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Effects of Breed of Ewe and Management System on the Lifetime Production of Lamb and Wool

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EFFECTS OF BREED OF EWE AND MANAGEMENT SYSTEM ON THE LIFETIME PRODUCTION OF LAMB AND WOOL

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This thesis is approved as a creditable and independent investigation by a candidate for the degree, Master of Science, and is acceptable for meeting the thesis requirements for this degree. Acceptance of this thesis does not imply that the conclusions reached by the candidate are necessarily the conclusions of the major department.

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INTRODUCTION

Sheep production in the United States is highly variable. The sources of this variation are many and may include breed, climatic condition, management system and selection emphasis. The sheep is a highly adaptable animal and the success of an operation may be due in part to the ability of producers to select breeds of sheep best suited to their situation.

Over time, two distinct management systems have developed. The first of these may be termed the farm flock system. The farm flock system is typical of the eastern United States in the crop farming areas of the country. This system may include such practices as early fall breeding, drylot confinement during the winter months, early lambing and weaning and rapid feedlot finishing of the lambs. The second management system may be termed the range flock system. As the name implies, the range flock system is typical of the western range areas of the United States. This system may employ such management practices as late fall breeding, reliance on grazing and limited feed supplementation during gestation, spring lambing and summer grazing of ewe and lamb pairs. Although these two systems are quite distinct, considerable overlap between the systems does exist.

It was the objective of this study to compare these two systems of management and to examine the effect on lifetime productivity of ewes. It was a further objective to compare three distinct breed combinations within both systems.

The Targhee breed is typical of the range type sheep used in many sheep operations. The experimental design of the study allowed the examination of the effect of replacing one-half of the Targhee genetic base with either Suffolk or Finnsheep breeding. The Suffolk represents a typical farm flock type sheep noted for growth and carcass quality. The Finnsheep is a breed known for multiple birth and early maturity.

This study was conducted over a 8-year period which allowed all ewes 6 years of production. The end points to evaluate production were kilograms of wool produced and kilograms of lamb weaned.

REVIEW OF LITERATURE

The performance of a ewe flock is influenced by a considerable number of factors. This performance can be measured by a large number of criteria which include birth weight of lambs, lamb type of birth, weaning weight of lambs, total lamb production, wool production, longevity and the performance of the ewe as a yearling. The following review will cover some of these criteria and examine those factors which influence them.

Fertility

Fertility tends to be lower for young and old ewes than for those of middle age (Sidwell et al., 1962; Shelton and Menzies, 1968; Hight and Jury, 1970; Martin et al., 1981; Vesely and Peters, 1981). Sidwell and Miller (1971a) found the same trend, but differences were not of a significant magnitude. The lowest fertility levels were at 2, 8 and 9 years of age. Dickerson and Glimp (1975) found fertility to be curvilinear with age at lambing. Fertility ranged from 45 to 75% at 1 year to 85 to 95% at 4 to 6 years and to 60 to 80% at 9 years, with large breed and year differences in the fertility-age curve. When looking only at yearling ewes, those which did not lamb were, on the average, 2 d younger ($P<.01$) than those which did lamb. Vesely and Peters (1974) reported that the most important factor influencing ewe fertility was age, with only 50% of the ewe lambs exposed to the ram conceiving. Vesely and Peters (1965) did not find 2-year-olds to be inferior to middle-aged ewes in fertility. Coop (1966) found that ewes of higher live weight were easier to get in lamb. Martin et al. (1981), however, found no differences in weights of yearlings which did lamb or failed to lamb. There is no evidence of a critical body weight with respect to the number of ewes failing to lamb, although there is a suggestion that ewes weighing less than 22.7 kg at 15 to 16 mo are barren more times over their lifetime than ewes of other weights (Lax and Brown, 1968). Vesely et al. (1966) reported fertility to be essentially the same in four range breeds, including Targhee (96.1%) and Suffolk (92.4%). Similar values found in other studies for these two breeds were Targhee, 84.4%, Suffolk, 82.1% (Sidwell and Miller, 1971a), Targhee, 82.8%, and Suffolk, 82.1% (Dickerson and Glimp, 1975). Percentage of ewe lambs lambing at approximately 12 mo of age reflects the precocity of sexual development in young females. Finnsheep had a lambing rate superior to Suffolk and Targhee (95, 90 and 51%, respectively; Oltenacu and Boylan, 1981a). The Finnsheep breed clearly has the ability to transmit its fertility to crossbred offspring (Barker, 1975). Several authors have reported improved fertility by crossbreeding (Sidwell et al., 1962; Hight and Jury, 1970, 1973; Vesely and Peters, 1974; Oltenacu and Boylan, 1981a; Fahmy, 1982). Fertility rates in crossbred ewes mated to purebred or crossbred rams were higher than those for purebred ewes mated to rams of another pure breed (Vesely and Peters, 1981). Also, crossbred ewes mated to crossbred rams have fertility significantly higher than purebred ewes mated to rams of the same breed. Vesely and Peters (1974) noted that conception rates in crossbred ewes were higher than in purebred ewes mated to rams of another breed. The lower fertility of the purebred ewe when bred to a ram of a different breed could be the result of a lack of compatability between the egg and sperm of the parental breed. Fertility was similar for Border Leicester-sired ewes and Finnsheep-sired ewes (Magid et al., 1981b). Bradley et al. (1972) found no differences in fertility between purebred and crossbred ewes. Shrestha et al. (1983) reported crossbred ewes were less fertile than purebred ewes (P<.01).

Hohenboken et al. (1976) reported a heterosis value for fertility of 5.7%. Later work by Clarke and Hohenboken (1983) reported a heritability of .02 for fertility. Sidwell and Miller (1971a) reported that 15 out of 20 crosses showed some positive hybrid vigor. The ability of the parents to transmit fertility to the offspring is not always highly predictable.

Birth Weight

One factor commonly found to affect lamb birth weight is the number of lambs born in that lambing. Lambs born as twins were lighter at birth than lambs born as singles (Hazel and Terrill, 1946a; Terrill et al., 1947; Blackwell and Henderson, 1955; Bennett et al., 1963; Dun and Grewal, 1963; Sidwell et al., 1964; Vesely and Peters, 1964; Lambe et al., 1965; Vesely et al., 1966; Donald et al., 1968; Gould and Whiteman, 1975; Ruttle, 1971; Baharin and Beilharz, 1977; Smith, 1977; Magid et al., 1981a,b; Òltenacu and Boylan, 1981b; Rastogi et al., 1982). Vesely and Peters (1964) found that type of birth was the largest source of variation in birth weight, with all other factors of minor importance in relation to total variability.

It has been widely accepted that sex of lamb will affect the birth weight of individual lambs, with ram lambs being heavier at birth than ewe lambs (Blackwell and Henderson, 1955; Bennett et al., 1963; Sidwell et al., 1964; Vesely and Peters, 1964; Vesely et al., 1966; Ruttle, 1971; Wiener and Hayter, 1975; Magid et al., 1981a,b; Oltenacu and Boylan, 1981a; Rastogi et al., 1982).

Age of dam can significantly influence lamb birth weight (Shrestha et al., 1982). Ewe lambs give birth to lighter lambs the first year than they do in subsequent years (Briggs, 1936). Lambs from mature ewes are heavier at birth than 3-year-olds, which in turn are heavier at birth than 2-year-olds (Sidwell et al., 1964; Lambe et al., 1965; Magid et al., 1981a; Oltenacu and Boylan, 1981a). Rastogi et al. (1982) found a .47-kg increase in lamb birth weight from 3-year-old ewes as from 2-year-old ewes. Donald et al. (1968) reported profound increases in lamb birth weight through 3 years of age. Blackwell and Henderson (1955) described the relationship between age of ewe and birth weight to be curvilinear. Vesely and Peters (1964) and Vesely et al. (1966) reported birth weights increasing for each year of increase in age of dam up to 6 years of age. Bennett et al. (1963) found no differences existed between lamb birth weights of first and second generations or between third and fourth generations. However, when birth weights of the first and second generations were combined, they were lighter than third and fourth generations combined.

A number of studies have been conducted comparing the birth weight of the lambs in purebred sheep. Sidwell and Miller (1971b) found Suffolk lambs were .48 kg heavier than Targhee lambs. Suffolks were superior to Hampshires and Southdowns in birth weight (Lambe et al., 1965). Average birth weights of lambs were Targhee, 3.93; Suffolk, 3.90; and Finnsheep, 2.60 kg as reported by Oltenacu and Boylan (1981b). Targhee lamb birth weight was 4.94 kg and Suffolk was 4.72 kg (Rastogi et al., 1982). Suffolk lamb birth weight was 4.75 kg and Targhee, 4.66 kg (Vesely et al., 1966).

A number of studies have been conducted which examine the effect of breed of sire on lamb birth weight. The breeds of particular interest here are those represented in the present study. Oltenacu and Boylan (1981b) reported that the breeding of Finnsheep rams to Suffolk ewes resulted in a reduction in birth weight from Suffolk rams and a similar reduction with Targhee ewes. Lambs sired by Finnsheep rams weighed .5 kg less at birth than lambs sired by North Country Cheviot, Dorset or Romney (Levine and Hohenboken, 1978). The use of Targhee rams on Hampshire and Dorset ewes increased birth weight but decreased birth weight on Suffolk ewes (Sidwell and Miller, 1971b). The use of Suffolk rams on Hampshire, Targhee or Dorset ewes increased birth weight (Sidwell and Miller, 1971b). Lambs sired by Finnish Landrace rams weighed less (P<.01) at birth than those sired by Suffolks (Shrestha et al., 1982). Birth weights were lower for lambs sired by Finnsheep rams vs Rambouillet-sired lambs, but the difference was less for multiple births than for singles (Dickerson et al., 1975). Magid et al. (1981b) found Border Leicester-sired lambs were .3 kg heavier at birth than Finnsheep-sired lambs.

Crossbreeding can influence lamb birth weight, with the combination of breeds used causing some variability. When Border Leicester-sired ewes were bred to Suffolk sires, the lambs were heavier than Finnsheep-sired ewes (Magid et al., 1981b). Lambs born to Finnsheep crossbred ewes were lighter than those born to non-Finnsheep crossbred ewes (Barker, 1975). When combinations of Finnsheep, Targhee and Suffolk were used, the following average birth weights were recorded: Suffolk x (Finnsheep x Suffolk), 3.67 kg; Targhee x (Finnsheep x Targhee), 3.53 kg; Finnsheep x (Finnsheep x Targhee), 3.25 kg; and Finnsheep x (Finnsheep x Suffolk), 3.24 kg (Oltenacu and Boylan, 1981b). When bred to Finnsheep cross ewes, Suffolk-sired lambs were heavier ($P<.05$) than Columbia-sired lambs (Leymaster and Smith, 1981). Meyer and Bradford (1973) reported that average birth weights of twins were significantly greater from Targhee dams than from Finnsheep x Targhee dams. Notter and Copenhaver (1980) found a similar response with Finnsheep. In their study, lambs from 1/2 Finnsheep ewes averaged 3.57 kg at birth, which was .75 kg less ($P<.001$) than lambs from 1/4 Finnsheep ewes and .83 kg less ($P<.001$) than lambs from Suffolk x Rambouillet ewes. Rastogi et al. (1982) conducted a study which included a large number of breed combinations. The following are the birth weights of some of those combinations: Suffolk x Targhee, 5.16 kg; Targhee x Suffolk, 5.02 kg; Suffolk x (Columbia x Targhee), 5.22 kg; Suffolk x (Targhee x Columbia), 5.43 kg; Targhee x (Columbia x Suffolk), 5.21 kg; Targhee x (Suffolk x Columbia), 5.02 kg; (Columbia x Targhee) x Suffolk, 4.91 kg; (Targhee x Columbia) x Suffolk, 5.13 kg and (Columbia x Suffolk) x Targhee, 5.27 kg. As a group, crossbred lambs show a weight advantage over purebreds at birth (Sidwell et al., 1964; Shrestha et al., 1983). For birth weight, crossbreds were slightly heavier than the mean of their parental breeds (Wiener and Hayter, 1975).

Gould and Whiteman (1975) found that the birth weights of the lambs born to the single- and twin-reared dams were very similar until the dams reached 96 mo of age, at which time the twin-reared ewes produced lambs .46 kg heavier. Terrill and Stoehr (1942) found no consistent differences in lamb production between ewes born as singles or twins.

Donald et al. (1981) found that a large part of the group or breed differences in birth weight could be accounted for by group differences in ewe weight. In that study when lamb weight was expressed as a percentage of ewe weight at mating, the differences became smaller and inconsistent in sign. Russel et al. (1981) found that mating weight accounted for 78% of the variance in birth weight in a low nutritional treatment group of ewes but had little effect in those on the higher level of feeding. Rastogi et al. (1982) obtained heterosis estimates for birth weight of 4.6% among single cross and .7% among three-way crosses. These values were somewhat lower than the 8.2% found by Fahmy (1982).

<u>Number of Lambs Born</u>

The number of lambs born per lambing is an important factor in determining ewe productivity. Ewes born as twins have a greater incidence of multiple birth than single-born ewes (Dun and Grewal, 1963). Selection for multiple birth can lead to a marked increase in the number of lambs born (Turner et al., 1962). Basthakur et al. (1973) concluded that increased lamb production would result from selecting ewes and rams born as twins. Clarke and Hohenboken (1983) reviewed previous work which reported heritability estimates for number of lambs born. The estimates for purebreds ranged from .03 to .26. The estimates reported for crossbreds which included Finnsheep and Suffolk were .12 and .14. Lax and Brown (1968) found that, among Australian Merinos, ewes born in multiple births produced four more lambs per 100 ewes joined than those born as singles. In contrast, Martin et al. (1981) could find no significant effect of birth-rearing class of the ewe on her subsequent litter traits. The age of a ewe may affect the relationship between her birth class and the number of lambs she produces. Baharin and Beilharz (1977) found that ewes born as twins were less fertile at first mating, improved rapidly in their reproductive performance at subsequent matings but declined in fertility quite early in their breeding life. Pipe and McGuirk (1976) found that in some flocks ewes born as twins had lower productive performance than singles until age 4 years. The environmental penalty of being born a twin thus mitigates against that animal leaving offspring for further generations. Mechling and Carter (1969) found ewes sired by single-born rams produced the same number of lambs as those sired by twin rams.

Number of lambs born increases with age of ewe (Sidwell et al., 1962; Turner et al., 1962; Vesely and Peters, 1965, 1974; Vesely et al., 1966; Donald and Read, 1967; Donald et al., 1968; Lax and Brown, 1968;

Shelton and Menzies, 1968; Glimp, 1971; Sidwell and Miller, 1971a; Hohenboken et al., 1976; Goot and Maijala, 1977; Martin et al., 1981; Oltenacu and Boylan, 1981a; Fahmy, 1982). Dickerson and Glimp (1975) concluded that the relationship of ewe age and lambs born per ewe lambing was curvilinear with peak production at 6 years of age. Vesely and Peters (1981) found peak production to be 5 years of age. In contrast, Cameron et al. (1983) found no increase in litter size for ewes lambing at 1, 2 or 3 years of age. Turner (1969) suggested that, in flocks with a higher average level of reproductive rate, ewes reach their maximum performance and start to decline at an earlier age than in flocks with a lower average level. It is not well documented whether this same theory could be applied to those breeds displaying higher average levels of reproductive rates.

Wide differences exist between breeds in the number of lambs produced per lambing. The following authors have reported the following values for lambing percentage of ewes lambing: Targhee, 167, Suffolk, 157 (Sidwell and Miller, 1971a); Targhee, 169, Suffolk, 174 (Bradley et al., 1972); Finnsheep, 203 (Goot and Maijala, 1977); Finnsheep, 251, Suffolk, 140, Targhee, 128 (Oltenacu and Boylan, 1981b); Targhee, 150, Suffolk, 181 (Vesely et al., 1966); Suffolk, 161, Targhee, 152 (Dickerson and Glimp, 1975); Suffolk, 182, Targhee, 171 (Glimp, 1971). Vesley and Peters (1974), Bradley et al. (1972), Wiener and Hayter (1975) and Shrestha et al. (1983) found that crossbreeding did not result in an improvement in ewe prolificacy. These reports are contrasted by those who did find an increase in number of lambs born per ewe lambing for crossbreds over purebreds (Sidwell et al., 1962; Botkin and Paules, 1965; Meyer and Bradford, 1973; Wiener and Hayter, 1975; Oltenacu and Boylan, 1981a; Vesely and Peters, 1981). Shrestha et al. (1983) did report an increase for crossbreds, but it was non-significant (P>.05). Sidwell and Miller (1971a) found 14 of 20 crosses studied showed some positive hybrid vigor for prolificacy. Fahmy (1982) found that crossbreeding with the Oxford breed resulted in much improved prolificacy at birth, but that crossbreeding the Suffolk did not have a similar effect.

Using Columbia or Suffolk rams, Leymaster and Smith (1981) found no sire effect on ewe prolificacy. Breed of sire failed to have a significant effect on numbers of lambs born per ewe lambing (Sidwell and Miller, 1971a; Bradford, 1972; Hohenboken et al., 1976; Levine and Hohenboken, 1978; Oltenacu and Boylan, 1981a; Fahmy, 1982). It is of interest to note that Fahmy (1982) found that rams that were 3 years of age or older sired litters that were significantly smaller than those sired by rams either 1 or 2 years old. Males could contribute to variation in litter size of their mates through differences in the fertilizing capacity of their semen or in prenatal survival of their offspring (Bradford, 1972).

Magid et al. (1981b) reported average numbers of lambs born per ewe lambing to be 1.67 for Targhee and 1.91 for Finnsheep x Targhee. Finnsheep ewes showed a 27% increase in numbers of lambs born per ewe mated over non-Finnsheep (Barker, 1975). Dzakuma et al. (1982a) found Finnsheep x Rambouillet ewes produced more lambs per ewe mated than either of two combinations of Dorset x Rambouillet breeding. Oltenacu and Boylan (1981a) reported values of 1.83 and 1.79 lambs per ewe lambing for Finnsheep x Suffolk and Finnsheep x Targhee, respectively. In a study utilizing ewe lambs, Meyer and Bradford (1973) found Finnsheep x Targhee ewes produced 1.68 lambs per ewe lambing, while Targhee ewes produced 1.18. At each age, Finnsheep crossbreds produced larger litters than Border Leicester, Dorset or Clun Forest (Donald et al., 1968). Increasing Finnsheep breeding by one-fourth at the expense of Rambouillet breeding may result in an increase of 8 to 9 lambs born per 100 ewes lambing (Thomas and Whiteman, 1979). Finnsheep-sired ewes tended to have higher ovulation rates, 2.04 per ewe ovulating vs Suffolk at 1.78 during August through September breeding (Lamberson and Thomas, 1982). There is a large difference in numbers born per 100 ewes mated at 1 year of age, but this difference was less at later ages. The greatest advantage by the Finnsheep crossbreds at a young age was largely due to the higher proportion of ewes which lambed rather than the number of lambs per ewe lambing (Barker, 1975).

Ducker and Boyd (1977) found that body size did not affect the mean ovulation rates of ewes, although body condition did. They further concluded that live weight per se was not a good indication of ovulation rate, as ewe live weight was a combination of both body size and body condition. Fletcher (1971) reported that over the live weight range of 42 to 57 kg the incidence of twin ovulation increased 1.3% for each 1 kg of live weight at ovulation due to inherent variations in live weight. Kelly and Johnstone (1982) found that for every kilogram difference in mean live weight mean ovulation rate changed by about .03 and that per 100 ewes a difference of 10 ovulations was accompanied by a difference of 6.1 to 6.9 lambs born. Therefore, a 1-kg increase in mean live weight at joining was associated with an increase of two lambs born per 100 ewes lambing. Lax and Brown (1968) reported that each 4.5-kg increase in body weight at 15 to 16 mo produced eight more lambs per 100 ewes joined. On average, the ewes with multiple births at first lambing weighed 1.0 kg more at the time of first mating than those producing singles (Wiener, 1967). Nichols and Whiteman (1966) concluded that average unadjusted lifetime weight was positively but nonsignificantly correlated with total lambs born.

Lambing rate has been found to increase as the normal lambing season progresses (Glimp et al., 1968; Glimp, 1971; Hohenboken et al., 1976). Glimp (1971) found ewes bearing triplets had shorter average gestation lengths than those bearing singles or twins.

Litter Weight at Birth

Litter weight at birth is a function of the number born and the individual weights of each lamb born. Martin et al. (1981) reported that, since numbers of lambs and average lamb birth weight are negatively correlated, selection for litter weight is likely to cause a slight reduction in lamb weight (-.07 kg lamb weight per 1-kg increase in litter weight). Fahmy (1982) found crossbreeding would increase litter weight, as would the use of older ewes, but found age of sire to have no effect. Cameron et al. (1983) found increases in litter weight at birth with increasing age of the ewe. Due to an increase in number of lambs born, Finnsheep or Finnsheep crossbred ewes had an advantage in litter weight, even though individual lambs were lighter (Meyer and Bradford, 1973). Shrestha et al. (1983) found crossbreeding had a positive effect on litter weight through a significant ($P<.01$) increase in average birth weight and a nonsignificant increase ($P>.05$) in number of lambs born. Donald et al. (1968) found that weight of litter as a percentage of ewe weight was 2 to 3% higher for twins than for singles in each age group and 5 to 9% for triplets. The higher heritability estimates for litter weight at birth suggested that selection on this trait might be more effective in changing total lamb weight weaned than direct selection (Martin et al., 1981).

Lamb Survival

Between 5 and 25% of all lambs born on individual farms die between birth and weaning. A high proportion die within 3 d (Hight and Jury, 1970). Evidence on the incidence of lamb mortality, derived mostly from institutional and experimental flocks, suggest that in the United Kingdom between 10 and 25% of lambs commonly die (Wiener et al. (1973). Kelly (1982) reported that, based on a potential of 161 lambs per 100 ewes (determined by ovulation rates), lambs dying from birth to weaning reduced this number by 13.1 lambs.

Body size, as indicated by birth weight, plays an obvious role in lamb survival, with very large lambs subject to dystocia losses and very small lambs more susceptible to starvation and exposure (Meyer and Clarke, 1970). When dystocia was examined, Smith (1977) found it to be minimal (9 to 15%) at birth weights of about 3.5 kg. Lamb mortality is quadratically related to birth weight and was minimal (26 to 30%) at about 5.5 kg (Smith, 1977). Low birth weights for lambs from ewes lambing the first time at 2 years of age are related to a consistent high incidence of lamb mortality (Russel et al., 1981). Hight and Jury (1970) found lambs weighing less than 2.7 kg at birth had a very low survival rate. Meyer and Clarke (1970) reported that among single-born lambs mean birth weights did not differ between surviving vs dead lambs. However, surviving twins averaged .3 kg heavier than dead twins. Hight and Jury (1970) concluded that for high survival rates the optimum birth weight for lambs was about 3.8 to 5.0 kg for singles and about 3.2 to 4.5 kg for twins. Lax and Brown (1968) found survival rate showed a curvilinear relationship with birth weight, the greatest survival rate occurring at or slightly above the mean birth weight, suggesting that survival would be increased by increasing birth weight to a point. In both sexes, the mean birth weight of lambs surviving was higher than for lambs dying (Meyer and Clarke, 1970). Lax and Brown (1968) found very little difference in survival rates of lambs weighing from 3.4 to 4.5 kg and noted that the effect of high birth weight was not as marked as that for low birth weight in reducing survival. It is apparent that lambs of below or above average birth weight had a decreasing survival rate and that within flocks lambs of about average birth weight had the highest survival rate (Hight and Jury, 1970). Meyer and Clarke (1970) results indicate that increasing birth weight was a definite advantage to survival of twin lambs and that selection for multiple births should be accompanied by selection for increased birth weight.

Female lambs have a higher survival rate than male lambs (Vesely et al., 1966; Hight and Jury, 1970; Meyer and Clarke, 1970; Magid et al., 1981a; Oltenacu and Boylan, 1981a; Vesely and Peters 1981). The differences may not always be considered significant as determined by the authors. Galal et al. (1981) found that sex of lamb had no significant effect on lamb survival at any age. Meyer and Clarke (1970) found no differences for cause of death between males and females. It is of interest to note that Oltenacu and Boylan (1981a) found no differences in perinatal survival for males or females.

Single-born lambs have higher survival than multiple-born lambs (Vesely et al., 1966; Donald and Read, 1967; Sidwell and Miller, 1971a; Dickerson et al., 1975; Galal et al., 1981; Magid et al., 1981b; Oltenacu and Boylan, 1981a; Vesely and Peters, 1981). Baharin and Beilharz (1977) found the twin lamb mortality rate to be three times that of singles. The better survival rate of singles did not differ between sex of lamb (Dickerson et al., 1975). Sidwell and Miller (1971a) found type of birth did not have a significant effect on whether the lamb was born alive or dead. Sidwell et al. (1962) reported that a higher percentage of single lambs were born alive and a higher percentage of single lambs born alive were weaned than twins. Wiener (1967) found single lamb survival to weaning was no better than for twins. Donald et al. (1968) noted that, although the mortality of lambs tended to be higher among twins and triplets than among singles, it was not nearly high enough to offset the extra prolificacy of multiple births except possibly among the lambs of 1-year-old ewes. Dystocia was considerably more important than starvation-exposure as the cause of death among singles, with the opposite being true for twins (Meyer and Clarke, 1970; Hight and Jury, 1970). Smith (1977) also noted that single-born lambs had more dystocia problems. Because birth weight and number of lambs born is correlated, it is difficult to separate these two traits as the cause of lamb mortality (Hight and Jury, 1970; Meyer and Clarke, 1970). Thomas and Whiteman (1979) noted that an increase in prolificacy may also result in an increase in lamb mortality. Meyer and Clarke (1970) concluded that, as fecundity increases, starvation-exposure will become a relatively more important factor in lamb losses and management may need to be altered. Lamb survival rate increases with increasing age of dam (Sidwell et al., 1962; Donald et al., 1968; Hight and Jury, 1970; Oltenacu and Boylan, 1981a; Fahmy, 1982; Cameron et al., 1983). Sidwell et al. (1962) found peak survival rates at 4 years of age with lower values for ewes younger or older, particularly after 7 years. Vesely et al. (1966) found the same trend with the peak at 3 to 5 years, while Vesely and Peters (1981) found the peak at 5 years. Magid et al. (1981a) reported 3 to 4 years and Hight and Jury (1970) reported 4 to 5 years as the age at which peak survival rates occurred. Donald and Read (1967) and Vesely and Peters (1965) noted lower survival rates for 2-year-old ewes. Dickerson and Glimp (1975) found age of dam had an effect on live lambs born but not for live lambs at 4 or 10 wk of age. Some reports have not shown age of ewe to be a major source of variation in lamb survival (Lax and Brown, 1968; Sidwell and Miller, 1971a; Hohenboken et al., 1976; Galal et al., 1981). Dickerson et al. (1975) described the age of ewe effect on lamb viability to be curvilinear.

Vesely et al. (1966) found no breed differences in survival of lambs between Rambouillet, Romnelet, Columbia, Targhee or Suffolk. Dickerson and Glimp (1975) reported birth to weaning lamb losses of 28% for Targhees and 36% for Suffolk. Breed effects did not affect lamb survival percentages among four crossbred ewe types (Hohenboken and Clarke, 1981). Cameron et al. (1983) noted that perinatal survival rates of lambs from three crossbred ewe types were similar, but the postnatal survival was lower for lambs from ABRO (Animal Breeding Research Organization) Damline ewes. Magid et al. (1981b) found Border Leicester-sired lambs to have 12% higher mortality than Finnsheep-sired lambs. Perinatal mortality was 8.5% higher ($P<.01$) among progeny of Suffolk x Rambouillet ewes than progeny of 1/2 Finnsheep ewes and 3.4% higher ($P<.01$) among progeny of 1/2 Finnsheep ewes than among progeny of 1/4 Finnsheep ewes (Notter and Copenhaver, 1980). Sidwell and Miller (1971a) reported very similar lamb viability results between Suffolks and Targhees. Hohenboken et al. (1976) found no significant breed effects for lamb survival. Oltenacu and Boylan (1981a) reported survival as the percentage weaned of total born and found values of 88.9% for Finnsheep, 66.7% for Suffolk and 77.1% for Targhee. Dickerson et al. (1975) reported that Finnsheep cross lambs were markedly superior to Rambouillet cross lambs in viability at 4 to 10 wk. Thomas and Whiteman (1979) found substituting 1/4 Finnsheep breeding for Rambouillet had no effect on survival. Barker (1975) suggested that lamb mortality rate differences between breeds may be largely a function of the relative number of lambs born as singles or as multiples. Dickerson et al. (1975) documented these differences and found there was a significant ($P<.02$) tendency for fewer triplet Finnsheep cross than Rambouillet cross lambs to be alive at birth (84 vs 95%, respectively). However, by 4 weeks, the higher viability of Finnsheep cross lambs as compared to Rambouillet ewe lambs was evident for singles (96 vs 84%), twins (88 vs 75%) and especially for triplets (66 vs 30%). When adjusted for their lower rate of twinning, Border Leicester-sired lambs were 14% poorer in survival to weaning (Magid et al., 1981b). Finnsheep crossbreds had a better survival rate than might have been expected for their litter size (Donald et al., 1968). Lamb loss differences between breeds may be related to differences in lamb shape or to inability to withstand the trauma of birth (Meyer and Clarke, 1970).

Hight and Jury (1970) found the highest survival rates among F_2 lambs from first cross (F_1) ewes, reflecting a possible heterosis effect. Meyer and Clarke (1970) suggested that lower survival rates of purebred lambs may be due to a lack of heterosis. Hohenboken et al. (1976) reported a nonsignificant heterosis value for lamb survival of 3.2%.

Crossbred lambs have higher survival rates than purebreds (Sidwell et al., 1962; Hight and Jury, 1970, 1971; Vesely and Peters, 1974, 1981; Wiener and Hayter, 1975; Fahmy, 1982). Survival to weaning among F_1 lambs (born alive) was greater than that among the respective standard breeds but lower than among Finnsheep lambs in a study using Finnsheep, Targhee and Suffolk breeds (Oltenacu and Boylan, 1981a). Wiener (1967), Bradley et al. (1972) and Shrestha et al. (1983) did not find significant differences between crossbred and straightbred lambs for lamb mortality. Inbreeding of the lambs caused a significant reduction in survival rate for ewe lambs but not for ram lambs (Lax and Brown, 1968). Increases in inbreeding of the dam were associated with higher mortality at all ages, but the trend was not significant (Galal et al., 1981). Smith (1977) reported more dystocia for crossbred lambs.

