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Post-weaning Growth and Carcass Traits of St. Croix White and Dorper X St. Croix White Lambs Grazing Pasture During the Dry and Wet Seasons in the U.S. Virgin Islands

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Summary

This study was conducted to evaluate post-weaning growth, carcass traits and parasite burdens St. Croix White (STX) and Dorper X St. Croix White (DRP) lambs grazing guinea grass pastures during the wet and dry seasons. Lambs (77 d of age) were placed in guinea grass pastures (0.5 ha) in a rotational grazing system. Fecal egg count (FEC), packed cell volume (PCV) and BW were measured weekly. Lambs were slaughtered at a BW of 30 kg. Carcass weight, fat thickness, rib eye area (REA), KPH and leg circumference were measured. Data were analyzed by SAS procedures. Total rainfall was 647.7 mm and 1495.3 mm for the dry and wet seasons, respectively. Forage availability was 432.5 ± 64.6 kg DM/ha and 1051.0 ± 261.9 kg DM/ha during the dry and wet seasons, respectively. The DRP lambs reached target weight sooner ($P < 0.0008$) than STX lambs (178.2 ± 6.3 d vs. 210.9 ± 6.7 d, respectively). Average daily gain was higher ($P < 0.0002$) for DRP than for STX lambs (90.3 ± 1.9 g/d vs. 79.1 ± 2.0 g/d, respectively). Carcass weight was not different ($P > 0.10$) between breed type (13.5 ± 0.1 kg). The REA of DRP lambs was greater ($P < 0.01$) than that of STX lambs (9.36 ± 0.19 cm^2 vs. 8.63 ± 0.21 cm^2, respectively). Fat thickness was greater ($P < 0.02$) in DRP than in STX lambs (1.92 ± 0.10 mm vs. 1.57 ± 0.10 mm, respectively). Leg circumference was larger ($P < 0.03$) for DRP than for STX lambs (38.2 ± 0.3 cm vs. 37.3 ± 0.3 cm, respectively). There was no difference ($P > 0.10$) between DRP and STX lambs in FEC or PCV. Dorper-sired lambs reared under an extensive management system will reach market weight sooner than St. Croix White lambs and can tolerate parasite burdens similar to those found in the indigenous hair sheep in the U.S. Virgin Islands.

Key words: Hair Sheep, Parasites, Tropics, Carcass, Cross-Breeding

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Introduction

Caribbean agriculture is marked by limited land availability, variable rainfall throughout the year and year round exposure of livestock to parasites. In locations where the amount of land available for agriculture is limited, sheep can be the only feasible option for large-scale livestock production. The predominant breeds of sheep found throughout the Caribbean region consist of hair breeds, such as the St. Croix White and Barbados Blackbelly, as well as crosses of these two breeds. These hair breeds produce relatively small lambs with light carcass weights at slaughter. Attempts to increase carcass weight by crossing with wool breeds have met with limited success (Godfrey and Collins, 1999; Godfrey et al., 2000). These studies also reported that crossbred lambs (Suffolk X St. Croix White) had higher lamb mortality, higher fecal egg counts and lower hematocrit values while grazing guinea grass (*Panicum maximum*) pasture during the rainy season, when compared to purebred St. Croix White lambs.

Previous research has determined that hair sheep lambs on St. Croix raised during the dry season of the year have lower weaning weights (Wildeus et al., 1988). Low forage quality and quantity was thought to be the main reason for the decrease in lamb weight during the dry season. Wildeus and Collins (1993) also reported that lamb survival was lower during the rainy season on St. Croix. During the wet season the forage quantity increases, but quality may not be at desirable levels. The grasses are growing rapidly and contain a high level of moisture that may limit the lamb's grass consumption so that they cannot meet their nutritional requirements for growth due to limited rumen capacity. Each of the aforementioned studies indicates that there are negative aspects of both the dry and rainy seasons with regards to raising lambs on tropical grasses.

