

Comparison of Dorper and Polypay as Maternal
Sire Breeds for Reduced Input Lamb Production

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AN ABSTRACT OF THE THESIS OF

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During years 2005, 2006, and 2007 ewes of predominantly Polypay breeding were bred to either Dorper or Polypay rams for spring lambing. Ewes were assigned to single-sire mating groups based on age and genotype. Internally generated replacements were added to the flock for the 2007 lambing season and bred to rams within their own sire breed. Litter size was recorded for ewes and lambs were weighed at birth and weaning. Inventory at weaning was used to determine lamb survival. Internally generated replacement females were weighed at approximately one year of age. Dorper-mated ewes gave birth to 0.14 more lambs than Polypay-mated ewes, suggesting a ram breed effect on litter size ($p < .10$). Polypay-sired internally generated replacement females had a mean litter size of 0.30 lambs greater than Dorper-sired generated ewes did ($p < .05$). Polypay-sired lambs were significantly heavier than Dorper-sired lambs at birth (0.2 kg, $p < .05$), but similar in terms of mean weaning weight. No significant difference in lamb survival was observed between the two sire breeds. Polypay-sired replacement females were slightly heavier (2.9 kg) than Dorper-sired replacements as yearlings ($p < .10$). Due to their advantage in litter size, Polypay-sired females would be expected to

generate more profit for commercial sheep producers than would Dorper-sired ewes.

Dorpers would still remain a viable ram breed for commercial production in Western

Oregon due to their comparable growth rates assuming lamb pelt quality could be

maintained through selective breeding.

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INTRODUCTION

Sheep are often the grazing species of preference for individuals or families utilizing smaller parcels of land for livestock production. When compared to cattle, sheep are simply a smaller animal generally requiring smaller facilities and less equipment to correctly manage. Consequently, starting a small sheep operation requires much less initial investment from potential livestock owners, making this enterprise more accessible to individuals or families desiring to convert forage resources into a saleable and potentially profitable product.

In areas of high rainfall, pasture soil may become thoroughly saturated with moisture thereby precluding the grazing of cattle due to the potential for mechanical damage caused by the large hooves of these large ruminants. Sheep are much more suitable for grazing under these conditions as they have a much smaller body mass along with relatively small hooves that are unlikely to cause substantial damage to wet pasture or cropland soils.

The Willamette Valley of western Oregon is an example of a geographical region experiencing soil-saturating levels of precipitation along with ample grazing opportunities on smaller parcels of land. While sheep are the best domestic ungulate species suited to this environment, many potential grazers simply don't have the resources to invest in lambing barn and related facilities associated with the early spring, shed lambing production system that is prevalent in the area. Therefore, considerable interest

in a "reduced input" system of farm flock production involving outdoor lambing has recently evolved. Heavy winter and early spring precipitation has precluded an acceptable rate of lamb survival for Willamette Valley flocks lambing outdoors. By breeding ewes later in the year (late November through early December), lambing for a reduced input flock would start in late April, when precipitation is typically much lighter and less frequent, thereby reducing death losses due to inclement weather.

Choice of breeds becomes a key factor impacting the productivity and profitability of a reduced input flock. Most of the lambs produced in western Oregon are grass fed on local pastures and rangelands and shipped to market at ten months to a year of age. Sheep produced in this environment should have the growth rate and frame size to reach at least 130 pounds by the age of harvest while maintaining adequate leanness to hang a carcass below a USDA yield grade of four. Currently, major packers have provided no incentives for lambs exhibiting superior carcass conformation or cutability. Lambs need only grade USDA choice with a yield grade of less than four to avoid discounts. Consequently, many of the more moderately framed breeds of sheep, particularly those tending to sire lambs with average or above average carcass conformation are popular in this area. Dorset, Romney, and Polypay are frequently used, often replacing the universally popular Suffolk and Hampshire in smaller flocks to produce replacement ewes adapted to the local production conditions.

