# Evaluation of the growth performance and carcass characteristics of lambs produced in Quebec

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Hammell, K. L. and Laforest, J. P. 2000. **Evaluation of the growth performance and carcass characteristics of lambs produced in Quebec.** Can. J. Anim. Sci. **80**: 25–33. Data for a total of approximately 1100 lambs tested in 12 trials from 1992 to 1995 in commercial lamb test stations in Quebec were used to determine the effect of sex, sire breed and genetic type on growth performance and carcass characteristics. Lambs were housed two to a pen and fed commercial diets. Maximum test length was 112 d. Lambs were slaughtered when their liveweight was approximately 47 ± 5 kg for the males and 43 ± 4 kg for the females. Feed intake and growth rate were measured during the test, and carcass measurements were taken at slaughter and at 24 h following slaughter. Feed intake was the average for the pen, while the growth and carcass measurements were taken individually. Males ate more per day, had better gain and were younger at slaughter than females. Females had more body fat and better carcass conformation scores than males. However, males did not have a greater loin muscle thickness compared to females. Lambs sired by Hampshire or Suffolk rams had superior growth performance and leaner carcasses than lambs sired by Dorset rams. However, Hampshire and Suffolk-sired lambs did not have a greater loin muscle thickness compared to Dorset-sired lambs. Analysis of different genetic types did not demonstrate a pronounced effect on lamb performance. No specific genetic composition was clearly superior to the others for the various variables studied. Genetic quality within a breed of sheep bought or kept for reproduction is as important as the choice of breed or the combination of breeds.

**Key words**: Lamb, growth performance, carcass composition

Hammell, K. L. et Laforest, J. P. 2000. **Évaluation des performances de croissance et des caractéristiques de carcasse des agneaux commerciaux au Québec.** Can. J. Anim. Sci. **80**: 25–33. Environ 1100 agneaux commerciaux ont été évalués dans les stations d'épreuves au Québec, à l'intérieur de 12 tests effectués entre 1992–1995. Les agneaux étaient groupés à deux par enclos et alimentés d'une moulée commerciale. La durée maximale de l'épreuve était de 112 j. Les agneaux ont été expédiés à l'abattoir à un poids de 47 ± 5 kg pour les mâles et 43 ± 4 kg pour les femelles. La prise alimentaire et les paramètres de croissance ont été évalués lors du test, et les mesures de carcasse ont été prises à l'abattage ainsi que 24 h après. La consommation alimentaire était la moyenne du parc tandis que les mesures de croissance et de la carcasse étaient prises individuellement. Les mâles ont mangé plus par jour, fait un meilleur gain et atteint le poids d'abattage à un plus jeune âge que les femelles. Les femelles étaient plus grasses et avaient une meilleure cote de conformation de la carcasse que les mâles. Cependant, les mâles n'avaient pas une épaisseur de muscle de la longe supérieure par rapport aux femelles. Les agneaux venant des béliers des races Suffolk et Hampshire ont eu un meilleur gain moyen quotidien et une carcasse moins grasse que ceux issus d'un bélier Dorset. Cependant, les agneaux des béliers Dorset ont montré des muscles de la longe semblables à ceux des agneaux des béliers Suffolk ou Hampshire. L'analyse des différents types génétiques n'a pas fait ressortir un effet trés prononcé sur les performances des agneaux. Il ne semble pas y avoir un type génétique qui surpasse clairement les autres. On doit donc considérer non seulement la race, mais aussi, à l'intérieur d'une race, la qualité intrinsèque de chaque bélier.

**Mots clés**: Agneaux, performances de croissance, composition de la carcasse



In 1996, Quebec had approximately 800 sheep producers, who marketed 30 000 heavy lambs (>36 kg liveweight) worth $3.5 million. From 1991 to 1995, lamb production in Quebec increased from 587 to 690 t per year, an increase of 18% (Hammell 1997). Crossbreeding systems used to produce lambs have the objective of increasing prolificacy, improving growth rate and dressing percentage, while providing a desirable carcass (Lirette et al. 1984). However, sheep flocks in Quebec are very heterogeneous. Also, there exist very few published reports providing information on growth performance, carcass quality and feed efficiency of crossbred lambs born from prolific and terminal meat breeds.

The former Record of Performance (ROP) or Programme d'Évaluation génétique (PEG) was implemented throughout Canada for selection purposes based on growth rates.

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**Abbreviations**: **ADG**, average daily gain; **EPD**, estimated predicted differences; **GR**, grade ruler; **PEQ**, Programme d'Évaluation génétique; **ROP**, Record of Performance

However lambs that are sold to wholesale and retail industries have never been fully evaluated for their carcass quality. France, with a larger sheep population has the "Berry test" for evaluating lambs produced in that country. The objective of the Berry test is to test progeny for their growth rate and carcass characteristics from rams previously selected in ram test stations. It is hoped to have a better knowledge of the genetic value of the selected rams. In the early 1990s, Quebec, through MAPAQ and various producer stakeholders, opened two lamb test stations in order to better evaluate growth and carcass performance of lambs, as in France. The first station located in Saint-Jean-de-Dieu started activities in the fall of 1992, while the second station in Saint-Celestin started in the fall of 1993. Feed intake, growth performance and carcass characteristics are evaluated on lambs tested in the stations. One can use the results from such a program to evaluate the influence of, for example, the sex and genotype of an animal on the productivity of lambs and to propose future production guidelines.

