Potential Indices For Calculating Economic Values For Resistance To Gastrointestinal Helminths

M.G. Gicheha[*], W. G. Joyce[†‡] and R.C. Bett[§]

Introduction

Use of incorrect economic values (EVs) in index calculation results in incorrect selection criterion and hence in suboptimal direction of selection. Appropriate economic values are important for selection within a population as well as in choices among breeds or crosses, evaluation of gene effects and for design of optimum breeding programmes (Ollivier 1986). Sivarajasingam (1995) described a method of estimating economic value for disease resistance. The method was used by Gicheha, M., Kosgey, I., Bebe, B. et al. (2005) in estimation of economic value for resistance to gastro-intestinal (GI) helminths (RES) in meat sheep using a two traits index. The current study presents economic values based on potential indices for estimating RES utilising multiple traits.

Material and methods

A method of estimating economic values for disease resistance described by Sivarajasingam (1995) was used. In that method, for a given set of assumptions, the breeding objective is matched to the expected responses in production traits and responses in these traits maximized relative to overall gains. Detailed description of the traits used in constructing alternative indices is presented in Gicheha and Bett (2009) using information from smallholder and pastoral production systems in the tropics (Kosgey, I., van Arendonk, J. and Baker, R. 2003).

Depending on the traits utilized, EVs were calculated under two different breeding objective options i.e. when response in the index trait(s) equals response from single trait selection and when index response for respective trait(s) was maximum. For example, in an index where yearling weight (YW) and litter size (LS) were utilized, four options were realized i.e. response in YW equals response from single trait selection ($R_{IYW} = R_{SYW}$), response in YW was maximum (R_{IYW} = max), response in LS equals response from single trait selection ($R_{ILS} = R_{SLS}$), and response in LS was maximum (R_{ILS} = max). Faecal egg count (FEC) was used as the indicator trait of RES (Baker, R., Mwamachi, D., Audho, E. et al. 1999). Therefore, animals were assumed to be selected for YW (kg), LS and low FEC (x1000 eggs per gram, epg). Mature ewe live weight (ELW) was considered for selection in production situations where feed resource was not limiting and against where feed available was scarce (Kosgey,

[*]Agriculture Group, Faculty of Agriculture, P.O. Box 84 Lincoln University, Lincoln 7647, Canterbury, New Zealand
[†]Pwani university College, P.O. Box 195, Kilifi, Kenya.
[‡]College of Education, University of Canterbury, Private Bag 4800, Christchurch, New Zealand
[§]Department of Animal Breeding in the Tropics and Sub-Tropics, Humboldt University of Berlin, Philippstraße 13, 10115 Berlin, Germany.

I., van Arendonk, J. and Baker, R. 2003). Responses were estimated using the selection index theory as described by (Hazel, 1943) and presented in either trait or monetary units.
Genetic and phenotypic parameters used in this study were obtained from Gicheha, M., Kosgey, I., Bebe, B. et al. (2007) and mainly came from the literature. Normally, genetic and phenotypic parameters should be obtained from experiments with the particular population used in the breeding system. Where this is difficult to achieve, estimates are usually obtained by a search from literature (Koots, K., Gibson, J., Smith, C. et al. 1994). Traits for which correlations with FEC were unavailable were assumed to be -0.05 for functional traits and -0.10 for production traits. Faecal egg count was assumed to be highly correlated with RES with a genetic correlation of -0.99. Therefore the correlation between RES and the other traits were similar to those with FEC but had positive signs.

Results and discussion

Table 1 presents the economic values, corresponding responses in each trait, overall response and accuracy of selection for all potential indices for production systems breeding for RES. Under R_{IYW} = R_{SYW} economic values for RES were US$ -0.50, 0.41, 0.35 and 1.58 for indices 1, 2, 3 and 4 respectively. They were US$ -1.11 and -1.08 for indices 2 and 3 under R_{ILS} = R_{SLS} respectively and -1.20 and -2.29 for indices 3 and 4 under R_{IELW} = R_{SELW} respectively.

Table 1: Economic values (EVs) and response to selection under different breeding options

Index[a]	EV (US$)	R_{IYW}(kg)	R_{IFEC} (epg)	R_{ILS}	R_{IELW} (kg)	R_{OVER} (US$)	r_{IH}
YW and FEC							
1 $R_{1YW} = R_{SYW}$	-0.50	1.68	0.22	-	-	1.57	0.63
2 R_{1YW} = max	0.00	1.71	0.32	-	-	1.71	0.66
YW, LS and FEC							
1 $R_{1YW} = R_{SYW}$	0.41	1.66	0.32	0.03	-	2.34	0.60
$R_{1LS} = R_{S\,LS}$	-1.11	1.49	0.06	0.03	-	2.04	0.55
2 R_{1YW} = max	0.41	1.66	0.32	0.03	-	2.34	0.60
R_{1LS} = max	-1.11	1.49	0.06	0.03	-	2.04	0.55
YW, LS, ELW and FEC							
1 $R_{1YW} = R_{SYW}$	0.35	1.65	0.31	0.03	0.13	2.34	0.59
$R_{1LS} = R_{S\,LS}$	-1.08	1.49	0.60	0.03	0.15	2.06	0.54
$R_{1ELW} = R_{S\,ELW}$	-1.20	1.50	0.04	0.03	0.15	2.06	0.53
2 R_{1YW} = max	0.35	1.65	0.31	0.03	0.13	2.34	0.59
R_{1LS} = max	-1.07	1.49	0.60	0.03	0.15	2.06	0.54
R_{1ELW} = max	-1.20	1.50	0.04	0.03	0.15	2.06	0.53

[a]See text for description of indices, r_{IH} = accuracy of selection.

