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Application of risk-rated profit model function in estimation of economic values for indigenous chicken breeding

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Introduction

Development of breeding objectives is the first step in genetic improvement as it defines the direction of selection and genetic merits of performance traits (BETT ET AL. 2011b). Breeding objectives should comprise of traits which influence profitability and should be developed in consultation with all the stakeholders along the production value chain (REWE ET AL. 2006). Definitions of breeding objectives involve identification of traits of economic importance to producers and estimation of their economic values (EVs). The traits of economic importance for indigenous chicken (IC) in Kenya have been identified (OKENO ET AL. 2010) but their EVs have not been estimated. Economic values for poultry are scarce and the few available are for commercial chicken and not IC (JIANG ET AL. 1998). These EVs cannot be used to develop breeding objectives for IC because EVs vary with evaluation models, production systems, species, breeds, production constraints and time frame (JIANG ET AL. 1998; REWE ET AL. 2006). The aim of this study was therefore to derive EVs for traits of economic importance for IC raised under different production systems in Kenya using risk-rated profit model function.

Material and Methods

The study employed the bio-economic model developed by OKENO ET AL. (2011). In that model, three production systems namely; free range system (FRS), semi-intensive system (SIS) and intensive systems (IS) were considered. The model used risk-rated profit model function to

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account for imperfect knowledge concerning risk attitudes of farmers and economic dynamics of input and output variables. It considered traits which were highly ranked by farmers, marketers and consumers as traits of economic importance (OKENO ET AL. 2010). They included, egg number (EN), average daily gain (ADG), live weight at 21 weeks (LW), mature weight (MW), fertility (FER), hatchability (HA), broodiness (BRD), survival rate (SR), feed intake (FI) and egg weight (EW). The EVs were derived based on a fixed-flock size and fixed-feed resource production circumstances. Fixed-flock size represented a situation where the chicken population could not be increased because of other production constraints apart from feeds. The risk-rated EVs (EVr_{fixed_flock}) assuming fixed-flock size production circumstance was estimated as:

$$EVr_{fixed-flock} = \Delta P_r / \Delta g \quad (1)$$

where ΔP_r and Δg are marginal changes in risk-rated profits and genetic merit of a trait respectively, after an increase in the genetic merit of a trait of interest by one unit. The risk-rated profit (P_r) was computed as:

$$P_r = \left\langle \mu_{po} \int (g,e) - e\mu_{pi} \right\rangle - \left\langle 0.5\lambda Var\left(\mu_{po} \int (g,e) - e\mu_{pi}\right) \right\rangle \quad (2)$$

where μ_{po} and μ_{pi} are the expected prices of output and inputs, respectively, g, the vector of genetic traits, e the vector of the inputs and λ the Arrow-Pratt coefficient of absolute risk aversion. The λ of 0.0001 and 0.02 were used because such values are scarce and complex to estimate (BETT ET AL. 2011b). The input and output price variances and co-variances for the period 2006 to 2010 adjusted for base year 2001 was assumed.

The fixed-feed resource production circumstances represented a scenario where flock size could not be increased due to lack of feed resources. The EVs assuming this production circumstance was estimated as:

$$EVr_{fixed-feed} = \left(\Delta P_r / \Delta g \right) - \left(\frac{\Delta FI}{\Delta g} \times P_r / FI \right) \quad (3)$$

where FI and ΔFI are the feed intake per hen per year before genetic improvement and marginal change in feed intake per hen after genetic improvement, respectively.

Results and Discussion

Traditional and risk-rated EVs for traits in the breeding objective assuming fixed-flock size production circumstance are presented in Table 1. The traditional EVs (EV_t) were higher than risk-rated EVs (EV_r). The differences were comparable when λ= 0.0001 but more pronounced when λ =0.02. The differences ranged between -33.33 to +27.18%, -47.26 to +39.40%, and -15.00 to +67.11% in FRS, SIS and IS, respectively. The large variance in EVs when the two models were compared indicates that not accounting for risks overestimates EVs. The difference of -47.26 to 67.11% observed in the current study concurs with previous study which compared the two models (BETT ET AL. 2011b).

