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Relative economic value estimates of grasscutter production traits

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The study was conducted to estimate relative economic values (REVs) of survival, body weight, growth rate, reproduction, docility and food intake. Data were obtained from records of grasscutters (*Thryonomys swinderianus*) kept at the grasscutter section of the Department of Animal Science Education, University of Education, Winneba, Ghana. Average values of production inputs and outputs parameters were computed from records of 502 kids born between 2006 and 2010. Relative economic values of traits were computed by using computer models in Microsoft Excel spreadsheet of Windows 2007. When feed intake was included in the breeding objective and economic evaluation was based on genetic standard deviation, mature body weight emerged as the most important trait. Ranking order of traits was body weight > survival > reproduction > growth rate > feed intake > docility. The ranking order was maintained when feed cost was set to zero. The use of coefficient of variation to estimate REVs changed the ranking order of traits: Growth rate > reproduction > docility > survival > body weight > feed intake. It was concluded that post-weaning growth rate, litter size at weaning and docility should be selected to be included in the breeding objective of grasscutter breeding programmes in Ghana.

Key words: Breeding objective, docility, food intake, growth traits, reproduction, survival.

INTRODUCTION

The idea of domesticating wild animal (game) species for meat production to improve dietary protein supply in Africa is not new (FAO, 1990; Mensah, 2000; Achana, 2002; Hanotte and Mensah, 2002). Domestication of wild species has been particularly popular in the West Africa sub-region where bush meat is an important dietary item (Asibey, 1966). For many rural people in the West African sub-region, game meat (known as “bushmeat”) is a highly valued forest product (FAO, 1990). Game is important source of meat in both rural and urban

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household diets. Conservationists and advocates of wild animal domestication (Achana, 2002) have argued for the farming of favourite species to increase bushmeat production and supply in the West African sub-region, and to reduce pressure on wild populations. Wild animal species advocated for farming include the grasscutter (*Thryonomys swinderianus),* giant rat (*Cricetomys gambianus*) and African giant snail (*Achatina achatina)* (NRC, 1991). In West Africa where grass provides its main habitat and food, the animal is commonly known as the “grasscutter” or “cutting grass” while in other parts of Africa, particularly Southern Africa, where it is closely associated with cane fields, it is known as “cane rat” (NRC, 1991).

Grasscutters are widespread and abundant across West Africa, and are a common source of food among rural populations. Ghanaians are farming the grasscutter for food. In 2009 the population of domesticated grasscutter was 17,400 (Annor et al., 2009). Ghana is in the process of establishing an Open Nucleus Breeding Scheme for genetic improvement of captive grasscutters (MoFA, 2004). There is a well-established series of logical steps to follow in designing animal breeding improvement programmes (Harris et al., 1984; Harris and Newman, 1994). The first step is to identify planned production, processing and marketing system (s). Using this information, economic merit for individual traits can be defined and subsequently breeding objectives for the species concerned (Morris et al., 1978). Thus, traits which should be improved have to be identified and their relative economic importance established.

Economic value of a trait is defined as the income per animal per unit of improvement in genetic merit for that trait, at constant levels of genetic merit for other traits in the breeding goal (Groen and Van Arendonk, 1996). It expresses the extent to which economic efficiency of production is improved for a given unit of genetic superiority of a trait. It is useful to know economic values of various traits relative to each other; hence the term relative economic value (REV) is commonly used (Blair, 1989). Relative Economic Values are needed to define breeding objectives whereby greater importance may be given to traits of higher economic merits (Morris et al., 1978). Economic values have been calculated for cattle (Annor et al., 2000) and sheep (Annor et al., 2007) in Ghana. However, there is lack of information on REVs of grasscutter production traits in the literature.

The objective of this work was to estimate relative economic values of survival, body weight, growth rate, reproduction, docility and food intake of grasscutter (*Thryonomys swinderianus*) production as a first step towards defining breeding objective for the grasscutter industry in Ghana.

