Productivity of Rambouillet, Polypay, and Romanov-White Dorper x Rambouillet Ewes Mated to Terminal Sires in a Western Range Production System

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REPORT SUMMARY

Objective: Compare productivity of Rambouillet, Polypay, and Romanov-White Dorper x Rambouillet ewes mated to terminal sires in an Intermountain West rangeland production system.

Approach: Productivity of 212 Rambouillet, 236 Polypay, and 231 Romanov-White Dorper x Rambouillet-crossbred ewes born in 2009, 2010, and 2011 was evaluated through 4 lambings. Beginning as lambs, study ewes were managed in a range-type production system, annually mated to terminal-sire type rams, and evaluated for multiple measures of ewe productivity.

Implication: Polypay and Romanov-White Dorper x Rambouillet ewes weaned a substantially greater weight and number of lambs than did Rambouillet ewes. Romanov-White Dorper x Rambouillet ewes weaned a modestly greater weight and number of lambs than Polypay ewes. The semi-prolific Polypay and Romanov-White Dorper x Rambouillet ewes benefitted from additive breed effects and hybrid vigor that favored better ewe lamb performance and greater numbers of lambs born per ewe lambing at all ewe ages.

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INTRODUCTION

Ewe productivity is a key indicator trait of lamb production efficiency. The trait is commonly measured as the total number and weight of lambs weaned divided by the number of ewes in the flock. On an industry or individual-ranch level, ewe productivity measures the efficiency of converting land and feed resources into marketable products. On an individual-ewe basis, it reveals differences among ewes in production efficiency and adaptation to the production environment. Measures of ewe productivity likewise set a baseline for overall profitability of a sheep production enterprise, recognizing that even relatively large differences in growth and carcass value generally cannot overcome limitations in the number of lambs produced.

The efficiency of sheep production is generally maximized by selecting ewes with high potential ewe productivity and mating these ewes to rams of terminal-sire breeds to enhance the size, growth, and leanness of resulting crossbred lambs. This mating strategy concurrently optimizes adaptation of breeding ewes to the local production environment, takes advantage of hybrid vigor in crossbred lambs, and utilizes value-added characteristics of terminal sires to maximize lamb value.

Ewe productivity has been studied at the U.S. Sheep Experiment Station (USSES) in Dubois, ID for nearly 100 years. USSES scientists and innovative producers sought out genetic resources with potential to enhance the productivity of traditional white-faced, fine-wool Merino and Rambouillet ewes, which are the backbone of Western range production. Accordingly, USSES scientists developed the Targhee breed in the late 1930s and 1940s by crossing Corriedale and coarse-wool Lincoln rams to local fine-wool ewes. The Polypay breed was subsequently developed at the USSES in the 1970s by crossing the Rambouillet, Targhee, Dorset, and Finnsheep breeds to attempt to retain rangeland adaptation, flocking instinct, and wool production and quality characteristics of the Rambouillet and Targhee, enhance ewe prolificacy by introducing 25% Finnsheep breeding, and use the Dorset breed to enhance milk production and reduce seasonal breeding. The resulting Polypay breed proved to be productive and well-adapted to both rangeland and intensive farm-flock production. Also, reflecting the innovative breeders that embraced these newly created maternal breeds, Targhee and Polypay breeders are two of the most active groups participating in sheep performance-recording and genetic evaluation in the U.S. National Sheep Improvement Program (NSIP).

More recently, evidence for superiority of Romanov compared with Finnsheep as a prolific breed and for a potential contribution of hair sheep breeds, such as the White Dorper to increase ewe productivity and lamb survival, emerged from research at the U.S. Meat Animal Research Center (USMARC) in Clay Center, NE. Research to evaluate these breeds was conducted in a Midwestern production environment, and adoption of resulting Romanov and White Dorper crossbred ewes was mainly in this region. However, some breeders have used these crossbred ewe types in Western range production with good results. Therefore, the objective of our study was to compare productivity of Rambouillet, Polypay, and Romanov-White Dorper x Rambouillet ewes mated to terminal sires under Intermountain West rangeland conditions at the USSES.
METHODS