Table 1. Economic values in Kenya Shillings (KSh) per hen per unit increase in genetic merit of traits in the breeding objective assuming fixed flock size in the three production systems

Traits[a]	Free range system			Semi-intensive system			Intensive system		
	[b]EV_t	[c]EV_r		EV_t	EV_r		EV_t	EV_r	
		λ=0.0001[d]	λ=0.02[d]		λ=0.0001	λ=0.02		λ=0.0001	λ=0.02
EN	10.64	10.43	9.08	9.89	9.89	8.97	9.78	9.78	8.87
EW	-0.004	-0.004	-0.003	-0.005	-0.005	-0.004	-0.06	-0.06	-0.05
BRD	-1.48	-1.47	-1.33	-2.96	-2.95	-2.01	-7.40	-7.40	-6.66
SR	19.38	19.37	17.41	16.13	16.12	14.22	9.00	8.97	7.85
ADG	29.86	29.86	26.73	24.54	24.53	23.09	19.29	19.29	18.46
LW	86.11	86.06	77.49	82.32	82.28	74.09	79.40	79.37	73.46
MW	-42.94	-42.92	-38.65	-70.28	-70.24	-63.26	-95.91	-95.87	-83.42
FER	19.23	19.22	17.31	15.66	15.64	14.08	10.06	10.06	9.05
HA	16.63	16.62	14.97	13.53	13.52	12.17	8.70	8.70	7.83
FI	-0.25	-0.25	-0.22	-2.42	-2.42	-2.08	-6.85	-6.85	-6.17

[a]EN, egg number; EW, egg weight; BRD, broodiness; SR, survival rate; ADG, average daily gain; LW, live weight at 21 weeks; MW, mature weight; FER, fertility; HA, hatchability; FI, feed intake: [b]EV_t, economic values estimated using profit model: [c]EV_r, economic values estimated using risk-rated profit model: [d]Arrow-Pratt coefficient of absolute risk aversion

The EVs were higher under FRS and decreased with intensification. For instance, the EV_t for EN were KSh. 10.64, 9.89, and 9.79 with corresponding EV_r (assuming λ=0.02) of KSh. 9.08, 8.97 and 8.87 for FRS, SIS and IS, respectively (Table 1). This could be explained by low costs of production in FRS compared to SIS and IS which are capital intensive. Influences of production systems and marketing strategies on EVs have been reported in ruminants (REWE ET AL. 2006). The EVs for EN, ADG, LW, SR, FER and HA were positive. This indicates that improvement targeting these traits would result in a positive impact on profitability of production system. Improved EN combined with high FER, HA and SR would results in more eggs for hatching and more growers surviving to market age. Since the market demand for heavy chicken (BETT ET AL. 2011a) improved LW will help famers fetch high prices. The negative EVs for MW, EW, BRD and FI were expected because increasing their genetic merit had direct impact on increased feed consumption. Positive EVs for EN, LW, ADG FER and HA have been reported in the literature (JIANG ET AL. 1998; BETT ET AL., 2011b) while negative EVs for MW and FI have also been documented (JIANG ET AL. 1998; REWE ET AL. 2006).

The EV_t and EV_r for traits in the breeding objective, assuming fixed-feed resource, are presented in Table 2. In this analysis, only EVs for EN, ADG, LW, MW and EW differed from those estimated under fixed-flock size (Table 1). The EVs under fixed-feed resource were higher than those reported under fixed-flock size in all the production systems.

Table 2. Economic values in Kenya Shillings (KSh) per hen per unit increase in genetic merit of traits in the breeding objective assuming fixed-feed resource production circumstance in the three production systems

Traits[a]	Free range system			Semi-intensive system			Intensive system		
	[b]EV_t	[c]EV_r		EV_t	EV_r		EV_t	EV_r	
		λ=0.0001[d]	λ=0.02[d]		λ=0.0001	λ=0.02		λ=0.0001	λ=0.02
EN	11.41	11.38	10.72	10.63	10.61	9.86	10.40	10.39	9.07
EW	-0.002	-0.002	-0.002	-0.005	-0.005	-0.004	-0.04	-0.04	-0.04
ADG	41.70	41.70	38.80	33.50	33.43	28.91	21.38	21.34	19.21
LW	88.25	88.06	87.66	86.51	86.50	82.31	81.41	81.34	74.01
MW	-40.59	-40.57	-38.29	-69.92	-69.891	-62.89	-92.07	-91.92	-79.97

[a]EN, egg number; EW, egg weight; ADG, average daily gain; LW, live weight at 21 weeks and MW, mature weight: [b]EV_t, economic values estimated using profit model: [c]EV_r, economic values estimated using risk-rated profit model: [d]Arrow-Pratt coefficient of absolute risk aversion

For example, the EV_r (assuming λ=0.02) for EN were KSh. 10.72, 9.86 and 9.07 for FRS, SIS and IS, respectively (Table 2) compared to their corresponding EV_r KSh. 9.08, 8.97 and 8.87 under fixed-flock size (Table 1).This could be explained by the fact that feed consumption which constitute 70% (OKENO ET AL. 2011) of production costs was assumed to be fixed even after genetic improvement**.**

Conclusions and Outlook

The findings of this study provide important information on traits to be included in the breeding objective for improvement of IC. The positive EVs for EN, ADG, LW, FER, HA, and SR suggests that their genetic improvement will have a positive impact on the profitability of IC production. Using the risk-rated EVs obtained in this study there is need to develop breeding objective for genetic improvement of IC.

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