The introduction of Dorper sheep into the United States has led to a high level of interest in this breed in the U.S. Virgin Islands for use in crossbreeding programs. Several farms in the U.S. Virgin Islands have purchased Dorper sheep to incorporate into their hair sheep flocks, and interest about the performance of the breed under the local conditions is increasing. The Dorper was selected for use in crossbreeding with Caribbean hair sheep in this project due to its heavy muscling and the fact that it was developed for use in arid, tropical areas and that Dorpers have a fiber type more typical of hair than wool. There is very little information available on the ability of purebred and crossbred Dorper sheep to be productive under the conditions found in the Caribbean. Their ability to survive in an area of elevated parasite burdens is unknown. This project was designed to evaluate the post-weaning growth, carcass traits and parasite burdens of St. Croix White and Dorper X St. Croix White lambs raised on guinea grass pastures during two times of the year. The study was conducted during the dry (January through May) and the wet (September through December) seasons on St. Croix, U.S. Virgin Islands.

Materials and Methods

Animals

St. Croix White (STX) and Dorper X STX (DRP) lambs sired by two rams within each breed type were born in either July or November 2003. Lambs were weaned at 63 ± 3 d of age, kept in drylot pens (3.1 X 6.1 meters) and fed a commercial pelleted diet (PMI Nutrition, Mulberry, FL) at 2 percent BW•hd^{-1}•d^{-1} with ad libitum access to guinea grass hay and water for two weeks. Ram lambs were surgically castrated at 70 d of age. All lambs were treated with ivermectin (Ivomec®, 0.2mg/kg) and placed in pastures as they individually attained 77 d of age in October (wet season) or February (dry season). Lambs were dewormed with ivermectin once during the wet season grazing at day 84 of grazing, but not during the dry season. Distribution of lambs by breed and gender during the wet and dry grazing seasons is shown in Table 1.

Grazing treatments

A rotational-grazing system was utilized to move the lambs through a set of five pastures (0.5 ha each) that contained guinea grass with less than 10 percent leucaena (*leucaena leucocephela*). The timing of pasture rotation was determined by visual evaluation of forage quantity in each pasture. Wet-season grazing began in October, 2003 and dry-season grazing began in February, 2004. Herbage mass was measured at the start and the end of the grazing period in each pasture. Six 0.25 m^2 plots, randomly selected in each pasture, were harvested to a stubble height of 75 mm. Sub-samples (0.2 kg) were dried at 60° C for 48 h to determine forage dry matter per hectare (kg DM/ha). Quality traits of forage, determined on sub-samples collected at the start of grazing in a pasture, included percentage of CP, TDN and DM. Samples were sent to a commercial laboratory (Dairy One, Ithaca, NY) for analysis. Daily precipitation and high and low temperatures were also measured throughout the grazing period.

Animal sampling

Lambs were weighed, fecal samples were collected to determine fecal egg counts (FEC) and jugular blood samples were collected to determine packed cell volume (PCV) at weekly intervals during grazing. The FEC were determined using the modified McMaster's technique. Total gain was determined as the difference between BW at the start and end of grazing. Average daily gain (ADG) was calculated as total gain/day to reach market weight.

Carcass data

Lambs were slaughtered at a body weight of 30 kg, which is the preferred weight for the local market. Cold carcass weight, rib eye area measured between the 12th and 13th rib (REA),

Table 1. Distribution of lambs during wet and dry season grazing.

	Wet		Dry	
	DRP	STX	DRP	STX
Male	8	6	8	8
Female	6	6	7	6
Sub-total	14	12	15	14
Total	26		29	

fat thickness over the 12th rib, KPH percent and leg circumference were measured. Dressing percent was calculated as (cold carcass weight divided by live weight) x 100.

Economic analysis

Economic data was calculated for the three local markets available to producers. Lambs could be sold as live animals for religious slaughter at a rate of $2.21/kg (live). Carcasses could be sold to retail outlets at a rate of $3.96/kg (commercial) or to individual customers for personal consumption at a rate of $4.41/kg (individual). A variable to provide an indicator of efficiency (how many days it took to generate $1 of revenue) was created by dividing the number of days to reach market weight by the sale price.

