Dual-purpose production of genetically different breeds in Ethiopia

Chicken production plays an important socio-economic role in developing countries. Family poultry contributes to human nutrition by providing food (eggs and meat) with high-quality nutrients and micronutrients. The small income and savings provided by the sale of eggs and chickens are especially important for women in Ethiopia, enabling them to cope with urgent needs, and reduce their economic vulnerability.

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In the past decades, there has been a shift to commercial small and medium-scale chicken production in developing countries, exploiting mainly urban markets. However, the expansion of commercial chicken production in Ethiopia, and in similar developing countries, has been hindered by the shortage of adequate local supply of high performing chicken stocks.

Efforts are made to alleviate this problem by evaluating and identifying suitable local and imported breeds adaptable to intensive or extensive management conditions in Ethiopia.

Global breeding companies tend to promote the breeds that are used under high level management in developed countries, claiming that they are suitable for all environments. Testing this claim was part of the present study.

Genetic improvement of chickens for developing countries is achieved by a selection of local breeds, or cross breeding of improved breeds, or both. Response to selection in most local breeds is limited due to lack of high performing genotypes, commonly existing in imported breeds that had been under many generations of intensive selection. Globally, most commercial chickens are crossbreeds, i.e. progeny of routine crossing of specialised parental breeds.

Alternatively, a population can be synthesised by one-time crossing of specialised breeds, followed by continuous within-breed selection for desired traits. Synthetic breeding appears to be advantageous for developing countries as only one parental population is maintained, instead of two or more parental populations that are needed in crossbreeding programmes. However, before adopting breeds and breeding strategies, adequate information on qualities and capabilities of different breeds and crossbreeds is required.

In developed countries, table eggs are produced by females bred specifically for high laying rate along with low body weight (and low feed intake) aiming at economically efficient egg production. Due to their low BW, the male brothers are culled upon hatch, and chicken meat is produced by young fast-growing meat-type chickens (broilers).

In dual-purpose production systems, the females produce table eggs and the males are reared (up to shortly before sexual maturity) for their meat. This system is very common in developed countries, where people are used to consuming cockerels (and spent hens).

Dual-purpose production

In developed countries, mainly in Europe, there is a rising interest in dual-purpose production, due to ethical objection to upon-hatch killing of the male brothers of the layers. Breeding chickens for dual-purpose production requires a compromise between negatively correlated traits: laying more eggs and high BW (for more meat). Egg-type crossbreeds with not-too-low BW or hardier medium-BW breeds with reasonable egg production are potential candidates for dual-purpose production. Recently, some breeding companies have been crossing meat-type males with egg-type females to produce specialised dual-purpose progeny. For years, Debre Zeit agricultural research center (DZARC) evaluated a single imported crossbreed at a time, concluding that it is either acceptable or not, without valid comparisons to alternative breeds.

In contrast, the present study was designed to evaluate together, for egg and meat production, several genotypes including top brown egg crossbreeds, egg type dual-purpose breeds, and specialised dual-purpose crossbreeds.

Material and methods

Six parent-stocks (PS) from three European companies were imported: two commercial brown egg crossbreeds, Lohmann Brown Classic (LB) and Novogen-Brown (NB), two commercial egg-type breeds, Dominant Sussex (DS) and Dominant Red Barred (DR), and two experimental dual-purpose crossbreeds, Novogen-Color (NC) and Lohmann-Dual (LD). At PS, NC hens were the same as NB, but mated to meat-type males, also LD hens were egg-type, and mated to dwarf meat-types males.

The Koekoek (KK) breed was included as local reference, having been developed and used in commercial dual-purpose production in Ethiopia for more than 10 years.

The study also included three ad-hoc experimental crossbreeds: R×K (DS females and KK males), S×R (DS females and DS males), and K×S (KK females and DS males).

Day old chicks (DOC) for this study were progeny of these 10 commercial and experimental breeds and crossbreeds, all reared and reproduced in DZARC. Except LD and R×K, all other breeds/crossbreeds were segregated for genes allowing auto-sexing of DOC. In the trial with female progeny, each of the 10 breeds/crossbreeds was allocated at random to three replicated 3m² floor pens with 20 birds (7/m²) each.

