Lifetime Production of Kajli Ewes at Khushab and Khizerabad: Reproduction and Lamb Production as Affected by Ewe Longevity

M. A. Qureshi[1], M. Nawaz and M. A. Khan[2]
Geneticist, Animal Sciences Institute, National Agricultural Research Centre, Islamabad, Pakistan

ABSTRACT : Data from 5,311 ewes and 13,076 lambing from 1977 through 1994 were used to analyse both annual and cumulative outputs in terms on total number of lambs born, total lamb weight weaned and total wool produced per ewe for ewe longevity 1 to 8 depending on their productive life in the flock. Ewes at Khushab produced 0.08 more lambs per parturition than ewes at Khizerabad; however, 0.39 less lambs were weaned at Khushab than at Khizerabad. Similarly, cumulative number of lambs born was more at Khushab flock than Khizerabad flock ($p < .01$). However, total weight of lambs weaned was greater at Khizerabad than Khushab flock ($p < .01$) for each ewe longevity. Most ewes (35%) were sold/replaced just after their first parturition (i. e. ewe longevity 1). The overall mean for annual sale/replacement was 32 and 23% at Khushab and khizerabad, respectively. Distribution of growth and reproductive traits from 1977–94 did not show upward or downward trend inspite of heavy sale/replacement except yearly variation. Lack of any genetic progress over the year suggested that random breeding was employed without any scientific selection programme. Annual means for lambs born, lambs weaned and weight of lambs weaned per ewe present in the flock were the highest for ewe longevity 2 compared with other ewe longevity groups. Relative efficiency in terms of net income was highest for ewe longevity 5 followed by ewe longevity 4 and 6 in both flocks.

(**Key Words:** Ewes, Lambing, Reproduction, Litter Size, Longevity)

INTRODUCTION

Overall productivity of sheep depends on numerous components. In the case of meat production, ouptput of the breeding population is dependent principally upon net reproductive rate (i. e. number) and size of progeny produced. The decision whether to measure on an annual basis (e. g. weight weaned ewe mated) or over a longer time interval (e. g. lifetime productivity) is in part dependent on the replacement cost or depreciation rate of ewes.

Rapid replacement is an important factor in a population where selective breeding is employed for genetic gains. However, the expensive component of rapid replacement may not be economically justified under non-selective breeding system. Dickerson (1970, 1978) emphasized that one of the most effective methods of increasing the efficiency of meat production is to increase number of lambs marketed per ewe per year. Hence, in any breeding programme, it is prudent to consider that the annual cost per unit of product (Dickerson, 1970) reduces as female years in production increase and, more significantly, as total production per female increases.

As no study has been reported so far in Pakistan about ewes longevity, this study was planned to evaluate the productivity of Kajli ewes at two stations by assessing both cummulative over lifetime (i. e. varying from 1-8 years) and annual production to examine the component of ewe reproduction (i. e. lambing rate and litter size at birth and weaning), lamb survial and lamb growth in each flock. Attempt was also made to compare returns from ewes lifetime productivity with replacement cost for economic analysis and relative efficiency of ewes of various longevity.

MATERIALS AND METHODS

Source of data

Data were collected from Livestock Experiment Stations, Khushab and Khushab. The stations are within the radius of 50 miles in the central districts of Punjab province about 400 km south west to Islamabad. The pedigree and performance records of Kajli sheep from

Address reprint requests to N. Nawaz.
[1] Assistant Professor, Univ. Agri. College, Rawlakot, pakistan.
[2] Associate Professor, Dept. of Anim. Breeding & Genetics, University of Agriculture, Faisalabad, Pakistan.
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1977 through 1994 at Khushab and from 1980 through 1993 at Khizerabad were collected and analysed.

Animals were maintained in open sheds with adequate covered space to be used as shade and shelter for harsh summer and winter, breeding rams, dry and lactating ewes and lambs were kept in separate sheds. Ewes were grazed on fodder and forages grown on the farm land, and supplemented as necessary with concentrate during breeding, lambing and feed scarcity periods.

Ewes were bred during autumn for spring lambing and ewes failed to breed in autumn were bred during spring for autumn births. Therefore, the data contained a large proportion of spring born lambs and relatively small number of autumn born lambs in the two flocks under study. Ewes were group mated at evening and mornings during the breeding season under the surveillance of supervisory staff for accurate record keeping.