LITERATURE REVIEW

Dorper: An Alternative Ewe Breed

An interest in hair sheep has developed in western Oregon due to increased costs of shearing along with a diminishing market price for wool. Climatic conditions are generally mild enough in this region to preclude the need for wool for insulation. After professional shearing personnel are paid for necessary fleece removals, most western Oregon producers are only able to recover a fraction of this expense through wool sales. However, virtually all hair breeds of sheep sire lambs with abnormal pelt coloration. Lambs exhibiting this irregular pelt coloration are typically discounted at time of sale by major lamb packing organizations in the United States. This discount can range from three to fifteen dollars per head, depending on the current market value for lamb pelts.

Developed in South Africa from the crossing of Dorper and Persian Blackhead stock, Dorpers are a "shedding wool" breed that has recently been introduced into the United States. Since their wool is periodically shed, shearing sheep with a high percentage of Dorper influence becomes unnecessary. Dorper influenced lambs have exhibited carcass conformation traits superior to lambs sired by both hair sheep and traditional "meat" breeds such as the Suffolk (Snowder and Duckett, 2003). Dorper sheep have also demonstrated remarkable reproductive efficiency, exhibiting a smaller window of seasonal anestrus when compared to most traditional breeds (excluding, of course, the Dorset) along with above average prolificacy (Cloete et al., 2000). Unfortunately, Dorper-sired lambs typically have irregular pelt coloration resulting from the black head and neck coloration derived from the Persian Blackhead origins of this

breed. Known as "Dorsians" in South Africa, white Dorpers are a strain of Dorper sheep exhibiting entirely white hide coloration. White Dorper parentage in crossbred lambs seems to eliminate most of the incidence of unprofitable dark pelt markings from the resulting progeny. Research has shown that the hides of Dorper sheep exhibit superior leather quality when compared to wool breeds, closely matching the more desirable hide properties of hair-sheep pelts (Snyman et al., 1998).

Given their advantages in reduced shearing costs along with above average reproductive efficiency, white Dorpers would seem to be an ideal ewe breed for Oregon farm flocks seeking to reduce labor inputs. A local producer reported that when breeding white Dorper ewes to Suffolk rams, incidences of abnormal coloration and irregular hair follicles among lambs were nearly eliminated. Additionally, due to their rather short period of seasonal anestrus, these ewes would be capable of lambing in either mid-spring or early to mid-fall.

Since Dorpers are relatively new to the United States, only a few studies have been performed to compare the production traits of these sheep to the more established breeds. Recent research compared the progeny of Dorper vs. Dorset rams mated to ewes of 50% Dorset, 25% Rambouillet, and 25% Finnsheep heritage. The study concluded that growth rate, lamb survival, and carcass merit were similar between offspring of the two ram breeds, although Dorper-sired lambs were slightly fatter at similar harvest weights (Notter et al., 2004). Snowden and Duckett (2003) compared Dorper-sired lambs with the progeny of Suffolk and Columbia rams when all three breeds were mated to Columbia ewes. No significant sire breed differences were observed for growth or carcass characteristics. Loin chops from Dorper-sired lambs showed a significant

advantage in tenderness when subjected to both Warner-Bratzler shear force and sensory panel testing. Both of these studies involved outdoor lambing, although ewes and their newborn lambs were moved to indoor lambing pens for the first 24-48 hours following parturition. Lambs in both studies were weaned into dry lots and fed diets containing concentrates prior to harvest. Neither study featured the management of lambs and ewes in a truly reduced input, entirely forage-based production system, and both studies evaluated the capacity of Dorper sheep merely as a terminal sire breed rather than testing their performance as ewes.

Other studies documenting the performance and productivity of Dorper sheep have been reported from South Africa. Dorpers were found comparable to Suffolks in terms of post-weaning growth rate (Cloete et al., 2000), and Dorper lambs reached harvest weight at an earlier age than Merinos (Basson et al., 1970). In terms of reproductive efficiency, South African work comparing Merinos to Dorpers showed that purebred Dorper ewes bred to Dorper rams weaned a higher mean litter size when fed a controlled diet and managed in an accelerated lambing system (Basson et al., 1969). It is important to note that these studies were conducted in an intensively managed environment where predation was virtually eliminated and ewes were watched constantly for signs of dystocia by trained and experienced personnel. The subject lambs in these studies were finished on diets containing concentrates. Hence, these studies are also of questionable value in evaluating performance of Dorper influenced sheep in a true reduced input environment where forages comprise the sole available feed source for both ewes and lambs.