Ewe body weight at 15 to 16 mo had a small influence on the survival rate. The effect was linear throughout the range with no evidence for a critical weight. Survival rate increased five lambs per 100 lambs born for rams and two for ewes with each 4.5-kg increase in body weight (Lax and Brown, 1968). Lamb mortality was the highest for the earliest born lambs (Hight and Jury, 1970). Survival rate showed a curvilinear relationship with gestation period but was not significant (Lax and Brown, 1968). Wiener et al. (1973) noted that, although it appeared that the lowest mortality was among lambs in the flocks with the greatest number of ewes, their survey was unable to determine if this was due to the kind of management and labor used in different sizes of flocks.

Weaning Weight

Hazel and Terrill (1946a) researched weaning traits and found single lambs weighed 5.3 kg more than twin lambs and 2.3 kg more than twins raised singly. Ruttle (1971) found type of birth to have the greatest influence on weaning weight of early weaned lambs. Lambs born as singles weighed 3.5 kg more at weaning than lambs born and raised as twins. Lambs born and raised as triplets were 2.4 kg lighter at weaning than twin lambs and 5.9 kg lighter than singles. Lambs born and raised as singles were heavier at weaning than twins raised as singles, which were in turn heavier than twins raised as twins (Blackwell and Henderson, 1955; Bennett et al., 1963; Sidwell et al., 1964; Vesely and Peters, 1964; Botkin and Paules, 1965, Vesely et al., 1966; Shelton and Menzies, 1968; Gould and Whiteman, 1975; Baharin and Beilharz, 1977; Rastogi et al., 1982; Shrestha et al., 1982).

Onset of lactation was somewhat slower in ewes bearing twins than in ewes bearing singles (Alexander and Davies, 1959). Robinson and Orskov (1975) reported that with ewes suckling more than one lamb the potential growth rate of the lamb during the first month is likely to be limited by milk yield. Alexander and Davies (1959) noted that ewes bearing twins but suckling a single produced less milk than ewes bearing and suckling twins or ewes bearing and suckling singles and concluded that milk yield was greatly influenced by the number of lambs suckled but not by the number of lambs born. Torres-Hernandez and Hohenboken (1979) found ewes nursing twins produced 22% more milk than ewes nursing a single lamb.

Price et al. (1953) found that the weight disadvantage of multiple-reared lambs was still present at 12 mo. Single ewes were 2.9 kg heavier than twin ewes and .67 kg heavier than twins raised as singles. Dun and Grewal (1963) reported that by 18 mo of age twins had almost overcome the maternal handicap in body weight.

Individual weaning weights of males are heavier than females (Hazel and Terrill, 1946a; Blackwell and Henderson, 1955; Bennett et al., 1963; Sidwell et al., 1964; Vesely and Peters, 1964; Wiener and Hayter, 1975; Rastogi et al., 1982; Shrestha et al., 1982). Although age at weaning varied between studies, the magnitude of the advantage ranged from .8 to 4.9 kg in those studies reported. These findings were contrasted by Ruttle (1971) who found that the advantage male lambs had at birth was not reflected in weaning weight at 2 or 3 mo of age.

Hohenboken et al. (1976) found age of ewe to be a significant source of variation for weaning weight. Shelton and Menzies (1968) found weaning weights to be very similar for lambs from ewes aged 3 through 6, with lower values for younger and older ewes. The increases were less pronounced among twins than singles. Dickerson et al. (1975) described the trend comparing age of dam to growth of lamb to be curvilinear. Blackwell and Henderson (1955) described the same pattern with a peak at 5 years of age. Similar findings were reported by Hazel and Terrill (1946a), Bennett et al. (1963), Sidwell et al. (1964), Vesley and Peters (1964), Lambe et al. (1965), Hight and Jury (1971) and Rastogi et al. (1982).

Breed of dam predetermines to a large extent the outcome in weaning weight (Vesely and Peters, 1972). Oltenacu and Boylan (1981a) reported weaning weights of 21.0 kg for Suffolk, 17.6 kg for Finnsheep and 15.7 kg for Targhee. Lambe et al. (1965) also reported the Suffolk to be superior to the Hampshire and the Southdown. Other breed comparisons for lamb weaning weight included Suffolk, 30.3 kg; Targhee, 24.6 kg (Sidwell and Miller, 1971b); Suffolk, 28.8 kg; and Targhee, 22.6 kg (Rastogi et al., 1982). Vesely et al. (1966) found that weaned lamb production was essentially the same for Suffolk, Rambouillet and Targhee lambs.

The use of Suffolk sires resulted in higher ($P<.01$) weaning weights (Vesely and Peters, 1972). Magid et al. (1981b) found Border Leicester-sired lambs to be no heavier at weaning than Finnsheep-sired lambs. Shrestha et al. (1982) reported no significant effect of breed of sire on weight of single cross lambs at weaning when using East Friesian, Finnsheep, Ile de France or Suffolk sires. Suffolk-sired litters had higher weaning weights than Columbia-sired litters (Leymaster and Smith, 1981).

Purebred lambs exceeded two-breed cross lambs in weight at weaning (Sidwell et al., 1964; Hight and Jury, 1971, 1973; Vesely and Peters, 1972; Vesely, 1978; Oltenacu and Boylan, 1981b; Rastogi et al., 1982). Dahmen et al. (1979) found differences in weaning weight when Suffolk rams were bred to Panama or Finnsheep x Panama ewes. Sidwell and Miller (1971b) found Suffolk x Targhee lambs to be heavier than Targhee lambs at weaning but lighter than purebred Suffolks. Barker

(1975) noted that lambs born to Finnsheep crossbreds were lighter at 10 wk than those born to non-Finnsheep crossbreds. Lambs from Suffolk x Rambouillet and 1/4 Finnsheep ewes were heavier at 45 d than from 1/2 Finnsheep ewes (Notter and Coperhaven, 1980). Dickerson et al. (1975) found 10-wk weight did not differ significantly between Finnsheep cross, Rambouillet cross or Panama lambs. Weaning weights of 3/4 Finnsheep lambs were comparable to those of 1/4 Finnsheep lambs (Oltenacu and Boylan, 1981b).

Bradley et al. (1972) reported that heterosis occurred in weaning weight in several breed crosses. Lamb weaning weight of the crossbred lambs exceeded the midparent average but did not exceed the purebred Suffolks.

A weak negative relationship may exist between a ewe's nutritional state prior to 70 d of age and the estimated amount of milk that she gives her lambs during her early life, but the relationship disappears as she gets older (Gould and Whiteman, 1975). Yearling weight of the ewes was positively but not significantly correlated with the average 70-d weight, indicating that ewe size was not a good predictor of lamb growth rate (Nichols and Whiteman, 1966). In the context of improving individual animal performance, it is important to note that the more prolific the ewe the less important are decreases in ewe body size or individual increases in lamb slaughter weight in improving the overall efficiency of production (Robinson and Orskov, 1975).

Litter Weight at Weaning

The total kilograms of lamb weaned each year from a flock of sheep is no doubt the best single measure of that flock's productive ability. In sheep this characteristic is reflected in the kilograms of lamb weaned per ewe bred (Sidwell and Miller, 1971a). The total weight of lambs weaned each year from a flock generally depends more upon the number of lambs weaned than upon the weights of individual lambs (Sidwell et al., 1962; Sidwell and Miller, 1971a; Magid et al., 1981b; Martin et al., 1981). The number of lambs weaned is in turn dependent upon the number of ewes lambing of ewes bred, the number of lambs born of ewes lambing, the number of lambs born alive of total lambs born and the number of lambs weaned of live lambs born (Sidwell and Miller, 1971a). The importance of number weaned was shown by Botkin and Paules (1965). Suffolk ewes were below all other groups in lamb production. Even though Suffolk lambs averaged heaviest in weaning weight, they had a lower lambing percentage, higher percentage dry ewes and greater loss at birth. When regarded as litters, Donald et al. (1968) found the weaning weight of a single was on average about 65 to 70% of its dam weight at mating, a pair of twins was 100% or more and a set of triplets about 140%.

The advantages of crossbreeding are more pronounced when the total weight of lamb weaned per ewe bred is considered, since the component traits have a cumulative influence (Vesely and Peters, 1974). Additional gain in production of the three-breed cross can be expected from higher fitness of the crossbred ewes, which would be reflected in more kilograms of lamb produced per ewe bred (Vesely and Peters, 1972). Crossbred ewes were higher in kilograms of lamb raised per ewe bred than either parent breed (Botkin and Paules, 1965). Production of two- and three-breed crosses was substantially greater than that of purebreds for total weight of lamb weaned per ewe exposed (Vesely and Peters, 1974). Lamb weaning weights of three- and four-breed cross lambs were about 30% higher than those of purebreds (Vesely and Peters, 1981).

Magid et al. (1981b) reported Finnsheep-sired ewes to have greater total weight of lambs weaned than Border Leicester-sired ewes. When lambing at 1 year of age, the addition of 1/4 Finnsheep breeding resulted in an increase ($P<.01$) of 3.5 kg in weight of lamb weaned per ewe exposed due primarily to a greater ($P<.01$) proportion of the 1/4 Finnsheep ewes lambing than the non-Finnsheep ewes (+24%). When lambing at approximately 2 and 3 years of age, the 1/4 Finnsheep effect resulted in little change in weight of lamb weaned per ewe exposed (Thomas and Whiteman, 1979). Barker (1975) found the total litter weight of lamb reared to 10 wk per 50-kg metabolic ewe weight (at mating) was 16% more for Finnsheep crossbreds than for non-Finnsheep crossbreds when 1 year old, but this advantage was lost and even reversed at later ages. Moav (1966) suggested that the quickest lamb production improvement could be obtained by the use of prolific ewes in crossbred programs. Levine and Hohenboken (1978) found no significant differences among breed of sire for total weaning weight using North Country Cheviot, Dorset, Finnsheep or Romney rams. Parker (1969) reported that the causes for the ram effect on ewe reproduction were not genetic or highly repeatable but of a temporary environmental nature.

Body weight of ewe had both linear and quadratic significant effects on total lamb weight per ewe at weaning and age at weaning had a significant effect on total lamb weight per ewe at mating (Shrestha et al., 1983).

Fahmy (1982) reported the estimate of heterosis for litter weight at weaning to be 18.0% and noted that the magnitude of the heterosis exhibited in crossing depends on the genetic diversity between the breeds involved. Hohenboken et al. (1976) reported heterosis for production per ewe bred to be 13.5% and found that there was a tendency for greater heterosis for ewe productivity from crosses among breeds less similar genetically and heterosis for productivity appeared to be limited when the dam breed in the cross had poor maternal potential. Clarke and Hohenboken (1983) found heritabilities of -.05 for litter weight at birth.

Wool Production

Fleece production is one of the primary contributors to income to the sheep industry (Shelton and Menzies, 1968). Ewes born as singles or sired by single rams tend to produce more fleece in their lifetime than ewes born twins or sired by twin rams (Basuthakur et al., 1973). Ewes born and raised as singles tended to produce more wool than twins, but the differences were significant ($P < .01$) only in the Romnelet shearlings and not in the Rambouillet or Canadian Corriedale (Slen and Banky, 1958). Twin-born ewes cut .09 kg less clean wool per year over their lifetime than single-born ewes (Brown et al., 1966). Single yearling ewes produced .37 kg more grease wool than twins and .17 kg more than twins raised singly (Hazel and Terrill, 1946b). Terrill et al. (1947) and Price et al. (1953) found the same relationship with a grease fleece advantage for ewes born as singles. Dun and Grewal (1963) reported that by 18 mo of age twins have almost overcome the maternal handicap and have equal quality wool production and only slightly depressed quantity. Slen and Banky (1958) found that in twins maximum wool production occurred at a slightly earlier age and that the subsequent decline began sooner than in singles.

The correlation between yearling weight and average grease fleece production was small but significant (Nichols and Whiteman, 1966). Wool production generally was found to be positively related to weaning and yearling weights of the ewe, but the correlations were of relatively low magnitude (Basuthakur et al., 1973). Nichols and Whiteman (1966) reported that larger ewes actually produced only slightly more kilograms of wool during their lifetime than did the smaller ewes and concluded that fleece weight appeared to be associated with ewe weight only as ewe weight was a measure of size. Slen et al. (1954) reported highly significant coefficients of correlation between clean fleece weight and body weight but only a relatively small portion of the variability in clean fleece weight was explained by body weight.

Slen and Banky (1958) found that, in general, maximum fleece weight was obtained by the second year of production and was maintained until the end of the fourth year. At that time a significant ($P < .01$)

decline occurred which continued until the end of the seventh year. Blackwell and Henderson (1955) described the curve which relates wool production and age to be curvilinear with a maximum at age 4. Brown et al. (1966) found maximum grease and clean fleece wool weights at 3.5 years followed by a decline. Vesely et al. (1965) and Oltenacu and Boylan (1981b) both reported the youngest and oldest mature ewes produced less raw fleece than middle-aged ewes.

Oltenacu and Boylan (1981b) found Targhees produced the heaviest fleeces with the finest grades, while Suffolks produced the lightest fleeces, a higher proportion of which were of coarser grade. The Finnsheep fleeces were the lightest and intermediate in grade to the other two breeds. Magid et al. (1981b) found Border Leicester-sired ewes produced .3 kg more and 1.7 cm longer stapled wool and 2.6 μm coarser fiber than did Finnsheep-sired ewes. Drummond et al. (1982) reported that the introduction of Finnsheep blood would result in the production of a raggy fleece with increased staple length, producing greater waste due to tip damage from weathering. This was also shown to be the case when compared with the introduction of Rambouillet blood (Thomas and Whiteman, 1979), along with lower grease weight of the fleeces. Price (1971) reported Targhee ewes produced more and higher grading fleeces than did Finnsheep x Targhee yearling ewes. Dahmen et al. (1978) found Finnsheep x Panama ewes produced less wool with less crimp but of a finer diameter than Panama ewes. Drummond et al. (1982) showed an increase ($P < .05$) of fiber diameter as the percentage of Finnsheep breeding increased.

Oltenacu and Boylan (1981b) found F_1 ewes produced a greater weight of wool than the midparent mean of their respective breeds, which included Suffolk, Finnsheep and Targhee. Crossbreeding increased both grease and clean fleece weight in all crosses except the Suffolk x Targhee for grease fleece weight (Sidwell et al., 1971). Botkin and Paules (1965) reported Corriedale ewes produced heavier and more desirable fleeces than did Suffolk or the Suffolk x Corriedale. Shelton and Menzies (1968) found heritability estimates to be .58 and .52 for fleece weight calculated from offspring regression methods.

Reid (1978) found pregnancy plus lactation reduced wool growth rate 9% and clean fleece weight 11%. Brown et al. (1966) reported the combined effects of pregnancy and lactation would reduce wool production by 22%. Fleeces of ewes that were barren in the previous year were .38 kg heavier than those of ewes that raised one lamb and .44 kg heavier than those of ewes raising two lambs in the previous year (Vesely et al., 1965). Hight et al. (1976) found ewes rearing twins had a lower fleece weight than those that were dry. Ewes giving birth and nursing twins or single lambs produced significantly less clean and grease wool than ewes producing no lambs (Ray and Sidwell, 1964). Reid (1978) found pregnancy alone reduced wool growth rate 7% and clean fleece weight 10% and its effect was greater than that of lactation. Brown et al. (1966) found pregnancy lowered clean wool weight more than lactation. Ray and Sidwell (1964) found ewes pregnant with a single lamb did not produce significantly less grease wool than ewes which failed to lamb. Donald et al. (1968)

reported that fleeces from 1-year-old ewes were about .18 kg heavier if the ewes were barren.

Selection for wool production may have introduced genetic factors adverse to reproduction (Dun, 1964). Seebeck and Tribe (1963) reported that the results of their experiment indicated that, if ewes that have reared single lambs, twin lambs or no lambs are to be selected for retention in the flock on the basis of fleece weight, selection would be against those which have reared twin lambs. Increasing lamb production would result from selecting ewes and rams born as twins, but a reduction in fleece production may result (Basuthakur et al. (1973). Mean fleece weight was significantly, negatively related to total lamb production and reproductive efficiency. However, this can likely be explained by the effect of pregnancy and lactation on fleece weight and does not of itself indicate a negative genetic relationship (Shelton and Menzies, 1968). Kennedy (1967) reported that significant, negative genetic correlations were detected between number of lambs born per ewe mated and clean and grease wool weight. Dickerson (1970) noted that wool production added to total income but became decidedly minor relative to meat production as reproductive rate increased.

<u>Lambing as Yearlings (at 12 to 14 Mo of Age)</u>

A breed or breed cross of ewes that will give a high lambing rate at 1 year of age would significantly increase profits in the sheep industry (Laster et al., 1972). It is well established that breeding as ewe lambs may considerably check their growth and development at this early stage of life, even if only temporarily (Dyrmundsson, 1973). Ponzoni et al. (1979) found no indication of any harmful effect of the mating of young (7 to 11 mo) ewes on subsequent reproductive performance. On the contrary, ewes that lambed and reared a lamb as young ewes had the best reproductive performance.

Dyrmundsson (1973) reported that the most widely accepted definition of puberty was the time at which reproduction first becomes possible, characterized by the release of germ cells, and sexual maturity as the time when the animal expresses its full reproductive power. It was further noted that the mere attainment of physiological puberty in the female, i.e., the production and liberation of viable ova, cannot, however, be taken to imply the ability to carry a fetus to term. There are several indications that female sheep continue to be sexually or reproductively immature for some time following puberty, where puberty is defined as the occurrence of first estrus (Hare and Bryant, 1982). Southam et al. (1971) found ewes born and raised as singles reached puberty at a younger age and a heavier weight than twin-born lambs. Within a breed or breed cross, preweaning competition among twin or triplet lambs reduced lamb weight by about 3 kg at puberty but delayed puberty only about 1 wk (Dickerson and Laster, 1975). Lambs reared on a high plane of nutrition tend to attain puberty at a lower age and heavier body weight than those reared on a low plane of nutrition (Dyrmundsson, 1973). The author noted that faster growth rates and heavier body weights were, as a rule, associated with enhanced sexual performance in ewe lambs. Land (1978) reported that variation in the time of puberty may be associated with variation in body growth, as lambs born early in the season tend to attain puberty at higher ages and heavier body weights than lambs born later. Land (1978) noted that animals which mature before the onset of the first breeding season of their lives cannot be recognized as mature until the start of the season. Likewise, animals which mature soon after the end of the breeding season cannot be recognized until the onset of the next season.

Land (1978) summarized the genetic effect of attainment of puberty as two genetic effects, one which controls the response to a given photoperiodic change, given that an individual is mature enough to respond, and a second which determines whether it is able to respond.

The reproductive performance of young ewes is related to body weight (McGuirk et al., (1968). Dickerson and Laster (1975) found higher 70- to 160-d postweaning rate of growth improved the number of sheep reaching puberty their first year. Ewes which became pregnant as weaners (7 to 8 mo) tended to be heavier than ewes which did not become pregnant (Tyrell et al., 1974). Ewes that remained unmarked (during their first breeding season, 18 mo) by the rams were significantly lighter at the start of joining than those marked but which were subsequently dry. Dry ewes in turn were significantly lighter than wet and wet-dry (marked but failed to lamb) ewes (Kennedy and Kennedy, 1968). In contrast, Laster et al. (1972) found condition score and body weight of the ewe at the start of the breeding period had no effect on whether she lambed or not.

A wide range in reproductive response to breeding at 1 year of age can be seen among breeds and breed crosses (Laster et al., 1972). The percentage reaching puberty by November 10 was far higher for Finnsheep-sired (72) than for Rambouillet-sired (38) crosses or purebreds (34) of the Suffolk, Hampshire, Rambouillet, Dorset, Corriedale or coarse wooled breeds (Dickerson and Laster, 1975). Finnsheep x Rambouillet crossbred ewes had a higher ($P<.05$) percentage of ewes pregnant and higher but not significantly more live lambs born as a percentage of total ewes than did ewes of the Rambouillet, Targhee, Columbia or Dorset x Targhee breeds (Southam et al, 1971). Eighteen percent of ewes with Columbia dams vs only 2% of ewes with Suffolk dams failed to cycle as ewe lambs. Differences among sire breeds which included North Country Cheviot, Dorset, Finnsheep and Romney were small (Cedillo et al., 1977). Laster et al. (1972) reported the following breed comparisons for ewe lambs lambing per ewe exposed: Suffolk, 59%; Targhee, 38%; and Finnsheep x Targhee, 95%. Dickerson and Laster (1975) reported that Finnsheep crosses reached puberty earlier (219 d) and at a lighter weight (40 kg) than Rambouillet crosses (238 d and 44 kg). In the same study, 52.5% of the Suffolks reached puberty at an average age of 211 d and an average weight of 47.7 kg, while 62.1% of Targhees reached puberty at an average age of 213 d and average weight of 38.9 kg. Cedillo et al. (1977) concluded that age and weight differences may result from the shortened day length in the fall, triggering estrus at a relatively constant calendar time but at varying ages and weights, depending upon when the ewe lamb was born the previous spring.

Ewes that were in estrus as ewe lambs gave birth to more lambs than those ewes not in estrus and weaned more lambs at 2 years of age (Burfening et al., 1972). Ewes that exhibited estrus as young ewes but were not mated until 18 mo of age had a slightly better mature reproductive performance than ewes which did not do so (Ponzoni et al., 1979). The cumulative lamb production was without exception greater for ewes which showed estrus their first winter as lambs than for those which did not show estrus (Hulet et al., 1969).

Kennedy and Kennedy (1968) found there were no significant differences in performance following joining at 30 mo of age between ewes first joined at 18 mo of age and ewes first joined at 30 mo of age, although the early exposed group were lighter at 30 mo than the late exposed group. Tyrell et al. (1974) found a tendency for pregnancy in young ewes (7 to 9 mo) to be associated with reduced body weight and fertility at 18 mo of age. Spencer (1942) found ewes lambing at 1 year of age had the same weight disadvantage during their second year but not in years 3, 4 or 5. Pregnancy in ewes joined at 8 mo was associated with a short-term check to growth which was overcome by the time their second lamb crop was weaned (Briggs, 1936). The author further noted that ewe lambs that conceived gained more weight prior to lambing time faster than the open ewes but weighed less at the time the lambs were weaned than ewes remaining open. Female sheep lambing at 1 year of age were lighter at 2 years of age than ewes that did not lamb in their first year, but the differences had largely disappeared by 3 years of age (Omar et al., 1977). Cannon and Bath (1969) found ewes having raised a lamb as yearlings were lighter the next year.

Dzakuma et al. (1982b) reported that ewes producing twins at their first lambing subsequently produced an average of .11 more lamb per lambing than ewes producing singles and ewes producing singles subsequently produced an average of .16 more lamb per lambing than ewes that produced no lamb. They concluded that the first lambing at 1 year of age was a better predictor of the ewe's lifetime lambing rate than was the second lambing. Levine et al. (1978) found that how effectively the ability to lamb at 1 year of age predicted future production differed between breeds, with early lambing Columbias producing 48.9 more kg of lamb and early lambing Targhees only producing 5.9 kg more lamb over their lifetime than the late lambing group. The proportion of ewes pregnant and giving birth to twins following the 18-mo joining was independent of whether or not the ewes had lambed previously (Tyrell, 1976). For cumulative production per ewe present at lambing, ewes able to lamb at 1 year of age produced 5.6 kg more lamb than ewes unable to lamb at 1 year of age (Levine et al., 1978). Ponzoni et al. (1979) found that the effect of pregnancy and lactation as young ewes persisted throughout the 5 years during which the study was conducted. Ewes which were heavier in the fall as yearlings on the average weaned more kilograms of lamb per ewe during their lifetime. This advantage was due more to a higher percentage of lambs weaned than to heavier weaning weights (Terrill and Stoehr, 1942).

Levine et al. (1978) found that attrition rates for ewes not lambing at 1 year of age were higher than for ewes which did lamb at 1 year of age. Briggs (1936) noted that the early lambing group had more mouth problems as mature ewes.

Ewes rearing a lamb as yearlings had lower grease fleece weight during their second year than ewes not lambing until 18 mo (Ponzoni et al., 1979). This reduced fleece weight the second year was also noted by Spencer et al. (1942), Kennedy and Kennedy (1968), Tyrell et al. (1974) and Tyrell (1976). Burfening et al. (1972) found there was no significant effect on lifetime grease fleece production due to estrus as a ewe lamb. Hulet et al. (1969) found ewes which did not come in heat their first winter produced slightly but not significantly more kilograms of grease wool over their lifetime than those which came in heat their first winter. Terrill and Stoehr (1942) did find a slight advantage in lifetime average fleece weight in favor of the ewes heavier as yearlings.

Longevity

Total annual and lifetime weight of lamb weaned per ewe of the original flock is another way of expressing the overall economic advantage in production from various breeds or crosses because it takes longevity into consideration (Vesely and Peters, 1974). Longevity remains a trait that has received little emphasis in breed evaluation experiments (Hohenboken and Clarke, 1981). Later work by Saoud and Hohenboken (1984) found that longevity affected efficiency of lifetime production. In their study, total number of lambs born and weaned was considerably higher for ewes surviving until the end of the experiment.

Barker (1975) noted that, although no accurate figures were available, it would be reasonable to assume that for every 100 ewes put to the ram in their first year 95 would survive for the second year, 90 in the third year and 85 in the fourth year. Norman and Hohenboken (1979) reported annual attrition rates of 4.9% and 4.6% for ewes born in 1974 and 1975, respectively. From a New Zealand farm survey, Davis (1974) reported that ewe mortality averaged 4.9% annually. Forrest and Bichard (1974) found an overall reduction from culling and death of about 5% the first year and 10% per annum thereafter. Using summaries of studies with Australian Merinos, Turner and Young (1969) projected annual death rates of ewes to be 2.2 to 10% to 6 1/2 years and then 5.5 to 15% thereafter. Norman and Hohenboken (1979) found 42% of the attrition was due to illness, 5% reproductive, 16% accident and 37% culling or unknown.

At least part of the breed differences in cumulative lamb production is dependent upon breed differences in longevity (Hohenboken and Clarke, 1981). Significant differences in mortality rate were found among purebred Romnelet, Columbia, Suffolk and North Country Cheviot ewes by Vesely and Peters (1974). They found that at the end of 8 1/2 years of production the percentages of ewes remaining in the study were Romnelet, 36.6% (22/60); Columbia, 41% (25/61); Suffolk, 8% (5/63); and North Country Cheviot, 0% (0/40). Norman and Hohenboken (1979) found attrition rates were higher for Finnsheep- and North Country

Cheviot-sired ewes than for Dorset- and Romney-sired ewes. Saoud and Hohenboken (1984) noted that examination of ewes surviving the entire duration of the experiment failed to identify any early life trait that predicted longevity.

Vesely and Peters (1981) found mortality of crossbred ewes was no different from the average mortality of the purebreds. As reported earlier, Levine et al. (1978) found attrition rates for ewes not lambing at 1 year of age were higher than for ewes which did lamb at 1 year of age.

Management System (Location)

The multiplicity of sheep breeds throughout the world, greater perhaps than for any other species of livestock, suggests that breeding for local adaptation may be of considerable importance in the ovine species (Carter et al., 1971). Environmental levels of variation could take into account a wide array of combinations of at least temperature, nutrition, photoperiod and system of management (Morley, 1956).

Lax and Turner (1965) found location differences in survival rate were highly significant and noted in poorer environments age of ewe had a more marked effect on lamb survival than it did in more favorable environments. Wiener et al. (1973) reported that, although breed x environmental interactions could not be estimated, differences in lamb mortality were found between different types of farms. Hohenboken and Clarke (1981) found management system, classified as hill pasture or irrigated pasture, did not affect lamb survival percentages significantly.

Hohenboken and Clarke (1981) found Dorset, Finnsheep and Romney crossbreds to be more productive on irrigated pasture than on hill pasture, while Cheviot crossbreds were more productive on hill pastures. Hohenboken et al. (1976) found that with Hampshire, Suffolk and Willamette ewes each breed was more productive under hill pasture than under irrigated pasture. Hohenboken and Clarke (1981) reported that on hill pastures, Columbia crossbred ewes were more productive than Suffolk crossbreds, while on irrigated pasture the reverse was true.

Shrestha et al. (1983) found location, although very similar, had a significant effect on fertility, overall reproduction, average lamb weight per ewe at birth and weaning and total lamb weight per ewe at weaning. Carter et al. (1971) found a highly significant breed x location interaction for lambing date and a significant interaction for weight of lamb weaned per ewe mated. Hohenboken and Clarke (1981) found significant breed x management system interactions for longevity of the ewe.

It was noted by McManus et al. (1966) that the differences between animals for wool are usually more pronounced on high planes of nutrition, suggesting that harsh climate may have an equalizing effect on wool production. Mechling and Carter (1969) noted that some environments may be harsh enough to prevent ewes from expressing their full genetic potential.

No location, management system or environment are totally repeatable and research in this area tends to be difficult to compare. When differences do exist, breeds more adapted to those conditions will respond with greater production.

MATERIALS AND METHODS

Objectives

This experiment is a part of a continuing research effort designed to increase the efficiency of lamb production. Specific objectives of this study were as follows:

1. To determine those factors which contribute to efficient lamb and wool production.
2. To determine the production of Targhee, Finnsheep x Targhee and Suffolk x Targhee ewes.
3. To determine the effect of two different management (location) systems, farm vs range, on lamb and wool production.
4. To determine the lifetime productivity of the three breed groups within the two management systems.

Experimental Flock Development

A flock of straightbred Targhee ewes was purchased by the university to produce the experimental flock. Ewes (n = 365) were purchased during the summer of 1975 and allotted to the Antelope Range Research Station, Buffalo, South Dakota (Antelope), or to the South Dakota State University Sheep Research Unit, Brookings, South Dakota (Brookings). Numbers allotted were 256 at Antelope and 109 at Brookings.

Ewes assigned to Antelope were randomly allotted to sire groups of either Targhee or Suffolk. The Brookings group was allotted to the Finnsheep sire group. All groups were exposed to rams in a group mating system. The ewes at Antelope alternated between sire groups on succeeding years. The breeding season each year was in the fall and lasted approximately 35 d for early spring lambing.

Experimental Flock

The ewe lambs resulting from matings in 1976, 1977 and 1978 made up the experimental flock. No selection was used on the ewe lambs and all ewe lambs present at 7 to 8 mo of age were exposed and all ewe lambs surviving to 15 to 16 months were included in the study regardless of yearling production levels.

Data collected on the experimental ewes included year of birth, type of birth, breed of ewe, date of birth, date weaned, weaning weight, prebreeding weight (approximately 7 mo), weight at weaning of the first lamb crop (approximately 15 mo), date of first lambing and date and reason for disposal. Subsequent annual ewe weights at weaning were recorded at Brookings and annual ewe weights at breeding were recorded at Antelope. Annual wool weights were recorded at both stations. Data collection for the experimental flock and the progeny were the responsibility of the station manager at the respective locations. Lambs born at Brookings (Finnsheep x Targhee) were given access to creep feed and alfalfa hay from shortly after birth until weaning. Ewe lambs born at Antelope (Targhee and Suffolk x Targhee) were raised on native range without supplemental feeding prior to weaning. All groups were weaned at about 10 wk of age (approximately

June 1), at which time the Antelope groups were moved to Brookings and started on feed.