Statistical analysis

Data were analyzed using general linear models procedures (SAS, 1996). Body weight, FEC and PCV were analyzed using repeated measures procedures. The model contained the effects of breed, sex, days grazing, season and the appropriate interactions. The values for FEC were transformed using $\log_{10}$(FEC + 1) prior to analysis but results are presented as the untransformed least squares means. Carcass traits, ADG and economic data were analyzed using breed, sex and season and the appropriate interactions in the model. Mean separations were done using the PDIFF option of SAS. There was no significant effect of sex or the sex X breed and breed x season interactions for any trait so only breed and season effects are reported. Results are reported as least square means ± SEM.

Results and Discussion

Total rainfall during the dry season was 583.4 mm and 1495.30 mm during the wet season. This seasonal variation in rainfall affects both availability and quality of forage and can be a limiting factor to livestock production in the Caribbean. The dry period usually lasts from January through April, and September through December is considered the wettest time of the year (Godfrey and Hansen, 1996). Forage quantity was greater (P < 0.008) during the wet season than during the dry season (Table 2) but there was no difference (P > 0.10) in quality as indicated by CP or TDN between seasons. Lambs spent more time (P < 0.03) in each pasture during the wet season than during the dry season (Table 2).

The DRP lambs were heavier (P < 0.01) than the STX lambs in both seasons (Figure 1). Lambs allotted during the dry season were on pasture for 245 days, and during the wet season they were on pasture for 287 days. The number of days it took to reach target weight (30 kg) was less (P < 0.0008) for DRP than for STX lambs, but there was no difference (P > .10) between seasons (Table 3). Total gain was not different (P > 0.10) between DRP and STX lambs but was greater (P < 0.03) during the dry than the wet season (Table 3). The starting weight of lambs was lower (P < 0.02) during the dry season than the wet season (13.1 ± 0.5 kg vs. 14.9 ± 0.5 kg, respectively), which explains why total gain was greater during the dry season. Average daily gain was higher for DRP than for STX lambs (P < 0.0002) and higher (P < 0.002) during the dry season than the wet season (Table 3). Even though the total weight gain was not different between breed type, ADG was different due to the shorter time it took DRP lambs to reach the target weight. The difference in ADG between seasons is due to the combination of a lack of difference in time to reach market weight and the higher total weight gained during the dry season.

In semi-arid areas with long periods of little or no precipitation, tropical grasses can be low in energy and protein content, and growing lambs would be susceptible to under nutrition during these periods of low forage quality or quantity (Johnson et al., 1990). Wildeus et al. (1988) reported that hair sheep lambs on St. Croix have lower weaning weights when they are raised on pasture during the dry season of the year. This decrease in weaning weights is thought to be related to the low forage quality and quantity. The predominant forage, guinea grass, has an average crude protein content of 8 percent (on a DM basis), which is acceptable for maintenance of animals, but is not considered adequate for lactating ewes (Wildeus et al., 1988). The legume leucaena (*Leucaena leucocephela*) was reported to have crude protein content of 28 percent (Wildeus et al., 1988), but it was estimated to account for less than 10 percent of available forage in pastures in the present study. In the present study, the quality of the forage was similar between seasons, with quantity being the only difference. The nutritional analysis showed that the forage had 11 percent CP during both seasons. Kawas and Huston (1990) recommend that hair lambs gaining 100 g/d require 29 percent to 75 percent TDN and 9.5 to 14.9 percent CP, on a DM basis, depending on BW of the lamb. The forage quality during both the dry and wet season exceeded these levels, which indicates that nutritional quality was adequate for the lambs at both times.

