American-Eurasian Journal of Scientific Research 13 (4): 74-84, 2018
ISSN 1818-6785

DOI: 10.5829/idosi.aejsr.2018.74.84

Evaluation of Cross Breeding Effect on Growth of Local Horro Ecotype Crossed with Exotic Dominant Red Barred D 922 Chickens: A Step Towards Synthetic Breed Development in Ethiopia

[1]Kedija Hussen, [2]Gebeyehu Goshu, [3]Wondmeneh Esatu and [4]Solomon Abegaz

[1]Haramaya University, P.O. Box: 138, DireDawa, Ethiopia
[2]Addis Ababa University, College of Veterinary Medicine and Agriculture, P.O. Box: Debre Zeit, Ethiopia
[3]International Livestock Research Institute, Addis Ababa, Ethiopia
[4]Debre Zeit Agricultural Research Center, P.O. Box: 32, DebreZeit, Ethiopia
[5]Ethiopian Institute of Agricultural Research (EIAR), Debre Zeit Agricultural Research Center, P.O. Box: 32, DebreZeit, Ethiopia

Abstract: Cross breeding effects on growth performance of chicken were estimated with the aim of using the information on mode of inheritance of preferred traits for further synthetic breed development program in Ethiopia. The experiment was carried out by mating foundation strains of Horro ecotype (H) and Dominant Red Barred D 922 (DRB) chickens to obtain four genotypes such as two pure lines (HxH), (DRBxDRB) and their direct (DRBxH) and reciprocal crosses (HxDRB). Chicks from each genotype were randomly distributed between pens using completely randomized design with three replications. A total of 2440 day-old chicks from the four genetic groups were randomly distributed between pens using completely randomized design with three replications. The chickens were maintained on brooding house, grower house and breeding pens until 8 weeks, 18 weeks of age and thereafter, respectively. Body weight, cumulative feed intake, feed conversion ratio and mortality were analyzed at 0, 4, 8, 12, 16, 20 and 24 weeks of age. The result revealed that highest ($P \leq 0.05$) mean body weight and better feed conversion potential was registered in pure line DRB followed by DRB×H, H×DRB and Horro ecotypes. Cumulative feed intake was comparable ($P \geq 0.05$) among genotypes. However, at 20 and 24 weeks of age higher ($P \leq 0.001$) feed intake was reported for DRB×H chicken. At all ages, highest and lowest feed conversion efficiency was observed in pure line DRB and Horro ecotype, respectively. Additive effects (A^e) for body weight was significantly ($P \leq 0.01$) positive at most age. It ranges from 8.77 to 48.22%. Hence, A^e for body weight favored DRB strain in sire line in direct additive of genes for growth traits. While, estimates of maternal effects were significantly negative. It ranges from -6.45 to-0.07 %. Hence, it suggests the use of Horro ecotype as dam line. Whereas, estimates of heterosis effects were significantly ($P \leq 0.01$) positive and ranges from 3.28 to 21.89%. These indicate the benefit of crossbreeding using the two strains to improve growth. Findings of this study can be a base for making decision on pursuing crossbreeding or synthetic breed development for village production system in Ethiopia.

Key words: Additive · Maternal · Heterosis effect · Body weight

INTRODUCTION

In Ethiopia village poultry systems with indigenous breeds contributes to more than 90 % of the national chicken meat and egg production [1]. However, they have low production outputs in terms of eggs and body weight gain [2-6]. The total poultry population in Ethiopia is estimated to be about 60 million and with regard to breed, 88.5 percent, 6.25 percent and 5.25 percent of the total poultry were reported to be indigenous, hybrid and exotic,

Cprresponding Author: Kedija Hussen Mohammed, Haramaya University, PoBox 138, DireDawa, Ethiopia.

respectively [7]. Production levels of indigenous chicken can be improved by appropriate breeding program through pure breeding or cross breeding with other local or exotic breed. To this end, many local chicken improvement programs were under taken in Ethiopia. One of the first approaches was distributing exotic chickens dominantly White Leghorn (WLH) and Rhode Island Red (RIR) with the idea of improving the productivity of local birds. According to Permin [8], this scheme usually failed to work due to the fact that the introduced breeds could not adapt to the hot climate, low feeding and extensive management. In addition, this approach involved crossing of unselected indigenous chicken to different levels of exotic blood.

