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PROPOSED SCENARIOS TO IMPROVE THE EFFICIENCY OF CROP/LIVESTOCK PRODUCTION SYSTEM IN NEW LAND IN EGYPT

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SUMMARY

Production systems approach was used to study the response of the crop/livestock production system in the reclaimed land at South Tahreer Province to three improving scenarios. The study involved modelling of the existing production system, and building of three deterministic simulation models for the proposed scenarios. Data were collected over the agricultural year 1991-1992 from a random sample of 155 farms from three different sites. Site 1, comprised farms operated by ordinary farmers, site 2 included early retired employees' farms, and site 3 comprised university graduates' farms.

Least squares analysis of variance was performed using fixed-effects linear models for all productive traits to develop the technical coefficients used in the study. Whole farm budgets and net farm income were calculated for the current and improved production systems. Simulation techniques and linear programming were used to simulate and improve the current production system. Three proposed scenarios were constructed :1) increasing milk output by replacing the indigenous cows by crossbreds, 2) reducing feeding cost by utilization of crop residues as animal feed and 3) increasing milk revenues by producing better quality milk or selling it as simple home-made milk products. Return per feddan, per labor and per (AU) were used as measures of the efficiency of the production system.

Applying scenario 1, farm income, as compared with the base run, increased by 11.3%, 25.9% and 51.7% in the three studied sites, respectively. In response to scenario 2 farm income increased by 6.7%, 56.4% and 54.9%, and 2.4%, -2.1% and 9.1% in case of scenario 3, respectively.

The results showed that major improvement in site 1 was achieved by applying the first scenario. In site 2, reducing feeding costs by utilization of crop residues was recommended as first priority. In site 3, replacing native cows by crossbreds and using crop residues in feeding had almost the same effect of improvement, but the first scenario resulted in more milk revenues.

Keywords: System approach, crop/ livestock, simulation models, linear programming

INTRODUCTION

Mixed farming practicing both crop and animal production represent the dominant system in most developing countries. Interactions between those components often have major impact on the productivity and efficiency of the crop/livestock production system.

Most farmers in the new lands still, as in the old land, keep native cattle and buffaloes. Some farmers also keep sheep, goats and poultry. The production of small scale mixed farms is still low and would be raised to adequate standards to generate satisfactory income. This could be achieved by improving the skills of farmers and providing them with effective technologies to enhance the utilization of their limited resources.

The system approach was followed in the present study to characterize the existing crop/livestock production system in the reclaimed land at South Tahreer Province with the objective of proposing examples of models that can improve the overall efficiency of the existing production system.

MATERIALS AND METHODS

A. The Study Area

This study was carried out at Tahreer Province (South Tahreer area), a 40 years old desert reclaimed land. South Tahreer Province is located west of the Nile Delta of Egypt at 120 Km North-West of Cairo. This area contains a variety of small scale mixed farms of different farm sizes and types of farmers where both animal and crop production are practiced.

Three sites with respect to the age of land, size of farms and type of farmers were identified. The sites are Al-Rowad, Al-Fath, and Al-Tahaddi which will be refereed to as sites 1, 2 and 3, respectively. Site 1 contains the oldest land in South Tahreer. Farmers are traditional settlers who own no more than 5 feddans. Site 2 was reclaimed about 10 years later. The farmers are mainly the early retired employees who own 8-24 feddans. In site 3, the majority of settlers are university graduates. Farm size ranges between 20 and 30 feddans, and cultivation started about the same time as in site 2.

B. Data Collection

A random sample of 155 farms of the local agricultural cooperatives was taken from all of the three sites. A questionnaire was developed to assess resources, activities, services, cost, and revenues of each farm during the period from October 1991 to September 1992. Data included the following variables: 1) production resources: farm size, family size, labor, herd size, herd

structure, and herd composition, 2) animal production performance: daily milk yield in kg, lactation period in days, and total milk yield in kg, 3) crop production performance: main crops yield and by-product yield, and 4) farm budgets: gross output, variable costs which included hired labor, fertilizer, seed, feed, veterinary services, mechanical power; and fixed costs which included permanent labor, property taxes, annual installments, farm maintenance and insurance.

C. Data Analysis

Least squares analysis of variance using fixed effects linear models was used to develop estimates of resources inventory, crop and livestock enterprises, resource requirements per unit of each enterprise and gross margins. These estimates were used in building up of the simulation models.

Whole farm budgets were prepared for farms in each of the three sites. Total gross margin was calculated from the levels of the farm activities, then fixed expenses were deducted from total gross margin to show net farm income.

In order to compare the efficiency of the current production system among the different sites, return per feddan, per labor, and per animal unit (AU) were calculated.The return per unit of these limiting resources is found by dividing the gross margin by the number of resource units needed, the higher the value, the greater the efficiency of resource use.

