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LINEAR PROGRAMMING FOR EGYPTIAN BARKI RAMS SELECTION

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ABSTRACT

A Linear programming (LP) model was used to select Egyptian Barki rams, in a production unit, under some constraints of resources and performance. Illustration was made to select among 4 rams (each ram had at least 11 lambs of 6 months of age per year) to maximize the annual gross margin, subsequently the net farm income. Model constraints were farm capacity (was available for only 300 ewes), total lambs weight at 6 months old (was 1500 kg/farm/year) and available labor (was 30000 hour/year).

LP model modified using some mathematical equations under the same set of constraints in addition to feed constraint. The model input coefficients were selling lambs (price 20 LE/kg live body weight), paying feed (2.5 LE/kg dry matter intake) and paying labor (1.5 LE/hour) (farm gate price of Maryut research station, Desert Research Center, year 2004).

The present results showed that there was a difference between the two decisions of rams selection under farm resources constraints using LP model which done according to absolute kilogram yield of lambs at 6 months old. If the selection of ram was dependent only on kilograms produced at 6 months, rams were ranked as ram1, ram2, ram3 and ram4. While, selection according to LP solutions, which showing less opportunity cost, LE, the rank of rams were ram3, ram4, ram2 and ram1. The gross margin was 6497 LE and 5746 LE when keeping 8.22 and 7.72 lambs of the ram3 in LP model and LP modified model, respectively. These results were obtained under binding of the previous set of constraints. The results concluded that selection Barki rams should not be only according to the highest kilograms produced of their lambs at 6 months old but also, according to farm available resources.

Key words: linear programming, Egyptian Barki sheep and selection.

INTRODUCTION

Breeders usually select sires according to the highest estimate of transmitting abilities. In selection indices, the major difficulty is to determine the function of economic weights for different traits (Schneeberger, et al., 1982).

One way to solve this problem is to derive a gross margin equation for animals as a function of input and output traits and substitute estimated breeding values of those traits to obtain indices (Harris, 1970). If the objective is to select sires to maximize the gross margin within the farm system, the linear programming could deal with both resources and performance constraints to determine the most profitable combination in different sires (Jansen and Wilton, 1984).

The management program of Egyptian Barki sheep flock raised at Maryut research station, Desert Research Center, Ministry of Agriculture,

Egypt, was designed to select rams according to kilograms produced of their lambs at 6 months, individual own performance and breed characteristics (Alsheikh, 2005).

This work aimed at using the linear programming (LP) as a tool for selecting rams in the context of farming resources and to compare them with selected rams based on their production of absolute kilograms of lambs at 6 months of age.

MATERIALS AND METHODS

1. Flock management:

The management of Egyptian Barki sheep flock raised at Maryout Research Station, which belongs to the Desert Research Center, Ministry of Agriculture, Egypt, was established from many years ago. This station is located some 35 km west of Alexandria, longitudes 30^{o} 57' E and 30^{o} 41' E and latitudes 29^{o} 55' N and 29^{o} 25' N. The animals were housed in semi open shaded pens. Feeds consisted mainly of concentrate feed mixture plus berseem (*Trifolium alexantrinum*) (when available) and rice or wheat straw during the period from October to May. During, the rest of the year, berseem was replaced by berseem hay. The concentrate feed mixture consisted of cottonseed cake, maize, wheat or rice bran, calcium carbonate, and sodium chloride. The average crude protein content in this mixture ranged from 14 % to 16%. This mixture was fed once a day and water was available twice daily around noon after feeding and in late afternoon. The breeding season started during the second half of September for a period of 35 days (two estrous cycles). Ewes were joined in mating groups with a fertile ram. Rams were selected according to individual performance related to breed characteristics in addition to kilograms produced of their lamb at 6 months(Alsheikh, 2005).