METHODOLOGY

Data were obtained from records of grasscutters kept at the grasscutter section of the Department of Animal Science Education, University of Education, Winneba, Ghana, from 2006-2010. The derivation of REVs followed the following five steps:

1. Specification of breeding, production and marketing systems
2. Identification of sources of income and expenses
3. Determination of biological traits influencing income and expenses
4. Calculation of economic value (EV) of each trait
5. Calculation of REVs of traits

Specification of breeding, production and marketing system

Computer models were developed for the life cycle production of a family of grasscutter and the growth performance of their offspring. The family consisted of 4 breeding does and 1 breeding buck. Models were developed in Microsoft Excel spreadsheet of Windows 2007. Model calculations were based on complete life cycle of the breeding doe, which lasted for 60 months (Figure 1). Input and output parameters (Table 1) used in models were estimated from records of 502 kids born between 2006 and 2010. Model output consisted of profit derived from sale of mature bucks, does, and culled does (Figure 1).

Five classes of animals were considered in the model flow diagram: neonates (pre-weaners), young does, young bucks, breeding does and breeding bucks. Surplus does and all bucks were sold for consumption at 12 months old. Although most farmers sell whole carcass (live or slaughtered) to consumers without weighing, average sale price of a unit live weight was computed for the purposes of this study (Table 1).

Culled does and bucks were disposed off at 90% of the expected weight of marketed does and bucks, respectively to compensate for wastage resulting from old age (Morris, 1980). Average life cycle of a breeding doe ended at 60 months and age at first parturition was 11.9 months. Young does were mated for the first time at 6.9 months. Mortality was considered at the pre- and post-weaning stages, and in the breeding doe herd.

Doe replacement rate was 16.7%. This covered culling of old and unproductive does (14.6%) and also accounted for 2.1% mortality rate in breeding does. Breeding bucks were replaced at about 18 months of age when their female offspring were mature for mating. Replacement bucks were bought from outside and culled bucks were sold off. This means that mortality in breeding bucks was assumed to be zero.

Feed was provided in the form of elephant grass (*Pennisetum purpureum*), harvested freely from the rangeland by one labourer. It was assumed that the labourer spent only 2 h per day on the animals. Supplementary feed was provided in the form of concentrate (mixture of wheat bran, maize, oyster shell, common salt and vitamin-mineral-premix). Supplementary feed was provided to breeding does from birth to weaning and in a two weeks flushing period. Breeding bucks were given supplementary feed during a two week flushing period before mating. Feed (grass) costs were assumed to be zero (except compounded feed supplements) as grass was harvested free from the rangeland using costed labour. Costed labour also included cleaning of cages every morning. Treatment of sick animals against injuries and diseases was carried out by a veterinary officer. There was no cost associated with the marketing of animals because animals were sold at the farm gate.

Identification of sources of income and expenses

Profit was defined as the difference between income and expense. Income was derived from sale of surplus bucks and does, and culled does. In each class of animals, income was calculated as the sum of the product of number of animals sold and price per

