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ECONOMIC RETURN FROM IMPROVING ANIMAL PRODUCTION SYSTEM AT SMALL HOLDERS IN HIGH DAM AREA OF ASWAN, EGYPT

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ABSTRACT

The objectives of this study were to describe the mixed farming system under small holders in High Dam area of Aswan, Egypt and to investigate different scenarios for improving their economic return. Three villages were studied (Bashier Alkhir, Klabsha and Tomas We Afia). Data on 92 holders were used (19, 41 and 32 holders from the three studies villages, respectively) in year 2012. A linear programming (LP) model with four scenarios were tested to maximize economic return described as gross margin (GM), the first (base run (LP1)) assumes free choice among all studied variables of crops and animals. While, the second scenario (LP2) had a constraint on cropping pattern to meet farmer's needs of basic food and feed crops and assuming free choice of number of each different animal types (cattle, sheep and goat). The third scenario (LP3) assumed free choice of cropping pattern and had a constraint to the number of each studied animal type. The fourth scenario (LP4) had the cultivated area distributed equally on different crops and had a constraint to the number of each animal types. Results revealed that, in order that holders get the maximum GM, the output of LP1 suggests that, they should cultivate all their farm area with alfalfa in all villages in winter. While in summer, they should cultivate beans feeds, in Bashier Alkhir and Tomas We Afia. Also, they should keep 5.7, 10.5 and 7.9 head of cattle in Bashier Alkhir, Klabsha and Tomas We Afia, respectively. While, compared to actual situation, GM was changed by about 2.1% to 34.1% in LP1; -28% to 24.6% in LP2 and 0.5% to 29.3% in LP3 and -29.9% to 18.2% in LP4 in different villages. As compared to LP1, GM in LP2, LP3 and LP4 decreased by about 12.7 to 29.7%, 1.7% to 6.8% and 7.2% to 31.4%, respectively. It was concluded that linear programming model with the four scenarios showed that holders should cultivate Alfalfa. Also, the model showed that cattle followed by sheep are more profitable than goat within the crop-livestock production system in High-Dam area in Aswan, Egypt. GM in Klabsha was more negative affected by modification done on LP model than Bashier Alkhir and Tomas We Afia within each studied scenarios. Land, animal type and available amount of cash resources are limiting constrains but not labor.

Keywords: Linear programming, Gross margin, Sheep, Goat

INTRODUCTION

In many developing countries, the distribution of livestock ownership indicated that livestock farming is important especially for the poor and landless who have insufficient land to support their families. Egypt is one of the most densely populated countries in the Mediterranean, African and Near East region. Located in the most arid region of the world, the arable land does not exceed 3.4 millions hectares and more than 95% of crop lands are irrigated with the River Nile. The average land size does not exceed 1 ha per farm and the number of farms increased from 1 to 3.7 millions from 1950 to 2000. High Dam is area located in Aswan. Aswan is one of the governorates

of the South Upper Egypt Region that includes Souhag, Aswan, Qena, Red Sea, and Luxor City. It encompasses 5 districts, 10 cities, and 33 rural local units annexed by 106 villages. The Aswan River Port on Nasser Lake developed to streamline passengers transport, and increase trade between Egypt and Sudan. Agriculture is the main activity in the governorate, which is famous of growing sugar cane, hibiscus, wheat, henna, and dates (ICLDU, 2006). The main farming system in Aswan is the mixed (crop-livestock) farming system. This work aimed at proposing different scenarios of input combinations to improve the whole farming system among small holders in High Dam area in Aswan governorate, Egypt.

MATERIALS AND METHODS

Data Collection and Coefficients:

Aswan governorate is in the upper of the South Egypt between 24^{o} 36' 54" N latitudes and 32^{o} 54' 38" E longitudes. Data were collected through project of The Creation of Fixed Assets to Poor Communities in The High Dam Lake area using structured questionnaire to identify available resources. Three villages were studied (Bashier Alkhir, Klabsha and Tomas We Afia). Data on 92 farms were used (19, 41 and 32 farms from the three studies villages, respectively) in year 2012. Information available (Table 1) were as follows:

- general information on the three studied villages;
- family members contribution in cultivation and animal production activities;
- farm size and cultivation area and cropping pattern;
- herd size composition and structure and their management system(s); and
- available amount of cash resource in Egyptian pound (LE).