Ewes were moved in sheds an average of 2 weeks before they commence lambing in January and they were penned in groups of 40-50. Ewes were under surveillance at lambing. Immediately after lambing, lambs were weighed and ewes and their offspring were placed in separte pens.

The lambs were allowed to suckle their mothers during night. Most ewes returned to pasture/fodder grazing with their lambs within 15 days of lambing, depending on weather conditions. Lambs were remained with their mothers on grazing from morning to late afternoon and during nights until weaning weights were taken at an average age of 120 day. Lambs received routine vaccination and parasite treatment. Preweaning nutritional supplementation was supplied to ewes and lambs. Ewes were routinely treated as a management practice throughout the period of data collected for enterotoxemia and internal and external parasites.

Ewes were culled or replaced due to old age, failure to produce milk or udder infection and for poor body conditions. Replacements were made mainly from the on farm born animals and rarely males and females were introduced from outside purchases. Ewes were shorn from February to April during spring and September to November during autumn. Individual fleece weights were recorded from 1980 through 1994.

Statistical procedure

Lambing data and performance traits were recorded along with pedigree information. Over 19,000 performance records were used for the analyses Individual ewes in whole data from 1977 through 1994 were given a value from 1 to 8 depending on their total life year in the flock irrespective of their year of brith. Ewes of various longevity were compared for total number of lambs produced, total number of lambs weaned and total weight weaned per ewe exposed. Similarly, annual lambs born, annual lambs weaned and annual litter weaning weight produced per ewe present were compared for ewes of various longevity. Flock and ewe longevity were included as fixed effects in the model. GLM procedure of SAS (1986) was used to analyse the ewe traits.

Economic Analysis

Ewes could be replaced at any stage from 1 to 8 years of productivity. The presence of a particular ewe for certain number of years in the flock is termed as ewe longevity. The proportions of ewes replaced at certain longevity in a flock is important if the flock size is to be maintained. Input cost involved in replacement and returns from lamb, wool and salvage value were computed and compared for relative efficiency (RE %) of ewes of various longevity during 1977–1994 for Khushab and Khizerabad flocks.

Proportions of ewes for each longevity were computed as:

$n_1/N = P_1$

$n_2/N = P_2$

" = "

" = "

$n_8/N = P_8$

where

n_1 is the number of ewes replaced after completing one year in the flock.

n_8 is the number of ewes replaced after completing 8 years in the flock.

N is the total number of ewes in one sheep flock for the period under study.

P_1 is the proportion of ewes completed one year in the flock.

P_8 is the proportion of ewes completed eight year in the flock.

Input vs output comparison was made as under:

Using the above computed proportions of different groups, the total output from weaning weight and wool production were calculated using following equations I II and III for each ewe longevity groups by putting all values in the model.

$$P_i \times LWWT \times PLWWT \quad \cdots\cdots \quad I$$

$$P_i \times FLEECE \times PFLEECE \quad \cdots\cdots \quad II$$

$[P_i - (P_i \times 0.05)] \times (EBWT \times PEBWT)$ ………… III

where

LWWT = Average of total litter weaning weight (kg) for each longevity.

PLWWT = Price for litter weight weaned @ Rs. 50 per kg.

FLEECE = Average total ewe fleece produced (kg) for each longevity. Fleece produced per year was taken as 2.0 kg/ewe from this data.

PFLEECE = Price of ewe fleece @ Rs. 10 per kg.

BWTE = Average body weight of sold/culled ewes which was taken as 40 kg/ewe from this data.

PBWTE = Price of body weight @ Rs. 35 per kg for culled ewes.

i = Proprotion in $_i$th longevity.

.05 = 5 percent ewe mortality.

Wool price was taken @ of Rs. 10 per kg under the assumption that 50 percent of the wool price was repaid to the shearer. Price as salvage value for outgoing ewes was considered Rs. 35 per kg. The price of Rs. 35 instead of Rs. 50 was used to accommodate quality premium attached with relatively younger ewes and lambs.
Input cost was calulated by equation IV as under:

$P_i \times BWTR \times PBWTR$ ……………………………… IV

where

BWTR = Average body weight of replacement of ewes(kg) which was taken as 40 kg adult weight from this data.

PBWTR = Price of body weight of replacement ewes @ Rs. 50 per kg.

Above three equations; I, II and III represent the gross benefit equations whereas equation IV reperesents the replacement cost. The net benefit from output versus input from ewe enterprise is represented by D which is obtained as follows:

$$(I + II + III) - (IV) = D$$

Where D is the difference of output minus input. The D value was calculated for each group of ewe longevity i. e from P_i to P_8.

