	Household Consumption
1	Wheat	Sharkia	Traditional Farmers	2.5	3817	10.4	278	2.3	10.4	%8
			MRB Adopters	2.7	3837	11.5	278	2.5	11.5	%7
		Assiut	Traditional Farmers	2.5	3860	11.7	367	2.3	11.7	%8
			MRB Adopters	2.8	3914	10.6	346	2.5	10.6	%11
2	Clover	Sharkia	Traditional Farmers	27.5	490			27.5	0	0%
			MRB Adopters	27.2	490			27.2	0	0%
	Sugar Beet	Assiut	Traditional Farmers	25	662	7.3	200	25.0	7.3	%0
			MRB Adopters	25.3	670	5.3	200	25.3	5.3	%0

Table 30. Institutional Framework of Social Participation

Governorate			Sharkia		Assiut	
Category			Traditional Farmers	MRB Adopters	Traditional Farmers	MRB Adopters
Agricultural Cooperatives	Availability	Yes	90	90	90	90
		No				
	Role	Effective	84	90	72	31
		fairly Effective	3		13	8
		Ineffective	3		5	6
	Membership	Yes	90	90	60	45
		No			30	45
Water User Association (WUAs)	Availability	Yes	25	17		
		No	65	73	90	90
	Role	Effective	25	17		
		fairly Effective				
		Ineffective				
	Membership	Yes				
		No	90	90	90	90
Agricultural Marketing Cooperatives	Availability	Yes	66	90	90	90
		No	24			
	Role	Effective	58	71		
		fairly Effective	4	13		
		Ineffective	4	9		
		I do not know		1	90	90
	Membership	Yes	59	76		
		No	31	14	90	90
NGOs/Local Service Development Associations	Availability	Yes	89	89	90	90
		No	1	1		
	Role	Effective	40	49		
		fairly Effective	29	22		
		Ineffective	13	14		
		I do not know	7	5	90	90
	Membership	Yes		1		
		No	63	89	90	90

4. **Non-governmental Organizations (NGOs):** despite the fact that NGOs exist in Sharkia and Assiut, none of the sample farmers has a membership. However, 44% and 55% of the sample farmers mentioned that NGOs play an active role.

8 Water Use Rationalization and Soil Maintenance

8.1 Laser Leveling

Results in table 31 indicate that all of the sample famers in Sharkia and Assiut mentioned that they are well aware of laser leveling and that they do adopt it now. As for the source of information, it ranged between neighbors, agricultural extension and the media. MRB adopters in Sharkia and all of the sample farmers in Assiut mentioned that private sector is responsible for this practice.

Table 31. Laser Leveling

		Sharkia		Assiut	
		Traditional	MRB	Traditional	MRB
Knowledge about Laser Leveling	yes	90	90	90	90
Source of Information	Agricultural Extension	12	10	9	20
	Neighbors- Agric. Extension	8	25	18	0
	Neighbors	21	12	21	25
	Other (Extension--Neighbors--Media)	49	40	41	44
Applying Laser Leveling	yes	90	90	90	90
Which authority performed laser leveling?	Extension/service station	3			
	private company	57	90	90	90
	I don't know	1			
	Other (Extension/service station--private company)	29			
Do you believe laser leveling is useful?	yes	90	90	90	90
How much important is laser leveling?	High	90	90	90	90
Effects of laser leveling	Regulating Irrigation	90	90	90	90
	Saving water	90	90	90	90
	Reducing cost of irrigation	90	90	90	90
	Reducing cost of production	90	90	90	90
	Reducing irrigation time	90	90	90	90
	Saving inputs	86	90	90	90
	Improving yield	90	90	90	90
	Increasing income	90	90	90	90
	Making crop services easier	88	90	90	90
	Increasing cultivated areas	82	90	90	90
	Good distribution of plants	88	90	90	90
	Improving seed germination rate	89	90	90	90
Problems/obstacles faced related to laser leveling	Higher prices	90	90	90	90
Suggestion to solve such problems	Cost reduction	90	90	90	90
The reason for refusing to use laser leveling in the future	Because I prefer traditional land leveling			5	
	Because the benefits I get from laser leveling is less than what is costs			1	
	Because my land is too small to use it			13	

In addition, all of the sample farmers believe that laser leveling is highly important given the fact that it plays an active role in regulating irrigation, water saving, reducing irrigation thus production cost, reducing irrigation time, increasing production thus income, making crop service easier, increasing planted area, allowing even distribution of plants and improving germination rate. However, 19 farmers said they do not wish to apply laser leveling in the future because they have small holdings, where they found that traditional leveling is better compared to laser leveling due to the fact that revenue earned is low compared to the incurred cost.