The government of Ethiopia developed Livestock Master Plan (LMP) to support family poultry systems and improve the livelihood of the poor farmer at large. It was a step wise improvement program including phenotypic, performance and genetic characterization of local chicken. As clearly indicated by the LMP, cross breeding is taken as one of the ways in the improvement program of livestock genetic gains in general and poultry breeding in particular [9]. The crossing between the adapted local chicken and exotic standard breeds would allow exploiting the rusticity of first and the productive performances of the later at a time in tropical environment to produce adapted and more productive genetic types [10]. This crossing could consequently, allow higher genetic gains in shorter time and therefore reach the objectives of the crossing more quickly.

With the objective of upgrading the performance of local ecotypes, a pure breeding program was initiated at Debre-Zeit Agricultural center in 2008. Horro ecotype is the first indigenous chicken which entered into a breeding program in order to improve growth and egg production through selective breeding. To this end, on station comparative analysis of growth performance of the base population [3] and subsequent 7 selected generations [6] indicated a positive trend with advance in generations.

In addition, comparative performance analysis was undertaken between Horro ecotype at the 7th generation of selection and commercial exotic breeds at Debre Zeit Agricultural Research Center and under on farm management conditions [6]. The body weight of Horro ecotype at 20 weeks age under on station management condition was lower (964.2 g) than commercial breeds (1629.6g). Similar result was obtained for the comparison of body weight (684.8 g) at 20 weeks of age under on farm management condition. In this comparative analysis, even if Horro ecotype shows huge improvement on station over seven generations, the growth rate was far less than the exotic breeds. Hence, this proves that the indigenous chickens required alternative breeding program that strongly ensures expediting the improvement in performance of local chickens. Key to this is formation of synthetic breeds through crossbreeding program along with environmental modification and it could be taken as one of the good options for the current improvement program of the local ecotype.

Crossbreeding of indigenous chickens with fast-growing commercial birds will make full use of natural selection for resistance and artificial selection for productivity in exotic chickens [11]. The optimal crossbred chicken would have higher growth rate, feed conversion efficiency, reproductive and carcass performance than indigenous, without sacrificing adaptation to the local environment [12].

In addition, cross-breeding has been a major tool worldwide in developing present-day commercial chicken breed development program. Synthetic breed development using local ecotypes crossed with exotic chicken will be advantageous to develop appropriate native-type birds with higher production potential to village production system [13]. Comparatively, little research and development work has been carried out on synthetic breed development from local chicken ecotypes in Ethiopia.

Hence, the present research was a step towards synthetic breed development for village production system in Ethiopia using Horro ecotype crossed with exotic breed Dominant Red Barred D 922 in direct and reciprocal crosses. In this regard the effect of crossbreeding on direct additive, maternal additive and heterosic effects on growth performance of chicken were studied.

MATERIAL AND METHODS

The study was undertaken at Debre Zeit Agricultural Research Center (DZARC) which is located 45 km south east of Addis Ababa, at an altitude of 1900 meters above sea level and at 8.44°N latitude and 39.02° E longitude. The area has a bimodal rainfall pattern with a long rainy season from June to October and a short rainy season from March to May. The average annual rainfall and average maximum and minimum temperature for the area are 1100 mm and 28.3 °C and 8.9 °C, respectively [14].

Breeding Plan: The present work was done based on the previous pure breed selection scheme initiated in 2008 to improve growth and egg production of Horro ecotypes. Exotic breed of Dominant Red Barred D 922 (DRB) chickens were imported from Check Republic by DZARC. Hence, the project was started with the crossing of already imported DRB with the improved local Horro (H) ecotype obtained from the ninth generation of selection in direct and reciprocal crosses. The crossbreeding study was started by randomly picking 180 hens and 36 cocks as a foundation from each of the two strains. Each strain was randomly divided into two groups of 90 hens each to be mated with their own or the other strain. The two groups were pure line (H?×H? and DRB? × DRB?), while the other two groups were local crossed with exotic birds in direct and reciprocal crosses (H ? × DRB? and DRB? × H?) to produce the first filial (F_1) generation. The four genotype groups were managed in different pens.