2. Linear programming (LP) model:

An empirical study was conducted to select among 4 Egyptian Barki rams (each ram had at least 11 lambs at 6 months old per year) to maximize the annual gross margin. From the 16 rams used in matting groups (20 ewes each), only these 4 rams had two consecutive mating seasons. Table 1 shows the average of some productive traits of these 4 rams (recorded during 2003 and 2004).

3. Assumption:

The design of the present study was basid on the assumption of farm capacity was available for 300 ewes only, annual 6 months live weight lambs sold equaled 1500 kg/flock/year, and available labor time was 30000 hour/year. However, the price was 20 LE/kg live body weight, feed cost was 2.5 LE/kg dry matter and labor 1.5 LE/hour (farm gate price of Maryut research station, year 2004). Table 2 showed the estimated gross margin for lambs of the examined four rams.

Table 1: Average of some productive traits of the lambs of the four studied rams.

Traits	Rams				Overall mean
	1	2	3	4	
Birth weight, kg	3.30	3.32	3.44	3.80	3.45
Weaning weight, kg	17.81	16.97	17.94	20.17	18.15
6 months weight, kg	23.95	21.31	25.31	24.41	23.59
No. of lambs born	16.5	15.5	15	13	15
No. of lambs weaned	16	15.5	13	12.5	14.25
No. of lambs at 6 months	15	15.5	12	11.5	13.5
Kilograms born	55	51	52	44	50.5
Kilograms weaned	285	263	262	224	258.5
Kilograms of lambs at 6 mo.	359	330	304	281	318.5
Pre weaning body gain, kg	0.17	0.16	0.185	0.16	0.17
Post weaning body gain, kg	0.07	0.05	0.06	0.07	0.06

Table 2: Gross margin of the four studied rams

Traits	Value (LE/unit)	Flock mean	Rams			
			1	2	3	4
Lamb yield at 6 month old, kg/yr.	20	202	157	128	102	79
Feed requirement, kg DMI /yr.	2.5	600	466	380	202	157
Labor requirement, hour/yr.	1.5	0.5	0.4	0.33	0.25	0.2
Gross margin, LE/ yr.			501	515	790	662

Thus, from Table 2 the simple gross margin equation (Groen, 1989) for the ram could be calculated as follows:

Gross margin = lambs yield at 6 months old (its unit price) – feed requirement (its unit price) + labor requirement (its unit price in 8 hours in 365 days).

4. LP model structure: General Algebra Modeling System software (GAMS, 2000) was used to analyses input data according to the following structure:

Objective function:

Maximization (gross margin) = $501 X_1 + 515 X_2 + 790X_3 + 662 X_4$

where,

X_1 = ram1 X_2 = ram 2 X_3 = ram 3 X_4 = ram 4

Constrains:

Farm capacity:	X_1 +	X_2 +	X_3 +	X_4	≤ 300
kg lamb sold:	$359X_1$ +	$330 X_2$ +	$304 X_3$ +	$281X_4$	≤ 2500
Labor:	$0.9X_1$ +	$0.83X_2$ +	$0.75X_3$ +	$0.7X_4$	≤ 30000
Nonnegative:	X_1 +	X_2 +	X_3 +	X_4	≥ 0

5. LP modified model:

Using special equality constraints suggested by Jansen and Wilton, (1984) called transfer constraints could modify linear model formulated as:

Objective function:

Max.(gross margin) $=1X_1+ 1X_2+ 1X_3+ 1X_4+ 20X_5 – 2.5X_6 – 1.5X_7$

where

X_1 = ram1 X_2 = ram 2 X_3 = ram 3 X_4 = ram 4

X_5 = selling lambs X_6 = paying feed

X_7 = paying labor

Constrains:

Farm capacity: $1 X_1 + 1 X_2 + 1 X_3 + 1X_4+ 1 X_5 + 1 X_6 + 1 X_7 \leq 300$

Lambs sold: $359X_1 + 330X_2 + 304X_3 + 281X_4 + 0 X_5 + 0 X_6 + 0 X_7 \leq 2500$

