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EFFICIENCY OF SHEEP PRODUCTION SYSTEM UNDER ARID CONDITIONS OF SINAI: EFFECTS OF EWE BODY WEIGHT, LAMB MARKETING AGE AND ANNUAL RANGE AVAILABILITY

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SUMMARY

A stochastic sheep production simulation model was developed to simulate effects of combinations of ewe body weight (38, 42, 46 and 50kg) and lamb marketing age (4, 6, 8 and 12 months) under two systems situations of annual range availability (dry and wet areas) on life-time production efficiency. Input parameters used in this model were obtained from data collected from several producers' flocks in North Eastern Zone of Sinai and from published results. Kilograms of DM intake per kg ewe body weight (DM/EBW) as a measurement of biological efficiency (BE) and net income per ewe per year (NI) as economic efficiency (EE) were used for evaluation.

Results indicated, for all scenarios, negative returns (averaged L.E. –88.1/ewe/year) were obtained under dry area (DA) while a positive returns (averaged L.E. 25.6/ewe/ year) under wet area (WA) conditions. Although, heavier ewes (50kg) had better biological performance (27.6 and 26.9 DM/EBW in DA and WA, respectively) their superiority under DA were reversed by their higher feed cost consumption. On the other hand, increasing ewe body weight is associated with higher EE and better BE in WA. Both BE and EE were significantly (p<.01) improved as lambs were marketed at later ages. Across ewe weights, marketing lambs at 4 mo. had negative return (ranged from L.E. –20.0 to L.E. –10.5) in WA while low benefit was obtained when marketing at 6 mo. especially for lighter ewes. Marketing at 8 and 12 months was proved to be the most efficient when breeding heavier ewes under WA while lighter ewes was more efficient under DA.

Keywords: Sheep, efficiency, profitability, systems analysis, arid zones, range availability

INTRODUCTION

In arid areas, and as demand for increasing income, the questions of what is the optimum ewe body weight and what suitable marketing strategies can be applied in sheep production enterprisesis, are becoming important factors in sheep enterprises under arid conditions with meager feed resources. Increasing ewe body weight is associated with higher output rates (Thomson and Bahhady, 1988) that are counterbalanced by more input for maintenance and growth (Dickerson, 1978). These associations complicate the effect of ewe weight on life-cycle input/output efficiency, when nutrient intake prices increase and when lambs are marketed at age that increases total feed input. Modeling can help in identifying strategies and allow more flexibility in changing production systems without enormous expenditure of time and money (Lamb *et al.*, 1992). The objective of this study was to evaluate life-cycle performance and profitability of four categories of ewe's weights and four marketing strategies, under two system of annual range availability in flocks of 150 ewes under the producer's condition in northeastern zone of Sinai using systems analysis and modeling techniques.

MATERIALS AND METHODS

A dynamic computer model was used to simulate animal and enterprise performance. The model was a modified version of the stochastic lamb and wool production model adapted from the Texas A&M University Sheep Model (Blackburn and Cartwright, 1987a,b,c) by Almahdy (1997) to accomplish the simulation of different sheep production enterprises under northeastern zone of Sinai (NEZS). It is an arid area typified by nomadic system and annual ranges represent the principal feed resources, particularly in winter and spring seasons.

Management system:

In this study the performance of 150 ewes were simulated under the local producers' conditions in NEZS. Percentages of available feedstuffs were estimated based on total sheep requirement for normal condition and growth within an annual cycle (Table 1). Chemical composition of available feed was used after Metawi *et al.* (1998).

Details concerning management and sheep performance in north Sini were reported (El-Shaer, 1981; Kandil and Ahmed, 1997). Management practices include a free mating system and weaning the lambs at 120d of age.

Table 1. Percentage of available feedstuff in wet and dry area during the year

	Wet Area		Dry Area	
	Dec-May	Jun-Nov	Dec-May	Jun-Nov
Annual Range	75	50	40	20
Straw and Hay	10	25	35	55
Concentrate	15	25	25	25

Simulation model.

Almahdy *et al.*, (2000a,b) reported full descriptions of the original model. Individual ewes were simulated for 10 yr life-cycle production. Performance traits in the model were simulated deterministically except for reproduction and mortality, which were stochastically simulated. Probability of conception of the ewe (CR) and lambing rate (LR) was determined by flock means calculated by Metawi *et al* (1998) and adjusted for ewe body condition, weight change in the previous period, degree of maturity, and ewe age (Almahdy, 1997). The corrected CR and LR were then compared with a uniform random deviate. Probability of mortality at weaning (MRTW) was corrected for weight and litter size. Probability of mortality at birth was simulated as a linear function of MRTW as described by Wang and Dickerson (1991a).