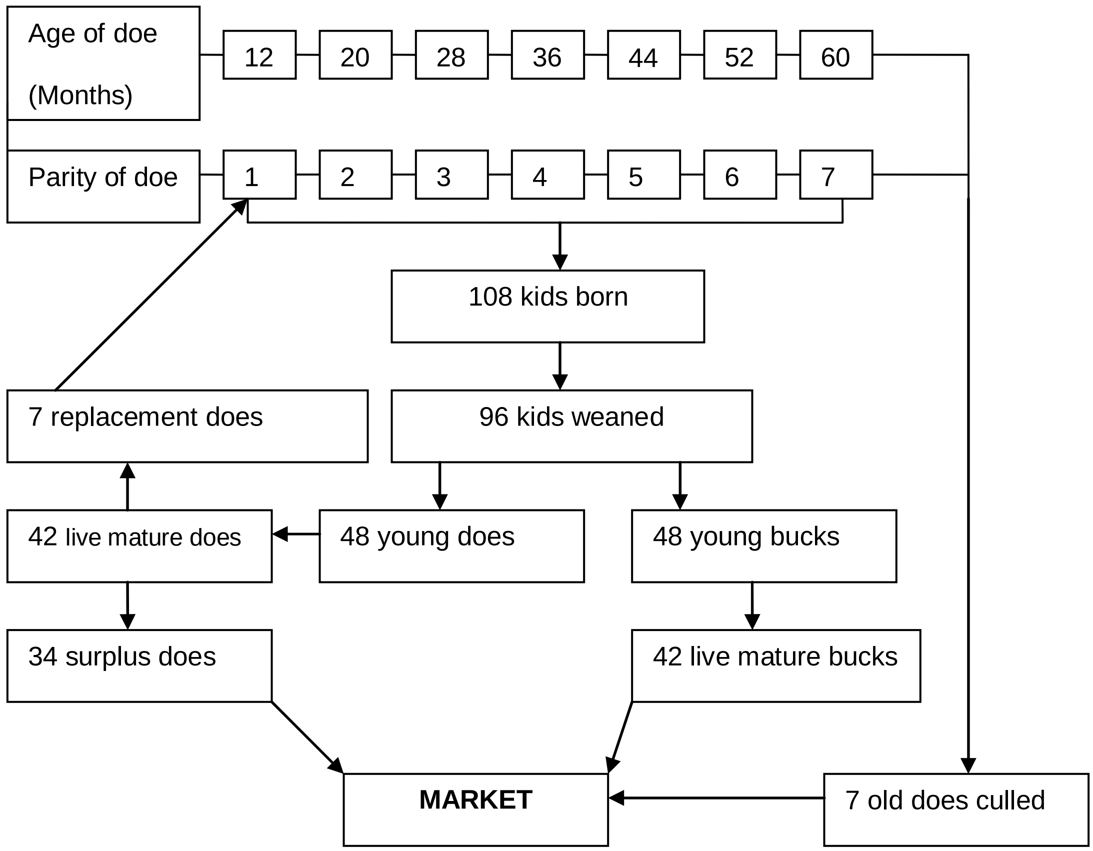

Figure 1. Model flow diagram for 4 does and their offspring derived from average values of all traits.

individual. Expenses were derived from supplementary feed, veterinary service charges and drugs, and fixed costs (breeding stock, cages, labour, equipment and stationery).

Determination of biological traits influencing income and expenses

The life cycle model was used to estimate the economic values of the following traits:

1. Survival (PRS, POWS)
2. Reproduction (AFP, LSB, PI)
3. Body weight (blBWT, dlBWT, blWWT, dlWWT, bMWT, dMWT)
4. Growth rate (blPWDG, dlPWDG, bPODG, dPODG)
5. Food intake (BLFI, DLFI, YBFI, YDFI)
6. Behavioural (Docility)

The acronyms of the traits specified above have been defined in Table 1. Individual traits assumed to have effect on either income or expenses are presented in Table 2.

Calculation of economic value of each trait

A partial budgeting approach was used to calculate economic values of traits (Barwick, 1992; Barwick and Fuscs, 1992). It involved combining income and expense as a function of profit. Economic value of a trait was defined as marginal profit per doe per year resulting from a one unit increase or decreases in the value of each trait, under the condition that performance levels of all other traits were held constant, at their mean values (Upton et al., 1988; Ponzoni and Newman, 1989). For example, if P is profit of breeding does in a herd and P^1 is the profit after increment of average value of a trait by one unit, then economic value of that particular trait is the difference between P and P^1.

Profit (P in Ghana Cedis, GH¢) was expressed as a function of traits in the breeding objectives as follows:

$$P = \sum_{i=1}^{m} ni(Vi - Ci)Xi - K$$

Where, m is the number of animal classes in the profit function, n is the number of expressions for a trait in the i^{th} class of animal, V is the revenue per unit, C the cost per unit for trait X, and K is fixed cost (Bekman and Van Arendonk, 1993). At the time of preparing the manuscript 1.45 GH¢ was equivalent to 1.00 US$ (BOG, 2010).

Combined life cycle profit was scaled down from a life time profit to a per doe per year basis by dividing total profit by total number of years in which a doe completed her entire life cycle. All costs and returns were discounted, taking into account the time of expression of traits (Smith, 1978) at a discount rate of 13.5% (BOG, 2010).

Economic value of docility was derived without using the above procedure (partial budgeting approach) because under the prevailing grasscutter production system, docility is neither connected to cost of production nor returns from production. Docility was defined as the ability of an animal to accept human presence.