In a normal routine farm practices, the females are entered in the flock at the age of 1-2 years. Therefore, only one rate was observed for computation of replacement cost. After obtaining D values for ewes of each longevity and for each flock. D. values (as income) were analysed for each flock using ewe lngevity as fixed effect in the model. Overall analyses for computed income trait was also conducted using flock and ewe longevity as fixed effects in the model (SAS, 1986). Means for income were ranked using student Newman Keuls Test (Sokal and Rolf, 1969) using SAS. The highest mean value for particular longevity was given a weight of 100. Relative efficiency for each ewe longevity group was calculated in proportion to the highest mean value of longevity group for comparison.

RE (%) = D value of each longevity group calculated in percentage proportion to the highest D value in the respective longevity groups.

For instance, for calculating relative efficiency (RE%) the highest D value of 485.42 is used as a baseline of one hundred and the D value of 80.48 in another group is weighted in terms of the highest D value as:

$$(80.48/485.42) \times 100 = 16.6\%.$$

RESULTS

Cumulative number of lambs born and weaned

Cumulative number of lambs born, weaned and cumulative weights of lamb produced for each ewe present in each ewe longevity, are presented in table 1. At Khushab mean cumulative number of lambs born per ewe present during the study was. 1.17 and 8.80 lambs for ewe longevity 1 and 8, respectively. Corresponding values for Khizerabad flock were 1.13 and 7.84 lambs. Additive increase was observed for number of lambs born with the increase of ewe longevity. Significant variation ($p < .01$) was observed between Khushab and Khizarabad flocks for cumulative number of lambs born. The mean cumulative number of lambs weaned per ewe present during the study period was 0.68 lamb for ewe longevity 1 and 5.50 for ewe longevity 8 at Khushab. The corresponding values at Khizerabad were 1.03 and 7.55, respectively, higher than that observed at Khushab ($p < .01$).

Cumulative weight of lamb produced

Cumulative weight of lamb produced based on pooled actual litter weight for each ewe present in each ewe longevity are presented in table 1 for the both flocks.

Mean cumulative litter weight produced per ewe present varied from 14.1 kg for ewe longevity 1 to 110.5 kg for ewe longevity 8 in Khushab flock. At Khizerabad, mean weight of lamb produced per ewe present during the study period was 19.8 kg for ewe longevity 1 and 151.2 kg for ewe longevity 8. Ewes at Khizerabad produced greater weight of lamb weaned ($p < .01$) inspite of bearing lower number of lambs born than ewes from Khushab ($p < .01$).

Table 1. Least square means for life time total lambs born, total lambs weaned and total litter weaning weight per ewe present of various longevity during 1977 – 93

Ewe longevity (Year)	Khushab				Khizarabad			
	No. of ewes	No. of Lambs born	No. of lambs weaned	Weight weaned (kg)	No. of ewes	No. of lambs born	No. of lambs weaned	weight weaned (kg)
1	401	1.17	0.68	14.1	1,239	1.13	1.03	19.8
2	170	2.44	1.63	34.9	669	2.28	2.10	41.8
3	154	3.53	2.10	42.9	625	3.53	3.03	59.5
4	130	4.77	3.03	62.7	554	4.26	4.04	80.2
5	121	5.66	3.40	71.2	501	5.36	5.05	99.6
6	76	6.99	4.28	89.3	366	6.42	6.04	119.0
7	55	8.22	4.40	88.6	202	7.25	6.96	139.4
8	10	8.80	5.50	110.5	38	7.84	7.55	151.2

Annual lambs born, weaned and total litter weight weaned

Means for annual lambs born weaned and total litter weight weaned per ewe are shown in table 2. Overall lambs born per ewe present in flock averaged 1.11 ranging from 1.03 for ewes longevity 8 to 1.18 for ewe longevity 2 ($p < .01$). Ewes from Khushab had higher ($p < .01$) mean lamb born (1.15) than ewes of Khizerabad (1.07). Overall annual lambs weaned per ewe present in the flock averaged 0.95 ranging from 0.60 lambs at Khushab and 1.01 at Khizerabad ($p < .01$). Ewes at Khushab produced 0.08 more lambs per parturition than ewes at Khizarabad ($p < .01$); however, 0.39 less lambs were weaned at Khushab than at Khizerabad. Overall annual lamb weight weaned per ewe exposed was 18.93 kg, ranging from 14.69 kg, at Khushab and 19.87 kg, at Khizarabad ($p < .01$). Ewes at Khizerabad weaned about 5 kg more weight than ewes at Khushab.