Polypay: An Existing Ewe Breed

A composite breed developed in the United States from the Targhee, Rambouillet, Dorset, and Finn breeds, the Polypay is noted for excelling in litter size while maintaining adequate levels of growth and survival (Hulet et al., 1984). When compared to Suffolks, Hampshires, and Columbias, Polypay are considered a “small breed type” with a lower mature body weight (Boggess et al., 1991). Their advantages in reproductive efficiency have led to a noticeable level of use both in Western Oregon and elsewhere. Due to their high mean litter size, Polypay ewes would seem to be an ideal maternal breed for producers seeking to maximize pounds of lamb sold. However, in a reduced input scenario, triplets and quadruplets needing additional care or bumming would be a concern from the standpoint of minimizing labor and facilities.

Little recent work has been performed directly comparing the progeny of Polypay rams or ewes with the offspring of other breeds for differences in growth and survival rates. The most recent work, conducted by Nawaz and Meyer (1992) compared Coopworth, Polypay, and Suffolk-sired Coopworth crossbred ewes in terms of both their reproductive efficiency and the performance of their progeny. It was concluded that while Polypay and Coopworth ewes differed little in production traits, the Suffolk-sired crossbred ewes produced lambs that were heavier at birth and weaning (Nawaz and Meyer, 1992). Furthermore, Coopworth ewes required more assistance at lambing while weaning similar poundages to their Polypay counterparts. Lambing indoors under constant surveillance, the ewes involved in this study were clearly not managed at a “reduced input” level of labor and facility use. Dystocia, mismothering, and bumming

would have a far greater impact on comparative performance if less intensive management practices had been utilized.

A Need for Further Research

Breed selection is a key component in developing profitable reduced input flocks for producers in Oregon's Willamette Valley and elsewhere. In order to make correct decisions regarding genetic potential for performance in a given operation, sheep need to be evaluated in a research environment that mirrors the production scenario in which they will be raised. As neither the Polypay nor the Dorper have been adequately compared in terms of production traits when lambing occurs in a reduced input situation, such a trial utilizing this protocol is clearly warranted. In addition, the performance of the Dorper as a maternal breed for use in a crossbreeding scenario is another production facet that deserves formal research and documentation.

MATERIALS AND METHODS

Animals

Eight hundred and sixty four lambs sired by Dorper and Polypay rams were produced at the Oregon State University Sheep Center during the months of April and May in years 2005, 2006, and 2007. The base flock of 201 ewes selected for this trial in 2004 was comprised of sheep that were predominantly Polypay with some Suffolk crossbreds. In 2005, surviving ewes were augmented with surplus ewes from the general Oregon State University breeding flock. Internally generated replacement ewes born in 2005 joined the flock for the 2006 breeding season.

The Polypay rams used in this study originated from the USDA research center at Dubois, Idaho. Their Dorper counterparts were donated by a local breeder as representative of his flock. Rams were used for only one mating season.

Experimental Procedures and Management

Base flock ewes were randomly assigned to single-sire mating groups within age and genotype for the 2004 breeding season. This scheme was used in subsequent years to re-randomize surviving ewes and assign incoming surplus ewes. The generated replacement females joining the flock for the 2006 season were randomly assigned to mating groups of their own sire breed. In 2004 and 2005, mating started in early November and lasted through mid-December. Severe weather occurring in early April 2006 required lambs to be moved indoors for 36 hours. Fall breeding was postponed that year to delay lambing and thereby reduce the probability of encountering serious storms

the next year.