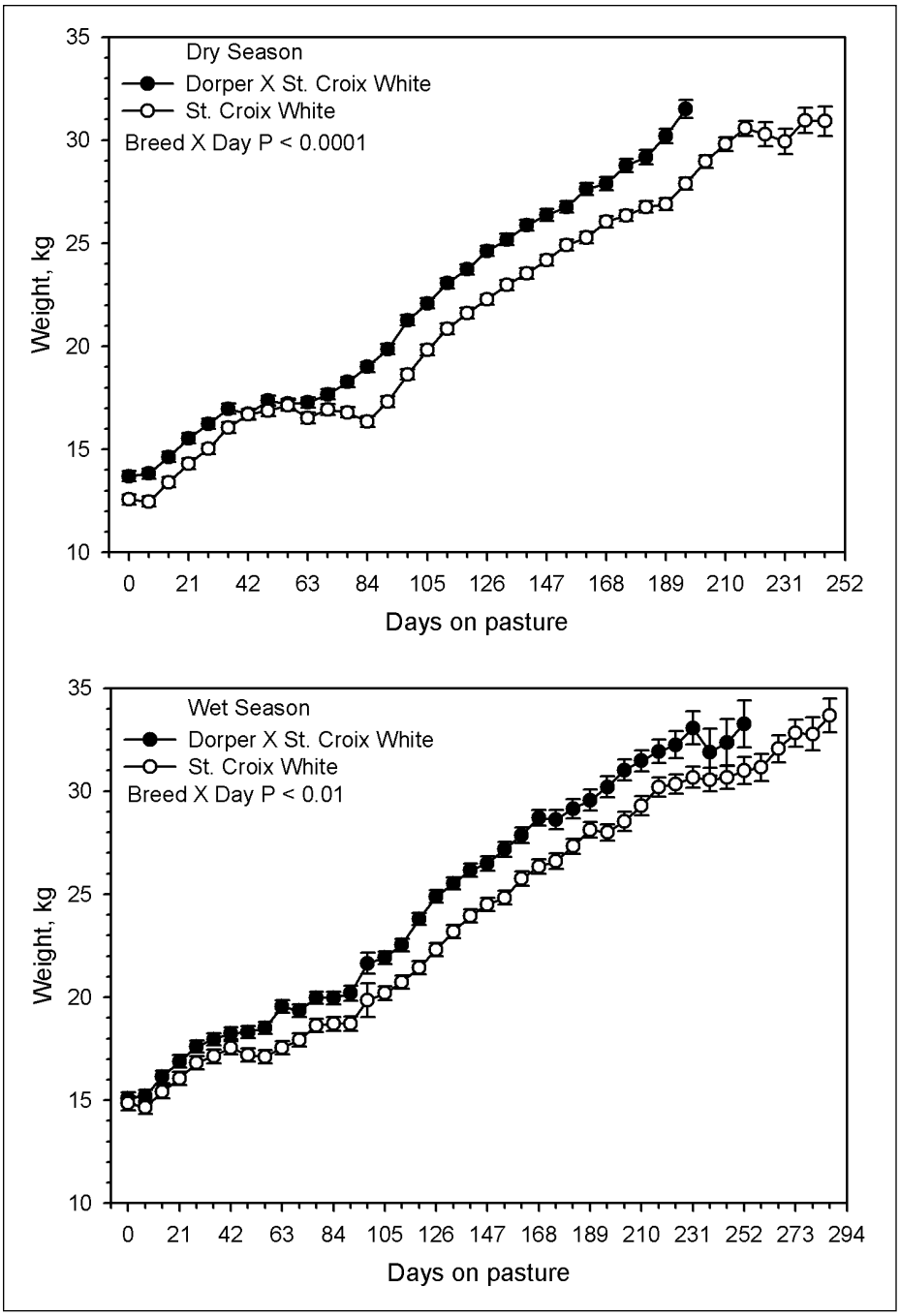
Table 2. Pasture rotation frequency and forage quality.