After adjusting to feed, the three groups were co-mingled in a single lot with a self-fed ration of 60% cracked corn and 40% chopped hay. All lambs were sheared in mid- to late June. Lambs were maintained on the 60/40 ration until 2 wk prior to the breeding season.

Approximately September 15, the ewe lambs were fed a ration of self-fed ground hay and .68 kg cracked corn per head per day. In addition, they had access to pasture during the day. Teaser rams were placed with the ewes for a period of approximately 2 wk. The breeding season began on September 30 and was of a 5-wk duration. All ewe lambs were group mated to Suffolk rams as a terminal sire. The progeny were of the following breed combinations: 1/2 Suffolk-1/2 Targhee, 1/2 Suffolk-1/4 Finnsheep-1/4 Targhee and 3/4 Suffolk-1/4 Targhee.

At the completion of the breeding season, ewe lambs were confined to drylot for the duration of gestation. The gestation ration consisted of .9 kg per head per day of the 60/40 cracked corn and alfalfa hay ration and they were given access to ground alfalfa hay free choice in self-feeders. Starting 8 wk prior to lambing, they were fed chopped hay and cracked corn at recommended levels throughout late gestation and lactation.

Lambing practices were consistent with typical farm flock procedures used at the Brookings Station and will be outlined later. Data collected on the progeny included dam, breed of dam, age of dam, year of birth, type of birth, date of birth, birth weight, sex, weaning weight and death of lamb.

Following weaning of the first lamb crop, one-half of the experimental flock in each breed group was assigned to Antelope and one-half to Brookings for collection of lifetime production. Only ewes surviving to the time of allocation were included in the study. Procedures used for 1976, 1977 and 1978 were similar for the establishment of the experimental flock. The first year lambing procedures were also similar for the years involved. Experimental ewes in the study are shown in table 1.

TABLE 1. NUMBERS OF EXPERIMENTAL EWES ALLOCATED TO TREATMENT GROUPS

Management and breed	Year 1976	1977	1978
Range			
Targhee	21	26	16
Finnsheep x Targhee	27	31	8
Suffolk x Targhee	28	23	19
Farm			
Targhee	21	30	17
Finnsheep x Targhee	27	35	16
Suffolk x Targhee	32	24	20

Experimental flock ewes were mated such that each group had an opportunity for six lamb crops. Ewes were culled from the flock as a result of death, failure to lamb in two consecutive opportunities (including 12-mo lambing) or for severe reproductive abnormalities such as damaged udder or prolapse.

Farm Management System, Brookings

The lambing and yearling management practices at Brookings were consistent with typical farm flock production. Brookings is located in east central South Dakota. Improved pastures were used along with drylot confinement during the winter months. Prior to the breeding season, ewes were wormed, tagged and hooves were trimmed. The flushing ration included free-choice pasture and .34 kg of cracked corn. Ewes were exposed to teaser rams for 2 wk prior to the breeding season. Breeding season began approximately September 1 and lasted 35 d. Ewes prior to lambing were semi-confined to a shed lambing system and monitored for parturition. At the time of birth, ewes and their lambs were confined to lambing jugs and moved into small group pens at approximately 2 to 3 d. Routine lambing procedures included ear tagging, dipping of navel, docking and assisting in suckling. All lambs had access to creep feed from shortly after birth and were switched gradually to a grower ration prior to weaning at approximately 65 d. Male lambs were left intact and were self-fed until finished for market. No ewe regardless of breed group was allowed to nurse more than two lambs during lactation. Those lambs which were placed on milk replacer diets or grafted were not included in the weaning analyses. Shearing of ewes took place 1 to 2 mo prior to lambing. Routine worming, external parasite control, hoof trimming and disease treatment were practiced based on the discretion of the shepherd.

Range Management System, Buffalo

The lambing and yearly management practices at Antelope were consistent with typical range flock production. Buffalo is located in northwest South Dakota. Native pastures in good range condition were used along with supplemental hay given when range and(or) weather conditions did not allow for grazing. Prior to the breeding season, ewes were routinely tagged and examined for those ewes not fit to breed that season. Ewes were given access to good quality range and exposed to rams for 35 d. For the 1978 lambing, the breeding season started on October 1. All years after that, the season started from November 5 to 15. Prior to lambing, ewes were given access to drylot and(or) range. At or just prior to lambing, the ewe and lamb were confined in a shed lambing unit for approximately 2 d, at which time they were returned to drylot or range, depending on weather conditions. Routine management practices included ear tagging, dipping of the navel, docking and assisting in receiving colostrum. Male lambs were castrated and no lamb received creep feed. No ewe was allowed to nurse more than two lambs during lactation. Extra lambs (i.e., triplets, etc.) were either grafted or sold shortly after birth. Ewe and lamb pairs were raised on native range until weaning at approximately 120 d. Shearing took place 1 to 2 mo prior to lambing. Routine worming, external parasite control and disease treatment were practiced based on the discretion of the shepherd.

Statistical Analysis of Data

The birth and growth characteristics of the experimental flock prior to their first lambing were tested using a least-squares analysis of variance. Differences in ewe productivity were first tested on an age of ewe basis with results analyzed at 12, 24, 36, 48, 60 and 72 mo. This procedure allowed differences to be determined at each age of ewe for those ewes present at that age. A second analysis was done on cumulative production with each year's values added to the previous values. These differences were determined for ewes present at the time and for those ewes initially entering the study.

Factors used in the analysis included ewe type of birth (type), breed of ewe (breed), year of production (year), number of lambs born (number born), sex of the lamb (sex) and birth and rearing class of the lamb(s) [birth/rearing]. For production after 12 mo, management system (management) was also used. In addition to the main effects, two-way interactions were tested.

Analyses for percentage of ewes lambing and cause of lamb loss used the Funcat procedure (Sall, 1979). This procedure models functions of categorical responses as a linear model. Funcat uses generalized least-squares to produce minimum chi-square estimates. Chi-square tests at the 5% level were performed on percentage of lambs lost from birth to weaning (Steel and Torrie, 1980). All other analyses utilized the least-squares analysis of variance procedures. All analysis of variance tables are found in the appendix. Sums of squares for weight traits are based on English values. Many of the significant two-way interactions occurred due to differences imposed by management. In addition, numbers of observations in some subclasses became very small in later years and may have affected the presence of interactions. All significant (P<.05) interactions are included in table 27 in the appendix. These interactions are not discussed in the text. Very few significant (P<.05) two-way interactions appeared in the cumulative analysis.

RESULTS AND DISCUSSION

Experimental Flock Birth and Growth Characteristics

In order to determine if treatment groups differed prior to production of their first lamb crop, ewe birth weight, birth date, weaning weight and prebreeding weight were analyzed. Factors used to test the main effects were ewe type of birth and breed of sire. Least-squares means and standard errors are shown in table 2.

Birth weights differed ($P < .001$) between ewes born as singles vs ewes born as multiples. Single-born ewes weighed 5.22 kg at birth, while multiple-born ewes weighed 4.39 kg. Finnsheep-sired ewes were lighter ($P < .05$) at birth than either Suffolk- or Targhee-sired ewes. Birth weights recorded were 4.64, 4.89 and 4.88 kg for Finnsheep x Targhee, Suffolk x Targhee and Targhee ewes, respectively. These findings are in agreement with work by many authors, including Oltenacu and Boylan (1981b), whose work included the same three breeds.

Birth dates differed ($P < .001$), partially due to different breeding dates imposed by management. Average birth date for all groups was March 4, with a range of March 1 to March 7 for individual treatment groups.

Weaning weight differed ($P < .001$) between ewes of single vs multiple birth types. Single-born ewes averaged 30.0 kg, with multiple-born ewes averaging 25.1 kg. Breeds also differed ($P < .001$) in weaning weight. The Finnsheep-sired ewes weighed 24.3 kg, with weights of the Suffolk-sired and Targhee-sired ewes 29.1 and 29.2 kg, respectively.

TABLE 2. LEAST-SQUARES MEANS AND STANDARD ERRORS FOR EWE BIRTH DATE (DAYS AFTER JANUARY 1), BIRTH WEIGHT, WEANING WEIGHT AND PREBREEDING WEIGHT (KG)

Parameter	Birth date	Birth weight	Weaning weight	Prebreeding weight
Overall mean	63.20	4.68	26.8	45.3
Ewe type of birth	***	***	***	***
Single	65.72 ± .817[a]	5.22 ± .065[a]	30.0 ± .45[a]	47.4 ± .69[a]
Multiple	62.40 ± .513[b]	4.39 ± .041[b]	25.0 ± .29[b]	44.1 ± .43[b]
Breed of sire	***	*	***	
Targhee	66.20 ± .739[a]	4.88 ± .059[a]	29.2 ± .41[a]	45.2 ± .62
Suffolk	65.73 ± .847[a]	4.88 ± .056[a]	29.1 ± .38[a]	47.0 ± .59
Finnsheep	60.26 ± 1.03[b]	4.64 ± .182[b]	24.3 ± .57[b]	45.0 ± .87

* P<.05.
*** P<.001.
[a,b] Means with unlike supercripts in the same column and within main effects differ (P<.05).

Weaning weight differences were also in agreement with reports from Oltenacu and Boylan (1981b).

Prebreeding weights obtained at approximately 7 mo of age did not differ (P>.05) between breed groups. Values obtained were as follows (kg): Finnsheep, 45.0; Suffolk, 47.0; and Targhee, 45.3. Single-born ewes were heavier (P<.001) at breeding time with a weight of 47.4 kg vs multiple-born ewes at 44.1 kg. This 3.3-kg difference is similar to that reported by Price et al. (1953).

Annual Ewe Weight

All treatment groups were weighed on an annual basis. Due to differences which existed between management systems, the stage in the production cycle at which ewes were weighed was different. The farm flock ewes were weighed each year when the lambs were weaned. The range flock ewes were weighed at the time of breeding. Due to imposed differences, the two systems were analyzed separately and were not compared. Factors used to test differences in ewe weight were ewe type of birth (type), breed of ewe (breed) and year of production (year). Least-squares means and standard deviations for the range flock ewes are found in table 3 and for farm flock ewes in table 4.

Under the range system, ewe type of birth was a highly significant source of variation (P<.001) for the first breeding season and significant (P<.05) at the second season. No differences were found in any of the succeeding years. This is in agreement with results found by Dun and Grewal (1963) who found a type of birth handicap for weight until 18 mo of age. The breed of ewe did not affect breeding weights

TABLE 3. LEAST-SQUARES MEANS AND STANDARD ERRORS FOR ANNUAL EWE WEIGHT (KG) AT BREEDING (RANGE MANAGEMENT SYSTEM, ANTELOPE)

Parameter	Age in months					
	12	24	36	48	60	72
Overall mean	45.0	65.2	68.9	70.8	69.1	66.9
Ewe type of birth	***	*				
Single	48.9 + .96^{a}	66.1 ± 1.17^{a}	67.9 ± 1.25	72.4 ± 1.67	69.4 ± 1.71	68.5 ± 1.86
Multiple	43.3 ± .51^{b}	63.4 ± .63^{b}	67.9 ± .66	69.0 ± .76	67.1 ± .82	65.0 ± .99
Breed of ewe^{d}			***	*	**	*
T	44.9 ± .69	65.4 ± .86	69.4 ± .88^{a}	72.4 ± .98^{a}	71.6 ± 1.05^{a}	69.6 ± 1.27^{a}
ST	47.2 ± .68	66.1 ± .82	71.0 ± .84^{a}	72.7 ± .94^{a}	70.2 ± 1.09^{a}	68.6 ± 1.13^{a}
FT	46.3 ± 1.27	63.0 ± 1.54	63.3 ± 1.68^{b}	66.9 ± 2.27^{b}	62.9 ± 2.26^{b}	62.0 ± 2.38^{b}
Year of production	***	***	***		*	**
1977	40.8 ± .67^{a}					
1978	47.3 ± .75^{b}	70.5 ± .83^{a}				
1979	50.3 ± 1.11^{c}	62.5 ± .90^{b}	71.2 ± .86			
1980		61.4 ± 1.35^{b}	67.6 ± 1.02	72.4 ± .98^{a}		
1981			64.9 ± 1.34	69.6 ± 1.36^{b}	69.9 ± 1.02^{a}	
1982				70.0 ± 1.64^{b}	69.3 ± 1.51^{ab}	70.8 ± 1.32^{a}
1983					65.5 ± 1.64^{a}	64.7 ± 1.65^{b}
1984						64.7 ± 1.95^{b}

* $P<.05$.
** $P<.01$.
*** $P<.001$.
^{a,b,c} Means with unlike superscripts in the same column and within main effects differ ($P<.05$).
^{d} T = Targhee, ST = Suffolk x Targhee and FT = Finnsheep x Targhee.

TABLE 4. LEAST-SQUARES MEANS AND STANDARD ERRORS FOR ANNUAL EWE WEIGHT (KG) AT WEANING (FARM MANAGEMENT SYSTEM, BROOKINGS)

	Age in months					
Parameter	12	24	36	48	60	72
Overall mean	53.8	55.7	58.5	62.5	66.1	73.5
Ewe type of birth	*					
Single	54.8 ± 1.14[a]	57.3 ± 1.10	60.2 ± 1.38	65.2 ± 1.81	69.5 ± 1.78	74.5 ± 1.99
Multiple	51.9 ± .68[b]	55.4 ± .65	57.2 ± .82	62.5 ± 1.08	65.6 ± .94	73.9 ± 1.28
Breed of ewe[d]						
T	51.8 ± 1.08	55.5 ± 1.00	56.8 ± 1.29	63.4 ± 1.68	66.0 ± 1.66	72.3 ± 1.98
ST	54.3 ± .97	57.7 ± .93	60.5 ± 1.15	66.1 ± 1.57	68.9 ± 1.62	77.4 ± 1.86
FT	54.0 ± 1.28	55.8 ± 1.28	58.9 ± 1.57	62.0 ± 1.94	67.7 ± 2.07	72.9 ± 2.15
Year of production	***	***	***	*	*	***
1977	57.0 ± .94[a]					
1978	55.6 ± 1.03[a]	62.5 ± .91[a]				
1979	47.5 ± 1.38[b]	49.4 ± .96[b]	56.8 ± .94[a]			
1980		57.2 ± 1.30[c]	63.7 ± 1.12[b]	66.2 ± 1.48[a]		
1981			55.7 ± 1.68[a]	60.5 ± 1.43[b]	63.6 ± 1.54[a]	
1982				64.8 ± 2.29[a]	67.4 ± 1.60[ab]	68.1 ± 1.80[a]
1983					71.5 ± 2.13[b]	76.3 ± 1.83[b]
1984						78.2 ± 2.35[b]

* P< .05.
** P< .01.
*** P< .001.
[a,b,c] Means with unlike superscripts in the same column and within main effects differ (P< .05).
[d] T = Targhee, ST = Suffolk x Targhee and FT = Finnsheep x Targhee.

for the first two breeding seasons. During the third season, the Finnsheep x Targhee ewes were lighter (P<.001) and the Suffolk x Targhee and Targhee did not differ. This same pattern remained for the duration of the experiment, as the Finnsheep x Targhee ewes were lighter (P<.05) through the sixth breeding season and the Suffolk x Targhee and Targhee did not differ (P>.05). These results would indicate that weight at 36 mo is the best reflection of mature weight of the three breeds. This is in agreement with reports by Barker (1975) who found Finnsheep crossbreds to be lighter at mating than non-Finnsheep crossbreds. Calendar year of production contributed to differences in ewe weight. Differences due to year are highly dependent upon environmental factors not controllable by management and were not considered to be of major interest.

For the farm flock, ewe type of birth was only a significant (P<.05) source of variation at weaning time of the first lamb crop. By weaning time of the second lamb crop, ewes were 24 mo old and the differences were no longer detectable. Ewe weights did not differ (P>.05) between breeds for any age of ewe. This may suggest that weaning time is not the most appropriate time of the production cycle to measure weight differences between breeds. As was found among the range ewes, year of production differences (P<.05) were detected.

Percentage of Ewes Lambing of Those Exposed

As a measure of fertility, data are presented on the percentage of ewes lambing of those exposed. Values are presented in table 5. No differences (P>.05) were found for fertility between birth classes of

TABLE 5. PERCENTAGE OF EWES LAMBING

Parameter	Age in months 12	24	36	48	60	72
Overall mean	60.3	85.1	87.0	93.6	88.5	87.1
Ewe type of birth						
Single	61.4	90.7	85.1	93.5	84.9	85.3
Multiple	59.8	82.2	88.0	93.7	90.6	88.2
Breed of ewe[a]	***					
T	40.5	86.8	85.3	92.9	91.4	82.8
ST	66.4	84.0	89.1	92.3	80.2	87.9
FT	72.2	84.6	86.4	95.8	91.8	90.6
Year of production	**					
1977	50.0					
1978	63.3	86.1				
1979	71.9	82.2	80.0			
1980		88.5	93.6	94.3		
1981			86.4	94.3	83.2	
1982				91.3	92.9	89.1
1983					89.8	85.0
1984						88.0
Management system						
Farm		87.2	85.2	92.3	88.3	84.8
Range		82.7	89.2	95.3	88.7	90.2

** $P<.01$.

*** $P<.001$.

[a] T = Targhee, ST = Suffolk x Targhee and FT = Finnsheep x Targhee.

ewe, single vs multiple. Breeds differed ($P<.001$) in their ability to lamb at 1 year of age. At this age, overall fertility was 60.3% with breed values of 40.5% for Targhee, 66.4% for Suffolk x Targhee and 72.2% for Finnsheep x Targhee. The superiority of the Finnsheep for fertility at 1 year of age was further documented by Oltenacu and Boylan (1981a) and Barker (1975). Years differed ($P<.01$) for fertility only at the first breeding season. For ages 2 through 6 years, breeds did not differ ($P>.05$). No breed group consistently had higher values nor did the rank between the three breed groups remain constant. At no age of ewe did management systems differ ($P>.05$). It is of interest to note that the lowest fertility was found at the first season, with a marked increase by the second season, 60.3% vs 85.1%. This is in agreement with work reported by Forrest and Bichard (1974) who found similar responses. The consistent rise in fertility with a peak at 4 years of age (93.6%) and small reductions at ages 5 and 6 suggested a curvilinear response similar to that described by Dickerson and Glimp (1975). It is important to remember that, due to ewes leaving the experiment, the performance of older ewes is derived from fewer individuals. In addition, failure to lamb in two consecutive seasons automatically eliminated a ewe from the study.

Date of Birth

Results on date of lamb birth are presented in table 6. Type, breed, year, management system (management), sex of lamb (sex) and number of lambs born (number born) were used to evaluate birth date differences.

TABLE 6. LEAST-SQUARES MEANS AND STANDARD ERRORS FOR DATE OF BIRTH OF LAMBS (DAYS AFTER JANUARY 1)

Parameter	Age in months					
	12	24	36	48	60	72
Overall mean	73.5	74.8	82.0	79.9	80.3	82.6
Ewe type of birth						
Single	72.5 ± 1.69	72.9 ± 4.77	83.8 ± 1.18	84.6 ± 1.27	82.2 ± 1.53	84.2 ± 1.95
Multiple	75.8 ± 1.30	78.2 ± 3.24	83.3 ± .82	82.5 ± .81	82.9 ± 1.06	86.3 ± 1.15
Breed of ewe[c]	*				**	
T	77.3 ± 2.76[a]	78.0 ± 4.49	85.6 ± .99	84.8 ± 1.05	86.9 ± 1.29[a]	86.0 ± 1.65
ST	74.9 ± 1.48[a]	77.3 ± 3.73	84.3 ± .86	81.5 ± .98	83.6 ± 1.16[a]	84.5 ± 1.29
FT	70.3 ± 1.40[b]	71.3 ± 7.45	80.7 ± 1.83	84.3 ± 1.77	77.1 ± 2.52[b]	85.3 ± 2.76
Year of production	**	***	***			
1977	73.3 ± 1.81[a]					
1978	71.3 ± 1.22[a]	61.6 ± 3.91[a]				
1979	77.9 ± 2.01[b]	84.7 ± 4.29[b]	86.7 ± 1.06[a]			
1980		80.2 ± 5.43[b]	80.6 ± 1.00[b]	82.6 ± 1.03		
1981			83.3 ± 1.41[b]	82.1 ± 1.16	80.4 ± 1.26	
1982				85.9 ± 1.47	82.2 ± 1.38	85.2 ± 1.57
1983					85.1 ± 1.91	86.6 ± 1.39
1984						84.1 ± 2.63
Management system		***	***	***	***	***
Farm		56.7 ± 3.68[a]	59.9 ± .89[a]	59.1 ± .94[a]	58.6 ± 1.14[a]	61.4 ± 1.84[a]
Range		94.4 ± 4.06[b]	107.2 ± 1.03[b]	108.0 ± 1.09[b]	106.5 ± 1.36[b]	109.1 ± 1.41[b]
Sex of lamb						
Female	74.6 ± 1.29	74.1 ± 3.92	83.1 ± 1.02	84.0 ± 1.00	83.5 ± 1.21	85.4 ± 1.41
Male	73.8 ± 1.60	77.0 ± 3.83	84.0 ± .89	83.1 ± .99	81.5 ± 1.33	85.1 ± 1.67
Number of lambs born						
Single	73.9 ± .87	76.3 ± 4.71	83.8 ± 1.22	84.1 ± 1.14	82.0 ± 1.67	85.8 ± 2.27
Multiple	74.4 ± 2.33	74.8 ± 3.83	83.3 ± .81	83.0 ± .89	83.1 ± .93	84.7 ± .97

* $P<.05$.
** $P<.01$.
*** $P<.001$.
[a,b] Means with unlike superscripts in the same column and within main effects differ ($P<.05$).
[c] T = Targhee, ST = Suffolk x Targhee and FT = Finnsheep x Targhee.

Ewe type of birth, sex of lamb and number of lambs born failed to have any significant effect ($P>.05$) on the date of birth. Finnsheep x Targhee ewes lambed earlier ($P<.05$) at 1 and 5 years of age. At these two ages, the range in average birth date was 7 to 10 d. The differences found due to year of production and management system were due in large part to differences imposed by management and were of little practical importance.

Lamb Birth Weight

Individual birth weights were obtained and recorded for all lambs. Type, breed, year, number born, sex and management were used to test the main effects. Least-squares means and standard errors are shown in table 7.

Lamb birth weights differed ($P<.01$) with ewe type of birth for ewes 1 and 3 years of age. Single-born ewes produced lighter lambs for the first two seasons. However, values only differed ($P<.05$) for ewes at 1 year of age. At 3 years of age, single-born ewes produced heavier ($P<.01$) lambs. This trend remained through age 5, although values were similar ($P>.05$). The variation in differences found is in agreement with work reported by Terrill and Stoehr (1942) who found no consistent differences in lamb weights between ewes born as singles or twins.

Lamb birth weights differed ($P<.01$) for the breed groups at each age. Finnsheep x Targhee ewes produced the lightest lambs at each age of ewe. Targhee and Suffolk x Targhee ewes produced lambs similar ($P>.05$) in weight at age 1 and 2 years, after which the Targhees were

TABLE 7. LEAST-SQUARES MEANS AND STANDARD ERRORS FOR LAMB BIRTH WEIGHT (KG)

Parameter	Age in months					
	12	24	36	48	60	72
Overall mean	4.54	4.40	4.69	4.96	4.87	4.74
Ewe type of birth	**		**			
Single	4.37 ± .131^{a}	4.64 ± .087	4.90 ± .098^{a}	5.36 ± .096	5.37 ± .115	5.23 ± .153
Multiple	4.76 ± .103^{b}	4.75 ± .062	5.22 ± .074^{b}	5.23 ± .065	5.21 ± .085	5.32 ± .094
Breed of ewe^{d}	***	**	***	***	***	***
T	4.89 ± .216^{a}	4.94 ± .079^{a}	5.50 ± .084^{a}	5.73 ± .083^{a}	5.49 ± .097^{a}	5.82 ± .127^{a}
ST	4.79 ± .110^{a}	4.74 ± .069^{a}	5.13 ± .075^{b}	5.38 ± .007^{b}	5.20 ± .090^{b}	5.30 ± .106^{b}
FT	4.02 ± .260^{b}	4.41 ± .367^{b}	4.54 ± .160^{c}	4.78 ± .136^{c}	4.77 ± .199^{b}	4.69 ± .217^{c}
Year of production		***				
1977	4.76 ± .321					
1978	4.44 ± .096	4.85 ± .076^{a}				
1979	4.51 ± .167	4.29 ± .080^{b}	4.98 ± .099			
1980		4.95 ± .102^{a}	5.02 ± .084	5.29 ± .081		
1981			5.17 ± .122	5.45 ± .090	5.33 ± .010	
1982				5.15 ± .115	5.12 ± .007	5.17 ± .130
1983					5.42 ± .147	5.26 ± .109
1984						5.38 ± .205
Number of lambs born	***	***	***	***	***	***
Single	4.96 ± .084^{a}	5.27 ± .100^{a}	5.73 ± .116^{a}	5.86 ± .098^{a}	5.85 ± .141^{a}	5.87 ± .191^{a}
Multiple	4.17 ± .173^{b}	4.12 ± .060^{b}	4.38 ± .057^{b}	4.73 ± .057^{b}	4.73 ± .057^{b}	4.67 ± .060^{b}
Sex of lamb			*	***		*
Female	4.59 ± .109	4.65 ± .073	4.94 ± .088^{a}	5.10 ± .076^{a}	5.30 ± .093	5.12 ± .113^{a}
Male	4.55 ± .116	4.74 ± .073	5.18 ± .077^{b}	5.49 ± .078^{b}	5.28 ± .104	5.42 ± .132^{b}
Management system		***	**		*	
Farm		4.84 ± .071^{a}	5.20 ± .079^{a}	5.40 ± .075	5.41 ± .091^{a}	5.29 ± .150
Range		4.55 ± .076^{b}	4.92 ± .089^{b}	5.19 ± .083	5.17 ± .104^{b}	5.25 ± .109

* P<.05.
** P<.01.
*** P<.001.
^{a,b,c} Means with unlike superscripts in the same column and within main effects differ (P<.05.
^{d} T = Targhee, ST = Suffolk x Targhee and FT = Finnsheep x Targhee.

heavier (P<.05). The reduction in lamb birth weight by the use of Finnsheep ewes is in agreement with studies reported by Barker (1975) and Notter and Copenhaver (1980).

Single-born lambs were heavier (P<.001) than those lambs born as multiples. This follows well-documented findings by numerous authors. The difference between the birth classes of lambs was the least from 1-year-old ewes at .79 kg and the greatest from 3-year-old ewes at 1.36 kg.

Female lambs were lighter (P<.05) than male lambs from ewes 3, 4 and 6 years old. Lamb birth weights did not differ (P>.05) for ewes of other ages. This inconsistency between lambs of different sexes does not follow the widely held finding that male lambs are heavier at birth than female lambs.

Although lambs produced under farm flock conditions were heavier at each age based on least-squares means, they only differed (P<.05) for lambs from 2-, 3- and 5-year-old ewes.

Number of Lambs Born Per Ewe Exposed

One of the most common factors used to compare ewe performance is the number of lambs born per ewe exposed (lambing percentage). Least-squares means and standard errors for number of lambs born per ewe exposed are found in table 8. Factors analyzed were type, breed, year and management.

Lambing percentage differed (P<.05) between ewes born as singles vs multiples for 2-year-old ewes. For 2-year-old ewes single-born ewes produced 1.53 lambs per ewe exposed compared to 1.31 for multiple-born

TABLE 8. LEAST-SQUARES MEANS AND STANDARD ERRORS FOR NUMBER OF LAMBS BORN PER EWE EXPOSED

Parameter	Age in months					
	12	24	36	48	60	72
Overall mean	.79	1.36	1.48	1.63	1.62	1.72
Ewe type of birth		*				
Single	.86 ± .072	1.53 ± .082[a]	1.43 ± .094	1.67 ± .097	1.58 ± .113	1.80 ± .137
Multiple	.74 ± .042	1.31 ± .048[b]	1.48 ± .056	1.67 ± .056	1.63 ± .069	1.71 ± .090
Breed of ewe[d]	***	***	***	***	***	***
T	.45 ± .062[a]	1.12 ± .071[a]	1.20 ± .079[a]	1.42 ± .079[a]	1.43 ± .096[a]	1.50 ± .121[a]
ST	.80 ± .058[b]	1.20 ± .065[a]	1.35 ± .075[a]	1.44 ± .073[a]	1.33 ± .091[a]	1.52 ± .109[a]
FT	1.14 ± .087[c]	1.94 ± .101[b]	1.80 ± .119[b]	2.15 ± .125[b]	2.05 ± .042[b]	2.24 ± .171[b]
Year of production	***					
1977	.58 ± .056[a]					
1978	.95 ± .062[b]	1.42 ± .065				
1979	.86 ± .084[b]	1.42 ± .070	1.44 ± .074			
1980		1.43 ± .097	1.46 ± .083	1.60 ± .075		
1981			1.46 ± .107	1.77 ± .083	1.54 ± .088	
1982				1.65 ± .109	1.70 ± .100	1.72 ± .117
1983					1.58 ± .129	1.63 ± .122
1984						1.91 ± .162
Management system						
Farm		1.50 ± .060	1.48 ± .068	1.67 ± .066	1.64 ± .079	1.89 ± .095
Range		1.34 ± .066	1.42 ± .076	1.68 ± .079	1.58 ± .094	1.62 ± .117

* $P<.05$.

*** $P<.001$.

[a,b,c] Means with unlike superscripts in the same column and within main effect differ ($P<.05$).

[d] T = Targhee, ST = Suffolk x Targhee and FT = Finnsheep x Targhee.

ewes. For all other ages of ewes, lambing percentage did not differ (P>.05). It is of interest to note that multiple-born ewes did have at least as high or higher lambing percentage for all other ages except 6 years of age. This increase in lambing percentage was also reported by Dun and Grewal (1963). The pattern of multiple-born ewes producing more lambs during middle age and then dropping is in agreement with reports by Baharin and Beilharz (1977).

Ewe breeds differed (P<.001) in lambing percentage for each age of ewe. Finnsheep x Targhee ewes produced more lambs than the Targhee or Suffolk x Targhee did at each of the six ages. Suffolk x Targhee ewes had a higher (P<.001) lambing percentage than the Targhee for 1-year-old ewes. The Targhee and Suffolk x Targhee ewes did not differ (P>.05) in any of the succeeding ages. The advantage of the Finnsheep is consistent with reports from Oltenacu and Boylan (1981a), Magid et al. (1981b) and Barker (1975). The similar values for the Targhee and Suffolk x Targhee are in agreement with work by Oltenacu and Boylan (1981b) and Dickerson and Glimp (1971).