The capacity of the animal to accept human presence was

Table 1. Assumptions used to construct grasscutter model.

Parameter	Acronym	Value
Flock structure		
Number of breeding does	Nd	4
Number of breeding bucks	Nb	1
Age at first parturition (months)	AFP	11.9
Doe fertility rate (%)	DFR	0.90
Length of life cycle of does (months)	LDoCyc	60
Number of parturitions/doe/lifetime	PartLife	7.0
Parturition interval (months)	PI	8.2
Survival rate from birth to weaning (%)	PRS	84.4
Survival rate from weaning to maturity (%)	POWS	85.0
Survival rate in doe flock (%)	SDF	97.9
Production variable		
Litter size at birth	LSB	3.9
Birth weight of buck kids (g)	blBWT	127.2
Birth weight of doe kids (g)	dlBWT	124.3
Weaning weight of buck kids (g)	blWWT	580.4
Weaning weight of doe kids (g)	dlWWT	555.7
Mature weight of bucks (g)	bMWT	2750.8
Mature weight of does (g)	dMWT	2442.7
Weight of breeding does (g)	bdWT	2,855.4
Weight of breeding buck (g)	bbWT	4,064.8
Pre-weaning daily gain of buck kids (g/day)	blPWDG	7.5
Pre-weaning daily gain of doe kids (g/day)	dlPWDG	7.2
Post-weaning daily gain of young bucks (g/day)	bPODG	7.2
Post-weaning daily gain of young does (g/day)	dPODG	6.3
Management variable		
Days from birth to weaning	DBW	60
Days from weaning to maturity	DWM	300
Days from weaning to mating of does	DWMD	14
Days for flushing breeding buck	DWMT	14
Days from birth to start of feed intake	DBSFI	14
Days from weaning to 4 months	DWFM	60
Number of three-tier cages used	CageNum	2
Buck kids pre-weaning intake of supplementary feed (g/kgW^0.75)	BLFI	0.022
Doe kids pre-weaning intake of supplementary feed (g/kgW^0.75)	DLFI	0.020
Post-weaning intake of supplementary feed by young bucks (g/kgW^0.75)	YBFI	0.045
Post-weaning intake of supplementary feed by young does (g/kgW^0.75)	YDFI	0.040
Supplementary feed intake by lactating does (g/kgW^0.75)	DOFI	0.065
Supplementary feed intake by breeding bucks (g/kgW^0.75)	BBFI	0.080
Costs and returns variable		
Purchase price of breeding buck (GH¢/animal)	pbBuck	35
Purchase price of breeding doe (GH¢/animal)	pbDoe	35
Cost/g supplementary feed (GH¢/g)	cgmFeed	4.87×10^{-3}

Table 1. Contd.

Cost of one three-tier cage (GH¢)	CosTier	200
Equipment cost per cage (GH¢)	Equip	12.80
Labour cost/head/day (GH¢)	LabDaySh	0.63
Annual cost of stationery (GH¢)	StationCost	2.50
Pre-weaning cost of veterinary services charges and drugs/animal (GH¢)	VetPreChar	0.06
Post-weaning cost of veterinary services charges and drugs/animal (GH¢)	VetPostChar	0.32
Selling price per g male grasscutter (GH¢)	gmPriceM	0.02
Selling price per g female grasscutter (GH¢)	gmPriceF	0.02
Discount rate (%)	d	13.5

Table 2. Biological traits influencing income and expenses.

Product or activity	Class of grasscutter	Traits in breeding objective[a]
Income		
Surplus progeny	Does	LSB, AFP, PI, PRS, POWS, dlBWT, dlPWDG, dPODG
Surplus progeny	Bucks	LSB, AFP, PI, PRS, POWS, blBWT, blPWDG, bPODG
Culled does	Breeding does	AFP, PI, dlBWT, dlPWDG, dPODG
Expenses		
Food intake	Surplus does	LSB, AFP, PI, PRS, DLFI, dlBWT, dlWWT, dMWT, YDFI
	Surplus bucks	LSB, AFP, PI, PRS, BLFI, blBWT, blWWT, bMWT, YBFI
	Breeding does	dMWT
	Breeding bucks	bMWT
Veterinary service charges and drugs	Surplus does	LSB, AFP, PI, PRS
	Surplus bucks	LSB, AFP, PI, PRS
	Breeding does	LSB
	Breeding bucks	LSB