Table 2. Least square means and standard errors for annual lambs born, lambs weaned and litter weaning weight per ewe present in the flock for ewes of various longevity during 1977 – 93

Ewe longevity (year)	No. of ewes	Lambs born		Lambs weaned		Weight weaned	
		Mean	SE	Mean	SE	Mean	SE
1	1,640	1.16^{ab}	.01	$.86^{ab}$	.01	17.09	.23
2	839	1.18^{a}	.01	$.92^{a}$	.01	18.65	.31
3	779	1.12^{ab}	.01	$.85^{ab}$	.01	17.17	.33
4	684	1.11^{ab}	.01	$.86^{ab}$	.01	17.63	.35
5	622	1.11^{ab}	.01	$.85^{ab}$	.01	17.23	.36
6	442	1.11^{ab}	.02	$.87^{ab}$	.02	17.28	.43
7	257	1.09^{b}	.02	$.83^{ab}$	.02	16.87	.55
8	48	1.03^{c}	.05	$.80^{b}$	.05	16.32	.27
Flock							
Khushab	1,117	1.15	.01	.60	.01	14.69	.31
Khizerabad	4,194	1.07	.01	1.01	.01	19.87	.21
Overall	5,311	1.11	.01	.95	.01	18.93	.20

[a,b,c] Means in the same column within categories without common in their supperscript letters differ ($p < 0.05$).

Annual ewe replacement

Number of ewes present and replacement pattern at Khushab and Khizarabad from 1977 through 1994 are shown in table 3. Mean annual number of ewes present were 187 and 1,260 at Khushab and Khizerabad, respectively. Mean annual replacement was 32 and 23% at Khushab and Khizerabad, respectively. The overall ewe dropout rate at Khushab due to sale/culling was high (32%) varying from 13 to 59%. ($p < .05$) among years. The flock size varied from 113 to 256 with an annual mean of 187. The overall ewe dropout rate due to sale/culling was 23% at Khizerabad which varied from 14 to 34% ($p < .05$) among years. The flock size varied for 681 to 1,881 with overall an annual mean value of 1,260. At Khushab annual replacement was 10% higher than that at Khizerabad. At Khushab flock size was almost similar in 1994 to that what was in 1977. However, flock size increased from 761 in 1980 to 1467 in 1993 at Khizerabad. The overall increase in flock size was about 90% in 1993 than that was in 1980.

Table 3. Number of ewes present and percentage replacement from 1977-94 at Livestock Experiment Station Khushab and Khizerabad

Year	Khushab			Khizerabad		
	No. of ewes present	No. of ewes replaced	Percentage ewes replaced	No. of ewes present	No. of ewes replaced	Percentage ewes replaced
1977	151	–	–			
1978	196	89	59			
1979	132	36	18			
1980	113	32	24	761	–	–
1981	164	75	66	681	145	19
1982	151	36	22	730	107	16
1983	167	60	40	817	144	19
1984	214	76	46	928	183	22
1985	196	28	13	1,013	259	28
1986	197	34	17	1,153	259	25
1987	209	75	38	1,336	163	14
1988	232	86	41	1,778	401	30
1989	242	72	31	1,710	599	34
1990	207	46	19	1,881	377	22
1991	222	62	30	1,785	481	27
1992	256	85	38	1,603	288	16
1993	179	35	14	1,467	388	24
1994	129	49	27			
Mean	187	57	32	1,260	292	23

% Replacement = Number of ewes replaced / Number of ewes present in the previous year.

Frequency of ewe replaced during longevity 1-8

Frequency of distribution of Kajli ewes replaced during ewe longevity 1-8 have been shown in figure 1. Out of total 5311 ewes under study for lamb and wool production from 1977 to 1994, most (35%) ewes were replaced just after their first parturitions i. e. after longevity 1. From ewe longevity 2 number of ewes replacement continues to decrease in declining order until ewe longevity 6 and then large number of ewes replaced afterwards. From ewe longevity 8 onward the number of ewes left were too small to be used in the analysis. Number of ewes longevity 4 to 6 were the most productive with respect to practically flock maintenance and its net output point of view.

