COMPARISON OF SHEEP CROSSBREDS IN TERMS OF GROWTH, REPRODUCTION AND CARCASS CHARACTERISTICS FROM FALL BORN LAMBS

By

SERKAN ERAT

Bachelor of Veterinary Medicine

Ankara University

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FROM FALL BORN LAMBS

Thesis Approved:

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Thesis Adviser

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Dean of the Graduate College

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TABLE OF CONTENTS

Chapter	Page

LIST OF TABLES

Table | Page

CHAPTER I

INTRODUCTION

Among the domestic animals sheep were the first animals that were raised by people for food and clothing. Meat and wool are the major products of the sheep industry. The importance of these two products will change according to the environment in which the production is main concern and genetic resources available to the producer (Chabo , 1994).

Efficient production in sheep is of large importance. Profitability plays an important role and is closely related to the ewe breeds' abilities to raise the maximum economically feasible number of lambs (Mukaso et al., 1991). Reproductive rate, growth and survival need to be increased for improvement of the efficiency of the flock (Chabo , 1994). Dickerson (1970) reported that an increase in both the biological and economic efficiency of animal production is the way to improve reproductive performance. Also Shelton (1971) has reported that an increased number of lambs per ewe is the greatest opportunity for increasing the efficiency of lamb meat production. Glimp (1971) , Sidwell and Miller (1971), Laser et al. (1972), Bradley et al. (1972) and Sidwell et al. (1964) have described the differences among domestic sheep breeds in terms of reproductive characteristics. Crossbreeding of sheep is widely practiced for effective sheep production since it produces ewes that are more fertile and prolific than pure breeds. Similarly, Sidwell and Miller (1971), Bradley et al. (1972) and Sidwell et al.(1964) have documented the effects of crossbreeding on production efficiency in sheep

The objectives of this study were to compare Rambouillet (RAMB), Dorset x Rambouillet (DR), and Romanov cross (ROM) ewes as dams of crossbred fall born lambs in terms of reproduction, growth and carcass characteristics .

CHAPTER II

LITERATURE REVIEW

General Characteristic of Breeds

Rambouillet

The Rambouillet is a breed developed from the Spanish Merino in Germany and France and imported into the U.S. in the 1800s. The breed is large, rugged, of medium to fast growth, long lived, and adapted to a wide variety of arid range conditions. The Rambouillet is white faced with wool on the legs. The Breed has also an extended breeding season and produces high quality fine-wool fleece.

Iniguez et al.(1986) reported that the Rambouillet breed is in among the better breeds for early breeding. The Targhee and Columbia derived from the Rambouillet, or crosses among the three, comprise most commercial ewe flocks in Western United States (Iniguez, 1986). Shelton and Morrow (1965) reported 84, 96,127 and 135 lambs born per 100 ewes exposed in March, June, September and December, respectively, for mature Rambouillet ewes in Texas.

The sheep industry in the Southwest and Intermountain West of the U.S. (60% of total U.S sheep population is found in this area) is dependent upon the annual lamb production and wool by Rambouillet or Rambouillet-cross ewes (Thomas and Whiteman, 1979). Even though these ewes are known to be very hardy, long lived and to shear heavy, high quality fleeces, they do not have a high reproductive rate (Thomas and Whiteman, 1979). Dickerson and Glimp (1975), Laster et al.,1972 , Dickerson and Laster (1975) reported that the Dorset and the Finnsheep (both whitefaced) are known to be superior to the Rambouillet in reproductive traits. Thomas and Whiteman (1979) concluded that increasing Finnsheep breeding by 1/4 at the expense of Rambouillet breeding can cause decreased lamb and wool production of fall-lambing flocks (such as in Southwestern United States). They also reported that the 1/4 Finnsheep ewes had very desirable lambing notes. One-quarter Finnsheep ewes may be very desirable for fall-lambing if, through selection or management, proportion of ewes lambing could be improved. Likewise, they indicated that 1/4 Dorset ewes had lower grease fleece weight and there was little effect on weight of lamb weaned per ewe exposed. On the other hand, Thrift and Whiteman (1969) concluded that 1/2 Dorset 1/2 Rambouillet were superior to the straightbred Rambouillet ewes for fall lamb production.

Dorset

The Dorset was originated in Southern England and imported into the U.S. in 1885. In that time all Dorsets were horned. In 1948 a mutation occurred resulting in Polled Dorsets at North Caroline State College, Raleigh, NC. Polled Dorsets have the same characteristics as the Horned Dorsets and are a popular commercial breed in the farm flock states. Both Horned and Polled Dorsets are all white, of medium size and have good body length and muscle conformation to produce a desirable carcass. Dorsets are medium-sized white-faced with wool on the legs, heavy milking, and yield medium wool fleeces free of black fibers.

The Horned Dorsets have a reputation for good out of season breeding performance, but this trait is not well documented for current strains of Polled Dorsets (Iniguez, 1986). Purebred Dorsets have been reported that they lack the hardiness, flocking instinct and fleece characteristics to be well adapted to many range environments (Iniguez,1986). But, Thrift and Whiteman (1969) reported that Dorset-Rambouillet crosses are superior to Rambouillet type ewes in terms of lambing rate and rearing lambs under spring mating management in Oklahoma.

Cochran et al.(1984) compared purebred Dorset with 1/4 Finnsheep-3/4 Dorset and 1/2 Finnsheep-1/2 Dorset ewes. There were 644 exposures and 552 lambings by ewes exposed to Hampshire and Suffolk rams for spring lambing from 1975 to 1978. The Dorsets ewes had lambs that were .80 and .64 kg heavier at birth than lambs from 1/2 Finnsheep and 1/4 Finnsheep ewes, respectively. Similarly, lambs from Dorset ewes have been reported to grow faster preweaning and were heavier at 90 d. In terms of lamb survival, the Dorset ewes had more singles die at birth than did Finnsheep crossbred ewes. On the other hand, Finnsheep crossbred ewes had more twins die shortly after birth than did Dorsets ewes. In addition, lambs from Dorset ewes lambed an average of 10.5 $\pm$ 1.3 d later than lambs Finnsheep-cross ewes.

In another study, growth rate of .24kg/d from birth to 12 wk for male lambs from Finnsheep-Dorsets ewes has been reported by Land and McClelland (1971).

Fogarty et al.,(1984a) studied season of lambing and other environmental effects on ewe performance of purebred Dorset (D), Finnsheep (F), Rambouillet (R), Targhee (T) and Suffolk (S) and the generations of crosses [(1/2F-1/4R-1/4D) and (1/2F-1/4T-1/4S)] in April lambing. The data were collected over four years and involved 10,959 ewe breeding season records for 4,219 ewes of 412 sire families. Dorset and Finnsheep ewes generated more weight of lambs/ewe exposed than Rambouillet, Suffolk and Targhee ewes. This was due to the higher Dorsets and Finnsheep fertility, higher Dorset lamb survival and larger Finnsheep litters.

Romanov

The Romanov originated in Russia and represents the northern short-tailed type of sheep. They are similar to the Finnsheep in many respects. The Romanov is a very prolific breed. Quadruplets, quintuplets and even sextuplets are not unusual for a Romanov ewe. They reach puberty very early and have exceptional newborn lamb vigor with small birth weights. Wool color is mostly black at the time of birth but lightens as lambs mature.

Highly prolific breeds such as Romanov and Finnsheep can be used in order to set reproductive rates at desired levels (Leymester, 1987).

A study by Vesel and Swierstra (1986) evaluated crossbred ewe lambs of eight genetic types (Dorset x 3/4 Dorset,DD; Dorset x 3/4 Finn,DF; Finn x 3/4 Dorset,FD; Finn x 3/4 Finn,FF; Romonov x 3/4 Dorset,RD; Romonov x 3/4 Finn,RF; Romonov x Western,RW; and Western x Western,WW) in order to determine age at weight at conception, conception rate, ovulation rate, litter size and prenatal mortality. Age at conception in days, ovulation rate (number of corpora lutea) and litter size for the eight groups were as follow: DD,236 ± 5, 1.5 ± .1, 1.3 ± .2; DF,218 ± 4, 1.5 ± .1, 1.4 ± .1; FD,234 ± 5, 2.2 ± .1, 1.8 ± .1; FF,228 ± 4, 2.6 ± .1, 2.3 ± .1; RD,209 ± 5, 2.2 ± .2, 2.0 ± .1; RF,213 ± 3, 2.7 ± .1, 2.4 ± .1; RW,222 ± 5, 2.1 ± .2, 2.1 ± .2; WW,247 ± 5, 1.0 ± .1, 1.0 ± .2. Romonov-sired lambs conceived at an earlier age than Dorsets and Finn-sired lambs(210 ± 3 vs 225 ± 3 and 220 ± 3 d). There was not a large difference between Romonov and Finn-sired lambs in terms of ovulation rate and litter size (2.5 ± .1 and 2.2 ± .1 vs 2.4 ± .1 and 2.1 ± .1). Similarly, Ricordeau et al., (1978) also reported that Romonov and Finnish Landrace crosses had the greatest and similar litter size. Overall , Vesel and Swierstra (1986) concluded that Romonov crosses and Finn crosses had similar ovulation rate and litter size but Romonov crosses conceived about 3 wk earlier.

Gallivan et al., (1993) compared the Finnish Landrace and Romonov in a terminal-sire crossbreding system. Their results showed the supeority of the Romonov over the Finnish Landrace as a prolific breed in a terminal-sire crossbreeding system. In this experiment Targhee ewes were mated to Romonov rams (RT) and Finnish Landrace rams (FT). RT ewes produced more lambs than FT ewes, RT ewes had earlier sexual maturity, gave birth to more lambs, and weaned more lambs than did FT ewes.

Polypay

The Polypay was developed in the 1970s by the U.S. Sheep Experiment Station at Dubois, Idaho and Nicholas Farms at Sonoma, California.

The primary goal for the development of the Polypay breed was to develop a composite breed that has an increased reproductive capacity along with desirable growth rate and carcass quality (Hulet et al., 1984). The Rambouillet and the Targhee were included for hardiness, large body size, long breeding season, herding instinct and fleece characteristics; the Dorset for carcass quality, milking ability and long breeding season and the Finnsheep for early puberty, early postpartum fertility and high lambing rate (Hulet et al., 1984).

Nawaz and Meyer (1992) evaluated reproductive traits and lamb growth of six ewe genotypes generated by mating Coopworth (C), Polypay (P) and Suffolk (S) rams to Polypay and Coopworth-type (Ct) ewes. These six ewe genotypes were exposed to Hampshire rams for spring lambing from 1986 through 1990. Data involved 1,092 exposures and 1,044 resultant lambings. Overall conception rate was 95% and varied from 93% for SxCt ewes to 97% for PxCt ewes. Mean litter size was 1.63 and ranged from 1.45 for CxC ewes to 1.75 for SxP ewes. P-sired ewes had higher mean litter size than Ct-sired ewes (1.73 vs 1.54). Survial of twins averaged 85% and ranged from 79% for lambs from SxCt ewes to 89% for lambs from PxP ewes.

Another study by Nawaz et al., (1992) used the same six ewe genotypes mentioned above and found that S-sired ewes weaned the heaviest lambs and P-sired ewes weaned the largest number of lambs. C-sired ewes produced 32% more wool than ewes sired by S and P.

Fleece characteristics of Finnsheep are inferior to most whiteface breed of sheep. Economically this undesirable effect in fleece characteristics of the Polypay can be concealed by the Polypay's superior lambing ability (Hulet et al., 1984).

Finnsheep

The Finnsheep originated in Finland, and was imported into Canada in 1966 and the U.S. in 1968. This breed is also known as the Finnish Landrace or Finn. They are polled, with no wool on the face and legs. The Finnsheep is one of the world's most prolific breeds. They have excellent maternal instincts and good lamb vigor at birth. Purebred Finnshep are small and lack desired carcass conformation.

Maijala and Osterberg (1977) reported that Finn might have as many as five to six lambs per litter, with an average litter size of 2.5 lambs per litter. Young and Dickerson (1991) compared productivity of Finnsheep and crossbreed ewes sired by Boorola Merino(BM) and Finnsheep(FS) rams. They found that BMxFS ewe had larger litters than Finnsheep ewes and FS rams produced lambs with more desirable level of performance than did BM rams.

In another study, Oltenacu and Boylan (1981b) investigated productivity of purebred and crossbred Finnsheep.(crossed with Suffolk, Targhee and Minnesota). Birth and weaning weights were studied for purebred Finnsheep, Suffolk, Targhee and Minnesota 100; F_1 Finnsheep crosses; F_2; and standard breed (Suffolk, Targhee and Minnesota) and Finnsheep backcrosses. (The F_1 ewes were bred to F_1. Finnsheep and standard breed rams to produce F_2, Finnsheep and standard breed backcrosses). Among purebreds, Finnsheep lambs had lightest birth weight but ranked second for 70-day weaning weight (Suffolk,21.0 kg vs Finnsheep,17.6). Likewise, the Finnsheep ewe was the smallest purebred, produced the lightest fleece, but its total weight of weaned lamb was the heaviest. Also F_1 ewes were all heavier, yielded more wool and produced more weaned lamb than did the parental standard breeds. Body weight, wool and lamb productions were all lower in the F_2 than in the F_1 groups.