[a]Acronyms of traits are defined in Table 1.

scored on a scale of 1 to 4 as follows:

1. Score 1: Docile - means that the animal is friendly and accepts to be touched and caressed.
2. Score 2: Flighty - means that the animal accepts to be touched but moves away slowly.
3. Score 3: Restless - means the animal does not allow to be touched, stays away and move around in the cage.
4. Score 4: Aggressive - means that the animal jumps when it sees somebody in an attempt to escape. It hits itself on the sides of the cage.

A docility test was carried out on 321 animals (162 females and 159 males) that were selected at random. Economic value of docility was derived by using regression analysis (Schroeder et al., 1992; Amer, 1994). An assumption was made that farmers will have to pay a premium price for buying docile animals in future. Farmers paid additional GH¢3.00, GH¢2.00, GH¢1.00 and GH¢0.00 to current average selling price if they are buying an animal with docility score of 1, 2, 3 and 4, respectively. Prices of animals were regressed on docility scores to compute economic value of docility (SAS, 2008).

Calculation of relative economic value of each trait

Relative Economic Value for each trait expressed as a percentage of total selection emphasis was calculated by multiplying discounted economic value by genetic standard deviation of the trait and then dividing each individual value by the sum of the absolute values of all traits (Wilder and van Vleck, 1988; Jagannatha et al., 1998; Wolfava et al., 2005; Eady and Garreau, 2008). The result was converted into percentage by multiplying by 100. A sensitivity analysis was carried out on relative economic values to find the effect of removing feed cost from the model. This was done because most grasscutter farmers in Ghana feed only grass to their animals. Grass is harvested free of charge from the rangeland. Another sensitivity analysis was carried out to find out the effect of using genetic coefficient of variation (CV_g) in computing REVs, instead of genetic standard deviation. Data on genetic standard deviation co-efficient of variation of traits were obtained

Table 3. Relative economic values of traits when feed intake was included in objective.

Trait[a]	Units	Non discounted EV (GH¢)	Discounted EV (GH¢)	Genetic standard deviation	REV (%)
PRS	%	1.67	1.47	5.95	7.19
POWS	%	1.81	1.59	3.03	3.97
AFP	Months	0.35	0.31	0.45	0.11
LSB	Number	1.67	1.47	0.32	0.38
PI	Months	1.43	1.11	2.79	2.55
blBWT	g	0.04	0.04	16.83	0.49
dlBWT	g	0.04	0.04	16.83	0.49
blWWT	g	0.22	0.19	120.00	19.09
dlWWT	g	0.20	0.18	120.00	17.36
bMWT	g	0.09	0.08	324.15	21.10
dMWT	g	0.10	0.09	324.15	23.44
blPWDG	g/day	0.16	0.14	1.30	0.15
dlPWDG	g/day	0.15	0.13	1.30	0.14
bPODG	g/day	0.75	0.66	2.61	1.41
dPODG	g/day	0.64	0.56	2.61	1.21
BLFI	g/kgW$^{0.75}$	-0.01	-0.01	4.86	0.04
DLFI	g/kgW$^{0.75}$	-0.01	-0.01	4.86	0.04
YBFI	g/kgW$^{0.75}$	-0.07	-0.06	4.86	0.24
YDFI	g/kgW$^{0.75}$	-0.06	-0.05	4.86	0.20
DOC	Number	0.87	0.77	0.63	0.40
Total					**100.0**

[a]Acronyms of traits are defined in Table 1; Economic Value (EV); Ghana Cedis (GH¢); Relative Economic Value (REV).

from Annor et al. (2012a).

RESULTS

REVs when feed cost was considered

Results obtained for REVs of traits are presented in Table 3. REV of pre-weaning survival (PRS) was higher than that of post-weaning survival (POWS). This means that PRS was more important than POWS.

