A running breeding program for indigenous chickens in Ethiopia: evaluation of success

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ABSTRACT: In 2008 a breeding program to increase production level in indigenous chickens was initiated at the Debre Zeit Agricultural Research Center in Ethiopia and is currently producing its 8th generation. Aim of this paper was to evaluate the success of the breeding program. Selection was on own performance for bodyweight at 16 weeks of age (BW16) and for the hens also on cumulative egg number at week 45 of laying (EN45). Heritability for BW16 in the 6th generation (G6) was 0.37, and for EN24 was 0.32. Phenotypic correlation between BW16 and EN24 was 0.36, but genetic correlation was -0.12. Genetic correlations of BW16 with cumulative egg production earlier in the laying series were 0.51 at 8 weeks of laying, decreasing to 0.22 at 16 weeks of laying. The genetic trends were positive for both traits under selection from generation 4 (G4) and G6.

Keywords: Indigenous chicken; genetic trend; heritability

Introduction

The rural poultry system is dominated by indigenous chickens and has made significant contribution to poverty alleviation and household food security in many developing countries (Alders and Pym (2009)). Even though indigenous chickens are not as high productive if kept under optimal conditions, they are well adapted to the more harsh conditions of the rural poultry system (Ajayi (2010)). Therefore, the indigenous chicken seemed the ideal starting material to increase production level, while maintaining the resilience to sub-optimal circumstances such as food (and water) of irregular quality and quantity. In addition, there are indications that indigenous chickens are better capable of dealing with infection pressure (Taddele et al. (2000)). In 2008 a breeding program was initiated at the Debre Zeit Agricultural Research Center in Ethiopia. The starting generation consisted of chicks that were hatched from eggs collected at various locations in the Horro region in Ethiopia. The breeding objectives were defined based on questionnaires and discussion meetings with small holder farmers in a number of regions in Ethiopia (Dana et al. (2010a)). The general consensus was to have a dual purpose chicken that was large and laid many eggs, but that could achieve that under the conditions of the rural production system. Currently the eighth generation is produced. Aim of this study was to evaluate the success of the breeding program thus far by 1. Estimating the genetic parameters, and 2. Presenting the genetic trends for the traits under selection.

Materials and methods

Data. Each generation 50 males and 300 females were selected to produce the next generation. This represents selected proportions of approximately 10-20% in the males and 50-60% in the females. Collected eggs were artificially incubated. All hatched chicks were checked for deformity, vaccinated (against Marek's at the hatchery, Newcastle at Day 1 and 21, Gumboro at day 7, Fowl pox in week 10 and Fowl Typhoid in week 14) , wing tagged, weighed and randomly assigned into pens of concrete floor filled with bedding material. The chicks were provided *ad libitum* with a standard chick (0-8 weeks: 20% CP and 2950 Kcal/kg of ME), grower (8-20 weeks: 18% CP and 2750 Kcal/kg of ME) and layer (21-onwards: 16%cp and 2750 Kcal/kg of ME) diet formulated at the center. Body weight and cumulative egg production were recorded on weekly basis. Males were selected on their body weight at 16 weeks (BW16), and females were selected on their BW16 and on their cumulative egg production in 24 weeks after start of lay (EN24). From week 18 onwards, the selected males and all females were transferred to the layer house and kept in floor pens with 1 male and 10 females per pen. Pens were fitted with trap nests to facilitate full pedigree recording. Eggs were collected from selected hens for 10-12 days and incubated in three hatches to produce the next generation. For all hens body weights at 12 weeks of age (BW12) and BW16 were analyzed, as well as the cumulative egg numbers at weeks 8 (EN8), 16 (EN16) and 24(EN24) after onset of laying. For estimating the genetic parameters only phenotypes collected in generation 6 were used. For estimating the genetic trend from generation four (G4) to generation six (G6), 4817 records were available for BW16, and 4108 records for EN24.

Statistical analyses. The same model was used for estimating genetic parameters and for estimating the genetic trend from G4 to G6. Preliminary analyses were conducted to identify significant fixed effects. The final model included the fixed effects of sex, hatch round, and pen. Genetic parameters and breeding values were estimated using an animal model in ASReml (Gilmour et al. (2009)). The breeding values for the genetic trend were estimated with generation four (G4) as reference. The trends are produced by taking the average breeding value of selected animals per generation.

Results and Discussion

Descriptive statistics. In Table 1 are the means, SD, minimum, maximum, and number of observations of the traits included in the analysis in G4 and G6. The means for all traits were larger in G6 compared to G4. Largest difference in SD are in the body weight traits. The distributions for body weight and egg number at the different ages are skewed towards to lower end of the distribution. It is not clear what causes this skewness towards the lower end of the distributions.