Oltenecu and Boylan (1981a) also studied female reproductive traits in four pure breeds and the crossbred Finnsheep mentioned above. Purebred Finnsheep ranked highest of all pure breeds and crosses for the percentage of ewe lambs lambing at 12 mo of age, lambing rate and weaning rate. Perinatal mortality was moderate for Finnsheep lambs, but lambs born alive had an excellent survival rate to weaning (97.5%), superior to that of Targhee (85.2%), Minesota 100 (78.9%) and Suffolk (76.8%).

Purebred Finn, Suffolk, Targhee and Dorset, F_1 Finn crossbred, and multiple crosses from crossbred Finn ewes mated to Suffolk, Targhee, Dorset and Lincoln rams were evaluated by Olthoff and Boylan (1991) to determine their potential in commercial sheep production. Traits were birth weight, 70-d adjusted weaning weight, age at a constant market weight, pre- and post-weaning daily gain in 468 lambs. Purebred Suffolk lambs showed the best performance for all traits, followed by Targhee, Dorset and Finn lambs. Performance of F_1 crossbreds was similar among sire breeds.

Crossbreeding Systems in Sheep

There is no breed of sheep that is best in all characteristics. To combine the best characteristics of several different breeds gives us an opportunity to get a better combination than we could get with any one breed. Due to heterosis resulting from breed crossing crossbred lambs have superiority over purebred lambs in terms of livability, early growth rate, productivity at an earlier age, fertility and adaptability to a wider range of conditions (Whiteman, 1979). Therefore, crossbreeding of sheep is a traditional practice that is widely used to achieve optimal levels of performance (Leymaster, 1987).

The review of literature clearly shows the superiority of crossbred lambs over purebred lambs. Whiteman (1979) reported that Dorset X Rambouillet crossbred ewes lambed twins at a rate of 60-75 %, but Rambouillet ewes had twins at a rate of 40-45 % . He also reported that the Dorset X Rambouillet combination would be better than anything else if a producer wants most or all of his ewes to lamb in fall. In another study, Thrift and Whiteman (1969) reported that the Dorset X Western ewes had a higher lambing rate (0.19), reared more lambs per 100 ewes (22.6) and lambed about 3 days earlier than the Western ewes.

Terril (1958) reported that crossbreeding increased both the number of lambs weaned and their weaning weights. Rastogi et al., (1982) investigated the relative merit of Columbia, Suffolk, and Targhee breeds in straightbred and two- and three-breed combination. Lambs performance traits studied were birth weight, preweaning average daily gain, weaning weight at 70-d- of age, postweaning average daily gain and age at market weight (50 to 55 kg). Among the purebreds Suffolk lambs were best in all traits. Three-way -cross lambs were superior to two-way-crosses in terms of performance. This suggest that the three-way-cross needs to be considered in the design of breeding programs.

A study by Guney showed that how crossbreeding can improve the reproductive, growth and carcass characteristics of the Awassi sheep of Turkey. The Chios was chosen for prolificacy and high milk production, the Ile-de-France for early growth and carcass quality, the Rambouillet for early growth. Firstly, the F_1 generation was produced by mating Awassi ewes with Chios rams. Secondly, F_1 ewes were mated with Ile-de-France sire to obtain F_1 ram lambs (II F_1) and F_1 ewes also mated with Rambouillet sires to obtain F_1 ram lambs (R F_1). Rambouillet (Ramb) and Awassi (Aw) sheep served as the control lines. Lambing rate was 1.65, 1.16. 1.05, and 1.03 for II X F_1 , R X F_1, Aw X Aw and Ramb X Ramb matings respectively. Average daily gain were 311.6, 253.2, 281.2 and 226.0 g/d for II F_1 , R F_1, Aw and Ramb lambs, respectively. II F_1 had the highest dressing percentage. Total muscle percentage was 54.9, 53.5, 54.3, and 54.1, and total intramuscular fat percentage 10.5, 9.5, 10.1, and 6.6 for II F_1, R F_1, Aw and Ramb lambs, respectively.

Commercial sheep producers often use the crossbreeding program in their breeding program. Much of the crossbreeding in sheep is focused on the ewe in order to take advantage of the heterosis, or hybrid vigor, associated with reproduction and maternal traits, such as weaning weight and mothering ability (Harrington, 1995).

Traits

Growth Traits

Growth traits are economically important to the sheep producer. The producer wants lambs to reach market weight as early as possible so he can make some savings on feed cost (Chabo,1994). Heritability for growth traits is considered moderate (Buchanan, 1993). This means any selection programs that focus on growth rate can usually result in rapid genetic gain. However, many non -genetic factors(sex of lamb, year, age of dam, season, type of birth rearing) can also affect growth traits in a sheep production.

Breed or genotype of the ewe has a significant effect on growth traits of the lamb. Dickerson et al., (1972) compared seven breeds of sheep in lamb growth and carcass characteristics. The breeds involved were Suffolk, Hampshire, Polled Dorset. Rambouillet, Targhee and Coarse wool sheep. The differences among breeds were significant and consistent from birth to 26 wk .In relation to the general mean, Suffolks were 108% in weight at birth, 111% at 10 wk and 115% thereafter. Dorset were 85% at all ages. Coarse wool sheep, Targhee, Rambouillet and Hampshire lambs grouped between 100 to 102%. At weaning, Hampshire were 96% and the other three breeds were 102 to 106 % ; Corredalis were 104% at birth but 95% at weaning.

In another study, Castonguay et.al., (1990) reported that the growth performance of Hampshire sired lambs from four genetic groups of ewes. It was shown that Hampshire X Suffolk lambs had the highest average daily gain in both preweaning and postweaning periods.

The genotype of the sire also has a significant effect on the performance of growth traits in lambs. Likewise, review of literature clearly showed that use of Suffolk and Hampshire as terminal sire in crossbreeding programs is desirable to increase growth rates and meat production per lamb marketed. Rams from Suffolk, Hampshire and five strains of Minnesota sheep (Minnesota 100, Minnesota 102, Minnesota 103, Minnesota 106 and Minnesota 107) were compared for effects of breed of ram on lambs weights by Sing et al., (1967). Suffolk and Minnesota 106 rams produced significantly heavier lambs at birth than Minnesota 100 rams. However, the Suffolk and Hampshire rams produced heavier lambs at weaning and the Minnesota 102, Minnesota 103 and Minnesota 107 rams produced significantly lighter lambs at weaning than the Minnesota 100. In another study, De Beca et al., (1956) and Pattie and Donnely (1962) reported improved lamb production by using Dorset and Suffolk breeds.

Olthoff and Boylan (1991) compared the performance of lambs from purebred and crossbred Finnsheep ewes. They found that Suffolk-sired lambs gained fastest pre-and postweaning followed by Targhee, Dorset and Finn sired lambs. Bunge et al., (1993) reported that lambs sired by Finnsheep and Combo-6 rams were heavier at weaning than lambs sired by Boorola Merino and Barbados ram. Sakul et al., (1993) evaluated wether lambs born to Targhee ewes and sired by Australian Merino, Rambouillet and Targhee ram. Lambs sired by Australian Merino gained more slowly than those sired by Rambouillet and Targhee rams.

Age of dam also affected growth traits. There is a consistent pattern in different breeds and flocks of sheep for the effect of age of dam an birth weight. However, the effect of age of dam on other lamb growth traits is not consistent (Chabo 1994). A study by Eltowil et al., (1970) in Navajo sheep showed that age of dam brings most of its influence on preweaning traits. Birth and weaning weight seemed to be affected by age of dam much more than yearling weight. Eight years old dams or older dams had lambs that were heavier at birth than all other groups. Wright et al., (1975) reported an age effect on productive characters of Soutdown sheep. Lambs from two-year-old ewes were lighter than from all other age of ewe classes at birth.

Sex of lamb also affects growth traits such as birth weight and weaning weight. In most species including sheep, the male newborn is heavier at birth and grows faster than the female. In many studies it has been shown that sex has a major influence on birth and weaning weights of lambs [Ruttle, (1971), Sidwell and Miller (1971), Dickerson et al., (1972), and Rastogi et al., (1975)]. Bunge et al., (1993) also reported the performance of hair sheep and prolific wool breeds of sheep. Ram lambs were again reported to be heavier by 1.3 kg at weaning than ewe lambs.

Type of birth-rearing has been shown to have an effect on lamb growth traits. As a general rule single-born lambs are heavier than twin-born lambs at birth and weaning. Singh and Dhillon (1992) reported that this may be due to limited uterine capacity, inadequate nutrition during pregnancy and competition among twins for milk from the dam during the preweaning period. A study by Pitchford (1993) showed that singles had 21% heavier birth weight than multiples.

Reproductive Traits.

Reproductive efficiency is critical to the economic success of a sheep production enterprise. The total number of lambs that are marketed defines profitability. This number will be large if fertility, prolificacy and lamb survival are maintained at a high level (Sidwell et al,1972). Reproductive traits are lowly heritable (Buchanan, 1993), meaning that rates of genetic improvement may be slow. The number of lambs weaned is dependent upon ewe fertility, prolificacy and lamb survival (Sidwell et al., 1972).

Sheep breeds differ in the reproductive capacity under different production environment. Dickerson and Glimp (1975) compared nine breeds of sheep for fertility and lamb production. The breeds were Hampshire, Dorset, Rambouillet, Targhee, Corriedale, Coarse wool, Fine wool and Suffolk. The most prolific breeds were Suffolk, Dorset, and Targhee. Meyer (1975) compared breeds for ovulation rate and uterine efficiency. Breed ovulation rate means ranged from 1.16 for Romneys to 2.04 for Finn-sired ewes. Daughters of Finn x Romney sires had an intermediate mean ovulation rate of 1.61. Ewe age also had a significant effect on ovulation rate. Three and a half and 2.5 year-old ewes had 20% and 14% higher ovulation rate than 1.5 year old ewes. Relative to purebred Romneys, uterine efficiency was highest for Border Leicester x Romney and Cheviot x Romneys crossbred ewes. Boorola X Romney ewes were only slightly above Romneys. Turner and Dolling (1965) noted that reproductive rate in the ewe rises with increasing age to a peak with subsequent decline.

Bradford et al., (1989) evaluated performance of D'Man and Sardi sheep on accelerated lambing. Mean ovulation rates for ewes 30 months and over were 1.32 for Sardi and 3.18 for D'Man, with 99.7% 1's and 2's in Sardi ewe, and a range of one to seven, with 38% ≥ 4, in D'Man ewes. Prenatal survival was high in both breeds. Pregnant Sardi ewes with two corpora lutea (CL) had survival rate of 89%, and D'Man ewes had survival rates of 90, 82.69 and 58% for those with 2,3,4 and 5 to 7 CL, respectively.

Bunge et al., (1993) evaluated breed of service ram effects on ewe fertility, prolificacy and productivity. Suffolk and Targhee breeds mated to Finnsheep, Combo-6, Boorola Merino, St Croix and Barbodos rams. Fertility rate of Suffolk and Targhee ewes sired by Finnsheep rams was lower than fertility of ewes sired by rams of all other breeds with the exception of the Boorola Merino. Fertility rate of ewes sired by hair-breed rams (St Croix and Barbados) was 9.0 % higher than rate of ewes sired by wool-breed rams (Suffolk, Targhee, Finnsheep, Combo-6 and Boorola Merino).

Gould and Whiteman (1974) compared reproductive performance of single vs twin born Dorset x Western crossbred ewes in Oklahoma. Twin-born ewes which lambed at 15 mo had lifetime productivity than single-born ewes lambing at the same age(11.8 vs 9.7 lambs).

Carcass Traits

Carcass traits are also economically important to a sheep enterprise. The purpose of a selection program for improved carcass merit is to produce more valuable carcass. Carcass traits have moderate to high heritabilities (Buchanan, 1993), suggesting that a selection program that emphasizes carcass traits can result in significant genetic improvement. Fat depth and loin eye area are two traits that provide useful information about carcass merit.

Makarechian et al., (1978) studied the relationship between growth rate, dressing percentage and carcass composition of 244 lambs from grade Rambouillet and Dorset grade x Rambouillet ewes sired by Dorset, Hampshire or Suffolk rams. Breed of sire affected growth rate, but carcass composition was not necessarily changed. Dorset-sired lambs had slower growth rate, less bone, more fat and higher dressing percentages than Suffolk-sired lambs. Hampshire-sired lambs showed a growth pattern similar to Suffolk-sired lambs but were similar to Dorset-sired lambs in carcass composition. Ram lambs had higher growth rates, less fat and more bone in the carcass and lower dressing percentages compared with wether and ewe twins. Weaning weight was positively associated with dressing percentage, but postweaning average daily gain showed a negative association with dressing percentage.