After the breeding season ended, mating groups were combined and moved to pasture for winter grazing. Two weeks prior to the expected arrival of the earliest lambs, ewes were separated to lambing pastures based on the breed of ram with which they were mated.

During lambing, sheep were checked morning and evening. Newly born lambs were weighed, ear-tagged, and their navels were dipped in iodine. Ewes were given the opportunity to raise all progeny born, but lambs considered to have less than a 50% chance of survival were removed for artificial rearing and considered dead for purposes of data analysis. At two weeks of age, lambs were docked, castrated, and vaccinated.

Lambs were weighed and weaned during mid-summer before being placed on pasture for further growth and finishing. Ewes were moved to drier, less productive pasture for maintenance until the fall breeding season. Replacement ewe lambs generated within the flock and retained for later use were weighed at approximately thirteen months of age. Although the majority of ewe lambs were retained, some culling was done on poor performance (i.e. low bodyweight).

Statistical Methods

All data was analyzed using the SAS ANOVA procedure. For data from base flock ewes and their lambs, birthweight, weaning weight, and survival rate were analyzed with sire breed, year, sex, birthrank, and all two-way interactions as fixed effects. Triplets and quadruplets were combined for purposes of birth rank effects. Litter size analysis included the fixed effects of sire breed, year, and the sire breed by year

interaction. Data for the internally generated ewes lambing in 2007 were analyzed using the same models.

RESULTS

Dorper-mated ewes produced 0.14 more lambs per litter on average than did their Polypay mated counterparts; this difference was suggestive of a difference between ram breeds ($p < 0.10$, table 1). The mean litter size for 2007 was slightly lower than in previous years ($p > 0.25$). Polypay-sired females generated within the trial and lambing in 2007 produced 0.30 more lambs per litter than did their Dorper-sired counterparts ($p < .05$, table 3).

Polypay-sired lambs had a 0.2 kg heavier mean birth weight than Dorper-sired lambs ($p < .05$, table 2). The magnitude of this difference was greater in 2005 than in the other two trial years, producing a strongly significant sire breed by birth year interaction ($p < .01$). Although no sire breed effect was observed among lambs born in triplet and quadruplet litters, Polypay-sired singles and twins were significantly heavier than Dorper-sired lambs produced in the same litter sizes, resulting in a sire breed by birth rank interaction ($p < .05$). Weighing an average of 4.8 kg, singles were heaviest at birth, 0.7 kg heavier than twins and 1.2 kg heavier than lambs born in larger litters ($p < .001$). Males were 0.2 kg heavier on average than females ($p < .05$). Lambs born in 2005 were only slightly heavier than lambs born in 2006 or 2007 ($p < .10$). No breed effect was observed for birthweight among generated females lambing in 2007.

No sire breed effect was observed for lamb pre-weaning survival. Singles had the highest mean survival rate at 90.9%, 9.5% higher than twins and 41.4% higher than lambs born in larger litters ($p < .001$). Males had a small but non-significant advantage over females in average survival, and lambs born in 2006 had a slightly higher survival

rate than lambs born in 2005. Data for 2007 lambing ewes is not available at this time.

Over the three year trial period, Polypay-sired lambs were slightly heavier (0.5 kg) at weaning than Dorper-sired lambs (table 2). Singles were significantly heavier (5.1 kg) at weaning than twins ($p < .05$). Twins were only 1.3 kg heavier than triplets or quadruplets ($p < .10$). The mean weaning weight of males was only 1.1 kg higher than for females ($p < .10$). Lambs born in 2005 were 6.5 kg heavier than lambs born in 2006 ($p < .001$).

Yearling weight of Polypay-sired females was 2.9 kg greater than for Dorper-sired ewes (table 2, $p < .10$). The magnitude of this difference was greater for ewes born in 2005, resulting in a significant year by breed interaction ($p < .05$). Females born as singles had the highest mean weight of 47.3 kg, 3.3 kg heavier than twins and 4.8 kg heavier than females originating from larger litters ($p < .05$). Ewes born in 2005 had the heaviest mean weight by 12.4 kg ($p < .001$). Data from male progeny is not available since these sheep were sold prior to reaching the appropriate age.

