ISSN 1682-8356
ansinet.org/ijps

INTERNATIONAL JOURNAL OF

POULTRY SCIENCE

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308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
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International Journal of Poultry Science 9 (7): 702-710, 2010
ISSN 1682-8356

Production Performance of Dual Purpose Crosses of Two Indigenous with Two Exotic Chicken Breeds in Sub-tropical Environment

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Abstract: An ongoing crossbreeding experiment is being conducted with the objective of producing dual purpose synthetic chicken for village poultry production in Ethiopia. The two exotic chicken breeds used were the Fayoumi (F) and Rhode Island Red (R) as dam line, whereas the two indigenous chicken breeds used were the Naked neck (N) and local Netch (W); a white feathered chicken. The indigenous breeds were used as sire line to produce the hybrids FN (F♀ X N♂) and RW (R♀ X W♂). Growth and egg production performance of the crosses were compared with each other and with the exotic pure line performance. Both body and egg weight of FN was improved while body weight of RW was reduced and age at first egg was significantly reduced, compared to their respective dam line. Egg production for the crosses was lower than for their maternal lines. Although FN cross chicks weighed more and grew faster than RW chicks during the brooding period, the difference became insignificant as they grew older. However, the higher overall average body weight gain of RW crosses that was observed was mainly due to higher weight gain for the RW cocks. No significant differences were observed in overall egg production and quality traits between the two crosses, but significant age effect within crosses was found. Mortality in the FN cross was lower than in the RW cross. These F1 crosses will be used as parents to produce a 4-way synthetic crossbred chicken.

Key words: Two-way crossing, egg production, egg quality, body weight

INTRODUCTION

It has been reported by researchers that the main problem of indigenous chickens in the tropics is that they are poor producer of egg and meat (Alemu, 1995; Gueye, 1998; Tadelle *et al*., 2000). But even if they show low productivity, they are well adapted to the tropics, resistant to poor management, feed shortages and tolerate some of the most common diseases and parasites. On the other hand, improved exotic chickens produce higher number of eggs and more meat than the indigenous chicken breeds, but tropical climate is a great challenge. They are not adapted to adverse environmental conditions, such as high temperature, disease and shortage of feed (Barua *et al*., 1998; Ali *et al*., 2000; Islam and Nishibori, 2009).

However, the genetic diversity of indigenous and exotic chicken breeds could be utilized by cross breeding schemes. The goal will then be to get a new breed or hybrid that is resistant to harsh tropical conditions and at the same time produces a reasonable amount of egg and meat (Barua *et al*., 1998; Iraqi *et al*., 2005; Mekki *et al*., 2005). Breeding programs for local chicken breeds are difficult to set-up because of the competition with commercial breeding companies, which often have access to expensive technology and also benefit on economics of scale (Saady *et al*., 2008).

Studies in Bangladesh indicated that the egg production at smallholder level could be doubled in the existing production system through intervention of crossbreeding in a semi-scavenging poultry model (Rahman *et al*., 2004). Moreover, in an evaluation of the egg production performance of crossbreeds between local and exotic birds, conducted by different research and development organizations in Ethiopia, it was showed that the overall performance of the crosses was better than either of the native or exotic parents under the prevailing production condition (Alemu 1995; Tadelle *et al*., 1999).

There are indigenous chicken breeds in tropical environment with special genetic attributes that have potential use in improvement of local chicken productivity. Among those chicken breeds, the Angete-Melata (naked neck) strain is well known for better performance. Teketel (1986) reported that the Angete-Melata strain had significantly larger body weight, higher egg production associated with heavier eggs and higher egg mass output. Several researchers have investigated how the naked neck gene is associated with high egg and meat production. The autosomal incomplete

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dominant naked neck (Na) gene is not only responsible for defeathering the neck region, but also restricts the feathering areas around the body by 20-30% in heterozygous (Nana) and up to 40% in the homozygous (NaNa) genotype. The Na gene and its effect on heat dissipation positively affect appetite. i.e. increased feed intake, resulting in higher body weight, egg size and liveability under high temperatures (Islam and Nishibori, 2009). In a review by Merat (1990) it is stated that the most likely use of the naked neck gene is at high mean ambient temperatures, i.e. 25°C and above, where it may lead to higher growth rate, slaughter yield, meat yield, and resistance to acute heat stress. In addition El-Safty (2006) concluded that incorporating Na gene in a breed increases the egg weight, egg number, egg mass and shell strength.

In this study indigenous Naked Neck and the white feathered (Netch) cocks were used. They are prevalent in the experiment area and assumed to be highly adapted to the environment. Body weight of Netch strain is comparable or even better than other indigenous strains of Ethiopia except the Naked neck (Teketel, 1986). Between the exotic lines used in this experiment, Fayoumi is an Egyptian breed developed for egg production and known to be adapted to tropical environment (Barua *et al*., 1998) and RIR is an exotic breed characterized by high productivity and hardiness (Gueye, 1998).

The work presented here is part of an on-going project to produce a synthetic chicken population by using 4-way cross breeding scheme. The objective of the present study is to evaluate the performance of the F1 crosses with each other and their maternal parents. The crosses will also be used as parents for the final synthetic chicken population.