Under R_{IYW} = max economic values were US$ 0.00, 0.41, 0.35 and -0.02 for indices 1, 2, 3 and 4 respectively. Under R_{ILS} = max economic values were US$ -1.11 and -1.07 for indices 2 and 3 respectively. They were US$ -1.20 and -2.29 under R_{IELW} = max for indices 3 and 4 respectively. In breeding for RES, selection for animals having the highest indices would create some improvement for RES because of the positive genetic correlation between RES and production traits. It may be possible to use selection indices to breed for animals which are both resistant to infection and have good productivity characteristics under prolonged periods of untreated challenge (Bisset, S., Vlassoff, A., Morris, C. et al. 1994).

Indices that incorporated ELW resulted in a decreased r_{IH} and R_{OVER}. For instance, increasing ELW by 0.15 as opposed by 0.13 kg resulted in 8.47 and 11.97% decreases in r_{IH} and R_{OVER} respectively. This shows that, even in production systems where feed is non-limiting as is the case with pastoral production in the tropics during wet seasons (Kosgey, I., van Arendonk, J. and Baker, R. 2003), benefits obtained from selecting for bigger ewes do not directly translate to increased productivity as the animal loses more weight compared to its lighter contemporaries during dry seasons and thus takes longer time to recover before transferring the benefits to lamb growth.

In all indices, response in LS was low (0.03), this imply that LS would be more improved through manipulation of the production environment than selection. Female reproductive traits are highly influenced by the environment (Koots, K., Gibson, J., Smith, C. et al. 1994). For instance, basing selection on maximum response in LS in an index that considers YW, LS, ELW and FEC would result in a 12.86 and 16.67% accompanying decreases in responses in YW and r_{IH}.

Indices targeting to maximise response in YW (R_{IYW} = max) resulted in an increase in response in FEC. In resource constrained smallholder and pastoral systems in the tropics, the objective of breeding for RES would be to increase responses in YW and LS and reduce subsequent positive response in FEC (Gicheha, M., Kosgey, I., Bebe, B. et al. 2007) while in high-input systems such as is the case with most New Zealand farms, the goal would be to reduce the present levels of drench use without compromising sheep health and productivity, assisting in extending the life of anthelmintics, managing anthelmintic resistance (Bisset, S., Vlassoff, A., Morris, C. et al. 1994) and reducing the cost of production (Brunsdon 1988). Utilisation of different values for RES as represented by alternative indices would result from differences in the aim of incorporating RES in the breeding objective.

Conclusion

Optimising the expected response in production traits relative to the overall gain in production systems breeding for RES is achievable through utilisation of traits considered important in a particular system. Different indices result in alternative EVs for RES based on the traits considered in a particular index construction. The choice of index suitable for estimating economic value for RES is dependent on the reason for incorporating RES in the breeding objective. Therefore choice of index should be dictated by the production system and the economic importance placed on different breeding objective traits.

References

Baker, R., Mwamachi, D., Audho, E. *et al.* (1999). *Anim. Sci.* 69: 335-344.

Bisset, S., Vlassoff, A, Morris, C. *et al.* (1994). *NZ J. Agric. Res*. 35: 51-58.

Brudson, R.V. (1988). NZ Soc. parasit. Misc. Pub. 1: 4-16. 44: 745-754.

Gicheha, M.G. and Bett, R.C. (2010). *Trop. Anim. Healt. Prod.* 42: 391-396.

Gicheha, M., Kosgey, I., Bebe, B. *et al.* (2007). *Small Rum*. *Res.* 69: 167-179.

Gicheha, M., Kosgey, I., Bebe, B. *et al.* (2005). *J. Anim. Breed. Genet.* 122: 165-171.

Hazel, R. (1943). *Genet.* 28: 476-490.

Koots, K.., Gibson, J., Smith, C. *et al.* (1994). *Anim. Breed. Abstr.* 62: 309-338.

Kosgey, I., van Arendonk, J. and Baker, R. (2003). *Small Rum. Res.* 50: 187-202.

Ollivier, L., (1986) *Third WCGALP*, Nebr, X, P.

Sivarajasingam, S. (1995). In *Proc. Austral. Assoc. Anim. Breed. Genet.* Roseworthy, Australia, 65-69.