

## **EVALUATION OF CROP-DAIRY PRODUCTION SYSTEM IN NILE DELTA**

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### **SUMMARY**

A linear programming (LP) model was applied to evaluate crop-dairy production system in small mixed farms in the Nile Delta through the impact of Food Sector Development Program (FSDP) of the Ministry of Agriculture and Land Reform. The LP model considered land, labor, large ruminant genotypes, cropping pattern and available cash resources (ACR) as factors affecting production of this system. Technical coefficients of the LP model were estimated from a survey data collected from 492 farmers in five different governorates, Damietta (DAM), Daqahleia (DAQ), Gharbeia (GHA), Kafr El-Sheikh (KEL) and Menoufeia (MEN), during the period from 1993 to 2001. Two districts were sampled within each governorate, one with farmers collaborating with FSDP, who got at least one training package ( $C_1$ ) and another with non-collaborating farmers (receiving no training packages (control group)) ( $C_0$ ). The objective function of LP model was to determine the optimum combination of crops and dairy production, which maximizes the gross margin (GM) of the farm, which enhances the return per feddan (RPF) and the return per animal (RPA). One LP model with three runs was tested. The first run (base run) was to simulate the actual situation, the second ( $LP_1$ ) to avoid the unacceptable solution for the base run while the third ( $LP_2$ ) to get feasible solution for the district that had no feasible solution. Results suggested that, in base run solution, farmers in general should combine cultivating berseem in winter with rice in summer plus keeping buffalo before FSDP package adoption. While, after FSDP package adoption the farmers should combine cultivating cash crops with berseem in winter, rice in summer and crossbred cattle in district  $C_1$  in MEN and in both district in DAQ, while other districts should keep exotic cattle. The FSDP improved GM, RPF and RPA by about 9%, 5% and 11%, respectively in base run, by about 10%, 7% and 10%, respectively, in  $LP_1$  and by about 8%, 3% and 10%, respectively in  $LP_2$ . In conclusion LP model showed that, both land and available cash resources were the limiting resources while labor was not. In mixed dairy production system in Nile delta, dairy animal activities contribute substantially, about 25%, to the total farm gross margin.

**Keywords:** *Linear programming, small mixed farm, cattle, buffalo, Egypt*

## INTRODUCTION

In Egypt, the crop-dairy production system is quite common in many regions, i.e. Nile delta and valley and newly reclaimed lands. This system harbors livestock producing 90 % of the total milk production (Abdel-Aziz, 1997). Eight five percent of the total domestic milk output is provided by traditional cropping-dairy farms and 15 % by the dairy-specialized commercial sector (MoALR, 2004).

Food Sector Development Program (FSDP), which is considered in the present study, lasted from 1991 to 2001 and was funded by the European Commission (EC) for a value of 9.9 million Euro and executed by the Ministry of Agriculture and Land Reform. FSDP activities were servicing the dairy sector and focused on the production, processing and marketing of milk. Also, FSDP included technical components, supporting the development of the dairy sector. FSDP activities were institution building, training and demonstration, technical assistance and a 75 million Euro fund as credit and guarantee scheme. Target group was the small and medium scale farmers.

The objective of this study was to evaluate cropping-dairy production system in small mixed farms in the Nile delta through the impact of FSDP.

## MATERIAL AND METHODS

### *Data:*

A survey was conducted using an objective questionnaire. Data were collected on 492 crop-dairy farms between 1993 and 2001 as a part of the FSDP to develop the cropping-dairy farming system in the Nile delta. The data were collected only from farmers who practice cropping plus buffaloes and/or one or more dairy cattle genotypes, i.e. native (Baladi) and exotic cattle and crosses between them. Each farm had two interviews, one at the beginning of the program during 1993 to 1997 and another at the end during 1998 to 2001. Five governorates in the Nile delta were involved, Damietta (DAM), Daqahleia (DAQ), Gharbeia (GHA), Kafr El-Sheikh (KEI) and Menoufeia (MEN). Two districts were sampled from each governorate, one had collaborating ( $C_1$ ) farmers and another that had no collaborating ( $C_0$ ) farmers. Collaborating farmers would get at least one of the FSDP training packages while non-collaborating farmers received no such training packages (as a control group). Training packages included 15 training programs on how farmers can increase their dairy animal productivity, produce clean milk and improve farm income. Table 1 shows the distribution of farmers.