Sample farmers believe that higher prices represent the main problem and obstacle faced. They said that serious actions should be taken to solve this problem.

8.2 Clover Drying

All of the sample farmers in Sharkia said they know about clover drying, but 58 of the traditional farmers and 72 of MRB adopters apply this practice, as shown in table 32. The main source of information is neighbors, followed by agricultural extensions agents and the media. As for Assiut, 63 and 52 of the two categories said they know about clover drying from agricultural extensions agents, followed by neighbors and the media. However, none of them apply it.

Table 32. Clover Drying

Gov.	Category	Knowledge about Clover Drying		Source of Information					Dry Cultivation		Do you think clover drying is useful?	
		yes	No	Agric. Extension	Neighbors	The Media	Other, Specify(Extension--Neighbors--Media)	Neighbors- Agric. Extension	yes	no	yes	no
Sharkia	Traditional Farmers	90		4	80	1	6		58	32	68	22
	MRB Adopters	89	1	2	76	1	9	1	72	18	69	21
Assiut	Traditional Farmers	63	27	30	4	8	4	17		90		
	MRB Adopters	52	38	37	5	3	4	3		90		

Exploring farmers' opinion regarding the importance of clover drying indicates that 68 of the traditional farmers and 69 of MRB adopters in Sharkia believe that it is very important.

Some of the sample farmers in Assiut said that the reason for not applying clover drying is that they lack information about the method, and that this practice is not suitable for the nature of their lands. However, some of them said they do not wish to apply this practice, while six of them said they wish to apply this practice in the future. On the other hand, most of the famers in Sharkia and all of the farmers in Assiut mentioned that they do not wish to apply this practice in the future.

Table 33. Economic and Environmental Impacts of Clover Drying

Governorate		Sharkia		Asuit	
category		Traditional	MRB	Traditional	MRB
Improving water use efficiency	effective	1	1		
	ineffective	23	33		
	neutral	33	38		
Saving water	effective	2	3		
	ineffective	16	32		
	neutral	39	37		
Reducing costs of irrigation	effective	6	9		
	ineffective	17	33		
	neutral	34	30		
Reducing costs of production	effective	15	17		
	ineffective	3	26		
	neutral	39	29		
Reducing irrigation time	effective	2	7		
	ineffective	42	27		
	neutral	13	37		
Saving inputs	effective	49	28		
	ineffective		17		
	neutral	8	27		
Improving yields	effective	46	23		
	ineffective	1	21		
	neutral		27		
Increasing income	effective	57	67		
	ineffective		3		
	neutral		2		
Improving quality of agricultural environment	effective	55	33		
	ineffective		7		
	neutral	2	32		
Why didn't you use dry cultivation of clover in your land?	Because I don't know how to use it		1	21	46
	Because it isn't suitable for my land	2		69	43
	To maintain soil fertility	1			
	other (I do not need it)	29	17		
Do you want to use dry cultivation of clover in the future**?**	yes	6			
	no	26	15	90	90

8.3 Wheat Cultivation on Raised Beds

Information in table 34 indicates that 78 and 46 of the traditional farmers in Sharkia and Assiut mentioned that they know about this farming system but they do not adopt it. As for the source of information, it came from the neighbors, agricultural extension agents and the media.

Table 34. Wheat Cultivation on Raised Beds

Governorate		Sharkia		Assiut	
Category		Traditional	MRB	Traditional	MRB
Hearing about wheat cultivation by planter	yes	78	90	46	90
	No	12		44	
Source of information	Extension	10	10	9	60
	Neighbors	19	2	8	4
	Media	28	31	12	19
	Other, Specify (Extension-Neighbors-Media)	13	7	13	4
	Neighbors-Extension	9	43		4
Using planter in wheat cultivation	yes		90		90
	no	90		90	
Do you think using planter is useful?	yes		90		90
	no				
Saving water	effective		90		90
	ineffective				
	neutral				
Reducing labor cost	effective		83		90
	ineffective		4		
	neutral		3		
Reducing production cost	effective		86		89
	ineffective		4		
	neutral				1
Saving inputs i.e. seeds	effective		90		90
	ineffective				
	neutral				
Saving inputs, time and effort	effective		89		90
	ineffective				
	neutral		1		
Improving yields	effective		90		89
	ineffective				
	neutral				1
Improving seed germination rate	effective		90		90
	ineffective				
	neutral				
Making weed control easier	effective		68		89
	ineffective		13		1
	neutral		9		
Good distribution of seeds	effective		86		90
	ineffective				
	neutral		4		
Making wheat harvesting easier by using combines	effective		57		90
	ineffective		13		
	neutral		20		

Exploring famers' opinions regarding the importance of MRB farming system revealed that all of them believe that it plays an effective role, where it helps in saving irrigation water and inputs, especially seeds, improving germination rate and yield, reducing labor and production cost, reducing irrigation time and effort, making weed control easier, making harvesting easier through use of combine, and allowing even distribution of seeds.