Eggs from the four genetic groups were collected on a daily basis and marked and stored for 10 days to be incubated to get uniform age groups. A total of 2440 unsexed day-old chicks were obtained from all genetic groups. Chicks from each genotype were randomly distributed between pens using completely randomized design with three replications. The day-old chicks were penned in a brooding house and reared for 8 weeks. At week 8, sexing and separation of the males from the females was performed phenotypically via external characteristics (comb size and tail, feather shape) and kept in the ratio of 1 male to 5 females in each pen. The chickens were reared in growing house to 18 weeks of age and then both male and female were transferred to breeding pen.

Management of the Experimental Chicken: All chickens were managed by one person to minimize environmental variation. The birds were provided with water ad libtum and standard feed were provided as per the requirement at each specific growth stage (age). Starting chicks were fed on ration of 20% CP and 2,950 kcal/kg for up to 8 weeks and the growers ration were 18% CP and 2,850 kcal/kg and provided from 8-18 weeks. The chickens were provided with natural lighting after 8 weeks of age. From 18 weeks on ward the birds were reared in deep litter house and provided with layer’s ration (17–18% CP and 2,750 kcal/kg). All chickens were inspected daily for their health status and vaccinations were provided against Newcastle and Marek’s diseases at one day old, Gumboro at 1 week and fowl pox at 10 weeks of age.

Table 1: Number of sires and dams used for the analysis of growth traits of chickens

Genotypes*	Sires	Dams	Number of progenies
H×H	18	90	700
DRB×DRB	18	90	420
H×DRB	18	90	630
DRB×H	18	90	690
	72	360	2440

*Sires are listed first in the crosses

Parameters That Were Considered for the Analysis: Data collection was performed as per the following procedure:

- Live Body weight was measured collectively in a group per pen using sensitive balance. Weight was taken at hatching (0 day) and every week thereafter up to 45 weeks of age. Average body weight per pen was calculated for weights at hatch, 4, 8, 12, 16, 20 and 24 weeks.
- The amount of feed offered and refused per pen was recorded daily at the same time.
- Cumulative feed intake and body weight gain recorded on weekly bases was summarized to calculate feed conversion ratio (FCR) at different age. Body weight gain was calculated as actual body weight at the specific period minimize from body weight at hatch.

$$FCR_{(g/g)} = \frac{\text{Cumulative feed consumed (g)/hen/week}}{\text{gram body weight gain/hen/week}}$$

*Both sex was considered for all growth traits of average body weight, commutative feed intake and feed conversion ration. Data was estimated on group basis per pen.

Statistical Analysis: The General Linear Models procedure of SPSS version 21 [15] was used for analysis of the data. Multiple mean comparisons on traits were analyzed to determine the differences among breeds with their respective age. The Least significant difference (LSD)-test was used for estimation of mean values with statistically significant differences at $P \leq 0.05$.

General Linear Model:

$$Y_{ijk} = \mu + g_i + e_{ijk} \qquad \text{(Equation 1)}$$

where:

Y_{ij} = Observation of the k^{th} population, of the i^{th} genotype,

μ - Grand mean of the trait
g_i - Fixed effect of the i^{th} genotype (i=1-4)
e_{ij} - Random error

Crossbreeding Parameters: Direct additive effect (A^e), maternal additive effect (M^e) and direct heterosis (H^e) were analyzed by means of Software Package CBE [16] following the model of Dickerson [17].