Table 2 shows available resources, cropping pattern, and dairy animal production before and after intervention through the FSDP adopted training package(s) in dairy animal activities excluding small ruminants due to their small number.

### *Mathematical LP model*

The LP model considered land, labor, large ruminant genotypes, cropping pattern and available cash resources (ACR) as factors affecting crop/dairy production system. This model is applied to determine the optimum combination of crops with dairy, which maximizes the gross margin (GM) of the farm and leads to increase the return per animal (RPA) and the return per feddan (RPF) (1 feddan = 4200 m<sup>2</sup>). One LP model with three runs was performed, the first run (base run) to simulate the

actual situation, the second (LP<sub>1</sub>) to avoid the unacceptable solution for the base run (cultivated only berseem, *Trifolium alexandrinum*, in winter and green fodder in summer). While the third (LP<sub>2</sub>) was to get feasible solution for the district(s) that had no feasible solution. Input estimates of the model were analyzed using General Algebra Modeling System (GAMS, 2000) software. The model structure for the three runs were as follows:

**Table 1. Number of farmers in two districts within each of the five studied governorates**

Governorate	District	Number of farmers	Total
Damietta	C <sub>0</sub> -Kafr Saad	26	73
	C <sub>1</sub> - Faraskur	47	
Daqahleia	C <sub>0</sub> -Sherbeen	12	103
	C <sub>1</sub> -Senblewien	91	
Gharbeia	C <sub>0</sub> -Tanta	20	104
	C <sub>1</sub> -Quttur	84	
Kafr-El-Sheikh	C <sub>0</sub> -Dessouk	8	87
	C <sub>1</sub> -Qallin	79	
Menoufeia	C <sub>0</sub> -Ashmoun	31	125
	C <sub>1</sub> -Shanshour	94	
Total	C <sub>0</sub>	97	492
	C <sub>1</sub>	395	

C<sub>0</sub>= no collaborating district    C<sub>1</sub>= collaborating district

**Base run:**

$$\text{Objective function: Maximize (gross margin)} = \sum_{j=1}^{12} a_j X_j$$

where,

a<sub>j</sub> gross margin for each variable of X<sub>i</sub>, X<sub>i</sub> are number of feddans cultivated with berseem (X<sub>1</sub>), wheat (X<sub>2</sub>), winter cash crops (X<sub>3</sub>), faba bean (X<sub>4</sub>), rice(X<sub>5</sub>), summer cash crops (X<sub>6</sub>), maize (X<sub>7</sub>), cotton(X<sub>8</sub>), number of buffaloes (X<sub>9</sub>), number of native cattle (X<sub>10</sub>), number of crossbred cattle (X<sub>11</sub>) and number of exotic cattle (X<sub>12</sub>).

Constraints:

Land,

Winter    X<sub>1</sub>+ X<sub>2</sub>+ X<sub>3</sub>+X<sub>4</sub>≤ average farm size

Summer    X<sub>5</sub>+ X<sub>6</sub>+ X<sub>7</sub>+ X<sub>8</sub>≤ average farm size

$$\text{Labor,} \\ \sum_{i=1}^{12} c_i X_i \leq b,$$

where,

$c_i$  is labor (adult-day) requirement  
 $b$  is total labor; and  $X_i$  as before.

$$\text{ACR,} \\ \sum_{i=1}^{12} d_i X_i \leq m,$$

where,

$d_i$  is variable cost for each variable;  $m$  available cash resources; and  $X_i$  as before.

Non negativity

$$X_i \geq 0, \quad i = 1, \dots, 12.$$

**Second run (LP<sub>1</sub>):**

Objective function: the same as base run.