Composition of Texel and Suffolk-sired crossbred lambs for survival, growth and compositional traits investigated by Leymaster and Jenkins (1993). Carcass traits were recorded on 183 lambs. Estimated accretion rates of carcass fat at 189 d of age were 96.1 and 78.5 g/d for Suffolk and Texel progeny, respectively. Carcass protein were 17.4 and 16.0 g/d for same breeds. Area of the longissimus muscle did not differ between sire breeds at fixed ages.Texel progeny weighed less at 189 d of age, and produced lighter and leaner carcasses of shorter length. Texel progeny had significantly greater depth of fat at the 12th rib and weight of kidney-pelvic fat. Texel sired lambs also deposited proportionally more subcutaneous and less intermuscular fat than did lambs by Suffolk sires.

Riley et al., (1989) reported that Rambouillet sheep had higher scores for USDA skeletal and overall maturity, more feathering and flank streaking, higher USDA leg conformation scores and produced loin chops with lower shear force values than Barbados and Karakul sheep. Karakul sheep had higher adjusted fat thicknesses than the other sheep and goat breeds.

Fahmy (1985) studied the accumulation effect of Finnsheep breeding in crossbreeding schemes in terms of growth and carcass traits. The lambs represented the DLS breed (Dorset-Leicester-Suffolk) and six of its crosses with the Finnsheep rams (F) ranging from 1/8F to 6/8 F. The Finn crosses had generally larger and deeper carcasses than the DLS. DLS had more leg development than most crosses. Dressing percentage increased slightly with the increase in proportion of Finn (from 41.2 to 44.1%) DLS lambs had higher percentages of lean and bone and lower percentages of fat in the 12th rib than Finn crosses.

Thomas et al., (1976) investigated carcass traits of lambs produced by crossbred dams of Finnsheep, Dorset, and Rambouillet breeding. Hampshire and Suffolk rams mated to five combination of Rambouillet(R), Dorset (D) and Finnsheep (F) crossbred ewes. The five-crossbred dam groups were 1/4F, 1/2D, 1/4R; 1/4F, 1/4D, 1/2R; 1/4F, 3/4R; 1/2D, 1/2R and 1/4D, 3/4R. Most of the carcass traits have been found to be similar among the lambs produced by each of the dam groups. Lambs from groups containing 1/4 Finnsheep tented to yield carcasses with a greater (p<.10) percent kidney and pelvic fat than did lambs from group containing 1/2D,1/2R breeding. Lambs from 1/4F,3/4R dams had smaller (p<.10) loin eye areas than lambs from 1/4F, 1/2D, 1/4R; 1/2D,1/2R or1/4D,3/4R dams.

Lopez et al., (1984) compared the growth and carcass characteristics of purebred Merino and Merino X (Romanov X Merino) lambs, cold carcass weight averaged 11.9, 11.2 and 10.0 kg for 20 single-born Merino, 20 single-born and 20 twin-born Merino X (Romanov X Merino) lambs, respectively. They found that sex of lamb had no significant effect on final body weight. In another study, Slano et al., (1985) investigated meat production of Improved Valanchian (IV) and Romanov sheep and their crossbreds. Dressing percentage were 44.0, 46.4, 45.4, 44.9, and 46.7; the percentage of leg in the carcass were 32.1, 31.8, 32.1, 29.9, and 30.6; ribeye area were 10.98, 11.79, 11.41, 10.51, and 10.88 cm^2 for IV, Romanov X IV, (Romanov X IV) X (Romonov X IV), IV X (Romanov X IV) and Romanov X (Romanov X IV), respectively. Fahmy (1986) reported that Romanov lambs had a dressing percentage of 43-46 in Canada.

Snowder et al., (1994) investigated carcass characteristics and optimal slaughter weights of Rambouillet , Targhee, Columbia and Polypay wether lambs. At each weight, Columbia lambs were less mature than the other breeds. Polypay, Rambouillet and Targhee wethers were similar in carcass fat and protein composition at a given slaughter weight. Optimal slaughter weights were 45-47 for Targhee, Rambouillet and Polypay and 45-55 kg for Columbia wethers. Targhee, Rambouillet and Polypay wethers had choice quality and yield grade of 2.7 while Columbia had 2.4.

Summary

Sheep were the first domestic animals raised by people for food and clothing. Domestic sheep breeds differ in terms of reproductive, growth and carcass traits. The Rambouillet has an extended breeding season and produces high quality fine wool fleece, but does not have a high reproductive rate. The Dorset has a good muscle conformation to produce a desirable carcass. Horned

Dorsets show good out of season breeding performance and the Dorset lambs grow faster. The Romanov and Finnsheep are among the most prolific sheep breeds in the world. However, the Finnsheep lack desired carcass conformation. The Polypay is the breed that was developed for increased reproductive capacity along with desirable growth rate and carcass quality.

Since no breed of sheep excels in all characteristics, crossbreeding of sheep is the way to achieve optimal levels of performance and it is widely practiced all over the world (Leymaster,1987).

Growth, reproductive and carcass traits are the traits that have economic importance in sheep enterprise. Heritability is moderate for growth traits, low for reproductive and high for carcass traits. Most of the time these traits are affected by genotype of ewe and sire, age of dam, sex of lamb, type of birth-rearing.

CHAPTER III

MATERIALS AND METHODS

Experimental Animals

The data used in this study were obtained from the USDA-ARS Grazinglands Research Laboratory near El Reno, Oklahoma from 1994-1996. The dams used to generate crossbred lambs were Dorset x Rambouillet (DR), Rambouillet (RAMB) and Romonov cross (ROM: Romanov X Dorset-Rambouillet) ewes between two and five years of age group mated to rams for 45 days beginning on May 1 of each year. Hampshire and Suffolk rams were used, but the Suffolk was the predominant ram breed. The total number of lamb records used in this study was 870 for growth traits, 876 for reproduction and 605 for carcass traits. The distribution of lambing by year of birth at lambing and weaning is presented in table 1.

TABLE 1

Distribution of lambs from ewe breeds by year of birth (YR) at lambing and weaning.

	Number of Lambs		
Year	At lambing	At weaning	Weaning Rate(%)
1994	256	209	81.60
1995	316	288	91.14
1996	298	290	97.30
Total	870	787	

Feeding and Management of Ewe Flock

Ewes were randomly assigned to a breeding group. Two weeks prior to beginning the breeding season ewes were flushed with corn. Initially they were fed 0.5 lbs of corn per head daily. This amount was increased to 1.0 over a week period of time. Warm season grass (Bermudagrass or Tall Grass Native Range) and cool season grass (Wheat) pastures were used to support the flock. Grass hay was provided when forage production was lower than animal needs.

Ewes were brought to the lambing barn approximately 30 days prior to lambing and fed 6.9 lbs of corn and 0.33 pounds of soybean meal daily. Ewes were fed as group in fence line bunk feeders. Once the ewe had lambed, she and her lambs were placed in a small pen (4x4 ft) for 24 to 48 hours and then in mixing pen for 3 to 4 days. Male lambs were castrated, and all lambs were tagged and tattooed in the small individual pen. At the same time birth weights were collected. From the mixing pen, the ewe and lambs were moved to wheat pasture and supplemented with hay when snow covered the wheat. Lamb had access to a creep diet (13% protein and 77% TDN) while nursing their dam on wheat pasture. Ewes were checked for pregnancy by ultrasound 35 days after the rams were removed. Non pregnant ewes were removed. They were given the opportunity to breed in August, and if they conceived , they became a spring lambing ewe. If they weaned a lamb early enough the following spring, they could be exposed to a ram in May to try to reenter the fall lambing flock. If they did not breed in August they were sold.

Lambs within a lambing group were weaned on the same day regardless of age. Lambs were separated from their dams, vaccinated for over eating disease (Enterotoxemia or pulpy kidney disease caused by a toxin produced by an anaerobic bacterium, *Clostridium perfringes*, Type D) and returned to the wheat pasture and creep feeder. Using the weaning data, lambs were blocked by sex and ewe breed and ranked by weaning weight within block. Within each block lambs were randomly assigned to be finished in the feedlot or on wheat pasture with ad libitum access to the same diet in the feedlot. In the feedlot, lambs within each block were fed in separate pens to determine feed intake. On pasture all lambs were fed from one feeder. The diet used in the feedlot and on pasture was formulated to contain 12% protein and 83% TDN on a dry matter basis. The diet contained 5.0% molasses, 1.5% limestone, 82% corn, 10% alfalla hay, and 1.5% ammonium chloride. In 1997, the corn portion was increased to 87% and the alfalla portion decreased to 5%. Lambs were fasted for 16 hours before the initial and feedlot weights were taken. When 80% of lambs had reached a weight of 100 lbs the feedlot portion was terminated. Lambs weighing 100 lbs were transported to Greely, Colorado for processing. Colorado State University provided assistance in the collection of carcass data.

Traits Studied

Data for each lambing record included dam id, lamb id, ewe breed, age of dam, lambing date, sex of offspring, type of birth (born as single and born as multiple), birth weight, weaning weight, final weight, weaning date, year of birth/lambing, hot carcass weight, fat thickness(measured as inches at the 12th rib), ribeye area (average area of the right and left ribeye or longissimus muscle as square inches), leg conformation (the degree of muscling in the leg expressed in terms of one-third of a conformation grade ; measured as Prime+; PR+ =15, PR=14, PR- =13, Choice+; CH+= 12, CH=11, CH-=10), flank fat streakings (fat deposits visible on the inside surfaces of primary and secondary flank muscles ; measured as Prime+; PR+ =15, PR=14, PR- =13, Choice+; CH+= 12, CH=11, CH-=10) and conformation (a subjective evaluation of relative distribution of muscling, especially in the leg, loin, rack, and shoulder regions ; measured as Prime+; PR+ =15, PR=14, PR- =13, Choice+; CH+= 12, CH=11, CH-=10)

The major traits of interest included birth weight (BWT), adjusted weaning weight (WWT), litter size at birth (LSB), litter size at weaning (LSW), litter weight at birth (LWB), litter weight at weaning (LWW), lamb viability to weaning (LVW), hot carcass weight (HCW), adjusted fat thickness (ADJFAT), ribeye area (REA), leg conformation (LEG), flank fat streaking (FFS), and conformation (CONF). Weaning weight was adjusted to a common 90 -d -age.

Traits were divided into three categories for the purpose of presentation. The three traits categories were lamb growth (BWT, WWT), ewe reproduction (LSB, LSW, LWB, LWW, LVW), and carcass traits (HCW, ADJFAT, REA, LEG, FFS, and CONF).

Statistical Analyses

Least squares procedure were used. Each trait was analyzed separately in order to include only those effects with significant influence on that particular traits.

The general linear model used to analyze lamb growth traits as follows:

For birth weight (BWT):

$$Y_{ijklmn} = \mu + A_i + B_j + C_k + D_l + F_m + AD_{il} + AF_{lm} + BD_{jl} + BF_{jm} + CF_{km} + E_{ijklmn}$$

Where Y_{ijklmn} = observed value for BWT measured on the n^{th} lamb, of the m^{th} sex class, of the l^{th} type of birth, of the k^{th} age of dam class, of the j^{th} year of birth , of the i^{th} ewe breed.

μ = overall mean

A_i = Effect of the i^{th} ewe breed

B_j = Effect of the j^{th} year of birth

C_k = Effect of the k^{th} age of dam class

D_l = l^{th} type of birth effect

F_m = m^{th} sex of lamb effect

AD_{il} = Effect of interaction of the i^{th} ewe breed with l^{th} type of birth

AF_{im} = Effect of interaction of the i^{th} ewe breed with m^{th} sex of lamb

BD_{jl} = Effect of the interaction of the j^{th} year of the birth with l^{th} type of birth

BF_{jm} = Effect of the interaction of the j^{th} year of the birth with m^{th} sex of lamb

CF_{km} = Effect of the k^{th} age of dam class with m^{th} sex of lamb

E_{ijklmn} = Random error effects, E's assumed NID $(0, \theta^2)$

For weaning weight (WWT):

$$Y_{ijklmn} = \mu + A_i + B_j + C_k + D_l + F_m + AB_{ij} + BD_{jl} + BF_{jm} + E_{ijklmn}$$

Where all terms defined as above except AB_{ij} which is the effect of interaction of the i^{th} ewe breed with j^{th} year of the birth.

The general linear model used to analyze reproductive traits as follows:

For litter weight at birth (LWB):

$$Y_{ijklm} = \mu + A_i + B_j + C_k + D_l + AD_{il} + BD_{jl} + E_{ijklm}$$

Where Y_{ijklm} = observed value for LWB measured on the m^{th} lamb, of the l^{th} of birth class, of the k^{th} age of dam class, of the j^{th} year of birth, of the i^{th} ewe breed.