Years were only significantly different for 1-year-old ewes (P<.001). Management system was not a significant source of variation for any age of ewe.

Based on overall least-squares means, lambing percentage increased with increasing age of ewe except for age 5 when lambing was slightly less. By placing confidence limits around the overall mean at a t value of .05 and comparing adjacent means, only 1-year-old and

2-year-old ewes differed in lambing percentage. The same age effect was found by Barker (1975).

Number of Lambs Born Per Ewe Lambing

By eliminating those ewes failing to lamb, it is possible to more accurately determine the ewes producing greater numbers of lambs per litter. This trait is many times termed fecundity. Factors used to evaluate this were type, breed, year and management. Least-squares means and standard errors are found in table 9.

Numbers of lambs born per ewe lambing were not different ($P > .05$) between single- or multiple-born ewes at any age of ewe. Years differed ($P < .05$) for 1- and 3-year-old ewes. Management systems differed ($P < .001$) for ewes in their sixth lambing season, at which time the farm flock ewes produced .49 more lamb per ewe lambing than the range flock ewes. This difference may have been due in part to a greater number of Finnsheep ewes being present in the farm flock (39 vs 19).

Ewe breeds differed ($P < .001$) for each age of ewe. Finnsheep x Targhee ewes had a higher ($P < .001$) fecundity rate at each age. Suffolk x Targhee and Targhee ewes did not differ ($P > .05$) at any age except for 2-year-old ewes, at which time the Suffolk x Targhee produced .17 more lamb per ewe lambing than the Targhee ewes. The advantage of Finnsheep breeding in fecundity was as apparent as was found for lambing percentage.

Based on overall least-squares means, number of lambs born per ewe lambing increased with increasing age of ewe. Values were the highest for 6-year-old ewes at 1.97. Based on confidence limits of .05

TABLE 9. LEAST-SQUARES MEANS AND STANDARD ERRORS FOR NUMBER OF LAMBS BORN PER EWE LAMBING

Parameter	Age in months					
	12	24	36	48	60	72
Overall mean	1.31	1.59	1.70	1.74	1.83	1.97
Ewe type of birth						
Single	1.25 ± .055	1.65 ± .060	1.73 ± .070	1.73 ± .082	1.83 ± .089	1.99 ± .098
Multiple	1.28 ± .040	1.57 ± .037	1.72 ± .042	1.78 ± .048	1.84 ± .053	1.88 ± .063
Breed of ewe[d]	***	***	***	***	***	***
T	1.08 ± .060[a]	1.24 ± .052[a]	1.46 ± .060[a]	1.53 ± .068[a]	1.63 ± .076[a]	1.76 ± .092[a]
ST	1.17 ± .044[a]	1.41 ± .050[b]	1.55 ± .054[a]	1.55 ± .064[a]	1.59 ± .071[a]	1.71 ± .078[a]
FT	1.53 ± .065[b]	2.18 ± .074[c]	2.17 ± .089[b]	2.17 ± .105[b]	2.27 ± .108[b]	2.33 ± .118[b]
Year of production	**		*			
1977	1.20 ± .055[a]					
1978	1.40 ± .050[b]	1.64 ± .048				
1979	1.19 ± .063[a]	1.65 ± .053	1.83 ± .057[a]			
1980		1.54 ± .069	1.62 ± .060[b]	1.67 ± .064		
1981			1.72 ± .080[ab]	1.83 ± .071	1.81 ± .069	
1982				1.76 ± .094	1.81 ± .076	1.88 ± 0.82
1983					1.88 ± .106	1.79 ± .086
1984						2.13 ± .120
Management system						***
Farm		1.67 ± .044	1.77 ± .050	1.80 ± .085	1.86 ± .061	2.18 ± .069[a]
Range		1.55 ± .049	1.68 ± .057	1.70 ± .068	1.80 ± .074	1.69 ± .084[b]

* P<.05.

** P<.01.

*** P<.001.

[a,b,c] Means with unlike superscripts in the same column and within main effects differ (P<.05).

[d] T = Targhee, ST = Suffolk x Targhee and FT = Finnsheep x Targhee.

about the mean, only 1- and 2-year-old ewes differed in number of lambs born per ewe lambing.

Total Weight Born Per Ewe Lambing

Litter weight of ewe is a reflection of the number born to that litter and the individual weight of each lamb. Type, breed, year, management and number born were used to test the main effects. Least-squares means and standard errors for total weight born per ewe lambing are found in table 10.

Litter weights differed ($P<.05$) for ewe type of birth for 1-year-old ewes. The difference for that age was only .1 kg and the advantage was for the multiple-born ewes. For all other ages, differences were less than .5 kg between the two groups and they did not differ ($P>.05$). Years differed ($P<.01$) only for 2-year-old ewes.

Litter weights under farm flock conditions were higher at each age of ewe and were different ($P<.05$) for each age except 4 years. The greatest variation between management groups was for 6-year-old ewes when farm flock ewes produced 2.0 kg more lamb per litter than range flock ewes.

Breeds differed ($P<.05$) in litter weight for all ages except 1-year-old ewes. For the ages when breeds differed, the Finnsheep x Targhee ewes had the highest values. Rank between the Suffolk x Targhee and Targhee breeds was not consistent across age. The increased weight of the Finnsheep x Targhee breeds was mostly a function of increased number of lambs per litter. The advantage of the Finnsheep

TABLE 10. LEAST-SQUARES MEANS AND STANDARD ERRORS FOR TOTAL WEIGHT OF LAMBS BORN PER EWE LAMBING (KG)

	Age in months					
Parameter	12	24	36	48	60	72
Overall mean	5.9	7.0	7.9	8.6	8.9	9.3
Ewe type of birth	*					
Single	5.9 ± .22^{a}	7.3 ± .22	7.7 ± .25	8.6 ± .32	8.9 ± .37	9.6 ± .39
Multiple	6.0 ± .16^{b}	7.0 ± .14	8.2 ± .15	8.5 ± .19	8.8 ± .22	8.9 ± .24
Breed of ewe^{c}		***	*	*	**	**
T	5.6 ± .24	6.4 ± .19^{a}	7.8 ± .21^{a}	8.4 ± .27^{a}	9.2 ± .32^{a}	9.7 ± .36^{a}
ST	5.7 ± .18	6.6 ± .18^{a}	7.5 ± .20^{a}	7.9 ± .25^{a}	8.0 ± .29^{a}	8.4 ± .30^{b}
FT	5.9 ± .26	8.4 ± .27^{b}	8.6 ± .32^{b}	9.3 ± .42^{b}	9.5 ± .45^{a}	9.7 ± .46^{a}
Year of production		**				
1977	5.8 ± .22					
1978	6.0 ± .20	7.6 ± .18^{a}				
1979	5.3 ± .25	6.7 ± .20^{b}	8.0 ± .20			
1980		7.1 ± .25^{ab}	7.7 ± .21	8.3 ± .25		
1981			8.2 ± .63	9.0 ± .28	8.8 ± .29	
1982				8.4 ± .37	8.4 ± .32	8.8 ± .32
1983					9.3 ± .44	8.9 ± .34
1984						10.0 ± .47
Management system		***	**	*		***
Farm		7.7 ± .16^{a}	8.3 ± .18^{a}	8.9 ± .23^{a}	9.3 ± .25	10.3 ± .27^{a}
Range		6.6 ± .18^{b}	7.6 ± .20^{b}	8.2 ± .27^{b}	8.5 ± .31	8.3 ± .33^{b}

* P<.05.
** P<.01.
*** P<.001.
[a,b] Means with unlike superscripts in the same column and within main effects differ (P<.05).
[c] T = Targhee, ST = Suffolk x Targhee and FT = Finnsheep x Targhee.

x Targhee in production of litters of greater weight is in agreement with reports by Meyer and Bradford (1973).

Based on overall least-squares means, litter weight increased with increased age of ewe. These weight increases were different ($P<.05$) through 4 years of age.

Lamb Losses

The cause of lamb losses from birth to weaning were categorized into one of five classes: born dead, died shortly after birth (within 7 d), unknown cause (7 d of age to weaning), grafted or bummed and disease. Those ewes producing more than two lambs were not given an opportunity to nurse more than two. This practice is one of a practical nature. Nevertheless, it is recognized that statistically it may penalize ewes and groups of ewes bearing triplets.

The percentages of lamb losses in the five categories are presented in table 11. The cause with the highest percentage lamb losses was unknown. Ranking of the other causes was variable between years. It is evident, however, that, as the numbers of multiple births increased with increasing age of the ewe, the percentage of lambs grafted and bummed also increased.

The overall percentages of lambs lost for each year are presented in table 12. The highest lamb loss percentage was found among 1-year-old ewes and declined to the lowest level for 4-year-old ewes. This trend is in agreement with work reported by Sidwell et al. (1962).

TABLE 11. CAUSE OF LAMB LOSS, BIRTH TO WEANING (%)

	Age of ewe in months					
Cause of loss	12	24	36	48	60	72
Born dead	8.1	13.6	8.1	9.8	9.9	12.5
Died shortly after birth[a]	5.4	12.9	13.5	4.9	8.8	6.3
Unknown[b]	49.5	45.0	52.3	46.3	38.5	31.3
Grafted or bummed	2.7	11.4	17.1	31.7	39.6	42.7
Disease[c]	34.2	17.1	9.0	7.3	3.3	7.3

[a] Within 7 d of birth.
[b] Seven d of age to weaning.
[c] Disease related to cause of death was specified.

Type, breed, year, sex, management and number of lambs born were used to test differences in percentage of lambs lost from birth to weaning (table 12). Percentage of lambs lost did not differ (P>.05) by type or sex. The effect of sex on lamb survival was also reported by Galal et al. (1981) and Meyer and Clarke (1970). At 1 year of age, Targhee-born lambs had higher (P<.05) mortality than the average. No other breed differences were significant, which was also found by Hohenboken et al. (1976). The range management system had a lower (P<.05) percentage of lambs lost for 6-year-old ewes. Lamb survival was greater (P<.05) for single-born lambs for 2-, 5- and 6-year-old ewes.

Lamb Weight at Weaning

All lambs within management system were weaned on the same day within the same year. Average age at weaning for the farm flock lambs was 77.5 d and 78.0 d for the range flock lambs. Some variability did exist between years and management system. This variation may be a

TABLE 12. PERCENTAGE OF LAMBS LOST FROM BIRTH TO WEANING

	Age in months					
Parameter	12	24	36	48	60	72
Overall mean	34	25	22	17	22	29
Ewe type of birth						
Single	33	29	21	16	17	24
Multiple	35	23	22	18	25	32
Breed of ewe[a]						
T	46*	24	17	14	14	21
ST	34	28	19	16	19	25
FT	30	24	27	21	30	37
Year of production						
1977	14*					
1978	38	26				
1979	35	25	25			
1980		23	24	18		
1981			14	19	22	
1982				12	26	33
1983					16	25
1984						29
Sex of lamb						
Female	29	25	22	16	20	26
Male	39	25	22	18	24	32
Management system						
Farm		28	24	18	28	35
Range		21	20	20	14	18*
Number of lambs born						
Single	36	15*	13	10	12*	14*
Multiple	32	29	24	19	24	31

[a] T = Targhee, ST = Suffolk x Targhee and FT = Finnsheep x Targhee.
* $P < .05$, from overall mean at that age of ewe.

major factor for statistical differences found for these two parameters. Type, breed, year, management, sex and birth/rearing class were used to test differences in lamb weaning weight. Three birth/rearing classes were developed. They were single-born lambs raised as singles, twin-born lambs raised as singles and twin- or triplet-born lambs raised as twins. Least-squares means and standard errors for lamb weight at weaning are found in table 13.

Lamb weaning weights did not differ (P>.05) between lambs born from single- or multiple-born ewes at any age of ewe. Breed of ewe was not a significant source of variation for lamb weight at weaning (P>.05). All lambs produced were 1/2 blood Suffolk, and this may have tended to have equalized weaning weights. This does conflict somewhat with findings by Vesely and Peters (1972), who attributed most of the outcome in weaning weight to the breed of dam.

Year and management were significant (P<.05) in determining weaning weight. Part of these differences may be explained by the variation in age at weaning time between these factors.

At each age of ewe, male lambs were heavier than female lambs. For 2-, 3- and 4-year-old ewes, the differences were significant (P<.01). On the average, male lambs were 2.2 kg heavier than female lambs. This 2.2-kg advantage is in the middle of the range found by numerous authors.

Differences in lamb weaning weight were found to be due to the birth/rearing class of the lamb (P<.01). At each age of ewe, single-born and reared lambs were heavier than twin-born and reared lambs.

TABLE 13. LEAST-SQUARES MEANS AND STANDARD ERRORS FOR LAMB WEIGHT AT WEANING (KG)

Parameter	Age in months: 12	24	36	48	60	72
Overall mean	22.3	26.4	25.4	25.1	27.4	28.3
Ewe type of birth						
Single	20.5 ± 1.71	26.2 ± .76	26.3 ± .80	24.3 ± 1.08	30.1 ± .93	30.9 ± 1.18
Multiple	22.6 ± 1.30	27.2 ± .52	26.2 ± .55	25.3 ± .71	28.9 ± .64	29.3 ± .83
Breed of ewe[a]						
T	20.5 ± 2.69	25.8 ± .82	25.0 ± .70	24.9 ± .76	29.3 ± .89	30.4 ± 1.05
ST	22.7 ± 1.66	27.9 ± .61	25.8 ± .63	25.9 ± 1.11	29.7 ± .73	30.1 ± .94
FT	21.5 ± 1.03	26.2 ± .97	28.1 ± 1.09	23.5 ± 1.18	29.3 ± 1.28	29.5 ± 1.55
Year of production		***	**	***	***	***
1977	24.7 ± 2.02					
1978	21.0 ± 1.01	31.0 ± .56^{b}				
1979	19.0 ± 2.14	22.9 ± .65^{d}	25.6 ± .66^{b}			
1980		26.1 ± 1.12^{c}	28.0 ± .68^{c}	28.0 ± .59^{b}		
1981			25.2 ± .93^{b}	23.3 ± .66^{c}	23.2 ± .76^{b}	
1982				23.1 ± 2.06^{c}	28.5 ± .91^{c}	27.0 ± .98^{b}
1983					36.6 ± 1.10^{d}	35.2 ± .88^{c}
1984						28.2 ± 1.61^{b}
Management system		***		**		
Farm		28.1 ± .61^{b}	25.5 ± .59	23.4 ± 1.02^{b}	29.9 ± .68	30.7 ± .99
Range		25.2 ± .63^{c}	27.0 ± .66	26.2 ± .76^{c}	28.9 ± .82	29.5 ± .97
Sex of lamb		**	***	**		
Female	20.4 ± 1.17	25.7 ± .61^{b}	24.9 ± .66^{b}	23.5 ± .78^{b}	28.8 ± .70	29.1 ± .93
Male	22.7 ± 1.77	27.7 ± .61^{c}	27.7 ± .55^{c}	26.1 ± .99^{c}	30.1 ± .82	31.1 ± .90
Birth rearing class	**	***	***	***	***	***
Single/single	23.1 ± .75^{b}	29.6 ± .76^{b}	29.2 ± .90^{b}	28.9 ± .59^{b}	32.2 ± 1.00^{a}	32.5 ± 1.56^{b}
Twin/single	23.8 ± 3.14^{b}	26.4 ± 1.03^{c}	27.0 ± .93^{b}	21.4 ± 2.21^{c}	28.8 ± 1.25^{c}	30.8 ± 1.37^{b}
Twin/twin	17.8 ± 1.61^{c}	24.1 ± .65^{c}	22.6 ± .46^{c}	24.0 ± .38^{c}	27.3 ± .47^{c}	27.0 ± .53^{c}

** $P < .01$.
*** $P < .001$.
[a] T = Targhee, ST = Suffolk x Targhee and FT = Finnsheep x Targhee.
[b,c,d] Means with unlike superscripts in the same column and within main effects differ ($P < .05$).

Lambs born as twins and raised as singles were intermediate to the other two classes. The average advantage for the single/single lambs over the twin/twin lambs was 5.4 kg and is in close agreement with results reported by Hazel and Terrill (1946).

Number of Lambs Weaned Per Ewe Exposed, Lambing and Weaning a Lamb

Least-squares means and standard errors for these data are found in tables 14, 15 and 16. Type, breed, year and management were used to evaluate number of lambs weaned.

Breed was the only significant source of variation for number of lambs weaned per ewe exposed ($P<.01$). For ages where breeds differed, the Finnsheep x Targhee ewes weaned more lambs ($P<.01$) than the Targhee or Suffolk x Targhee ewes. Differences in number weaned per ewe exposed were greatest at 1 year of age, where Finnsheep x Targhee ewes weaned .61 more lamb than the Targhee and .35 more lamb than the Suffolk x Targhee ewes. The increased production in lamb numbers at weaning for the Finnsheep x Targhee ewes agrees with work of Laster et al. (1972) and Notter and Copenhaver (1980). Peak production for the Finnsheep x Targhee ewes and the Suffolk x Targhee ewes occurred at 4 years of age. Peak production for the Targhee ewes occurred at 6 years of age. Number of lambs weaned per ewe exposed was higher ($P<.05$) for 2-year-old ewes (1.02) vs 1-year-old ewes (.52).

Multiple-born ewes weaned more lambs per ewe lambing than single-born ewes ($P<.05$) at 2 years of age. Type of birth of ewe was not a significant source of variation at any other age of ewe ($P>.05$). Finnsheep x Targhee ewes weaned more lambs ($P<.05$) than Targhee or

TABLE 14. LEAST-SQUARES MEANS AND STANDARD ERRORS FOR NUMBER OF LAMBS WEANED PER EWE EXPOSED

Parameter	Age in months					
	12	24	36	48	60	72
Overall mean	.52	1.02	1.15	1.34	1.25	1.21
Ewe type of birth						
Single	.55 ± .068	.96 ± .075	1.11 ± .085	1.39 ± .092	1.25 ± .106	1.38 ± .124
Multiple	.48 ± .040	.99 ± .045	1.19 ± .051	1.36 ± .054	1.28 ± .064	1.25 ± .081
Breed of ewe[d]	***	***		**		
T	.22 ± .058[a]	.82 ± .065[a]	1.01 ± .072	1.22 ± .075[a]	1.23 ± .090	1.25 ± .109
ST	.48 ± .055[b]	.84 ± .060[a]	1.11 ± .067	1.25 ± .070[a]	1.10 ± .085	1.16 ± .099
FT	.83 ± .082[c]	1.27 ± .093[b]	1.32 ± .107	1.66 ± .120[b]	1.47 ± .132	1.55 ± .155
Year of production						
1977	.52 ± .053					
1978	.59 ± .059	.97 ± .060				
1979	.41 ± .080	.98 ± .065	1.10 ± .067			
1980		.98 ± .089	1.13 ± .074	1.29 ± .071		
1981			1.21 ± .096	1.45 ± .080	1.18 ± .082	
1982				1.38 ± .104	1.31 ± .094	1.21 ± .105
1983					1.31 ± .121	1.25 ± .110
1984						1.50 ± .146
Management system						
Farm		.99 ± .055	1.14 ± .061	1.40 ± .063	1.22 ± .074	1.25 ± .086
Range		.96 ± .061	1.15 ± .069	1.35 ± .076	1.31 ± .089	1.39 ± .106

** P<.01.
*** P<.001.
[a,b,c] Means with unlike superscripts in the same column and within main effects differ (P<.05).
[d] T = Targhee, ST = Suffolk x Targhee and FT = Finnsheep x Targhee.

TABLE 15. LEAST-SQUARES MEANS AND STANDARD ERRORS FOR NUMBER OF LAMBS WEANED PER EWE LAMBING

	Age in months					
Parameter	12	24	36	48	60	72
Overall mean	.86	1.19	1.31	1.43	1.41	1.38
Ewe type of birth		*				
Single	.81 ± .081	1.04 ± .064[a]	1.33 ± .078	1.45 ± .083	1.42 ± .101	1.55 ± .114
Multiple	.89 ± .059	1.20 ± .040[b]	1.36 ± .046	1.45 ± .049	1.43 ± .060	1.37 ± .074
Breed of ewe[d]	***	***	**	*		
T	.65 ± .089[a]	.93 ± .056[a]	1.20 ± .066[a]	1.32 ± .069[a]	1.39 ± .087	1.47 ± .107
ST	.76 ± .065[a]	.99 ± .054[a]	1.15 ± .060[a]	1.34 ± .065[a]	1.29 ± .081	1.29 ± .091
FT	1.14 ± .097[b]	1.44 ± .079[b]	1.58 ± .098[b]	1.68 ± .107[b]	1.60 ± .123	1.62 ± .138
Year of production	**					
1977	1.05 ± .083[a]					
1978	.89 ± .074[a]	1.15 ± .052				
1979	.61 ± .094[b]	1.15 ± .057	1.35 ± .063			
1980		1.06 ± .075	1.25 ± .066	1.67 ± .064		
1981			1.43 ± .089	1.83 ± .070	1.81 ± .069	
1982				1.76 ± .090	1.81 ± .076	1.31 ± .096
1983					1.88 ± .106	1.36 ± .101
1984						1.71 ± .140
Management system						
Farm		1.12 ± .047	1.34 ± .056	1.53 ± .058	1.37 ± .069	1.45 ± .081
Range		1.12 ± .053	1.35 ± .063	1.37 ± .068	1.48 ± .085	1.47 ± .098

* P<.05.

** P<.01.

*** P<.001.

[a,b,c] Means with unlike superscripts in the same column and within main effects differ (P<.05).

[d] T = Targhee, ST = Suffolk x Targhee and FT = Finnsheep x Targhee.

TABLE 16. LEAST-SQUARES MEANS AND STANDARD ERRORS FOR NUMBER OF LAMBS WEANED PER EWE WEANING A LAMB

	Age in months					
Parameter	12	24	36	48	60	72
Overall mean	1.22	1.36	1.43	1.53	1.57	1.54
Ewe type of birth						
Single	1.17 ± .070	1.28 ± .054	1.49 ± .065	1.50 ± .069	1.55 ± .080	1.58 ± .088
Multiple	1.17 ± .045	1.37 ± .032	1.47 ± .038	1.55 ± .042	1.58 ± .047	1.57 ± .060
Breed of ewe[c]	*	***	***		**	
T	1.07 ± .077[a]	1.13 ± .045[a]	1.33 ± .056[a]	1.45 ± .059	1.51 ± .067[a]	1.58 ± .084
ST	1.14 ± .057[a]	1.21 ± .044[a]	1.38 ± .050[a]	1.46 ± .055	1.42 ± .064[a]	1.44 ± .073
FT	1.31 ± .068[b]	1.65 ± .066[b]	1.72 ± .082[b]	1.66 ± .087	1.77 ± .097[b]	1.70 ± .105
Year of production						
1977	1.15 ± .058					
1978	1.23 ± .059	1.34 ± .042				
1979	1.14 ± .092	1.31 ± .044	1.51 ± .053			
1980		1.33 ± .064	1.39 ± .055	1.44 ± .054		
1981			1.54 ± .074	1.57 ± .059	1.52 ± .062	
1982				1.57 ± .080	1.57 ± .069	1.53 ± .080
1983					1.60 ± .094	1.44 ± .079
1984						1.74 ± .107
Management system		*		*		
Farm		1.38 ± .040[a]	1.49 ± .047	1.60 ± .049[a]	1.57 ± .055	1.63 ± .065
Range		1.27 ± .041[b]	1.46 ± .052	1.46 ± .057[b]	1.57 ± .066	1.51 ± .076

* P<.05.

** P<.01.

*** P<.001.

[a,b] Means with unlike superscripts in the same column and within main effects differ (P<.05).

[c] T = Targhee, ST = Suffolk x Targhee and FT = Finnsheep x Targhee.

Suffolk x Targhee ewes through 4 years of age. Targhee and Suffolk x Targhee ewes did not differ (P>.05) in number of lambs weaned per ewe lambing. Breed differences are in agreement with results found by Oltenacu and Boylan (1981a). Years differed (P<.01) for 1-year-old ewes.

Ewe type of birth and year were not significant (P>.05) sources of variation for number of lambs weaned per ewe weaning a lamb. Farm flock ewes weaned more lambs (P<.05) than range flock ewes for 2- and 4-year-old ewes. Finnsheep x Targhee ewes weaned more (P<.05) lambs per ewe weaning a lamb than Targhee ewes through 5 years of production and more lambs than the Suffolk x Targhee ewes at each age of ewe.

Total Weight of Lamb Weaned Per Ewe Exposed

Type, breed, year and management were used to evaluate total weight of lamb weaned per ewe exposed. Least-squares means and standard errors are found in table 17.

Type of birth of the ewe was significant (P<.05) for total weight weaned for 2-year-old ewes. At that age, multiple-born ewes weaned 1.9 kg more lamb than single-born ewes. No differences (P>.05) were found for any other age of ewe. The typical environmental handicap of being born a twin was not found in this study and was, in fact, reversed at 2 years of age.

Breeds differed (P<.05) for weight of lambs weaned for 1-, 2- and 4-year-old ewes. For those ages when breeds differed, Finnsheep x Targhee ewes weaned more total kilograms of lamb than either Targhee or Suffolk x Targhee ewes. The superiority of the Finnsheep was also

TABLE 17. LEAST-SQUARES MEANS AND STANDARD ERRORS FOR TOTAL WEIGHT OF LAMB WEANED PER EWE EXPOSED (KG)

Parameter	Age in months					
	12	24	36	48	60	72
Overall mean	11.6	26.7	28.9	33.6	34.3	34.5
Ewe type of birth		*				
Single	12.0 ± 1.51	24.9 ± 2.02[a]	26.5 ± 2.10	36.7 ± 2.45	37.0 ± 2.78	39.2 ± 3.65
Multiple	10.4 ± .88	26.8 ± 1.19	29.1 ± 1.25	34.7 ± 1.43	36.4 ± 1.70	34.9 ± 2.39
Breed of ewe[d]	***	*		**		
T	4.8 ± 1.31[a]	22.9 ± 1.73[a]	24.4 ± 1.77	30.3 ± 2.00[a]	36.0 ± 2.36	34.8 ± 3.22
ST	10.4 ± 1.22[b]	24.4 ± 1.61[a]	28.6 ± 1.67	34.0 ± 1.86[a]	32.8 ± 2.25	34.7 ± 2.91
FT	18.4 ± 1.83[c]	30.3 ± 2.50[b]	30.3 ± 2.65	42.6 ± 3.18[b]	41.3 ± 3.52	41.6 ± 4.54
Year of production		***			***	*
1977	12.5 ± 1.19					
1978	12.7 ± 1.32	30.3 ± 1.61[b]				
1979	8.4 ± 1.78	21.6 ± 1.72[a]	26.1 ± 1.66			
1980		25.7 ± 2.37[ab]	31.0 ± 1.84	36.4 ± 1.90		
1981			26.3 ± 2.38	35.6 ± 2.11	27.3 ± 2.17[a]	
1982				35.0 ± 2.78	34.2 ± 2.45[b]	71.0 ± 3.10[a]
1983					48.6 ± 3.20[c]	44.4 ± 3.26[b]
1984						34.5 ± 4.30[ab]
Management system						
Farm		27.7 ± 1.49	27.8 ± 1.61	35.3 ± 1.68	36.8 ± 1.95	36.5 ± 2.53
Range		24.0 ± 1.63	27.8 ± 1.70	36.0 ± 2.02	36.6 ± 2.35	37.6 ± 3.12

* P<.05.
** P<.01.
*** P<.001.
[a,b,c] Means with unlike superscripts in the same column and within main effects differ (P<.05).
[d] T = Targhee, ST = Suffolk x Targhee and FT = Finnsheep x Targhee.

noted by Barker (1975). Even though individual weights of lambs at weaning were lower for the Finnsheep x Targhee, total weight was higher. The importance of the contribution of number of lambs weaned to total weight weaned was also found by Sidwell et al. (1962) and Sidwell and Miller (1971a).

The greatest increase in total weight of lamb weaned occurred between ewes 1 and 2 years old. Two-year-old ewes produced 15.1 kg more lamb per ewe exposed than 1-year-old ewes ($P<.05$). The largest value for weight of lamb weaned per ewe exposed was achieved by the Finnsheep x Targhee ewes (42.6 kg) at 4 years of age.

Total Weight of Lamb Weaned Per Ewe Lambing

Type, breed, year and management were variables used to test weight of lamb weaned per ewe lambing. Least-squares means and standard errors are found in table 18.

Type was a significant source of variation ($P<.05$) for total weight weaned for ewes at 2 years of age. Values for 2-year-old ewes were 27.3 and 32.3 kg for single- and multiple-born ewes, respectively.

Breed was significant ($P<.05$) through 4 years of age. For ages 1 through 4, Finnsheep x Targhee ewes weaned more total weight of lamb than Targhee or Suffolk x Targhee ewes ($P<.05$). These data would suggest that the advantage of Finnsheep breeding occurs at young ages. Mature ewes of Targhee or Suffolk x Targhee breeding tended to equal the Finnsheep ewes later in life. On the average, the Finnsheep x Targhee ewes weaned 7.28 kg more lamb per year than the Targhee and 6.06 kg more than the Suffolk x Targhee.

TABLE 18. LEAST-SQUARES MEANS AND STANDARD ERRORS FOR TOTAL WEIGHT OF LAMBS WEANED PER EWE LAMBING (KG)

Parameter	Age in months					
	12	24	36	48	60	72
Overall mean	19.2	31.3	33.2	35.8	38.6	39.7
Ewe type of birth		*				
Single	18.1 ± 1.80	27.3 ± 1.75^{a}	32.0 ± 1.92	38.4 ± 2.25	41.3 ± 2.73	43.8 ± 3.31
Multiple	19.6 ± 1.30	32.3 ± 1.08^{b}	33.4 ± 1.13	36.8 ± 1.34	39.8 ± 1.62	38.3 ± 2.12
Breed of ewe^{d}	***	**	*	*		
T	14.5 ± 1.95^{a}	25.4 ± 1.51^{a}	29.3 ± 1.63^{a}	33.1 ± 1.87^{a}	40.0 ± 2.35	41.2 ± 3.09
ST	16.7 ± 1.45^{a}	28.8 ± 1.44^{a}	32.3 ± 1.48^{ab}	36.8 ± 1.80^{a}	38.1 ± 2.18	38.1 ± 2.62
FT	25.3 ± 1.85^{b}	35.0 ± 2.17^{b}	36.6 ± 2.42^{b}	42.9 ± 2.90^{b}	43.5 ± 3.32	43.9 ± 3.97
Year of production	***	***			***	*
1977	25.1 ± 1.81^{a}					
1978	19.2 ± 1.64^{b}	35.6 ± 1.43^{a}				
1979	12.2 ± 2.06^{c}	25.5 ± 1.53^{b}	32.4 ± 1.55			
1980		28.1 ± 2.02^{b}	34.3 ± 1.63	38.3 ± 1.76		
1981			31.4 ± 2.19	36.7 ± 1.95	32.1 ± 2.10^{a}	
1982				37.9 ± 2.59	35.7 ± 2.32^{a}	34.5 ± 2.76^{a}
1983					53.8 ± 3.27^{b}	49.1 ± 2.93^{b}
1984						39.6 ± 4.04^{ab}
Management system						
Farm		31.4 ± 1.29	32.7 ± 1.37	38.5 ± 1.59	40.4 ± 1.86	42.3 ± 2.33
Range		28.1 ± 1.43	32.7 ± 1.56	36.7 ± 1.86	40.6 ± 2.29	39.8 ± 2.85

* P<.05.
** P<.01.
*** P<.001.
[a,b,c] Means with unlike superscripts in the same column and within main effects differ (P<.05).
[d] T = Targhee, ST = Suffolk x Targhee and FT = Finnsheep x Targhee.