8.3.1 Rice Cultivation Using Transplanter

Results regarding rice cultivation, presented in table 35, in Sharkia indicate that 52 of the traditional farmers and 63 of MRB adopters said they know about rice cultivation using rice transplanter from neighbors, agricultural extension agents and the media. In Assiut, all of the sample farmers said they do not adopt this farming method given the fact that they do not know how to use it, and it is not suitable for the nature of their lands.

Table 35. Rice Cultivation Using Transplanter

Governorate		Sharkia		Assiut	
Category		Traditional	MRB	Traditional	MRB
Knowledge about Rice Transplanter	yes	52	63		
	No	38	27	90	90
Source of information	Agric. Extension	16	18		
	Neighbors	10	2		
	The Media	9	3		
	Other (Extension, Neighbors, the Media)	16	29		
	Neighbors -Agric. Extension	1	11		
Using Rice Transplanting	yes				
	no	90	90	90	90
Reasons for NOT using Rice Trans planter	Because I don't know how to use it	16			
	Because it is not suitable for my land	2			
	Other: Because I don't know how to use it-Because it is not suitable for my land	64	77		
Do you wish to use Rice Trans planter in the future	yes	4			
	no	20			

8.4 Compost Processing

Data in table 36 indicate that, in Sharkia, 63 of the traditional farmers and 77 of MRB adopters, in addition to 61 of the traditional farmers and 55 of MRB adopters in Assiut said they know about compost processing from neighbors, agricultural extension agents and the media, and that they do process compost.

Table 36. Compost Processing

Governorate		Sharkia		Assiut	
Category		Traditional Farmers	MRB Adopters	Traditional Farmers	MRB Adopters
Hearing about Compost	yes	63	77	61	55
	No	27	13	29	35
Source of Hearing	Extension	18	20	33	29
	Neighbors		2	2	3
	Media	20	14	13	1
	Other, Specify (Extension--Neighbors--Media)	23	39	8	5
	Neighbors-Extension		2	5	17
Using Compost	yes	61	77	61	55
	no	62	80	88	58
Reasons for NOT using use compost	I don't know how to use it	90	90	90	90
Do you wish to use compost in the future	I don't know	90	90	90	90

8.5 Soil fertification with agricultural gypsum

It can be noted from table 37 that 89 of the traditional farmers and 84 of MRB adopters in Sharkia, in addition to 55 of the traditional farmers and 25 of MRB adopters in Assiut said they know about adding agricultural gypsum from neighbors, agricultural extension agents and the media. However, only 7 farmers in Sharkia apply it manually during the winter, where they believe it is useful for the soil by reducing soil alkalinity and salinity.

One of the main reasons for not applying agricultural gypsum is that it is sold unpacked, which is the reason why they suggested that it should be sold in packs.

As for the potentials for applying agricultural gypsum in the future, 186 of the sample farmers said it is not suitable for their lands, while 101 said they do not know how to apply it, and 20 said it is not available.

Table 37. Adding Agricultural Gypsum

Governorate		Sharkia		Assiut	
Category		Traditional Farmers	MRB Adopters	Traditional Farmers	MRB Adopters
Knowledge about Agricultural Gypsum	yes	89	84	55	25
	No	1	6	35	65
Source of Information	Agric. Extension	6	14	3	9
	Neighbors	24	2	4	7
	Media	3	3	21	
	Other (Agric. Extension--Neighbors--Media)	56	57	8	6
	Neighbors-Agric. Extension		8	18	3
Applying and Agricultural Gypsum	yes	5	2		
	no	85	88		
Do you think applying agricultural gypsum is useful	yes	5	2		
	No				
What is the suitable time for applying agricultural gypsum	Winter season	5	2		
Method of applying agricultural gypsum (Manual)		5	2		
Impact of agricultural gypsum application	Reducing soil alkalinity and salinity	5	2		
Problems/obstacles faced while applying agricultural gypsum to your land	Sold unpacked	46	11		
	More use of irrigation water	1			
Suggestion to solve these Problems	It should be packed	45	11		
Reasons for NOT using applying agricultural gypsum to your land	Because I don't know how to use it	4		45	52
	Because it is not suitable for my land	85	85	10	6
	unavailable			14	6

8.6 Adoption of Recommended Water Management Technologies

All of the sample farmers use some water management technologies, including adoption of mechanized raised beds, application of compost, sub-leveling and laser leveling, which all help in increasing agricultural production, reducing production cost and improving soil fertility.