MATERIALS AND METHODS

Experimental site: The cross breeding of chicken breeds was conducted at Awassa College of Agriculture (Hawasa University). The site is located at latitude 7°3 N, longitude 38°28 E; 275 km south of the Ethiopian capital, Addis Ababa. The elevation is, 1700 m.a.s.l; and the area receives annual rain fall of 900-1100 mm with temperatures ranging from 10-35°C.

Development of the F1-crosses: Two exotic chicken breeds, Fayoumi (F) and Rhode Island Red (R), were used as female lines and crossed with two local chicken breeds, Naked neck (N) and Local *Netch* (W), as male line, with the objective of producing two F1 crossbreds that later would become parents for a four way final crossbred. Fayoumi hens were mated to Naked neck cocks to produce FN crosses and Rhode Island Red hens were mated to local *Netch* cock to produce RW crosses. The mating of heavier Rhode Island Red also called as RIR to the lighter local *Netch* and the heavier local naked neck to lighter Fayoumi chickens would help to increase body weight of the offspring from a lighter breed and at the same time improve egg production by the local breed.

The source and growth of pure bred Fayoumi and RIR chickens was described by Fassill *et al*. (2009). Naked neck and local *Netch* cocks were purchased from local markets in Awassa, Arba Minch and other surrounding towns and villages. Adult average body weight of Naked Neck and *Netch* cocks used for crossing was 1890 and 1400 g, respectively. For each mating, 50 hens and 25 cocks were used, i.e. each cock was mated with two hens. All chickens were leg-banded with number for identification and individual records were collected. One hen and one cock were placed into a pen and kept there until mating had taken place. The first hen was then taken out and replaced with the second hen. Every hen was mated 3 times a week to ensure better fertilization. The mating was conducted in two rounds. Each cock was mated to two hens in the first round and the same cock was then mated to another two hens in the second round, i.e. the hens mated to a cock in the first round would be mated to another cock in the second round. There was a pause of 4 weeks between the consecutive crossings to clear any live sperm cell from the previous mating.

Management of experiment animals: Trap nests were provided in pens of both the two parent lines and the two F1 crosses and individual egg recordings could thus be performed. The date of each lay and ID number of the hen that laid the egg were written on all eggs. Eggs from the parents were collected from the pens and stored in ventilated room until they were incubated. Because of the small number of eggs collected per day from the few parent hens, the eggs were incubated in 6 different batches. All eggs were weighed individually at setting. At the 18th day of incubation the eggs were candled and eggs with live embryo transferred to the hatchery. The trays in the hatchery were modified by fitting 6 cm x 6 cm cells made of plywood and individual eggs were placed in each cell. Each cell was identified with the same information that was written on the egg shell. The tray was also covered with a wooden frame with mesh wire to avoid mix-up of chicks at hatching and during tagging. Each chick was individually tagged with a unique number, weighed individually and transferred to the brooding houses. Chicks from the same batch with different dams and sires but of the same line-cross were placed in the same pen within the brooding house, and they were also moved as one unit to one pen in the layer house when they were 4 months old.

The layer house was a deep litter house with pens divided by wire mesh. Only 6 pens for the 6 different batches of chickens were used. Part of the walls of the house was made of strong wire mesh window for natural ventilation. The ceiling was corrugated iron sheet approximately 3.5 meter above the floor.

Table 1: Ingredient and analyzed chemical composition of chick and layer rations used in the trial

Ingredient	Chick ration	Layer ration
Maize	32%	39%
Wheat bran	29%	22%
Noug (*Guiziota abyssinica*) cake	19%	25%
Soya bean (roasted)	18%	6%
Salt	1%	1%
Bole (soil with limestone)	1%	7%
Chemical composition (DM basis)		
Crude protein (%)	17.4	16.8
ME (MJ/kg)	13.2	13.4

Feed for both the chicks and the grown chicken was prepared at the college feed processing unit. Type and amount of ingredients used for chick and layer ration, analyzed Crude Protein (CP) and Metabolizable Energy (ME) are presented in Table 1. Feeder and waterer were placed in each pen and feeding was ad libitum. Clean drinking water was always available for the chickens, and all chicks were vaccinated against Newcastle Disease (NCD).
Parallel on-farm experiment was started with 200 chicks distributed to 10 women farmers in a village called Boricha. However, due the prevailing draught in the area, the chickens were either deceased or consumed by the farmers before data collection was completed.

Traits recorded

Hatching weight and growth: Hatching weight of each chick was recorded. Individual body weight of the chicks was recorded every week until they were 8 weeks old and every 30 days after the 8th week. Body Weight Gain (BWG) was calculated as the difference between weights measured in consecutive measurements.

Mortality: Mortality of chickens was calculated when a particular chicken was missing at one of the regular weighing days, i.e. every week up to 8 weeks of age and every 30 day then after.