Crops variables included in the current study were, cultivated area with fruits and alfalfa as annual crops, while barley, faba bean (*Vicia faba*) , Onions and wheat (*Triticum Sp*.) lupine as winter crops and beans feed and cash crops as summer crops. Some of seasonal crops were cultivated under the tree of the fruits. Livestock variables were number of cattle (head), sheep as ewe equivalent (EE), and goats as doe equivalent (DE). Buffalo and camel were not used due to small keeping number of it with one or two holders. Animal unit (AU) calculated according to Barnard and Nix (1993) as one AU equal one head of cattle, 5.9 ewe equivalent and 5.9 doe equitant.

Table 1. Survey of available resources in the three different studied villages

Item	*Bashier Alkhir*	*Klabsha*	*Tomas We Afia*
Sample size (farm)	19	41	32
Resources:			
Family size (person)	5	5	5
Farm size (feddan)*	5	5	5
Cropping area (feddan)	3.05	4.55	4.66
Annual labor used (p/d)			
Winter	100	200	160
Summer	100	200	160
Cultivation pattern (feddan)			
Fruits	1.57	1.5	2.5
Alfalfa	0.67	2.76	2.16
Winter crops			
Barley	--	--	2.41
Faba bean	0.5	--	0.5
Onions	0.4	--	0.5
Wheat	--	3.05	--
Lupine	0.63	--	0.57
Summer crops			
Beans feeds	0.75	--	0.88
Cash crops	1	--	1.50
Animal types			
Cattle (h)	3.5	6.3	4.0
Sheep (h)	8.3	16.8	13.3
Goat (h)	4.5	8.2	10.1
Total (AU)	5.7	10.5	7.9
ACR (LE)	11000	7100	12200

*** feddan = 4200 m^2, p/d = person per day, AU= animal unit, 1 mature cattle, AU = 5.9 ewe or doe (Barnard and Nix, 1993). ACR = available cash resource, LE = Egyptian pound.**

Linear Programming (LP) Model structure.

Studies by Alsheikh et al. (2002, 2007 and 2011) showed that land and livestock are the most determinant variables in crop livestock farming system in Egypt. One annual and static LP model was used with four modified scenarios tested utilizing land, animal, labor and amount of available cash resources (ACR) using General Algebra Modeling Systems (GAMS, 2000). According to Ahmed et al. (2006) modification was tried only on land and livestock constrains, which the main constrain affected on crop-livestock production systems in Egypt. While, labor and ACR constancies are the same in the different four studies scenarios. Also, fruits were excluded from the model in the four scenarios within the three studied villages due to its different types and trees age from farm to another.

Base Run Scenario (LP1).

Assuming free choice of crops and livestock studied variables to maximize the gross margin (GM), where,

Objective function:

$$\text{Maximize (GM)} = \sum_{i=1}^{11} a_i x_i,$$

where,
a_i is GM for each unit of variable x_i , x_i represents the different activites in the farm as alfalfa (x_1), barley (x_2), faba bean (x_3), onions (x_4), wheat (x_5), lupine (x_6), beans feeds (x_7), cash crops (x_8), local cattle (x_9), sheep (x_{10}), and goat (x_{11}).
with the constraints:
Land: Winter $x_1+x_2+x_3+ x_4+x_5+ x_6 \leq$ average cultivated area (feddan)
Summer $x_7 +x_8 \leq$ average cultivated area (feddan)
Livestock: $x_9+ x_{10}+ x_{11} \leq$ Total AU,

Labor: $\sum_{i=j=1}^{11} c_j x_i \leq b,$

where,
c_j is labor (person per day) requirement per unit of activity,
b is the total family labor and x_i as before;

and available cash resources (ACR), $\sum_{i=j=1}^{11} d_j x_i \leq m,$

where,
d_j is variable cost for each unit of variable,
m is ACR, and x_i as before.