9 Household Characterization

9.1 Household Head

Table 38, which presents the general characteristics of sample farmers at the level of Sharkia and Assiut, indicates that all of the researched farmers are males with different levels of education. Literate farmers ranked first, followed by holders of non-agricultural technical certificates. It can also be noted that average age ranged between 45 and 56 years.

Table 38. Characteristics of Household Head

Governorate	Sharkia		Assiut	
Category of farmers	Traditional	MRB	Traditional	MRB
No	90	90	90	90
Sex: Male	90	90	90	90
Age	52	56	54	45
Level of Education				
Illiterate	6	4	17	10
Literate	30	30	27	22
high school	16	17	12	11
High Agricultural School	3	21		
Other high technical education	29	2	24	27
College	6	16	5	17
Marital Status				
Single	4	4		6
Married	86	84	90	83
Widow		2		1
Main Occupation				
None	1	2	6	
Farmer		1	6	
Animal husbandry				
Technician		1		
Trader				
off-farm job	12	13	9	12
Student				
Housekeeping	73	71	57	66
other	4	2	12	12

9.2 Owned Properties

Table 39 indicates that, besides being land owners, the majority of farmers in Sharkia and Assiut own the house they live in. In addition, around 50% of them have storage in their houses.

As for the owned machinery and equipment, results indicate that farmers own Tractors, Plows, Harvesters, Threshing Machines and Motorized Sprayers. Some of the sample farmers own trucks and trailers. In regard to the quality of owned land, results indicate that soil salinity in Assiut is less than in Sharkia due to water availability in Assiut.

9.3 Sources of Fund

The majority of sample farmers in Sharkia and Assiut said they are unable to get loans. Around 1.1% said they borrowed from relatives to buy inputs, while 0.6% got loans from village traders for the same purpose and 3.6% got bank loans to cover the expenses of getting their children married.

Table 39. General Characteristics of Properties and Lands Owned by Sample Farmers at the Level of Sharkia and Assiut

Governorate		Sharkia		Assiut	
Category of farmers		Traditional	MRB	Traditional	MRB
House	Owned	85	90	88	90

	Rented	5		2	
Wall material		90	90	90	90
Store house	yes	43	39	55	57
	No	46	51	35	33
Land Tenure	Owns the land and exploit it	84	89	90	88
	Owns the land and lease it to others				
	Share farming	4			
	Other (Rent)	2	1		2
Degree of soil salinity	High	23	18		
	Moderate	58	59	40	31
	Low	9	13	50	59
Depth of water table	High	39	21		
	Moderate	44	59	39	30
	Low	7	10	51	60
Tractor	Owned	1	2	13	11
	Rented	89	87	77	72
	Shared				7
Plow	Owned	4	3	14	7
	Rented	86	87	75	77
	Shared			1	6
Irrigation wheel	Owned	76	85	83	84
	Rented	14	5	6	6
	Shared			1	
Harvester	Owned	1	1	2	1
	Rented	89	89	88	88
	Shared				1
Threshing machine	Owned	4	1	12	4
	Rented	86	89	77	81
	Shared			1	5
Motorized sprayer	Owned	12	17	15	7
	Rented	78	73	74	78
	Shared			1	5
Trailer	Owned	15	3	14	4
	Rented	13	12	26	18
	Shared			1	4
Pickup	Owned	1	7		
	Rented	43	39	43	38
	Shared				

9.4 Knowledge about Wheat Cultivation under MRB System

Results obtained from farmers' opinions regarding wheat cultivation under MRB system are presented in table 40.

Table 40. Farmers' Opinions Regarding Wheat Cultivation under MRB System

NO					
Knowledge about MRB technology	yes	47	90	28	90
	no	43		62	
	Extension staff demo plots	2	8	2	24

Main source of info. on new varieties planted under MRB system this year (2018)	Other farmers in the village	3	4		1
	Market (Agrovet/local trader/stockist)				1
	Farmer group/Coop				1
	Governmental				1
	Private Company				
	Cooperative				1
	Other (Extension staff demo plots-Other farmers in the village)	41	72	1	4
	Extension staff demo plots & Cooperatives		3	4	38
	Extension staff demo plots&Other farmers in the village & Cooperative		3	6	20

10 knowledge about the Attributes of MRB Technology

Results in table 41 illustrate the attributes of applying MTB technology.