Egg production and quality: Age at First Egg laid (AAFE) was recorded as number of days between date of hatching and date of their first egg. Thereafter total Egg Number (EN) produced per chicken and Hen-housed Egg Production (HHEP) were recorded, the latter being the number of eggs that a hen lays after placement in the laying house (Fairful and Gowe, 1990). HHEP was calculated as the number of egg produced in a period divided by the number of hen originally housed in a pen. The time of placement of the chickens in the layer house was at 4 month of age and egg production was then recorded up until they were 12 months of age. Mortality of chickens was recorded at all recording times. Percent Hen-Day Egg Production (HDEP) was also calculated as the number of eggs produced by the number of chickens alive on a particular period. All eggs laid by chickens were weighed every week and Average Egg Weight (AEW) and Egg Mass (EM) per bird were calculated every 30 days.
The following egg quality parameters were recorded: Average Egg Shell Thickness (AEST) in mm, Yolk Colour (YC) using Roche colour fan scale (1 = very pale to 16 = deep orange), Albumen Height (AH) in mm, Yolk Height (YH) in mm, Haugh Unit (HU) and Egg Shape Index (ESI). For the albumen and yolk height measurements, the eggs were broken out on a flat glass and then the maximum albumen and yolk heights were measured with a tripod micrometer. Individual Haugh Unit was calculated using formula cited by Tulin and Ahmet (2009):

$$HU = 100 \log (AH + 7.57 - 1.7EW^{0.37})$$

Where, AH = observed albumen height in mm and EW = egg weight in grams.
ESI was calculated as:

$$\text{Egg shape index} = \frac{\text{Width of egg (nm)}}{\text{Length of egg (nm)}} \times 100$$

Egg shell thickness was measured on the side and at each end of the egg using digital calliper and then the average of the three sites was calculated. The average grading for egg colour was made on the basis of three different persons' grading using a Roche colour fan.

Statistical analysis: The data were analysed using Mixed Model procedure of the Statistical Analysis System (SAS) (SAS, 2002-2003). The data from the parents (Fayoumi and RIR females) and F1 (FN and RW) crosses were analysed separately using different models because the experiments were done at different times but under the same management condition and the parents were hatched in a single batch whereas the F1 individuals were hatched in several batches, which had significant effect on most traits. Moreover, the body weight of F1 crosses was measured on both sexes while only female body weight was measured on parent chickens. The genotype (strain) was used as fixed effect in parent chicken models and batch was added as fixed effect in the F1 crosses. In both parents and the F1 crosses, ID number of each chicken and the pen number, in which groups of chickens were housed, were used as random effect when there were repeated observations per animal or per pen. Although group of chicks were distributed to farmers for on-farm testing, the experiment under on-farm condition failed and genotype X environment interaction could thus not be estimated.
Table 2 shows the different models used to analyze the different traits. The models were modifications of a single model depending on the type of trait to be analysed. All models include the general mean (μ) and random error.

Table 2: The different models used during analysis with levels of main effects in bracket and 'X' where there is interactions between the effects

			Fixed effects				Random effects		Interactions		
	Model No.	Traits	Ai[1] (Age)	Gj (Genotype)	Bk (Batch)	Sl (Sex)	Pm (Pen)	IDn (ID number)	Ai (Gj)	Sl (Gj)	Sl*Ai (Gj)
Parent	1	Egg production, egg quality, body weight		(F, R)			(1-6)	(1-120) hens	X		
	2	Age at first egg		(F, R)			(1-6)				
	3	HHEP		(F, R)			(1-6)		X		
F1 crosses	1	Egg production and egg quality		(FN, RW)	(1-6)		(1-7)	(1-82) chickens	X		
	2	Body weight of chicks and grown chickens		(FN, RW)	(1-6)	(m,f)		(1-166) chickens			X
	3	Age at first egg		(FN, RW)	(1-6)		(1-7)				
	4	Hatching weight		(FN, RW)	(1-6)			(1-166) chickens		X	
	5	HHEP		(FN, RW)			(1-7)		X		

[F] = Fayoumi, [R] = RIR, [FN] = Cross of Fayoumi and Naked neck, [RW] = Cross of RIR and local *netch*, [m] = male, [f] = female

[1]Age of chickens was not used as a main effect in the models but as interaction with G and S. The age varies from 2 to 3 groups for both parents and F1 crosses depending on the type of trait to be analysed.

1. (1-2) for egg number i.e. start of lay to 8 months and from 8 to 12 months
2. (1-2) for egg quality i.e. at 8 months and 12 months
3. (1-3) for body weight i.e. at 4, 8 and 12 months
4. (1-2) for body weight gain i.e. from 4 to 8 months and from 8 to 12 months
5. (1-3) for chick body weight i.e. at weeks 1, 4 and 8
6. (1-2) for chick body weight gain i.e. from hatching to 4 weeks and from 4 weeks to 8 weeks

RESULTS

The results of the two separate experiments with the parent lines and the F1 crosses is used for comparison. The experiments were made under the same management conditions but at different times. In the parent lines only the exotic female parents were tested which was not enough to estimate heterosis.

Hatching weight and chick body weight: Significant difference was observed between hatching weights of the two crosses and between male and female (Table 3). Hatching weight of RW crosses was found to be higher than for FN crosses, whereas chick body weight and body weight gain were significantly higher for FN crosses than for RW crosses (Table 3). Figure 1 shows the body weight and weight gain of the two crosses at different ages. The standard errors in Fig. 1a varies from ±12.6 g for FN male at week 1 to ±4.8 g for FN female at week 4.