Constraints:

Land,

$$\text{Winter } X_1 + X_2 + X_3 + X_4 \leq \text{average farm size}$$

$$X_1 \geq 1 \text{ feddan}$$

$$X_2 \geq 1 \text{ feddan}$$

$$X_3 \geq 1 \text{ feddan}$$

$$X_4 \geq 1 \text{ feddan}$$

$$\text{Summer } X_5 + X_6 + X_7 + X_8 \leq \text{average farm size}$$

$$X_5 \geq 1 \text{ feddan}$$

$$X_6 \geq 1 \text{ feddan}$$

$$X_7 \geq 1 \text{ feddan}$$

$$X_8 \geq 1 \text{ feddan}$$

Labor,

$$\sum_{i=1}^{12} c_i X_i \leq b,$$

where,

$c_i$  is labor (adult-day) requirement  
 $b$  is total labor; and  $X_i$  as before.

ACR,

$$\sum_{i=1}^{12} d_i X_i \leq m,$$

where,

$d_i$  is variable cost for each variable;  $m$  available cash resources; and  $X_i$  as before.

Non negativity

$$X_i \geq 0, \quad i = 1, \dots, 12.$$

**Table 2. Raw means of available resources before and after adopting FSDP training packages**

	DAM		KEL		MEN		DAQ		GHA	
	C <sub>1</sub>	C <sub>0</sub>	C <sub>1</sub>	C <sub>0</sub>	C <sub>1</sub>	C <sub>0</sub>	C <sub>1</sub>	C <sub>0</sub>	C <sub>1</sub>	C <sub>0</sub>
Average farm size (feddan)	5.4 (5.7)	3.1 (3.1)	8.9 (9.9)	4.8 (4.8)	6.4 (6.8)	2.3 (2.3)	10.1 (10.6)	5.5 (5.5)	8.8 (9.0)	5.2 (5.1)
Labor (person day)/farm per year	616 (528)	528 (528)	615 (492)	352 (352)	528 (528)	616 (738)	738 (861)	528 (616)	704 (792)	861 (1107)
Winter	581 (516)	516 (516)	590 (472)	472 (472)	498 (708)	357 (516)	708 (826)	516 (602)	944 (1062)	602 (774)
Summer	Winter cropping area (feddan)									
Winter cropping area (feddan)	3.0 (3.0)	1.1 (1.1)	3.5 (3.6)	1.9 (2.9)	2.5 (2.9)	1.0 (1.0)	4.1 (5.6)	2.6 (2.6)	3.6 (3.7)	3.2 (3.1)
Berseem	1.4 (1.7)	1.0 (1.0)	3.3 (2.3)	1.8 (1.9)	2.0 (2.0)	0.5 (0.5)	2.5 (3.0)	1.5 (1.5)	2.0 (3.0)	1.5 (1.5)
Wheat	1.0 (1.0)	1.0 (1.0)	2.1 (2.0)	- (-)	1.9 (1.9)	0.8 (0.8)	2.5 (2.0)	1.4 (1.4)	2.0 (2.3)	1.5 (1.5)
Cash crops	- (-)	- (-)	- (2.0)	1.1 (-)	- (-)	- (-)	1.0 (-)	- (-)	1.2 (-)	- (-)
Faba bean	Summer cropping area (feddan)									
Summer cropping area (feddan)	3.0 (2.1)	1.1 (1.1)	3.1 (3.6)	1.9 (1.9)	- (-)	- (-)	4.1 (4.6)	2.6 (2.6)	3.6 (3.7)	3.2 (3.1)
Rice	1.0 (0.6)	1.0 (1.0)	1.2 (2.0)	- (-)	2.0 (2.0)	1.3 (1.3)	1.0 (1.0)	1.5 (1.5)	1.2 (1.3)	1.5 (1.5)
Cash crops	1.4 (2.0)	1.0 (1.0)	1.6 (2.0)	1.8 (1.8)	2.5 (2.9)	1.0 (1.0)	2.5 (2.0)	1.4 (1.4)	2.0 (1.0)	1.5 (1.5)
Maize	- (1.0)	- (-)	3.0 (2.1)	1.1 (1.1)	1.9 (1.9)	- (-)	2.5 (3.0)	- (-)	2.0 (3.0)	- (-)
Cotton	Average herd size (head)									
Average herd size (head)	1.3 (1.3)	1.2 (1.0)	1.5 (1.2)	2.0 (2.0)	2.4 (2.5)	1.5 (1.5)	1.4 (1.4)	2.1 (2.0)	1.7 (4.7)	1.2 (1.2)
Buffalo	0.6 (0.2)	0.5 (0.2)	0.8 (0.4)	0.8 (0.5)	0.5 (-)	0.4 (-)	0.5 (0.2)	0.7 (0.4)	0.5 (-)	0.7 (-)
Baladi	0.4 (0.6)	0.5 (0.6)	1.0 (1.1)	1.3 (2.0)	1.2 (0.5)	- (0.6)	0.7 (0.7)	1.1 (1.3)	1.0 (-)	1.3 (2.0)
Crossbred	0.2 (0.6)	- (0.5)	0.6 (0.7)	- (-)	- (0.6)	- (-)	0.2 (0.8)	0.8 (1.3)	1.0 (-)	1.0 (1.0)
Exotic	DAM= Damietta    KEL= Kafr El Sheikh    MEN= Menoufia    DAQ= Daqahleia GHA=Gharbeia    C <sub>0</sub> = non-collaborating district    C <sub>1</sub> = collaborating district    - = non-practiced activity    * values in brackets for after adopting project between brackets									