Income and relative efficiency for ewes longevity

Income as result of difference between returns (from ewes as lambs, wool product during their flock life and ewe salvage value) and input cost involved in ewe lamb replacement are given in table 4. Income means ranged from 20 for ewe longevity 1 to 324 for ewe longevity 5 at Khushab and 64 for ewe longevity 8 to 525 for ewe longevity 5 at Khizerabad. The highest means for ewe longevity 5 was followed by ewe longevity 4 and 6 at both stations. Relative efficiency of ewes at Khushab and Khizarabad flock are given in figure 2. Maximum

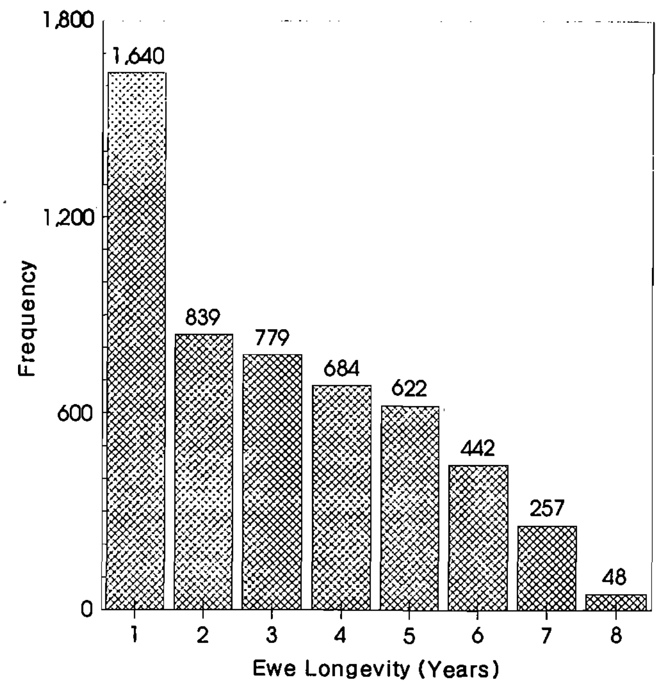

Figure 1. Frequency distribution of Kajli ewes replaced during 1977-94.

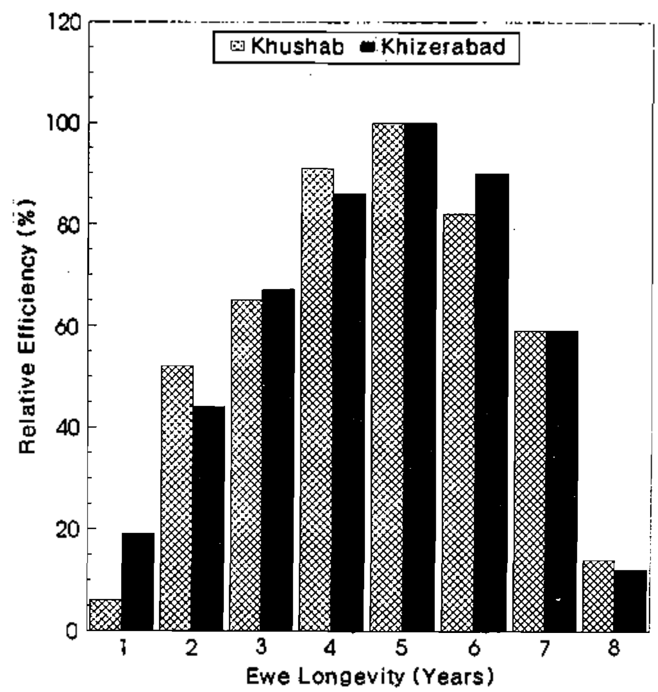

Figure 2. Relative efficiency of Kajli ewes from 1977-94.

Table 4. Mean income (Rs.) from ewes of various longevity with reference to flock size

Ewe longevity	Khushab		Khizerabad		Overall	
	No. of ewes	Mean	No. of ewes	Mean	No. of ewes	Mean
1	401	19.89	1,239	100.09	1,640	80.48
2	170	169.23	669	233.23	839	220.27
3	154	211.62	625	353.01	779	325.06
4	130	295.07	554	451.27	684	421.59
5	121	323.52	501	524.53	622	485.42
6	76	266.70	366	470.14	442	435.16
7	55	190.37	202	309.57	257	284.06
8	10	45.20	38	64.06	48	60.13

efficiency was for ewes longevity group 5 followed by ewe longevity 4 and 6. For economical and practical point of view ewe longevity 4-6 were the most efficient groups compared with other longevity groups at the Khushab and Khizerabad flocks.