Years differed (P<.01) for 1-, 2-, 5- and 6-year old ewes. Management system did not differ (P>.05) for any age of ewe.

Total Weight of Lamb Weaned Per Ewe Weaning a Lamb

Type, breed, year and management were used to evaluate total weight of lamb weaned per ewe weaning a lamb. Least-squares means and standard errors are found in table 19.

Ewe type of birth was a significant (P<.05) source of variation for total weight weaned for 2-year-old ewes. For 2-year-old ewes, multiple-born ewes weaned more kilograms of lamb than single-born ewes.

Breeds differed (P<.05) through 3 years of age. When breeds differed, Finnsheep x Targhee ewes weaned more lamb than Targhee or Suffolk x Targhee ewes.

Year was a significant source of variation (P<.001) for ewes 2, 4 and 5 years old.

Management system differed in total weight of lambs weaned for 2- and 6-year-old ewes (P<.05). Farm flock ewes weaned more total kilograms of lamb than range flock ewes at 2 and 6 years of age.

Wool Production

All ewes were shorn within 60 d prelambing. Due to differences in lambing date between management systems, shearing dates were not the same. All breed groups within management system were shorn at the same time. Factors used to evaluate grease fleece weight were type, breed, year, management and number born. Least-squares means and standard errors for grease fleece weight are found in table 20.

TABLE 19. LEAST-SQUARES MEANS AND STANDARD ERRORS FOR TOTAL WEIGHT OF LAMB WEANED PER EWE WEANING A LAMB (KG)

	Age in months					
Parameter	12	24	36	48	60	72
Overall mean	27.2	35.7	36.2	38.4	42.9	43.5
Ewe type of birth		*				
Single	25.1 ± 1.65	33.8 ± 1.43^{a}	36.0 ± 1.52	39.9 ± 1.93	44.8 ± 2.28	44.8 ± 2.68
Multiple	25.6 ± 1.06	37.1 ± .83^{b}	36.0 ± .89	39.5 ± 1.18	43.4 ± 1.36	42.9 ± 1.79
Breed of ewe^{d}	*	***	**			
T	23.2 ± 1.81^{a}	31.0 ± 1.17^{a}	32.7 ± 1.30^{a}	36.5 ± 1.66	43.5 ± 1.91	44.5 ± 2.52
ST	24.2 ± 1.35^{a}	35.0 ± 1.14^{b}	35.7 ± 1.17^{a}	39.9 ± 1.55	41.4 ± 1.82	41.6 ± 2.20
FT	28.7 ± 1.60^{b}	40.5 ± 1.75^{c}	40.1 ± 1.91^{b}	42.6 ± 2.46	47.4 ± 2.79	45.4 ± 3.20
Year of production		***			***	***
1977	27.4 ± 1.37					
1978	26.5 ± 1.41	41.5 ± 1.10^{a}				
1979	22.1 ± 2.15	29.3 ± 1.17^{b}	36.3 ± 1.25			
1980		35.7 ± 1.67^{c}	38.1 ± 1.28	40.8 ± 1.53		
1981			34.2 ± 1.73	38.1 ± 1.66	34.8 ± 1.76^{a}	
1982				40.2 ± 2.25	40.9 ± 1.98^{a}	39.7 ± 2.35^{a}
1983					56.7 ± 2.68^{b}	52.1 ± 2.40^{b}
1984						40.7 ± 3.24^{a}
Management system		***				*
Farm		38.7 ± 1.06^{a}	36.7 ± 1.10	40.2 ± 1.37	45.1 ± 1.57	46.7 ± 1.95^{a}
Range		32.3 ± 1.09^{b}	35.7 ± 1.22	39.1 ± 1.61	43.1 ± 1.89	41.0 ± 2.33^{b}

* P<.05.
** P<.01.
*** P<.001.
^{a,b,c} Means with unlike superscripts in the same column and within main effects differ (P<.05).
^{d} T = Targhee, ST = Suffolk x Targhee and FT = Finnsheep x Targhee.

TABLE 20. LEAST-SQUARES MEANS AND STANDARD ERRORS FOR GREASE FLEECE WEIGHT (KG)

Parameter	Age in months					
	12	24	36	48	60	72
Overall mean	3.46	3.99	4.18	4.35	4.36	4.17
Ewe type of birth	***					
Single	3.61 ± .068^{a}	4.13 ± .090	4.33 ± .081	4.40 ± .184	4.32 ± .124	4.01 ± .167
Multiple	3.35 ± .049^{b}	3.96 ± .048	4.25 ± .068	4.44 ± .223	4.17 ± .150	3.76 ± .156
Breed of ewe^{d}	***	***	**	*	**	*
T	3.73 ± 1.00^{a}	4.35 ± .081^{a}	4.48 ± .081^{a}	4.78 ± .149^{a}	4.67 ± .117^{a}	4.20 ± .144^{a}
ST	3.44 ± .056^{b}	3.98 ± .060^{b}	4.44 ± .083^{a}	4.55 ± .279^{a}	4.20 ± .116^{b}	4.11 ± .152^{a}
FT	3.26 ± .066^{c}	3.81 ± .113^{b}	3.94 ± .131^{b}	3.95 ± .279^{b}	3.87 ± .244^{b}	3.35 ± .230^{b}
Year of production	***	***	**			*
1977	3.66 ± .063^{a}					
1978	3.51 ± .054^{b}	4.17 ± .072^{a}				
1979	3.26 ± .084^{c}	4.19 ± .069^{a}	4.48 ± .076^{a}			
1980		3.78 ± 1.00^{b}	4.13 ± .098^{b}	4.29 ± .268		
1981			4.25 ± .120^{b}	4.30 ± .166	4.11 ± .148	
1982				4.68 ± .215	4.30 ± .158	4.19 ± .175^{a}
1983					4.34 ± .232	3.92 ± .185^{a}
1984						3.55 ± .187^{b}
Number of lambs born						
None	3.51 ± .053	4.05 ± .117	4.41 ± .128	4.42 ± .425	4.06 ± .248	3.61 ± .315
Single	3.37 ± .044	4.11 ± .074	4.26 ± .089	4.33 ± .093	4.37 ± .127	3.94 ± .176
Multiple	3.55 ± .120	3.98 ± .060	4.19 ± .063	4.52 ± .072	4.18 ± .072	4.10 ± .077
Management system		***				*
Farm		3.83 ± .067^{a}	4.25 ± .070	4.42 ± .104	4.40 ± .130	4.14 ± .123^{a}
Range		4.25 ± .065^{b}	4.33 ± .089	4.42 ± .284	4.09 ± .143	3.63 ± .207^{b}

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

^{a,b,c} Means with unlike superscripts in the same column and within main effects differ ($P<.05$).

^{d} T = Targhee, ST = Suffolk x Targhee and FT = Finnsheep x Targhee.

Single-born ewes produced more (P<.001) wool than multiple-born ewes at 1 year of age. Kilograms of wool produced were 3.61 kg and 3.35 kg for single- and multiple-born ewes, respectively. Type was not significant for any other age of ewe (P>.05). This is in agreement with work of Dun and Grewal (1963).

Breeds differed (P<.05) in production of wool. Differences were greatest (P<.001) for 1- and 2-year-old ewes. At each age of ewe, Targhee ewes produced more wool than Finnsheep x Targhee ewes. This same finding was reported by Price (1971) and Oltenacu and Boylan (1981b).

Years differed (P<.05) for wool production for 1-, 2-, 3- and 6-year-old ewes.

Range flock ewes produced more (P<.001) wool than farm flock ewes at 1 year of age. This difference was due in large measure to the longer time between shearing of the range flock ewes between their first and second year. Range flock ewes moved from a February lambing their first year to an April lambing their second year. Farm flock ewes produced .51 kg (P<.05) more wool than range flock ewes at 6 years of age.

Number of lambs born failed to have a significant effect on wool production (P>.05). Due to a shearing schedule of 30 to 60 d prior to lambing, the effect of pregnancy and lactation could not be measured.

Wool production increased with increasing age of ewe until 6 years of age. Values obtained did not differ (P>.05) for 4-, 5- and

6-year-old ewes. The changes in wool production with age of ewe corresponded to the curvilinear response found by Blackwell and Henderson (1955).

Ewe Longevity

The number and percentages of ewes present at breeding at each age are presented in table 21. At breeding time of the sixth year, 46% of the original ewes were present. Among Suffolk x Targhee ewes, 45% were present in the farm flock and 46% in the range flock. A higher percentage of Targhee survived under farm conditions (53%) than under range conditions (44%). Finnsheep x Targhee survival was also greater for farm flock than for range flock ewes, 54% vs 33%, respectively. For the sixth year, 50.4% of the farm flock ewes were still present and 41.2% of the range flock were present.

Cumulative Lamb and Wool Production Per Ewe Present

Values for numbers of lamb born and weaned, kilograms of lamb born and weaned and kilograms of wool produced were accumulated for each year. Accumulations were completed after years 2, 3, 4, 5 and 6. When analyzed on a per ewe present basis, production of only those ewes present at breeding time was used. Type, breed and management were used to test each main effect.

Least-squares means and standard errors for number of lambs born per ewe present are found in table 22. Single-born ewes had a higher ($P<.05$) cumulative production of number of lambs born after 2 years. Single-born ewes produced 2.31 lambs, while multiple-born ewes had produced 2.05 lambs. Single- and multiple-born ewes did not

TABLE 21. NUMBER AND PERCENTAGE OF EWES PRESENT AT BREEDING TIME FOR EACH AGE OF EWE

		Management system/breed[a]					
		Farm			Range		
Year	Total	T	ST	FT	T	ST	FT
1	421 (100)	68 (100)	76 (100)	78 (100)	63 (100)	70 (100)	66 (100)
2	416 (99)	68 (100)	74 (97)	77 (99)	61 (97)	70 (100)	66 (100)
3	346 (82)	59 (87)	60 (79)	70 (90)	50 (79)	59 (84)	48 (73)
4	297 (71)	55 (80)	53 (70)	61 (78)	43 (68)	51 (73)	34 (52)
5	252 (60)	45 (66)	46 (61)	54 (69)	36 (57)	40 (57)	31 (47)
6	194 (46)	36 (53)	34 (45)	42 (54)	28 (44)	32 (46)	22 (33)

[a] T = Targhee, ST = Suffolk x Targhee and FT = Finnsheep x Targhee.

TABLE 22. LEAST-SQUARES MEANS AND STANDARD ERRORS FOR CUMULATIVE NUMBER OF LAMBS BORN PER EWE PRESENT (ENTERING)

	Year				
Parameter	2	3	4	5	6
Overall mean	2.16	3.84	5.50	7.19	8.98
	(2.13)	(3.34)	(4.49)	(5.46)	(6.25)
Ewe type of birth					
Single	2.31 ± .104[a]	3.84 ± .135	5.58 ± .183	7.20 ± .217	9.07 ± .282
	(2.29 ± .106[d])	(3.47 ± .161)	(4.62 ± .221)	(5.61 ± .284)	(6.52 ± .349)
Multiple	2.05 ± .066[b]	3.79 ± .087	5.51 ± .113	7.18 ± .143	8.94 ± .198
	(2.02 ± .067[e])	(3.19 ± .101)	(4.29 ± .138)	(5.21 ± .177)	(5.92 ± .218)
Breed of ewe[g]					
T	1.56 ± .095[a]	2.92 ± .121[a]	4.35 ± .152[a]	5.87 ± .192[a]	7.30 ± .257[a]
	(1.52 ± .096[d])	(2.55 ± .145[d])	(3.63 ± .199[d])	(4.54 ± .257[d])	(5.24 ± .315[d])
ST	1.97 ± .089[b]	3.53 ± .114[b]	4.99 ± .145[b]	1.43 ± .184[b]	8.06 ± .249[b]
	(1.96 ± .090[e])	(3.07 ± .137[e])	(4.10 ± .188[d])	(4.89 ± .241[d])	(5.59 ± .296[d])
FT	3.00 ± .132[c]	4.99 ± .175[c]	7.29 ± .247[c]	9.27 ± .287[c]	11.65 ± .375[c]
	(2.98 ± .135[f])	(4.38 ± .204[f])	(5.63 ± .280[e])	(6.80 ± .359[e])	(7.82 ± .441[e])
Management system					
Farm	2.29 ± .081[a]	3.92 ± .102	5.67 ± .130	7.36 ± .158	9.43 ± .214[a]
	(2.26 ± .081)	(3.51 ± .123[d])	(4.78 ± .169[d])	(5.87 ± .218[d])	(6.81 ± .267[d])
Range	2.06 ± .086[b]	3.71 ± .113	5.42 ± .152	7.02 ± .186	8.58 ± .246[b]
	(2.05 ± .087)	(3.16 ± .132[e])	(4.12 ± .182[e])	(4.95 ± .233[e])	(5.62 ± .286[e])

[a,b,c] Means with unlike superscripts in the same column and within main effects differ per ewe present (P< .05).

[d,e,f] Means with unlike superscripts in the same column and within main effects differ per ewe entering (P< .05).

[g] T = Targhee, ST = Suffolk x Targhee and FT = Finnsheep x Targhee.

differ (P>.05) after any other age. Breeds differed (P<.05) for each accumulated year. Finnsheep x Targhee ewes produced more lambs (P<.05) than Suffolk x Targhee ewes, who, in turn, produced more lambs (P<.05) than the Targhee ewes. After 6 years, the Finnsheep x Targhee ewes had produced 11.65 lambs, while the Suffolk x Targhee ewes had produced 8.06 lambs and the Targhee ewes 7.30 lambs. Farm flock ewes produced more lambs (P<.05) than the range flock ewes after the second and sixth years. After 6 years, the farm flock ewes produced 9.43 lambs and the range flock ewes 8.58 lambs.

Least-squares means and standard errors for cumulative weight of lamb born per ewe present are presented in table 23. Single-born ewes produced more total weight of lamb at lambing (P<.05) than multiple-born ewes after 2 years. For years 3 through 6, type did not differ (P>.05). Finnsheep x Targhee ewes gave birth to more kilograms of lamb (P<.05) at each year. After 6 years, Finnsheep x Targhee, Suffolk x Targhee and Targhee ewes had produced 48.78, 39.89 and 40.06 kg of lamb at birth, respectively. Cumulative weight of lamb born was greater (P<.05) for Suffolk x Targhee ewes than for Targhee ewes after 2 and 3 years. Ewes in the farm management system produced more weight of lamb at birth (P<.05) than did range management system ewes. By year 6, the farm ewes exceeded the range ewes by 4.26 kg.

Least-squares means and standard errors for cumulative number of lambs weaned per ewe present are presented in table 24. Single- and multiple-born ewes did not differ (P>.05) for number of lambs

TABLE 23. LEAST-SQUARES MEANS AND STANDARD ERRORS FOR CUMULATIVE WEIGHT OF LAMB BORN PER EWE PRESENT (ENTERING) [KG]

Parameter	Year 2	Year 3	Year 4	Year 5	Year 6
Overall mean	9.58	17.47	25.75	33.96	42.95
	(9.45)	(15.13)	(20.79)	(25.49)	(29.23)
Ewe type of birth					
Single	10.22 ± .456[a]	17.16 ± .582	25.69 ± .776	33.40 ± .956	42.70 ± 1.317
	(10.13 ± .463[d])	(15.02 ± .707)	(21.35 ± .992)	(26.19 ± 1.308)	(30.55 ± 1.632)
Multiple	9.09 ± .288[b]	17.41 ± .373	25.74 ± .479	34.11 ± .630	43.12 ± .922
	(8.97 ± .290[e])	(14.59 ± .442)	(19.89 ± .617)	(24.39 ± .814)	(27.72 ± 1.019)
Breed of ewe[g]					
T	7.90 ± .416[a]	15.21 ± .519[a]	23.08 ± .645[a]	31.44 ± .845[a]	40.06 ± 1.204[a]
	(7.70 ± .417[a])	(13.22 ± .637[d])	(19.16 ± .892[d])	(24.24 ± 1.182)	(28.11 ± 1.473)
ST	9.34 ± .388[b]	16.92 ± .492[b]	24.40 ± .616[a]	31.55 ± .812[a]	39.89 ± 1.161[a]
	(9.27 ± .392[e])	(14.64 ± .600[d])	(19.95 ± .841[de])	(23.89 ± 1.081)	(27.35 ± 1.385)
FT	11.73 ± .576[c]	19.73 ± .753[c]	29.66 ± 1.047[b]	38.27 ± 1.266[b]	48.78 ± 1.752[b]
	(11.67 ± .587[f])	(17.24 ± .896[e])	(22.74 ± 1.255[e])	(27.73 ± 1.651)	(31.96 ± 2.063)
Management system					
Farm	10.44 ± .352[a]	18.20 ± .437[a]	26.79 ± .552[a]	35.12 ± .705[a]	45.04 ± .966[a]
	(10.28 ± .354[d])	(16.22 ± .542[d])	(22.54 ± .758[d])	(27.86 ± 1.003[d])	(32.27 ± 1.250[d])
Range	8.87 ± .375[b]	16.38 ± .484[b]	24.63 ± .645[b]	32.39 ± .820[b]	40.78 ± 1.148[b]
	(8.81 ± .380[e])	(13.84 ± .581[e])	(18.69 ± .815[e])	(22.72 ± 1.071[e])	(26.00 ± 1.338[e])

[a,b,c] Means with unlike superscripts in the same column and within main effects differ per ewe present ($P < .05$).

[d,e,f] Means with unlike superscripts in the same column and within main effects differ per ewe entering ($P < .05$).

[g] T = Targhee, ST = Suffolk x Targhee and FT = Finnsheep x Targhee.

TABLE 24. LEAST-SQUARES MEANS AND STANDARD ERRORS FOR CUMULATIVE NUMBER OF LAMBS WEANED PER EWE PRESENT (ENTERING)

Parameter	Year 2	Year 3	Year 4	Year 5	Year 6
Overall mean	1.55	2.85	4.22	5.59	6.92
	(1.52)	(2.46)	(3.41)	(4.15)	(4.72)
Ewe type of birth					
Single	1.57 ± .096	2.79 ± .132	4.28 ± .173	5.60 ± .208	7.08 ± .270
	(1.55 ± .096)	(2.46 ± .141)	(3.41 ± .189)	(4.19 ± .240)	(4.87 ± .288)
Multiple	1.48 ± .061	2.83 ± .085	4.23 ± .107	5.63 ± .137	6.96 ± .189
	(1.46 ± .060)	(2.38 ± .088)	(3.27 ± .117)	(3.98 ± .150)	(4.48 ± .180)
Breed of ewe[g]					
T	1.09 ± .088[a]	2.22 ± .118[a]	3.50 ± .143[a]	4.84 ± .184[a]	6.16 ± .247[a]
	(1.06 ± .087[d])	(1.91 ± .127[d])	(2.84 ± .169[d])	(3.63 ± .217[d])	(4.20 ± .260[d])
ST	1.37 ± .082[b]	2.60 ± .112[b]	3.79 ± .137[a]	5.03 ± .176[a]	6.25 ± .238[a]
	(1.36 ± .082[e])	(2.25 ± .119[d])	(3.11 ± .160[d])	(3.75 ± .204[d])	(4.27 ± .244[d])
FT	2.11 ± .121[c]	3.62 ± .171[c]	5.47 ± .233[b]	6.96 ± .275[b]	8.66 ± .359[b]
	(2.10 ± .122[f])	(3.09 ± .178[e])	(4.06 ± .238[e])	(4.89 ± .303[e])	(5.57 ± .364[e])
Management system					
Farm	1.58 ± .074	2.81 ± .099	4.28 ± .123	5.58 ± .151	7.00 ± .204
	(1.55 ± .074)	(2.48 ± .108)	(3.54 ± .144[d])	(4.33 ± .184)	(4.97 ± .221)
Range	1.47 ± .079	2.81 ± .110	4.23 ± .144	5.64 ± .178	7.04 ± .236
	(1.46 ± .079)	(2.35 ± .116)	(3.14 ± .155[e])	(3.84 ± .197)	(4.39 ± .236)

[a,b,c] Means with unlike superscripts in the same column and within main effects differ per ewe present (P< .05).

[d,e,f] Means with unlike superscripts in the same column and within main effects differ per ewe entering (P< .05).

[g] T = Targhee, ST = Suffolk x Targhee and FT = Finnsheep x Targhee.

weaned after any year. Finnsheep x Targhee ewes weaned more lambs (P<.05) than Targhee or Suffolk x Targhee ewes at each year. Finnsheep x Targhee ewes had weaned 8.66 lambs, while Targhee and Suffolk x Targhee ewes had weaned 6.16 and 6.25 lambs, respectively, after year 6. Suffolk x Targhee ewes weaned more lambs (P<.05) than Targhee ewes after 2 and 3 years. Management system did not have a significant effect (P>.05) on number of lambs weaned.

Least-squares means and standard errors for cumulative weight of lamb weaned per ewe present are presented in table 25. Ewe type of birth did not have a significant effect on weight of lamb weaned for any year (P>.05). Finnsheep x Targhee ewes weaned more kilograms of lamb (P<.05) than Targhee or Suffolk x Targhee ewes. Finnsheep x Targhee ewes had weaned 43.9 kg more than the Suffolk x Targhee ewes and 52.2 kg more than the Targhee ewes after 6 years. Management systems did not differ (P>.05) in weight of lamb weaned for any year.

Least-squares means and standard errors for cumulative weight of wool produced per ewe present are found in table 26. Single-born ewes produced more wool (P<.05) than multiple-born ewes at each age. Single-born ewes had produced 24.84 kg of wool, while multiple-born ewes had produced 23.35 kg after 6 years. Targhee ewes produced more wool (P<.05) than Suffolk x Targhee and Finnsheep x Targhee ewes at each age. Suffolk x Targhee ewes produced more wool (P<.05) than Finnsheep x Targhee ewes after 2 years. Targhee, Suffolk x Targhee and Finnsheep x Targhee ewes produced 25.77, 23.81 and 22.70 kg of

TABLE 25. LEAST-SQUARES MEANS AND STANDARD ERRORS FOR CUMULATIVE WEIGHT OF LAMBS WEANED PER EWE PRESENT (ENTERING) [KG]

Parameter	Year 2	3	4	5	6
Overall mean	38.6	71.8	106.6	144.3	183.0
	(38.1)	(61.7)	(85.4)	(105.9)	(121.8)
Ewe type of birth					
Single	40.1 ± 2.44	70.9 ± 3.29	111.3 ± 4.45	146.9 ± 5.57	188.0 ± 7.28
	(39.7 ± 2.45)	(62.2 ± 3.54)	(87.6 ± 4.80)	(108.9 ± 6.28)	(128.2 ± 7.66)
Multiple	36.7 ± 1.54	70.9 ± 2.11	106.2 ± 2.74	145.1 ± 3.67	183.8 ± 5.09
	(36.1 ± 1.54)	(59.4 ± 2.21)	(81.6 ± 2.99)	(101.7 ± 3.91)	(115.7 ± 4.78)
Breed of ewe[g]					
T	28.0 ± 2.23^{a}	56.7 ± 2.93^{a}	88.8 ± 3.70^{a}	125.7 ± 4.93^{a}	165.5 ± 6.65^{a}
	(27.4 ± 2.21^{d})	(49.1 ± 3.18^{d})	(72.2 ± 4.31^{d})	(94.0 ± 5.68^{d})	(110.9 ± 6.91^{d})
ST	36.5 ± 2.08^{b}	69.6 ± 2.78^{b}	102.8 ± 3.53^{b}	138.0 ± 4.73^{a}	174.1 ± 6.41^{a}
	(36.2 ± 2.08^{e})	(59.6 ± 3.00^{e})	(83.3 ± 4.07^{d})	(101.4 ± 5.33^{d})	(116.7 ± 6.50^{de})
FT	50.5 ± 3.09^{c}	86.5 ± 4.26^{c}	134.5 ± 6.01^{c}	174.4 ± 7.38^{b}	218.0 ± 9.68^{b}
	(50.3 ± 3.11^{f})	(73.7 ± 4.48^{f})	(98.4 ± 6.07^{e})	(120.4 ± 7.93^{e})	(138.2 ± 9.68^{e})
Management system					
Farm	40.7 ± 1.88	72.9 ± 2.47	110.3 ± 3.17	146.7 ± 4.07	188.2 ± 5.50
	(40.1 ± 1.88)	(64.1 ± 2.71)	(90.3 ± 3.66^{d})	(112.3 ± 4.82^{d})	(130.7 ± 5.86^{d})
Range	36.0 ± 2.01	68.9 ± 2.74	107.1 ± 3.70	145.3 ± 4.78	183.5 ± 6.34
	(35.8 ± 2.01)	(57.5 ± 2.90)	(79.0 ± 3.94^{e})	(98.2 ± 5.14^{e})	(113.2 ± 6.28^{e})

[a,b,c] Means with unlike superscripts in the same column and within main effects differ per ewe present ($P < .05$).

[d,e,f] Means with unlike superscripts in the same column and within main effects differ per ewe entering ($P < .05$).

[g] T = Targhee, ST = Suffolk x Targhee and FT = Finnsheep x Targhee.

TABLE 26. LEAST-SQUARES MEANS AND STANDARD ERRORS FOR CUMULATIVE WEIGHT OF WOOL PRODUCED PER EWE PRESENT (ENTERING) [KG]

Parameter	Year 2	Year 3	Year 4	Year 5	Year 6
Overall mean	7.20	11.18	15.50	19.67	23.99
	(7.14)	(10.37)	(13.33)	(15.79)	(17.60)
Ewe type of birth					
Single	7.65 ± .138[a]	11.83 ± .219[a]	16.16 ± .308[a]	20.45 ± .401[a]	24.84 ± .560[a]
	(7.61 ± .145[d])	(11.12 ± .258[d])	(14.27 ± .410[d])	(17.06 ± .574[d])	(19.26 ± .724[d])
Multiple	6.95 ± .087[b]	10.86 ± .141[b]	15.14 ± .190[b]	19.25 ± .264[b]	23.35 ± .393[b]
	(6.89 ± .091[e])	(9.93 ± .161[e])	(12.69 ± .255[e])	(14.91 ± .357[e])	(16.47 ± .452[e])
Breed of ewe[g]					
T	7.83 ± .126[a]	12.02 ± .195[a]	16.66 ± .255[a]	21.32 ± .355[a]	25.77 ± .512[a]
	(7.72 ± .131[d])	(11.29 ± .233[d])	(14.74 ± .368[d])	(17.67 ± .518[d])	(19.82 ± .654[d])
ST	7.23 ± .117[b]	11.34 ± .185[b]	15.48 ± .244[b]	19.42 ± .341[b]	23.81 ± .494[b]
	(7.19 ± .123[e])	(10.46 ± .219[e])	(13.44 ± .347[e])	(15.80 ± .486[e])	(17.60 ± .615[e])
FT	6.84 ± .175[c]	10.69 ± .284[b]	14.81 ± .415[b]	18.81 ± .532[b]	22.70 ± .745[b]
	(6.82 ± .184[e])	(9.82 ± .327[e])	(12.26 ± .518[e])	(14.49 ± .724[e])	(16.18 ± .916[e])
Management system					
Farm	6.98 ± .107[a]	11.14 ± .165	15.48 ± .219	19.79 ± .293	24.20 ± .424
	(6.90 ± .113[d])	(10.37 ± .198)	(13.63 ± .313)	(16.46 ± .440)	(18.64 ± .555[d])
Range	7.63 ± .114[b]	11.55 ± .182	15.82 ± .256	19.92 ± .344	23.98 ± .489
	(7.59 ± .119[e])	(10.68 ± .212)	(13.33 ± .337)	(15.51 ± .470)	(17.10 ± .594[e])

[a,b,c] Means with unlike superscripts in the same column and within main effects differ per ewe present (P<.05).

[d,e,f] Means with unlike superscripts in the same column and within main effects differ per ewe entering (P<.05).

[g] T = Targhee, ST = Suffolk x Targhee and FT = Finnsheep x Targhee.

wool, respectively, after 6 years. Range flock ewes produced more wool ($P<.05$) than farm flock ewes after the second year.

Cumulative Lamb and Wool Production Per Ewe Entering the Study

Values for number of lambs born and weaned, kilograms of lamb born and weaned and kilograms of wool produced were accumulated for each ewe. Accumulations were completed after years 2, 3, 4, 5 and 6. Zeros were added to a ewe's cumulative production for each year in which she failed to lamb and for each year after she left the flock. Type, breed and management were used to test each main effect.

Least-squares means and standard errors for number of lambs born per ewe entering the experiment are found in table 22. Single-born ewes produced more lambs ($P<.05$) than multiple-born ewes after 2 years of age. Single-born ewes had produced 6.52 lambs, while multiple-born ewes had produced 5.92 lambs after 6 years. These values did not differ ($P>.05$). Finnsheep x Targhee ewes produced more lambs ($P<.05$) than Suffolk x Targhee or Targhee ewes at each age. Suffolk x Targhee ewes produced more lambs ($P<.05$) than Targhee ewes after 2 and 3 years of age. Finnsheep x Targhee, Suffolk x Targhee and Targhee ewes had given birth to 7.82, 5.59 and 5.24 lambs, respectively, after 6 years. Number of lambs born per ewe was greater ($P<.05$) for ewes in the farm flock than for ewes in the range flock after years 3 through 6. Farm flock ewes had produced 1.19 more lambs than range flock ewes after 6 years.

