RELATIVE IMPORTANCE OF TRAITS FOR EFFICIENCY OF MARKET LAMB AND WOOL PRODUCTION IN NORTH AMERICA

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SUMMARY

A deterministic computer model was used to predict effects of genetic improvement in nine performance traits on flock feed cost per unit of empty body weight (TDN/EBW) or of carcass lean (TDN/CLN) equivalent output value from lambs, ewes and wool, when nutrient requirements for normal fleshing are supplied. Relative values used for EBW or CLN were 1.0 for market lambs, .33 for cull ewes vs 2.04 or 1.0 for clean wool. Under optimal annual lambing, a 10% trait improvement was expected to reduce TDN/EBW or CLN most (-15 to -20%) for lamb viability, -6 to -8% for litter size born, -5 to -6% for ewe fertility, -1 to -3% for mature size or growth rate and for wool growth, -1 to -2% for milk production and for earlier sexual maturity. A 10% greater leanness reduced TDN/CLN less when lambing rate was low than high (-1 vs -3%), but increased TDN/EBW by 3%. Effect of genetic change diminished at higher levels, especially for lambs born and milk. A 10% increase in length of breeding season reduced TDN/EBW only under shortened 7 or 8 mo lambing intervals and more when other reproductive traits were low (-9 to -14%) than high (-2 to -3%). The 8- and 7-mo intervals reduced TDN/EBW more for long-season sheep with low vs high reproductive rate (-35 to -45% vs -15 to -20%), but would increase costs for short season sheep by 35 to 45% vs 3 to 2%. Increased protein requirements or greater increases in non-feed than in feed cost for higher performance would mean slightly less reduction in costs than shown. Greater than US values of wool vs meat or costs of feed vs other costs would change importance of traits.

INTRODUCTION

Most effective selection to improve efficiency of production requires estimation of relative economic importance for alternative genetic changes in performance traits under relevant production-marketing systems (Hazel, 1947) obtainable from production system simulation. The deterministic Texas A & M sheep model (Blackburn and Cartwright, 1987) was adapted to simulate effects on life-cycle efficiency of lamb and wool production from different combinations of genetic, management and marketing variables (Wang and Dickerson, 1990).

MATERIAL AND METHODS

The model simulates linear growth from birth to inflection point and then asymptotic approach to average mature empty body weight, when feed intake allows normal growth. If energy and protein intake fluctuate, the animal can store fat or catabolize tissue energy. Total energy and protein requirement includes maintenance, wool growth, lean and fat gain, gestation and lactation. Feed intake can be limited by physical or physiological capacity or by availability but feed intake allows normal fleshing during all phases of reproductive cycle, except as specified. Simulation begins with 21-wk-old ewe lambs mated in optimum season at 31 wk of age. Then ewes are distributed into categories of open and of gestating with one, two, three, and four or more fetuses. After parturition, categories are dry or lactating with one, two, three and four or more lambs, and orphaned nursery lambs. After weaning, ewes and lambs remain in their separate categories for recovery and growth, until ewes are combined for next breeding.
and lambs are marketed at 30 wk of age. Numbers of animals are updated weekly for mortality. This process is repeated to 6 yr of age, when surviving ewes are marketed. Ewes are culled after any 13 mo of continuous infertility. Other management options are restricted feeding after weaning and during early gestation, creep vs no creep feeding with or without flushing before breeding, and 12-, 8- or 7-mo intervals between lambings of same ewe (Hogue, 1989).

Ranges of genetic traits simulated were 60, 70 and 80 kg mature ewe empty body weight (WMA); 66, 71 and 76% of lean in WMA (LEAN), 4.9, 7.1 and 9.3 g/day for wool growth of 60 kg WMA ewe (WOOL), 83, 87 and 90% for lamb survival (VIAB), 85, 100 and 115% of standard fertility (FERT), 0, 50 and 100% of the deviation of perfect fertility at 1 yr from standard (PREC); 72, 132 and 192 d inherent length of breeding season (BS, Dzakuma and Harris, 1989), 1.25, 2.05 and 2.85 lambs born (LB) and 1.5, 2.7 and 3.9 kg/d for milk production of 60 kg WMA ewes (MILK).

Input is total energy (TDN) and protein (CP) intake for ewes and lambs. Output is total amount of empty body weight (EBW) and carcass lean (CLN) from market lambs, plus .33 of cull ewe EBW and 2.04 or 1.0 of clean wool weight relative to EBW or CLN, respectively. Life cycle efficiency is ratio of TDN to EBW or CLN output, adjusted for change in TDN cost from increase in protein content required (Dickerson 1982; Smith et al., 1986).

RESULTS

The relative importance of traits is expressed as mean change (%) in TDN/EBW or CLN per 10% of increase over the simulated range in trait mean (Table 1), and by plotting change in TDN/EBW for the ranges simulated to show curvilinearity of response (Figure 1).

In general, increasing performance level of component traits increases output more than input, thus reducing production cost, (TDN)/EBW or CLN. Proportional reduction in cost is greatest at lower levels of genetic potentials and diminishes as performance levels increase, especially for LB and MILK. Increased leanness is beneficial only when output is evaluated as carcass lean, CLN (Table 1).