The trial with male progeny had identical design, but without LD

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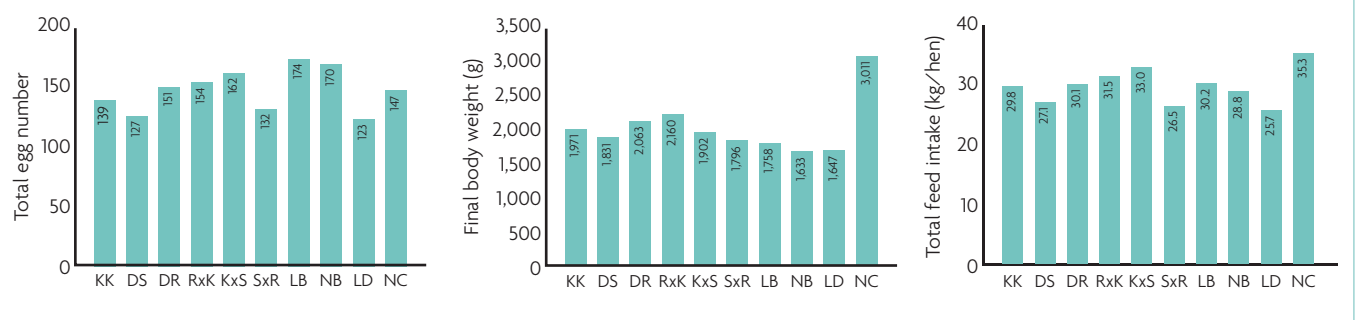
Fig. 1. The means of three economically important traits: total egg number (income), BW of spent hens (income), and total feed intake (variable cost).



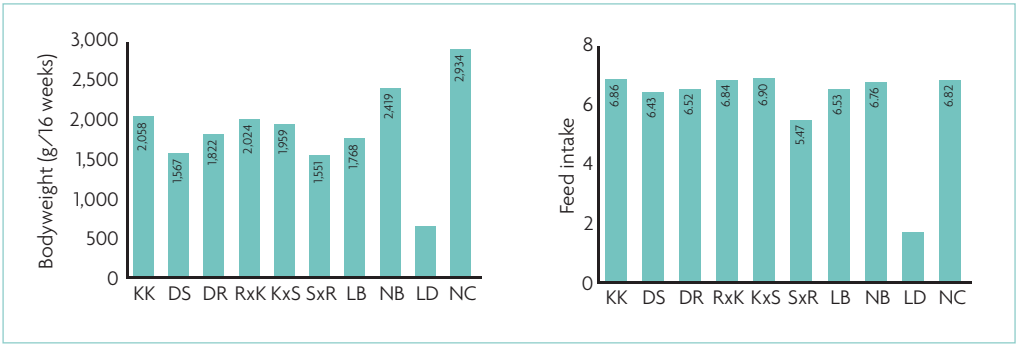


Fig. 2. Means of males' (cockerels) two economically important traits: BW at 16 weeks (income) and total feed intake (variable cost).

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males due to lack of DOCs. The experimental houses were open-sided with 15cm deep litter of teff straw on concrete floors. Standard age-dependent lighting programmes were applied in the female trial. Feed for female chickens was formulated at DZARC using Feed Win software according to the recommendations of each breeder's manual.

The males of all crossbreeds were fed with the same diets: at 0-4 weeks, 4-8 weeks, and 8-16 weeks of age, respectively, these diets contained 22, 20, and 20% CP and 3,000, 3,100, and 3,200 kcal/kg (ME). Routine data recording from each pen included weekly BW, feed intake and egg number.

Results and discussion

Ibrahim et al. (2019a,b) published the detailed results of this study. Here we present only breed and crossbreed means of the traits that are most important economically.

The results, expressed in performance units and by sale revenue and net income, are discussed by the genetic types of the 10 breeds and crossbreeds, as follows:

- Single breeds with DOC auto-sexing (KK, DS, DR).
- Experimental crosses between the single breeds (RxK, KxS, SxR).
- Leading brown egg crossbreeds (LB, NB).
- Special dual-purpose crossbreeds, progeny of egg-type PS hens and meat-type PS males (LD, NC). It should be noted that due to the very high mature BW of the PS males of NC (~5kg) and LD (dwarfs, ~3.7kg) compared to their PS hens counterparts (~1.65kg), the males failed to naturally mate the hens.