	Season	Mean ± SEM	Minimum	Maximum
Rotation frequency[a,d]	Wet	18.2 ± 2.0[c]	6	33
	Dry	11.2 ± 2.1[d]	2	36
Dry matter, %	Wet	29.7 ± 1.8	21.6	50.3
	Dry	32.2 ± 1.6	18.2	49.1
Crude proteinb, %	Wet	11.3 ± 0.7	6.9	15.2
	Dry	11.7 ± 0.9	6.2	20.8
TDN[b], %	Wet	60.8 ± 0.4	59.0	65.0
	Dry	60.9 ± 0.3	59.0	64.0
Forage DM , kg/ha	Wet	1051.0 ± 261.9[e]	121.3	3339.3
	Dry	432.5 ± 64.6[f]	20.7	1123.3

[a] Lambs were rotated through five 0.5 ha pastures
[b] DM basis

Means within a trait different superscripts are different: [c,d] P < 0.03; [e,f] P < 0.008

Figure 1. Weight of St. Croix White (open circles) and Dorper X St. Croix White (closed circles) lambs grazing guinea grass pastures during the dry (upper panel) and wet (lower panel) seasons on St. Croix. The dry season grazing lasted for 245 d and the wet season grazing lasted for 287 d. During both seasons the Dorper lambs were heavier than the St. Croix White lambs (P < 0.01).



We have previously reported that Suffolk X STX lambs had higher average daily gain, but lower feed efficiency, when compared to purebred St. Croix White lambs being fed a concentrate ration after weaning (Godfrey and Collins, 1999). In a subsequent study conducted to evaluate one quarter Suffolk x three quarter St. Croix White lambs grazing pasture, mortality was too high (57.1 percent) to accurately evaluate their rate of gain (Godfrey et al., 2000). In a review of South African Sheep Performance Testing Scheme records, Schoeman (2000) found the Dorper had the highest feed efficiency and ADG of all breeds tested, except for the Finnish Landrace composites. The crossbred lambs in the present study had greater ADG than the local hair sheep which is most likely due to breed differences between the Dorper and St. Croix White.

The DRP lambs had larger REA (P < 0.01), more back fat (P < 0.02), lower KPH (P < 0.06) and greater leg circumference (P < 0.0001) than STX lambs (Table 4). Results from our laboratory (Godfrey and Collins, 1999; Godfrey et al., 1999) have shown that St. Croix White lambs fed a concentrate diet tended to store fat in the body cavity as KPH and had very little external fat, compared to wool or hair crossbred lambs. In agreement with the present study, Godfrey and Weis (2005) reported that DRP lambs had higher KPH than the STX lambs did, but there was no difference in back fat when lambs were fed a concentrate diet. The trimness of hair sheep carcasses may be useful when marketing the meat to consumers who are interested in purchasing leaner cuts of meat for dietary or perceived health reasons. Notter et al. (2004) also reported an increase in muscling in Dorper-sired lambs. The larger REA and leg circumference of the DRP lambs compared to the STX lambs in the present study is indicative of more muscling on the carcass.

There was no difference in FEC or PCV (P > 0.10) between DRP and STX lambs. In both groups of lambs there was an elevation of FEC and a decrease in PCV between days 21 and 84 during the dry season. This corresponded to a period where the weight gain was decreased (Figure 1). The lambs were not treated with anthelmintic during this time and FEC and PCV returned to levels that were similar to those at the start of the grazing, and BW began increasing. The DRP lambs had elevated FEC around day 161, but this may have been due to the fact that by then 40 percent of the DRP lambs had reached market weight and were removed from the pasture, and an increase in FEC of one or two lambs could account for the elevated mean. During the wet season there was only a slight elevation in FEC between day 21 and 42 (Figure 2), and there was a decrease in weight gain at that time as well (Figure 1). Burke and Miller (2002) reported that Dorper crossbred lambs were less tolerant than hair-breed lambs when faced with an elevated-parasite challenge. This is in contrast to the cur-

Table 3. Growth traits of STX and DRP lambs during the dry and wet seasons.