μ = overall mean

A_i= Effect of the i^{th} ewe breed

B_j= Effect of the j^{th} year of birth

C_k= Effect of the k^{th} age of dam class

D_l= l^{th} type of birth effect

AD_{il} = Effect of interaction of the i^{th} ewe breed with the l^{th} type of birth effect

BD_{jl}= Effect of interaction of the j^{th} year of birth with l^{th} type of birth effect

E_{ijklm}= Random error effect, E's assumed NID $(0, \theta^2)$

For litter weight at weaning (LWW):

$$Y_{ijklm} = \mu + A_i + B_j + C_k + D_l + AD_{il} + BD_{jl} + CD_{kl} + ABC_{ijk} + E_{ijklm}$$

Where all terms were defined as above except CD_{kl} which is the effect of interaction of the the k^{th} age of dam class with the l^{th} type of birth and ABC_{ijk} which is effect of interaction of the i^{th} ewe breed , of j^{th} year of birth, of k^{th} age of dam class.

For litter size at birth (LSB), litter size at weaning (LSW) :

$$Y_{ijkl} = \mu + A_i + B_j + C_k + ABC_{ijk} + E_{ijkl}$$

Where Y_{ijkl} = observed value for LSB, LSW, and measured on the l^{th} lamb, of k^{th} age of dam class, of the j^{th} year of birth, of the i^{th} ewe breed. All others terms were defined as same as in LWW.

For lamb viability to weaning (LVW) :

$$Y_{ijkmn} = \mu + A_i + B_j + C_k + F_m + ABC_{ijk} + E_{ijkmn}$$

Where all terms were defined as same as in BWT except ABC_{ijk} which was defined as same as in LSB and LSW.

The general model used to analyze carcass traits as follows:

For hot carcass weight (HCW) :

$$Y_{ijklmn} = \mu + A_i + B_j + C_k + D_l + F_m + AF_{im} + BD_{jl} + BF_{jm} + CD_{kl} + CF_{km} + DF_{lm} + E_{ijklmn}$$

Where Y_{ijklmn} = observed value for HCW and measured on the n^{th} lamb, of the m^{th} sex class, of the l^{th} type of birth, of the k^{th} age of dam class, of the j^{th} year of birth , of the i^{th} ewe breed.

μ = overall mean

A_i = Effect of the i^{th} ewe breed

B_j = Effect of the j^{th} year of birth

C_k = Effect of the k^{th} age of dam class

D_l = l^{th} type of birth effect

F_m = m^{th} sex of lamb effect

AF_{im} = Effect of interaction of the i^{th} ewe breed with m^{th} sex of lamb

BD_{jl} = Effect of the interaction of the j^{th} year of the birth with l^{th} type of birth

BF_{jm} = Effect of the interaction of the j^{th} year of the birth with m^{th} sex of lamb

CD_{kl} = Effect of the interaction of the k^{th} age of dam class with l^{th} type of birth effect

CF_{km}= Effect of the interaction of the k^{th} age of dam class with m^{th} sex of lamb

DF_{lm} = Effect of the interaction of the l^{th} type of birth effect with m^{th} sex of lamb

E_{ijklmn} = Random error effects, E's assumed NID $(0, \theta^2)$

For adjusted fat (ADJFAT) :

$$Y_{ijklmn} = \mu + A_i + B_j + C_k + D_l + F_m + AB_{ij} + BF_{jm} + E_{ijklmn}$$

Where all terms were defined as above except AB_{ij} which is the effect of interaction of the i^{th} ewe breed with j^{th} year of birth.

For dressing percentage (DP) :

$$Y_{ijklmn} = \mu + A_i + B_j + C_k + D_l + F_m + BD_{jl} + BF_{jm} + CD_{kl} + CF_{km} + DF_{lm} + E_{ijklmn}$$

Where all terms were defined as in HCW.

For ribeye area (REA) :

$$Y_{ijklmn} = \mu + A_i + B_j + C_k + D_l + F_m + AD_{il} + AF_{im} + BD_{jl} + CD_{kl} + DF_{lm} + E_{ijklmn}$$

Where AD_{il} = the effect of interaction of the i^{th} ewe breed with l^{th} type of birth.

The others terms were defined as above

For leg conformation (LEG) :

$$Y_{ijklmn} = \mu + A_i + B_j + C_k + D_l + F_m + AF_{im} + BD_{jl} + E_{ijklmn}$$

Where all terms were defined as above

For flank fat streaking (FFS) and conformation (CONF) :

$$Y_{ijklmn} = \mu + A_i + B_j + C_k + D_l + F_m + BF_{jm} + CD_{kl} + DF_{lm} + E_{ijklmn}$$

Where all the terms were defined as above.

In the preliminary analysis of all the above models, contribution of main effects and all two-factor, three-factor and higher order interactions were examined. Non-significant (P>.30) two-factor, three-factor and higher order interactions were pooled with the model error term. All main effects were considered fixed.

CHAPTER IV

RESULTS AND DISCUSSION

Results

Lamb Growth Traits

The analyses of variance for BWT and WWT of lambs from different breeds are presented in table 2. Both BWT and WWT were influenced by YR and TOB. Also, BWT was influenced by SEX and WWT was influenced by EWEBR. YR*TOB (P<.001) interaction had significant effect on both BWT and WWT while EWEBR*SEX (P<.05) and YR*SEX (P<.05) interaction had significant effect on BWT.

The least squares means and standard errors for BWT and WWT are shown in table 3.

Dorset X Rambouillet (DR) cross ewes had the heaviest lambs at birth (9.96 lbs) compared to other two breeds. DR and RAMB lambs were heavier than ROM lambs (P<.05). However, there was no significant difference between DR and RAMB.

TABLE 2

ANALYSIS OF VARIANCE FOR BIRTH WEIGHT (BWT) AND WEANING WEIGHT (WWT) OF LAMBS FROM FALL LAMBING

	Birth Weight (lbs)		Weaning Weight (lbs)	
Source of Variation	df	Mean Squares	df	Mean Squares
Ewe Breeds(EWEBR)	2	34.27	2	616.50*
Year of Birth(YR)	2	76.32**	2	4218.60***
Age of Dam (AOD)	2	16.88	2	254.32
Type of Birth(TOB)	1	627.53***	1	15247.43***
Sex of Lamb(SEX)	1	67.90*	1	707.18
EWEBR*YR	-	-	4	391.16
EWEBR*TOB	2	14.45		
EWEBR*SEX	2	35.79*	-	-
YR*TOB	2	166.26***	2	2273.06***
YR*SEX	2	36.93*	2	315.88
AOD*SEX	2	17.96	-	-
Residual	851	11.74	770	192.12

*P<.05
**P<.01
***P<.001

TABLE 3

LEAST SQUARES MEANS AND STANDARD ERRORS FOR LAMB BIRTH WEIGHT AND WEANING WEIGHT

	Birth Weight(lbs)			Weaning Weight(lbs)		
Source of Variation	n	LSMeans	SE	n	LSMeans	SE
Ewe Breeds					*	
DR	306	9.96[a]	.39	284	63.25[a]	1.66
RAMB	251	9.85[a]	.43	216	62.32[a]	1.90
ROM	313	9.24[b]	.41	287	59.09[b]	1.98
Year of Birth		**			***	
1994	256	8.95[a]	.40	209	60.63[a]	1.75
1995	316	9.67[b]	.42	288	66.47[b]	1.87
1996	298	10.43[c]	.45	290	57.55[a]	1.96
Age of Dam						
2 yr	11	8.62	1.10	10	63.70	4.90
3 to 4 yr	404	10.05	.21	348	61.81	1.26
5 and 5 + yr	455	10.37	.20	429	59.13	.97
Type of Birth		***			***	
Single	404	10.57[a]	.41	368	67.14[a]	1.76
Multiple	466	8.79[b]	.37	419	55.96[b]	1.71
Sex of Lamb		*				
Ewe	457	8.80[a]	.50	410	60.58	1.68
Ram	413	10.56[b]	.54	377	62.51	1.71

[a,b,c] Means within a column in a subgroup with different superscripts differ (P<.05)
*P<.05; **P<.01; ***P<.001

BWTs for lambs born in 1994,1995 and 1996 were all different, but the difference between fall born lambs in 1994 and 1996 was highly significant (P<.001). Lambs born in 1994 had lighter BWT than lambs born in 1995 and 1996 (8.95, 9.67 and 10.43 lbs, respectively).

Lambs born as multiples were lighter than lambs born as singles (P<.001; 8.79 vs 10.57 lbs). Male lambs were heavier than female lambs at birth (P<.01;10.56 vs 8.80 lbs).

Similarly to BWT , WWT of ROM lambs was lighter than DR and RAMB lambs at weaning (P<.05). There was no significant difference between DR and RAMB.

Lambs born in 1995 were heavier than those born in1994 and 1996 in weight at weaning (P<.001; 66.47 vs 60.63 and 57.55 lbs, respectively). Lambs born in 1994 and 1996 were not different in weight at weaning.

Similarly to BWT lambs born as singles were heavier (P<.001) at weaning than those born as multiples (67.14 vs 55.96 lbs).

EWEBR*YR interaction affected WWT (table 4). Only RAMB and ROM lambs were different at weaning in 1994 (P<.05; 62.42 and 56.2 lbs, respectively). There was no significant difference between DR and RAMB and also between DR and ROM lambs at weaning in 1994. ROM lambs at weaning in 1995 were the lightest (63.22 lbs) and differed (P<.01) than DR lambs (69.43 lbs). Breeds did not differ in 1996 in terms of WWT.

TABLE 4
LEAST-SQUARES MEANS AND STANDARD ERRORS FOR BIRTH WEIGHT AND WEANING WEIGHT BY INTERACTION:
EWE BREED VS YEAR OF BIRTH (EWEBR*YR), EWE BREED VS TYPE OF BIRTH (EWEBR*TOB), AND EWE BREED VS SEX OF LAMB (EWEBR*SEX)

Source of Variation		Birth Weight (lbs)			Weaning Weight (lbs)		
		n	LSMeans	SE	n	LSMeans	SE
Interaction: EWEBR*YR							
Ewe Breed	Year of Birth						
DR	1994	-	-	-	47	63.19^{ab}	2.59
RAMB	1994	-	-	-	68	62.42^{b}	2.64
ROM	1994	-	-	-	94	56.27^{a}	2.78
DR	1995	-	-	-	114	69.43^{a}	2.13
RAMB	1995	-	-	-	70	66.76^{ab}	2.44
ROM	1995	-	-	-	104	63.22^{b}	2.49
DR	1996	-	-	-	123	57.13	2.13
RAMB	1996	-	-	-	78	57.75	2.39
ROM	1996	-	-	-	89	57.76	2.34
Interaction: EWEBR*TOB							
Ewe Breed	Type of Birth						
DR	Single	118	10.81	.50	-	-	-
RAMB	Single	122	11.00	.49	-	-	-
ROM	Single	164	9.92	.47	-	-	-
DR	Multiple	188	9.11	.40	-	-	-
RAMB	Multiple	129	8.70	.48	-	-	-
ROM	Multiple	149	8.56	.45	-	-	-
Interaction: EWEBR*SEX							
Ewe Breed	Sex of Lamb						
DR	Ewe	164	9.50^{a}	.52	-	-	-
RAMB	Ewe	122	8.70^{ab}	.59	-	-	-
ROM	Ewe	171	8.21^{b}	.56	-	-	-
DR	Ram	142	10.42	.57	-	-	-
RAMB	Ram	129	10.99	.63	-	-	-
ROM	Ram	142	10.22	.61	-	-	-

[a,b] Means within different ewe breed with same year of birth, type of birth and sex of lamb with different superscripts differ (P<.05).

In EWEBR*TOB interaction (table 4), there was no breed differences between lambs born as singles and between lambs born as multiples.

The EWEBR*SEX interaction affected BWT (table 4). Breed differences were observed only in ewe lambs. Female lambs born to ROM were lighter at birth than those born to DR and ROM (P<.01; 8.21 vs 9.50 and 8.70 lbs, respectively). There was no significant differences between female lambs born to DR and RAMB at birth.

The YR*TOB interaction resulted from lambs born as singles in all three different years at birth and lambs born as singles being similar to lambs born as multiples in all years at weaning (table 5). Lambs born as singles in 1994 were the lightest at birth and differed than lambs born as singles in 1995 and 1996 ($P<.001$;8.78 vs 11.04 and 11.90 lbs, respectively). At weaning, lambs born as singles in 1995 were the heaviest and differed than those born as singles in 1994 and 1996 ($P<.001$ and $P<.05$; 71.56 vs 62.79 and 67.05 lbs, respectively). Year 1994 and 1996 showed no difference in terms of lambs born as singles at weaning. Lambs born as multiples in 1994 and 1995 at weaning showed no difference (58.46 and 61.38 lbs, respectively) but both were heavier than those born as multiples in 1996 at weaning ($P<.001$; 48.04 lbs).

The YR*SEX interaction affected both BWT and WWT (table 5). Only male lambs born in three different years at birth showed difference. Ram lambs born in 1994 were the lightest and different than those born in 1995 and 1996 ($P<.01$ and $P<.001$; 9.33 vs 10.79 and 11.56, respectively). There was no significant difference between ram lambs born in 1995 and 1996. On the other hand, ewe and ram lambs were different in all years at weaning. Female lambs born in 1995 were the heaviest at weaning than female lambs born in 1994 and 1996 ($P<.05$ and $P<.001$; 64.33 vs 59.97 and 57.46 lbs, respectively). There was no significant difference between ewe lambs born in 1994 and 1996. Same pattern was observed for ram lambs born in all different years at weaning.