Animals. We used data from 212 Rambouillet, 236 Polypay, and 231 Romanov-White Dorset x Rambouillet crossbred (RW-RA) ewe lambs born in 2009, 2010, and 2011. In the previous fall of each year, 7 Rambouillet, 7 Polypay, and 7 Romanov x White Dorper rams were mated to USSES Rambouillet, Polypay, and Rambouillet ewes, respectively, to produce the study ewe lambs. Most rams were used for only 1 year, but 1 Polypay ram was used a second year. Romanov x White Dorper rams were obtained from the USMARC, where this crossbred type was produced to contribute to an easy-care composite flock for evaluation in a pasture-lambing production system. Selection at the USMARC favored ram lambs that were polled, resistant to scrapie, and naturally raised as twins or triplets and shed white fleeces. Of the 21 Romanov x White Dorper rams used at the USSES, 15 had previously produced progeny at the USMARC. Polypay rams were sampled from 18 industry flocks in 10 states between Colorado and Ohio. Rambouillet rams were sampled from 20 industry flocks in 13 states from Ohio to Idaho. Nine Polypay and 2 Rambouillet flocks were enrolled in NSIP, and an additional 4 Rambouillet flocks subsequently enrolled. One Rambouillet and 1 Polypay ram were also sampled from the USSES flocks. Study ewe lambs were exposed to rams for the first time at approximately 7 to 8 months of age and retained for up to 4 annual lambings. Ewes left the flock when they died or culled for functional unsoundness. Ewe lambs were mated separately from older ewes. In each year, ewes were mated to Suffolk, Columbia, Suffolk x Columbia, or Columbia x Suffolk rams in 1 of 4 mating pens. Each pen contained a random sample of study ewes, with all ewe breed types equally represented, and was assigned at random to 1 of the 4 ram breeds. Each mating pen contained 3 to 4 rams. Ewes were annually mated to the original sire breed that they were first mated to as ewe lambs.

Animal Management. Ewe lambs were exposed to rams in drylot pens for approximately 42 days, beginning in mid- to late October. Adult ewes were exposed to rams in drylot or pasture pens for 21 days beginning in late October. At the end of the primary mating period, adult ewes were combined into a single group, moved to shrub-dominated winter range, and exposed to cleanup Suffolk or Suffolk-crossed rams for an additional 21 days. Mature ewes were maintained on winter range until early to mid-January and then moved to drylot pens until lambing, while ewe lambs were maintained in drylot pens only (no winter range) through lambing. Ewes were annually shorn and vaccinated against clostridial diseases in February and Campylobacter spp. and Corynebacterium pseudotuberculosis in October or November. Ewes lambed in March and April in outdoor drylots. Within approximately 30 minutes of parturition, ewes and their lambs were moved indoors to individual lambing jugs. Within 1 day of birth, all lambs were ear-tagged, weighed, treated for any apparent problems, and tail docked with rubber rings, and male lambs were castrated with rubber rings. After approximately 2 days in lambing jugs, ewes and lambs were then moved to outdoor lots, where they remained for approximately 1 month. In 2009 and 2010, ewes and lambs grazed sagebrush steppe from late April through early July and subalpine forest from early July until weaning in early to mid-August. From 2011 through 2015, ewes and lambs grazed sagebrush steppe from


late April until weaning in mid- to late July. The average weaning age was approximately 105 days.

**Measures of Ewe Productivity.** Our focus in this study was on ewe productivity and associated components. Several measures of ewe productivity were included. **Cumulative ewe productivity** was defined as the total weight of lambs weaned for each ewe lamb entering the study and accumulated across 4 possible lambing opportunities. Components of cumulative ewe productivity included longevity (number of mating opportunities), overall fertility (total number of pregnancies), cumulative prolificacy (total number of lambs born), lamb survival to weaning (total number of lambs surviving to weaning), and average lamb weaning weights. The **weight of lamb weaned per ewe exposed** was based only on ewes present at lambing in each lambing year and therefore independent of ewe survival. Weight of lamb weaned per ewe exposed was summarized separately for ewe lambs and older ewes. The **weight of lamb weaned per ewe lambing** was based only on ewes that lambed and excluded effects of ewe longevity and fertility to focus more narrowly on ewe prolificacy and lamb growth and survival. The weight of lamb weaned per ewe lambing was summarized separately for ewe lambs and older ewes.