	Breed		Season	
Trait	DRP	STX	Dry	Wet
Days to target weight	178.2 ± 6.3[a]	210.9 ± 6.7[b]	188.8 ± 6.3	200.4 ± 6.6
Total gain, kg	15.8 ± 0.5	16.5 ± 0.5	16.9 ± 0.5[c]	15.4 ± 0.5[d]
ADG, g/d	90.3 ± 1.9[e]	79.1 ± 2.0[f]	90.6 ± 1.9[e]	78.8 ± 2.0[f]

Means in a row within breed or season are different: [a,b] $P < 0.0008$; [c,d] $P < 0.03$; [e,f] $P < 0.0002$

Table 4. Carcass traits of STX and DRP lambs during the dry and wet seasons.

	Breed		Season	
Trait	DRP	STX	Dry	Wet
Hot carcass weight, kg	13.7 ± 0.1	13.3 ± 0.1	13.6 ± 0.1	13.4 ± 0.1
Dressing percent	43.3 ± 0.4	42.2 ± 0.4	42.9 ± 0.4	42.7 ± 0.4
Rib eye area, cm^2	9.36 ± 0.19[a]	8.63 ± 0.21[b]	8.8 ± 0.2	9.2 ± 0.2
Back fat, mm	1.92 ± 0.10[c]	1.57 ± 0.1[d]	1.92 ± 0.10[c]	1.57 ± 0.10[d]
KPH, %	2.5 ± 0.2[e]	3.0 ± 0.2[f]	3.1 ± 0.2[c]	2.4 ± 0.2[d]
Leg circumference, cm	38.2 ± 0.3[g]	37.3 ± 0.3[h]	38.6 ± 0.2[i]	36.9 ± 0.3[j]

Means in a row within breed or season are different: [a,b] $P < 0.01$; [c,d] $P < 0.02$; [e,f] $P < 0.06$; [g,h] $P < 0.03$; [i,j] $P < 0.0001$

rent study where both the STX and DRP lambs exhibited an elevation in FEC during grazing in the dry season that was temporary, even though the lambs were not treated with anthelmintic at that time.

During the dry season FEC was higher ($P < 0.001$) than during the wet season (Figure 2), but there was no difference ($P > 0.10$) in PCV (Figure 3). The higher FEC during the dry season was unexpected, but it may have played a role in the lower ADG (Table 3), as well as the plateau in BW between day 21 and 84 (Figure 1). Neither FEC nor PCV reached levels that were deemed abnormal during either season. However, three lambs (1 DRP and 2 STX) died of parasitism between day 81 and day 88 of the wet season, even though FEC was low and PCV was within the normal range for our sheep at this time (Figure 2). Parasitism was confirmed based on the large numbers of adult worms found in the gastrointestinal tract of these lambs during necropsy. During the 45-day period prior to the deaths, 626 mm of rain fell, accounting for 64 percent of the total rainfall during the 245-day, wet-season grazing period. One possible explanation for the lack of an increase in FEC during this time is that the *Haemonchus contortus* entered a diapause or arrested development phase during the wet season (Johnson et al., 1990; Wildeus and Collins, 1993) and were not shedding eggs that could be detected in the feces. If the parasites were in a dormant state, that would also explain why there was no detected decrease in PCV at that time as well. Gerisch and Antebi (2004) have studied the nematode *Caenorhabditis elagans* as a model of molecular mechanisms of environmental signaling due to its ability to arrest at the third larval stage (L3) in response to sensory inputs. Perhaps *Haemonchus contortus* possesses some ability to detect environmental cues outside of the host and can regulate its reproductive pattern to suit the environmental conditions. The only differences detected between the wet and dry seasons were forage quantity and rainfall amount. Whether or not *Haemonchus contortus* has the ability to respond to these environmental signals is unknown at the present time.