**Third run (LP<sub>2</sub>):**

Objective function: the same as base run

Constraints:

Land,

$$X_1 + X_2 + X_3 + X_4 \leq \text{average farm size}$$

$$X_1 \geq 0.75 \text{ feddan}$$

$$X_2 \geq 0.75 \text{ feddan}$$

$$X_3 \geq 0.75 \text{ feddan}$$

$$X_4 \geq 0.75 \text{ feddan}$$

Summer  $X_5 + X_6 + X_7 + X_8 \leq$  average farm size

$$X_5 \geq 0.75 \text{ feddan}$$

$$X_6 \geq 0.75 \text{ feddan}$$

$$X_7 \geq 0.75 \text{ feddan}$$

$$X_8 \geq 0.75 \text{ feddan}$$

Labor,

$$\sum_{i=1}^{12} c_j X_i \leq b,$$

where,

$c_j$  is labor (adult-day) requirement

$b$  is total labor; and  $X_i$  as before.

ACR,

$$\sum_{i=1}^{12} d_j X_i \leq m,$$

where,

$d_j$  is variable cost for each variable;  $m$  available cash resources; and  $X_i$  as before.

Non negativity

$$X_i \geq 0, \quad i = 1, \dots, 12.$$

## RESULTS AND DISCUSSION

### *LP (base run) solution:*

LP (base run) solution shown in Table 3 suggests that, farmers in all districts should cultivate berseem in winter and rice in summer, except Sherbeen in DAQ ( $C_0$ ) where the solution suggested that farmers should cultivate cash crops beside berseem in winter and rice in summer. While in both districts in MEN (Shanshour and Ashmoun) farmers should cultivate berseem in winter and cash crops in summer. Moreover, the solutions suggested that farmers before FSDP should keep buffalo in all governorates except both district in DAM governorate where the solutions suggested that farmers should keep crossbred cattle. While after FSDP, the solution suggested that farmers should keep crossbred cattle in district  $C_1$  in MEN and in both district in DAQ, while other districts should keep exotic breeds. This result indicates that the FSDP impacted dairy animal activities. Also, DAQ is traditionally a rice growing governorate, when a farmer goes to dairy production, he does so by raising crossbreed, exotic or buffalo and grows more of fodder crops

The solutions of the base run (Table 3) found the highest GM and RPA in  $C_1$  in KEI in both states of FSDP intervention. Also, the solutions showed that GM, RPA and RPF, in general, showed positive FSDP impact, where differences between after and before FSDP within all  $C_1$  districts were higher than the differences between after and before FSDP within all  $C_0$  districts. This result could possibly occur due to FSDP credit and guarantee and intervention packages schemes available to  $C_1$  farmers. Results of base run also showed that dairy animal activities contributed considerably to the total GM, representing about 25%, which is greater than those reported by Ahmed (1995) of about 20% for dairy animals in newly reclaimed lands. GM, RPF and RPA increased in general by about 9%, 5% and 11%, respectively after FSDP.