The objective of the present study was to evaluate the effect of sex, sire breed and various genetic types (breed combinations) on growth performance and carcass characteristics of lambs from the test stations.

## MATERIALS AND METHODS

### Description of the Tests

Approximately 1400 lambs were evaluated in the two test stations during the 12 tests in 1992–1995 (tests 1–7 of Saint-Jean-de-Dieu and 1–5 of Centre du Quebec). There were spring (April) and fall (November) tests conducted annually in both stations. From 114 to 118 lambs (Saint-Jean-de-Dieu and Centre du Quebec, respectively) coming from 9 to 14 different flocks were evaluated in each test. Lambs had to be between 45 and 75 d of age and have a minimum body weight of 14 kg in order to enter the test station. No maximum weight was set as long as the maximum age was respected. Participating producers provided the birth date, the birth weight, the number of lambs born and raised (e.g., born a triplet but raised as a twin), the breed of the sire, the genetic composition and the number of lambings of the dam. Test stations consisted of pens containing two lambs each. Within each pen, lambs were paired by same flock, same sex (female or intact males), same genetic type when possible and similar weight. Experimental conditions respected the guidelines set by the Canadian Council on Animal Care.

The evaluation started immediately on the day of entry. It was strongly recommended that lambs be weaned at least a few days before entering the test station. Both test stations had the same concentrate diets. Forage quality was also measured and was similar between the two stations. Lambs were left in their pens to acclimatize for the first 3 h. Water was immediately and freely available. A first 0.30-kg serving of hay was given after the acclimatization period. Then, 6 h later, they received a further 0.60 kg of hay. By the second day of test the hay was served ad libitum. Progressively, lambs received from 0.035 kg $d^{-1}$ to 0.270 kg $d^{-1}$ of a 17% CP starter concentrate between the 2nd and 9th days of test. From day 10 onwards the lambs received the concentrate ad libitum. The starter concentrate was given to the lambs until they reached 30 kg body weight. They were then given a 15% CP finishing concentrate until they reached target liveweight. The target liveweight at slaughter was 43 kg for females and 47 kg for males. Intuitively there was a concern that females would have too fat a carcass at 47 kg, and therefore a lower target slaughter weight was chosen. Feed given to the lambs was weighed daily and for each pen. The uneaten concentrate was weighed at the end of each week. Lambs were weighed individually, with full access to feed, at the start, at 14 d, 28 d and then every 28 d. The test lasted a maximum of 112 d. Before slaughter, lambs were weighed after restricting access to feed for 6–12 h. At the end of test, backfat and loin muscle thicknesses were measured individually with ultrasound (Krautkramer, model USM 2 F, Germany). Measurements were taken just behind the last rib at 4 cm from the midline of the back.

Lambs were removed weekly from the test station for slaughter upon reaching target weight and sent to the abattoir. Carcasses were graded in accordance with Canadian lamb carcass grading standards (Agriculture Canada 1978), whereby the skin is removed from the carcass and the head is cut at the first cervical vertebrae. The carcass contains kidneys and kidney fat and is weighed immediately after slaughter. The conformation of the hind leg, the loin and the shoulder are evaluated on the cold carcass, 24 h after slaughter. A score of 5 denotes excellent muscling, whereas a score of 1 means a marked deficiency in muscling. A global conformation score is calculated based on the addition of the hind leg, loin and shoulder scores. Carcass lean yield is calculated using warm carcass weight and GR measurement (Jones et al. 1992) (Table 1). Grade ruler measurements are taken on the carcass with a ruler on the 12th rib, 11 cm from the midline of the back. Saleable meat yield is calculated by using the GR measurement and the global conformation score, using the equation of Jones et al. (1996) (Table 1).

### Measurements and Statistical Analysis

Approximately 1100 lambs (805 males and 297 females), comprising more than 200 different "genetic types" were used in the analyses. All lambs weighing more than ±10% of the final target weight, as well as lambs with unknown genetic composition, were eliminated from the analyses. For each test, growth and carcass measurements were taken on individual animals, whereas, feed performance was averaged per pen (Table 1). Due to the design of the test stations, it was not possible to have individual pens. However, since the number of lambs per pen was low and the lambs were also similar for various factors, such as sex and size, it was assumed that the consumption of feed concentrate was a very close approximation to an individual value. It should also be noted that the consumption of hay was not included in the calculation of feed conversion, as hay refusal was not measured.