Table 1. Means, SD, minimum, maximum, and number of observations of the traits included in the analysis in generation G4 and G6

Gen.	Traits	n	Mean	SD	Min.	Max.
G-4	EN8	1307	6.7	3.5	4	18
	EN16	1139	17	11.2	11	54
	EN24	1014	63	24.6	42.4	93.5
	BW12	1758	516	127.8	321	916
	BW16	1389	689	212.5	500.5	1290
G-6	EN8	1367	13.6	5.5	11	29
	EN16	1291	24.6	12.7	21.6	71
	EN24	1251	76	28.6	71	101
	BW12	1709	572	310.5	412	1432
	BW16	1451	1211	211.2	1110	1760

EN8, EN16, EN24= cumulative egg number in 8, 16 and 24 weeks after onset of laying; BW12 and BW16 = body weight at 12 and 16 weeks of age

Genetic parameters. Heritability estimates are presented in Table 2. The heritability of BW16) was 0.37. This is higher than the heritability of 0.23 reported by Dana et al. (2010b), who estimated it on the first generation of the same population. Reason for this difference may be a small change in management of the chicks. The heritability for EN24 is 0.32. It is difficult to compare that to the results of Dana et al. (2010b) as they defined egg production differently. However, their heritability for cumulative egg production to the 6th month of laying was 0.35, which is of similar size as the 0.32 in the current study.

Table 2. Estimates of heritability of direct effects (h^2) for week 16 body weight and cumulative egg number in 24 weeks after onset of laying (EN24) with their corresponding standard errors

Traits	h2
BW16	0.37(0.05)
EN24	0.32(0.08)

BW16= body weight at 16 weeks of age; EN24= cumulative egg number in 24 after onset of laying

Correlation among egg production and body weight traits. Table 3 presents phenotypic and genetic correlations among body weight and egg production traits. Phenotypic and genetic correlations between body weight at 12 weeks (BW12) and cumulative egg number traits were all positive, but only of moderate size. Reason for the positive relation may be that hens that are healthy and in good condition at younger age are more likely to develop well and are capable of producing more eggs than hens that were in poor condition earlier in life. This condition may relate to the capability of coping with the environment. Infectious diseases are unlikely to be the reason of poor condition, as the hens were vaccinated for the common diseases. Further research is needed to investigate the reason for the poor condition. The phenotypic correlations with BW16 were also positive and of fluctuating size. There, however, was a trend in the genetic correlations with BW16. It decreased with increasing age of egg production, and even became negative with EN24, although not significantly. A similar negative genetic correlation was reported from a three years short term selection of a Nigerian local chicken ecotype (Vivian et al. (2012)). If that correlation between BW16 and EN24 really is negative, it is important to re-estimate the correlation in the next generation to check whether there is a trend developing. Improving both traits simultaneously is possible, but considering the production system the animals are aimed for, it is important to realize whether the balance between body weight and egg production may be an optimum trait. Trying to maximize both may result in chickens that are less suitable for the relatively harsh production circumstances they are meant to function in.

Table 3. Phenotypic and Genetic correlations among egg production and body weight traits with their corresponding standard errors ( )

Traits	BW12	BW16
Phenotypic correlations		
EN8	0.35 (0.20)	0.36 (0.54)
EN16	0.41 (0.09)	0.23 (0.21)
EN24	0.32 (0.10)	0.36 (0.21)
Genetic correlations		
EN8	0.54 (0.31)	0.51 (0.12)
EN16	0.27 (0.43)	0.22 (0.30)
EN24	0.34 (0.43)	-0.12 (0.21)

Genetic trends. The genetic trends for BW16 and EN24 are shown in Figure 1. Generation four (G4) was taken as a reference. Generation five (G5) and generation six (G6) birds had an EBV of +1 and +3 for cumulative egg production in 24 weeks after start of lay. This means hens of G5 and G6 had the genetic potential to lay 0.5 and 1.5 more eggs compared to hens with an EBV of 0 (G4) at 45 weeks of age. G5 and G6 birds had a genetic potential to be 5 and 6 grams heavier compared to chickens with an EBV of 0 (G4). The number of animals per generation and the variation within population made it not possible to obtain significant differences across three generations, but it is clear there is a genetic trend.

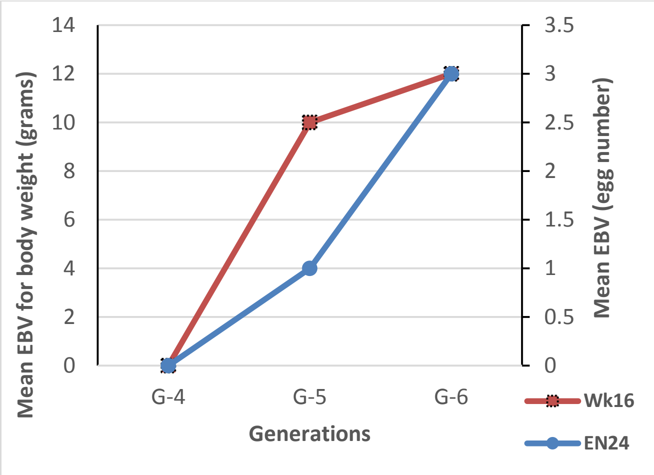

Figure 1. Genetic improvement (trends) of week 16 body weight (BW16) and Egg number in 24 after onset of laying (EN24) as reference of generation four (G4) for expressed as mean estimated value(EBV) of selected animals

Concussion

The breeding program of Horro chickens at the Debre Zeit Research Centre in Addis has been very successful in increasing cumulative egg number in 24 weeks after onset of laying, as well as body weight at 16 weeks of age. Some attention should be paid to the negative genetic correlation between BW16 and EN24 to assure that adaptability to the local production system is not lost in the future generations of selection.

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