In our lab, we have reported that even with just 25 percent wool genetics, crossbred hair lambs were unable to tolerate the high parasite loads experienced by native hair sheep in the tropics during the wet season (Godfrey et al., 2000). In a study comparing the Dorper to the Red Maasai (Schoeman, 2000), the Dorper had higher mortality rates due to suspected parasitism by *Haemonchus contortus*. The Dorper had higher FEC and

Figure 2. Fecal egg counts (FEC) of St. Croix White (open symbols) and Dorper X St. Croix White (closed symbols) lambs grazing guinea grass pastures during the dry (triangles) and wet (circles) seasons on St. Croix. FEC was higher during the dry season than during the wet season ($P < 0.001$).

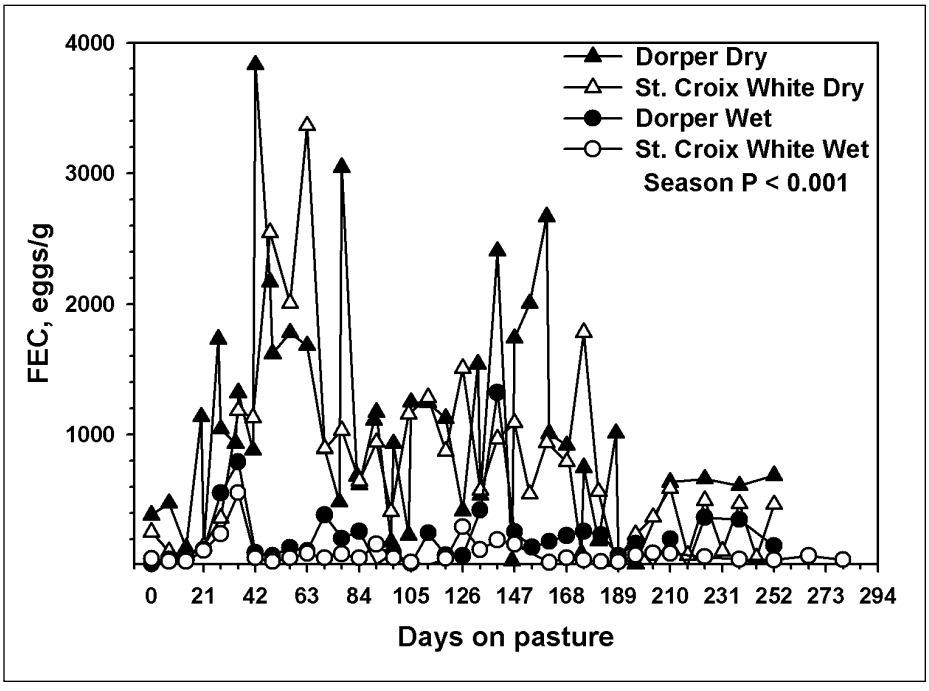


Table 5. Revenue generated from sales and efficiency of St. Croix White and Dorper X St. Croix White lamb production.

	Breed	
Revenue	**DRP**	**STX**
Live[a]	$66.72 ± 0.15	$66.64 ± 0.16
Commercial[b]	$50.85 ± 0.52	$51.92 ± 0.55
Individual[c]	$56.63 ± 0.58	$57.82 ± 0.61
Efficiency[d] (number of days to produce $1 of revenue)		
Live	2.7 ± 0.1[e]	3.2 ± 0.1[f]
Commercial	3.5 ± 0.1[g]	4.1 ± 0.1[h]
Individual	3.2 ± 0.1[g]	3.6 ± 0.1[h]