Factors of variation studied were sex, breed of ram and genetic type. The GLM procedure (General Linear Model) of the SAS Institute, Inc. (1988) was used for statistical analysis. Age and entry weight were used as covariates for growth performance, whereas warm carcass weight was

**Table 1. Measurements recorded at the test stations and abattoirs for Quebec lambs**

For each test the following dependent variables were studied:
(a) Growth performance at the test stations
- i) Feed measurements averaged for each pen of two lambs
  - Total feed intake during test (kg)
  - Daily feed intake (kg)
  - Feed conversion (calculated for concentrate only, using liveweight before slaughter: does not include hay consumption)
- ii) Measurements taken on each individual lamb
  - Age (d) and weight (kg) at the beginning of test
  - Age (d) and weight (kg) at slaughter
  - Test duration (d)
  - Average daily gain (g $d^{-1}$)
  - Backfat thickness at end of test (ultrasound, mm)
  - Loin eye thickness at end of test (ultrasound, mm)

(b) Carcass yield measurements for each lamb
  - Warm carcass weight (kg)
  - Dressing percentage = (warm carcass weight/end of test weight) × 100
  - GR measurement (mm) = 6.38 + (0.88 × TTD[z])
  - Carcass lean yield (%) = 65.80 – (0.074 × warm carcass weight) – (0.432 × GR)
  - Saleable meat yield (%) = 78.92 – 0.51 (GR) + 1.25 (global score)
  - Conformation score:
    - Hind leg
    - Loin
    - Shoulder
    - Global score

[z]TTD = Total tissue depth (mm) measured on the 12th rib.

**Table 2. Effect of sex of lamb on growth and feed consumption performances.**

| | Male | | Female | | |
|---|---|---|---|---|---|
| | N[z] | LSM[y] | N | LSM | SE[x] |
| Total feed intake during test (kg) | 269 | 93.9 | 84 | 93.2 | 0.54 |
| Daily feed intake (kg) | 269 | 1.3*a* | 84 | 1.2*b* | 0.01 |
| Feed conversion[w] | 269 | 3.8*a* | 84 | 4.2*b* | 0.03 |
| Weight at end of test (kg) | 805 | 47.0*a* | 297 | 44.1*b* | 0.04 |
| Age at slaughter (d) | 805 | 137.0*a* | 297 | 141.7*b* | 0.34 |
| Test duration (d) | 805 | 74.0*a* | 297 | 78.8*b* | 0.34 |
| Average daily gain (g $d^{-1}$) | 805 | 352.4*a* | 297 | 294.9*b* | 1.67 |
| Backfat thickness (ultrasound, mm) | 753 | 3.9*a* | 279 | 4.7*b* | 0.04 |
| Loin eye thickness (ultrasound, mm) | 753 | 31.2 | 279 | 31.5 | 0.09 |
| Warm carcass weight (kg) | 805 | 23.2*a* | 297 | 22.6*b* | 0.03 |
| Dressing percentage (%) | 805 | 49.1*a* | 297 | 52.0*b* | 0.04 |
| GR measurement (mm) | 802 | 12.5*a* | 297 | 16.9*b* | 0.09 |
| Carcass lean yield (%) | 802 | 56.6*a* | 297 | 54.9*b* | 0.03 |
| Saleable meat yield (%) | 802 | 77.1*a* | 297 | 75.2*b* | 0.05 |
| Hind leg score | 803 | 3.3 | 297 | 3.4 | 0.02 |
| Loin score | 803 | 3.9*a* | 297 | 4.2*b* | 0.02 |
| Shoulder score | 803 | 3.7*a* | 297 | 4.1*b* | 0.02 |
| Global conformation score | 803 | 3.6*a* | 297 | 4.0*b* | 0.02 |

[z]Number of lambs (or pens, when $N$ = 269 or 84).
[y]Least square means.
[x]Standard error of the mean.
[w]Feed conversion for the concentrate only, does not include hay consumption.
*a,b* Means with different letters in the same row differ ($P < 0.05$).

used as a covariate for carcass performance. Certain tests were eliminated in the statistical analysis so that each level of each source of variation (e.g., Polled Dorset, Hampshire, and Suffolk breeds for the effect of sire) was represented in all tests. Therefore, the effect of each variable (e.g., sex, breed of ram) was introduced in the model separately. Each sex was also analyzed separately (except for the analysis between the two sexes) due to the different target end weights for each sex, which created two distinct populations.

Effect of different breeds of rams bred to cross-bred ewes was analyzed (in order of decreasing number of lambs used, these were: Suffolk, Polled Dorset and Hampshire). The effect of various genetic types was also analyzed. Despite the variety of genetic types, those kept for analysis were the type of lambs most frequently entered into the test stations. They represent both breeds and crosses of these breeds that were of interest to producers and could be either found or reproduced on their farms. In conducting the analysis it was hoped to make comparisons of genetic types that would be