**Table 3. LP (base run) solution for the two districts within five governorates before and after FSDP impact**

	DAM		KEI		MEN		DAQ		GHA	
	C <sub>1</sub>	C <sub>0</sub>	C <sub>1</sub>	C <sub>0</sub>	C <sub>1</sub>	C <sub>0</sub>	C <sub>1</sub>	C <sub>0</sub>	C <sub>1</sub>	C <sub>0</sub>
Winter cropping area, feddan										
Berssem	5.4 (5.7)	3.13 (3.13)	8.9 (9.9)	4.8 (4.8)	6.4 (6.8)	2.3 (2.3)	7.1 (10.6)	5.5 (5.5)	8.8 (9.0)	5.2 (5.1)
Wheat	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)
Cash crops	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	3 (-)	- (-)	- (-)	- (-)
Faba been	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)
Summer cropping area, feddan										
Rice	5.4 (5.7)	3.13 (3.13)	8.9 (9.9)	4.8 (4.8)	- (-)	- (-)	7.1 (7.6)	5.5 (5.5)	8.8 (9.0)	5.2 (5.1)
Cash crops	- (-)	- (-)	- (-)	- (-)	6.4 (6.8)	2.3 (2.3)	3.00 (3.00)	- (-)	- (-)	- (-)
Maize	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)
Cotton	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)
Dairy production, head										
Buffalo	- (-)	- (-)	4.6 (-)	4.0 (-)	4.3 (-)	2.1 (1.6)	4.6 (-)	4.1 (-)	4.7 (-)	3.9 (3.0)
Native cattle	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)
Crossbred	3.8 (-)	2.4 (-)	- (-)	- (-)	- (4.1)	- (-)	- (4.7)	- (3.5)	- (-)	- (-)
Exotic	- (3.6)	- (2.3)	- (4.8)	- (4.0)	- (-)	- (0.5)	- (-)	- (-)	- (4.5)	- (1)
Objective function value, LE										
GM	6946 (7678)	3363 (3443)	9619 (10910)	5216 (5248)	6979 (7839)	2450 (2615)	9085 (9626)	4936 (4977)	8417 (9648)	4701 (5177)
RPF	1249 (1337)	1074 (1100)	1093 (1102)	1086 (1093)	1090 (1152)	1065 (1137)	900 (908)	898 (904)	957 (1072)	904 (1015)
RPA	1819 (2145)	1401 (1496)	2091 (2272)	1304 (1312)	1663 (1912)	1166 (1245)	1975 (2048)	1204 (1422)	1791 (2144)	1205 (1294)

C<sub>0</sub>= non-collaborating district C<sub>1</sub>= collaborating district - = non-practiced activity  
 DAM= Damietta KEL= Kafr El Sheikh MEN= Menoufeia DAQ= Daqahleia  
 GHA= Gharbeia GM= gross margin RPF =return per feddan RPA= return per animal

**LP<sub>1</sub> solution:**

To develop the base run solution of cultivating only berseem in winter and rice in summer, the land constraint was modified as to cultivate at least one feddan of each crop in the cultivation pattern in all districts in LP<sub>1</sub>. The total cropping area suggested by LP<sub>1</sub> was smaller than the total farm size due to limiting available cash resource which led to leaving some fallow.

Moreover, the solution (Table 4) suggested that, farmers before FSDP should keep buffalo in all districts, except both districts in DAM where the solution suggested they should keep crossbreeds and C<sub>1</sub> district in GHA where farmers should keep buffalo plus exotic genotypes. While after FSDP, the solution suggested that, farmers should keep combinations of buffalo, crossbreed and exotic cattle in all districts except in both districts in DAM where farmers should keep just exotics. That might be due to the fact that DAM is known for milk processing (dairy products) that needs higher producing dairy animals for the industry (ISDC, 2002).