Performance of individual lambs was considered by tabulating **weaning rates** (number of lambs weaned per lamb born), **actual birth weights**, and **actual weaning weights**. Weaning rates, birth weights, and weaning weights were adjusted to a mid-sex basis (50% ewe lambs and 50% wethers). However, the three traits were not adjusted for effects of litter size, and thus include negative effects of larger litters on lamb weaning rates and body weights. Actual weaning weights were likewise not adjusted for the number of lambs raised or differences in weaning ages. However, an **age-adjusted weaning weight** was calculated to remove effects of differences in weaning age on realized weaning weights.

**Ewe body weights** were recorded each year in early September and summarized for adult (3- and 4-yr-old) ewes. Only ewes that had weaned lambs were included in the summary.

Preliminary analyses indicated that effects of lamb sire breed were small. Suffolk-sired lambs grew slightly, but not significantly, faster than lambs sired by the other breed types. Columbia rams had somewhat, but not significantly, higher fertility when mated to ewe lambs, but this difference was not observed in adult ewes. Ewe productivity records were therefore not adjusted for the breed of the service sire, and lamb records from Suffolk clean-up rams were included in ewe productivity calculations. However, lambs sired by clean-up rams were excluded from the analysis of individual lamb performance.
RESULTS

Cumulative Ewe Productivity. Ewes of the 3 breed types differed in cumulative ewe productivity as shown in Figure 1A. Over the 4 lambings beginning at 1 year of age, RW-RA ewes weaned 24% more pounds of lamb than Polypay ewes and 53% more pounds of lamb than Rambouillet ewes. Polypay ewes weaned 24% more pounds of lamb than Rambouillet ewes. These differences corresponded to differences in cumulative numbers (counts) of lambs born and weaned shown in Figure 1B. This result mainly reflected greater prolificacy of semi-prolific Polypay and RW-RA ewes, but also included greater longevity for RW-RA ewes compared with Polypay ewes and higher cumulative fertility for RW-RA ewes compared with Polypay and, especially, Rambouillet ewes, as shown in Figure 1C.

Figure 1 - Panels A, B, and C. Cumulative ewe productivity across 4 lambings opportunities for Rambouillet (RA), Polypay (PP), and Romanov-Dorper x Rambouillet (RW-RA) ewes. Means and standard errors (SE) are presented in Panel A for ewe productivity, which is expressed as total pounds of lamb weaned per ewe; Panel B for counts of lambs weaned, alive at 3 days of age (SE not shown), and born per ewe; and Panel C for counts of mating and lambing opportunities per ewe. Values within black bars in Panel A, B, and C are means for pounds of lamb weaned, counts of lambs weaned, and opportunities of lambing, respectively. Values above the stacked bars in Panels B and C are means for counts of lambs born and opportunities of mating, respectively.
**Lambs Weaned per Ewe Exposed.** Ewe lamb performance had a major impact on cumulative ewe productivity. Differences among ewe breed types in pounds of lamb weaned per ewe exposed for ewe lambs and adult ewes are presented in Figure 2A. Pregnancy rates for Rambouillet ewe lambs were low, averaging only 31% across the 3 ewe birth years (Figure 2B). Numbers of lambs born and weaned (Figures 2C) and pounds of lamb weaned per ewe lamb exposed were correspondingly low for Rambouillet ewes, compared with Polypay and RW-RA lambs exposed. Pregnancy rates for RW-RA ewe lambs were 87%, compared with 77% per Polypay ewe lamb, and RW-RA ewe lambs weaned more pounds of lamb per ewe exposed than did Polypay ewe lambs. Differences in productivity in adult ewes were smaller than those in ewe lambs but still significant. Adult pregnancy rates were similar for the 3 ewe types but, as expected, numbers of lambs weaned per ewe exposed were approximately 0.3 lambs greater for Polypay and RW-RA ewes than for Rambouillet ewes.