**Table 3. Effect of three breeds of rams on feed, growth performance and carcass characteristics of their progeny**

| | Male | | | | | | | Female | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Polled Dorset | | Hampshire | | Suffolk | | | Polled Dorset | | Hampshire | | Suffolk | | |
| | N[z] | LSM[y] | N | LSM | N | LSM | SE[x] | N | LSM | N | LSM | N | LSM | SE |
| Total feed intake during test (kg) | 64 | 94.7*a* | 41 | 90.4*b* | 103 | 91.3*ab* | 1.18 | 7 | 102.5 | 15 | 94.8 | 19 | 97.5 | 2.05 |
| Daily feed intake (kg) | 64 | 1.29*a* | 41 | 1.33*b* | 103 | 1.34*b* | 0.01 | 7 | 1.17 | 15 | 1.20 | 19 | 1.24 | 0.03 |
| Feed conversion[w] | 64 | 3.9*a* | 41 | 3.7*b* | 103 | 3.7*b* | 0.05 | 7 | 4.4 | 15 | 4.0 | 19 | 4.1 | 0.10 |
| Weight at end of test (kg) | 214 | 46.6*a* | 160 | 47.1*b* | 291 | 47.2*b* | 0.10 | 64 | 44.0 | 66 | 43.9 | 111 | 44.0 | 0.14 |
| Age at slaughter (d) | 214 | 139.4a | 160 | 133.1*b* | 291 | 132.7*b* | 0.73 | 64 | 150.9*a* | 66 | 146.6*ab* | 111 | 143.3*b* | 1.27 |
| Test duration (d) | 214 | 77.0*a* | 160 | 70.7*b* | 291 | 70.3*b* | 0.73 | 64 | 88.0*a* | 66 | 83.7*ab* | 111 | 80.5*b* | 1.27 |
| Average daily gain (g $d^{-1}$) | 214 | 332.1*a* | 160 | 363.2*b* | 291 | 368.5*b* | 3.74 | 64 | 273.4*a* | 66 | 288.0*ab* | 111 | 302.2*b* | 4.94 |
| Backfat thickness (ultrasound, mm) | 190 | 4.1*a* | 156 | 3.9*b* | 282 | 3.7*b* | 0.08 | 58 | 4.9 | 65 | 4.7 | 104 | 4.6 | 0.15 |
| Loin eye thickness (ultrasound, mm) | 190 | 31.4 | 156 | 31.1 | 291 | 31.2 | 0.19 | 58 | 30.6*f* | 65 | 32.0*g* | 104 | 31.4*fg* | 0.36 |
| Warm carcass weight (kg) | 214 | 23.2 | 160 | 23.1 | 291 | 23.2 | 0.07 | 64 | 23.0*a* | 66 | 22.3*b* | 111 | 22.5*b* | 0.12 |
| Dressing percentage (%) | 214 | 49.8*a* | 160 | 49.2*b* | 291 | 49.2*b* | 0.09 | 64 | 51.7*f* | 66 | 51.2*fg* | 111 | 51.2*g* | 0.15 |
| GR meassurement (mm) | 213 | 13.5*a* | 159 | 12.2*b* | 291 | 12.0*b* | 0.18 | 64 | 18.1*a* | 66 | 16.7*b* | 111 | 15.6*b* | 0.34 |
| Carcass lean yield (%) | 213 | 56.2*a* | 159 | 56.7*b* | 291 | 56.8*b* | 0.07 | 64 | 54.5*a* | 66 | 55.0*b* | 111 | 55.5*b* | 0.13 |
| Saleable meat yield (%) | 213 | 76.7*a* | 159 | 77.3*b* | 291 | 77.3*b* | 0.09 | 64 | 74.6*a* | 66 | 75.3*ab* | 111 | 75.7*b* | 0.17 |
| Hind leg score | 213 | 3.3 | 160 | 3.3 | 291 | 3.4 | 0.04 | 64 | 3.2 | 66 | 3.4 | 111 | 3.3 | 0.06 |
| Loin score | 213 | 4.0*a* | 160 | 3.9*ab* | 291 | 3.8*b* | 0.04 | 64 | 4.4*a* | 66 | 4.1*b* | 111 | 4.0*b* | 0.05 |
| Shoulder score | 213 | 3.7*f* | 160 | 3.7*fg* | 291 | 3.6*g* | 0.05 | 64 | 4.1*a* | 66 | 4.1*a* | 111 | 3.8*b* | 0.07 |
| Global conformation score | 213 | 3.70 | 160 | 3.67 | 291 | 3.62 | 0.04 | 64 | 3.93*f* | 66 | 3.91*fg* | 111 | 3.77*g* | 0.06 |

[z]Number of lambs (or pens, when $N$ = 64, 41, 103, 7, 15 or 19).
[y]Least square means.
[x]Standard error of the mean.
[w]Feed conversion for the concentrate only, does not include hay consumption.
*a,b* Means with different letters in the same row differ ($P < 0.05$).
*f,g* Means with different letters in the same row differ ($P < 0.10$).