Table 41. knowledge about the Attributes of MRB Technology

Governorate		Sharkia		Assiut	
Farming System		Traditional	MRB	Traditional	MRB
Market price received	Don't know	9	50	87	80
	No Difference		25	3	7
	Better		15		3
Marketability (demand)	Don't know	43		71	1
	No Difference		3		1
	Better	47	87	19	88
Yield	Worse				1
	Don't know	43		71	
	No Difference		2		
	Better	47	88	19	89
Cost of Adoption	Worse				1
	Don't know	43	10	72	3
	No Difference		20		3
	Better	47	60	18	83
Technology. Knowledge needed	Don't know	43	3	71	
	No Difference		1		2
	Better	47	86	19	88
Availability of MRB machine	Don't know	41		70	
	No Difference	5			
	Better	44	90	20	90
Knowledge about the attributes of MRB Tech.	No	43		62	
	Yes	47	90	28	90

10.1 Main Criteria for Adopting MRB Technology

Crop Production, Table 42 presents the main criteria for adopting MRB technology in crop production.

Table 42. Main Criteria for Adopting MRB Technology in Crop Production

Governorate		Sharkia		Assiut	
Farming System		Traditional	MRB	Traditional	MRB
Own experience	very much	82	72	1	19
	a lot	6	11	3	3
	sometimes			24	13
	Seldom	2		27	43
	not at all		7	35	12
NGO	very much	2	1		18
	a lot	4			30
	sometimes	3	4	26	13
	Seldom	21	28	35	22
	not at all	60	57	29	7
Research Centre	very much	4	15		
	a lot	3	6	6	10
	sometimes	10	31	36	34
	Seldom	72	38	43	36
	not at all	1		5	10
Radio programs/TV	very much	9	23		3
	a lot	3	6		12
	sometimes	3	12	34	46
	Seldom	63	43	30	19
	not at all	12	6	26	10
Market (e.g. Agro vet, etc.)	very much				1
	a lot		2		
	sometimes	5	14	32	8
	Seldom	77	68	32	64
	not at all	8	6	26	17
Neighbors/relative/Other farmers	very much	9	32		
	a lot	16	24	12	23
	sometimes	55	31	19	41
	Seldom	10	3	58	17
	not at all			1	9
Extension officer	very much		19	2	35
	a lot	13	46	23	49
	sometimes	35	15	7	1
	Seldom	42	10	58	5
	not at all		9		4
Main criteria for adopting MRB tech.	Don't know	43	10	77	45
	Availability of the machine &Technology. Knowledge needed&Yield	47			
	Availability of the machine &Yield&Water saving		80	13	45

Livestock Production, Table 43 presents the main criteria for adopting MRB technology (livestock production).

Table 43. Main Criteria for Adopting MRB Technology (Livestock Production)

Governorate		Sharkia		Assiut	
Farming System		Traditional	MRB	Traditional	MRB
own experience	very much	77	69		15
	a lot	4	9	1	9
	sometimes	2	1	18	11
	Seldom	6	6	54	49
	not at all	1	5	17	6
NGO	very much	2	2		12
	a lot	1	5	5	17
	sometimes	3	5	22	10
	Seldom	7	8	40	46
	not at all	77	70	23	5
Research Centre	very much	3	14		4
	a lot	3	6		5
	sometimes	3	10	43	24
	Seldom	44	39	32	45
	not at all	37	21	15	12
Radio programs/TV	very much	7	17		
	a lot	3	8	2	6
	sometimes	4	9	26	36
	Seldom	37	27	40	37
	not at all	39	29	22	11
Market (e.g. Agro vet, etc.)	very much		1		
	a lot	3	4	1	
	sometimes	2	7	20	10
	Seldom	51	47	46	60
	not at all	34	31	23	20
neighbors/relatives/other farmers	very much	12	15		
	a lot	3	13	7	9
	sometimes	40	25	30	43
	Seldom	32	36	38	30
	not at all	3	1	15	8
Extension officer	very much	9	19		31
	a lot	3	10	9	50
	sometimes	2	23	41	2
	Seldom	36	31	24	1
	not at all	40	7	16	6

10.2 Information Receiver

Table 44 presents the main criteria for adopting MRB technology (information receiver).

Table 44. Main Criteria for Adopting MRB Technology (Information Receiver)

Governorate		Sharkia		Assiut	
Farming System		Traditional	MRB	Traditional	MRB
own experience	Very difficult		1	1	
	Difficult		4	51	50
	Rather easy	3	6	18	2
	very easy	87	79	20	38
NGO	Very difficult	68	52	5	1
	Difficult	19	28	19	51
	Rather easy	3	5	33	7
	very easy		5	33	31
Research Centre	Very difficult	11	13	3	3
	Difficult	66	40	10	39
	Rather easy	7	22	40	13
	very easy	6	15	37	35
Radio programs/TV	Very difficult	15	17	5	
	Difficult	62	38	18	24
	Rather easy	4	9	29	35
	very easy	9	26	38	31
Market (e.g. Agro vet, etc.)	Very difficult	12	15	1	2
	Difficult	44	59	13	50
	Rather easy	28	7	32	23
	very easy	6	9	44	15
Neighbors/relatives/other farmers	Very difficult	4	4	1	1
	Difficult	6	5	11	31
	Rather easy	68	36	41	34
	very easy	12	45	37	24
Extension officer	Very difficult	31		2	4
	Difficult	27	20	5	4
	Rather easy	23	46	30	14
	very easy	9	24	53	68

10.3 Main Problems Confronting Farmers

Farmers' perspectives regarding main problems confronting them are presented in Table 45 sample opinions.