Least-squares means and standard errors for cumulative weight of lambs born per ewe entering the experiment are presented in table 23. Single-born ewes produced more kilograms of lamb at birth ($P<.05$) than multiple-born ewes after 2 years of age. This trend had reversed after 6 years, but the difference was not significant ($P>.05$). It is of interest to examine the trend of weight of lamb over time. After years 2 and 3, the Finnsheep x Targhee ewes had given birth to more kilograms of lamb ($P<.05$) than both the Suffolk x Targhee and Targhee ewes. By year 4, production by the Finnsheep x Targhee ewes was only greater ($P<.05$) than the Targhee ewes. Breeds did not differ ($P>.05$) after years 5 and 6. The Suffolk x Targhee ewes were only superior ($P<.05$) to the Targhee ewes after 2 years. Weight of lamb produced at birth was greater ($P<.05$) for farm flock ewes than for range flock ewes at each year.

Least-squares means and standard errors for cumulative number of lambs weaned per ewe entering the experiment are presented in table 24. Ewe type of birth, single vs multiple, had no significant effect on number of lambs weaned ($P>.05$). Finnsheep x Targhee ewes weaned more lambs ($P<.05$) than Suffolk x Targhee and Targhee ewes at each age of ewe. Suffolk x Targhee ewes weaned more lambs ($P<.05$) than Targhee ewes after 2 years. Finnsheep x Targhee, Suffolk x Targhee and Targhee ewes had weaned 5.57, 4.27 and 4.20 lambs, respectively, after 6 years of production. Number of lambs weaned differed ($P<.05$) by management system after year 4. Farm flock ewes had weaned more lambs ($P<.05$) than range flock ewes after year 4.

Least-squares means and standard errors for cumulative weight of lambs weaned per ewe entering the experiment are presented in table 25. Single-born and multiple-born ewes did not differ (P>.05) in kilograms of lamb weaned at any age. For years 2 through 5, Finnsheep x Targhee ewes weaned more kilograms of lamb (P<.05) than Suffolk x Targhee and Targhee ewes. Finnsheep x Targhee ewes produced more weaned lamb (P<.05) than the Targhee ewes and more but not significantly so than the Suffolk x Targhee ewes (P = .07) after 6 years. Finnsheep x Targhee, Suffolk x Targhee and Targhee ewes had weaned 138.2, 116.7 and 110.9 kg of lamb, respectively, after 6 years. Farm flock ewes weaned more kilograms of lamb (P<.05) than range flock ewes after years 4, 5, and 6. After year 6, the farm flock ewes had a 17.5-kg advantage over range flock ewes.

Least-squares means and standard errors for cumulative weight of wool produced per ewe entering the experiment are presented in table 26. Single-born ewes produced more wool (P<.05) than multiple-born ewes after each year. Single-born ewes produced 2.79 kg more wool than multiple-born ewes after 6 years. Targhee ewes produced more wool (P<.05) than Suffolk x Targhee or Finnsheep x Targhee ewes in all years. Wool production between Suffolk x Targhee and Finnsheep x Targhee ewes was not different (P>.05). After 6 years of age, Targhee, Suffolk x Targhee and Finnsheep x Targhee ewes had produced 19.82, 17.60 and 16.18 kg of wool, respectively. After 2 years, range flock ewes had produced more wool (P<.05) than farm flock ewes. This trend reversed and farm flock ewes produced more wool ($P<.05$) than range flock ewes by year 6.

SUMMARY

The major objective of this study was to determine the production of lamb and wool under two management systems with three different breed combinations of ewes. Two ewe flocks were maintained, one in a farm flock management system and the other in a range flock management system. Data were first evaluated on a yearly basis followed by an analysis of cumulative production after each year on a per ewe present and a per ewe entering the experiment basis.

Wool production showed a curvilinear type response with age of ewe with very small differences between management systems. The superiority of the Targhee for wool production was evident in each analysis. Single-born ewes were more productive than multiple-born ewes for wool. The accelerated rate of mortality of the range flock ewes in later years was reflected in the lower wool production per ewe entering the study.

Fertility differences among groups were only evident for ewe lambs bred to lamb as yearlings. The failure of a large percentage of the Targhee ewes to lamb at 12 mo placed them at a disadvantage for cumulative production. The substitution of one-half of the genetic base with Suffolk breeding improved fertility. The early maturation of the Finnsheep crossbred ewes was clearly displayed by higher fertility at 12 mo of age.

Number of lambs born had a larger effect on litter weight at birth than did individual birth weights of lambs. The lower birth weight of individual lambs born to crossbred Finnsheep ewes was more

than offset by the larger number of lambs in the litter. A trade-off between the heavier lambs for Targhee ewes and the slight increase in lambing rate for the Suffolk x Targhee ewes resulted in similar litter weights and similar cumulative production of litter weight for the two breeds.

The loss of 25% of the lambs from birth to weaning was comparable to other published reports. The procedure of placing a limit of two lambs nursed per ewe may have masked the Finnsheep's biological ability to wean even larger numbers of lambs.

Evaluation of the kilograms of lamb weaned per ewe exposed gave the clearest picture of a ewe's ability to produce product. Based on evaluation at each age of ewe, there was no indication of any differences due to ewe type of birth or management system. In ewes over 4 years old, breeds did not differ in total weight of lamb weaned per ewe exposed.

By accumulating lamb and wool production over the lifetime of the ewe on a per ewe entering the experiment basis, longevity differences were detectable. These data would indicate that, for every 100 Targhee ewes brought into the breeding flock, 11,000 kg of weaned lamb and 1,982 kg of wool were produced after 6 years. Substituting one-half of the genetic base with Suffolk breeding resulted in a nonsignificant increase of 600 kg of lamb and a significant decrease of 222 kg of wool produced after 6 years. The use of one-half Finnsheep breeding resulted in 2,800 more kg of lamb and 364 kg less wool than for the Targhee ewes.

LITERATURE CITED

Alexander, G. and H. L. Davies. 1959. Relationship of milk production to number of lambs born or suckled. Australian J. Agr. Res. 10:720.

Baharin, K. and R. G. Beilharz. 1977. A comparison of performance of single and twin born Corriedale ewes and lambs. Australian J. Exp. Agr. Anim. Husb. 17:242.

Barker, J. D. 1975. A field trial of Finnish Landrace rams as sires of crossbred ewes. Anim. Prod. 20:371.

Basuthakur, A. K., P. J. Burfening, J. L. Van Horn and R. L. Blackwell. 1973. A study of some aspects of lifetime production in Targhee and Columbia sheep. J. Anim. Sci. 36:813.

Bennett, J. A., D. H. Matthews and M. A. Madsen. 1963. Range sheep breeding studies in southern Utah. Utah Agr. Exp. Sta. Bull. 442.

Blackwell, R. L. and C. R. Henderson. 1955. Variation in fleece weight, weaning weight and birth weight of sheep under farm conditions. J. Anim. Sci. 14:831.

Botkin, M. P. and L. Paules. 1965. Crossbred ewes compared with ewes of parent breeds for wool and lamb production. J. Anim. Sci. 24:1111.

Bradford, G. E. 1972. Genetic control of litter size in sheep. J. Reprod. Fertil. (Suppl. 15):23.

Bradley, B. P., A. B. Chapman, A. L. Pope and C. O. Rydberg. 1972. Two- and three-way crosses estimating combining ability of Suffolk, Targhee and Shropshire breeds of sheep. J. Anim. Sci. 34:541.

Briggs, H. M. 1936. Some effects of breeding ewe lambs. North Dakota Agr. Exp. Sta. Bull. 285.

Brown, G. H., H. Turner, S. S. Y. Young and C. H. S. Dolling. 1966. Vital statistics for an experimental flock of Merino sheep. Australian J. Agr. Res. 17:557.

Burfening, P. J., A. S. Hoversland, J. Drummond and J. L. Van Horn. 1972. Effect of estrus as a ewe lamb on lifetime production. J. Anim. Sci. 34:889 (Abstr.).

Cameron, N. D., C. Smith and F. K. Deeble. 1983. Comparative performance of crossbred ewes from three crossing sire breeds. Anim. Prod. 37:415.

Cannon, D. J. and J. G. Bath. 1969. Effect of age at first joining on lifetime production by Border Leicester x Merino ewes. Australian J. Exp. Agr. and Anim. Husb. 9:477.

Carter, R. C., G. M. Carman, F. S. McClaugherty and P. S. Haydon. 1971. Genotype-environment interaction in sheep. I. Ewe productivity. J. Anim. Sci. 33:556.

Cedillo, R. M., W. Hohenboken and J. Drummond. 1977. Genetic and environmental effects on age at first estrus and on wool and lamb production of crossbred ewe lambs. J. Anim. Sci. 44:948.

Clarke, S. E. and W. D. Hohenboken. 1983. Estimation of repeatability, heritability and breed differences for lamb production. J. Anim. Sci. 56:309.

Coop, I. E. 1966. Effect of flushing on reproductive performance of ewes. J. Agr. Sci. (Camb.) 67:305.

Dahmen, J. J., D. D. Hinman, J. A. Jacobs and D. O. Everson. 1978. Wool traits of Panama and Finn x Panama yearlings and 2 year old ewes. J. Anim. Sci. 47:331.

Dahmen, J. J., D. D. Hinman, J. A. Jacobs and D. O. Everson. 1979. Performance and carcass characteristics of Suffolk sired lambs from Panama and Finn x Panama dams. J. Anim. Sci. 49:55.

Davis, G. E. 1974. A sheep mortality survey in Hawke's Bay. New Zealand Vet. J. 22:39.

Dickerson, G. E. 1970. Efficiency of animal production - Molding the biological components. J. Anim. Sci. 30:849.

Dickerson, G. E. and D. B. Laster. 1975. Breed, heterosis and environmental influences on growth and puberty in ewe lambs. J. Anim. Sci. 41:1.

Dickerson, G. E. and H. A. Glimp. 1975. Breed and age effects on lamb production of ewes. J. Anim. Sci. 40:397.

Dickerson, G. E., H. A. Glimp and K. E. Gregory. 1975. Genetic resources for efficient meat production in sheep: Preweaning viability and growth of Finnsheep and domestic crossbred lambs. J. Anim. Sci. 41:43.

Donald, H. P. and J. L. Read. 1967. The performance of Finnish Landrace sheep in Britain. Anim. Prod. 9:471.

Donald, H. P., J. L. Read and W. S. Russell. 1968. A comparative trial of crossbred ewes by Finnish Landrace and other sires. Anim. Prod. 10:413.

Drummond, J., R. A. O'Connel and K. L. Colman. 1982. The effects of age and Finnsheep breeding on wool properties and processing characteristics. J. Anim. Sci. 54:8.

Ducker, M. J. and J. S. Boyd. 1977. The effect of body size and body condition on the ovulation rate of ewes. Anim. Prod. 24:377.

Dun, R. B. 1964. Skin folds and Merino breeding. I. The net reproductive rates of flocks selected for and against skin folds. Australian J. Exp. Agr. Anim. Husb. 4:376.

Dun, R. B. and R. S. Grewal. 1963. A comparison of the productive performance of single and twin born Merino ewes. Australian J. Exp. Agr. Anim. Husb. 3:235.

Dyrmundsson, O. R. 1973. Puberty and early reproductive performance in sheep. I. Ewe lambs. Anim. Breed. Abstr. 41:273.

Dzakuma, J. M., D. J. Stritzke and J. V. Whiteman. 1982a. Fertility and prolificacy of crossbred ewes under two cycles of accelerated lambing. J. Anim. Sci. 54:213.

Dzakuma, J. M., J. V. Whiteman and R. W. McNew. 1982b. Repeatability of lambing rate. J. Anim. Sci. 54:540.

Fahmy, M. H. 1982. Maternal performance of Oxford and Suffolk breeds of sheep and their crosses. Anim. Prod. 35:327.

Fletcher, I. C. 1971. Effects of nutrition, liveweight and season on the incidence of twin ovulation in South Australian Strong-Wool Merino ewes. Australian J. Agr. Res. 22:321.

Forrest, P. A. and M. Bichard. 1974. Analysis of production records from a lowland sheep flock. 2. Flock statistics and reproductive performance. Anim. Prod. 19:25.

Galal, E. S. E., E. A. Afifi, I. S. El-Kimary, I. A. Ahmad and A. F. Shawar. 1981. Lamb survival as affected by inbreeding and cross-breeding. J. Agr. Sci. (Camb.) 96:1.

Glimp, H. A. 1971. Effect of breed and mating season on reproductive performance of sheep. J. Anim. Sci. 32:1176.

Glimp, H. A., W. P. Deweese and R. H. Dutt. 1968. Effects of date of breeding and on orally administered synthetic progestogen on reproductive performance of crossbred ewes. J. Anim. Sci. 27:447.

Goot, H. and K. Maijala. 1977. Reproductive performance at first lambing and in twice-yearly lambing in a flock of Finnish Landrace sheep in Finland. Anim. Prod. 25:319.

Gould, M. B. and J. V. Whiteman. 1975. Relationship between preweaning growth rate of female lambs and growth of their offspring. J. Anim. Sci. 40:585.

Hare, L. and M. J. Bryant. 1982. Characteristics of oestrous cycles and plasma progesterone profiles of young female sheep during their first breeding season. Anim. Prod. 35:1.

Hazel, L. N. and C. E. Terrill. 1946a. Effects of some environmental factors on weaning traits of range Columbia, Corriedale and Targhee lambs. J. Anim. Sci. 5:318.

Hazel, L. N. and C. E. Terrill. 1946b. Effects of some environmental factors on fleece and body characteristics of range Rambouillet yearling ewes. J. Anim. Sci. 5:382.

Hight, G. K., J. J. Atkinson, R. M. W. Sumner and M. L. Bigham. 1976. Wool traits of Romney and Border Leicester x Romney ewes. New Zealand J. Agr. Res. 19:197.

Hight, G. K. and K. E. Jury. 1970. Hill country sheep production. II. Lamb mortality and birth weights in Romney and Border Leicester x Romney flocks. New Zealand J. Agr. Res. 13:735.

Hight, G. K. and K. E. Jury. 1971. Sources of variation in Romney and Border Leicester x Romney lambs and hoggets. New Zealand J. Agr. Res. 14:669.

Hight, G. K. and K. E. Jury. 1973. Ewe live weights and the relationship of live weight and fertility in Romney and Border Leicester x Romney ewes. New Zealand J. Agr. Sci. 16:447.

Hohenboken, W. D. and S. E. Clarke. 1981. Genetic, environmental and interaction effects on lamb survival, cumulative lamb production and longevity of crossbred ewes. J. Anim. Sci. 53:966.

Hohenboken, W., K. Corum and R. Bogart. 1976. Genetic, environmental and interaction effects in sheep. I. Reproduction and lamb production per ewe. J. Anim. Sci. 42:299.

Hulet, C. V., E. L. Wiggins and S. K. Ercanbrack. 1969. Estrus in range lambs and its relationship to lifetime reproductive performance. J. Anim. Sci. 28:246.

Kelly, R. W. 1982. Reproductive performance of commercial sheep flocks in South Island districts I. New Zealand J. Agr. Res. 25:175.

Kelly, G. W. and P. D. Johnstone. 1982. Reproductive performance of commercial sheep flocks in South Island districts II. New Zealand J. Agr. Res. 25:519.

Kennedy, J. P. 1967. Genetic and phenotypic relationships between fertility and wool production in 2 year old Merino sheep. Australian J. Agr. Res. 18:515.

Kennedy, T. G. and J. P. Kennedy. 1968. Relationship between joining age, body weight, fertility and productivity of fine wool Merino ewes in Southern New South Wales. Proc. Australian Soc. Anim. Prod. 7:215.

Lambe, J. W., Jr., G. H. Bowman and J. C. Rennie. 1965. Production traits in sheep as affected by breeds and environment. Can. J. Anim. Sci. 45:1.

Lamberson, W. R. and D. L. Thomas. 1982. Effects of season and breed of sire on incidence of estrus and ovulation rate in sheep. J. Anim. Sci. 54:533.

Land, R. B. 1978. Reproduction in young sheep: Some genetic and environmental sources of variation. J. Reprod. Fertil. 52:427.

Laster, D. B., H. A. Glimp and G. E. Dickerson. 1972. Factors affecting reproduction in ewe lambs. J. Anim. Sci. 35:79.

Lax, J. and G. H. Brown. 1968. The influence of maternal handicap, inbreeding and ewes' body weight at 15 to 16 months of age on reproductive rate in Australian Merino ewes. Australian J. Agr. Res. 19:433.

Lax, J. and H. N. Turner. 1965. The influence of various factors on survival rate to weaning of Merino lambs. Australian J. Agr. Res. 16:981.

Levine, J. M. and W. Hohenboken. 1978. Crossbred lamb production from Columbia and Suffolk ewes. I. Ewe production and lamb traits. J. Anim. Sci. 47:89.

Levine, J. M., M. Vaura, R. Phillips and W. Hohenboken. 1978. Ewe lamb conception as an indicator of future production in farm flock Columbia and Targhee ewes. J. Anim. Sci. 46:19.

Leymaster, K. A. and G. M. Smith. 1981. Columbia and Suffolk terminal sire breed effects. J. Anim. Sci. 53:1225.

Magid, A. F., V. B. Swanson, J. S. Brinks, G. E. Dickerson and G. M. Smith. 1981a. Border Leicester and Finnsheep crosses. I. Survival, growth and carcass traits of Fl lambs. J. Anim. Sci. 52:1253.

Magid, A. F., V. B. Swanson, J. S. Brinks, G. E. Dickerson and G. M. Smith. 1981b. Border Leicester and Finnsheep crosses. II. Productivity of Fl ewes. J. Anim. Sci. 52:1262.

Martin, T. G., D. Nicholson, C. Smith and D. I. Sales. 1981. Phenotypic and genetic parameters for reproductive performance in a synthetic line of sheep. J. Agr. Sci. (Camb.) 96:107.

McGuirk, B. J., A. K. Bell and M. D. Smith. 1968. The effect of body weight at joining on the reproductive performance of young crossbred ewes. Proc. Australian Soc. Anim. Prod. 7:220.

McManus, W. R., G. W. Arnold and M. L. Dudzinski. 1966. Studies in the wool production of grazing sheep. 4. Variation between sheep in intake, wool production and efficiency. Australian J. Exp. Agr. Anim. Husb. 6:96.

Mechling, E. A. and R. C. Carter. 1969. Genetics of multiple births in sheep. J. Hered. 60:261.

Meyer, H. H. and G. E. Bradford. 1973. Reproduction in Targhee and Finnish Landrace x Targhee ewes. J. Anim. Sci. 36:847.

Meyer, H. H. and J. N. Clarke. 1970. Genetic and environmental effects on incidence and causes of lamb mortality. New Zealand J. Agr. Res. 13:735.

Moav, R. 1966. Specialized sire and dam lines. I. Economic evaluation of crossbreds. Anim. Prod. 8:193.

Morley, F. H. W. 1956. Selection for economic characters in Australian Merino sheep. VII. Interactions between genotype and plane of nutrition. Australian J. Agr. Res. 7:140.

Nichols, C. W. and J. V. Whiteman. 1966. Productivity of farm flock ewes in relation to body size. J. Anim. Sci. 25:460.

Norman, L. M. and W. Hohenboken. 1979. Genetic and environmental effects on internal parasites, foot soundness and attrition in crossbred ewes. J. Anim. Sci. 48:1329.

Notter, D. R. and J. S. Copenhaver. 1980. Performance of Finnish Landrace crossbred ewes under accelerated lambing. II. Lamb growth and survival. J. Anim. Sci. 51:1043.

Oltenacu, E. A. and W. J. Boylan. 1981a. Productivity of purebred and crossbred Finnsheep. I. Reproductive traits of ewes and lamb survival. J. Anim. Sci. 52:989.

Oltenacu, E. A. and W. J. Boylan. 1981b. Productivity of purebred and crossbred Finnsheep. II. Lamb weights and reproduction indices of ewes. J. Anim. Sci. 52:998.

Omar, I., C. Jordan and C. Smith. 1977. A note on effects of lambing at one year and farm production level on the performance of prolific ewes. Anim. Prod. 25:389.

Parker, C. F. 1969. Ram influence on lambing rate, lamb crop percentage and quantity of lamb weaned of Columbia and Targhee ewes. Anim. Breed. Abstr. 38:619.

Piper, L. R. and B. J. McGuirk. 1976. Age effects on the difference in reproductive performance between twin and single born Merino ewes. Proc. Australian Soc. Anim. Prod. 11:105.

Ponzoni, R. W., M. Azzarini and S. K. Walker. 1979. Production in mature Corriedale ewes first mated at 7 to 11 or 18 months of age. Anim. Prod. 29:385.

Price, D. A. 1971. Performance and characteristics of Finnsheep crosses. U.S. Sheep Exp. Sta. Res. Rep., USDA, ARS, Dubois, Idaho.

Price, D. A., G. M. Sidwell and J. O. Grandstaff. 1953. Effects of some genetic and environmental factors on yearling traits of Navajo and Navajo crossbred ewes. J. Anim. Sci. 12:697.

Rastogi, R., W. J. Boylan, W. E. Rempel and H. F. Windels. 1982. Crossbreeding in sheep with evaluation of combining ability, heterosis and recombination effects for lamb growth. J. Anim. Sci. 54:524.

Ray, E. E. and G. M. Sidwell. 1964. Effects of pregnancy, parturition and lactation upon wool production of range ewes. J. Anim. Sci. 23:989.

Reid, R. N. D. 1978. The effects of pregnancy and lactation on wool production and liveweight in Polworth ewes. Australian J. Exp. Agr. Anim. Husb. 18:58.

Robinson, J. J. and E. R. Orskov. 1975. An integrated approach to improving the biological efficiency of sheep meat production. World Review Anim. Prod. 11(3):63.

Russel, A. J. F., J. Z. Foot, I. R. White and G. J. Davies. 1981. The effect of weight at mating and of nutrition mid-pregnancy on the birth weight of lambs from primiparous ewes. J. Agr. Sci. (Camb.) 97:723.

Ruttle, J. L. 1971. Influence of sex and type of birth on performance of early weaned lambs. J. Anim. Sci. 32:974.

Sall, J. P. 1971. Funcat. In: Jane T. Helwig and Kathryn A. Council (Ed.) SAS User's Guide. SAS Institute, Inc., Cary, NC. p 221.

Saoud, N. B. and W. D. Hohenboken. 1984. The effect of selection in retrospect on lifetime production efficiency in sheep. J. Anim. Sci. 59:620.

Seebeck, R. M. and D. E. Tribe. 1963. The relation between the lamb production and the wool production of the ewe. Australian J. Exp. Agr. 3:149.

Slen, S. B. and E. C. Banky. 1958. The relationship of clean fleece weight to age in three breeds of range sheep. Can. J. Anim. Sci. 38:61.

Slen, S. B., H. F. Peters and P. I. Nyhs. 1954. The relationship of clean fleece weight to body weight in range sheep. Can. J. Agr. Sci. 34:198.

Shelton, M. and J. W. Menzies. 1968. Genetic parameters of some performance characteristics of range fine-wool ewes. J. Anim. Sci. 27:1219.

Shrestha, J. N. B., H. F. Peters and D. P. Heaney. 1982. Growth performance of lambs sired by rams of the East Friesian, Finnish Landrace, Ile De France and Suffolk breeds. Can. J. Anim. Sci. 62:689.

Shrestha, J. N. B., W. E. Rempel, W. J. Boylan and K. P. Miller. 1983. General, specific, maternal and reciprocal effects for ewe productivity in crossing five breeds of sheep. Can. J. Anim. Sci. 63:497.

Sidwell, G. M., D. O. Everson and C. E. Terrill. 1962. Fertility, prolificacy and lamb livability of some pure breeds and their crosses. J. Anim. Sci. 21:875.

Sidwell, G. M., D. O. Everson and C. E. Terrill. 1964. Lamb weights in some pure breeds and crosses. J. Anim. Sci. 23:105.

Sidwell, G. M. and L. R. Miller. 1971a. Production in some pure breeds of sheep and their crosses. I. Reproductive efficiency in ewes. J. Anim. Sci. 32:1084.

Sidwell, G. M. and L. R. Miller. 1971b. Production in some pure breeds of sheep and their crosses. II. Birth weights and weaning weight of lambs. J. Anim. Sci. 32:1090.

Sidwell, G. M., R. L. Wilson and M. E. Hourikan. 1971. Production in some pure breeds of sheep and their crosses. IV. Effect of crossbreeding on wool production. J. Anim. Sci. 32:1099.

Smith, G. M. 1977. Factors affecting birth weight, dystocia and preweaning survival in sheep. J. Anim. Sci. 44:745.

Southam, E. R., C. V. Hulet and M. P. Botkin. 1971. Factors influencing reproduction in ewe lambs. J. Anim. Sci. 33:1282.

Spencer, D. A., R. G. Schott, R. W. Phillips and B. Aune. 1942. Performance of ewes bred first as lambs compared with ewes bred first as yearlings. J. Anim. Sci. 1:27.

Steel, R. G. D. and J. H. Torrie. 1980. Principles and Procedures of Statistics. McGraw-Hill Book Co., New York.

Terrill, C. E., G. M. Sidwell and L. H. Hazel. 1947. Effects of some environmental factors on yearling traits of Columbia and Targhee ewes. J. Anim. Sci. 6:115.

Terrill, C. E. and J. A. Stoehr. 1942. The importance of body weight in selection of range ewes. J. Anim. Sci. 1:221.

Thomas, D. L. and J. V. Whiteman. 1979. Effects of substituting Finnsheep and Dorset breeding for Rambouillet breeding. I. Productivity of young spring lambing ewes. J. Anim. Sci. 45:256.

Torres-Hernandez, G. and W. Hohenboken. 1979. Genetic and environmental effects on milk production, milk composition and mastitis incidence in crossbred ewes. J. Anim. Sci. 49:410.

Turner, H. N. 1969. Genetic improvement of reproduction rate in sheep. Anim. Breed. Abstr. 37:545.

Turner, H. N., R. H. Hayman, L. K. Triffitt and R. W. Prunster. 1962. Response to selection for multiple births in the Australian Merino: A progress report. Anim. Prod. 4:165.

Turner, H. N. and S. S. Y. Young. 1969. Quantitative Genetics in Sheep Breeding. Cornell Univ. Press, Ithaca, NY. p 253.

Tyrell, R. N. 1976. Some effects of pregnancy in eight-month-old Merino ewes. Australian J. Exp. Agr. Anim. Husb. 16:458.

Tyrell, R. N., N. M. Fogarty, R. D. Kearins and B. J. McGuirk. 1974. A comparison of the subsequent production by Border Leicester x Merino ewes first joined as weaners or at 18 months of age. Proc. Australian Soc. Anim. Prod. 10:270.

Vesely, J. A. 1978. Performance of progeny of Finnish Landrace and Dorset Horn rams mated to ewes of various breeds and crosses. Can. J. Anim. Sci. 58:399.

Vesely, J. A. and H. F. Peters. 1964. The effects of breed and certain environmental factors on birth and weaning traits of range sheep. Can. J. Anim. Sci. 44:215.

Vesely, J. A. and H. F. Peters. 1965. Fertility, prolificacy, weaned lamb production and lamb survival ability in four range breeds. Can. J. Anim. Sci. 45:75.

Vesely, J. A. and H. F. Peters. 1972. Lamb growth performance of Romnelet, Columbia, Suffolk and North Country Cheviot breeds and all single and 3 breed crosses among them. Can. J. Anim. Sci. 52:283.

Vesely, J. A. and H. F. Peters. 1974. Lamb production from ewes of four breeds and their two-breed and three-breed crosses. Can. J. Anim. Sci. 54:543.

Vesely, J. A. and H. F. Peters. 1981. Lamb production from ewes of four breeds and their two-, three-, and four-breed crosses. Can. J. Anim. Sci. 61:271.

Vesely, J. A., H. F. Peters and S. B. Slen. 1965. The effects of breed and certain environmental factors on wool traits of range sheep. Can. J. Anim. Sci. 45:91.

Vesely, J. A., H. F. Peters and S. B. Slen. 1966. Lamb and wool production from five breeds on range. Can. J. Anim. Sci. 46:9.

Wiener, G. 1967. A comparison of the body size, fleece weight and maternal performance of five breeds of sheep kept in one environment. Anim. Prod. 9:177.

Wiener, G., F. K. Deeble, J. S. Broadhent and M. Talbot. 1973. Breed variation in lambing performance and lamb mortality in commercial sheep flocks. Anim. Prod. 17:229.

Wiener, G. and S. Hayter. 1975. Maternal performance in sheep as affected by breed, crossbreeding and other factors. Anim. Prod. 20:19.