**Table 4a. Pairwise comparisons of genetic types of male lambs (DP = Polled Dorset; RV = Romanov; SU = Suffolk) on their feed, growth performance and carcass characteristics**

| | Comparison 1 | | | | | Comparison 2 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 48SU16DP | | 48SU16RV | | | 48DP16RV | | 48SU16RV | | |
| | *N*[z] | LSM[y] | *N* | LSM | SE[x] | *N* | LSM | *N* | LSM | SE |
| Total feed intake during test (kg) | 17 | 83.4 | 13 | 84.6 | 2.33 | 11 | 88.5 | 16 | 95.6 | 3.22 |
| Daily feed intake (kg) | 17 | 1.28*f* | 13 | 1.37*g* | 0.02 | 11 | 1.30 | 16 | 1.35 | 0.02 |
| Feed conversion[w] | 17 | 3.5 | 13 | 3.5 | 0.10 | 11 | 4.1 | 16 | 4.2 | 0.15 |
| Weight at end of test (kg) | 41 | 47.0 | 55 | 47.1 | 0.21 | 28 | 47.0 | 44 | 47.0 | 0.20 |
| Age at slaughter (d) | 41 | 128.9 | 55 | 125.9 | 1.40 | 28 | 137.6 | 44 | 130.8 | 1.98 |
| Test duration (d) | 41 | 67.8 | 55 | 64.8 | 1.40 | 28 | 72.1 | 44 | 65.3 | 1.98 |
| Average daily gain (g $d^{-1}$) | 41 | 368.2 | 55 | 387.3 | 8.21 | 28 | 331.4 | 44 | 361.5 | 9.88 |
| Backfat thickness (ultrasound, mm) | 41 | 3.9 | 55 | 3.6 | 0.16 | 26 | 3.6 | 41 | 3.9 | 0.18 |
| Loin eye thickness (ultrasound, mm) | 41 | 31.8 | 55 | 30.9 | 0.35 | 26 | 34.4*a* | 41 | 32.4*b* | 0.33 |
| Warm carcass weight (kg) | 41 | 23.2 | 55 | 22.9 | 0.14 | 28 | 23.2 | 44 | 23.1 | 0.16 |
| Dressing percentage (%) | 41 | 49.2 | 55 | 48.8 | 0.18 | 28 | 49.5 | 44 | 49.3 | 0.19 |
| GR measurement (mm) | 41 | 12.4 | 55 | 12.3 | 0.37 | 28 | 12.6 | 44 | 12.2 | 0.44 |
| Carcass lean yield (%) | 41 | 56.6 | 55 | 56.7 | 0.14 | 28 | 56.5 | 44 | 56.7 | 0.17 |
| Saleable meat yield (%) | 41 | 77.0 | 55 | 77.3 | 0.20 | 28 | 77.0 | 44 | 76.9 | 0.23 |
| Hind leg score | 41 | 3.3 | 55 | 3.5 | 0.08 | 28 | 3.4 | 44 | 3.4 | 0.10 |
| Loin score | 41 | 3.9 | 55 | 3.8 | 0.08 | 28 | 3.8 | 44 | 3.6 | 0.09 |
| Shoulder score | 41 | 3.4 | 55 | 3.6 | 0.08 | 28 | 3.8 | 44 | 3.6 | 0.10 |
| Global conformation score | 41 | 3.5 | 55 | 3.7 | 0.07 | 28 | 3.6 | 44 | 3.4 | 0.09 |

[z]Number of lambs (or pens, when $N$ = 17, 13, 11 or 16).
[y]Least square means.
[x]Standard error of the mean.
[w]Feed conversion for the concentrate only, does not include hay consumption.
*a,b* Means with different letters in the same row differ ($P < 0.05$).
*f,g* Means with different letters in the same row differ ($P < 0.10$).



**Table 4b. Pairwise comparisons of genetic types of male lambs (DP = Polled Dorset; HA = Hampshire; RV = Romanov; SU = Suffolk) on their feed, growth performance and carcass characteristics**

| | Comparison 3 | | | | | Comparison 4 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 32SU16RV16DP | | 48SU16RV | | | 32DP16RV16SU | | 32HA16RV16SU | | |
| | *N*[z] | LSM[y] | *N* | LSM | SE[x] | *N* | LSM | *N* | LSM | SE |
| Total feed intake during test (kg) | 5 | 87.6 | 17 | 88.2 | 2.85 | 4 | 93.0 | 4 | 93.5 | 8.21 |
| Daily feed intake (kg) | 5 | 1.42 | 17 | 1.38 | 0.03 | 4 | 1.30 | 4 | 1.36 | 0.02 |
| Feed conversion[w] | 5 | 3.6 | 17 | 3.7 | 0.12 | 4 | 3.9 | 4 | 3.5 | 0.20 |
| Weight at end of test (kg) | 15 | 47.6 | 45 | 47.4 | 0.26 | 13 | 45.9 | 16 | 47.0 | 0.44 |
| Age at slaughter (d) | 15 | 123.7 | 45 | 124.5 | 1.77 | 13 | 144.3*a* | 16 | 132.7*b* | 2.11 |
| Test duration (d) | 15 | 65.1 | 45 | 66.0 | 1.77 | 13 | 81.3*a* | 16 | 69.7*b* | 2.11 |
| Average daily gain (g $d^{-1}$) | 15 | 387.9 | 45 | 387.8 | 9.72 | 13 | 318.3*a* | 16 | 377.7*b* | 10.45 |
| Backfat thickness (ultrasound, mm) | 15 | 4.4 | 45 | 4.0 | 0.24 | 13 | 4.4 | 16 | 4.3 | 0.40 |
| Loin eye thickness (ultrasound, mm) | 15 | 31.5 | 45 | 31.2 | 0.47 | 13 | 31.8 | 16 | 29.4 | 0.03 |
| Warm carcass weight (kg) | 15 | 23.6 | 45 | 23.0 | 0.17 | 13 | 23.2 | 16 | 23.0 | 0.29 |
| Dressing percentage (%) | 15 | 48.9 | 45 | 48.8 | 0.24 | 13 | 49.5 | 16 | 48.7 | 0.35 |
| GR measurement (mm) | 15 | 11.9 | 45 | 13.0 | 0.47 | 13 | 13.6 | 16 | 11.7 | 0.85 |
| Carcass lean yield (%) | 15 | 56.8 | 45 | 56.4 | 0.18 | 13 | 56.2 | 16 | 56.9 | 0.32 |
| Saleable meat yield (%) | 15 | 77.3 | 45 | 77.2 | 0.25 | 13 | 76.5 | 16 | 78.0 | 0.42 |
| Hind leg score | 15 | 3.4 | 45 | 3.5 | 0.09 | 13 | 3.1 | 16 | 3.1 | 0.15 |
| Loin score | 15 | 3.8 | 45 | 4.0 | 0.08 | 13 | 3.7 | 16 | 4.1 | 0.20 |
| Shoulder score | 15 | 3.5 | 45 | 3.8 | 0.11 | 13 | 3.9 | 16 | 4.1 | 0.19 |
| Global conformation score | 15 | 3.5*f* | 45 | 3.9*g* | 0.10 | 13 | 3.6 | 16 | 4.0 | 0.17 |