D. Proposed Scenarios

As this study was more concerned with livestock production, three scenarios were proposed to enhance the overall efficiency of the production system using modifications of the animal component, namely :1) Increasing milk output by replacing indigenous cows by crossbreds, 2) Reducing feeding cost by utilizing crop residues as animal feed, 3) Increasing milk revenues by producing better quality milk or selling it as simple home-made milk products. Proposed scenarios are presented in detail in Annex A.

E. Simulation Models

Simulation techniques were used to apply the proposed scenarios on farm models in each site. The sets of estimates produced by least squares analysis were analyzed by Simplex Linear Programming using Microcomputer Models for Management and Decision Making (Dennis and Dennis, 1988).The general mathematical formula of a linear programming problem used to allocate the resources and to maximize the net farm income is given in Annex B. Detailed description of the simulation models and constraints structure are presented in Ahmed, 1995.

F. Criteria for Assessment

Cropping pattern, total labor per farm and herd size were kept constant. Changes in net farm income, milk production and milk revenues in response to the proposed scenarios were estimated. The improvement in the efficiency of the system was measured for each site as the response to scenarios 1, 2, and 3 on the return per feddan, return per labor, and return per AU.

RESULTS AND DISCUSSION

Tables 1, 2, and 3 include the base runs as well as responses of the three studied sites to the proposed improvement models. The base run included the variables of the current production system in each of the three sites.

Table 1. Simulation results for the three proposed scenarios in site 1

Item	Unit	Base run	Scenario(1)		Scenario(2)		Scenario(3)	
			Value (LE)	%	Value (LE)	%	Value (LE)	%
Farm income	LE	3695	4113	11.3	3943	6.7	3785	2.4
Milk Prod.	Kg	1257	2350	86.9	1257	--	1257	--
Milk revenues	LE	1257	2350	86.9	1257	--	1524	20.0
Efficiency of the system:								
Return/fed.	LE	808.5	900.0	--	862.8	--	828.2	--
Return/lab.	LE	7.2	8.01	--	7.7	--	7.4	--
Return/AU	LE	1734.7	1930.9	--	1851.2	--	1776.7	--

Scenario (1): Replacement of a native cow by a cross bred cow.
Scenario (2): Utilization of crop residues in animal feeding.
Scenario (3): Improving milk quality.

Table 2. Simulation results for the three proposed scenarios in site 2

Item	Unit	Base run	Scenario(1)		Scenario(2)		Scenario(3)	
			Value (LE)	%	Value (LE)	%	Value (LE)	%
Farm income	LE	1380	1737	25.9	2159	56.4	1351	-2.1
Milk Prod.	Kg	870.00	1890.00	117.2	870.00	--	870.00	--
Milk revenues	LE	870	1890	117.2	870	--	1044	20.0
Efficiency of the system:								
Return/fed.	LE	100.0	125.9	--	156.4	--	98.3	--
Return/lab.	LE	2.1	2.7	--	3.3	--	2.1	--
Return/AU	LE	605.0	762.0	--	946.9	--	595.2	--

Scenario (1): Replacement of a native cow by a cross bred cow.
Scenario (2): Utilization of crop residues in animal feeding.
Scenario (3): Improving milk quality.

Table 3. Simulation results for proposed scenarios in site 3

Item	Unit	Base run	Scenario(1)		Scenario(2)		Scenario(3)	
			Value (LE)	%	Value (LE)	%	Value (LE)	%
Farm income	LE	1081	1640	51.7	1674	54.9	1179	9.1
Milk Prod.	Kg	1600.00	3000.00	87.5	1600.00	--	1600.0	--
Milk revenues	LE	1600	3000	87.5	1600	--	1920	20.0
Efficiency of the system:								
Return/fed.	LE	70.10	106.40	--	108.60	--	76.5	--
Return/lab.	LE	2.50	3.80	--	3.80	--	2.7	--
Return/AU	LE	423.90	643.00	--	656.50	--	462.4	--

Scenario (1): Replacement of a native cow by a cross bred cow.
Scenario (2): Utilization of crop residues in animal feeding.
Scenario (3): Improving milk quality.

Cropping patterns, total labor and herd size were kept constant. Applying the proposed scenarios resulted in variable improvement rates of the three studied sites. Changes in farm income, total milk production per farm, milk revenues were reflected on measures of efficiency in sites 1, 2, and 3 (tables 1, 2, and 3, respectively).