BWT was affected by a AOD*SEX interaction (table 5). Ewe lambs born to 2 yr-old ewes were lighter (P<.05) than female lambs born to 3 to 4 yr-old and older ewes (5 and 5+ yr-old) at birth (6.53 vs 9.68 and 10.19 lbs, respectively). Female lambs born to 3 to 4 yr-old ewes and older ewes (5 and 5+ yr-old) showed no significant difference at birth. Male lambs born to all age groups of ewes were not different at birth.

TABLE 5
LEAST-SQUARES MEANS AND STANDARD ERRORS FOR BIRTH WEIGHT AND WEANING WEIGHT BY INTERACTION:
YEAR OF BIRTH VS TYPE OF BIRTH (YR*TOB), YEAR OF BIRTH VS SEX OF LAMB (YR*SEX), AND AGE OF DAM VS SEX OF LAMB (AOD*SEX)

Source of Variation		Birth Weight (lbs)			Weaning Weight (lbs)		
		n	LSMeans	SE	n	LSMeans	SE
Interaction: YR*TOB							
Year of Birth	Type of Birth						
1994	Single	142	8.78[a]	.52	119	62.79[a]	2.34
1995	Single	159	11.04[b]	.46	154	71.56[b]	2.03
1996	Single	103	11.90[b]	.52	95	67.05[a]	2.27
1994	Multiple	114	9.11	.43	90	58.46[a]	2.19
1995	Multiple	157	8.30	.47	134	61.38[a]	2.08
1996	Multiple	195	8.95	.47	195	48.04[b]	2.01
Interaction: YR*SEX							
Year of Birth	Sex of Lamb						
1994	Ewe	136	8.56	.53	109	59.97[a]	1.97
1995	Ewe	167	8.55	.56	155	64.33[b]	2.02
1996	Ewe	154	9.29	.62	146	57.46[a]	2.14
1994	Ram	120	9.33[a]	.58	100	61.28[a]	2.03
1995	Ram	149	10.79[b]	.61	133	68.62[b]	2.06
1996	Ram	144	11.56[b]	.65	144	57.65[a]	2.11
Interaction: AOD*SEX							
Age of Dam	Sex of Lamb						
2	Ewe	6	6.53[a]	1.47	-	-	-
3 to 4	Ewe	214	9.68[b]	.29	-	-	-
5 and 5+	Ewe	237	10.19[b]	.27	-	-	-
2	Ram	5	10.71	1.60	-	-	-
3 to 4	Ram	190	10.42	.30	-	-	-
5 and 5+	Ram	218	10.54	.29	-	-	-

[a,b] Means within different year of birth, age of dam with type of birth and sex of lamb with different superscripts differ (P<.05).

Ewe Reproductive Traits

Litter Weight at Birth: Analysis of variance mean squares for LWB are shown in table 6. Significant sources of variation for LWB included YR, TOB, EWEBR*TOB and YR*TOB. LWB was different for all years (table 7). LWB in 1996 was heavier (P<.001) than LWB in 1994 and 1995 (15.43 vs 13.21 and 13.98 lbs, respectively).

TABLE 6

ANALYSIS OF VARIANCE FOR LITTER WEIGHT AT BIRTH (LWB)[a] AND LITTER WEIGHT AT WEANING (LWW)[b]

	Litter weight at Birth (lbs)		Litter Weight at Weaning (lbs)	
Source Of Variation	df	Mean Squares	df	Mean Squares
Ewe Breeds (EWEBR)	2	8.55	2	691.91
Year of Birth (YR)	2	121.79***	2	2993.13***
Age of Dam (AOD)	2	9.13	2	707.65*
Type of Birth (TOB)	1	7391.59***	1	121123.42***
EWEBR*TOB	2	28.87*	2	2931.31***
YR*TOB	2	94.74***	2	1738.75**
AOD*TOB	-	-	1	1780.59*
EWEBR*YR*AOD	-	-	9	826.15*
Residual	617	8.65	560	346.37

[a]LWB= total weight (lbs)of lamb born/ewe lambing
[b]LWW= total weight (lbs) of lamb weaned/ewe lambing
*P<.05
**P<.01
***P<.001

Ewes having multiple-birth produced 7.55 more lbs of lamb than ewes lambing singles (P<.001)(table 7).

EWEBR*TOB interaction affected LWB (table 8). Breed differences were observed only in lambs born as singles at birth. ROM lambs born as singles at birth were the lightest and differed than DR and RAMB lambs born as singles at birth (P<.01 and P<.001; 9.69 vs 10.64 and 10.95 lbs, respectively). There was no significant difference between DR and RAMB lambs born as singles at birth.

TABLE 7

LEAST -SQUARES MEANS AND STANDARD ERRORS FOR LITTER WEIGHT AT BIRTH AND FOR LITTER WEIGHT AT WEANING MAIN EFFECTS

	Litter Weight at Birth(lbs)			Litter Weight at Weaning(lbs)		
Source of Variation	n	LSMeans	SE	n	LSMeans	SE
Ewe Breeds						
DR	209	14.31	.47	198	Non-est	-
RAMB	185	14.37	.52	165	Non-est	-
ROM	235	13.93	.50	219	Non-est	-
Year of Birth		***			***	
1994	194	13.21^a	.48	169	Non-est	-
1995	236	13.98^b	.51	230	Non-est	-
1996	199	15.43^c	.54	183	Non-est	-
Age of Dam					*	
2-yr	5	12.86	1.39	5	Non-est	-
3 to 4 yr	314	14.92	.22	286	Non-est	-
5 and 5+ yr	310	14.84	.21	291	Non-est	-
Type of Birth		***			***	
Single	404	10.43^a	.49	368	Non-est	-
Multiple	225	17.98^b	.47	214	Non-est	-

^{a,b,c} Means within a column in a subgroup with different superscripts differ (P<.05)

LWB was affected by YR*TOB interaction (table 9). Single litter weights at birth were different in all years. 1994 fall born single lambs at birth were lighter than those born in fall 1995 and 1996 (P<.001; 8.46 vs 10.88 and 11.93 lbs, respectively). In the case of multiple born lambs, only 1995 and 1996 fall born multiple litter weights at birth were different (P<.001; 17.07 and 18.92 lbs, respectively).

TABLE 8

LEAST -SQUARES MEANS AND STANDARD ERRORS FOR LITTER WEIGHT AT BIRTH AND LITTER WEIGHT AT WEANING BY INTERACTION: EWE BREED VS TYPE OF BIRTH (EWEBR*TOB) AND EWE BREED VS YEAR OF BIRTH VS AGE OF DAM (EWEBR*YR*AOD)

			Litter Weight at Birth(lbs)			Litter Weight at Weaning(lbs)		
Source of Variation Interaction:EWEBR*TOB			n	LSMeans	SE	n	LSMeans	SE
Ewe Breed	Type of Birth							
DR	Single		118	10.64^{a}	.55	113	Non-est	-
RAMB	Single		122	10.95^{a}	.54	105	Non-est	-
ROM	Single		164	9.69^{b}	.53	150	Non-est	-
DR	Multiple		91	17.97	.49	85	Non-est	-
RAMB	Multiple		63	17.80	.60	60	Non-est	-
ROM	Multiple		71	18.17	.57	69	Non-est	-
Interaction:EWEBR*YR*AOD								
Ewe Breeds	Year of Birth	Age of Dam						
DR	1994	3 to 4	-	-	-	3	52.29^{a}	11.23
RAMB	1994	3 to 4	-	-	-	52	81.31^{b}	2.64
ROM	1994	3 to 4	-	-	-	90	89.50^{b}	3.58
DR	1994	5&5+	-	-	-	17	68.29^{a}	6.50
RAMB	1994	5&5+	-	-	-	2	38.59^{b}	13.64
DR	1995	3 to 4	-	-	-	54	88.07	2.81
RAMB	1995	3 to 4	-	-	-	2	76.07	13.47
ROM	1995	3 to 4	-	-	-	74	86.98	2.16
DR	1995	5&5+	-	-	-	42	94.42^{a}	3.06
RAMB	1995	5&5+	-	-	-	58	84.39^{b}	2.68
DR	1996	3 to 4	-	-	-	10	87.55	6.02
ROM	1996	3 to 4	-	-	-	1	86.46	18.83
DR	1996	5&5+	-	-	-	67	84.05	2.28
RAMB	1996	5&5+	-	-	-	51	81.80	2.61
ROM	1996	5&5+	-	-	-	54	81.71	2.53

[a,b,c] Means within different ewe breeds with same type of birth, year of birth and age of dam with different superscripts differ (P<.05)

TABLE 9

LEAST -SQUARES MEANS AND STANDARD ERRORS FOR LITTER WEIGHT AT BIRTH AND LITTER WEIGHT AT WEANING BY INTERACTION: YEAR OF BIRTH VS TYPE OF BIRTH (YR*TOB) AND AGE OF DAM VS TYPE OF BIRTH (AOD*TOB)

		Litter Weight at Birth (lbs)			Litter Weight at Weaning (lbs)		
Interaction:YOB*TOB		n	LSMeans	SE	n	LSMeans	SE
Year of Birth	Type of Birth						
1994	Single	142	8.46[a]	.57	119	Non-est	-
1995	Single	159	10.88[b]	.52	154	Non-est	-
1996	Single	103	11.93[c]	.57	95	Non-est	-
1994	Multiple	52	17.95[ab]	.54	50	Non-est	-
1995	Multiple	77	17.07[a]	.59	76	Non-est	-
1996	Multiple	96	18.92[b]	.58	88	Non-est	-
Interaction:AOD*TOB							
Age of Dam	Type of Birth						
2 yr	Single	-	-	-	-	Non-est	-
3 to 4 yr	Single	-	-	-	204	Non-est	-
5 and 5+ yr	Single	-	-	-	164	Non-est	-
2 yr	Multiple	-	-	-	5	Non-est	-
3 to 4 yr	Multiple	-	-	-	82	Non-est	-
5 and 5+ yr	Multiple	-	-	-	127	Non-est	-

[a,b,c] Means within different year of birth and age of dam with same type of birth with different superscripts differ (P<.05)

Litter weight at weaning: LWW was significantly influenced by YR, AOD, TOB, and the interaction EWEBR*TOB, YR*TOB, AOD*TOB and EWEBR*YR*AOD (table 6). All the main effects and two-way interactions were non-estimable for LWW (table 7,8, and 9). Therefore, three-way interaction (EWEBR*YR*AOD) least squares means will be discussed here. Means from group with less than 10 observations should be considered as suspect due to the small number (table 8).

Significant differences were observed only in 1994 fall born lambs from 3 to 4 yr-old and older ewes (5 and 5+ yr -old) and 1995 fall born lambs from 5 and 5+ -yr old ewes (table 8). Litters from 3 to 4 yr-old DR in 1994 were lighter than litters from 3 to 4 yr-old RAMB (P<.05) and ROM (P<.01) ewes at weaning

(52.29 vs 81.31 and 89.50 lbs, respectively). However, LWW from 3 to 4 yr-old RAMB and ROM ewes did not differ. LWW from older DR and RAMB (5 and 5+yr-old) in 1994 (68.29 and 38.59 lbs, respectively) and in1995 (94.42 and 84.39 lbs, respectively) were different.

Litter size at birth (LSB), Litter size at weaning (LSW), and Lamb viability to weaning (LVW): The significant sources of variation for LSB were EWEBR, YR, and the interaction EWEBR*YR*AOD, for LSW was the interaction EWEBR*YR*AOD and finally for LVW were YR and the interaction EWEBR*YR*AOD (table 10). The main effects and two way interactions were non-estimable for LSB, LSW, abd LVW.

These results will be focused on the three-way combination of EWEBR, YR and AOD. Means based on fewer than 10 observations should be considered as suspect due to the small number (table 11).