![Figure 2 - Panels A, B, and C](image)

*Figure 2 - Panels A, B, and C.* Annual ewe-lamb and adult-ewe (2- to 4-years-old) productivity per ewe exposed for Rambouillet (RA), Polypay (PP), and Romanov-White Dorper x Rambouillet (RW-RA) ewes. Means and standard errors (SE) are presented in Panel A for pounds of lamb weaned per ewe exposed; Panel B for pregnancy rates (percentage ewes lambing) per ewe exposed; and Panel C for count of lambs weaned, alive at 3 days of age (SE not shown), and born per ewe exposed. Values within black bars in Panels A, B, and C are means for pounds of lamb weaned, pregnancy rates, and lamb counts, respectively. Values above the stacked bars in Panel C are means for counts of lambs born.
**Lambs Weaned per Ewe Lambing.** As shown in Figure 3, prolificacy levels and pounds of lamb weaned per ewe lambing were only slightly greater for RW-RA adult ewes and ewe lambs than for Polypay adult ewes and ewe lambs, but they were substantially greater for semi-prolific (i.e., Polypay and RW-RA) ewes than for Rambouillet ewes. Lamb death losses around the time of lambing were greater for Polypay and RW-RA ewes. However, numbers of lambs weaned per ewe lambing still favored Polypay and RW-RA ewes, compared with Rambouillet ewes by approximately 0.25 for both adult ewes and ewe lambs, even though realized numbers of lamb weaned for adult Rambouillet ewes in this study were greater than those generally reported for the U.S. sheep industry.

![Figure 3 - Panels A and B. Annual ewe-lamb and adult-ewe (2- to 4-years-old) productivity per ewe lambing for Rambouillet (RA), Polypay (PP), and Romanov-White Dorper x Rambouillet (RW-RA) ewes. Means and standard errors (SE) are presented in Panel A for pounds of lamb weaned per ewe lambing and Panel B for counts of lambs weaned, alive at 3 days of age (SE not shown), and born per ewe lambing. Values within black bars in Panels A and B are means for pounds and counts of lambs weaned, respectively. Values above the stacked bars in Panel B are means for counts of lambs born.](image-url)
**Lamb Growth and Survival.** Birth weights, shown in Figures 4A, were heavier for lambs out of Rambouillet ewes than for lambs out of Polypay and RW-RA ewes. This was expected because of the greater frequencies of triplets in semi-prolific ewes and the knowledge that single-born lambs are typically heavier at birth than are twin- or triplet-born lambs. In adult ewes, lamb survival rate to weaning (Figure 4B) was greatest for lambs out of Rambouillet ewes and least for lambs out of Polypay ewes, despite the somewhat greater prolificacy of the RW-RA ewes. However, for ewe lambs, Rambouillet ewe lambs produced almost all singles (Figure 3B) but still had lower lamb survival to weaning than Polypay and RW-RA ewe lambs. This result emphasized the later maturity of Rambouillet ewe lambs and their lack of capacity, compared with ewe lambs of the semi-prolific breed types, to successfully care for their lambs.

**Figure 4 - Panels A, B, C, D and E.** Annual performance of lambs born to ewe-lamb and adult-ewe (2- to 4-years-old) for Rambouillet (RA), Polypay (PP), and Romanov-White Dorper x Rambouillet (RW-RA) ewes. Means and standard errors (SE) are presented in Panel A for actual birth weights; Panel B for survival rates to weaning; Panel C for actual weaning weights; Panel D for weaning ages; and Panel E for age-adjusted (105 days) weaning weights. Values within black bars are means for each measured variable.
Differences in actual lamb weaning weights (unadjusted for differences in prolificacy or lamb ages at weaning) among ewe breed types are shown in Figure 4C. Differences were small for ewe lambs but favored lambs from Rambouillet adult ewes by 3 lb compared with lambs from Polypay ewes and 5 lb compared with lambs from RW-RA ewes. These differences were less than might have been anticipated from expected differences in adult body weight between Rambouillet ewes and semi-prolific ewes, in part because of differences among ewe types in average weaning age (Figure 4D). Rambouillet adult ewes lambed an average of 2 days later than Polypay and RW-RA ewes, and Rambouillet ewe lambs lambed an average of 12 days later than Polypay and RW-RA ewe lambs, further emphasizing their later maturity relative to semi-prolific ewe lambs. When lamb weights were adjusted to a constant age of 105 days (Figure 4E), lamb weaning weight for Rambouillet ewes was greater than semi-prolific Polypay and RW-RA ewes by approximately 5 lb in adult ewes and 6 lb in ewe lambs.