Grown chicken body weight and gain: Average body weight after 8 weeks was not significantly different between the two crosses. But still body weight gain was significantly higher in the RW crosses than in the FN crosses (Table 3). Males weighed more and gained higher weight than females (Fig. 2). At 4 months of age, the FN crosses of both sexes weighed more than the RW crosses, but after 8 months of age, the difference between females of the two crosses became small but the males were much heavier than the females (Fig. 2A). The standard errors for body weight in Fig. 2A varies from ±17.4 for FN female at 4 months of age to ±46.4 for

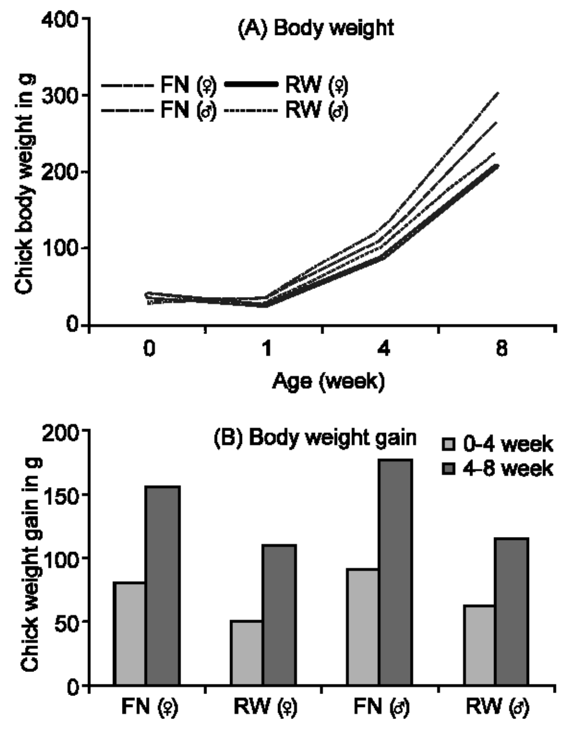

Fig. 1: Chick body weight and gain of the two F1 crosses at different ages

RW male at 12 months of age. The pure breed Fayoumi parent females were lighter than the two crosses and RIR were heavier than all genotypes (crosses). Body weight gain for the F1 crosses was higher than for the

Table 3: Least square means (±s.e.) of F1 Hatching Weight (HW), Chick Body Weight (CBW) and Chick Body Weight Gain (CBWG), grown Chicken Body Weight (BW) and chicken Body Weight Gain (BWG) of the two crossings

Effects and level	HW	CBW	CBWG	BW	BWG
Genotype	***	***	***	NS	**
FN	28.8±0.3	144.9±2.9	126.5±3.3	1110.7±12.4	327.8±13.1
RW	39.2±0.6	112.2±5.2	85.2±5.9	1095.9±22.7	405±24.6
Sex	**	*	NS	***	***
Male	35.0±0.5	135.3±4.8	112.0±5.6	1272.2±20.5	484.9±21.6
Female	33.1±0.4	121.8±3.4	99.7±3.9	934.3±15.5	247.9±17.3
Sex Age (Genotype)		***	***	***	***
Sex (Genotype)	*				
Variance component					
IdNo		290.0	148.9	8426.4	0
Residual	9.0	1568.8	1876.7	14934	26955

*** = p≤0.001, ** = p≤0.01, * = p≤0.05, NS = Not Significant

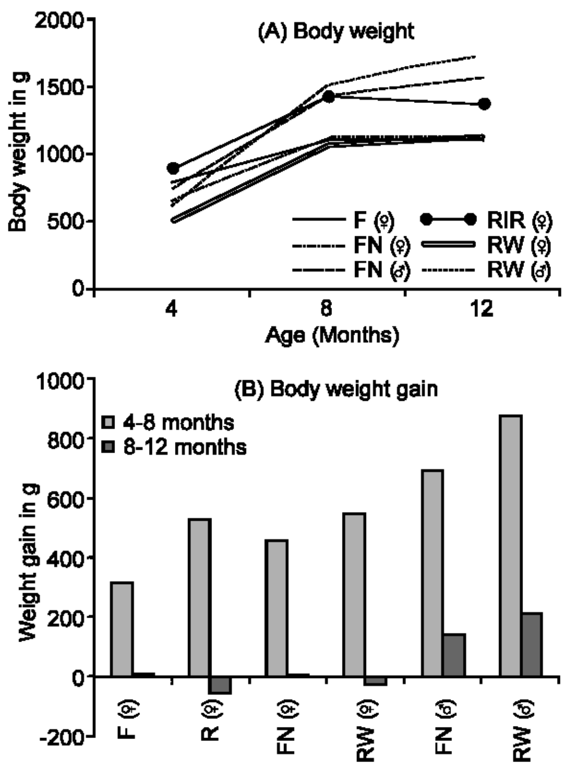

Fig. 2: Body weight and gain of adult parent breeds and their F1 crosses at different ages

purebred parents (Table 3 and 7). Body weight gain between 4-8 months of age was much higher than between 8-12 months of age for all genotypes (Fig. 2B).