**Table 4. LP<sub>1</sub> solution for the two districts in five governorates before and after FSDP impact**

	DAM		K El		MEN		DAQ		GHA		
	C <sub>1</sub>	C <sub>0</sub>	C <sub>1</sub>	C <sub>0</sub>	C <sub>1</sub>	C <sub>0</sub>	C <sub>1</sub>	C <sub>0</sub>	C <sub>1</sub>	C <sub>0</sub>	
Winter cropping area, feddan											
Berssem	3.3 (3.5)	1 (1)	4.2 (6.0)	1.8 (1.8)	3.8 (4.3)	No feasible solution	4.4 (4.4)	3.5 (2.9)	5 (5.3)	3 (2.7)	
Wheat	1 (1)	1 (1)	1 (1)	1 (1)	1.2 (1.1)		1.5 (1.5)	1 (1)	1 (1)	1 (1.3)	
Cash crops	1 (1)	1 (1.3)	2.8 (1)	1 (1)	1 (1)		2.3 (2.3)	1 (1)	1 (1)	1 (1)	
Faba been	- (-)	- (-)	- (-)	1 (1)	- (-)		1 (1)	- (-)	1 (1)	- (-)	
Summer cropping area, feddan											
Rice	1 (1)	1 (1)	3 (4)	1 (1)	- (-)		3.0 (3.0)	2.4 (1)	4 (4.3)	1.7 (1.7)	
Cash crops	3.3 (3.5)	1 (1.3)	2.2 (2.0)	1.8 (1)	2.8 (2.9)		2 (2)	1.1 (1)	2 (2.3)	1.3 (1.3)	
Maize	1 (1)	1 (1)	1.8 (1)	1 (1.8)	2 (2)	2.2 (2.2)	1 (1)	1 (1)	1 (1)		
Cotton	- (-)	- (-)	1 (1)	1 (1)	1.2 (1.5)	1 (1)	- (-)	1 (1)	- (-)		
Dairy production, head											
Buffalo	- (-)	- (-)	4.6 (1.3)	4.1 (-)	4.2 (0.5)	4.6 (1.2)	4.0 (1.2)	1.5 (1.2)	3.7 (3.9)		
Native cattle	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)		
Crossbred	3.6 (-)	2.5 (-)	- (-)	- (-)	- (3.4)	- (3.5)	- (2.6)	- (-)	- (-)		
Exotic	- (3.7)	- (2.6)	- (3.6)	- (3.9)	- (-)	- (-)	- (-)	3.1 (3.3)	- (-)		
Objective function value, LE											
GM	7.70 (8003)	3730 (3962)	9803 (10956)	5750 (5918)	7116 (7930)	9706 (10304)	5082 (5599)	8640 (9811)	5035 (5505)		
RPF	1334 (1455)	1191 (1265)	1252 (1370)	1198 (1233)	1186 (1239)	1055 (1120)	924 (1018)	1080 (1182)	1007 (1101)		
RPA	1911 (2163)	1492 (1524)	2131 (2236)	1402 (1509)	1694 (2033)	2110 (2192)	1270 (1473)	1878 (2180)	1259 (1311)		

C<sub>0</sub>= non-collaborating district C<sub>1</sub>= collaborating district - = non-practiced activity  
DAM= Damietta KEL= Kafr El Sheikh MEN= Menoufeia DAQ= Daqahleia  
GHA= Gharbeia GM= gross margin RPF =return per feddan RPA= return per animal



**LP<sub>2</sub> solution**

To avoid the result of no feasible solution in Ashmoun (C<sub>0</sub>) in LP<sub>1</sub>, the imposed constraint was modified to cultivate at least 0.75 feddan of each eight crops in the cultivation pattern in all districts. LP<sub>2</sub> solution (Table 5) suggested that total cropping area was smaller than the total farm size, which led to leaving some fallow. The solution suggested that farmers should keep the same genotypes as LP<sub>1</sub> but in different ratio.