APPENDIX

TABLE 1. LEAST-SQUARES ANALYSIS OF VARIANCE FOR EWE BIRTH DATE, BIRTH WEIGHT, WEANING WEIGHT AND PREBREEDING EWE WEIGHT

Source	Ewe birth date		Birth weight		Weaning weight		Prebreeding weight	
	df	SS	df	SS	df	SS	df	SS
Ewe type of birth	1	831.713***	1	255.719***	1	9002.025***	1	3893.643***
Breed of sire	2	1736.263***	2	14.395*	2	5964.737***	2	1352.838
Type x breed	2	258.217	2	3.334	2	228.332	2	175.374
Error	415	29080.518	415	907.344	414	42989.967	415	100101.333

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

TABLE 2. LEAST-SQUARES ANALYSIS OF VARIANCE FOR ANNUAL EWE WEIGHT AT BREEDING FOR RANGE MANAGEMENT SYSTEM (ANTELOPE)

	Age in months											
	12		24		36		48		60		72	
Source	df	SS	df	SS	df	SS	df	SS	df	SS	df	SS
Ewe type of birth	1	3948.901***	1	929.719*	1	1.409	1	613.331	1	251.078	1	432.499
Breed of ewe	2	826.010	2	674.814	2	3168.833***	2	1084.059*	2	2074.004**	2	1388.065*
Year of production	2	11375.776***	2	13299.758***	2	3530.092***	2	703.311	2	1062.722*	2	1940.451**
Type x breed	2	3.644	2	234.248	2	318.618	2	146.350	2	80.134	2	80.721
Type x year	2	422.240	2	420.359	2	178.756	2	137.360	2	608.409	2	16.108
Breed x year	4	3163.795***	4	546.275	4	1054.065	4	53.744	4	217.610	4	382.231
Error	185	25220.863	182	36755.475	142	25089.543	114	19853.118	88	14273.032	66	9477.012

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

TABLE 3. LEAST-SQUARES ANALYSIS OF VARIANCE FOR ANNUAL EWE WEIGHT AT WEANING FOR FARM MANAGEMENT SYSTEM (BROOKINGS)

	Age in months											
	12		24		36		48		60		72	
Source	df	SS	df	SS	df	SS	df	SS	df	SS	df	SS
Ewe type of birth	1	1417.305*	1	495.379	1	1103.720	1	805.564	1	1382.609	1	26.093
Breed of ewe	2	1092.667	2	779.590	2	1521.429	2	1537.756	2	668.673	2	1951.037
Year of production	2	10134.123***	2	25654.593***	2	8126.526***	2	4188.848*	2	4150.807**	2	7082.587***
Type x breed	2	169.850	2	73.297	2	1393.470	2	803.039	2	1342.104	2	1778.339
Type x year	2	122.531	2	252.344	2	959.053	2	60.693	2	314.860	2	548.841
Breed x year	4	1155.242	4	720.550	4	197.141	4	931.386	4	3321.837	4	3969.706
Error	204	61902.975	182	43608.147	153	48558.064	141	69000.463	109	12902.317	83	35794.290

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

TABLE 4. LEAST-SQUARES ANALYSIS OF VARIANCE FOR DATE OF BIRTH

	Age in months											
	12		24		36		48		60		72	
Source	df	SS	df	SS	df	SS	df	SS	df	SS	df	SS
Ewe type of birth	1	272.885	1	1519.716	1	6.608	1	148.229	1	14.944	1	77.863
Breed of ewe	2	555.167*	2	863.861	2	380.686	2	463.841	2	919.730***	2	34.891
Year of production	2	770.902**	2	33086.011***	2	1446.489	2	366.738	2	396.485	2	63.377
Management system			1	100762.274***	1	112140.797***	1	102501.207***	1	77777.028***	1	35285.809***
Sex	1	21.287	1	600.151	1	40.025	1	40.928	1	124.491	1	2.284
No. of lambs born (NOLMB)	1	2.012	1	91.594	1	10.246	1	44.166	1	27.067	1	14.166
Type x breed	2	3.826	2	5300.343	2	86.047	2	205.473	2	200.216	2	115.674
Type x sex	2	43.009	2	3703.244	2	13.192	2	55.490	2	13.590	2	139.015
Breed x year	4	624.599	4	6665.513	4	203.572	4	161.396	4	398.353	4	238.811
Type x management			1	2763.659	1	14.486	1	174.437	1	25.856	1	2.163
Breed x management			2	2472.243	2	47.174	2	461.019	2	146.331	2	44.090
Year x management			2	14521.633***	2	669.675**	2	99.477	2	261.574	2	1088.687***
Type x sex	1	59.549	1	464.229	1	.133	1	19.379	1	85.081	1	33.115
Breed x sex	2	47.126	2	1825.061	2	103.226	2	210.058	2	177.192	2	69.849
Year x sex	2	106.877	2	1307.179	2	114.226	2	136.785	2	246.737	2	71.912
Management x sex			1	1734.330	1	219.412	1	36.515	1	171.702	1	19.901
Type x NOLMB	1	1.429	1	3150.272	1	7.196	1	2.943	1	89.186	1	47.496
Breed x NOLMB	2	.158	2	2416.892	2	382.452	2	54.258	2	683.099*	2	189.459
Year x NOLMB	2	50.415	2	3049.176	2	19.775	2	700.241*	2	122.220	2	25.824
Management x NOLMB			1	2639.776	1	15.144	1	31.077	1	10.694	1	54.442
Sex x NOLMB	1	59.443	1	1806.004	1	172.912	1	38.664	1	82.859	1	20.071
Error	225	16803.588	318	445898.004	265	17551.664	242	18712.753	188	14565.206	134	8900.959

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

TABLE 5. LEAST-SQUARES ANALYSIS OF VARIANCE FOR LAMB WEIGHT AT BIRTH

	Age in months											
	12		24		36		48		60		72	
Source	df	SS	df	SS	df	SS	df	SS	df	SS	df	SS
Ewe type of birth	1	23.284**	1	4.560	1	26.438**	1	3.590	1	4.365	1	.955
Breed of ewe	2	92.024***	2	37.109**	2	102.006***	2	112.709***	2	118.049***	2	72.751***
Year of production	2	14.861	2	158.192***	2	5.377	2	14.084	2	12.504	2	2.829
Management system			1	39.259***	1	25.630**	1	11.156	1	12.579*	1	.120
Sex of lamb	1	.243	1	4.502	1	18.487*	1	47.049***	1	.103	1	12.969*
No. of lambs born (NOLMB)	1	58.184***	1	348.393***	1	387.089***	1	335.214***	1	169.157***	1	98.167***
Type x breed	2	.580	2	13.225	2	2.552	2	1.134	2	4.103	2	1.458
Type x year	2	3.554	2	43.586**	2	5.023	2	1.531	2	37.361**	2	1.046
Breed x year	4	30.917	4	28.120	4	14.003	4	7.902	4	12.775	4	10.589
Type x management			1	29.730**	1	.360	1	.000	1	.416	1	.018
Breed x management			2	8.795	2	2.979	2	5.128	2	11.797	2	3.469
Year x management			2	.228	2	18.156	2	6.950	2	19.014*	2	29.444**
Type x sex	1	10.033	1	6.248	1	6.869	1	.176	1	1.687	1	1.065
Breed x sex	2	7.308	2	.360	2	4.541	2	.431	2	5.538	2	1.800
Year x sex	2	1.828	2	1.112	2	1.865	2	.129	2	5.587	2	.051
Management x sex			1	2.903	1	.448	1	.007	1	.282	1	3.089
Type x NOLMB	1	.019	1	15.874*	1	.000	1	.306	1	11.055	1	10.004
Breed x NOLMB	2	2.938	2	18.807	2	13.664	2	1.884	2	7.938	2	1.978
Year x NOLMB	2	2.584	2	27.142*	2	7.964	2	7.490	2	2.716	2	5.255
Management x NOLMB			1	11.290	1	2.118	1	.034	1	.254	1	.079
Sex x NOLMB			1	7.017	1	.704	1	2.222	1	3.489	1	1.098
Error	299	1051.220	523	1760.532	470	1545.657	439	1355.346	372	1100.760	298	810.656

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

TABLE 6. LEAST-SQUARES ANALYSIS OF VARIANCE FOR NUMBER OF LAMBS BORN PER EWE EXPOSED

Source	Age in months											
	12		24		36		48		60		72	
	df	SS	df	SS	df	SS	df	SS	df	SS	df	SS
Ewe type of birth	1	.970	1	2.925*	1	.127	1	.000	1	.121	1	.181
Breed of ewe	2	20.015***	2	28.399***	2	11.012***	2	14.259***	2	12.049***	2	10.893***
Year of production	2	10.116***	2	.004	2	.033	2	1.352	2	1.021	2	1.318
Management system			1	1.953	1	.290	1	.005	1	.180	1	2.654
Type x breed	2	.579	2	1.208	2	.677	2	.347	2	.180	2	1.024
Type x year	2	.935	2	1.957	2	.030	2	1.359	2	.951	2	.169
Breed x year	2	5.558*	2	8.196**	2	1.280	2	2.708	2	.978	2	4.169
Type x management			1	.023	1	.115	1	.048	1	.417	1	.066
Breed x management			2	.716	2	.631	2	1.211	2	.253	2	5.705*
Year x management			2	2.558	2	2.102	2	5.181**	2	.319	2	1.699
Error	407	176.748	396	219.976	326	197.645	277	136.523	232	145.650	174	122.010

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

TABLE 7. LEAST-SQUARES ANALYSIS OF VARIANCE FOR NUMBER OF LAMBS BORN PER EWE LAMBING

Source	Age in months											
	12		24		36		48		60		72	
	df	SS	df	SS	df	SS	df	SS	df	SS	df	SS
Ewe type of birth	1	.0416	1	.396	1	.000	1	.069	1	.003	1	.273
Breed of ewe	2	5.240***	2	31.167***	2	13.571***	2	10.707***	2	10.519***	2	7.118***
Year of production	2	1.820**	2	.486	2	2.032*	2	1.118	1	.098	2	1.610
Management system			1	1.003	1	.511	1	.521	1	.158	1	7.618***
Type x breed	2	.167	2	.760	2	.176	2	.228	2	.296	2	.472
Type x year	2	.035	2	1.272	2	.557	2	.514	2	.053	2	.591
Breed x year	4	.596	4	1.635	4	2.036	4	2.620	4	.713	4	1.736
Type x management			1	.005	1	.045	1	.001	1	.447	1	.008
Breed x management			2	.562	2	.955	2	.716	2	1.554	2	1.822
Year x management			2	.641	2	1.705*	2	2.053	2	.945	2	2.032*
Error	240	40.155	334	90.338	281	78.309	258	88.292	203	65.565	149	47.436

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

TABLE 7. LEAST-SQUARES ANALYSIS OF VARIANCE FOR NUMBER OF LAMBS BORN PER EWE LAMBING

	Age in months											
	12		24		36		48		60		72	
Source	df	SS	df	SS	df	SS	df	SS	df	SS	df	SS
Ewe type of birth	1	.0416	1	.396	1	.000	1	.069	1	.003	1	.273
Breed of ewe	2	5.240***	2	31.167***	2	13.571***	2	10.707***	2	10.519***	2	7.118***
Year of production	2	1.820**	2	.486	2	2.032*	2	1.118	1	.098	2	1.610
Management system			1	1.003	1	.511	1	.521	1	.158	1	7.618***
Type x breed	2	.167	2	.760	2	.176	2	.228	2	.296	2	.472
Type x year	2	.035	2	1.272	2	.557	2	.514	2	.053	2	.591
Breed x year	4	.596	4	1.635	4	2.036	4	2.620	4	.713	4	1.736
Type x management			1	.005	1	.045	1	.001	1	.447	1	.008
Breed x management			2	.562	2	.955	2	.716	2	1.554	2	1.822
Year x management			2	.641	2	1.705*	2	2.053	2	.945	2	2.032*
Error	240	40.155	334	90.338	281	78.309	258	88.292	203	65.565	149	47.436

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

TABLE 8. LEAST-SQUARES ANALYSIS OF VARIANCE FOR TOTAL WEIGHT OF LAMBS BORN PER EWE LAMBING

	Age in months											
	12		24		36		48		60		72	
Source	df	SS	df	SS	df	SS	df	SS	df	SS	df	SS
Ewe type of birth	1	51.165*	1	32.596	1	38.190	1	2.453	1	.121	1	50.655
Breed of ewe	2	17.182	2	759.085***	2	159.039*	2	219.351*	2	326.058**	2	232.343**
Year of production	2	55.002	2	220.399**	2	32.532	2	127.936	2	77.735	2	124.207
Management system			1	391.515***	1	177.623**	1	145.276*	1	103.816	1	586.989***
Type x breed	2	28.622	2	70.882	2	7.785	2	14.962	2	3.328	2	35.175
Type x year	2	2.907	2	20.421	2	19.291	2	15.561	2	68.521	2	34.485
Breed x year	4	13.068	4	11.684	4	168.711*	4	132.283	4	94.733	4	246.343***
Type x management			1	4.818	1	9.831	1	.721	1	41.262	1	.273
Breed x management			2	58.895	2	4.911	2	18.073	2	43.871	2	146.583*
Year x management			2	21.410	2	129.571*	2	119.751	2	34.676	2	84.485
Error	240	3132.683	328	5788.969	281	4827.844	257	6684.054	203	5603.209	148	3489.007

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

TABLE 9. LEAST-SQUARES ANALYSIS OF VARIANCE FOR LAMB WEIGHT AT WEANING

	Age in months											
	12		24		36		48		60		72	
Source	df	SS	df	SS	df	SS	df	SS	df	SS	df	SS
Ewe type of birth	1	268.760	1	198.533	1	.594	1	126.891	1	185.567	1	198.112
Breed of ewe	2	132.165	2	824.757	2	813.245	2	439.697	2	21.242	2	42.280
Year of production	2	1034.401	2	16157.776***	2	1461.313**	2	3047.437***	2	14984.643***	2	6601.797***
Sex of lamb	1	381.360	1	1122.756**	1	2150.167***	1	931.646**	1	242.588	1	511.763
Birth/rearing class (BRC)	2	1812.339**	2	4274.766***	2	7618.314***	2	5988.197***	2	3013.247***	2	2505.990***
Management system			1	2196.666***	1	528.062	1	991.439**	1	134.247	1	140.071
Type x breed	2	21.516	2	5.932	2	190.894	2	65.986	2	1209.112*	2	1163.533*
Type x year	2	73.358	2	193.906	2	599.574	2	132.867	2	19.653	2	826.489
Breed x year	4	1359.132	4	367.424	4	1526.752*	4	106.747	4	565.701	4	1675.902*
Type x sex	1	33.301	1	114.778	1	225.223	1	370.543	1	2.854	1	587.829*
Breed x sex	2	24.391	2	8.047	2	786.755	2	209.770	2	154.993	2	239.334
Year x sex	2	67.689	2	1386.394**	2	1.087	2	57.810	2	738.669	2	317.188
Type x BRC	2	340.810	2	128.555	2	875.767*	2	57.389	2	700.140	2	184.222
Breed x BRC	2	727.110	2	356.993	2	1852.026*	2	659.548	2	328.743	2	613.554
Year x BRC	4	311.870	4	50.059	4	1197.055	4	557.810	4	1230.749	4	1655.141*
Sex x BRC	2	53.427	2	160.099	2	593.952	2	229.632	2	400.526	2	474.114
Type x management			1	1285.591***	1	9.047	1	10.079	1	12.862	1	200.713
Breed x management			2	127.503	2	403.790	2	1154.387**	2	528.021	2	390.712
Year x management			2	638.645	2	14443.887***	2	8691.371***	2	9231.015***	2	5608.454***
Sex x management			1	362.113	1	97.779	1	.003	1	6.703	1	29.725
BRC x management			2	265.872	2	818.911	2	1142.658**	2	190.028	2	333.362
Error	184	32714.182	380	52372.397	351	48554.913	352	35981.330	273	36742.022	195	28896.227

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

TABLE 10. LEAST-SQUARES ANALYSIS OF VARIANCE FOR NUMBER OF LAMBS WEANED PER EWE EXPOSED

	Age in months											
	12		24		36		48		60		72	
Source	df	SS	df	SS	df	SS	df	SS	df	SS	df	SS
Ewe type of birth	1	.307	1	.076	1	.353	1	.023	1	.024	1	.429
Breed of ewe	2	14.824***	2	9.036***	2	2.899	2	5.031**	2	3.252	2	2.810
Year of production	2	1.238	2	.006	2	.464	2	1.132	2	.790	2	1.668
Management system			1	.079	1	.012	1	.185	1	.364	1	.764
Type x breed	2	.394	2	1.735	2	.654	2	.257	2	.977	2	.849
Type x year	2	.447	2	1.537	2	.432	2	1.752	2	1.002	2	.515
Breed x year	4	.985	4	1.334	4	3.614	4	2.430	4	5.735*	4	2.585
Type x management			1	.515	1	.323	1	.159	1	.267	1	.660
Breed x management			2	1.157	2	.426	2	1.010	2	.412	2	3.750*
Year x management			2	.372	2	7.203***	2	.751	2	4.217*	2	3.139
Error	407	158.420	396	186.349	324	157.997	277	123.850	232	126.765	174	99.466

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

TABLE 11. LEAST-SQUARES ANALYSIS OF VARIANCE FOR NUMBER OF LAMBS WEANED PER EWE LAMBING

	Age in months											
	12		24		36		48		60		72	
Source	df	SS	df	SS	df	SS	df	SS	df	SS	df	SS
Ewe type of birth	1	.206	1	1.364*	1	.039	1	.000	1	.005	1	.759
Breed of ewe	2	6.090***	2	9.983***	2	4.012**	2	3.100*	2	2.018	2	2.057
Year of production	2	5.159**	2	.334	2	1.031	2	1.092	2	.485	2	2.596
Management system			1	.002	1	.010	1	1.300	1	.535	1	.014
Type x breed	2	1.050	2	2.122*	2	.038	2	.476	2	.660	2	.870
Type x year	2	.305	2	1.602	2	1.112	2	.874	2	.289	2	.302
Breed x year	4	1.075	4	1.186	4	4.314*	4	1.469	4	3.423	4	.984
Type x management			1	.649	1	.194	1	.436	1	.430	1	.762
Breed x management			2	1.372	2	.616	2	.545	2	.664	2	1.270
Year x management			2	.371	2	2.573*	2	.031	2	1.026	2	1.488
Error	240	88.300	334	105.653	281	96.548	258	90.804	203	85.187	149	64.572

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

TABLE 12. LEAST-SQUARES ANALYSIS OF VARIANCE FOR NUMBER OF LAMBS WEANED PER EWE WEANING A LAMB

Source	Age in months											
	12		24		36		48		60		72	
	df	SS	df	SS	df	SS	df	SS	df	SS	df	SS
Ewe type of birth	1	.001	1	.338	1	.022	1	.111	1	.022	1	.004
Breed of ewe	2	1.096*	2	8.011***	2	3.679***	2	1.182	2	2.313**	2	1.208
Year of production	2	.202	2	.075	2	.821	2	.793	2	.156	2	1.254
Management system			1	.834*	1	.058	1	.943*	1	.000	1	.307
Type x breed	2	.105	2	.310	2	.144	2	.019	2	.254	2	.476
Type x year	2	.173	2	.063	2	.371	2	.043	2	.025	2	.204
Breed x year	4	.286	4	.500	4	3.705**	4	1.522	4	.999	4	.970
Type x management			1	.020	1	.701	1	.369	1	.077	1	.307
Breed x management			2	.595	2	.127	2	.124	2	.206	2	.286
Year x management			2	.128	2	.970	2	.395	2	.399	2	.601
Error	166	26.536	290	48.874	256	54.762	239	55.867	181	42.173	132	32.395

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

TABLE 13. LEAST-SQUARES ANALYSIS OF VARIANCE FOR TOTAL WEIGHT WEANED PER EWE EXPOSED

	Age in months											
	12		24		36		48		60		72	
Source	df	SS	df	SS	df	SS	df	SS	df	SS	df	SS
Ewe type of birth	1	828.729	1	1027.365	1	1604.874	1	740.085	1	49.407	1	2375.215
Breed of ewe	2	36004.631***	2	10291.917*	2	6787.221	2	16628.090**	2	8012.581	2	4683.239
Year of production	2	4469.337	2	24231.540***	2	7167.888	2	342.726	2	60868.917***	2	19861.123*
Management system			1	5407.150	1	1.236	1	123.928	1	20.461	1	200.736
Type x breed	2	1485.466	2	4568.309	2	3127.135	2	4530.430	2	4289.157	2	7585.054
Type x year	2	1557.055	2	4163.230	2	2138.866	2	9374.718*	2	4326.097	2	8824.652
Breed x year	4	6175.888	4	1585.501	4	5717.424	4	8108.328	4	25552.443**	4	12105.891
Type x management			1	5921.763	1	169.695	1	12.078	1	586.734	1	1086.700
Breed x management			2	2190.011	2	1373.337	2	1063.434	2	146.443	2	19037.891*
Year x management			2	1265.455	2	28939.415***	2	12462.702*	2	51771.160***	2	31697.035**
Error	407	383608.213	391	634621.946	325	475771.976	275	422293.637	231	424346.035	173	415514.519

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

TABLE 14. LEAST-SQUARES ANALYSIS OF VARIANCE FOR TOTAL WEIGHT WEANED PER EWE LAMBING

	Age in months											
	12		24		36		48		60		72	
Source	df	SS	df	SS	df	SS	df	SS	df	SS	df	SS
Ewe type of birth	1	458.037	1	6379.415	1	437.426	1	453.412	1	326.742	1	3468.699
Breed of ewe	2	14827.999***	2	14852.894**	2	6682.960*	2	10367.224*	2	2920.046	2	3077.360
Year of production	2	21106.469***	2	30076.206***	2	1512.781	2	542.653	2	50514.611***	2	24402.906**
Management system			1	3768.936	1	1.368	1	726.182	1	8.798	1	908.113
Type x breed	2	3471.434	2	4083.752	2	170.167	2	4150.785	2	2508.252	2	8525.627
Type x year	2	496.225	2	4778.703	2	3812.532	2	5800.583	2	1018.581	2	3279.181
Breed x year	4	5223.520	4	10320.583	4	6828.568	4	5300.644	4	14952.933*	4	8182.802
Type x management			1	8097.721**	1	398.732	1	396.086	1	739.911	1	1249.982
Breed x management			2	2413.906	2	303.701	2	582.777	2	179.605	2	6887.521
Year x management			2	3061.862	2	29146.277***	2	14080.113**	2	33930.395***	2	24972.846**
Error	239	207895.812	330	366364.105	281	284133.287	257	323589.567	203	300825.474	148	258337.240

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

TABLE 15. LEAST-SQUARES ANALYSIS OF VARIANCE FOR TOTAL WEIGHT WEANED PER EWE WEANING A LAMB

	Age in months											
	12		24		36		48		60		72	
Source	df	SS	df	SS	df	SS	df	SS	df	SS	df	SS
Ewe type of birth	1	33.174	1	2242.982*	1	14.712	1	26.536	1	265.633	1	385.567
Breed of ewe	2	3036.861*	2	12315.027***	2	6105.288**	2	4193.796	2	3324.311	2	1396.855
Year of production	2	1979.421	2	35599.433***	2	2078.619	2	1434.028	2	46453.211***	2	19821.541***
Management system			1	12754.330***	1	275.658	1	262.827	1	797.485	1	4398.368*
Type x breed	2	58.570	2	602.272	2	558.491	2	2967.471	2	2858.813	2	7477.017*
Type x year	2	89.465	2	1052.788	2	642.382	2	2041.402	2	160.776	2	2397.569
Breed x year	4	1183.952	4	2629.320	4	5612.708*	4	4274.299	4	4412.346	4	3047.841
Type x management			1	1477.398	1	1712.655	1	596.449	1	31.357	1	334.993
Breed x management			2	735.311	2	817.851	2	1243.093	2	670.353	2	1544.877
Year x management			2	1469.269	2	23363.844***	2	10297.327**	2	23659.214***	2	21195.276***
Error	165	70117.771	287	159128.024	256	145109.726	238	214394.455	181	167509.142	133	145812.962

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

TABLE 16. LEAST-SQUARES ANALYSIS OF VARIANCE FOR WEIGHT OF WOOL PRODUCED

	Age in months											
	12		24		36		48		60		72	
Source	df	SS	df	SS	df	SS	df	SS	df	SS	df	SS
Ewe type of birth	1	16.236***	1	5.274	1	1.124	1	.046	1	1.450	1	3.561
Breed of ewe	2	18.860***	2	34.467***	2	24.938**	2	22.592*	2	30.300**	2	20.127*
Year of production	2	21.980***	2	25.635***	2	18.074**	2	9.261	2	3.505	2	16.471*
No. of lambs born (NOLMB)	2	5.988	2	3.148	2	4.797	2	7.745	2	3.107	2	6.290
Management system			1	48.932***	1	1.119	1	.000	1	6.161	1	10.772*
Type x breed	2	3.499	2	.190	2	3.885	2	.862	2	.204	2	4.315
Type x year	2	2.127	2	.235	2	.820	2	.703	2	8.295	2	5.601
Breed x year	4	8.872	4	5.294	4	3.923	4	5.000	4	3.895	4	4.013
Type x NOLMB	2	.895	2	1.124	2	3.548	2	4.573	2	.663	2	17.017*
Breed x NOLMB	4	7.538	4	9.443	4	11.207	4	4.771	4	2.878	4	25.275*
Year x NOLMB	4	3.551	4	3.051	4	9.117	4	24.439*	4	6.919	4	2.038
Type x management			1	.562	1	.000	1	.144	1	1.273	1	1.070
Breed x management			2	1.813	2	.046	2	6.057	2	7.133	2	.634
Year x management			2	36.825	2	1.402	2	94.687***	2	22.451**	2	26.568**
NOLMB x management			2	.317	2	11.177	2	3.858	2	9.000	2	6.693
Error	390	457.009	360	601.168	292	547.550	253	625.347	203	480.576	150	325.277

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

TABLE 17. LEAST-SQUARES ANALYSIS OF VARIANCE FOR CUMULATIVE NUMBER OF LAMBS BORN PER EWE PRESENT

	Year									
	2		3		4		5		6	
Source	df	SS	df	SS	df	SS	df	SS	df	SS
Ewe type of birth	1	4.826*	1	.141	1	.262	1	.016	1	.547
Breed of ewe	2	87.284***	2	145.570***	2	223.941***	2	289.479***	2	383.646***
Management system	1	4.919*	1	3.333	1	4.081	1	6.341	1	31.353**
Type x breed	2	.105	2	.478	2	.697	2	2.121	2	14.416
Type x management	1	.623	1	.661	1	1.486	1	.243	1	1.568
Breed x management	2	.104	2	.937	2	3.104	2	2.445	2	3.908
Error	404	456.182	335	517.375	287	630.316	242	702.090	184	751.687

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

TABLE 18. LEAST-SQUARES ANALYSIS OF VARIANCE FOR CUMULATIVE NUMBER OF LAMBS BORN PER EWE ENTERING THE STUDY

	Year									
	2		3		4		5		6	
Source	df	SS	df	SS	df	SS	df	SS	df	SS
Ewe type of birth	1	5.343*	1	5.732	1	8.182	1	11.741	1	26.725
Breed of ewe	2	90.887***	2	144.963***	2	174.800***	2	231.063***	2	305.888***
Management system	1	3.950	1	11.504*	1	39.486**	1	75.509**	1	129.128**
Type x breed	2	.001	2	2.806	2	8.722	2	12.075	2	10.491
Type x management	1	.780	1	.867	1	.595	1	.067	1	1.014
Breed x management	2	.126	2	4.245	2	17.772	2	28.139	2	59.182
Error	411	480.411	411	1105.336	411	2078.874	411	3419.638	411	5177.782

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

TABLE 19. LEAST-SQUARES ANALYSIS OF VARIANCE FOR CUMULATIVE WEIGHT OF LAMB BORN PER EWE PRESENT

	Year									
	2		3		4		5		6	
Source	df	SS	df	SS	df	SS	df	SS	df	SS
Ewe type of birth	1	454.378*	1	17.596	1	.699	1	102.400	1	30.093
Breed of ewe	2	3009.450***	2	3373.169***	2	5464.680***	2	6400.322***	2	8832.438***
Management system	1	1076.465**	1	1218.319**	1	1458.127**	1	2020.172**	1	3826.561**
Type x breed	2	1.989	2	28.188	2	105.561	2	155.485	2	2814.000*
Type x management	1	10.339	1	4.527	1	32.500	1	13.650	1	294.537
Breed x management	2	183.198	2	48.941	2	54.140	2	165.571	2	1695.081
Error	404	42204.091	335	46496.813	287	55000.000	242	16372.487	184	79526.949

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

TABLE 20. LEAST-SQUARES ANALYSIS OF VARIANCE FOR CUMULATIVE WEIGHT OF LAMB BORN PER EWE ENTERING THE STUDY

	Year									
	2		3		4		5		6	
Source	df	SS	df	SS	df	SS	df	SS	df	SS
Ewe type of birth	1	487.048*	1	281.801	1	762.814	1	1163.320	1	2883.254
Breed of ewe	2	3281.721***	2	3354.683**	2	2733.459	2	3446.846	2	4758.023
Management system	1	961.255**	1	2508.291**	1	6558.268***	1	11665.180***	1	17384.763***
Type x breed	2	10.218	2	313.627	2	1006.208	2	1428.665	2	1346.271
Type x management	1	14.584	1	13.871	1	.004	1	136.169	1	371.893
Breed x management	2	165.969	2	1045.790	2	3283.306*	2	4935.802	2	8130.423*
Error	411	44416.385	411	103512.357	411	203103.683	411	352172.575	411	549734.797

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

TABLE 21. LEAST-SQUARES ANALYSIS OF VARIANCE FOR CUMULATIVE NUMBER OF LAMBS WEANED PER EWE PRESENT

Source	Year 2 df	Year 2 SS	Year 3 df	Year 3 SS	Year 4 df	Year 4 SS	Year 5 df	Year 5 SS	Year 6 df	Year 6 SS
Ewe type of birth	1	.594	1	.086	1	.085	1	.030	1	.491
Breed of ewe	2	44.429***	2	66.553***	2	103.005***	2	118.551***	2	141.657***
Management system	1	.986	1	.000	1	.183	1	.186	1	.062
Type x breed	2	1.362	2	2.211	2	2.875	2	.065	2	5.225
Type x management	1	.000	1	.001	1	.872	1	.965	1	10.750
Breed x management	2	.762	2	3.310	2	3.017	2	3.645	2	.646
Error	404	384.706	335	493.297	287	560.552	242	642.971	184	688.585

*** P<.001.

TABLE 22. LEAST-SQUARES ANALYSIS OF VARIANCE FOR CUMULATIVE NUMBER OF LAMBS WEANED PER EWE ENTERING THE STUDY

	Year									
	2		3		4		5		6	
Source	df	SS	df	SS	df	SS	df	SS	df	SS
Ewe type of birth	1	.689	1	.428	1	1.474	1	3.381	1	11.345
Breed of ewe	2	46.197***	2	59.537***	2	65.258***	2	74.987**	2	92.687**
Management system	1	.702	1	1.670	1	14.431*	1	21.730	1	30.030
Type x breed	2	1.008	2	7.457	2	17.585	2	18.398	2	17.958
Type x management	1	.004	1	.012	1	.074	1	.000	1	.010
Breed x management	2	1.153	2	3.678	2	13.995	2	16.623	2	25.707
Error	411	396.073	411	844.761	411	1502.042	411	2445.843	411	3522.196

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

TABLE 23. LEAST-SQUARES ANALYSIS OF VARIANCE FOR CUMULATIVE WEIGHT OF LAMB WEANED PER EWE PRESENT

	Year									
	2		3		4		5		6	
Source	df	SS	df	SS	df	SS	df	SS	df	SS
Ewe type of birth	1	4140.747	1	.198	1	6039.433	1	664.597	1	2842.842
Breed of ewe	2	103919.806***	2	149487.822***	2	260582.958***	2	278201.879***	2	272525.830***
Management system	1	9890.982	1	6015.480	1	3172.931	1	540.441	1	4793.950
Type x breed	2	856.955	2	4236.967	2	19460.244	2	29948.916	2	41377.447
Type x management	1	3607.882	1	5077.683	1	151.392	1	3723.579	1	7580.924
Breed x management	2	344.689	2	157.552	2	1432.926	2	4301.309	2	39388.304
Error	404	1208443.126	335	1485141.553	287	1808567.774	242	2255100.216	184	2425365.223

*** P<.001.

TABLE 24. LEAST-SQUARES ANALYSIS OF VARIANCE FOR CUMULATIVE WEIGHT OF LAMB WEANED PER EWE ENTERING THE STUDY

	Year									
	2		3		4		5		6	
Source	df	SS	df	SS	df	SS	df	SS	df	SS
Ewe type of birth	1	4717.891	1	2787.495	1	13189.210	1	18933.419	1	57064.050
Breed of ewe	2	109179.171***	2	128227.733***	2	145121.281**	2	144113.189*	2	158260.762
Management system	1	8299.443	1	19731.832	1	56518.990*	1	86731.841*	1	136404.662*
Type x breed	2	620.547	2	16057.535	2	26106.430	2	15080.961	2	31391.820
Type x management	1	3118.191	1	3048.062	1	2250.252	1	9889.126	1	10074.312
Breed x management	2	303.035	2	9956.613	2	47665.979	2	71910.973	2	127730.600
Error	411	1245981.162	411	2588896.957	411	4751877.860	411	8124470.886	411	12100494.504