Labor: $0.9X_1 + 0.83X_2 + 0.75X_3 + 0.7X_4 + 0 X_5 + 0 X_6 + 0 X_7 \leq 30000$

Equality:

$359X_1 + 330X_2 + 304X_3 + 281X_4 – 1 X_5 +0X_6 + 0X_7 = 0$

$1066X_1 + 980X_2 + 802X_3 + 757X_4 + 0 X_5 - 1X_6 + 0X_7 = 0$

$0.9X_1 + 0.83X_2 + 0.75X_3 + 0.7X_4 + 0 X_5 +0X_6 - 1X_7 = 0$

Nonnegative: $X_1, X_2, X_3, X_4, X_5, X_6, X_7 \geq 0$

RESULTS AND DISCUSSION

1. LP and LP modified models:

Table 3 showed the optimal solution of LP and LP modified models. It could be noted that, both models gave the same choice of keeping the lambs of ram 3, which led to the maximum of gross margin. The two model solutions showed that number of lambs kept of ram 3 were 8.22 and 7.27 lambs for LP and LP modified models, respectively.

The gross margin showed different between the two examined model to be 6497 LE and 5746 LE for LP and LP modified models, respectively. In the same respect, keeping the lambs of ram 3 using previous number led to the highest gross margin using the two models (binding farm capacity, selling lambs and paying labor constraints). However, the gross margin in the case of modifing, was less than the gross margin in LP model which might be due to feed constraint addition. Moreover, rounding number of kept lambs to 8 or to 7 months would make some changes in output solutions (McGilliard and Clay, 1983).

2. Selected rams:

The present results showed that, there were differences between the two decisions if rams were selected within farm resources and that selected only according to their kilograms at 6 months produced. Thus, in the case of selected ram depended only on kilograms produced at 6 months the rams were ranked as ram1, ram2, ram3 and ram4. While, in the other side, selection with expected LP linear program showed the rank of rams would be ram3, ram4, ram2 and ram1 with less opportunity cost (Table 3). This finding supported with the concept of Van der werf (2000), that breeders should use

animal genetic variation to make the livestock more efficient in addition to farm available resources. However, in spite of the obtained the encountered between results still Egyptian Barki breeders prefer the Barki rams, which would give more lambs without any attention to other concept, wich in agreement with Goren (2000).

Table 3: Selected rams within available farm resources

Variables	Solution	Opportunity cost, LE
LP model		
Objective (Max.), LE	6496.71	
No. of lambs at 6 mo. old / (head)		
Ram 1	0	431.97
Ram 2	0	342.57
Ram 3	8.22	0
Ram 4	0	68.23
LP modified model		
Objective (Max.), LE	5745.87	
No. of lambs at 6 mo. old / (head)		
Ram 1	0	734.22
Ram 2	0	675.83
Ram 3	7.27	0
Ram 4	0	97.10

No doubt on the advantage of LP and LP modified models to the absolute kilograms, that it had more sensitivity of selection decisions to rams within farm resources. Therefor, the analysis of results of Table 4 showed that the range of gross margin for ram 3 was from 716.18 LE to infinity and that for ram4 was -infinity to 730 LE. This means that, the minimum value of ram3 was nearest to the maximum value of ram4. This result seemed to be logic, and lead to conclude that the program would start selecting from lambs of ram3 than ram4 until the minimum value of ram3 equal to maximum value of ram 4.

CONCLUSION

The present study is an attempt to focusing the light on introducing the economical weights of the traits in selection program of Egyptian Barki rams in relation to using only the highest kilograms produced of lambs at 6 months old. No doubt that adding the farm avaliable resources subsequently the highest gross margin to the highest kilograms produced of lambs at 6 months will be coinciding with more effective selection program of Barki rams, as shown from the present study.