Estimation of Different Crossbreeding Components (Equation 2)

Direct Additive Effect (A^e): ½ [(DRB × DRB)-(H × H)] - [(H ×DRB) - (DRB× H)]

Maternal Additive Effect (M^e): ½ [(H ×DRB) - (DRB× H)]

Direct Heterosis (H^e): ½ [(H × DRB) + (DRB x H)] – [(H × H) + (DRB × DRB)]

Percentage of each effects (% A^e, M^e and H^e) were calculated using mean estimate of each crossbred effect (additive or maternal or hetrosis) divided by mean of the pure line multiplied by 100.

$$\text{i.e } \%A^e = \frac{\text{mean of } A^e}{\text{mean of (HxH)+ (DRBxDRB) /2}} * 100$$

Estimation of mean values for breed and age were compared using t-test with significant differences at $P \leq 0.05$.

RESULTS

The mean values for body weight, cumulative feed intake, feed conversion ratio and mortality at various age intervals for different genotype groups are presented in Table 2. Both sexes were considered in analyses of body weight gain. The result indicates that body weight gain at different week of ages were significantly ($P \leq 0.001$) affected by genotypes. Highest average day-old weight was registered in DRB (42.25g) than the Horro ecotypes (28.70g). In the current report, in comparing the crossbred genotypes, DRB×H (39.26g) shows better growth performance than crossbred chickens of H×DRB (34.52g).

The mean values for body weight gain at all the ages studied were higher for pure line DRB than other genotypes. Horro ecotype shows significantly ($P \leq 0.001$) lower body weight than the crossed chicken of H×DRB as well as its reciprocal crosses at all age. In general, crossbred chickens shows improved growth performance than the pure line Horro ecotype at all studied age.

Estimation of cumulative feed intake among genotype at different weeks of age is presented in Table 2. In most age, non-significant difference among genotype for cumulative feed intake were reported, except at 20 and 24 weeks of age. At 4,8,12,16 week of age, cumulative feed intake was comparable ($P \geq 0.05$) among genotypes. In comparing the pure genotypes, in most age no significant different were reported in cumulative feed intake, however, at 20 and 24 weeks of age Horro ecotypes shows higher ($P \leq 0.001$) commutative feed intake than pure line DRB. In comparing the crossbred chickens, in most age non-significant difference was encountered, however, DRB×H chickens shows higher feed intake at 20 and 24 weeks of age than H×DRB. Similarly, in comparing the whole genotypes DRB×H chicken shows higher cumulative feed intake at 20 and 24 weeks of age.

Feed conversion ratio among genotype at different age is reported in Table 2. Significant genotype effects for feed conversion ratio at different weeks of age was found. In comparing the pure genotypes, significantly ($P \leq 0.001$) DRB chickens shows higher feed conversion efficiency at all ages. Similarly, among genotypes, pure line DRB shows higher significant ($P \leq 0.001$) feed conversion performance than the pure line Horro ecotypes as well as their crosses. While, from the crossbred genotypes at all weeks of age DRB×H shows better feed conversion potential than H×DRB. Whereas, DRB×H genotype shows relatively better feed conversion potential next to pure DRB. In all genotypes (Table 2) feed conversion was better at early age of rearing period of 4 and 8 weeks than later age of growing period. At rearing period of 4 to 24 weeks of age, significantly ($P \leq 0.05$) pure line DRB shows better feed conversion potential whereas lower performance was recorded on pure line Horro ecotype.

As indicated in Table 2, in most age significant ($P \leq 0.05$) mortality different were reported among the genotypes. Almost in all age DRB genotypes shows highest mortality record and the least mortality percent were reported on cross breed chicken of DRB×H.

Cross Breeding Effects: Direct additive, maternal additive and heterosis effect for body weight from day-old to growing age of 24 weeks are presented in Table 3. Additive effects (A^e) for body weight gain indicated that there was positively highly significant ($P \leq 0.001$ at BW8,12 and 16; $P \leq 0.01$ at BW0, 20 and 24) effect among the genotype at all age and it ranges from 8.77 up to 48.22%. Highly significantly positive additive effects were reported at age of BW4 (48.22%) and the least contribution of additive effect on body weight were reported at BW20 (8.77%).