TABLE 10

ANALYSIS OF VARIANCE FOR LITTER SIZE AT BIRTH (LSB), LITTER SIZE AT WEANING (LSW) AND LAMB VIABILITY TO WEANING (LVW)

	Litter Size					
	At Birth		At Weaning		Viability of lambs to Weaning	
Source of Variation	df	Mean Squares	df	Mean Squares	df	Mean Squares
Ewe Breeds (EWEBR)	2	1.14**	2	.62	2	950.75
Year of Birth (YR)	2	1.95***	2	.03	2	8478.84***
Age of Dam (AOD)	2	.29	2	.68	2	2477.15
Sex of Lamb	-	-	-	-	1	1408.33
EWEBR*YR*AOD	9	2.67***	9	1.10***	9	3249.50***
Residual	613	.22	613	.29	859	813.37

*P<.05
**P<.01
***P<001

TABLE 11

LEAST- SQUARES MEANS AND STANDARD ERRORS FOR LITTER SIZE AT BIRTH (LSB), LITTER SIZE AT WEANING (LSW) AND LITTER VIABILITY TO WEANING (LVW) BY INTERACTION: EWE BREEDS VS YEAR OF BIRTH VS AGE OF DAM (EWEBR*YR*AOD)

			LSB			LSW			LVW[+]		
Source of Variation			n	LS Mean	SE	n	LS Mean	SE	n	LS Mean	SE
Interaction: EWEBR*YR*AOD											
Ewe Breed	Year of Birth	Age of Dam									
DR	94	3 to 4	3	2.33^{a}	.26	3	1.33	.31	3	50.26^{a}	11.65
RAMB	94	3 to 4	67	1.31^{b}	.05	67	.95	.06	73	68.75^{a}	2.91
ROM	94	3 to 4	99	1.05^{c}	.04	99	.95	.05	99	91.42^{b}	2.81
DR	94	5&5+	18	2.00	.10	18	1.61^{a}	.12	18	80.52^{a}	4.45
RAMB	94	5&5+	2	2.00	.32	2	1.00^{b}	.38	2	49.74^{b}	12.76
DR	95	3 to 4	56	1.21^{a}	.06	56	1.08^{a}	.07	56	89.86	3.46
RAMB	95	3 to 4	2	1.00^{ab}	.32	2	1.00^{ab}	.38	2	100.00	20.16
ROM	95	3 to 4	76	1.54^{b}	.05	76	1.37^{b}	.06	76	88.90	2.64
DR	95	5&5+	42	1.28	.07	42	1.26	.08	42	98.38	3.89
RAMB	95	5&5+	60	1.25	.06	60	1.13	.07	60	90.58	3.29
DR	96	3 to 4	10	1.70	.14	10	1.55	.17	10	88.01	6.92
ROM	96	3 to 4	1	1.00	.46	1	1.00	.53	1	98.72	28.54
DR	96	5&5+	75	1.45	.05	75	1.21	.06	75	83.52	2.73
RAMB	96	5&5+	54	1.46	.06	54	1.30	.07	54	88.59	3.21
ROM	96	5&5+	59	1.55	.06	59	1.37	.07	59	88.19	2.98

[a,b,c] Means within different ewe breeds with same year of birth and age of dam with different superscripts differ (P<.05)
[+]LVW = %

LSB: In 1994, all 3 to 4-yr-old ewes differed for LSB (table 11). Three to 4 yr-old DR ewes had a larger number of litters at birth than did RAMB and ROM (P<.001 ;2.33 vs 1.31 and 1.05 lambs, respectively). In 1995, only 3 to 4 yr-old DR and ROM ewes differed for LSB (P<.001). .Three to 4 yr-old ROM ewes in 1995 were more prolific than 3 to 4 yr-old DR ewes in same year. Breeds showed no significant difference for other years and age groups in terms of LSB.

LSW: Only significant differences were detected among 3 to 4 yr -old ewes in 1995 (table 11). ROM ewes had a larger number of litters at weaning

(P<.01) than did DR ewes (1.37 vs 1.08 lambs, respectively). However, there was no significant difference between DR and RAMB and between RAMB and ROM within the same year and age group.

LVW: Breed differences were observed only in 1994 between lambs born to 3 to 4 -yr old ewes and between lambs born to 5 and 5+ yr- old ewes (table 11). ROM had higher (P<.001) LVW than RAMB and DR within the 3 to 4 yr-old dams (91.42 vs 68.75 and 50.26 %, respectively). Older (5 and 5+ yr-old) RAMB ewes had lower (P<.05) LVW than same age groups of DR ewes (49.74 vs 80.52 %).

Carcass Traits

Table 12 represents the ANOVA table for HCW, ADJFAT, DP, REA, and LEG. Significant breed differences were obtained for REA (P<.001). YR showed significant differences for ADJFAT (P<.001), DP (P<.01), and REA (P<.001). ADJFAT was affected by the TOB (P<.001). REA was the only carcass trait which showed significant SEX difference (P<.01).

Only ADJFAT was affected by EWEBR*YR interaction (P<.05). YR*TOB interactions influenced both HCW and DP (P<.05) while YR*SEX interaction affected the HCW (P<.01), ADJFAT (P<.05) and DP (P<.05). AOD*SEX interaction had effect on only DP (P<.05) while TOB*SEX interaction only affected HCW (P<.05).

TABLE 12

ANALYSIS OF VARIANCE FOR HOT CARCASS WEIGHT (HCW)[a], ADJUSTED FAT THICKNESS (ADJFAT)[b], DRESSING PERCENTAGE (DP)[c], RIBEYE AREA (REA)[d] AND LEG CONFORMATION (LEG)[e]

	HCW		ADJFAT		DP		REA		LEG	
Source of Variation	df	MS	df	MS	df	MS	df	MS	df	MS
Ewe Breeds(EWEBR)	2	1935.83	2	.01	2	812.65	2	1.40***	2	2.98
Year of Birth (YR)	2	1993.93	2	.22***	2	2580.45**	2	4.10***	2	3.32
Age of Dam (AOD)	2	806.10	2	.01	2	943.45	2	.23	2	1.10
Type of Birth (TOB)	1	404.65	1	.1***	1	45.40	1	.15	1	15.35
Sex of Lamb (SEX)	1	1929.97	1	.006	1	54.67	1	1.33**	1	24.08
EWEBR*YR	-	-	4	.02*	-	-	-	-	-	-
EWEBR*TOB	-	-	-	-	-	-	2	.14	-	-
EWEBR*SEX	2	1214.11	-	-	-	-	2	.13	2	26.18
YR*TOB	2	3745.00**	-	-	2	2431.60*	2	.16	2	19.63
YR*SEX	2	4212.58**	2	.03*	2	2121.44*	-	-	-	-
AOD*TOB	2	2286.79	-	-	2	1805.28*	2	.36	-	-
AOD*SEX	2	2037.32	-	-	2	1115.72	-	-	-	-
TOB*SEX	1	3811.16*	-		1	1754.47	1	.15	-	-
Residual	583	690.26	590	.0086	572	533.64	587	.122	592	21.56

[a]HCW = Weight (lbs) of lamb carcass
[b]ADJFAT =Fat thickness (inches) at the 12[th] rib
[c]DP= Dressing Percentage (%)
[d]REA = Average area (in square inches) of the right and left ribeye (longissimus) muscle.
[e]LEG = Measured as Prime +(PR+)=15, PR=14, PR- =13, Choice +(CH+) =12, CH=11, CH- =10.
*P<.05
**P<.01
***P<.001
MS = Mean Square

Main effects of HCW, ADJFAT and DP are presented in table 13. For HCW, DR crossbred lambs produced the heaviest HCW (63.27 lbs) and differed from RAMB and ROM lambs ($P<.05$; 57.71 and 57.62, respectively). No significant differences were observed between RAMB and ROM lambs for HCW. Lambs born in 1994 fall and slaughtered in 1995 had heavier HCW than lambs born in 1994 ($P<.05$; 63.70 and 56.97 lbs, respectively). There was no significant HCW differences between lambs born in 1994 and 1996 and between 1995 and 1996.

Fall born lambs in 1994 had the highest fat thickness (.32 inches) and differed from 1995 and 1996 fall born lambs ($P<.001$; .25 and .26 inches, respectively). 1995 and 1996 fall born lambs did not differ fot ADJFAT. Lambs born as singles had greater fat thickness than lambs born as multiples ($P<.001$; .29 and .27 inches, respectively).

Lambs born in 1994 were dressed higher ($P<.01$) than lambs born in 1995 and 1996 (55.92 vs 49.34 and 47.32 %, respectively). DP of lambs born in 1994 and 1996 did not differ.

TABLE 13

LEAST- SQUARES MEANS AND STANDARD ERRORS FOR HOT CARCASS WEIGHT (HCW)[a], ADJUSTED FAT THICKNESS (ADJFAT)[b], AND DRESSING PERCENTAGE (DP)[c],

Source of Variation	HCW			ADJFAT			DP		
	n	LSMeans	SE	n	LSMeans	SE	n	LSMeans	SE
Ewe Breeds									
DR	222	63.27^{a}	4.94	223	.29	.01	216	53.29	4.35
RAMB	176	57.71^{b}	5.28	177	.27	.01	171	49.38	4.66
ROM	205	57.62^{b}	5.20	205	.27	.01	203	49.90	4.58
Year of Birth		*			***			**	
1994	204	63.70^{a}	4.95	204	$.32^{a}$	.01	204	55.92^{a}	4.36
1995	183	56.97^{b}	5.24	184	$.25^{b}$	.01	181	49.34^{b}	4.62
1996	216	57.93^{ab}	5.39	217	$.26^{b}$	.01	205	47.32^{b}	4.77
Age of Dam									
2 yr	11	53.63	14.47	11	.29	.03	11	44.78	12.72
3 to 4 yr	272	60.41	1.90	272	.29	.01	267	51.56	1.72
5 and 5+ yr	320	64.56	1.77	322	.26	.007	312	56.23	1.59
Type of Birth					***				
Single	298	63.37	3.23	298	$.29^{a}$	.01	294	52.14	2.85
Multiple	305	55.70	9.34	307	$.27^{b}$	.01	296	49.57	8.22
Sex of lamb									
Ewe	315	54.42	5.13	315	.28	.01	307	50.02	4.50
Ram	288	64.65	6.32	290	.28	.01	283	51.70	5.54

[a]HCW = Weight (lbs) of lamb carcass; [b]ADJFAT =Fat thickness (inches) at the 12^{th} rib ;[c]DP= Dressing Percentage (%);
*P<.05, **P<.01, ***P<.001 ; [a,b] Means within a column in a subgroup with different superscripts differ (P<.05

Main effect least squares means on REA and LEG are presented in table 14. DR lambs had larger REA than RAMB and ROM crosses (P<.01 and P<.001; 2.64 vs 2.54 and 2.47 square inches, respectively). RAMB and ROM lambs did not differ for REA. REA was increased gradually as years progressed. Lambs born in 1996 had larger REA (2.74 square inches) than previous years (P<.001). Also, lambs born in 1995 had larger REA than those in 1994 (P<.001;2.53 and 2.38 square inches, respectively). In addition, REAs 'collected from male lambs were larger than those collected from female lambs (P<.01; 2.60 vs 2.50 square inches).

There was no significant main effect for LEG conformation score.

Two way interactions for HCW, ADJFAT, and DP are shown in table 15. In EWEBR*SEX interaction, female lambs born to DR ewes had heavier HCW (61.06 lbs) than female lambs born to RAMB (P<.01; 50.63 lbs) and ROM (P<.05; 51.56 lbs) lambs. There was no significant HCW difference between ewe lambs of RAMB and ROM. Ram lambs of breeds did not differ for HCW.

In YR*TOB interaction, HCW of lambs born as singles for all years did not differ, but lambs born as multiples in 1994 had the heaviest (65.27 lbs) and differed from those born as multiples in 1995 (P<.01; 53.27 lbs) and in 1996 (P<.001; 48.55 lbs).

TABLE 14

LEAST- SQUARES MEANS AND STANDARD ERRORS FOR RIBEYE AREA (REA)[d] AND LEG CONFORMATION (LEG)[e]

Source of Variation	n	REA LSMeans	SE	n	LEG LSMeans	SE
Ewe Breeds		***				
DR	223	2.64[a]	.06	223	13.05	.53
RAMB	177	2.54[b]	.07	177	12.82	.63
ROM	205	2.47[b]	.07	205	13.03	.60
Year of Birth		***				
1994	204	2.38[a]	.06	204	12.80	.54
1995	184	2.53[b]	.07	184	13.00	.61
1996	217	2.74[c]	.07	217	13.11	.65
Age of Dam						
2 yr	11	2.52	.19	11	13.25	1.49
3 to 4 yr	272	2.60	.02	272	12.87	.33
5 and 5+ yr	322	2.52	.02	322	12.78	.31
Type of Birth						
Single	298	2.62	.04	298	12.80	.54
Multiple	307	2.48	.12	307	13.13	.57
Sex of Lamb		**				
Ewe	315	2.50[a]	.06	315	12.77	.55
Ram	290	2.60[b]	.06	290	13.17	.55

[a,b,c] Means within a column in a subgroup with different superscripts differ (P<.05)
[d]REA = Average area (in square inches) of the right and left ribeye (longissimus) muscle.
[e]LEG = Measured as Prime +(PR+)=15, PR=14, PR- =13, Choice +(CH+) =12, CH=11, CH- =10.
*P<.05
**P<.01
***P<.001

In YR*SEX interaction, female lambs born in 1994 had heavier HCW than those in 1995 and 1996 (P<.001 ; 64.84 vs 50.68 and 47.74 lbs , respectively). HCW of ewe lambs in 1995 and 1996 and HCW of ram lambs born in 1994,1995 and 1996 did not differ.

In AOD*TOB interaction, only HCW of multiples born lambs to 3 to 4 yr-old and older (5 and 5+ yr-old) ewes differed (P<.01 ; 56.73 and 67.76 lbs, respectively).