[z]Number of lambs (or pens, when $N$ = 5, 17, 4 or 4).
[y]Least square means.
[x]Standard error of the mean.
[w]Feed conversion for the concentrate only, does not include hay consumption.
*a,b* Means with different letters in the same row differ ($P < 0.05$).
*f,g* Means with different letters in the same row differ ($P < 0.10$).

of interest to the producers, in terms of comparing prolific vs. non-prolific ewes, or terminal meat breeds crossed with different hybrids of prolific ewes. Due to the low number of subjects for certain genetic types, only comparisons between male lambs were included. The composition of the various genetic types analyzed were the following: 48SU16DP vs. 48SU16RV; 48DP16RV vs. 48SU16RV; 32SU16RV16DP vs. 48SU16RV; 32DP16RV16SU vs.

**Table 5. Comparison of growth and carcass characteristics of purebred male lambs in test station for commercial lambs in Quebec**

| Characteristic | LSM[z] | StdLSM[y] | Minimum | Maximum |
|---|---|---|---|---|
| *Dorset* (N = *29*)[x] | | | | |
| Average daily gain (g $d^{-1}$) | 303.8 | 18.6 | 233.8 | 432.7 |
| GR measurement (mm) | 13.1 | 0.8 | 9.0 | 23.0 |
| Global conformation score | 3.8 | 0.1 | 3.0 | 5.0 |
| *Suffolk* (N = *14*) | | | | |
| Average daily gain (g $d^{-1}$) | 352.6 | 28.1 | 229.6 | 442.9 |
| GR measurement (mm) | 12.3 | 1.2 | 7.0 | 15.0 |
| Global conformation score | 3.5 | 0.2 | 2.0 | 4.0 |

[z]Least square means.
[y]Standard error of the least square mean.
[x]For all the variables, significant differences ($P < 0.05$) were found between Dorset and Suffolk lambs.



32HA16RV16SU. The numbers identify the proportion of each breed in 64ths for the genetic composition of the lamb; always starting with the genetic composition of the sire. The letters identify the breed of the sire first, followed by the breed or breeds making up the genetic composition of the ewe (DP = Polled Dorset; HA = Hampshire; RV = Romanov; SU = Suffolk). The ewe was considered prolific if her genetic composition had 50% or more of the Romanov breed.

## RESULTS AND DISCUSSION

### Growth Performance

*Sex*

Independent of sex, an effect ($P < 0.05$) of tests and stations was observed for the majority of the growth performance variables, but no interaction. Final test weight, age at slaughter, test duration, ADG and backfat thickness were different ($P < 0.05$) between sexes (Table 2). Male lambs ate more ($P < 0.05$) feed per day than females and had a better feed conversion. Despite a heavier final end weight, the males had a better ADG, were younger at slaughter and had less backfat. Ahmad and Davies (1986), Notter et al. (1991), and Peeters et al. (1995) also found that males had a better ADG than females. Results of Ahmad and Davies (1986) also showed a better feed conversion ratio for ram lambs compared to females.

However, in the present study, there was no significant difference between sexes for loin eye thickness. This agrees with the results of Gallivan and Hosford (1997), who also observed heavier postweaning weights, less backfat, yet no difference in ultrasonic muscle depth between male and female lambs, respectively.