Diversity of cropping pattern scenario (LP2):

In this scenario the cultivated area was distributed equally among the different crops and assuming free choice of livestock species to maximize GM, where the
Objective function:

Maximize (GM) = $\sum_{i=1}^{11} a_i x_i,$

where,
a_i and x_i are as defined before,
with constraints:
Land: Winter
$x_1 = x_2 = x_3 = x_4 = x_5 = x_6 =$ equal part of cultivated area
$x_1+x_2+x_3 +x_4+x_5 +x_6 \leq$ average cultivated area
Summer
$x_7 = 1/2$ cultivated area
$x_8 = 1/2$ cultivated area
$x_7 + x_8 \leq$ average cultivated area
Livestock, labor and ACR constraints are the same as in LP1.

Modified Flock Structure Scenario (LP3):

In this scenario a free choice of cultivated crops was assumed and livestock production was constrained with at least one animal unit (AU) of

cattle, in addition to at least one ewe equivalent (EE) of sheep and doe equivalent (DE) of goat to maximize GM.
Objective function:

Maximize (GM) = $\sum_{i=1}^{11} a_i x_i$,

where,
a_i and x_i are as defined before.
with constraints:
Land: Winter $x_1+x_2+x_3+ x_4+x_5+ x_6 \leq$ average cultivated area (feddan)

Summer

$x_7 +x_8 \leq$ average cultivated area (feddan)

Livestock:
$x_9 \geq 1$ AU of cattle
$x_{10} \geq 1$ ewe equivalent
$x_{11} \geq 1$ doe equivalent
Labor and ACR constraints are the same as LP1.

Scenario real situation (LP4) model:

The constraints of this scenario were designed to simulate the real situation as appearing in the actual situation. In this scenario the cultivated area was distributed equally on different crops while livestock was constrained with at least one animal unit (AU) of cattle, in addition to at least one ewe equivalent (EE) of sheep and one doe equivalent (DE) of goat to maximize GM.
Objective function:

Maximize (GM) = $\sum_{i=1}^{11} a_i x_i$,

where,
a_i and xi are as defined before.
Constraints:
Land: Winter
$x_1 = x_2 = x_3 = x_4 = x_5 = x_6 =$ equal part of cultivated area
$x_1+x_2+x_3 +x_4+x_5 +x_6 \leq$ average cultivated area

Summer

$x_7 = 1/2$ cultivated area
$x_8 = 1/2$ cultivated area
$x_7 + x_8 \leq$ average cultivated area
Livestock:
$x_9 \geq 1$ AU of cattle
$x_{10} \geq 1$ ewe equivalent
$x_{11} \geq 1$ doe equivalent
Labor and ACR are the same as LP1.

Financial data:

Table 2 shows GM for each crop per feddan and livestock activity calculated from available data. The GM of all the studied variables was

positive in the three studied villages. The available amount of cash resources in Klabsha was 7100 LE smaller than those 11000 and 12200 in Bashier Alkhir and Tomas We Afia, respectively. This result was occur due holders in Klabsha were cultivated only two crops.

Table 2. Gross output (GO), variable cost (VC), gross margin (GM) and available cash resources (ACR) in Egyptian pound (LE).

