Bio-economic Performance Objectives in Livestock Production

The comprehensive objective in livestock improvement surely is more efficient conversion of plant feeds into animal products useful to mankind (Byerly, 1967). The problems are to predict the future relative values of animal products and costs of inputs, and what changes in biological characteristics of animals will contribute most to reduction in costs per equivalent value unit of animal product (Lerner and Donald, 1966; Dickerson, 1970; Harris, 1970). Costs, rather than profits, are emphasized here because prices tend toward total costs per unit of production, making realized profit an illusory criterion (Melton et al., 1979). Only when product prices are assumed to remain constant do "profit" and cost per value unit of output provide equivalent rankings for economic efficiency of animal production (Moav, 1973; Brascamp et al., 1985.; Smith et al., 1986). Even then, proportional changes in the real efficiency of production are greatly exaggerated by changes in the "profit" projected for reduced costs at a fixed price per value unit of output (Dickerson, 1970, 1976, 1982).

Efficiency, in terms of cost per value-equivalent unit of output from a livestock production system, is influenced not only by the genetic potential for performance of the animals in the chosen breeding system, but also by environmental effects of climate, exposure to diseases or parasites and feed resources, by the management system and by relative prices for inputs and outputs. Thus, the expected effect of genetic changes in potential performance on efficiency of production must be estimated for the particular total production-marketing environment in which the genetic potential of the animals is expressed (Hammond, 1947). This requires computer simulation of the production-marketing system, using the best information available from past research to predict effects of alternative genetic changes and breeding systems on input costs and output value (e.g., Tess et al., 1983a). The economic weighting of component traits, especially in meat production species, will differ for terminal sire *vs* maternal breed roles in crossbreeding (e.g., Bennett et al., 1983). Thus, choice of specialized breed role in crossbreeding influences the relative economic weights for most effective within-breed selection. Also, whenever the alternatives compared differ in the time frame of inputs and/or outputs, comparisons should be based on discounted costs and returns, using net rate of interest (actual less inflation rate, Dickerson, 1976; Smith, 1978; Melton et al., 1992).

The relative economic importance of component performance traits in choosing among alternative breeds or breeding systems can be estimated from the partial regressions of efficiency (E) on genetic change *(*G*i)* in each of the component traits (b_{EG_i}), where E is cost/output unit from the specified production-marketing system (Dickerson,' 1982). These partial regressions can be estimated using computer simulation models, by evaluating effects on E from changing G for each component trait separately. Values for $\_\ b_{EG_i}$ for any component trait will decline with increasing mean genetic level for the trait (G), especially when the reduction in cost/unit of output arises from spreading fixed costs over more units of output, as for breeding female costs over more progeny or for body maintenance costs over faster growth rate. For examples of calculating economic weights of component traits, see Tess et al. (1983b) for swine and Wang and Dickerson (1991) for sheep.

If the effect of one trait is modelled to include its environmental effect on a second trait, as for effect of litter size born on viability or weaning weight in pigs, care must be taken to model effects of genetic change in the second trait with the primary trait (litter size) held constant. Then in using these partial regressions in multiple-trait index selection among breeds or breeding system, values for the second trait must be first adjusted to a constant primary trait basis, and the environmental association excluded from any estimated genetic association between the two traits used in the index construction. If accuracy of breed and breeding system evaluation is high (i.e., $h\frac{2}{x}\text{SCALESYM500} \rightarrow 1$ for breed or system means) only the partial regressions (b_{EGi}) on change in each trait breeding values ΔG_i are required to predict genetic change in efficiency, $(\Delta G_e)\left(\text{i.e., SCALESYM100}\Delta\widehat{G}_e = \sum_{i}^{n}(\text{SCALESYM100}\Delta\overline{G}_i \bullet b_{EG_I})\right)$. If heritabilities of breed or system means for traits are appreciably less than perfect $(h\frac{2}{x} < 1)$, then use of both the estimated heritabilities of trait means and the genetic and phenotypic correlations among traits also are required to construct the most accurate multiple-trait index for predicting the genetic differences in efficiency (Hazel, 1943).