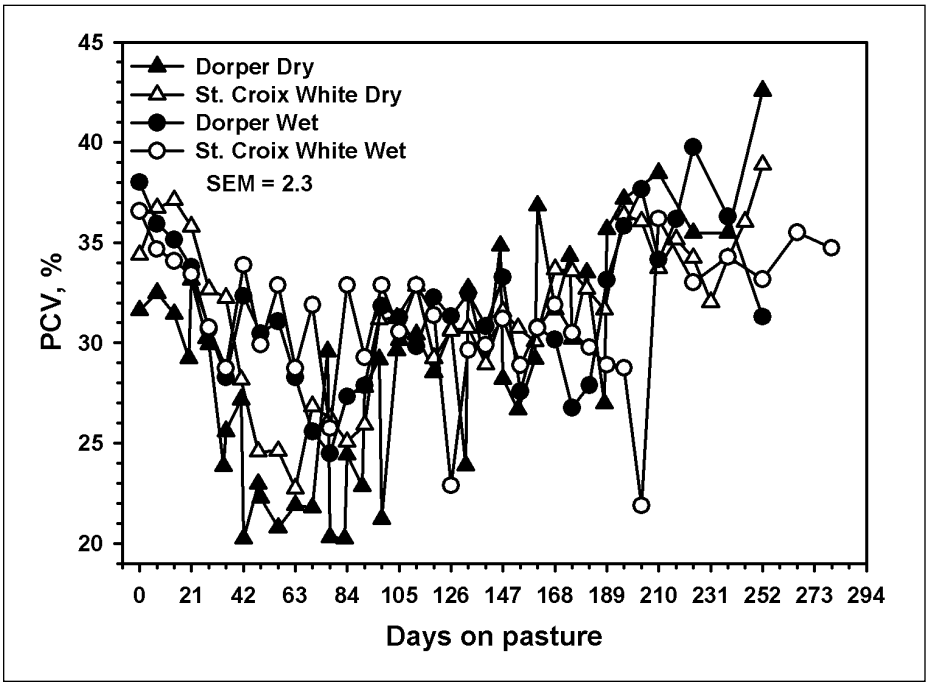
[a] Sold as live animal to ethnic consumers for $2.21/kg
[b] Sold as carcass to local grocery stores at $3.96/kg
[c] Sold as carcass to individual consumers ate $4.41/kg
[d] Efficiency = number of days to slaughter / sale price

Means in a row are different: [e,f] P < 0.0007; [g,h] P < 0.002

lower PCV and subsequently higher mortality rates (Baker et al., 1999; Schoeman, 2000). Burke and Miller (2004) have reported that Dorper crossbred lambs were less resistant and required anthelmintic treatment sooner than St. Croix White lambs, when exposed to a high parasite load. In contrast, St. Croix White sheep have demonstrated tolerance to high parasite loads during the tropical rainy season (Godfrey et al., 2000).

Because all the lambs in the present study were slaughtered at a target weight (30 kg) there were no differences (P > 0.10) in the revenue generated among the three markets that are available to local sheep producers (Table 5). In the previous study by Godfrey and Collins (1999) where wool x hair and hair lambs were fed a concentrated ration, the crossbred lambs had higher ADG. However, the lower feed efficiency of the crossbreds and the high cost of the imported feed eliminated any economic advantage of the growth and size of the wool-sired lambs. There were differences detected in the efficiency of the lambs for the three markets. In each market the efficiency was greater (P < 0.002) for the DRP than for the STX lambs (Table 5). Since this variable is a measure of how many days the lambs take to produce $1 of revenue, the shorter time to reach target weight and the higher ADG of the DRP lambs contributed to the difference in efficiency.

Figure 3. Packed cell volume (PCV) of St. Croix White (open symbols) and Dorper X St. Croix White (closed symbols) lambs grazing guinea grass pastures during the dry (triangles) and wet (circles) seasons on St. Croix. There was no difference (P > 0.10) between breeds or seasons.



Conclusion

Forage differed between seasons by amount but not quality. The DRP lambs had higher ADG, shorter time to reach target weight and heavier muscled carcasses, based on REA and leg circumference but more back fat than STX lambs. Regardless of season, DRP lambs reached the target weight approximately 30 days sooner that STX lambs. This did not impact their sale value, but was reflected in an increased efficiency. The DRP lambs grew rapidly and could tolerate parasite burdens similar to those found in the indigenous hair sheep. The heavier crossbred lambs can lead to an increase in the amount of marketable product for sheep producers without increasing costs for parasite control in an extensive management system in the U.S. Virgin Islands. Further studies need to be done using a larger sampling of sires within each breed type so that inferences are not being made from a small sample size.

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