**Table 5. LP<sub>2</sub> Solution for the two districts in five governorates before and after FSDP impact**

	DAM		K EI		MEN		DAQ		GHA	
	C <sub>1</sub>	C <sub>0</sub>	C <sub>1</sub>	C <sub>0</sub>	C <sub>1</sub>	C <sub>0</sub>	C <sub>1</sub>	C <sub>0</sub>	C <sub>1</sub>	C <sub>0</sub>
Winter cropping area, feddan										
Berssem	3.2 (3.2)	1 (1)	4.2 (6.8)	1.8 (1.8)	3.8 (4.6)	0.85 (0.75)	4.7 (4.3)	3.5 (2.9)	5.1 (5.3)	3 (2.1)
Wheat	1 (1)	1 (1)	1 (1)	1 (1)	1.2 (1)	0.75 (0.75)	1.6 (2)	1 (1)	1 (1)	1 (1)
Cash crops	1 (1)	1 (1.3)	2.8 (1)	1 (1)	1 (1)	0.75 (0.75)	2.2 (1.5)	1 (1)	1 (1)	1 (1)
Faba been	- (-)	- (-)	- (-)	1 (1)	- (-)	- (-)	1 (1)	- (-)	1 (1)	- (-)
Summer cropping area, feddan										
Rice	1 (2.6)	1 (1)	3 (4)	1 (1)	- (-)	- (-)	3.5 (3.5)	2.4 (2.9)	4.1 (4.2)	2.0 (1.3)
Cash crops	3.2 (1.6)	1 (1.3)	2.2 (2)	1.8 (1)	2.8 (2.6)	1 (1)	3 (3.3)	1.1 (1)	2 (2.1)	2 (2.8)
Maize	1 (1)	1 (1)	1.8 (1.8)	1 (1.8)	2 (2)	1.2 (1.1)	2 (2)	1 (1)	1 (1)	1 (1)
Cotton	- (-)	- (-)	1 (1)	1 (1)	1.2 (1.4)	- (-)	1 (1)	- (-)	1 (1)	- (-)
Livestock production, head										
Buffalo	- (-)	- (-)	4.8 (2.2)	3.9 (-)	4.2 (0.2)	1.9 (1.9)	4.7 (1.5)	3.9 (1.2)	4.5 (1.5)	3.9 (3.6)
Native cattle	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)
Crossbred	3.6 (-)	2.3 (-)	- (-)	- (-)	- (3.4)	- (-)	- (3.2)	- (2.4)	- (-)	- (-)
Exotic	- (3.5)	- (2.3)	- (2.6)	- (3.9)	- (-)	- (-)	- (-)	- (-)	- (3)	- (-)
Economic indicators, LE										
GM	7019 (7546)	3455 (3706)	9745 (10932)	5664 (5870)	7010 (7893)	2580 (2644)	9622 (9974)	4991 (5277)	8622 (9698)	4998 (5428)
RPF	1349 (1451)	1104 (1184)	1218 (1242)	1180 (1195)	1168 (1103)	1121 (1149)	1132 (1133)	1109 (1077)	1.64 (1241)	1000 (1064)
RPA	1950 (2185)	1482 (1592)	2030 (2278)	1451 (1498)	1669 (1899)	1370 (1422)	2047 (2122)	1295 (1466)	1916 (2155)	1290 (1492)

C<sub>0</sub>= non-collaborating district C<sub>1</sub>= collaborating district - = non-practiced activity  
 DAM= Damietta KEL= Kafr El Sheikh MEN= Menoufeia DAQ= Daqahleia  
 GHA= Gharbeia GM= gross margin RPF =return per feddan RPA= return per animal

Also, LP<sub>2</sub> solution showed that, the dairy animal activities contribution slightly increased from 25% in base run and 24% in LP<sub>1</sub> to about 26% to the total farm gross margin. This could be due to modifying the land constraint (to cultivate at least 0.75

feddan) which led to decreased cultivated cropping area and increased the dairy animal activities.

GM, RPF and RPA in LP<sub>2</sub> increased in general by about 8%, 3% and 10%, respectively after FSDP impact and by 3%, 10%, 5% than the base run and by 2%, 10, and 9% than LP<sub>1</sub>, respectively.