The most economically important trait was lamb viability, with effect of 10% improvement ranging from -20% when LB-1.25 to -15% when LB-2 or more. A 10% increase in fertility also reduced cost -4.5 to -6%, more when LB was 1.25. Benefit from a 10% improvement in LB was markedly greater in the lower than in the upper range of LB (-13 to -3%, averaging -6 to -8%).

Effects from a 10% increase in wool growth were nearly linear but greater when LB was low (-3%) than high (-1.2%) because wool was more of output. A 10% increase in WMA reduced TDN costs -2% only up to WMA-70 kg. A 10% increase in precocity of fertility (PREC) reduced TDN costs only -1.5 to -1.1%, less than for fertility because it applies primarily to the younger ewes. Increasing leanness by 10% had opposite linear effects on TDN/EBW and TDN/CLN, +3 and -2%, but effect on TDN/CLN was greater when LB was high than low (-2.6 vs -1.2%).

Increasing length of breeding season (BS) had no effect on cost for annual breeding in optimum season, but would reduce costs most under frequent (8- or 7-mo) lambing management and much more when other reproductive traits are low than high (-9 to -14 vs -2 to -3%). Under 12-mo lambing intervals, a 10% increase in LB reduced cost more (-6.4%) than one in FERT (-5%) or PREC (-2%). Under 8- or 7-mo lambing intervals, increasing FERT 10% was more beneficial when BS was short (-16 or -11%) than long (-4 or -3%).

For management alternatives, restricted feeding during early gestation
and after weaning did not reduce total cost of output because ewes ate more to
regain weight when unrestricted. Flushing was beneficial for restricted-fed
ewes, more for low than high LB (-6 vs -4%). Creep feeding was helpful only when
ewe’s MILK was low but LB high (-12%). Shorter 7.2 mo lambing intervals were
more efficient than 12-mo only when BS was moderate to high, and more so when
other reproductive performance was low (-28 to -44%) than high (-11 to -20%).

DISCUSSION
There are several limitations in applying the relative importance of the
traits evaluated. Since only US production-marketing situations were simulated,
changes in relative values of lambs, culled ewes and clean wool will alter the
relative importance of the traits. Also, the cost reductions presented in terms
of TDN/EBW or CLN are slightly overestimated because of required increases in
protein content, and thus cost of TDN for genetic increases in performance. Any
effects on non-feed costs from genetic increases in potential performance that
are not proportional to the required increases in TDN intake also were ignored.

The lower weaned lamb production per ewe exposed to breeding for 8-mo
lambing interval than for annual lambing in actual experimental data (Fogarty
et al., 1984) is in agreement with simulation results. Shorter lambing intervals
increased costs per unit of output for genetically short breeding season sheep
because of the lower mean fertility, and lambing rate in off-season matings, and
reduced culling for infertility when frequently mated ewes are allowed the same
13 mo of continuous infertility before culling in both systems.

<table>
<thead>
<tr>
<th>Trait</th>
<th>LB = 1.25</th>
<th>LB = 2.05</th>
<th>LB = 2.85</th>
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<tbody>
<tr>
<td></td>
<td>TDN/EBW</td>
<td>TDN/CLN</td>
<td>TDN/EBW</td>
</tr>
<tr>
<td>WMA</td>
<td>-3.4</td>
<td>-3.3</td>
<td>-0.9</td>
</tr>
<tr>
<td>LEAN</td>
<td>3.2</td>
<td>-1.2</td>
<td>2.8</td>
</tr>
<tr>
<td>WOOL</td>
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</tr>
<tr>
<td>MILK</td>
<td>-0.9</td>
<td>-1.0</td>
<td>-1.5</td>
</tr>
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</table>

WMA = 60

LB    | -7.7 | -8.1 | -6.8 | -7.4 | -6.1 | -6.9 |
| LEAN  | 2.8  | -2.3 | 3.0  | -2.0 | 3.0  | -1.7 |

BS-12 mo | -.04 | +.03 | -.04 |
8 mo    | 9.2  | 3.6  | 2.2  |
7 mo    | 13.7 | 6.6  | 2.6  |

aSee Figure 1 for range in effect of each trait and text for
definitions of traits. Increased protein required in TDN would make
reductions in cost slight less than shown, especially for LB and MILK.
bLOW:LB=1.25, FERT=.85, PREC=0; MED:LB=2.05, FERT=1.0, PREC=.5;
HIGH:LB=2.85, FERT=1.15, PREC=1.0.
cIntervals between lambings of same ewe (i.e., 12 mo, 4 mo and 73 d
between breeding periods).
Figure 1. Simulated changes in TDN/EBW (%) for genetic deviations of performance traits (%) from intermediate population means. Deviations shown for BS are for planned 7.2 mo intervals between lambings of same ewe (73 d intervals between breeding periods) at high, medium and low levels of other reproductive traits. MILK-H for LB=2.85.

The results presented provide a first approximation of the relative economic importance of traits affecting efficiency of lamb and wool production for use in developing optimal selection criteria. The simulation model can be used to evaluate differing economic values and differing breed roles in industry crossbreeding systems.

REFERENCES