DISCUSSION

The decision whether to measure on an annual basis or over a longer time interval (e. g. lifetime productivity) is in part dependent as the replacement cost or depreciation rate of ewes. This study assessed both cumulative and annual outputs form 1 to 8 year in ewe productive life depending on the ewe longevity in the flock with reference to input cost due to their sale/replacement. It was not possible to measure nutritional intakes by the various ewe longevity group mostly under year-round grazing with partial supplementation during scarcity/breeding period. The cumulative production levels for number of lambs born was higher ($p < .01$) for Khushab flock; however, the number and weight of lambs weaned per ewe of each longevity was greater at Khizerabad flock ($p < .01$). The higher proportion of lambs sold even before weaning resulted in less number and weight of lambs weaned at Khushab.

The cumulative production levels for per ewe present in the flock for ewe longevity 4 (i. e. cumulative production over 4 year) were 10 to 20% less than for number of lambs weaned and 35 to 44% less for weight of lambs weaned than those reported by Hohenboken and Clarke (1981), Ercanbrack and Knight (1989) and Nawaz et al. (1992) from studies of several crossbred and purebred ewe genotypes. It seems that the above difference in lamb weight is due to cumulative effect of more lamb born, higher lamb survival and higher lamb growth as reported by the above authors.

Comparison based on annual litter weaning weight per ewe present is the flock during her life among ewes of various longevity has shown the highest means for lamb born, lambs weaned and weight of lamb weaned for ewe longevity 2. These traits were lowest for ewe longevity 8 which was due to the fact that there was high likelihood for an ewe to be infertile in any year among 8 ewe years. Whereas the probability for being infertile is zero for 2 ewe years, as if she had lambed only once she would have been in ewe longevity 1. The superiority of Khizerabad ewes (producing about 5 kg more lamb weight at weaning) over Khushab ewes was due to early sale of young lambs before weaning at Khushab as they were considered asdied in the analysis. The overall annual litter weight produced by Kajli sheep is only 50% of what was observed by Nawaz et al. (1992). The difference may be attributed to the higher genetic merit of sheep breeds involved in the above study. Moreover, this study is based on data from sheep multiplication farms much longer period probably without any imporvement target and designed experiment. The longer period of 17 years seems to be contributed in bringing down the annual average production compared with the well designed experiment of four years reported by Nawaz et al. (1992).

A sister study (Qureshi, M. A., 1996) has indicated that reproductive and growth traits have not shown an upward trend during 1977–93 as the weaning weight means were same for year 1977 and 1993. Similarly, 14 month weight, ewe breeding weight, fertility and litter size did not show upward trend. All these traits were significantly different among years but the difference was due to yearly managemental variation rather than any significant increase over years. It is interesting to note that no meaningful improvement was noticed inspite of annual heavy sale/culling which suggest that breeding programme at these two stations has been based on random mating without any scientific breeding and selection programme.

This is contrary to what has happened sheep industry around the world. Sheep industry has seen dramatic changes in production components in advanced countries in last three decades.

Significant improvement in litter size was achieved by Wallace (1964) in New Zealand. Parker and Pope (1983) reported that slaughter weights had increased an average of 0.31 kg per year during the previous 25 years while the average annual change in lamb slaughter weight per breeding ewe in the USA during this period was 4.5 times greater than average increase in lamb crop percentage. The increases in weight were attributed to use of larger breeds for slaughter lamb production, selection emphasis on body size within breeds and feeding lambs to heavier slaughter weights in sheep production in past 25 years in the USA.

Ewes continue to add up their productivity as their longevity increases in the flock (tables 1 and 2). Increased years in production can decrease, the annual cost of production, that attributable to replacements; increasing totals production per ewe (Lamb plus Wool in economic equivalents) decreases the entire cost per unit of product (Dickerson, 1970).

Relative efficiency for ewes of various longevity signifies the net income of each longevity along with maintaining a flock size for practical point of view. Ewes having longevity 7 or 8 are great as they increase total production per ewe however, their proportion becomes too low to be existed as numerically optimal viable flock. Ewe longevity group 5 turned out to be most appropriate for maximum returns followed by ewe longevity 4 and 6. Greeff et al. 1990 have observed that ewes performed the best over the first five lambings in terms of kilogram of lambs weaned which is in consonance to the present findings.

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