Among reproductive traits, parturition interval (PI) was the most important trait, whilst age at first parturition (AFP) was the least important. Mature body weight of males (bMWT) and females (dMWT) were the most important body weight traits and birth weights (blBWT and dlBWT) were the least important. REVs of growth from birth to weaning (blPWDG and dlPWDG) were small compared with those for the post-weaning (bPODG and dPODG) period. Young buck feed intake (YBFI) and young doe feed intake (YDFI) were more important than buck feed intake (BLFI) and doe feed intake (DLFI).

Relative to all traits, mature body weights (bMWT and dMWT) had the highest REVs. These were followed by weaning weight and survival traits. Traits with the lowest REVs were BLFI and DLFI. The combined body weight traits had the highest REV (81.97%), followed by survival (11.16%), reproduction (3.04%), growth rate (2.91%) and feed intake (0.52%). Docility was the least important trait with REV of 0.40%.

REVs when feed cost was set to zero

When feed intake was set to zero, discounted EVs of all survival and reproduction traits increased slightly, with exception of POWS which remained constant (Table 4).

Discounted EV of docility also did not change. However, discounted EVs of all body weight traits regressed towards zero, whilst those of growth rates did not change. The new REVs of all traits increased whilst those of mature body weights decreased. Weaning weight and PRS ranked higher than mature body weight.

Relative to all other traits, the order of importance was blWWT, dlWWT, PRS, bMWT, POWS and dMWT, with AFP being the least important traits. Body weight traits still remained the most important traits, despite removing FI from the objective. When similar traits were

Table 4. Relative economic values of traits when feed cost was set to zero.

Trait[a]	Units	Non-discounted EV (GH¢)	Discounted EV (GH¢)	Genetic standard deviation	REV (%)	% Change in EV	% Change in REV (%)
PRS	%	1.80	1.59	5.95	12.4	0.12	72.44
POWS	%	1.81	1.59	3.03	6.35	0.00	59.92
AFP	Months	0.38	0.33	0.45	0.20	0.02	79.96
LSB	Number	1.82	1.60	0.32	0.67	0.13	77.43
PI	Months	1.52	1.18	2.79	4.33	0.07	69.63
blBWT	g	0.04	0.04	16.83	0.78	0.00	59.05
dlBWT	g	0.04	0.04	16.83	0.78	0.00	59.05
blWWT	g	0.20	0.18	120.00	27.78	-0.01	45.54
dlWWT	g	0.19	0.17	120.00	26.39	-0.01	52.04
bMWT	g	0.03	0.03	324.15	11.26	-0.05	-46.65
dMWT	g	0.01	0.01	324.15	3.75	-0.08	-83.99
blPWDG	g/day	0.16	0.14	1.30	0.24	0.00	60.53
dlPWDG	g/day	0.15	0.13	1.30	0.23	0.00	61.25
bPODG	g/day	0.75	0.66	2.61	2.27	0.00	60.72
dPODG	g/day	0.64	0.56	2.61	1.93	0.00	59.82
DOC	Number	0.87	0.77	0.63	0.63	0.00	58.63
Total					**100.0**		

[a]Acronyms of traits are defined in Table 1. Economic Value (EV); Ghana Cedis (GH¢); Relative Economic Value (REV).

combined, the order of importance of traits still remained the same as when FI was included in the objective.

Using coefficient of variation to standardize EVs

When the CV_g was used to calculate the REVs, there were changes in magnitude and ranking of REVs (Table 5). Post-weaning daily gain and docility emerged as the most important traits (Table 5). These were followed by LSB, PRS and PI. The least important traits were pre-weaning food intake of males and females, respectively. Based on the combined REVs it was concluded that growth rate was the most important trait with REV of 42.94%, followed by reproduction (19.09%), docility (15.01%), survival (12.44%) and body weight (10.04%). Feed intake was the least important trait with combined REV of 0.47%.