Two quantitative definitions of system merit were computed, each reflecting a different production goal. One measure of biological efficiency (life cycle feed conversion) and another measure of profit were used for the evaluation of different systems. Life cycle feed conversion was calculated as kg DM input per kg body weight sold (DM/EBW). To calculate DM/EBW, outputs of ewe weight were adjusted to a market lamb equivalent based on the relative values of outputs from different ages and classes of sheep. Flocks feed costs were determined by physiological status of lambs and ewes and feed availability throughout the production year. Profitability was defined as net income (NI) or income minus variable costs per ewe per year. Income included weaned lambs, surplus replacement ewes, and culled ewes. Variable costs included annualized costs for buildings and equipment, feed, veterinary care and supplies, and labor.

Average input and output prices for 1999 were determined locally and by prices set as LE 6.5/kg for ewe and LE 9/kg for lambs and based on survey study ($1=LE3.45, May 1999). Feed prices (LE/kg) were .80 for concentrate, .25 for straw, .35 for hay, and free pasture. An annual cost for veterinary care was LE 12/ewe/year. Daily labor expenses were assumed to be LE .20 per ewe per month. Capital investment in building and equipment was assumed to be nil since houses are made of available and cheap materials and no special equipment are needed under the nomadic system (Metawi *et al*, 1998). Input parameters for LR and MRTW were 1.06, 1.00, 2.75% and 12.2% in WA and DA, respectively. Estimates of 41.8kg for ewe mature weight and .03 as a probabilities of abortion and ewe mortality rate were used.

Experimentation and statistical analysis:

For each flock, 150 ewes were simulated for 10 years. Each flock was simulated in two different system situations depending on annual range availability, dry area (DA) and wet area (WA). Responses of the system to changes in ewe mature weights (38, 42, 46 and 50kg) and to lamb marketing age (4, 6, 8 and 12mo) with all possible combination were simulated independently. Each combination of management system was replicated 20 times. Analyses of variance were conducted using the General Linear Model (GLM) procedure of SAS (SAS, 1990). Statistical model components were annual range availability, ewe mature weight and marketing age, and all possible interaction as factors affecting the biological and economic efficiencies of the flock. Comparisons among different means were accomplished using Duncan's New Multiple Range test.

Note that because the model included stochastic as well as deterministic elements, replications of simulations using identical inputs showed variation in results. Hence, analyses of variance were possible, including the computation of p-values associated with comparisons of means. It is not claimed that this variation is of the same magnitude expected from real production systems; however, it serves as a means to evaluate small differences in simulated results. A threshold of $P < .01$ for declaring differences significant was used.

RESULTS AND DISCUSSION

Statistical analysis indicated that, all main effects of annual range availability (ARA), ewe mature weight (EMW) and lamb marketting age (LMA) on BE and EE were highly significant ($P<.01$). Interactions between these factors were markedly significant ($P<.01$), however the effect of

ARA*EMW on BE and effect of ARA*EMW*WMA on EE and BE were not significant. Effect of EMW*LMA has a less but significant (P<.05) magnitude on BE. General means (Table 2) of biological efficiency (BE) shows that sheep production system are more efficient in WA than in DA (27.4 vs. 28.1 DM/EBW). Higher efficiency in WA could be attributed to the higher reproductive rate and the lower mortality rates as compared to DA resulting from the drought stress (Wilson and Light, 1986 and Metawi *et al.*, 1998). Wide range of estimated net income (LE –88.1 to LE 25.6 in DA and WA, respectively) were observed.

A little increase in BE as weight increased with no significant differences between 38 and 42 kg and between 46 and 50 kg in DA. Same trend was noticed in WA with no significant difference between 42 and 46 kg. This agrees with finding of Dickerson, 1978) who stated that "larger animals are not necessarily more efficient". However, BE was the highest for the heaviest ewes (50 kg) in both DA and WA (Table 2). Changing EMW from 38 to 50kg would improve expected DM/EBW by about 3.2%, by spreading input over more output. This finding agrees with Thompson and Bahhady (1988) who found that increasing ewe mature body weight (EMW) is associated with higher output. Impact of EMW on NI was clearly observable and significant (P<.01) in WA, as EMW increased NI as well has increased. In contradiction, negative and unfavorable impact of increasing EMW on NI was noticed in DA. This result implies that heavier animals are not commended in drought areas.