Judging by the improvement in the criteria for assessment, different positive impacts on the overall efficiency of the production system was obvious in all cases as compared with the current situation (base run):

Site1; replacing the indigenous cows by crossbreds (scenario 1) increased the farm income and the value of milk revenues by 11.3% and 86.9% over the base run, respectively. In case of reducing feed cost by better utilization of crop residues (scenario 2), farm income increased only by 6.7%, because the current production system in this site is characterized by depending mainly on low cost rations.In the same time, milk revenues did not change as the total milk yield remained at the same level. The increase of milk price by 20% through using better milking technology (scenario 3) increased the value of milk revenues by 20%, but was accompanied by a very slight increase in farm income (2.4%), because the extra cost incurred in running the portable milking machine. The differences in values of return per feddan, per labor and per AU among the different scenarios revealed that scenario 1 achieved the highest improvement which reflects the fact that total milk yield is the major determinant of the improving efficiency of the current production system in this site.

Site 2; results of field survey for some features of the current production system in site 2 showed that farmers depended mainly on concentrate feed mix in feeding their animals which is relatively expensive, so, using crop residues (scenario 2) is expected to have positive impact on farm income. Reducing feeding cost increased farm income by 56.4%. This exceeded the increase attained by replacing the indigenous cows with the crossbreds

(scenario 1). The unexpected decrease in net farm income as milk price increases might be due to the little increase of the added value of milk which could not cover the additional cost of introducing milking machine. Measures of assessment in site 2 showed that scenario 2 was the most effective one in improving the efficiency of the system.

Site3; Simulation results for the proposed scenarios (table 3) showed that either replacing indigenous cows by crossbreds or using crop residues as feed had nearly the same positive effect on farm income though the first scenario had increased both farm income and milk revenues. Measures of efficiency followed the same trend. That indicated that both total milk yield and feeding cost are equally important in determining the efficiency of the system.

In conclusion, the results showed that, in site 1, replacing the native cows with crossbreds was recommended to achieve improvement in the production system while in site 2, reducing feeding cost by better utilization of crop residues was more recommended. In site 3, replacing native cows by crossbreds or using crop residues in feeding had almost the same amount of improvement, but the first scenario resulted in more milk revenues. Generally, the increase in milk yield and quality expected from applying these scenarios in all sites should be met with better milk marketing and/ or milk processing to achieve a considerable improvement on the overall efficiency of the production system.

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Annex "A"

The Proposed Scenarios

To simplify the economic evaluation and comparing the effect of each scenario between different sites, assumptions were made for each scenario as follows:

Scenario 1: Increasing milk output by replacing the indigenous cows by crossbreds

In this simulation trial, local cows in the present stock in each site were replaced by crossbred cattle to improve milk production in the studied areas.

Assumptions:

- Fixed herd size and structure of the herd for each site.
- A crossbred cow is equal to 1.1 animal unit (AU). So, feeding costs per animal unit in the simulation model would be multiplied by 1.1 to meet feeding requirements of the crossbred cow.
- Fodder utilization was increased to meet the increased requirement of the crossbred cow. The extra feed required would be covered by: 1) purchase from the market, or 2) increase fodder area on the expense of wheat area, or 3) increase fodder consumption instead of selling it if extra fodder is produced. To handle the case, the last option was chosen.
- Total milk yield was taken from the technical coefficients obtained from each site.

Scenario 2: Reducing feeding cost by utilizing of crop residues, as animal feed.

The use of low-cost feed prepared on farm using crop by- products was proposed by the Animal Production Research Institute. The financial feasibility of this technology was assessed by the Agricultural Production and Credit Project (APCP), 1990 and the results were positive.

A chopper which chops various types of crop residues and green fodder was identified and tested under field condition by the Agriculture Machinery Research Institute. This chopper was locally manufactured and some modifications have been introduced to make it cheaper and easier to move and operate.

Assumptions:

- Fixed herd size and structure of the herd for each site.
- Total milk yield per farm will be unchanged.
- The expected number of farmers who benefits from this service is 200-300 farmers per chopper depending on the averages farm size.
- Electric motor would be used to run the chopper.
- Annual working days = 200 days and 5.5 hours daily.
- Reduction in total feed costs per AU due to utilization of crop residues would be about 20%.

Scenario 3: Increasing milk revenues by producing better quality milk or selling it as simple home-made milk products.

Introduction of better techniques in milking (portable milking machine), handling of milk and improved practices at the farm level is assumed to increase milk price.

Assumptions:

- Fixed herd size and structure of the herd for each site.
- Total milk yield per farm will be unchanged.
- Milk price would be increased by 20% in all sites studied.
- Daily milking time takes 20 min/AU (milking twice daily)
- Lactation period derived from the data would be 175.5 days, 200.4 days and 202.1 days for the three studied sites, respectively.

-Total daily operational cost for using portable milking machine per AU (labor cost + machine running costs) = 0.43 LE.