*Sire Breed*

There were differences ($P < 0.05$) among tests and stations for the variables studied, but no interaction for both male and female lambs. Sire breeds influenced ($P < 0.05$) all performance variables except loin eye thickness (Table 3). Lambs from a DP sire ate less feed per day, but more in total and had a poorer feed conversion compared to lambs from HA or SU sires. There was no difference ($P > 0.05$) in feed performance for the females. Male lambs from DP sires were also lighter and similarly for both sexes, lambs from DP sires were older at slaughter, had a lower ADG on test and a greater backfat thickness; Hampshire-sired female lambs were intermediate. For the females, loin eye thickness tended to be greater ($P < 0.10$) for lambs from HA sires compared to DP sires, lambs from SU sires being intermediate.

Similarly, in the study of Sharpe et al. (1994), SU and DPXSU lambs grew faster than the other genotypes and were among the most feed efficient, while RV and RVXDP lambs were slower growing and less efficient than the other genotypes. Also, Wolf (1980) found that SU crossed lambs were heavier and younger at slaughter than DP crossed lambs.

*Genetic Type*

NON-PROLIFIC EWE VS. PROLIFIC EWE (48SU16DP VS. 48SU16RV). There was no significant difference among tests or stations for the majority of variables studied. In general, there was no significant difference ($P > 0.05$) between the two genetic types for growth performance (Table 4a). However, 48SU16DP lambs tended ($P < 0.10$) to have a lower daily feed consumption compared to 48SU16RV lambs. It seems that lambs from prolific ewes were not penalized for their growth performance.

DP RAM VS. SU RAM, CROSSED WITH A PROLIFIC EWE (48DP16RV VS. 48SU16RV). There was no significant difference among tests or stations for the variables studied. Lambs of type 48DP16RV had a greater ($P < 0.05$) loin eye thickness compared to 48SU16RV lambs (Table 4a). Although lambs sired by SU rams had superior growth performance than those sired by DP rams, means were not statistically different. Perhaps with a larger sample size, breed differences would become more apparent.

SU RAM, CROSSED WITH A PROLIFIC EWE (32SU16RV16DP VS. 48SU16RV). There was no significant difference among tests or stations for the variables studied. There was no significant difference ($P > 0.05$) between the two genetic types for growth performance (Table 4b). Lambs from these two genetic types were very similar. DP represented a relatively small part of the genetic composition of the lambs compared to SU, since both genetic types were SU-sired, which could explain the lack of a significant difference between crosses.

DP RAM VS. HA RAM, CROSSED WITH A PROLIFIC EWE (32DP16RV16SU vs. 32HA16RV16SU). There was no significant difference among tests or stations for the majority of variables studied. Lambs of type 32DP16RV16SU had a lower ADG and thus a longer test duration and were older at slaughter compared to 32HA16RV16SU lambs (Table 4b). As for the results of the analysis of sire breed, the effect of a terminal meat breed sire (HA) demonstrated better growth performance compared to using DP as a terminal breed.

## Carcass Characteristics

*Sex*

Independent of sex, an effect ($P < 0.05$) of tests and stations was observed for the majority of variables studied, but no interaction. An effect of sex ($P < 0.05$) was noted for all variables except for conformation of the hind leg (Table 2). Males had a lower GR measurement and had higher carcass lean and saleable meat yields, indicative of leaner carcasses, compared to females. However, females had a higher dressing percentage and scored better for their conformation. Correlations between global conformation score and GR measurement (0.29 and 0.36 for males and females, respectively), showed that as the GR measurement increases, so does the conformation score. This indicates that the conformation score is confounded with fatness and promotes the selection of fatter animals. Jeremiah et al. [(1993b) cited by Jeremiah (1998)] concluded that lambs being produced and marketed were too fat to be acceptable to the vast majority of Canadian consumers at the point of purchase. It is also clear from previous studies that consumers want more lean and less fat in lamb meat [reviewed by Stanford et al. (1998)]. Jones et al. (1992) found that a visual score provided the least useful prediction of carcass lean or fat. Therefore, conformation score, even though it is still widely used as a selection tool, is actually not very useful to select for lambs that would give a type of meat that is more appreciated by consumers.

Jones (1982), Ahmad and Davies (1986) and Tatum et al. (1998) also found that carcasses of males were less fat than females. In agreement with the present study, rams had a poorer dressing percentage compared to females (Ahmad and Davies 1986). Jones et al. (1996) also found that ewe carcasses generally had a lower saleable meat yield than male carcasses. Contrary to the present study, Stanford et al. (1997) did not find a difference between sexes for the overall conformation score, though they did find that females had higher loin conformation scores than males. However, in the study of Stanford et al. (1997) the conformation scores were expressed for carcasses adjusted to the same GR measurement.