Table 2: Means and ±SE for growth traits in Horro ecotypes (H), Dominant Red Barred D 922 (DRB) and their reciprocal crossbred chickens

	Genetic groups of chicken				
Traits	DRB[A] × DRB	H[A]×H	DRB[A] × H	H[A] × DRB	p-value
BW(g) 0	42.25±0.65[a]	28.70±0.94[d]	39.26±0.22[b]	34.52±0.82[c]	0.000
4	328.23±11.42[a]	134.63±0.83[d]	297.03±8.41[b]	266.24±10.61[c]	0.000
8	654.41±6.21[a]	341.42±10.93[d]	625.22±28.83[a]	577.86±43.24[c]	0.000
12	996.46±1.18[a]	613.94±15.36[d]	898.32±0.52[b]	859.99±3.54[c]	0.000
16	1389.17±4.19[a]	984.25±2.53[d]	1292.56±3.71[b]	1158.56±21.91[c]	0.000
20	1645.43±3.37[a]	1198.58±5.14[c]	1602.91±48.39[a]	1490.36±3.92[b]	0.000
24	2056.52±11.23[a]	1480.19±19.04[c]	2048.52±30.13[a]	1823.45±34.01[b]	0.000
CFI (g) 4	586.14±1.99	592.73±1.11	594.22±2.39	588.46±4.43	0.221
8	1702.69±2.19	1780.20±40.52	1780.39±30.15	1809.79±0.46	0.071
12	3402.82±34.24	3449.83±56.50	3256.69±115.13	3455.01±31.49	0.082
16	5261.43±61.48	5478.81±125.69	5403.46±57.87	5453.68±92.84	0.371
20	6752.88±50.41[d]	7353.29±176.08[c]	7991.93±57.76[a]	7935.48±32.99[b]	0.000
24	9977.32±1.46[d]	11108.68±63.01[b]	11540.01±321.86[a]	10887.27±153.18[c]	0.001
FCR(g/g)4	2.06±0.08[d]	5.59±0.03[a]	2.30±0.07[bc]	2.55±0.13[b]	0.000
8	2.78±0.02[d]	5.75±0.34[a]	3.04±0.12[bc]	3.37±0.26[b]	0.000
12	3.57±0.03[d]	6.08±0.25[a]	3.79±0.14[c]	4.19±0.04[b]	0.000
16	3.90±0.06[d]	5.73±0.14[a]	4.31±0.06[cd]	4.86±0.18[b]	0.000
20	4.21±0.02[d]	6.29±0.15[a]	5.12±0.17[bc]	5.45±0.01[b]	0.000
24	4.95±0.02[d]	7.66±0.12[a]	5.74±0.09[c]	6.08±0.06[b]	0.000
Mortality (%) 4	12.30±1.61[a]	0.66±0.66[d]	7.99±0.58[b]	2.35±0.91[c]	0.000
8	14.57±2.90[a]	5.59±0.20[c]	8.43±1.12[b]	1.73±0.97[d]	0.003
12	9.93±0.31[a]	2.45±0.27[c]	6.54±0.24[b]	0.46±0.48[d]	0.000
16	11.42±4.07[a]	6.67±0.68[c]	9.51±3.43[b]	2.48±1.53[d]	0.036
20	14.50±2.95[a]	4.27±1.44[c]	11.91±2.49[b]	2.50±2.51[d]	0.015
24	10.02±2.04[a]	4.83±0.42[c]	3.33±3.33[d]	7.85±2.62[b]	0.05

[A]Males are listed first in crosses; BW0=body weight at hatch,4,8,12,16,20,24=body weight at 4,8,12,16,20, 24 weeks of age respectively; CFI=cumulative feed intake; FCR=feed conversion ratio; [a,b,c,d] means with in a raw with different superscript different significantly; SE: standard error of mean

Table 3: Estimation of additive, maternal and heterosis effects (Mean± SE) for body weight at different ages of Horro ecotypes (H), Dominant Red Barred D 922 (DRB) and their crossbred chickens