DISCUSSION

REVs when feed intake was considered

Relative Economic Value of PRS was more important than POWS. Similar observation was made by Nasiri and Fayazi (2008) in sheep production in Iran. Pre-weaning survival was more important than POWS because kids are more vulnerable than adults (Annor et al., 2000). Effects of diseases, poor nutrition and stress are more severe in kids than in adults. Ability of an animal to survive and produce up to a certain age reflects its ability to adapt to prevailing conditions. Adaptability increases as the animal grows. Burden of survival associated with the pre-weaning stage of growth is therefore higher than that for the post-weaning stage.

Parturition interval, being the most important reproductive trait in this study, has also been recognized as one of the most important female reproductive traits in many livestock farming systems in the tropics (ESGPIP, 2010). Lower intervals result in lower culling of breeding females, lower cost of mating, fewer female kids for replacement and a higher length of productive life.

Relative Economic Value of mature weight was higher than birth weight and weaning weight, and post-weaning growth rate was also higher than pre-weaning growth rate. This observation was also made by MacNeil et al. (1994) and Annor et al*.* (2000) in cattle. Cost of production associated with product (growth or weight) production during the pre-weaning stage is lower than that of the post-weaning period and returns from product produced during the pre-weaning period is also lower than that of the post-weaning stage, because the post-weaning period is longer than the pre-weaning. Cost of product production is determined by passage of time. Relative Economic Values of feed intake of both young does and young bucks at the pre-weaning stage were lower than those of the same class of animals at the post-weaning stage. The above explanation given for body weight and growth rate also holds for feed intake.

Relative to all traits, the most important traits were mature body weight of males (bMWT) and females

Table 5. Relative economic values of traits when CV_g is used.

Trait[a]	Units	Non discounted EV (GH¢)	Discounted EV (GH¢)	CV_g (%)	REV (%)
PRS	%	1.67	1.47	6.7	7.94
POWS	%	1.81	1.59	3.5	4.50
AFP	Months	0.35	0.31	8.3	2.06
LSB	Number	1.67	1.47	8.1	9.60
PI	Months	1.43	1.11	8.3	7.42
blBWT	g	0.04	0.04	13.6	0.39
dlBWT	g	0.04	0.04	13.6	0.39
blWWT	g	0.22	0.19	22.4	3.50
dlWWT	g	0.20	0.18	22.4	3.18
bMWT	g	0.09	0.08	19.2	1.23
dMWT	g	0.10	0.09	19.2	1.36
blPWDG	g/day	0.16	0.14	18.9	2.15
dlPWDG	g/day	0.15	0.13	18.9	2.01
bPODG	g/day	0.75	0.66	39.3	20.93
dPODG	g/day	0.64	0.56	39.3	17.86
BLFI	$g/kgW^{0.75}$	-0.01	-0.01	4.5	0.04
DLFI	$g/kgW^{0.75}$	-0.01	-0.01	4.5	0.04
YBFI	$g/kgW^{0.75}$	-0.07	-0.06	4.5	0.22
YDFI	$g/kgW^{0.75}$	-0.06	-0.05	4.5	0.18
DOC	Number	0.87	0.77	24.3	15.01
Total					**100.00**

[a]Acronyms of traits are defined in Table 1; Economic Value (EV); Ghana Cedis (GH¢); Relative Economic Value (REV). Genetic Co-efficient of Variation (CV_g).

(dMWT). This was followed by blWWT, dlWWT, PRS and POWS, with the least important traits being BLFI and DLFI. Combining similar physiological traits, results of this work indicate that on average, body weight was the most important trait that made the greatest contribution to profit in relation to other traits. This was followed by survival, reproduction, growth rate and feed intake, with docility making the lowest contribution. This work contrasts earlier results reported by Annor et al. (2000) in beef cattle and Annor et al. (2007) in sheep in Ghana. Results of those two studies showed that survival and reproductive traits were more important than body weight and growth traits. Difference between the last two reports and this is that whereas economic evaluation in this study was based on relative economic values, the other reports were based on absolute economic values. When this work is based on absolute economic values, survival and reproduction become more important than body weight and growth traits (Table 3).