This problem was successfully solved by artificial insemination. Also at the reproductive phase, hatchability was significantly higher in the three experimental crosses (between the single-breed PS) compared to the parental single breeds, demonstrating the expected heterosis.

Fig. 1 shows means of three economically important traits: total egg number (income), BW of spent hens (income), and total feed intake (variable cost). The highest egg number was exhibited by the two commercial brown egg crossbreeds, LB (174) and NB (170). The three single breeds differed considerably, led by DR (151), then the local KK (139) and DS (127), that possibly did not adapt to the trial's conditions.

Only two ad-hoc experimental crossbreeds exhibited heterosis in egg number: KxS (162) and RxK (154). The NC hens laid less eggs (147) then NB (170), both crossbreeds had the same maternal line, but NC hens were progeny of meat-type males. This was very apparent with the final BW of the NC hens, at ~3kg, it was about 1kg higher than all other groups. The LD hens were also progeny of meat-type makes, but being dwarf, they possibly suffered under the trial's conditions, hence their low BW (1,647g) and also egg number (123).

There were differences among breeds and crossbreeds in egg weight, but they are not presented here because in Ethiopia, eggs are sold only by unit. But difference in total egg mass, along with hens' BW, affected total feed intake (16-60 weeks). The means ranged between 35.3 kg/hen (NC) to 25.7kg/hen (the dwarf LD hens).

Fig. 2 shows males' (cockerels) means of their two economically important traits: BW at 16 weeks (income) and total feed intake (variable cost). The highest BW was exhibited by the NC cockerels (2,934g), reflecting their meat-type fathers.

LD males, also progeny of meat-type fathers, were not included in this trial. NB males exhibited the second highest mean BW, this result was not expected hence it requires confirmation. BW means around 2kg were exhibited by KK and the two crossbreeds with KK (RxK and KxS). Mean BW of DR and LB were around 1.8kg. The lowest BW means, around 1.55kg, were exhibited by cockerels of DS and its SxR crossbreed.

The means of total feed intake were quite similar for most breeds and crossbreeds, with SxR being the only exception.

The mean relative economic net income per hen, or hen+cockerel (if reared), for each breed or crossbreed, was assessed by deducting the feed cost per bird (the only variable cost, due to differences in feed intake) from the farmer's income obtained by selling eggs and spent hens, and 16 week old cockerels (if reared). Currently, Ethiopian farmers get four birr per egg, regardless of egg weight. Spent hens and cockerels are sold alive, and there are two price situations:

- One fixed price for spent hen (350 birr) and for cockerel (450 birr), regardless of their BW.
- BW dependent price of 150 birr/kg for spent hens and 200 birr/kg for cockerels. The current feed cost in Ethiopia is 8.3 birr/kg.

These prices, although they may vary over time and location and do not include all fix-per-bird costs (housing, labour, etc), were used to rank the breeds and crossbreeds that were evaluated in this study.

Fig. 3. shows income minus feed cost of all breeds/crossbreeds, at four market situations. The two options on the right are dual-purpose production, with live spent hens and cockerels sold for fix price (Eggs+hen+cockerel/fix) or by BW (Eggs+hen+cockerel/BW).

The two options on the left represent the situation where only females are reared, with income from the eggs they lay and their sale as spent hens (for fix or by-BW price). The apparent conclusions are:

- Rearing the male brothers of the layers, i.e. dual-purpose production, increase – similarly in all breeds/crossbreeds, the net income from a given number of female and male hatchlings.
- Selling live cockerels by BW gives advantage to breeds/crossbreeds with higher BW.
- In Ethiopia, most live chickens are sold for a fixed price hence the most profitable breeds are those with high egg production along with low BW (for the consequent lower feed intake).
- Accordingly, the two commercial brown egg crossbreeds (LB and NB), although bred for better conditions, appear to be the best ones for dual-purpose production in Ethiopia. ■

References are available from the author on request

Fig. 3. Income minus feed cost of all breeds/crossbreeds at four market situations.