Table 45. Farmers' Perspectives Regarding Main Problems Confronted

Governorate		Sharkia		Assiut	
Farming System		Traditional	MRB	Traditional	MRB
Long distance between land and the main canal	no problem	10	5	3	23
	weak	36	43	55	54

	sever	44	42	32	13
High costs of cleaning the mesqa	no problem		4	2	36
	weak	33	32	25	40
	sever	57	54	63	14
High costs of energy i.e. electricity and diesel	no problem		2		27
	weak	4	2		4
	sever	86	86	90	59
Irregular irrigation shifts	no problem			1	35
	weak	9	15	11	48
	sever	81	75	78	7
Inadequate scheme of irrigation rotation	no problem			1	11
	weak	2	15	12	53
	sever	88	75	77	26
using agricultural drainage water in irrigation	no problem	2	4	78	59
	weak	19	17	8	29
	sever	69	69	4	2
Spread of weeds that hinder water flow	no problem		6	9	21
	weak	19	21	3	20
	sever	71	63	78	49
Irrigation water doesn't reach the mesqa tail, especially in summer	no problem			3	2
	weak	12	14	16	19
	sever	78	76	71	69
Water shortage, especially in the summer	weak	7	10	4	19
	sever	83	80	86	61
Malfunctioning of hydraulic lifting gates	no problem	31	37	29	64
	weak	47	46	52	25
	sever	12	7	9	1
Frequent interruption of irrigation water	no problem	6	6		61
	weak	50	46	43	7
	sever	34	38	47	14
Frequent electricity cut off	no problem	29	30	1	69
	weak	38	37	8	
	sever	23	23	81	21
Frequent blockage of sprayers	no problem	48	48	33	71
	weak	34	36	14	5
	sever	8	6	43	14
Absence of drainage system even surface drainage	no problem	56	41	17	6
	weak	35	44	20	2
	sever	9	5	53	82
Unsuitable width of the mesqa for irrigation due to collapse of bridges	no problem	14	25	41	58
	weak	64	58	35	31
	sever	12	7	14	1
Inability to cultivate some crops, like vegetables, due to water shortage	no problem	10	16	53	68
	weak	64	59	27	13
	sever	16	15	10	9
Narrow path across the mesqa	no problem	6	10	19	61
	weak	54	56	51	24
	sever	30	24	20	5
Pollution of irrigation water	no problem	1	3	29	54
	weak	31	31	20	46
	sever	58	56	41	8

Farmers' suggestions to solve irrigation problems are presented in Table 46, and problems related to soil properties from farmers' point of view are presented in table 47.

Table 46. Farmers' Suggestions to Solve Irrigation Problems

Water shortage, especially in the summer	Cultivating water saving crops Artesian irrigation
Irrigation water doesn't reach the mesqa tail, especially in the summer	Periodic purification of mesqa
Spread of weeds that hinder the water flow	Removing weeds
Using agricultural drainage water in irrigation	Providing fresh water and alternatives
Inadequate scheme of irrigation shifts	Increasing irrigation shifts
Irregular irrigation shifts	Follow up and Monitoring
High costs of energy i.e. electricity and diesel	Subsidizing energy sources
High costs of cleaning the mesqa	Extending subsidy to farmers
Pollution of irrigation water	Strict legislations to ban pollution of irrigation canals
Narrow path across the mesqa	Widening the narrow paths
Inability to cultivate some crops, like vegetables, due to water shortage	Rationalizing water resources' use
Unsuitable width of the mesqa for irrigation due to collapsing of bridges	Maintenance
Absence of drainage system, even surface or tile drainage	Follow up of maintenance operations and expanding drainage systems
Frequent blockage of sprayers	Follow up and maintenance
Frequent electricity cut off	Supervision, follow up and periodic maintenance
Frequent interruption of irrigation water	Follow up and Monitoring
Disable hydraulic lifting gates	Governmental Monitoring and supervision, in addition to maintenance.