This study questions the statistic to use to standardize absolute economic values involving different physiological traits in order to calculate REVs. Genetic or phenotypic standard deviations have been used for computing REVs (Wilder and Van Vleck, 1988; Jagannatha et al., 1998; Wolfava et al., 2005; Eady and Garreau, 2008). However, this may not be appropriate when different physiological traits are considered because trait mean and the standard deviation tend to change together (Steel and Torrie, 1980; Gregory et al., 1995). Therefore, traits with large means such as body weight are likely to have higher REVs compared to traits with small means such as litter size. Furthermore, different traits have different units of measurements, and their comparison using the standard deviation, may be subjected to scale of measurement effects (Steel and Torrie, 1980). The coefficient of variation may be more appropriate for different physiological traits because it is used for relative comparison of variability of different means (Gregory et al., 1995). In some studies, the coefficient of variation of a trait is even used as its economic value (de Carvalho et al., 1999).

REVs when feed was set to zero

Effect of setting feed cost to zero increased EVs of PRS and all reproductive traits but decreased those of body weights. However, EVs of POWS, birth weight, growth rate and docility did not change. Relative Economic Values of body weight regressed towards zero and those of growth rate did not change because the tendency for animals to grow without feed was limited (Wolfava et al., 2005). The model ignored the capacity of animals to put on weight without feed, and therefore modified the results (Phocas et al., 1998). Annor (1996) reported similar results to this work. He observed that when feed cost was set to zero EVs of growth traits regressed towards zero. It is therefore important that feed intake should be included in models of economic evaluations (Wolfava et al., 2005).

Changes that occurred in EVs when feed cost was set to zero were minor, and did not affect ranking order of combined REVs of traits. Body weight traits were still more important than other traits. Similar results have been reported in dairy cattle. Vargas et al. (2002) and Kahi and Nitter (2004) found minor effects of feed price change on economic values of traits.

Using coefficient of variation to standardize EVs

The use of CVs to calculate REVs is not popular in animal breeding, although CVs are used as measures of genetic evolvability and diversity (variation) in the animal industry (Morris et al., 1978; McLennan and Lewer, 2005). The procedure points to the fact that growth rate, docility and litter size are the most important traits influencing the financial rewards of the farmer. In fact, litter size and docility would have been left out of the top traits if economic evaluation were based on genetic standard deviation. Reports from the literature justify the importance of these traits in genetic improvement programmes of the grasscutter industry. Grasscutter has poor growth rate (Adu, 2005). This has resulted in longer age at maturity or slaughter. The slaughter age is reported to be 43 to 53 weeks (Van der Merwe and Van Zyl, 2009), compared to a slaughter age of 8 to 16 weeks for the rabbit (Adu et al., 2005). Grasscutter in captivity has poor reproductive performance. This is reflected in their small litter size, long gestation periods and parturition intervals (Adu, 2005). The most important behavioural trait in grasscutter is docility. The National Research Council of the United States of America has recognized that there is a particular need to select and breed docile grasscutters because the animals are aggressive (NRC, 1991).

Traits to be included in the breeding objective

It was concluded that growth rate, litter size and docility are the traits suggested to be included in the breeding objective. Growth rate is an ideal trait because it has a positive genetic relationship with post-weaning survival and body weight, and negatively correlated with feed conversion ratio (Annor et al., 2012b). Improving growth rate will therefore improve survival, body weight and feed conversion ratio. In addition, growth rate has high genetic variance and heritability. Though litter size has low genetic variance and heritability (Annor et al., 2012a), its moderate relative economic value gives it an advantage to be included in the breeding objective. It also has a positive moderate genetic relationship with docility. Litter size has a negative genetic relationship with growth rate (Annor et al., 2012b). If it is excluded from the breeding objective, its mean value will deteriorate due to selection for improved growth rate (Goddard, 2009). Docility has moderate economic variance, high heritability and high relative economic value.

Conclusion

It was concluded that growth rate, docility, litter size and pre-weaning survival are the most important traits that will increase the financial rewards of the farmer. The results could be used as a guide to define breeding objectives for the grasscutter industry because emphasis on each trait in the objective is determined by its relative economic value. It is suggested that post-weaning growth rate, litter size at weaning and docility are the traits to be included in the breeding objective of grasscutter breeding programmes in Ghana. However, final traits to be included in the objective need to be determined in consultation with all actors (farmers, processors, retailers and consumers) in the industry.

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