Despite the negative net income in all scenarios in DA, significant (P<0.01) improvement on BE and EE, as lamb marketed at later age was shown in both DA and WA (Table 2). Marketing lambs at 12mo had the highest BE and EE in both DA and WA. On the other hand, negative NI returns were obtained for marketing lambs at earlier age (ranged from LE –115.4 in DA to LE –15.6 in WA). Relationship between BE and EE was positive in WA and negative in DA, which implies that, biologically efficient animals, are not necessarily the most economic one.

Across ewe mature weights, marketing lambs at 4 mo had a negative return (ranged from L.E. –20.0 to L.E. –10.5) in WA while low benefit was obtained when marketing at 6 mo especially for lighter ewes. However, larger EMW would be less economically efficient when marketing at earlier age (Table 3). At 4 mo marketing age, increasing EMW from 38 to 50kg would reduce NI by LE –16.6 in DA and increase NI by LE 9.5 in WA. While, at 12mo marketing age, the corresponding values were LE .8 and 35.4. On the other hand, marketing lambs at later ages would be more efficient when breeding heavy ewe. At 38 kg body weight, increasing LMA from 4 mo to 12 mo would improve NI by LE 51.2 and 79.6 in DA and WA, respectively. While, at 50 kg body weight, the corresponding values were LE 68.6 and 105.5. However, the highest NI is obtained (LE 95.0) in WA from breeding 50kg ewe and marketing their lambs at 12 mo. Simulated results indicated that range condition in arid environment would affect the optimum combinations of ewe body weight and lamb marketing age which increase the flock offtake of sheep production.

Table 2. Averages of biological (BE) and economic (EE) efficiencies as affected by ewe mature weight (kg) and lamb marketing age (months) in wet and dry areas

	Dry area		Wet area	
	BE (kg)	EE (LE)	BE (kg)	EE (LE)
Overall	28.1	-88.1	27.4	25.6
Weight (kg)				
38	28.5 [a]	-85.2 [a]	27.8 [a]	15.0 [d]
42	28.3 [a]	-87.7 [ba]	27.4 [b]	23.0 [c]
46	27.8 [b]	-88.6 [bc]	27.4 [b]	28.0 [b]
50	27.6 [b]	-91.1 [c]	26.9 [c]	36.4 [a]
Lamb Age (months)				
04	35.5 [a]	-115.4 [d]	34.4 [A]	-15.6 [d]
06	29.6 [b]	-103.7 [c]	28.8 [B]	8.3 [c]
08	26.4 [c]	-80.1 [b]	26.0 [C]	30.8 [b]
12	20.7 [d]	-53.3 [a]	20.3 [D]	79.0 [a]

[abcd] Means within a column within each factor with different superscripts differ, P<.01.

Table 3. Average biological (BE) and economic (EE) efficiencies as affected by the combinations (W/A) of ewe mature weight (W) and lamb marketing age (A)

W/A	Dry area		Wet area	
	BE (kg)	EE (LE)	BE (kg)	EE (LE)
38/04	35.6 [b a]	-106.4 [d]	34.7 [a]	-20.0 [k]
38/06	30.4 [c]	-100.0 [c]	29.3 [b]	0.6 [i]
38/08	27.0 [f]	-79.4 [b]	26.4 [d]	19.9 [g]
38/12	21.1 [h]	-55.2 [a]	20.7 [f]	59.6 [d]
42/04	36.2 [a]	-115.1 [e]	34.4 [a]	-16.5 [k]
42/06	30.0 [d c]	-103.6 [d c]	29.0 [b]	5.4 [i h]
42/08	26.4 [g f]	-79.1 [b]	25.9 [e d]	28.0 [f]
42/12	20.7 [h]	-52.8 [a]	20.3 [f]	75.1 [c]
46/04	35.2 [b]	-117.3 [e]	34.6 [a]	-15.4 [k j]
46/06	29.3 [d e]	-104.5 [d c]	29.0 [b]	8.3 [h]
46/08	26.4 [g f]	-81.5 [b]	25.9 [e d]	33.1 [f]
46/12	20.5 [h]	-51.0 [a]	20.0 [f]	86.1 [b]
50/04	35.1 [b]	-123.0 [f]	33.9 [a]	-10.5 [j]
50/06	28.9 [e]	-106.6 [d]	28.2 [c]	19.1 [g]
50/08	25.8 [g]	-80.3 [b]	25.6 [e]	42.0 [e]
50/12	20.6 [h]	-54.4 [a]	20.1 [f]	95.0 [a]

[abc...k] Means within a column with different superscripts differ, $P < .01$.

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