Traits	Additive[1]	%	Maternal	%	Heterosis	%
BW0	9.14±0.45**	25.79	-2.37±0.43*	-0.07	1.41±0.92	4.09ns
BW4	112.20±14.70**	48.22	-15.39±9.47ns	-6.45	50.20±7.41	21.89*
BW8	180.18±4.92***	36.21	-23.68±9.38ns	-4.75	103.62±41.50	21.03ns
BW12	210.42±5.81***	26.15	-19.16±1.61**	2.38	73.96±9.94	9.21**
BW16	269.46±8.04***	22.71	-67.00±9.30*	5.64	38.84±13.36	3.28ns
BW20	279.69±29.40**	8.77	-56.27±25.25ns	-3.96	124.63±24.11	8.77*
BW24	400.70±29.73**	22.67	-112.53±31.39ns	-6.37	167.63±8.09	9.48**

BW0,4,8,12,16,20,24=body weight at hatch,4,8,12,16,20,24 weeks of age respectively; [1]Percentage calculated as (mean estimate of each component (additive or maternal or hetrosis)/ (HxH+DRBxH)/2) x100

Estimates of maternal additive effects (M^e) were negative (at all age) and significant at 0, 16 ($P\leq0.05$) and 12 ($P\leq0.01$) weeks of age. However, non-significant effect was reported at the age of 4, 8, 20 and 24 weeks. Estimate of M^e was ranging from -6.45% to -0.07 (Table 3).

Estimate of heterosis effects in the present study shows a substantial effect on body weight. At most age, estimates of H^e were positive and highly significant at 4 ($P\leq0.05$), 12 ($P\leq0.01$), 20 ($P\leq0.05$) and 24 ($P\leq0.01$) weeks of age and ranged from 2.24 to 21.86%.

DISCUSSION

Body weight gain at day old age was significantly ($P\leq0.001$) different among genotypes. Highest average day-old weight was registered in pure line DRB (42.25g) than Horro ecotypes (28.70g). Similarly, significant higher day-old body weights of exotic chickens (RIR, 35.2g) than Ethiopian ecotypes (which ranges from 25.5 to 29.3 g) were reported by Halima *et al*. [18]. However, the current report is higher day-old weight for Horro ecotypes was observed than the report of Dana [19] which was 24.7 g at day old age for Horro ecotype at base population. The improved body weight gain observed in the current report for Horro ecotypes may be the positive trend encountered through generation interval (the current report for Horro ecotype was at 10th generation). In the present report, from the crossbred genotypes, DRB×H (39.26g) shows better performance for day old age than crossbred chickens of H×DRB (34.51g). This result indicates that crossbreeding has impact on improving body weight of local Horro with almost 10g at day old age. In comparing the whole genotype pure line DRB shows higher weight at day old age followed by DRB×H H×DRB and Horro ecotypes. Similarly, Keambou *et al.* [20] reported that the weight at hatching among local, exotic ad their crossbreds genotypes was significantly different ($p = 0.05$) and higher day old weight was reported for exotic pure bred Hubbard chicken. Significant body weight differences at day old age among genotypes may be due to larger egg weight of DRB chickens than other genotypes and it shows observed impact of hetrosis effect on crossbred chicks. Similarly, Teketel [21] indicates that the hatching weights of chicks followed the egg weight pattern in the parental population. Similarly Haq *et al*. [22] indicated that egg weight has positive relation with body weight of chicken for Dokki and Fayoumi breeds. Accordingly, Sola-Ojo *et al*. [23] found the positive and significant inter-correlation between body weight of Fulani ecotype chicks obtained from small and medium egg size. In addition, Wilson [24] pointed out that chick weight composes of 62 to 78% of egg weight hence egg weight loss affects chick weight.