Annex "B"

The general mathematical formula of a linear programming problem used to allocate the resources and to maximize the net farm income, was as follows:

$$\text{Max. } Z = c_1x_1 + c_2x_2 + c_jx_j + \ldots\ldots + c_nx_n$$

Subject to the conditions

$$x_1, x_2, \ldots\ldots x_n \geq 0$$

$$a_{i1}x_1 + a_{i2}x_2 + \ldots. + a_{in}x_n \leq b_i$$

and $$a_{m1}x_1 + a_{m2}x_2 + \ldots. + a_{mn}x_n \leq b_m$$

Where;

m = the number of resources

n = the number of commodities

a_{ij} = are constants referring to the number of units of resource i required to produce one unit of commodity j, i = 1,2 ...,m, j = 1,2, ...,n and m < n.

b_i = the maximum number of units of resource i available.

c_j = coefficients referring to profit (gross margin) per unit of commodity j produced.

x_j = the level of activity of the jth commodity.

The total amount of the ith resource that is used, is given by the linear expression.

$$a_{i1}x_1 + a_{i2}x_2 + \ldots\ldots\ldots + a_{in}x_n.$$

This total amount must be less than or equal to the maximum number of units of the ith resource available.

سيناريوهات مقترحة لتحسين كفاءة نظام الإنتاج النباتى/الحيوانى في الاراضى حديثة الإستصلاح في مصر

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استخدم منهج دراسة النظم لدراسة مدى استجابة نظام الإنتاج النباتى/الحيوانى في الأراضى المستصلحة في منطقة جنوب مديرية التحرير لثلاثة سيناريوهات مقترحة لتحسين نظام الإنتاج.

وقد اختيرت عينة عشوائية حجمها ١٥٥ مزرعة تمثل ثلاثة مواقع للدراسة. ثم جمعت البيانات عن السنة الزراعية ١٩٩١-١٩٩٢ ، واستخدمت في بناء نماذج مزرعية لمحاكاة نظام الإنتاج الحالى.

وتميز كل موقع من المواقع الثلاثة داخل منطقة الدراسة بما يلى (موقع ١) يضم المزارع الصغيرة الأقل من ٥ أفدنه ويملكها الفلاحين التقليدين، موقع (٢) ويشمل المزارع التى تتراوح بين ٨-٢٤ فدان ويملكها الموظفون الذين أنهوا خدمتهم بالحكومة، موقع (٣) ويشمل المزارع التى تتراوح بين ٢٠-٣٠ فدان ويملكها خريجوا الجامعات.

تم اقتراح ثلاث سيناريوهات لتحسين كفاءه نظام الإنتاج وهى :١) زيادة إنتاج اللبن بإحلال الأبقار الخليطه محل الأبقار البلدية ،٢) تقليل تكاليف التغذية بإستخدام بقايا المحاصيل كغذاء للحيوان، ٣) زيادة عوائد اللبن عن طريق إستعمال أجهزه الحليب المتنقلة في إنتاج لبن عالى الجودة أوتصنيعه وبيعه كمنتجات ألبان.

استخدم نموذج التأثيرات الثابتة الخطية في تحليل الصفات الإنتاجية. كما استخدم هامش الربح للوحدة الحيوانية وللفدان وصافى العائد للمزرعة كمقاييس مالية. وأخذ العائد بالنسبة للوحدة الحيوانية ولوحدة الفدان ووحدة العمل كدلائل قبل وبعد تطبيقه لقياس السيناريوهات المقترحة لتحسين كفاءة نظام الإنتاج.

وقد أدى تطبيق السيناريوهات المقترحة إلى زيادة الدخل المزرعى مقارنه بالوضع الحالى بنسبة ١١,٣٪، ٢٥,٩٪ و٥١,٧٪ في مناطق الدراسة الثلاث، على التوالى في حالة إحلال الأبقار المحلية بالأبقار الخليطة. وبنسبة ٦,٧٪، ٥٦,٤٪ ، ٥٤,٩٪ في حالة تقليل تكاليف التغذية باستخدام بقايا المحاصيل وبنسبة ٢,٤٪، ٢,١٪ و ٩,١٪ في حالة إنتاج لبن عالى الجودة، على التوالى.

وقد أظهرت النتائج أن استبدال الأبقار المحلية بالأبقار الخليطة أكثر ملائمة لتحسين نظام الإنتاج في موقع (١) بينما تقليل تكاليف التغذية باستخدام بقايا المحاصيل يلائم موقع (٢) أما بالنسبة للموقع (٣) فإن استبدال الأبقار المحلية بالأبقار الخليطة وكذلك استخدام بقايا المحاصيل في تغذية الحيوان لهما نفس التأثير في تحسين نظام الإنتاج ولكن الأول علاوة على ذلك يزيد من عائد اللبن.