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

TABLE 25. LEAST-SQUARES ANALYSIS OF VARIANCE FOR CUMULATIVE WEIGHT OF WOOL PRODUCED PER EWE ENTERING THE STUDY

	Year									
	2		3		4		5		6	
Source	df	SS	df	SS	df	SS	df	SS	df	SS
Ewe type of birth	1	188.762***	1	506.253***	1	898.085**	1	1660.654**	1	2804.906**
Breed of ewe	2	188.835***	2	489.541***	2	1357.123***	2	2349.229***	2	3131.482**
Management system	1	208.492***	1	43.547	1	42.183	1	395.649	1	1047.797*
Type x breed	2	26.301	2	83.697	2	253.964	2	477.703	2	689.688
Type x management	1	1.976	1	1.558	1	10.916	1	55.007	1	113.192
Breed x management	2	1.987	2	139.631	2	483.317	2	698.146	2	1040.809
Error	411	4371.345	411	13803.998	411	34602.254	411	67789.769	411	108368.220

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

TABLE 26. LEAST-SQUARES ANALYSIS OF VARIANCE FOR CUMULATIVE WEIGHT OF WOOL PRODUCED PER EWE PRESENT

	Year									
	2		3		4		5		6	
Source	df	SS	df	SS	df	SS	df	SS	df	SS
Ewe type of birth	1	177.262***	1	274.908***	1	242.052**	1	297.571*	1	368.281*
Breed of ewe	2	225.786***	2	307.147***	2	552.218***	2	1034.870***	2	1063.026**
Management system	1	187.685***	1	61.512	1	37.555	1	4.489	1	10.344
Type x breed	2	38.118	2	8.987	2	3.401	2	15.809	2	16.467
Type x management	1	2.903	1	1.945	1	.603	1	38.462	1	2.320
Breed x management	2	2.216	2	23.082	2	31.715	2	26.165	2	117.679
Error	404	3878.511	335	6591.200	287	8639.361	242	11704.930	184	14394.621

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

TABLE 27. LEAST-SQUARES MEANS AND STANDARD ERRORS FOR SIGNIFICANT TWO-WAY INTERACTIONS

Breed x Year Interaction for Annual Ewe Weight for Range Ewes (12 months)
Least-Squares Means (Kg) = 44.97 ± 5.30

	Breed[a]		
Year	T	S x T	F x T
1977	39.31 ± 1.177	43.68 ± 1.073	39.32 ± 1.244
1978	45.02 ± 1.041	45.70 ± 1.195	51.00 ± 1.476
1979	50.32 ± 1.387	52.26 ± 1.277	48.43 ± 2.446

Year x Management Interaction for Date of Birth (24 Months)
Least-Squares Means (Days after January 1) = 74.8 ± 37.45

	Management	
Year	Farm	Range
1978	52.0 ± 5.14	71.2 ± 5.20
1979	60.5 ± 5.17	109.0 ± 5.82
1980	57.4 ± 6.62	103.1 ± 7.40

Year x Management Interaction for Date of Birth (36 Months)
Least-Squares Means (Days after January 1 = 82.0 ± 8.14

	Management	
Year	Farm	Range
1979	63.7 ± 1.49	109.7 ± 1.32
1980	54.8 ± 1.19	106.4 ± 1.36
1981	61.2 ± 1.58	105.4 ± 1.97

Year x Number of Lambs Born Interaction for Date of Birth (48 Months)
Least-Squares Means (Days after January 1) = 79.9 ± 8.79

	Number of lambs born	
Year	One	Two
1980	83.6 ± 1.61	81.6 ± 1.29
1981	80.2 ± 1.78	84.1 ± 1.25
1982	88.3 ± 2.14	83.4 ± 1.79

TABLE 27 CONTINUED

Breed x Number of Lambs Born Interaction for
Date of Birth (60 Months)
Least-Squares Means (Days after January 1) = 80.3 ± 8.80

	Number of lambs born	
Breed	One	Two or more
T	89.4 ± 1.95	84.3 ± 1.49
S x T	84.2 ± 1.78	83.0 ± 1.47
F x T	72.4 ± 4.42	81.9 ± 1.74

Year x Management Interaction for Date of Birth (72 Months)
Least-Squares Means (Days after January 1) = 82.6 ± 8.15

	Management	
Year	Farm	Range
1982	59.9 ± 2.37	110.4 ± 1.90
1983	66.7 ± 1.85	106.5 ± 1.94
1984	57.7 ± 3.45	110.5 ± 2.92

Type x Year Interaction for Lamb Weight at Birth
(24 Months)
Least-Squares Means (Kg) = 4.40 ± .830

	Year		
Type	1978	1979	1980
Single	4.74 ± .104	4.05 ± .124	5.13 ± .168
Multiple	4.95 ± .100	4.52 ± .089	4.78 ± .095

Type x Management Interaction for Lamb Weight at Birth
(24 Months)
Least-Squares Means (Kg) = 4.40 ± .830

	Management	
Type	Farm	Range
Single	4.66 ± .106	4.63 ± .117
Multiple	5.02 ± .076	4.48 ± .083

TABLE 27 CONTINUED

Type x Number of Lambs Born Interaction for
Lamb Weight at Birth (24 Months)
Least-Squares Means (Kg) = 4.40 ± .830

Type	Number of lambs born: One	Two or more
Single	5.11 ± .147	4.36 ± .077
Multiple	5.43 ± .103	4.07 ± .073

Year x Number of Lambs Born Interaction for
Lamb Weight at Birth (24 Months)
Least-Squares Means (Kg) = 4.40 ± .830

Year	Number of lambs born: One	Two or more
1978	5.33 ± .131	4.36 ± .077
1979	4.74 ± .135	3.84 ± .093
1980	5.74 ± .165	4.16 ± .127

Type x Year Interaction for Lamb Weight at Birth
(60 Months)
Least-Squares Means (Kg) = 4.87 ± .780

Type	Year: 1981	1982	1983
Single	5.45 ± .127	4.95 ± .162	5.71 ± .225
Multiple	5.21 ± .134	5.28 ± .112	5.14 ± .138

Year x Management Interaction for Lamb Weight
at Birth (60 Months)
Least-Squares Means (Kg) = 4.87 ± .780

Year	Management: Farm	Range
1981	5.30 ± .126	5.36 ± .128
1982	5.24 ± .122	4.99 ± .138
1983	5.68 ± .160	5.16 ± .193

TABLE 27 CONTINUED

Year x Management Interaction for Lamb Weight at Birth (72 Months)
Least-Squares Means (Kg) = 4.74 ± .748

Year	Management: Farm	Management: Range
1982	4.99 ± .186	5.34 ± .149
1983	5.47 ± .139	5.05 ± .150
1984	5.40 ± .262	5.37 ± .220

Breed x Year Interaction for Number of Lambs Born Per Ewe Exposed (12 Months)
Least-Squares Means = .79 ± .66

Breed	Year: 1977	Year: 1978	Year: 1979
T	.21 ± .097	.25 ± .084	.21 ± .121
S x T	.55 ± .083	.54 ± .096	.36 ± .105
F x T	.80 ± .099	.99 ± .111	.69 ± .151

Breed x Year Interaction for Number of Lambs Born Per Ewe Exposed (24 Months)
Least-Squares Means = 1.02 ± .686

Breed	Year: 1978	Year: 1979	Year: 1980
T	1.35 ± .119	.98 ± .100	1.03 ± .145
S x T	1.23 ± .102	1.15 ± .114	1.21 ± .126
F x T	1.66 ± .119	2.12 ± .134	2.04 ± .185

Year x Management Interaction for Number of Lambs Born Per Ewe Exposed (48 Months)
Least-Squares Means = 1.63 ± .702

Year	Management: Farm	Management: Range
1980	1.70 ± .099	1.49 ± .107
1981	1.87 ± .094	1.66 ± .120
1982	1.42 ± .132	1.87 ± .157

TABLE 27 CONTINUED

Breed x Management Interaction for Number of Lambs Born Per Ewe Exposed (72 Months)
Least-Squares Means = 1.72 ± .837

Breed	Management: Farm	Management: Range
T	1.39 ± .152	1.62 ± .177
S x T	1.67 ± .150	1.37 ± .155
F x T	2.61 ± .179	1.87 ± .246

Year x Management Interaction for Number of Lambs Born Per Ewe Lambing (36 Months)
Least-Squares Means = 1.70 ± .528

Year	Management: Farm	Management: Range
1979	1.96 ± .080	1.70 ± .076
1980	1.71 ± .073	1.53 ± .081
1981	1.64 ± .096	1.80 ± .115

Year x Management Interaction for Number of Lambs Born Per Ewe Lambing (72 Months)
Least-Squares Means = 1.97 ± .564

Year	Management: Farm	Management: Range
1982	2.15 ± .114	1.62 ± .122
1983	1.89 ± .101	1.70 ± .124
1984	2.51 ± .132	1.75 ± .179

Breed x Year Interaction for Total Weight of Lambs Born Per Ewe Lambing (36 Months)
Least-Squares Means (Kg) = 7.94 ± 1.880

Breed	Year: 1979	Year: 1980	Year: 1981
T	8.56 ± .376	7.27 ± .286	7.51 ± .444
S x T	7.36 ± .300	7.40 ± .345	7.68 ± .361
F x T	7.99 ± .383	8.46 ± .416	4.75 ± .551

TABLE 27 CONTINUED

Year x Management Interaction for Total Weight of Lambs Born Per Ewe Lambing (36 Months)
Least-Squares Means (Kg) = 7.94 ± 1.880

	Management	
Year	Farm	Range
1979	8.56 ± .285	7.38 ± .271
1980	8.39 ± .261	7.04 ± .289
1981	8.07 ± .342	8.25 ± .408

Breed x Year Interaction for Total Weight of Lambs Born Per Ewe Lambing (72 Months)
Least-Squares Means (Kg) = 9.34 ± 2.202

	Year		
Breed	1982	1983	1984
T	8.48 ± .610	8.93 ± .462	7.38 ± .271
S x T	8.99 ± .532	7.90 ± .531	8.37 ± .567
F x T	9.11 ± .538	9.77 ± .716	10.12 ± .796

Breed x Management Interaction for Total Weight of Lambs Born Per Ewe Lambing (72 Months)
Least-Squares Means (Kg) = 9.39 ± 2.202

	Management	
Breed	Farm	Range
T	10.08 ± .478	9.31 ± .503
S x T	9.46 ± .428	7.38 ± .429
F x T	11.23 ± .477	8.12 ± .676

Year x Sex Interaction for Lamb Weight at Weaning (24 Months)
Least-Squares Means (Kg) = 26.4 ± 5.33

	Sex	
Year	Female	Male
1978	28.9 ± .77	33.2 ± .70
1979	22.7 ± .76	23.0 ± .85
1980	25.4 ± 1.30	26.8 ± 1.27

TABLE 27 CONTINUED

Type x Management Interaction for Lamb Weight at Weaning (24 Months)
Least-Squares Means (Kg) = 26.4 ± 5.33

Type	Management: Farm	Management: Range
Single	26.5 ± .92	25.8 ± .98
Multiple	29.7 ± .64	24.7 ± .72

Breed x Year Interaction for Lamb Weight at Weaning (36 Months)
Least-Squares Means (Kg) = 25.4 ± 5.33

Breed	Year: 1979	Year: 1980	Year: 1981
T	24.1 ± 1.13	27.4 ± .99	23.5 ± 1.34
S x T	25.5 ± .93	28.5 ± 1.03	23.2 ± 1.08
F x T	27.2 ± 1.26	28.1 ± 1.23	28.8 ± 1.76

Type x Birth/Rearing Class Interaction for Lamb Weight at Weaning (36 Months)
Least-Squares Means (Kg) = 25.4 ± 5.33

Type	Birth/rearing Class: Single/single	Twin/single	Twin/twin
Single	27.6 ± 1.30	28.7 ± 1.66	22.5 ± .75
Multiple	30.7 ± .95	25.3 ± 1.27	22.7 ± .51

Breed x Birth/Rearing Class Interaction for Lamb Weight at Weaning (36 Months)
Least-Squares Means (Kg) = 25.4 ± 5.33

Breed	Birth/rearing class: Single/single	Twin/single	Twin/Twin
T	28.3 ± .88	25.7 ± 1.61	20.9 ± .91
S x T	28.4 ± .87	24.6 ± 1.53	24.2 ± .68
F x T	30.7 ± 2.28	30.7 ± 1.64	22.8 ± .77

TABLE 27 CONTINUED

Year x Management Interaction for Lamb Weight at Weaning (36 Months)
Least-Squares Means (Kg) = 25.4 ± 5.33

Year	Management: Farm	Management: Range
1979	25.9 ± .91	25.3 ± .83
1980	30.5 ± .77	25.5 ± .93
1981	20.1 ± 1.03	30.3 ± 1.24

Breed x Management Interaction for Lamb Weight at Weaning (48 Months)
Least-Squares Means (Kg) = 24.9 ± 4.59

Breed	Management: Farm	Management: Range
T	22.2 ± .98	27.5 ± .93
S x T	24.8 ± 1.38	27.1 ± 1.08
F x T	23.1 ± 1.35	23.9 ± 1.31

Year x Management Interaction for Lamb Weight at Weaning (48 Months)
Least-Squares Means (Kg) = 24.9 ± 4.59

Year	Management: Farm	Management: Range
1980	29.7 ± .77	26.3 ± .82
1981	19.5 ± .88	27.0 ± .80
1982	21.0 ± 2.34	25.2 ± 1.99

Birth/Rearing Class x Management Interaction for Lamb Weight at Weaning (48 Months)
Least-Squares Means (Kg) = 24.9 ± 4.59

Birth/rearing class	Management: Farm	Management: Range
Single/single	28.0 ± .77	29.9 ± .82
Twin/single	18.1 ± 2.89	24.8 ± 1.99
Twin/twin	24.1 ± .44	23.6 ± .58

TABLE 27 CONTINUED

Type x Breed Interaction for Lamb Weight at Weaning (60 Months)
Least-Squares Means (Kg) = 27.4 ± 5.26

Type	Breed: T	S x T	F x T
Single	28.4 ± 1.18	30.3 ± 1.08	31.5 ± 1.98
Multiple	30.1 ± 1.11	29.1 ± .94	27.2 ± 1.11

Type x Breed Interaction for Lamb Weight at Weaning (60 Months)
Least-Squares Means (Kg) = 27.4 ± 5.26

Year	Management: Farm	Range
1981	21.1 ± .90	25.2 ± 1.07
1982	27.2 ± 1.03	29.8 ± 1.17
1983	41.4 ± 1.22	31.8 ± 1.44

Type x Breed Interaction for Lamb Weight at Weaning (72 Months)
Least-Squares Means (Kg) = 28.3 ± 5.52

Type	Breed: T	S x T	F x T
Single	31.7 ± 1.66	29.4 ± 1.12	31.7 ± 2.35
Multiple	29.1 ± 1.22	31.4 ± 1.42	27.4 ± 1.30

Breed x Year Interaction for Lamb Weight at Weaning (72 Months)
Least-Squares Means (Kg) = 28.3 ± 5.52

Breed	Year: 1982	1983	1984
T	26.8 ± 1.55	35.5 ± 1.35	28.9 ± 2.07
S x T	29.9 ± 1.48	33.6 ± 1.34	27.7 ± 1.73
F x T	24.2 ± 1.65	36.4 ± 1.77	27.9 ± 2.78

TABLE 27 CONTINUED

Type x Sex Interaction for Lamb Weight at Weaning (72 Months)
Least-Squares Means (Kg) = 28.3 ± 5.52

Type	Sex: Female	Sex: Male
Single	30.8 ± 1.50	31.0 ± 1.31
Multiple	27.4 ± .98	31.2 ± 1.07

Year x Birth/Rearing Class Interaction for Lamb Weight at Weaning (72 Months)
Least-Squares Means (Kg) = 28.3 ± 5.52

Year	Birth/rearing class: Single/single	Twin/single	Twin/twin
1982	28.3 ± 2.05	27.4 ± 1.79	24.2 ± .85
1983	39.1 ± 1.49	32.2 ± 1.79	34.2 ± .90
1984	29.0 ± 3.09	33.0 ± 3.42	22.5 ± .99

Year x Management Interaction for Lamb Weight at Weaning (72 Months)
Least-Squares Means (Kg) = 28.3 ± 5.52

Year	Management: Farm	Management: Range
1982	25.1 ± 1.31	28.8 ± 1.30
1983	39.3 ± 1.18	31.0 ± 1.16
1984	27.9 ± 1.76	28.6 ± 2.06

Year x Management Interaction for Number of Lambs Weaned Per Ewe Exposed (36 Months)
Least-Squares Means = 1.15 ± .698

Year	Management: Farm	Management: Range
1979	.88 ± .089	1.32 ± .096
1980	1.23 ± .090	1.03 ± .104
1981	1.31 ± .122	1.11 ± .131

TABLE 27 CONTINUED

Breed x Year Interaction for Number of Lambs Weaned
Per Ewe Exposed (60 Months)
Least-Squares Means = 1.25 ± .739

Breed	Year 1981	Year 1982	Year 1983
T	1.07 ± .138	1.31 ± .128	1.31 ± .193
S x T	.84 ± .135	1.36 ± .158	1.09 ± .160
F x T	1.63 ± .161	1.24 ± .180	1.54 ± .227

Year x Management Interaction for Number of Lambs Weaned
Per Ewe Exposed (60 Months)
Least-Squares Means = 1.25 ± .739

Year	Management Farm	Management Range
1981	1.04 ± .107	1.33 ± .119
1982	1.14 ± .103	1.47 ± .137
1983	1.49 ± .152	1.14 ± .171

Breed x Management Interaction for Number of Lambs Weaned
Per Ewe Exposed (72 Months)
Least-Squares Means = 1.21 ± .756

Breed	Management Farm	Management Range
T	.97 ± .137	1.53 ± .160
S x T	1.13 ± .135	1.18 ± .140
F x T	1.64 ± .161	1.46 ± .222

Type x Breed Interaction for Number of Lambs Weaned
Per Ewe Lambing (24 Months)
Least-Squares Means = 1.19 ± .562

Type	Breed T	Breed S x T	Breed F x T
Single	.93 ± .085	.97 ± .082	1.22 ± .145
Multiple	.92 ± .075	1.00 ± .071	1.67 ± .060

TABLE 27 CONTINUED

Breed x Year Interaction for Number of Lambs Weaned Per Ewe Lambing (36 Months)
Least-Squares Means = 1.31 ± .586

	Year		
Breed	1979	1980	1981
T	1.47 ± .117	1.02 ± .089	1.09 ± .138
S x T	1.21 ± .093	1.20 ± .108	1.33 ± .113
F x T	1.37 ± .119	1.52 ± .130	1.85 ± .172

Year x Management Interaction for Number of Lambs Weaned Per Ewe Lambing (36 Months)
Least-Squares Means = 1.31 ± .586

	Management	
Year	Farm	Range
1979	1.26 ± .089	1.44 ± .084
1980	1.37 ± .082	1.13 ± .090
1981	1.38 ± .106	1.47 ± .127

Breed x Year Interaction for Number of Lambs Weaned Per Ewe Weaning A Lamb (36 Months)
Least-Squares Means = 1.43 ± .463

	Year		
Breed	1979	1980	1981
T	1.61 ± .098	1.13 ± .074	1.26 ± .119
S x T	1.39 ± .079	1.36 ± .091	1.40 ± .092
F x T	1.52 ± .103	1.68 ± .106	1.96 ± .138

Year x Management Interaction for Weight of Lamb Weaned Per Ewe Exposed (36 Months)
Least-Squares Means (Kg) = 28.9 ± 17.37

	Management	
Year	Farm	Range
1979	21.1 ± 2.22	30.6 ± 2.36
1980	36.2 ± 2.25	25.7 ± 2.58
1981	25.4 ± 3.03	27.1 ± 3.26

TABLE 27 CONTINUED

Type x Year Interaction for Weight of Lamb Weaned
Per Ewe Exposed (48 Months)
Least-Squares Means (Kg) = 33.6 ± 17.78

Type	Year 1980	1981	1982
Single	35.7 ± 2.79	41.0 ± 3.82	33.3 ± 4.85
Multiple	37.1 ± 2.69	30.2 ± 2.03	36.8 ± 2.59

Year x Management Interaction for Weight of Lamb Weaned
Per Ewe Exposed (48 Months)
Least-Squares Means (Kg) = 33.6 ± 17.78

Year	Management Farm	Range
1980	40.6 ± 2.50	32.3 ± 2.71
1981	33.3 ± 2.39	37.8 ± 3.05
1982	32.1 ± 3.36	38.0 ± 3.98

Breed x Year Interaction for Weight of Lamb Weaned
Per Ewe Exposed (60 Months)
Least-Squares Means (Kg) = 34.3 ± 19.46

Breed	Year 1981	1982	1983
T	25.2 ± 3.63	35.8 ± 3.37	47.1 ± 5.07
S x T	19.4 ± 3.54	37.3 ± 4.16	41.9 ± 4.20
F x T	37.4 ± 4.23	29.6 ± 4.74	56.8 ± 6.11

Year x Management Interaction for Weight of Lamb Weaned
Per Ewe Exposed (60 Months)
Least-Squares Means (Kg) = 34.3 ± 19.46

Year	Management Farm	Range
1981	21.8 ± 2.83	32.8 ± 3.13
1982	28.8 ± 2.83	39.6 ± 3.61
1983	59.9 ± 4.00	37.3 ± 4.61

TABLE 27 CONTINUED

Breed x Management Interaction for Weight of Lamb Weaned Per Ewe Exposed (72 Months)
Least-Squares Means (Kg) = 34.5 ± 22.23

Breed	Management: Farm	Management: Range
T	27.5 ± 4.03	42.1 ± 4.72
S x T	35.4 ± 3.97	33.9 ± 4.13
F x T	46.5 ± 4.74	36.7 ± 6.55

Year x Management Interaction for Weight of Lamb Weaned Per Ewe Exposed (72 Months)
Least-Squares Means (Kg) = 34.5 ± 22.23

Year	Management: Farm	Management: Range
1982	24.1 ± 3.92	40.4 ± 4.75
1983	51.3 ± 3.72	37.5 ± 4.66
1984	34.2 ± 4.98	34.9 ± 6.32

Type x Management Interaction for Weight of Lamb Weaned Per Ewe Lambing (24 Months)
Least-Squares Means (Kg) = 31.3 ± 15.11

Type	Management: Farm	Management: Range
Single	26.4 ± 2.16	28.2 ± 2.43
Multiple	36.4 ± 1.44	28.0 ± 1.57

Year x Management Interaction for Weight of Lamb Weaned Per Ewe Lambing (36 Months)
Least-Squares Means (Kg) = 33.2 ± 14.42

Year	Management: Farm	Management: Range
1979	30.8 ± 2.19	34.1 ± 2.08
1980	40.5 ± 2.00	28.2 ± 2.22
1981	26.8 ± 2.62	36.0 ± 3.13

TABLE 27 CONTINUED

Year x Management Interaction for Weight of Lamb Weaned Per Ewe Lambing (48 Months)
Least-Squares Means (Kg) = 35.8 ± 16.09

Year	Management: Farm	Management: Range
1980	43.3 ± 2.35	33.2 ± 2.50
1981	33.8 ± 2.19	39.5 ± 2.84
1982	38.3 ± 3.31	37.5 ± 3.62

Breed x Year Interaction for Weight of Lamb Weaned Per Ewe Weaning A Lamb (36 Months)
Least-Squares Means (Kg) = 38.6 ± 17.46

Breed	Year: 1981	Year: 1982	Year: 1983
T	29.4 ± 3.55	36.8 ± 3.08	53.9 ± 5.33
S x T	27.0 ± 2.10	39.1 ± 3.86	48.2 ± 4.03
F x T	39.8 ± 3.90	31.4 ± 4.64	59.3 ± 5.73

Year x Management Interaction for Weight of Lamb Weaned Per Ewe Lambing (60 Months)
Least-Squares Means (Kg) = 38.6 ± 17.46

Year	Management: Farm	Management: Range
1981	26.4 ± 2.84	37.7 ± 3.03
1982	31.5 ± 2.71	40.0 ± 3.33
1983	63.4 ± 3.70	44.2 ± 4.78

Year x Management Interaction for Weight of Lamb Weaned Per Ewe Lambing (72 Months)
Least-Squares Means (Kg) = 39.7 ± 19.95

Year	Management: Farm	Management: Range
1982	29.4 ± 3.82	39.6 ± 4.11
1983	57.9 ± 3.40	40.2 ± 4.25
1984	39.6 ± 4.45	39.6 ± 6.01

TABLE 27 CONTINUED

Breed x Year Interaction for Weight of Lamb Weaned
Per Ewe Weaning A Lamb (36 Months)
Least-Squares Means (Kg) = 36.2 ± 10.80

Breed	Year 1979	Year 1980	Year 1981
T	36.5 ± 2.29	32.7 ± 1.74	29.1 ± 2.77
S x T	36.5 ± 1.85	38.9 ± 2.13	31.7 ± 2.14
F x T	36.0 ± 2.40	42.7 ± 2.48	41.6 ± 3.22

Year x Management Interaction for Weight of Lamb Weaned
Per Ewe Weaning A Lamb (36 Months)
Least-Squares Means (Kg) = 36.2 ± 10.80

Year	Management Farm	Management Range
1979	37.4 ± 1.82	35.2 ± 1.58
1980	43.9 ± 1.54	32.3 ± 1.78
1981	28.8 ± 2.03	39.5 ± 2.48

Year x Management Interaction for Weight of Lamb Weaned
Per Ewe Weaning A Lamb (48 Months)
Least-Squares Means (Kg) = 38.4 ± 13.61

Year	Management Farm	Management Range
1980	45.5 ± 2.04	36.0 ± 2.20
1981	36.2 ± 1.90	40.0 ± 2.43
1982	38.9 ± 2.83	41.5 ± 3.19

Year x Management Interaction for Weight of Lamb Weaned
Per Ewe Weaning A Lamb (60 Months)
Least-Squares Means (Kg) = 42.9 ± 13.80

Year	Management Farm	Management Range
1981	30.1 ± 2.42	39.6 ± 2.47
1982	39.5 ± 2.42	42.3 ± 2.71
1983	65.9 ± 2.96	47.4 ± 3.94

TABLE 27 CONTINUED

Type x Breed Interaction for Weight of Lamb Weaned Per Ewe Weaning A Lamb (72 Months)
Least-Squares Means (Kg) = 43.5 ± 15.02

	Breed		
Type	T	S x T	F x T
Single	47.4 ± 4.19	37.1 ± 3.10	49.8 ± 5.88
Multiple	41.5 ± 3.28	46.2 ± 3.24	40.9 ± 2.57

Year x Management Interaction for Weight of Lamb Weaned Per Ewe Weaning A Lamb (72 Months)
Least-Squares Means (Kg) = 43.5 ± 15.02

	Management	
Year	Farm	Range
1982	35.3 ± 3.34	42.1 ± 3.44
1983	62.5 ± 2.82	41.7 ± 3.51
1984	42.2 ± 3.61	39.1 ± 4.84

Year x Number of Lambs Born Interaction for Weight of Wool Produced (48 Months)
Least-Squares Means (Kg) = 4.35 ± .713

	Number of lambs born		
Year	None	One	Two or more
1980	4.84 ± .777	3.89 ± .131	4.14 ± .103
1981	4.04 ± .445	4.50 ± .143	4.36 ± .100
1982	4.38 ± .576	4.59 ± .180	2.41 ± .144

Year x Management Interaction for Weight of Wool Produced (48 Months)
Least-Squares Means (Kg) = 4.35 ± .713

	Management	
Year	Farm	Range
1980	4.26 ± .196	4.32 ± .401
1981	3.94 ± .215	4.65 ± .238
1982	5.07 ± .165	4.30 ± .359

TABLE 27 CONTINUED

Year x Management Interaction for Weight of Wool Produced (60 Months)
Least-Squares Means (Kg) = 4.36 ± .698

	Management	
Year	Farm	Range
1981	4.05 ± .157	4.17 ± .203
1982	4.55 ± .153	4.04 ± .228
1983	4.61 ± .307	4.06 ± .236

Type x Number of Lambs Born Interaction for Weight of Wool Produced (72 Months)
Least-Squares Means (Kg) = 4.17 ± .668

	Number of lambs born		
Type	None	One	Two or more
Single	3.91 ± .367	3.78 ± .269	4.35 ± .125
Multiple	3.32 ± .429	4.10 ± .160	3.85 ± .094

Breed x Number of Lambs Born Interaction for Weight of Wool Produced (72 Months)
Least-Squares Means (Kg) = 4.17 ± .668

	Number of lambs born		
Breed	None	One	Two or more
T	3.90 ± .348	4.08 ± .214	4.60 ± .126
S x T	4.17 ± .407	4.34 ± .171	3.92 ± .597
F x T	2.77 ± .597	3.51 ± .386	3.78 ± .141

Year x Management Interaction for Weight of Wool Produced (72 Months)
Least-Squares Means (Kg) = 4.17 ± .668

	Management	
Year	Farm	Range
1982	4.55 ± .173	3.82 ± .262
1983	3.90 ± .153	3.95 ± .286
1984	3.97 ± .242	3.13 ± .247

TABLE 27 CONTINUED

Type x Breed Interaction for Cumulative Weight of Lamb Born Per Ewe Present (6 Years)
Least-Squares Means (Kg) = 42.95 ± 9.430

	Breed		
Type	T	S x T	F x T
Single	37.19 ± 1.65	40.87 ± 1.642	50.02 ± 3.201
Multiple	42.93 ± 1.77	38.90 ± 1.642	47.54 ± 3.330

Breed x Management Interaction for Cumulative Weight of Lamb Born Per Ewe Entering the Study (4 Years)
Least-Squares Means (Kg) = 25.49 ± 13.278

	Management	
Breed	Farm	Range
T	27.16 ± 1.652	21.31 ± 1.687
S x T	24.38 ± 1.537	23.41 ± 1.591
F x T	32.05 ± 1.922	23.41 ± 2.196

Breed x Management Interaction for Cumulative Weight of Lamb Born Per Ewe Entering the Study (6 Years)
Least-Squares Means (Kg) = 29.23 ± 16.59

	Management	
Breed	Farm	Range
T	31.10 ± 2.052	25.12 ± 2.107
S x T	28.05 ± 1.921	26.65 ± 1.988
F x T	37.67 ± 2.402	26.24 ± 2.743

[a] T = Targhee, S x T = Suffolk x Targhee and F x T = Finnsheep x Targhee.