DISCUSSION

Litter Size

The ram breed effect suggests a difference in embryo survival as Dorper-mated ewes had consistently larger litter sizes, particularly in the first two years of the trial. As management conditions were similar between the two groups of ewes, it is unlikely that nutrition or any other environmental effects contributed to this difference. The observed variation could be the result of an in utero interaction between the two genotypes. It has been found that white-faced breeds have a decreased level of embryo mortality when compared to Suffolks (Meyer, unpublished work). Dorpers may have a similar advantage over Polypay sheep in terms of embryo survival. The difference in embryo survival may also be due to heterosis since mating of Dorper rams to a predominantly Polypay ewe base produced the larger litter sizes. As one of the few documented studies dealing with heterosis and embryo survival in sheep, work conducted with the D'man and Sardi sheep breeds by Boujenane et al. (1991) concluded that heterozygosity did not have a significant effect on embryo mortality. However, this study was conducted with different breeds in a very different production scenario.

Internally generated replacement females followed expected patterns with Polypay-sired ewes having a significantly larger mean litter size than Dorper-sired females. Previous work conducted by Gaskin et al. (2005) concluded that Polypay females were superior in terms of fertility and prolificacy to Columbia, Targhee, and Rambouillet females when managed under Western U.S. range conditions. Further litter

size and bodyweight data from future trial years will help in documenting the magnitude of this difference. Current data is confounded as generated females mated for lambing in 2007 were back-crossed onto rams of their own breed. In future years it is planned to mate both ewe genotypes to rams of unrelated breed. This will help clarify the sire breed effect on embryo survival and resulting litter sizes.

Mean litter size was slightly smaller in 2007 compared to the first two trial years, and the litter size difference between Polypay-mated and Dorper-mated ewes was smaller than in previous years. Prior to the mating seasons of the first two trial years, western Oregon had experienced adequate fall rainfall for ample forage availability. During fall of 2006, rainfall was minimal, resulting in lower feed availability. While sheep were provided with alfalfa and mixed grass hay indoors during mating, a lower energy balance prior to this period may have resulted in decreased ovulation rates. The effects of pre-mating nutrition on litter size is well documented (West et al., 1991, Rattray et al., 1981). Previous research conducted by Fogarty (1984) suggests that increased ovulation leads to slightly lower levels of embryo survival. With a reduced ovulation rate, overall embryo survival may have been higher, mitigating some of the potential difference due to sire-breed effect.

Birthweight and Pre-Weaning Survival

Polypay-sired singles and twins were heavier than Dorper-sired lambs of the same birthranks, but birthweight of triplet lambs didn't differ significantly by sire breed. Lambs with genotypically higher in utero growth potential could have been held back due to lack of resources needed for full development. This would be consistent with the findings of

previous research that litter weight increases at a decreasing rate with increased litter size (Freetly and Leymaster, 2004). Chandler et al. (1985) observed that undernourishment of pregnant ewes decreased the blood flow of oxygen and glucose through the umbilical cord. As a result of their findings, Freetly and Leymaster (2004) suggested that ewes should be fed a plane of nutrition consistent with their bodyweight and anticipated litter size rather than having their feed allowance determined by bodyweight alone.

The survival rate of triplets was significantly lower than that of twins or singles, a result that is consistent with other studies (Notter et al. 2004). Jelbart and Dawe (1984) suggested that ewes carrying multiple foeti may be more likely to mobilize tissue impacting maternal performance in order to fuel their own energy demands as well as those of their developing offspring. This mobilization of maternal tissues may negatively impact milk production and lower lamb survival probabilities.