**Adult ewe body weights.** Ewes were weighed in September, following weaning of their lambs, and weights were summarized for 3- and 4-year-old ewes that had weaned lambs. The average weight of RW-RA ewes (157 lb) was significantly less than that of Polypay (163 lb) and Rambouillet (166 lb) ewes. The difference in weight between Polypay and Rambouillet ewes was not significant after adjusting for the greater number of lambs born to, and suckled by, the Polypay ewes.

**DISCUSSION**

**Advantages of Semi-prolific Breeds.** Lifetime lamb production was substantially greater for the semi-prolific Polypay and RW-RA ewes than for the Rambouillet ewes. This is because Polypay and RW-RA ewes held major advantages in ewe lamb performance and modest, but consistent, advantages in many components of adult ewe productivity. Cumulative lamb production was likewise considerably greater for RW-RA than for Polypay ewes. Many range sheep producers do not breed ewe lambs, instead allow ewes to lamb for the first time at 2 years of age. However, even in adult ewes (2- to 4-year-old; Figure 2), RW-RA ewes still weaned 8% more pounds of lamb per ewe exposed than Polypay ewes and 25% more pounds of lamb per ewe exposed than Rambouillet ewes. Adult Polypay ewes weaned 16% more pounds of lamb per ewe exposed than adult Rambouillet ewes. Use of semi-prolific crossbred and composite ewes was, thus, still associated with large increases in the weight and number of lambs weaned by adult ewes. The RW-RA ewes were also lighter as adults than Rambouillet and Polypay ewes and, presumably, had lower associated maintenance requirements.

**The Effect of Heterosis.** Advantages of the RW-RA ewes over Polypay and Rambouillet ewes and of Polypay ewes over Rambouillet ewes likely arose in part from differences in realized levels of heterosis among the ewe types. The RW-RA ewes would have expressed the full effects of heterosis in the crossbred ewes whereas Rambouillet ewes would not have benefited from effects of heterosis in the ewe. The Polypay is a stabilized composite breed derived from crosses among 4 breeds (Rambouillet, Targhee, Dorset, and Finnsheep) and would have been initially expected to express 75% of maximum heterosis. However, expression of heterosis will decline when a newly created composite line accumulates inbreeding and may also have been
less than expected because the Rambouillet and Targhee founder breeds were related. Based on this founder relationship and an average inbreeding coefficient of approximately 0.10 in USSES Polypay sheep (Zhang et al., 2013), the current level of realized heterosis in USSES Polypay ewes was expected to be approximately 65% of maximum. All lambs were sired by breeds that were unrelated to the ewes; therefore, the lambs benefited from the full effects of heterosis.

Based on expected heterosis levels in different ewe types and anticipated average effects of heterosis in crossbred ewes (Nitter, 1978, as cited in Bradford, 2003), differences in longevity (cumulative numbers of matings; Figure 1B) between Rambouillet and RW-RA ewes were consistent with differences expected between ewe types in heterosis. However, lower survival rates for Polypay ewes were not consistent with expected effects of heterosis and might have arisen from negative founder effects of the Dorset and Finnsheep compared with the Rambouillet and Targhee. Lower ewe survival for Polypay ewes, compared with RW-RA ewes, was consistent with expected differences in heterosis, but survival rates could also reflect founder effects of the Romanov and White Dorper in the RW-RA ewes compared with founder effects of the Dorset and Finnsheep in the Polypay. High average fertility in adult ewes prevented expression of potential effects of heterosis on ewe fertility, but small advantages in fertility for RW-RA adult ewes (Figure 2B) were consistent with their greater heterosis. By contrast, ewe lamb fertility for Rambouillet ewe lambs, compared with Polypay and RW-RA ewe lambs, was much less than expected from differences in heterosis. This result presumably reflects breed differences in maturing rate and age at puberty (Stobart et al., 1987). Differences in litter size (Figure 3B) between Polypay and RW-RA females were small for both ewes and ewe lambs and might have arisen from differences in expression of heterosis. However, the larger litter sizes for Polypay and RW-RA adult ewes and ewe lambs, compared with Rambouillet adult ewes and ewe lambs, were too large to be accounted for by heterosis alone and presumably reflected contributions of prolific Finnsheep and Romanov breeds to Polypay and RW-RA ewes, respectively.