In AOD*SEX interaction, ewe lambs born to 3 to 4 yr-old ewes had different HCW than those born to 2 and older ewes (5 and 5+ yr +old) (P<.05; 57.48 vs 38.70 and 67.08 lbs, respectively). There was no significant HCW differences among male lambs born to three different age groups of ewe. HCW was not different between single and multiple born ewe lambs and between single and multiple born ram lambs.

EWEBR*YR interaction affected ADJFAT. Breed differences were observed only in 1994. RAMB lambs had lowest fat thickness and differed from DR and ROM lambs (P<.05 and P<.01; .29 vs .35 and .33 inches, respectively). DR and ROM lambs did not differ for ADJFAT in 1994.

In YR*SEX interaction, ADJFAT differed for ewe and ram lambs born in three different years. In 1994 ewe lambs had the highest fat thickness (.34 inches) and differed from those born in 1995 (.25 inches) and in 1996 (.25 inches) (P<.001). Fat thickness of ewe lambs born in 1995 and 1996 did not differ. Same pattern was observed for ram lambs for ADJFAT.

YR*TOB, YR*SEX, AOD*TOB, AOD*SEX and TOB*SEX interaction had effect on DP. Lambs born as multiples in 1994 had higher DP than those born in later years (P<.01; 59.31 vs 47.53 % and P<.001 ; 59.31 vs 41.88 %, respectively). Also female lambs born in 1994 dressed higher than those in 1995 and 1996 (P<.01; 59.38 vs 48.15 % and P<.001 ; 59.38 vs 42.51 %, respectively). Multiple born lambs from older ewes (5 and 5+yr -old) had the highest DP and differed only from multiple born lambs from 3 to 4 yr- old ewes (P<.001; 60.85 vs 49.88 %).

Ewe lambs born to older ewes (5 and 5+ yr-old) dressed higher than ewe lambs born to 3 to 4 yr-old ewes ($P<.01$; 59.86 vs 50.86 %). Male lambs born to three different age groups of ewes did not differ for DP. Likewise, there was no significant DP difference between single and multiple born female lambs and between single and multiple born male lambs.

TABLE 15

LEAST- SQUARES MEANS AND STANDARD ERRORS FOR HOT CARCASS WEIGHT (HCW)[a], ADJUSTED FAT THICKNESS (ADJFAT)[b], DRESSING PERCENTAGE (DP)[c] BY THE INTERACTION: EWE BREED VS YEAR OF BIRTH (EWEBR*YR)EWE BREED VS SEX OF LAMB (EWEBR*SEX) YEAR OF BIRTH VS TYPE OF BIRTH (YR*TOB), YEAR OF BIRTH VS SEX OF LAMB (YR*SEX), AGE OF DAM VS TYPE OF BIRTH (AOD*TOB), AGE OF DAM VS SEX OF LAMB (AOD*SEX), AND TYPE OF BIRTH VS SEX OF LAMB (TOB*SEX)

Source of Variation		HCW			ADJFAT			DP		
Interaction:EWEBR*YR		n	LSMeans	SE	n	LSMeans	SE	n	LSMeans	SE
Ewe Breeds	Year of Birth									
DR	1994	-	-	-	53	.35[a]	.01	-	-	-
RAMB	1994	-	-	-	75	.29[b]	.01	-	-	-
ROM	1994	-	-	-	76	.33[a]	.01	-	-	-
DR	1995	-	-	-	76	.26	.01	-	-	-
RAMB	1995	-	-	-	45	.26	.01	-	-	-
ROM	1995	-	-	-	63	.23	.01	-	-	-
DR	1996	-	-	-	94	.26	.01	-	-	-
RAMB	1996	-	-	-	57	.27	.01	-	-	-
ROM	1996	-	-	-	66	.25	.01	-	-	-
Interaction :EWEBR*SEX										
Ewe Breeds	Sex of Lamb									
DR	Ewe	117	61.06[a]	5.24	-	-	-	-	-	-
RAMB	Ewe	87	50.63[b]	5.88	-	-	-	-	-	-
ROM	Ewe	111	51.56[b]	5.66	-	-	-	-	-	-
DR	Ram	105	65.48	6.43	-	-	-	-	-	-
RAMB	Ram	89	64.78	6.95	-	-	-	-	-	-
ROM	Ram	94	63.69	6.84	-	-	-	-	-	-

cont. Table 15

Source of Variation		HCW			ADJFAT			DP		
Interaction: YOB*TOB		n	LSMeans	SE	n	LSMeans	SE	n	LSMeans	SE
Year of Birth	Type of Birth									
1994	Single	117	62.12	3.42	-	-	-	117	52.52	3.01
1995	Single	101	60.68	4.07	-	-	-	101	51.14	3.58
1996	Single	80	67.30	4.70	-	-	-	76	52.77	4.18
1994	Multiple	87	65.27[a]	9.46	-	-	-	87	59.31[a]	8.32
1995	Multiple	82	53.27[b]	9.78	-	-	-	80	47.53[b]	8.61
1996	Multiple	136	48.55[b]	9.80	-	-	-	129	41.88[b]	8.66
Interaction : YR*SEX										
Year of Birth	Sex of Lamb									
1994	Ewe	97	64.84[a]	5.32	97	.34[a]	.01	97	59.38[a]	4.67
1995	Ewe	107	50.68[b]	5.72	107	.25[b]	.01	106	48.15[b]	4.99
1996	Ewe	111	47.74[b]	6.07	111	.25[b]	.01	104	42.51[b]	5.35
1994	Ram	107	62.56	6.43	107	.31[a]	.01	107	52.45	5.65
1995	Ram	76	63.27	6.96	77	.26[b]	.01	75	50.52	6.09
1996	Ram	105	68.12	7.03	106	.26[b]	.01	101	52.15	6.20
Interaction: AOD*TOB										
Age of Dam	Type of Birth									
2 yr	Single	10	64.66	9.01	-	-	-	10	51.57	7.93
3 to 4 yr	Single	136	64.09	2.68	-	-	-	136	53.26	2.36
5 and 5+ yr	Single	152	61.36	2.37	-	-	-	148	51.61	2.09
2 yr	Multiple	1	42.61[ab]	27.89	-	-	-	1	38.00[ab]	24.53
3 to 4 yr	Multiple	136	56.73[a]	2.58	-	-	-	131	49.88[a]	2.38
5 and 5+ yr	Multiple	168	67.76[b]	2.58	-	-	-	164	60.85[b]	2.32

cont. Table 15

Source of Variation		HCW			ADJFAT			DP		
Interaction :AOD*SEX		n	LSMeans	SE	n	LSMeans	SE	n	LSMeans	SE
Age of Dam	Sex of Lamb									
2 yr	Ewe	5	38.70[ab]	15.09	-	-	-	5	39.76[ab]	13.20
3 to 4 yr	Ewe	140	57.48[a]	2.65	-	-	-	138	50.42[a]	2.31
5 and 5+ yr	Ewe	170	67.08[b]	2.42	-	-	-	164	59.86[b]	2.13
2 yr	Ram	6	68.57	18.67	-	-	-	6	49.81	16.34
3 to 4 yr	Ram	132	63.34	2.71	-	-	-	129	52.70	2.41
5 and 5+ yr	Ram	150	62.04	2.56	-	-	-	148	52.60	2.24
Interaction: TOB*SEX										
Type of Birth	Sex of Lamb									
Single	Ewe	161	55.60	4.84	-	-	-	158	49.51	4.24
Multiple	Ewe	137	71.14	4.17	-	-	-	136	54.79	3.62
Single	Ram	154	53.24	8.95	-	-	-	149	50.53	7.85
Multiple	Ram	151	58.16	10.83	-	-	-	147	48.62	9.51

[a,b]Means within different ewe breeds, year of birth, age of dam and type of birth with same year of birth, sex of lamb and type of birth with different superscripts differ ($P<.05$).

Interactions effects on REA and LEG are represented in table 16. In EWEBR*TOB interaction lambs born as singles to DR ewes had the largest REA and differed from those born as singles to RAMB and ROM ewes (P<.05 ; 2.70 vs 2,58 and 2.57 square inches , respectively). However, there was no significant difference between RAMB and ROM lambs born as singles. In the case of multiple type of birth ROM lambs had the smallest REA (2.37 square inches) and differed from DR (P<.001 ; 2.58 square inches) and RAMB (P<.05 ; 2.49 square inches) lambs. DR and RAMB multiple born lambs did not differ.

In the EWEBR*SEX interaction, REA of ROM female lambs were smaller than REA of RAMB (P<.05 ; 2.40 vs 2.52 square inches) and DR (P<.001 ; 2.40 vs 2.58 square inches) female lambs. REA of DR and RAMB ewe lambs were similar. In the case of male lambs, only differences were observed between DR and RAMB (P<.01 ; 2.71 vs 2.55 inches) and between DR and ROM (P<.001 ; 2.71 vs 2.53 square inches).

In the YR*TOB interaction , REA of lambs born as singles in three different years were all different (P<.05). Single born lambs in 1996 had the largest REA (2.78 square inches) as compare to those in 1994 (2.48 square inches) and in 1995 (2.59 square inches). REA of multiple born lambs in three different years were also different (P<.001). Similarly, multiple born lambs in 1996 had the largest REA (2.70 square inches) as compare to those in 1994 (2.27 square inches) and in 1995 (2.47 square inches).

In AOD*TOB interaction ,single born lambs to three different age groups of ewes showed no significant difference for REA , but lambs born as multiples to older ewes (5 and 5+ yr-old) had smaller REA than those born to 3 to 4 yr - old ewes (P<.01 ; 2.46 vs 2.62 square inches.

In TOB*SEX interaction , single and multiple born ewe lambs and single and multiple born ram lambs did not differ for REA.

No significant LEG score differences were detected for interactions shown in table 16.

Table 17 shows the ANOVA table for FFS and CONF. YR had a highly significant effect (P<.001) on both FFS and CONF. AOD also had a significant effect on CONF (P<.05). YR*SEX ,AOD*TOB, and TOB*SEX interactions affected FFS (P<.05) but not CONF.

Main effects of EWEBR, YR, AOD TOB and SEX on FFS and CONF presented in table 18. FFS scores of lambs born in three different years were all different (P<.001). Lambs born in 1996 had higher FFS (12.46) than lambs born in 1994 (11.95) and in 1995 (11.25). CONF scores of lambs born in 1994 and 1995 were similar (11.60 and 11.49, respectively), but were lower (P<.001) than the CONF score of lambs born in 1996 (P<.001). Lambs born to younger ewes (2-yr-old) had higher CONF score than those born to 3 to 4 yr-old ewes (P<.05 ; 12.60 vs 11.59) and 5 and 5 + yr-old ewes (P<.01 ; 12.60 vs 11.49)

TABLE 16

LEAST- SQUARES MEANS AND STANDARD ERRORS FOR RIBEYE AREA (REA)[d] AND LEG CONFORMATION (LEG) BY INTERACTION: EWE BREED VS TYPE OF BIRTH (EWEBR*TOB), EWE BREED VS SEX OF LAMB (EWEBR*SEX), YEAR OF BIRTH VS TYPE OF BIRTH (YR*TOB), AGE OF DAM VS TYPE OF BIRTH (AOD*TOB), AND TYPE OF BIRTH VS SEX OF LAMB (TOB*SEX)

Source of Variation		REA			LEG		
Interaction: EWEBR*TOB		n	LSMeans	SE	n	LSMeans	SE
Ewe Breeds	Type of Birth						
DR	Single	118	2.70[a]	.04	-	-	-
RAMB	Single	104	2.58[b]	.05	-	-	-
ROM	Single	76	2.57[b]	.05	-	-	-
DR	Multiple	105	2.58[a]	.12	-	-	-
RAMB	Multiple	73	2.49[a]	.12	-	-	-
ROM	Multiple	129	2.37[b]	.12	-	-	-
Interaction:EWEBR*SEX							
Ewe Breeds	Sex of Lamb						
DR	Ewe	117	2.58[a]	.08	117	12.98	.62
RAMB	Ewe	87	2.52[a]	.07	87	12.90	.73
ROM	Ewe	111	2.40[b]	.07	111	12.42	.71
DR	Ram	106	2.71[a]	.07	106	13.13	.62
RAMB	Ram	90	2.55[b]	.07	90	12.74	.71
ROM	Ram	94	2.53[b]	.07	94	13.65	.69
Interaction: YR*TOB							
Year of Birth	Type of Birth						
1994	Single	117	2.48[a]	.04	117	12.26	.57
1995	Single	101	2.59[b]	.05	101	13.02	.69
1996	Single	80	2.78[c]	.06	80	13.12	.76
1994	Multiple	87	2.27[a]	.12	87	13.33	.70
1995	Multiple	83	2.47[b]	.12	83	12.98	.71
1996	Multiple	137	2.70[c]	.12	137	13.10	.69
Interaction: AOD*TOB							
Age of Dam	Type of Birth						
2 yr	Single	10	2.70	.12	-	-	-
3 to 4 yr	Single	136	2.58	.04	-	-	-
5 &5+yr	Single	152	2.59	.03	-	-	-
2 yr	Multiple	1	2.35[ab]	.35	-	-	-
3 to 4 yr	Multiple	136	2.62[a]	.03	-	-	-
5 & 5+ yr	Multiple	170	2.46[b]	.03	-	-	-
Interaction: TOB*SEX							
Type of Birth	Sex of Lamb						
Single	Ewe	161	2.55	.04	-	-	-
Multiple	Ewe	154	2.45	.11	-	-	-
Single	Ram	137	2.68	.05	-	-	-
Multiple	Ram	153	2.51	.12	-	-	-

[a,b,c] Means within different ewe breeds, year of birth, age of dam and type of birth with same type of birth and sex of lamb with different superscripts differ (P<.05).