Higher survival rates in 2006 compared to 2005 may be explained by differing weather and management circumstances. In 2006, potential death losses due to inclement weather forced research staff to move ewes indoors for a 36 hour period. During the previous year all ewes had remained outdoors for the entire duration of lambing. However, as this treatment was applied equally to both groups of ewes and their lambs, it is unlikely that it created a bias. During the 2007 season, the start of lambing occurred two weeks later in the year, resulting in a higher mean daily temperature and a lower mean daily precipitation level. Although data isn't available at this time, it is expected that survival rates for 2007 should be higher, especially for triplets. This hypothesis is based on recent studies documenting the effects of environmental heat loss on lamb survival (Coronato, 1999) as well as weather effects on ewe energy balance during late

pregnancy.

Previous work conducted in the U.S. comparing Dorpers to Dorsets by Notter et al. (2004) in an indoor lambing scenario showed a survival rate similar to the current results for singles and twins, but differed significantly in survival of larger litters. The current study weaned 49.5% of lambs born in triplet and quadruplet litters while Notter et al. showed a 68% survival rate for lambs born in these litter sizes. True survival rates in our study were actually higher than the weaning percentage as lambs deemed to have less than a fifty percent chance of survival were bummered and recorded as dead during data collection. It would be expected that triplets and quadruplets may have a higher mortality rate in a reduced input, outdoor lambing production system than they would in the more wide-spread indoor "shed" lambing system.

Appropriate pre-parturition nutrition and management may have the potential to reduce some of this effect. A study by Coronato et al. (1999) has shown that weather conditions during late pregnancy, measured in terms of heat loss, were at least as important as conditions during lambing in determining the survival of lambs. Moving multiple-carrying ewes to pasture areas with more shelter from trees or other natural landscape features may be a cost effective method of decreasing environmental heat loss.

Using ultrasonic pregnancy testing to identify triplet-bearing ewes would be useful for nutritional management if such services could be obtained at a cost-effective price. Work by Scales et al. (1986) showed that increasing the plane of nutrition for multiple bearing ewes during late gestation decreased lamb mortality. Identifying ewes carrying triplet litters and supplementing the diets of these individuals with additional hay and/or grain may enhance the survival rates of their progeny without creating the need for

additional facilities or other costly inputs.

Based on mean daily temperature and precipitation records observed for the trial period, outdoor lambing ewes in Western Oregon should be mated to lamb no sooner than the last week of April. This practice would result in increased forage availability, and a lower probability of inclement weather. The comparatively higher mean daily temperature occurring later in the season should result in less heat loss, increasing the probability of lamb survival in a manner consistent with the findings of Coronato (1999).

Weaning and Yearling Weights

Since lambs were weaned in late July through mid-August when feed resources tend to be sparse, lack of feed availability prior to weaning may have temporarily decreased growth rates of Polypay-sired ewe lambs. This may explain the clear advantage of Polypay-sired ewes over Dorper-sired females in yearling weight despite similar weights at weaning. Availability of forages during the fall and winter months was higher, likely allowing individuals with greater genetic potential more bodyweight gain due to compensatory growth. As lambs in the reduced input management model used in this study are typically marketed as yearlings, Polypay-sired lambs would have an advantage. Weaning and yearling growth data from the progeny of generated ewes lambing in 2007 will be needed to make inferences to maternal influences on these traits.

The differences in yearling weight by birth year were most likely the result of varying fall feed availability between years 2005 and 2006. In 2005, adequate rainfall occurred for typical western Oregon fall pasture forage regrowth to occur. However, in 2006, precipitation levels were well below normal, resulting in minimal pasture

regeneration and poorer feed availability. This would seem to be a ready explanation for the significant sire breed by birth year interaction as ewes with higher growth genes wouldn't have been able to express their full potential.

Further Research

Exploring the difference between these two breeds in terms of embryo survival would be one avenue for further study. This could be accomplished by utilizing laparoscopic procedures to determine the number of corpora lutea present on the ovaries of subject ewes after mating and then comparing these numbers to actual litter sizes. Base flock ewes and generated females would be compared separately, allowing investigation of both ram and ewe effects on this trait.