Table 47. Problems Related to Soil Properties from Farmers' Point of View

Governorate		Sharkia		Assiut	
Farming System		Traditional	MRB	Traditional	MRB
Spread of pests i.e. nematodes	no problem	31	43	42	58
	weak	57	47	4	26
	sever	2		44	6
Spread of diseases i.e. root rot	no problem	28	31	41	58
	weak	58	46	4	26
	sever	4	13	45	6
Spread of weeds	no problem	1	5		37
	weak	42	35	7	25
	sever	47	50	83	28
Inability to cultivate some crops due to poor soil fertility	no problem	14	25	28	59
	weak	44	37	47	25
	sever	32	28	15	6
High level of soil salinity	no problem	13	20	25	28
	weak	51	42	59	39
	sever	26	28	6	23
Poor nutrients	no problem	1	4	4	9
	weak	26	37	67	53
	sever	63	49	19	28
High water table due to absence of drainage system	no problem	43	40	23	28
	weak	10	21	55	32
	sever	37	29	12	30

Farmers' suggestions to address soil problems are presented in Table 48, and problems confronted in plant production from farmers' point of view are presented in Table 49.

Table 48. Farmers' Suggestions to Address Soil Problems

High water table due to absence of drainage system	Establishing drainage systems
Poor nutrients	Adding organic fertilizers
High level of soil salinity	Cultivation salinity tolerant crop; adding agricultural gypsum
Inability to cultivate some crops due to poor soil fertility	Adopting a crop rotation that helps improve soil fertility
Spread of weeds	Periodic removal of weeds
Spread of diseases i.e. root rot	Spraying, stopping repetition of cultivated crops, returning to crop rotation
Spread of pests i.e. nematodes	Spraying

Table 49. Problems Confronted in Plant Production from Farmers' Point of View

Governorate		Sharkia		Assiut	
Farming System		Traditional	MRB	Traditional	MRB
Agric. coops associate provision concerning agric. inputs with the collection of installments due	no problem	4	21	64	85
	weak	76	61	22	4
	sever	10	8	4	1
Agric. Coops sell farmers undesired types of chemical fertilizers	no problem	57	51	71	67
	weak	17	29	17	18
	sever	16	10	2	5
Unavailability of improved varieties	no problem	5	4	44	62
	weak	7	26	8	22
	sever	78	60	38	6
Inadequate supply of chemical fertilizers	no problem	2	4	2	4
	weak	7	12	38	42
	sever	81	74	50	44
Unavailability of inputs (seeds – pesticides)	no problem	1	3	25	34
	weak	3	6	14	45
	sever	86	81	51	11
High prices of chemical fertilizers obtained from agric. Coops.	no problem	9	15		
	weak	63	46	1	6
	sever	18	29	89	84
High prices of inputs and labor	Weak				5
	sever	90	90	90	85
Poor role of agricultural extension	no problem	8	8	45	72
	weak	3	12	36	4
	sever	79	70	9	14
Low yield	no problem	6	6	1	13
	weak	8	61	12	28
	sever	76	23	77	49
Low price of crop	no problem	3		2	
	weak	5	8	3	16
	sever	82	82	85	74
Spread of pests	no problem	22	26	30	48
	weak	63	56	12	20
	sever	5	8	48	22
Decision regarding crops to be cultivated is taken according to availability of irrigation water and soil fertility regardless of market needs	no problem	19	23	47	85
	weak	28	28	14	4
	sever	43	39	29	1

Farmers' suggestions to address plant production problems are presented in Table 50.

Table 50. Farmers' Suggestions to Address Plant Production Problems

High price of inputs and labor	Subsidizing prices of agriculture inputs Cultivating fodder crops
High prices of chemical fertilizers offered by agricultural co-operatives	Subsidizing prices of chemical fertilizers
Unavailability of inputs (seeds - pesticides)	Providing seeds and pesticides and reducing their prices
Inadequate supply of chemical fertilizers	Increasing quantities supplied of fertilizers
Unavailability of improved varieties	Increasing quantities supplied of improved varieties

Problems confronted in livestock product Problems from farmers' point of view are presented in Table 51, and farmers' suggestions to address livestock production problems are presented in Table 52.