Egg production and quality: Table 4 and 7 show egg production traits of the F1 crosses and their parents. Age at first egg laid was not significantly different between the two F1 crosses, but lower than for the parent breeds. There was also no significant difference in the overall average for egg number, egg weight and egg mass between the F1 crosses, but the FN cross was significantly higher in HHEP than RW due to low mortality in the FN cross. In the parental generation

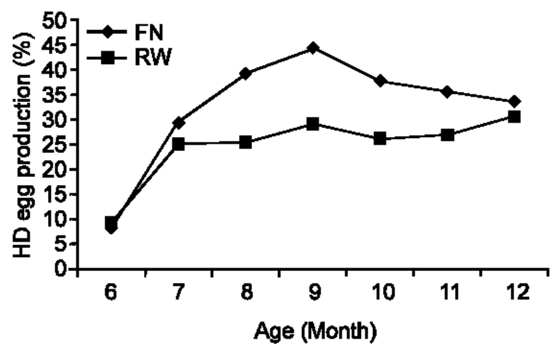

Fig. 3: Percent hen day egg production from 6 to 12 months of age for the two crossings

Fayoumi laid more eggs with higher HHEP and egg mass but RIR laid heavier egg. Significant difference in age with genotype interaction was observed for EN and HHEP in the F1 crosses. Percent hen-day egg production for the F1 crosses is presented in Fig. 3.
There was no significant difference between the two F1 crosses in any main effects of the egg quality traits measured, but significant interaction between age and crosses were observed for some of these egg quality traits (Table 5). Significant difference in egg quality traits was observed in the Fayoumi and RIR parents test, except for yolk colour and egg shape index (Table 6).

Mortality: Table 8 shows that there is little difference in percent mortality between the two crosses up to the age of 8 weeks. However, between 4-12 months of age, mortality percentage for FN was lower than for RW.

DISCUSSION

Body weight and growth: Eggs with heavier weight were hatched to heavier chicks. The relationship between egg weight and hatching weight for different poultry species has been studied by several researchers, who concluded that egg weight is positively correlated with hatching weight. They also suggested that hatching weight can be predicted by some physical egg characteristics and mainly egg weight measured prior to

Table 4: Least square means (±s.e.) of F1's Age at First Egg (AAFE) in days, Egg Number (EN), Hen Housed Egg Production (HHEP) and Egg Mass (EM) in g

Effects and levels	AAFE	EN	HHEP	EM
Genotype	NS	NS	*	NS
FN	195.8±4.9	29.5±2.4	29.0±2.1	1245.6±107.31
RW	198.3±8.9	29.1±4.3	19.6±3.3	1268.6±187.5
Age (Genotype)		***	**	***
Start of lay to 8 months (FN)		20.5±2.6	20.2±3.0	813.8±114.0
8 months to 12 months (FN)		38.5±2.6	37.9±3.0	1677.4±114.0
Start of lay to 8 months (RW)		21.6±4.5	14.9±4.6	913.1±198.6
8 months to 12 months (RW)		36.5±4.9	24.4±4.6	1624.0±214.9
Variance component				
Pen	87.1	24.1	0	47979
IdNo		89.7		175004
Residual	700.0	103.5	63.9	192291

*** = p≤0.001, ** = p≤0.01, * = p≤0.05, NS = Not Significant

Table 5: Least square means (±s.e.) of egg quality traits of F1 chickens

Effects and levels	AEST	EW	YC	YH	AH	EL	EWd	ESI	HU
Genotype	NS	NS	NS	NS	NS	NS	NS	NS	NS
FN	0.3±0.004	43.7±0.8	5.9±0.1	15.9±0.2	4.9±0.3	51.7±0.3	38.9±0.2	75.3±0.5	73.5±1.9
RW	0.29±0.01	45.4±2.1	5.5±0.3	16.1±0.6	6.2±0.8	52.7±0.7	39.6±0.5	75.6±1.2	81.1±4.9
Age (Genotype)	NS	***	NS	**	NS	***	***	*	NS
FN (8 month)	0.31±0.01	41.1±0.9	6.1±0.1	15.6±0.3	5.2±0.3	50.5±0.3	38.2±0.2	75.8±0.5	75.5±2.1
FN (12 month)	0.30±0.01	46.3±0.9	5.9±0.2	16.3±0.3	4.8±0.3	52.9±0.4	39.5±0.2	74.7±0.6	71.5±2.3
RW (8 month)	0.30±0.01	41.9±2.1	5.9±0.3	15.5±0.6	6.6±0.8	50.4±0.8	39.1±0.5	77.9±1.3	84.6±5.2
RW (12 month)	0.27±0.02	48.9±2.4	5.1±0.4	16.6±0.8	5.8±0.9	54.9±1.0	40.1±0.6	73.4±1.7	77.6±6.3
Variance component									
Pen	0	4.7	0	0.3	0.4	0	0.1	0	11.8
IdNo	0.0002	3.5	0	0.1	0.3	1.7	0.6	4.0	17.6
Residual	0.001	9.1	1.0	1.2	2.1	3.8	1.2	11.5	123.7