Generated females were backcrossed by being mated to rams of their own breed. While this practice should have increased homozygosity and caused differences between breed genotypes to become more apparent, it created an inevitable confounding of effects. In future trial years, it would be desirable to cross Dorper-sired generated females with Polypay rams and Polypay-sired females with Dorper-rams in order to better isolate the effects of sire vs. dam genotype on the variables of interest. If an in-utero interaction between genotypes truly is influencing embryo survival, crossbreeding generated females should allow this difference to be readily identified.

CONCLUSION

While pre-weaning survival and growth appear to be similar between lambs sired by either breed, Polypay-sired females had a significant advantage in yearling growth, a trait which they would be expected to transmit to their offspring. In addition, Polypay-sired females also had a significantly higher mean litter size when compared to their Dorper-bred counterparts. Both of these advantages make Polypay-influenced females more suitable for general farm flock production.

Use of White Dorpers as maternal sires may eliminate most of the shearing cost for producers. Pelt discounts occurring due to minor discoloration or wool variations could potentially negate at least a portion of this savings. The net savings of avoiding shearing costs on all ewes still wouldn't compensate for the added profit generated by the larger litter sizes produced by Polypay females.

Differences in litter size by ram breed suggest that Dorper-mated ewes may have an advantage in embryo survival. Further research is needed to verify these results. Dorpers may still present a viable alternative as a sire breed in a reduced input lambing scenario as they appear to have comparable pre-weaning growth to Polypays and above average carcass merit, the latter trait being well documented by previous research.

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Table 1. Numbers and least square means for litter size (L.S.) by ram breed and lambing year.

Ram Breed	2005		2006		2007		Overall	
	No.	L.S.	No.	L.S.	No.	L.S.	No.	L.S.
Dorper	77	2.06	59	2.08	39	1.87	175	2.01 ^b
Polypay	84	1.86	61	1.93	43	1.84	188	1.87 ^a
<i>Overall</i>	<i>161</i>	<i>1.96</i>	<i>120</i>	<i>2.01</i>	<i>82</i>	<i>1.85</i>	<i>363</i>	<i>1.93</i>

^{a, b} Overall means listed between sire breeds or lambing years with different superscripts differ at $p < 0.10$.

Table 2. Numbers and least square means for birth weight (kg), pre-weaning survival (%) for all lambs born, weaning weight (kg), and female yearling weight (kg) by sire breed, birth rank, sex, and birth year.

Item	Lambs Born			Lambs Weaned		Yearlings	
	No.	Weight	Percent Survival	No.	Weight	No.	Weight
<i>Sire Breed</i>							
Dorper	368	4.0 ^d	73.9	202	25.9	83	43.1 ^d
Polypay	365	4.2 ^e	74.0	216	26.4	88	46.0 ^e
<i>Birth Rank</i>							
Single	80	4.8 ^f	90.9 ^e	52	30.0 ^c	23	47.2 ^c
Twin	459	4.1 ^e	81.4 ^e	293	24.9 ^b	111	44.0 ^b
Triplet/ Quad.	185	3.6 ^d	49.5 ^d	73	23.6 ^a	37	42.4 ^a
<i>Sex</i>							
Male	278	4.3 ^b	70.1	202	26.7		NA
Female	285	4.0 ^a	77.8	216	25.7		NA
<i>Birth Year</i>							
2005	322	4.2	70.8	228	29.4 ^e	91	50.8 ^e
2006	241	4.0	77.1	190	22.9 ^d	80	38.3 ^d
2007	267	4.2	NA		NA		NA

^{a, b, c} Means within an item and trait with differing superscripts differ at $p < 0.05$.

^{d, e, f} Means within an item and trait with differing superscripts differ at $p < 0.01$.

Table 3. Numbers and least square means for litter size and progeny birth weight (kg) for generated females by sire breed.

Sire Breed	<i>Ewes</i>		<i>Lambs</i>	
	No.	Litter Size	No	Birth weight
<i>Dorper</i>	30	1.37 ^a	41	3.6
<i>Polypay</i>	36	1.67 ^b	60	3.7

^{a,b} Means within a trait with differing superscripts differ at $p < 0.01$.