Table 51. Problems Confronted in Livestock Production from Farmers' Point of View

Governorate		Sharkia		Assiut	
Farming System		Traditional	MRB	Traditional	MRB
Lack of finance	no problem			30	11
	weak	9	30	3	16
	sever	81	60	57	63
Far distance between production site and markets	no problem	2	3	1	23
	weak	15	33	44	31
	sever	73	54	45	36
Lack of veterinary services	no problem	2	2		
	weak	12	21	45	33
	sever	76	68	45	57
Unavailability of concentrates and dry fodders	no problem	4	2	1	1
	weak	7	15	16	20
	sever	79	73	73	69
High prices of veterinary drugs	weak	16	13		2
	sever	74	77	90	88
High prices of concentrates and dry fodders	no problem				1
	weak	9	7		1
	sever	81	83	90	88
High price per head of live animals	no problem		2	2	2
	weak	11	9		7
	sever	79	79	88	81
Lack of green fodders	no problem	7	2	44	34
	weak	70	68	11	15
	sever	13	20	35	41

Table 52. Farmers' Suggestions to Address Livestock Production Problems

Lack of green fodders	Expanding fodder crops' planted area and reducing feed prices
High price per head of live animals	Reducing feed prices to encourage livestock production
High prices of concentrates and dry feed	Increasing the quantities supplied of concentrated feed and subsidizing their prices
High prices of veterinary drugs	Subsidizing veterinary drugs
Lack of veterinary services	Activating the role of vet. care units and providing vet. drugs
Lack of finance	Facilitating loans to farmers and agric. activities

Problems related to obtaining credit from farmers' point of view and suggestions to solve them are presented in Table 53. Moreover, the problems related to agricultural marketing from farmers' point of view and suggestions to solve them are presented in Table 54.

Table 53. Problems Related to Obtaining Credit from Farmers' Point of View

Governorate		Sharkia		Assiut	
Farming System		Traditional	MRB	Traditional	MRB
Difficulties in providing collaterals	no problem				7
	weak	9	15	1	24
	sever	81	75	89	59
Suggestion to solve the problem		Facilitating bank procedures			
Complicated banking procedures and required documents	no problem				1
	weak	3	2	12	13
	sever	87	88	78	76
Suggestion to solve the problem		Extending grace periods for loan receivers who start projects that offer services to agric projects			
Short grace period	weak	3	3	1	8
	sever	87	87	89	82
Suggestion to solve the problem		Reducing interest rates on agric. projects			
High interest rate	weak	4	2		
	sever	86	88	90	84

Table 54. Problems Related to Agricultural Marketing from Farmers' Point of View

Governorate		Sharkia		Assiut	
Farming System		Traditional	MRB	Traditional	MRB
Suggestion to solve the problem		Increasing procurement prices to encourage farmers cultivate the crops			
Low crop price	no problem	2	1	1	
	weak	4	8		
	sever	84	81	89	90
Suggestion to solve the problem		Activating the role of cooperatives			
Unavailability of cooperative storages	no problem	16		12	
	weak	16	40	26	
	sever	58	50	52	90
Suggestion to solve the problem		Establishing marketing outlets under the umbrella and supervision of Governmental Entities			
Unavailability of marketing channels rather than the village merchant	no problem	1	4	2	
	weak	2	7	18	
	sever	87	79	70	90
Suggestion to solve the problem		Reducing the prices of fuels used by trucks transporting agric. crops			
High transportation costs	no problem		2	1	
	weak	23	16	16	
	sever	67	72	73	90
Suggestion to solve the problem		Paving roads to facilitate transportation to markets			
Far distance between production site and markets	no problem	1	10		24
	weak	23	37	38	43
	sever	66	52	52	23

11 Concluding Remarks and Recommendations

Based on the achieved results, promoting the adoption of wheat cultivation on raised beds requires formulating a set of policies and alternative instruments that aim to activate the role of agricultural extension in providing farmers with information and updates on appropriate new farming systems and technology packages in order to increase their knowledge about the introduced technology package and associated benefits.

The set of policies should focus on the following:

- Activating the role of agricultural cooperative societies in providing the machinery required for implementing raised-bed technology package to tenant farmers at a reasonable cost, which will encourage them to adopt the introduced new technology package. Moreover, farmers' access to credit should also be enhanced to allow them access to the machinery as well as essential inputs to increase their overall productivity.

- Assure the availability of prober information about MRB package by increasing the number of extension officers and pilot plots, as most of the farmers knew about MRB farming from neighbors.

- Enhance and support the role of private sector in overcoming obstacles faced while using the machine to allow proper application of MRB technology package, which requires proper land preparation before using the machine, especially in old lands, in addition to solving the problem of clogging in seed tubes.

- Facilitate farmers' access to finance. This will certainly facilitate to allow them have access to the machine as well as essential inputs to increase their overall productivity thus income and livelihood.

- Enhancing the role of research is also highly important, where conducting a study to assess the economic efficiency of RBM use shall help in evaluating alternative uses of the machine, especially that farmers highlighted its use in planting maize and rice.

- Finally, it is important to develop tools to coordinate the efforts of private sector, RBM industries, machinery traders and users; this will increase the opportunities, sustainability and economic efficiency of using the machine.