TABLE 17
ANALYSIS OF VARIACE FOR FLANK FAT STREAKING (FFS)[1] AND CONFORMATION (CONF)[2]

	FFS		CONF	
Source of Variation	df	Mean squares	df	Mean Squares
Ewe Breeds(EWEBR)	2	1.24	2	1.00
Year of Birth (YR)	2	59.62***	2	50.40***
Age of Dam(AOD)	2	.30	2	2.28*
Type of Birth (TOB)	1	.69	1	.98
Sex of Lamb (SEX)	1	.33	1	.01
YR*SEX	2	6.43**	2	.86
AOD*TOB	2	3.29*	2	.76
TOB*SEX	1	3.93*	1	.55
Residual	589	1.00	591	.61

*P<.05
**P<.01
***P<.001
[1]FFS measured as Prime +(PR+)=15, PR=14, PR- =13, Choice +(CH+) =12, CH=11, CH- =10.
[2]CONF measured as Prime +(PR+)=15, PR=14, PR- =13, Choice +(CH+) =12, CH=11, CH- =10.

TABLE 18
LEAST -SQUARES MEANS AND STANDARD ERRORS FOR FLANK FAT STREAKING (FFS)[1] AND CONFORMATION (CONF)[2] MAIN EFFECTS

	FFS			CONF		
Source of Variation	n	LSMeans	SE	n	LSMeans	SE
Ewe Breeds						
DR	222	11.96	.18	223	11.93	.14
RAMB	177	11.91	.20	177	11.95	.15
ROM	204	11.80	.19	205	11.81	.15
Year Of Birth		***			***	
1994	204	11.95[a]	.18	204	11.60[a]	.14
1995	182	11.25[b]	.19	184	11.49[a]	.15
1996	217	12.46[c]	.20	217	12.60[b]	.15
Age of Dam					*	
2 yr	11	11.93	.53	11	12.60[a]	.42
3 to 4 yr	271	11.91	.07	272	11.59[b]	.05
5 and 5+ yr	321	11.82	.06	322	11.49[b]	.05
Type of Birth						
Single	296	12.03	.12	298	11.72	.09
Multiple	307	11.74	.34	307	12.07	.26
Sex of Lamb						
Ewe	315	11.91	.18	315	11.89	.14
Ram	288	11.87	.19	290	11.90	.14

P<.05
**P<.01
***P<.001
[a,b,c]Means within a column in a subgroup with different superscripts differ (P<.05)
[1]FFS measured as Prime +(PR+)=15, PR=14, PR- =13, Choice +(CH+) =12, CH=11, CH- =10.
[2]CONF measured as Prime +(PR+)=15, PR=14, PR- =13, Choice +(CH+) =12, CH=11, CH- =10.

Table 17 presents the interaction effects on FFS and CONF.

In YR*SEX interaction, FFS scores of ewe lambs born in three different years differed. Ewe lambs born in 1996 had the highest FFS score (12.49) and differed from those born in 1994 (12.16 ; P<.001) and 1995 (11.08 ; P<.05). FFS scores of female lambs born in 1994 and 1995 also differed (P<.001). Similar to ewe lambs, male lambs born 1996 had the highest FFS score (12.43) and differed from those born in 1994 (11.75; P<.001) and 1995 (11.42 ; P<.001). Ram lambs born in 1994 and 1995 were also different (P<.05). CONF scores of ewe lambs born in three different years also differed. Female lambs born in 1996 had the highest CONF score (12.57) and differed from those born in 1994 (11.67 ;P<.001) and 1995 (11.43 ; P<.001). Ewe lambs of 1994 and 1995 had also different CONF scores (P<.05). In the case of male lambs, only significant differences were detected between ram lambs born in 1996 and those born in1994 (P<.001 ; 12.63 and 11.53, respectively) and between ram lambs born in1996 and those born in 1995 (P<.001 ; 12.63 and 11.54, respectively).

In AOD*TOB interaction, FFS and CONF cores of lambs born as singles to three different age groups of ewes did not differ while FFS scores of lambs born as multiples to three different age groups of ewes differed. Multiple born lambs to 3 to 4 yr-old ewes had higher FFS score than those born to older ewes (5 and 5+ yr-old)(P<.05 ; 11.97 and 11.68 , respectively). Multiple born lambs to 3 to 4 yr -old ewes and those born to older ewes (5 and 5+ yr-old) ewes did not differ.

In TOB*SEX interaction, there were no significant differences between female lambs born as singles and multiples and between male lambs born as singles and multiples in terms of FFS and CONF scores.

TABLE 19

LEAST -SQURES MEANS AND STANDARD ERRORS FOR FLANK FAT STREAKING (FFS) AND CONFORMATION (CONF) BY INTERACTION: YEAR OF BIRTH VS SEX OF LAMB (YR*SEX), AGE OF DAM VS TYPE OF BIRTH (AOD*TOB), AND TYPE OF BIRTH VS SEX OF LAMB (TOB*SEX)

Source of Variation		FFS			CONF		
Interaction:YR*SEX		n	LsMeans	SE	n	LsMeans	SE
Year of Birth	Sex of Lamb						
1994	Ewe	97	12.16^{a}	.19	97	11.67^{a}	.15
1995	Ewe	107	11.08^{b}	.20	107	11.43^{b}	.16
1996	Ewe	111	12.49^{c}	.21	111	12.57^{c}	.17
1994	Ram	107	11.75^{a}	.20	107	11.53^{a}	.15
1995	Ram	75	11.42^{b}	.21	77	11.54^{a}	.17
1996	Ram	106	12.43^{c}	.21	106	12.63^{b}	.16
Interaction:AOD*TOB							
Age of Dam	Type Of Birth						
2 yr	Single	10	12.28	.33	10	12.06	.26
3 to 4 yr	Single	135	11.85	.09	136	11.57	.07
5 & 5+ yr	Single	151	11.97	.08	152	11.53	.07
2 yr	Multiple	1	11.57^{ab}	1.01	1	13.15^{a}	.79
3 to 4 yr	Multiple	136	11.97^{a}	.09	136	11.61^{ab}	.07
5 & 5+ yr	Multiple	170	11.68^{b}	.08	170	11.46^{b}	.07
Interaction:TOB*SEX							
Type of Birth	Sex of Lamb						
Single	Ewe	161	11.98	.13	161	11.69	.10
Multiple	Ewe	154	11.85	.34	154	12.10	.26
Single	Ram	135	12.09	.13	137	11.75	.10
Multiple	Ram	153	11.64	.34	153	12.05	.27

[a,b]Means within different year of birth, age of dam ,type of birth with same sex of lamb and type of birth with different superscripts differ (P<.05).

Discussion

The results of the present study will be discussed under the three categories which are lamb growth, ewe reproduction and lamb carcass traits.

Lamb Growth Traits

The effect of YR, TOB and YR*TOB interaction were significant factors influencing both BWT and WWT. SEX, EWEBR*SEX and YR*SEX were significant factors only for BWT, while EWEBR affected only WWT. The DR lambs ranked first and followed by RAMB and ROM lambs in both BWT and WWT measurements. Olthoff and Boylan (1991) compared the performance of lambs from purebred and crossbred Finnsheep ewes and reported lambs from Dorset dams ranked higher than lambs from Finnsheep ewes. Cochran et al,. (1984) reported similar findings in comparisons of Dorset and Finnish Landrace crossbred ewes. Similar to the results in this study, Burditt et.al., (1988) founded that lambs born to Rambouillet ewes sired by Dorset were heavier than lambs born to Rambouillet ewes sired by Finnsheep Landrace, and Rambouillet ewes sired by Boorola Merino.

Lambs born as multiples were significantly lighter than lambs born as a singles. This is a general rule and it was also reported by Singh and Dhillon (1992), Ganai and Pandey (1990), and Pitchford (1993). Tsarev et.al., (1982) reported that the growth rate of triplet lambs born to Romanov ewes was higher than that of twins and singles, and twins grew more rapidly than singles.

Male lambs were heavier at birth and weaning than their female littermates. This situation is consistent with observations in most livestock species, where the male newborn is heavier than the female. The present results agree with findings by Ruttle (1971), Sidwell and Miller (1972), Dickerson et al.,(1972), Rastogi et al.,(1975) and Bunge et al.,(1993).

Age of dam affected BWT. Older ewes had heavier lambs at birth. Eltawil et al., (1970) showed that age of dam brings most of its influence on preweaning traits. Birth and weaning weight seemed to be affected by age of dam much more than yearling weight.

Lambs born in 1994 had lighter BWT than lambs born in 1995 and 1996. Lambs born in 1995 were significantly heavier in weight than lambs born in 1994 and 1996 at weaning.

Ewe Reproductive Traits

Litter weight at birth and weaning: YR, TOB, EWEBR*TOB and YR*TOB significantly influenced both LWB and LWW. However, only AOD, AOD*TOB and EWEBR*YR*AOD interactions significantly influenced LWW.

The RAMB dams ranked first in LWB and followed by DR and ROM dams.

Age of dam did not influence LWB. This is in agreement with results reported by Oltenacu and Boylan (1981). However, AOD had a significant influence on LWW, in close agreement with finding reported by Dickerson and Glimp (1975). Multiple births resulted in more lbs of lamb at birth than was single births.

Litter size at birth (LSB), Litter size at weaning (LSW), and Lamb viability to weaning (LVW): The significant sources of variation for LSB were EWEBR, YR, and the interaction EWEBR*YR*AOD, while EWEBR*YR*AOD interaction was the only significant source of variation for LSW. Finally, YR and EWEBR*YR*AOD interaction were the significant source of variation for LVW.

In general, older (3 to 4 and 5 and 5+ yr-old) ROM ewes were more prolific at birth and weaned more lambs than other breeds over the years. These present results are in agrement with results reported by Vesel and Swierstra (1986), Ricardeau et al., (1978) and Galliva et al., (1993). Survival of lambs was predominantly a function of birth weight and this was also reported by Hall et.al., (1995).

Carcass Traits

The DR and RAMB lambs had heavier HCW and larger REA than did ROM. Male lambs had larger REA than female lambs. Also single born lambs were heavier in HCW and larger in REA than multiple born lambs. In general, these results are in agreement with the results cited in the literature review.

The DP was highest in 1994 than 1995 and 1996. Multiple born lambs from older ewes (5 and 5+ yr -old) had higher DP than single born lambs from older ewes (5 and 5+ yr-old). Fahmy (1986) founded a dressing percentage of 43-46 for Romanov sheep. This was close to findings in this study.

The ram lambs dressed higher than ewe lambs. This is not in agreement with results reported by Makerachian et.al., (1978).

In general ,DR lambs had the greatest fat thickness. The DR, RAMB and ROM were similar in terms of FFS and CONF scores.

Implication

The Dorset-cross ewes were superior in birth weight, weaning weight, litter weight at birth and weaning , as well as having better carcass composition. On the other hand the Romanov cross showed an advantage over the Dorset cross for prolificacy.

When making selection it is important to realize that certain situations require different types of animals. Most animals have traits that can make them superior under one set of circumstances. However, these same traits can be of a little value under different conditions. Therefore, a producer must consider that each breed was developed for a distinct purpose. The white-faced or ewe breeds were developed for maternal traits and the black-faced or ram breeds were developed for paternal traits. Thus, a producer should focus on reproductive efficiency, milk production, and wool production as performance traits for a ewe breed in the selection program. In the case of a ram breed, one should emphasize growth rate and carcass cutability (Boggs, 1993).

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VITA

Serkan Erat

Candidate for the Degree of

Master of Science

Thesis: COMPARISON OF SHEEP CROSSBREDS IN TERMS OF GROWTH, REPRODUCTION AND CARCASS CHARACTERISTICS FROM FALL BORN LAMBS

Major Field: Animal Science

Biographical:

Personal Data: Born in Van, Turkey, on January 1, 1970, the son of Rasim and Raziye Erat.

Education: Graduated from Mustafa Kemal Lisesi, high school, Ankara, Turkey in June 1987; received Bachelor of Science degree in Veterinary Medicine from Ankara University, Ankara, Turkey in June 1992. Completed the requirements for the Master of Science degree with a major in Animal Science at Oklahoma State University in May 1998.

Experience: Completed Military service as a food controller office in Iskenderun, Turkey and trained in Atomic Energy Council, Animal Health and Nuclear Research Institute In Lalahan, Ankara, Turkey.