*Sire Breed*

There were differences ($P < 0.05$) among tests and stations for the variables studied, but no interaction for both male and female lambs. Sire breeds influenced ($P < 0.05$) warm carcass weight, dressing percentage, GR measurement, carcass lean, saleable meat yield and loin conformation. (Table 3). Female DP-sired lambs had heavier carcasses compared to HA and SU-sired lambs. For both sexes, lambs from DP sires had a higher dressing percentage, a greater GR measurement, and poorer carcass lean, and saleable meat yields compared to lambs from HA or SU sires. Similarly, Wolfe (1980) and Kirton et al. (1995) found that DP crossed lambs had heavier and fatter carcasses compared to SU crossed lambs. Also, SU lambs had leaner carcasses and a lower dressing percentage compared to RV or RVXSU lambs (Aziz 1992). For the males, lambs from DP sires scored higher for loin conformation than lambs from SU sires, with lambs from HA being intermediate. Lambs from DP sires tended to score higher ($P$ <0 .10) for shoulder conformation than lambs from SU sires, lambs from HA sires being intermediate. This agrees with Stanford et al. (1997) who found that medium-frame breeds had higher shoulder scores than large-frame breeds, but there was no difference ($P > 0.05$) between medium-frame and large-frame breeds for the hind leg conformation score.

*Genetic Type*

NON-PROLIFIC EWE VS. PROLIFIC EWE (48SU16DP VS. 48SU16RV). There was no significant difference among tests or stations for the majority of variables studied. There was no significant difference ($P > 0.05$) between the two genetic types for carcass characteristics (Table 4a). Results showed that lambs from prolific ewes were not penalized for their carcass characteristics.

DP RAM VS. SU RAM, CROSSED WITH A PROLIFIC EWE (48DP16RV VS. 48SU16RV). There was no significant difference among tests or stations for the variables studied. There was no significant difference ($P > 0.05$) between the two genetic types for carcass characteristics (Table 4a). Surprisingly, results of the analysis did not show the superiority of the SU breed compared to DP for leaner carcasses of their offspring. Sample size might have been to small to detect breed differences.

SU RAM, CROSSED WITH A PROLIFIC EWE (32SU16RV16DP VS. 48SU16RV). There was no significant difference among tests or stations for the variables studied. Lambs of type 32SU16RV16DP tended ($P < 0.10$) to have a lower global conformation score than 48SU16RV lambs (Table 4b). As seen before for growth performance, lambs from these two genetic types were very similar. DP represented a relatively small part of the genetic composition of the lambs compared to SU, since both genetic types were SU-sired which could explain the lack of a significant difference between crosses.

DP RAM VS. HA RAM, CROSSED WITH A PROLIFIC EWE (32DP16RV16SU VS. 32HA16RV16SU). There was no significant difference among tests or stations for the majority of variables studied. There was no significant difference ($P > 0.05$) between the two genetic types for carcass characteristics (Table 4b). Although lambs sired by HA rams were expected to present better carcass characteristics compared to those sired by DP rams, it was not the case, but sample size was relatively small.

Interestingly, some lambs on test were purebred animals. Dorset and Suffolk, which are among the most popular breeds in Quebec, were therefore compared for average daily gain, GR measurement and global conformation score (Table 5). The GLM procedure (General Linear Model) of the SAS Institute, Inc. (1988) was used for statistical analysis. Large variations were found for all these traits between male lambs of the same breed, and breeds were not different on average. While the number of purebred animals is relatively small, it is believed that the lack of difference between breeds is due to the amount of variation within breed and not to sample size. Therefore, it seems that a wide genetic variation exists even within a breed for growth and carcass quality traits which complicates the evaluation of genetic types for commercial lambs.

## CONCLUSION

The data used in the present study (approximately 1100 lambs over a 4-yr period) were very heterogeneous with over 200 different genetic types. This diversity, however, is representative of lamb production in Quebec and elsewhere in Canada, with many breeds and combinations of these breeds. Despite this diversity, analyses showed that males have a faster growth rate and are less fat than females. However, males did not have a greater loin eye thickness and hind leg conformation score compared to females. Canadian genetic selection programs have only provided sheep producers with estimated predicted differences (EPDs) for growth performance. Once EPDs are created for backfat and loin eye thicknesses, sheep producers will be able to select not only for faster growing animals, but also for leaner and meatier ones. It is possible to use both sexes for lamb production, though females should be slaughtered at a lighter weight than males in order to avoid too much carcass fat. Lambs from rams of either SU or HA breeds had a faster growth rate and a leaner carcass than lambs from DP rams. However, in general, lambs from DP rams did not differ from SU or HA rams, for loin eye thickness and hind leg conformation score. One must not only consider the breed, but also the quality of the animal within each breed or combination of breeds, as indicated by the amount of variation within breed. In general, analyses of comparisons between different genetic types did not demonstrate a pronounced effect on lamb performance. However, sample size was limited. There does not seem to be one genetic type or cross that clearly surpasses all others, though there are indications of the necessity of using certain breeds for terminal crosses. Therefore, the Canadian sheep industry must design a production system in function of the target market, ensuring a meat-type terminal breed (e.g., SU or HA) to produce heavy lamb. Furthermore, animals bought or kept for reproduction, no matter what the breed or commercial system used, must be of high genetic quality. Unfortunately, for many producers there often seems to be an absence of a clear market signals, except for “not too much fat”. With other species, such as the pig, producers are given a premium for a carcass that meets certain specifications. Without a clear signal from the industry as to what type of carcass is valued, such as what weight, or how much less fat or more muscling, there will be no real incentive to select for these traits.

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