*** = p≤0.001, ** = p≤0.01, * = p≤0.05, NS = Not Significant, AEST = Average Egg Shell Thickness, EW = Egg Weight, YC = Yolk Colour, YH = Yolk Height, AH = Albumen Height, EL = Egg Length, EWd = Egg Width, ESI = Egg Shape Index, HU = Haugh Unit

Table 6: Least square means (±s.e.) of egg quality traits of parent chickens

Effects and levels	AEST	EW	YC	YH	AH	EL	EWd	ESI	HU
Genotype	***	***	NS	***	***	***	***	NS	***
F	0.33±0.01	42.5±0.5	4.9±0.1	16.6±0.1	5.4±0.2	50.2±0.2	38.6±0.2	76.9±0.5	78.1±1.1
R	0.29±0.01	58.0±0.6	4.7±0.1	18.2±0.1	9.6±0.2	56.7±0.2	43.4±0.2	76.6±0.5	96.8±1.1
Age (Genotype)	*	NS	**	***	***	**	***	**	***
F (8 month)	0.33±0.01	40.6±0.7	5.0±0.2	17.0±0.2	5.9±0.3	49.9±0.3	37.9±0.2	75.9±0.6	82.4±1.5
F (12 month)	0.34±0.01	44.4±0.7	4.7±0.1	16.1±0.2	4.9±0.3	50.5±0.3	39.2±0.2	77.7±0.6	73.7±1.4
R (8 month)	0.31±0.01	57.3±0.9	5.1±0.2	18.6±0.2	9.3±0.3	57.3±0.4	43.5±0.3	75.9±0.7	95.7±1.9
R (12 month)	0.29±0.01	58.7±0.7	4.3±0.2	17.9±0.2	9.9±0.3	56.1±0.3	43.3±0.2	77.3±0.6	97.9±1.4
Variance component									
Pen	0.0001	0	0	0	0.1	0	0.01	0.5	3.1
IdNo	0.0003	0	0.1	0.2	0^2	0.1	0.7	3.4	0
Residual	0.001	26.4	1.2	1.1	2.8	4.5	1.7	10.4	80.3

*** = p≤0.001, ** = p≤0.01, * = p≤0.05, NS = Not Significant, AEST= Average Egg Shell Thickness, EW = Egg Weight, YC = Yolk Colour, YH = Yolk Height, AH = Albumen Height, EL = Egg Length, EW = Egg Width, ESI = Egg Shape Index, HU = Haugh Unit

setting (Shanawany, 1987; Narushin and Romanov, 2002; Khurshid *et al*., 2003; Saatci *et al*., 2005).

Although RW crosses had higher hatching weight, the growth of FN cross chicks were much faster than RW crosses, which resulted in higher body weight and body weight gain for FN cross chicks (Table 3 and Fig. 1). However, as both crosses grew older, the difference in body weight became smaller and insignificant. Grown RW crosses had relatively lower body weight than FN crosses, but they still had significantly higher body weight gain (Table 3); this may be due to the relatively higher body weight gain of male RW crosses (Fig. 2). The reason for the zero variance estimated in BWG for the effect of IDNo in Table 3 and likewise the zero variance component results in other tables, may be due to no or little relationship between the variance component and the different measurement periods.

The final body weight of crosses from lighter Fayoumi dam was expected to be low compared to the crosses with heavier RIR dams. However, in the present study Fayoumi was mated with much heavier and fast growing Naked Neck cocks while RIR was mated to lighter and

Table 7: Least square means (±s.e.) of Age at First Egg (AAFE) in days, Egg Number (EN), Hen Housed Egg Production (HHEP), Egg Mass (EM), Body Weight (BW) and Body Weight Gain (BWG) of parent chickens

Effects and levels	AAFE	EN	HHEP	EM	BW	BWG
Genotype	***	***	***	***	***	***
F	201.9±3.2	46.2±1.7	46.2±1.9	1946.9±76.5	1001.7±14.9	163.5±17.3
R	236.9±3.3	23.2±1.8	21.6±1.9	1375.5±80.6	1235.2±15.0	238.9±17.4
Age (Genotype)		***	***	***	***	***
Start of lay to 8 months (F)		29.6±1.9	29.6±2.3	1188.5±88.4		
8 months to 12 months (F)		62.8±1.9	62.8±2.3	2705.3±88.4		
Start of lay to 8 months (R)		12.1±2.2	9.9±2.3	720.1±99.9		
8 months to 12 months (R)		34.4±1.9	33.3±2.3	2030.4 ±89.5		
Variance component						
Pen	16.9	6.2	13.8	11651	242.3	838.7
IdNo		51.9		117710	7026.3	0
Residual	449.2	104.7	17.3	234353	11908	18797

*** = $p \leq 0.001$, NS = Not Significant

Table 8: The number of chickens alive at different stages of growth

	FN crosses	Mortality (FN)	RW crosses	Mortality (RW)
Number of hatched chicks (male and female)	221		196	
Number of chicks alive at 8 weeks of age	178		161	
Mortality in number and % (0-8 weeks)		43 (19%)		35 (18%)
Number of layers at 4 months of age	58		20	
Number of layers alive at 12 month of age	53		12	
Mortality in number and % (4-12 months)		5 (9%)		12 (40%)

slower growing *Netch* cocks. This might have led to a boost in the final body weight of Fayoumi crosses and likewise a decrease for RIR crosses, which eventually made the body weights of the two crosses insignificantly different. In a study by Zaman *et al*. (2004) crosses of Fayoumi and Naked Neck resulted in insignificant body weight compared with crosses of RIR and Naked Neck genotypes on 2 out of 3 measurements done at different ages. This is comparable with the present study in that Fayoumi crosses grew faster and reached nearly the body weight of RIR crosses. This is also in agreement with the conclusions given by various researchers that chickens carrying Naked neck have relatively high growth rate (Merat, 1990; El-Safty, 2006; Islam and Nishibori, 2009).