## CONCLUSION

LP model with three runs showed that, both land and available cash resources were the limiting resources while labor was not. In mixed dairy production system in Nile delta, dairy animal activities contribute substantially, about 25%, to the total farm gross margin. LP analysis showed that implementation of FSDP could cause a shift from farmers raising mainly buffaloes and/or native cattle only to farmers raising buffaloes plus cross breed or raising exotic breeds.

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## تقييم منظومة إنتاج المحاصيل- الحيوانات الحلابة في دلتا النيل

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استخدم نموذج برمجته خطيه لتقييم منظومة إنتاج المحاصيل – الحيوانات الحلابة في المزارع الصغيرة المختلطة بمنطقة دلتا النيل من خلال تأثير برنامج إنماء قطاع الغذاء التابع لوزارة الزراعة واستصلاح الأراضي. أحتوى نموذج البرمجة الخطية على عوامل الأرض والعمالة والتراكيب الوراثية من المجترات الكبيرة والنمط الزراعي والدخل المتاحة كمحددات تؤثر على الإنتاج في هذه المنظومة. حسبت العوامل الفنية لنموذج البرمجة الخطية من بيانات استبيان جمعت من 492 مزارع في خمسة محافظات هي دمياط الدقهلية والغربية وكفر الشيخ والمنوفية خلال الفترة من 1993-2001. اختير مركزيان داخل كل محافظة أحدهما احتوى على مزارعين متعاونين مع البرنامج (حصل على دوره تدريبيه واحده على الأقل)  $C_1$  والمركز الأخر احتوى على مزارعين غير متعاونين (لم يحصل على اى دورة تدريبيه (مجموعة مقارنه))  $C_0$ . احتوت دالة الهدف لنموذج البرمجة الخطية على التوليفة المثلى من إنتاجية المحاصيل والحيوانات الحلابة التي تمعظم العائد الكلى للمزرعة (GM) والتي تؤدي إلى زيادة العائد من الفدان (RPF) والعائد من الحيوان (RPA). استخدم نموذج واحد للبرمجة الخطية بثلاثة طرق، الأولى (الطريقة الأساسية) نفذت لمحاكاة الوضع الفعلي والثانية ( $LP_1$ ) لتقادي الحل غير المقبول الناتجة من الطريقة الأساسية بينما الثالثة ( $LP_2$ ) أجريت للحصول على حل ممكن للمركز الذي ليس له حل ممكن في طريقة  $LP_1$ . اقترحت النتائج في حل الطريقة الأساسية أن المزارعين عموما يجب عليهم عمل توليفة بين زراعة البرسيم في الشتاء وزراعة الأرز في الصيف مع الاحتفاظ بجاموس قبل تنفيذ البرنامج. بينما بعد تطبيق البرنامج يجب عليهم عمل توليفة بين زراعة محاصيل سريعة العائد بجانب البرسيم في الشتاء ومحاصيل سريعة العائد بجانب الأرز في الصيف مع الاحتفاظ بأبقار خلطيه في  $C_0$  بمحافظة المنوفية وفي كلا المركزين داخل محافظة الدقهلية، بينما في باقي المراكز ينصح بالاحتفاظ بسلاطات أجنبية. كما وجد أن برنامج إنماء قطاع الغذاء حسن GM، RPF، RPA بحوالي 9%، 5%، 11% على الترتيب في الطريقة الأولى وبحوالي 10%، 7%، 10% على الترتيب في  $LP_1$  وبحوالي 8%، 3%، 10% على الترتيب في  $LP_2$ . ويمكن استخلاص أن نموذج البرمجة الخطية بالثلاث طرق أوضح أن الأرض ومصدر الدخل يعتبران عوامل محدودة لإنتاجية هذه المنظومة بينما العمالة لا تشكل مثل هذه المحدودية. كانت أنشطة الحيوانات الحلابة تمثل حوالي 25% من إجمالي العائد الكلى للمزرعة في منظومة المزارع المختلطة الحلابة في دلتا النيل.