Item	*Bashier Alkhir*			*Klabsha*			*Tomas We Afia*		
	GO	VC	GM	GO	VC	GM	GO	VC	GM
Crops activities (feddan)									
Alfalfa	6000	3920	2080	7200	4050	3150	6750	4200	2550
Winter crops									
Barley	--	--	--	--	--	--	1900	1000	900
Faba bean	2100	600	1500	--	--	--	2093	521	1572
Onions	3177	1692	1485	--	--	--	3200	1700	1500
Wheat	--	--	--	2300	1365	935	--	--	--
Lupine	2400	1200	1200	--	--	--	2477	1222	1255
Summer crops									
Beans feeds	2527	1045	1482	--	--	--	2540	1052	1488
Cash crops	2232	900	1332	--	--	--	2249	902	1347
Livestock activities (h)									
Cattle	2050	1464	586	1752	1467	285	2062	1388	674
Ewe	201	91	110	287	132	155	283	110	173
Doe	173	71	102	191	68	123	187	62	125
ACR		11000			7100			12200	

Values rounded to the nearest integer. h = head

RESULTS AND DISCUSSION

Base Run (LP1):

The results of LP1 for the three studied village are shown in Table 3. In order that holders get the maximum GM, the output suggests that, they should go for cattle and cultivate all their farm area with alfalfa in all villages in winter. While in summer, they should cultivate beans feeds, in Bashier Alkhir and Tomas We Afia. Also, they should keep 5.7, 10.5 and 7.9 head of cattle in Bashier Alkhir, Klabsha and Tomas We Afia, respectively. Moreover, if holders decided to cultivate faba bean, onions and lupine in winter (Table 3) in Bashier Alkhir their production cost would reduce by LE 580, 595 and LE 880 per feddan, respectively. While, in summer cultivating cash crops would reduce production cost by LE 150 per feddan. GM in LP1 was higher than that in the actual situation by about 34.1%, 2.1% and 19.2%, in Bashier Alkhir, Klabsha and Tomas We Afia, respectively. This improvement of GM is due to directing the available cash resources to variables with the highest GM. This result confirms the result obtained by Ahmed et al. (2006). These results have the same trend as the results obtained by Alsheikh *et al*. (2002, 2007 and 2011). The contribution of livestock to GM in LP1 came from cattle in the three studied villages. This could be due to that cattle have high GM. Also, sheep have the lower opportunity cost (LE 476) than goat (LE 484) in Bashier Alkhir and the same trend in the two other studied villages. These results disagree with Younis (1998) that small ruminants could be more profitable than large ruminants in crop-livestock production system in South Egypt.

Diversity of cultivated crops (LP2):

The optimal LP2 for Bashier Alkhir, Klabsha and Tomas We Afia is shown in Table 3.This scenario was designed to avert market risk due to cultivating only one or crop and to satisfy holders family's basic crop needs. To get maximum GM holders should raise 5.7, 10.5 and 7.9 head of cattle in the three villages, respectively. In addition to the restricted cultivated area within each village. In this scenario, the land constraint led to change GM by about 24.6%, -28% and -1.8 % than actual situation and to decreased GM by about 12.7%, 29.7% and 24.6% than the base run (LP1) in Bashier Alkhir, Klabsha and Tomas We Afia, respectively. These results could be due to holders transferring their ACR to the cultivation of crops to satisfy their needs, they have less money to keep cattle. These results support the finding of Bhatia and Gangwar (1981) that, farmers have different type of thinking other than just maximizing their farm income. Also, Abdulkadri and Ajibefun (1998) suggested that farmers could have objective(s) other than profit maximization like family consumption and diversification of crops to avert market risk.

Modified flock structure (LP3):

In this scenario the LP programming was modified as free choice of cropping pattern in winter and summer, while livestock was constrained with at least one animal unit from cattle, one ewe equivalent and one doe equivalent to maximize GM. The optimal LP3 for the three studied villages are shown in Table 3. The cropping pattern in LP3 was the same as suggested from LP1 along with raising 3.7, 8.5 and 5.9 head of cattle in the three studies villages respectivelly; plus one EE and one DE in the three studied villages,. These results led GM in LP3 being higher than that in actual situation by about 29.3%, 0.5% and 15.5%, less than the value obtained in LP1 by 6.8%, 1.7% and 4.3% and higher than the value obtained in LP2 by 6.3%, 28.5% and 17% in Bashier Alkhir, Klabsha and Tomas We Afia, respectively. This is due to the constraints on raising livestock which has less GM than crops and keeping less number of cattle.