Egg production and quality: Age at first egg was reduced by a few days in the FN crosses and by more than a month in the RW crosses, compared to their respective female parents. Related studies have also reported that age at first egg was reduced by a few days in crosses of Fayoumi and RIR with Naked Neck chickens (Zaman *et al*., 2004, Islam and Nishibori, 2009).

The overall mean of egg number produced from start of lay to 12 months of age was not different between the F1 crosses, but different from the parent breed. Egg number of FN crosses was lower than Fayoumi hens (Table 4 and 7). In a study by Zaman *et al*. (2004) the egg number in Fayoumi X Naked Neck was reduced by almost half compared to the pure Fayoumi parent. However, HHEP was significantly higher for FN than RW crosses and likewise for Fayoumi than RIR. This was due to lower mortality in Fayoumi (Fassill *et al*., 2009) and in FN crosses (Table 8).

Egg number for RIR hens was lower than for their RW crosses (Table 4 and 7). Moreover, the number of eggs produced by FN crosses was lower than by RW crosses between 4 and 8 months (Table 4). The reason for the increase in egg number for RW crosses could be due to the reduction in age at first egg, which made them start laying earlier and enabled them to produce higher number of eggs between 4 and 8 months of age. But FN crosses produced more eggs than RW crosses between 8 and 12 months of age. Similar difference was observed for egg mass and this was due to the difference in number of eggs produced at different age (Table 4).

Percent hen-day egg production in Fig. 3 shows that both F1 crosses reaches a peak in production at the age of 9 months, although RW shows a slightly higher peak at the age of 12 months. As the recording stopped after 12 months of age it is not possible to predict what the egg production trend would be for the next few months.

There was no significant difference in any egg quality trait between the two F1 crosses, whereas RIR was higher in most of these traits when compared to Fayoumi (Table 5 and 6). Crossing of Fayoumi and RIR with Naked neck and Netch cocks respectively reduced the mean value of most egg quality traits, except yolk colour for both F1 crosses and egg length and egg weight for FN crosses. Zaman *et al*. (2004) also recorded an increase in yolk colour based on Roche colour fan scale but a reduced value for other egg quality traits for Fayoumi X Naked Neck cross. Although the improvement in yolk colour was in accordance with the consumer preference in Ethiopia for yellowish yolk colour; this trait is probably more easily affected by the type of feed the chickens are consuming (Fassill *et al.*, 2009).

Mortality: Mortality records showed that FN crosses were found to survive better than RW crosses. Since anti-bacterial and anti-coccidial medicines were provided as soon as signs of illness were observed, no prevalent infectious diseases were identified during the whole experimental period. The death of chickens was mainly due to some bacterial and/or coccidial infections just before administering the medicines. Moreover, although heritability of total mortality in chickens is low (Gavora, 1990), this experiment shows that there is a relationship in mortality percentage between female parent breeds and F1 crosses. According to Fassill *et al.* (2009) there was no mortality in Fayoumi chickens compared to RIR chickens during the experiment laying period, which may be related with relatively lower mortality in FN than RW crosses.

Conclusion: Egg production and body weight of F1 crosses were higher than for the local chickens kept under farmer's condition (Fassill *et al.*, 2009), which indicates that cross breeding has potential for improving economically important traits. This improvement is likely to be very important since farmers in the village will economically benefit from both the increased egg production and the heavier body weight of the chickens. FN crosses survived better than RW, which in turn resulted in higher egg productivity expressed as HHEP. The study also generated useful information that will be utilized in the analysis of the performance of the final 4-way synthetic chicken population. Because of the genetic difference between local and exotic chicken breeds it was expected that heterosis in some of the production traits would be found. In the present study, however, no on-station production data was available on indigenous chickens and it was thus not possible to compare the crossbreds with the indigenous parental lines and consequently heterosis could not be evaluated. The F1-crosses will be used to produce synthetic breed, which will be tested both on-farm and on-station.

ACKNOWLEDGMENTS

The authors are grateful for the financial support by Norwegian Development Organization (NORAD), Operational Research (Ireland) and Hawassa University (Ethiopia). All facility and other technical support by Norwegian University of Life Sciences (Norway) and Hawassa College of Agriculture (Ethiopia) are also highly appreciated.

REFERENCES

Alemu, Y., 1995. Poultry production in Ethiopia. World's Poult. Sci. J., 51: 197-202.