Table 4: Sensitivity analysis of selected rams within farm available resources

Variables	Sensitivity analysis					
	Objective function			Right hand side		
	Min.	Orig.	Max.	Min.	Orig.	Max.
LP model						
No. of lambs at 6 mo. old / (head)						
Ram 1	- Infinity	501	932.93			
Ram 2	- Infinity	515	857.57			
Ram 3	716.19	790	Infinity			
Ram 4	- Infinity	622	730.23			
Constraints						
Farm capacity				8.22	300	Infinity
Sailing lambs				0	2500	91200
Paid labor				6.17	30000	Infinity
LP modified model						
No. of lambs at 6 mo. old / (head)						
Ram 1	- Infinity	1	735.22			
Ram 2	- Infinity	1	676.83			
Ram 3	102.46	1	Infinity			
Ram 4	- Infinity	1	98.10			
Selling lambs	6.60	20	Infinity			
Paying feed	-7.58	2.5	19.79			
Paying labor	-543.67	1.5	Infinity			
Constraints						
Farm capacity				0	300	9109.79
Sailing lambs				82.33	2500	Infinity
Paid labor				0.20	30000	Infinity
Equality 1				-300	0	113.49
Equality 2				-300	0	786.92
Equality 3				-300	0	0.203

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البرمجة الخطية لانتخاب الكباش البرقي المصرية

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استخدم نموذج البرمجة الخطية لانتخاب الكباش البرقي المصرية على أساس وحدة الإنتاج فى حدود الإمكانيات المتاحة و أداء الكباش كمحددات للإنتاج. بنيت الدراسة على أساس انتخاب بين ٤ كباش (كل كبش له على الأقل ١١ حمل عند عمر ٦ شهور) بهدف معظمة العائد السنوي الكلى، وبالتالي صافى عائد المزرعة. كانت محددات النموذج هي سعة المزرعة (فرضت على أساس ٣٠٠ نعجة) إجمالي وزن الحملان عند عمر ٦ شهور (كان ١٥٠٠ كجم / مزرعة / سنة) والعمالة المتاحة (٣٠٠٠٠ ساعة / سنة). استخدم نموذج برمجة خطية معدل باستخدام بعض المعادلات الحسابية تحت نفس المجموعة من الشروط وكذلك نظام التغذية. حسبت معاملات مدخلات النموذج على أساس الحملان المباعة (السعر ٢٠ جنيه / كجم من وزن الحي للجسم) ، سعر العلف (٢,٥ جنيه / كجم الجافة) واجر العامل (١,٥ جنيه / ساعة) (هذه اسعار مزرعة محطة البحوث مريوط ، مركز بحوث الصحراء ، سنة ٢٠٠٤). أظهرت النتائج أن هناك فرقا في القرارين من حيث اختيار الكباش تحت ظروف الإمكانيات المتاحة فى المزرعة باستخدام نموذج البرمجة الخطية والذي تم وفقا لعدد الكيلوجرامات من الحملان عند عمر ٦ اشهر المطلق. وإذا كان اختيار الكبش يتم على عدد الكيلو جرامات عند عمر ٦ اشهر، فانه يتم ترتيبها الكبش الأول، الثاني، الثالث، الرابع. في حين إذا كان الاختيار وفقا لنموذج البرمجة الخطية، فانه طبقا لفرصة سعر التكلفة البديلة كان ترتيب الكباش هو الثالث، الرابع ، الثاني ثم الأول. كان صافى العائد السنوي ٦٤٩٧ جنيه و ٥٧٤٦ جنيه عند الاحتفاظ بعدد ٨,٢٢ و ٧,٧٢ حملان للكبش الثالث في نموذج البرمجة الخطية والنموذج المعدل من البرمجة الخطية على التوالي. تم الحصول على هذه النتائج تحت الشروط لمجموعة من القيود السابقة. وقد خلصت النتائج إلى إن اختيار الكباش البرقي لا ينبغي أن يكون على أساس أعلى عدد من كيلوجرامات التى تنتج من الحملان عند عمر ٦ اشهر ولكن أيضا وفقا للموارد المتاحة في مزرعة.