There were significant ($P \leq 0.001$) differences for body weight gain occurred at all age groups among genotypes. The obtained results were consistent with the findings of Taha *et al*. [25], Olawumi and Fagbuaro [26] and Wondmeneh [6] who reported marked strain or breed differences for body weight. Binda *et al.* [27] also reported that body weight at various ages among the improved breed and local ecotypes of chickens differ significantly. The mean values in all the ages studied were higher for pure line DRB than other genotypes. Horro ecotypes shows lower body weight at all age than the crossbred, H×DRB as well as its reciprocal crosses ($P \leq 0.001$). This result is agreed with report of Munisi *et al*. [28] that the body weight of exotic chicken was higher than indigenous chickens and their crossbreds. Similarly, other report also confirms the higher body weight difference of the exotic chicken over the local chicken. Mikulsk *et al.* [29] observed a high weight difference ($P<0.01$) between a fast growing and slow growing chicken breed. This confirms the observation that the highest performance is expected in the breed (exotic DRB) which had been selected purposely for higher performance in that trait. In the current report body weight gain of the Horro ecotype at the age of 8 weeks and 12 weeks were lower (341.42g and 613.94g) than the report of Wondmeneh [6] which was 428.9g and 742g, respectively. However, in the consecutive age of 16 and 20 weeks the current report shows higher performance. Accordingly, in comparative analysis, Tadelle *et al*. [30] indicates that the local ecotypes at eight weeks of age (212g) shows lower body weight again than the Fayomine chicks on station management, which is lower than the current report for Horro ecotype.

The mean body weight gain of Horro ecotype at 12 weeks of age (613.94g) was lower than DRB (996.46g), DRB×H (898.32g) and H×DRB (859.99g). However, the current report is higher (485.5g) than the report of Dana [19] for Horro ecotypes and Tadelle *et al*. [30] for Ethiopian chickens (405g) at 12 weeks of age. In general, the current report proves the higher performance of the crossbred chickens of DRBxH and HXDRB than the pure line Horro ecotypes at all studied age. This result showed similarity to the findings of Wondmeneh [6] that the crossed breed chicken (RIR with Horro) in body weight gain shows superior performance than the improved Horro ecotypes at all age groups. Accordingly, Adedokun and Sonaiya [31] reported the better performance of crossbred male chicken of Dahlem Red with Fulani ecotype (508g) and its reciprocal crossbred chicken (390g) than Fulani (283g) native chicken at the age of 8 weeks in Nigeria. Similarly, report by Padhi *et al.* [32] in India indicated that the native chicken (212) body weight at week 8 was significantly lower than the crossbred of white leghorn with Brown Nicobari chcicken (WLH × BRN, 269g). Similarly, study conducted by Kayitesi [33] indicate that breed is one of the factors that significantly affected body weight of chickens at all ages from hatching to the end of the study (20 weeks).

Generally, significant genotype effects on growth performance of chicken were reported by several authors [18], [34-36]. Other report also proves the higher performance of the crossbred chickens than the native chicken at the age of 20 weeks [31], [32]. In addition, Alewi and Aberra [37] reported that local Kei performance could be improved by using the crossbreeds of Fayoumi and local Kei native chicken breeds. The significant difference for body weight observed in the current report is an indication that genotypes have different genetic potentials for growth.

At 4,8,12,16 week of age, cumulative feed intake was comparable ($P \geq 0.05$) among genotypes, However, at 20 and 24 weeks of age higher ($P \leq 0.001$) feed intake was reported for DRB×H chicken among the genotypes. In comparing the pure genotypes, in most age no significant different were reported in feed intake, however, numerically Horro ecotypes shows higher commutative feed intake than pure line DRB. Similarly, Wondmeneh [6] indicates that cumulative feed intake was highest for Horro ecotypes at the age of 8 and 12 weeks but at later age of 16 and 20 weeks of age Horro ecotypes shows the lowest (5030.6g and 6837.6) feed intake than the pure exotic (5752.1g,7368.0), as well as crossed (5100.6g and 6912.0g) genotypes. Significant breed effect on feed intake among chickens have been reported by Tadelle *et al*. [30] but this report shows the higher feed consumption of the exotic chicks (Fayoumi) than Ethiopian ecotypes of *Chefe* and *Jarso* chicken. The lower cumulative feed intake of the DRB genotype in the current report may be the incidence of Newcastle diseases in the farm in which Horro ecotypes recovered more quickly than the exotic DRB chicken genotype.