**Lamb Survivability.** Differences in lamb survival of the progeny of ewe lambs (Figure 4B) were consistent with differences in heterosis in the ewe lambs. However, differences in survival of progeny of adult ewes were a more complicated function of breed effects, differences in heterosis, and average prolificacy. Polypay and RW-RA adult ewes had similar numbers of lambs. The slightly greater survival to weaning of lambs out of RW-RA ewes, compared with Polypay ewes, might have been caused by differences in heterosis. However, greater survival of lambs from adult Rambouillet ewes presumably was driven largely by their smaller litter sizes, but also perhaps by better adaptation to rangeland conditions. By contrast, effects of heterosis in the ewes on age-adjusted lamb weaning weights seemed to be compensated by the apparent greater lamb growth potential in progeny of Rambouillet ewes.

**The Question of Wool.** In this study, wool was the only obvious advantage of Rambouillet ewes over the semi-prolific ewes, although an analysis of the fleece data from the various ewe types is not yet completed. Nevertheless, wool from the RW-RA ewes clearly had little, if any, commercial value, whereas wool from Polypay and Rambouillet ewes clearly had commercial
value. Moreover, wool from the Rambouillet ewes had potentially more value than the wool from Polypay ewes.

Demonstrated in Table 1, are the cumulative lamb weaning weight advantages of semi-prolific ewes over Rambouillet ewes, RW-RA over Polypay ewes, and the corresponding market price advantages. Over 4 years, Polypay and RW-RA ewes produced 52 and 117 more pounds of lamb, which resulted in $100 and $225 advantage, respectively, over Rambouillet ewes. Therefore, Rambouillet ewes would need to produce greater than $25 and $56 per ewe, respectively, in annual wool sales to make up for the weight-weaned advantage of semi-prolific ewes in this study. Similarly, Polypay ewes would need to exceed $31 per ewe in annual wool sales to compensate for the RW-RA weaned-weight advantage.

Table 1. Demonstration of cumulative weight-weaned advantages of semi-prolific Polypay and Romanov-White Dorper x Rambouillet (RW-RA) ewes over Rambouillet ewes

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<th>Polypay vs. Rambouillet</th>
<th>RW-RA vs. Polypay</th>
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<tr>
<td>Cumulative weight weaned* (lb)</td>
<td>Weight weaned advantage (lb)</td>
<td>Market price advantage** ($)</td>
</tr>
<tr>
<td>Rambouillet</td>
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<td>0</td>
</tr>
<tr>
<td>Polypay</td>
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<td>+52</td>
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<tr>
<td>RW-RA</td>
<td>336</td>
<td>+117</td>
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* Data are from Figure 1.A.
** Based on $1.92/lb market price as reported by the Livestock Marketing Information Center, 2016.

CONCLUSION

Taken together, these results indicate that in a range production system, Polypay and RW-RA (Romanov-White Dorper x Rambouillet) ewes benefitted from additive breed effects and hybrid vigor, favoring better ewe lamb performance and greater numbers of lambs born per ewe lambing at all ewe ages. As expected, death losses were greater for lambs born to the more prolific Polypay and RW-RA ewes, and realized lamb growth rates were less when compared with Rambouillet ewes. Nonetheless, combined effects of additive breed differences and hybrid vigor in Polypay and RW-RA ewes resulted in substantially greater weight and number of lambs weaned compared with Rambouillet ewes. Further, the RW-RA ewes had modestly greater weight and number of lambs weaned compared with Polypay ewes.
REFERENCES