The real scenario (LP4):

The optimal solution of LP4 for the three studied village are shown in Table 3. When modifying the LP model constraints to tried to simulate the real situation, the output shows that holder should have at lest one AU of cattle, one EE of sheep and one DE of goat in Bashier Alkhir, Klabsha and Tomas We Afia, respectively, to get maximum GM. Constraining cultivated crops and keeping all animal genotypes led to less GM than the value obtained in LP1 by 19.4%, 31.4% and 7.2% in Bashier Alkhir, Klabsha and Tomas We Afia, respectively. While GM was change by 18.2%, -29.9% and -7.2% than that in actual situation in Bashier Alkhir, Klabsha and Tomas We Afia, respectively. This could be due to the land constrain, which led to directing the available cash resources to cultivation and raising small ruminants, which have less GM than cattle thus allowing less available cash resources to keep cattle.

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CONCLUSIONS

The present linear programming model with the four scenarios showed that holders should cultivated Alfalfa. Also, the model showed that cattle followed by sheep are more profitable than goat within the crop-livestock production system in High-Dam area in Aswan, Egypt. Land, animal type and available amount of cash resources are limiting constrains but not labor. GM in Klabsha was more negative affected by modification done on LP model than Bashier Alkhir and Tomas We Afia within each studied scenarios.

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العائد الاقتصادى من تحسين منظومة الانتاج الحيوانى عند صغار الحائزين فى منطقة السد العالى باسوان، مصر

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تهدف هذه الدراسة إلى وصف منظومة الإنتاج الحيوانى لدى صغار الحائزين في منطقة السد واقتراح بسناريوات لتحسين عائدهم الاقتصادى. اشتملت الدراسة على ثلاث قرى هى بشير الخير و كلابشا وتومس وعافية. جمعت البيانات من ٩٢ حائز (١٩ و ٤١ و ٣٢ من الثلاث قرى محل الدراسة على الترتيب) خلال عام ٢٠١٢. استخدم نموذج واحد للبرمجة الخطية (LP) مع اقتراح أربعة سيناريوهات لذلك النموذج وذلك لمعظمة هامش الربح. السيناريو الأول، يفترض حرية الاختيار بين جميع المتغيرات محل الدراسة (LP1)، في حين، كان السيناريو الثاني (LP2) يفرض قيدا على نمط الزراعة لتلبية احتياجات المزارعين من المحاصيل الغذائية و العلفية على أن يترك الحرية للبرنامج في اختيار المتغيرات الممثلة للحيوانات المزرعية. السيناريو الثالث (LP3) يترك الحرية للبرنامج للاختيار بين متغيرات المحاصيل محل الدراسة ووضع قيدا على عدد ونوع الحيوان المحتفظ به فى المزرعة . بينما فى السيناريو الرابع (LP4) كانت فيه المساحة المنزرعة موزعة بالتساوي على المحاصيل المختلفة محل الدراسة كما وضع قيدا على عدد ونوع الحيوانات المحتفظ بها لتجنب الحل الناتج من LP1 . وقد أوضحت النتائج أنه بالمقارنة مع الوضع الفعلى، هامش الربح تحسن ما بين حوالى ٧.٥% الى ٢٨.٥٪ في LP1 ، -٣.٨٪ الى ١.٣٪ في LP2 و٧.٣٪ الى ٢٨.٣٪ في LP3 و- ٠.٣% الى ٣.٦% فى LP4 فى القرى المختلفة. وبالمقارنه مع LP1 هامش الربح فى كلا من LP2 و LP3 وLP و LP انخفض بحوالى ٦.٢% الى ٣١% و ٠.٣% الى ٥.٦% و ٧.٧ الى ٢٥.٩ على الترتيب. ويمكن استنتاج ان نموذج البرمجة الخطية بالاربعة سناريوات المقترحة اوضحت ان الابقار متبوعة بالماعز كانت اكثر ربحية من الاغنام فى منظومة الانتاج الحيوانى بمنطقة اسد العالى فى اسوان . كانت الأرض ونوع الحيوان ورأس المال المتاح من العوامل المحددة لنموذج البرمجة الخطية بينما لم تكن العمالة كذلك

قام بتحكيم البحث

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Table 3. Linear programming LP1, LP2, LP3 and LP4 output of the three studies villages.