Ali, K.O., A.M. Katule and O. Syrstad, 2000. Genotype X Environment interaction for growing chickens: Comparison of four genetic groups on two rearing systems under tropical condition. Acta Agriculturae Scandinavica, Section A-Animal Sciences, 50: 65-71.

Barua, A., M.A.R. Howlider and Y. Yoshimura, 1998. A study on the performance of Fayoumi, Rhode Island Red and Fayoumi X Rhode Island Red chickens under rural condition in Bangladesh. Asian-Aust. J. Anim. Sci., 11: 635-641.

El-Safty, S.A., 2006. Influence of naked neck, frizzle, crest genes and their triple segregation on productivity of layer chickens under hot environmental conditions. Egypt Poult. Sci., 26: 1253-1267.

Fairful, R.W. and R.S. Gowe, 1990. Genetics of egg production in chickens, In: Crawford, R.D. (Ed.), Poultry breeding and genetics. Elsevier Science Publishers, Amsterdam, pp: 705-759.

Fassill, B., M.G. Hans, K. Jessica, A. Tormod and A. Girma, 2009. Genotype X environment interaction in two breeds of chickens kept under two management systems in southern Ethiopia. Tropical Anim. Health Prod., 41: 1101-1114.

Gavora, J.S., 1990. Disease genetics, In: Crawford, R.D. (Ed.), Poultry breeding and genetics. Elsevier Science Publishers, Amsterdam, pp: 805-846.

Gueye, E.H.F., 1998. Village egg and fowl meat production in Africa. World's Poult. Sci. J., 54: 73-86.

Iraqi, M.M., E.A. Afifi, A.M. Abdel-Ghany and M. Afram, 2005. Diallel crossing analysis for liveability data involving two standard and two native Egyptian chicken breeds, Livestock Research for Rural Development, 17(7) (http://www.lrrd.org/lrrd17/7/iraq17075.htm).

Islam, M.A. and M. Nishibori, 2009. Indigenous naked neck chickens: A valuable genetic resource for Bangladesh. World's Poult. Sci. J., 65: 125-138.

Khurshid, A., M. Farooq, F.R. Durrani, K. Sarbiland and N. Chand, 2003. Predicting egg weight, shell weight, shell thickness and hatching chick weight of Japanese Quails using various egg traits as regressors. Int. J. Poult. Sci., 2: 164-167.

Mekki, D.M., I.A. Yousif, M.K. Abdel Rahman, J. Wang and H.H. Musa, 2005. Growth performance of indigenous X exotic crosses of chicken and evaluation of general and specific combining ability under Sudan condition. Int. J. Poult. Sci., 4: 468-471.

Merat, P., 1990. Pleiotropic and associated effects of major genes, in: Crawford, R.D. (ed.), Poultry breeding and genetics. Elsevier Science Publishers, Amsterdam, pp: 429-467.

Narushin, V.G. and M.N. Romanov, 2002. Egg physical characteristics and hatchability. World's Poult. Sci. J., 58: 297-303.

Rahman, M.M., M.A. Baqui and M.A.R. Hwlider, 2004. Egg production performance of RIR X Fayoumi and Fayoumi X RIR crossbreed chicken under intensive management in Bangladesh. Livestock Research for Rural Development, 16(11) (http://www.lrrd.org/lrrd16/11/rahm16092.htm).

Saady, S., A. Mekky, H.I. Galal and E. Zein, 2008. Diallel crossing analysis for body weight and egg production traits of two native Egyptian and two exotic chicken breeds. Int. J. Poult. Sci., 7: 64-71.

Saatci, M., T. Kirmizibayrak, A.R. Aksoy and M. Tilki, 2005. Egg weight, shape index and hatching weight and interrelationships among these traits in native Turkish geese with different coloured feathers. Turkish J. Vet. Anim. Sci., 29: 353-357.

Shanawany, M.M., 1987. Hatching weight in relation to egg weight in domestic birds. World's Poult. Sci. J., 43: 107-115.

Statistical Analysis System (SAS), 2002-2003. SAS Institute Inc., Release 9.1, Carry. NC, USA.

Tadelle, D., Y. Alemu and K.J. Peters, 1999. Indigenous chicken in Ethiopia: their genetic potential, attempts made in the past for improvement and future areas of research. In: Proceedings of Deutscher Tropentag, Session: Biodiversity and development of animal genetic resources. Berlin, pp: 1-11.

Tadelle, D., Y. Alemu and K.J. Peters, 2000. Indigenous chicken in Ethiopia: Genetic potential and attempts at improvement. World's Poult. Sci. J., 56: 45-54.

Teketel, F., 1986. Studies on the meat production potential of some local strains of chickens in Ethiopia. Ph.D. Thesis. J.L. University of Giessen, Germany.

Tulin Cicek and Ahmet Kartalkanat, 2009. Comparison of village eggs and commercial eggs in terms of egg quality. J. Anim. Vet. Adv., 8: 2542-2545.

Zaman, M.A., P. Sørensen and M.A.R. Howlider, 2004. Egg production performance of a breed and three crossbreeds under semi-scavenging system of management. Livestock Research for Rural Development, 16(8): (http://www.lrrd.org/lrrd16/8/zama16060.htm).