Item	*Bashier Alkhir*								*Klabsha*								*Tomas We Afia*							
	AS	**LP1**	**OC**	**LP2**	**OC**	**LP3**	**OC**	**LP4**	**AS**	**LP1**	**OC**	**LP2**	**OC**	**LP3**	**OC**	**LP4**	**AS**	**LP1**	**OC**	**LP2**	**OC**	**LP3**	**OC**	**LP4**
Cropping pattern (feddan)																								
Winter																								
Alfalfa	0.67	3.05	0	0.76	0	3.05	0	0.76	2.76	4.55	0	2.25	0	4.55	0	2.25	2.16	4.66	0	0.93	0	4.66	0	0.93
Barley	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	2.41	0	1650	0.93	0	0	1650	0.93
Faba bean	0.5	0	580	0.76	0	0	580	0.76	--	--	--	--	--	--	--	--	0.5	0	978	0.93	0	0	978	0.93
Onions	0.4	0	595	0.76	0	0	595	0.76	--	--	--	--	--	--	--	--	0.5	0	1050	0.93	0	0	1050	0.93
Wheat	--	--	--	--	--	--	--	--	3.05	0	2215	2.25	0	0	2215	2.25	--							
Lupine	0.63	0	880	0.76	0	0	880	0.76	--	--	--	--	--	--	--	--	0.57	0	1295	0.93	0	0	1295	0.93
Summer																								
Beans feeds	0.75	3.05	0	1.53	0	3.05	0	1.53	--	--	--	--	--	--	--	--	0.88	4.66	0	2.33	0	4.66	0	2.33
Cash crops	1	0	150	1.53	0	0	150	1.53	--	--	--	--	--	--	--	--	1.50	0	141	2.33	0	0	141	2.33
Livestock																								
Cattle (AU)	3.5	5.7	0	5.7	0	3.7	0	3.7	6.3	10.5	0	10.5		8.5	0	8.5	4.0	7.9	0	7.9	0	5.9	0	5.9
Sheep (EE)	8.3	0	476	0	476	1.0	0	1.0	16.8	0	130	0	130	1.0	0	1.0	13.3	0	501	0	501	1.0	0	1.0
Goat (DE)	4.5	0	484	0	484	1.0	0	1.0	8.2	0	162	0	162	1.0	0	1.0	10.1	0	549	0	549	1.0	0	1.0
Land (feddan)																								
Winter	3.05	3.05	0	3.05	0	3.05	0	3.05	4.55	4.55	0	4.55	0	4.55	0	4.55	4.66	4.66	0	4.66	0	4.66	0	4.66
Summer	3.05	3.05	0	3.05	0	3.05	0	3.05	4.55	4.55	0	4.55	0	4.55	0	4.55	4.66	4.66	0	4.66	0	4.66	0	4.66
Labor (p/d)																								
Winter	100	100	0	100	0	100	0	100	200	200	0	200	0	200	0	200	160	160	0	160	0	160	0	160
Summer	100	100	0	100	0	100	0	100	200	200	0	200	0	200	0	200	160	160	0	160	0	160	0	160
ACR (LE /F)	11000								7100								122000							
GM (LE)	9360.1	14204.3		12407.2		13244.3		11447.2	16953.85	17325		12183.75		17033		11891.75	19517.69	24141.68		19162.76		23091.68		18112.76

AS = actual situation; OC = opportunity cost; p/d = person per day; ACR = available cash resources; GM = gross margin.