Feed conversion has significant different among the genotype. In all genotypes, feed conversion was better at early age of rearing period of 4 and 8 weeks than later age of growing period. Similarly, other reports [6, 38, 39] also show the same trend that feed conversion potential is higher at early age than in advanced age. At all ages, among genotypes, pure line DRB shows better feed conversion potential whereas lower performance was recorded on pure line Horro ecotype. The result is agreed with the report of Kayitesi [33] who indicated that the Kuroiler chickens were significantly more efficient in feed conversion at all phases of growth compared to local chickens. This different among the pure line genotype in the current report shows the importance of crossbreeding program. Whereas, DRB×H genotype shows relatively better feed conversion next to pure line DRB genotype.

In addition, the current report confirmed that feed conversion was better in crossbred chickens than the Horro ecotypes at all studied age. This explains the positive impact of crossbreeding program on improving the growth traits of local chicken. Similar findings were reported by different authors [6, 18, 30] that shows the higher feed conversion potential of the exotic as well as crossbred chicken than the local ecotypes in Ethiopia under similar on station management conditions. Accordingly, the report of Aengwanich [40] indicates that feed conversion of crossbred chickens was better than the indigenous chicken. Hence, the current result shows a large variation in growth and feed utilization potentials between pure line genotypes and crossbred genotypes which agrees with other previous reports from Ethiopia and other countries [1, 34-36, 41].

In general, the current result confirmed that genotypes had significant impact on growth traits of chicken. In comparing the whole genotypes pure DRB that was selected for high growth rate, have the best performance in terms of body weight gain and feed conversion efficiency followed by DRB×H, H×DRB than the pure Horro ecotype. These results show that crossbreeding provided offspring with higher potentials of growth traits when compared to purebred local Horro ecotypes chicken. Similarly, the report of Cruz1 *et al*. [42] indicates that crossbred chicken of indigenous with exotic chicken performs well and higher values of weight gain, feed intake and feed conversion were observed.

Almost in all age DRB genotypes shows highest mortality record and the least mortality percent were reported on cross breed chicken of DRB×H. Hence, cross breeding program may have impact on decreasing mortality on chicken. Similarly, other report also shares this result that cross-breeding improved chicken viability [43-45].

However, Halima *et al*. [18] in this regards found that Rhode Island Red survive better than the local breed under intensive management system. The current result also pointed out that there is genotypes effect on mortality rate. Similarly, Awobajo *et al*. [47] found that mortality rate significantly ($P<0.001$) differed between two breeds of broiler from brooding to maturity stage. These findings are different from the results of Kayitesi [33], in which Kuroiler and Local chickens showed no difference on the survive rate. However, the recent report for mortality were higher than report of Wondmeneh [6] indicates that 97 and 98.8 % survival rate for Horro and RIR×Horro ecotype respectively under on station management. The reason for high mortality in the current research could be due to the incidence of Newcastle diseases during the experimental period. In general, the current results showed that DRB×H showed better performance in growth traits and survival ability than crossbred chickens of H×DRB and Horro ecotype.

Additive effects (A^e) for body weight gain was positive and highly significant among the genotype at all age and it ranges from 8.77 to 48.22%. These highly significant and positive additive effects on body weight favored the use of DRB strain at sire line than H ecotype. Similarly, estimates of direct additive effect for growth performance at the age of 4 and 8 weeks for Alexandrian chicken were 22.43 and 56.16, respectively. Accordingly, Iraqi *et al*. [48] reported that the positive significant additive effect for body weight gain of Mandarah and Matrouh local chickens which ranges from 2.1 to 10.6 to %. Lalev *et al*. [49] indicates that estimates of direct additive effects in cross breeding two white Plymouth rock lines chickens for body weight from the age of 2 to 10 weeks were positive and highly significant ($P \leq 0.01$) and ranges 4.89 to 15.23%. Likewise, Iraqi *et al*. [50] reported that additive genes had a positive effect on growth with estimates on body weight between 2.22 and 10.4% from 1 to 10 weeks of age.

Estimates of maternal additive effects (M^e) on body weight gain were negative and significant at 0, 16 ($P \leq 0.05$) and 12 ($P \leq 0.01$) weeks of age. Estimates of M^e was ranging from-6.45% to -0.07. Hence this report indicates that H ecotype is superior over DRB to be used at dam line to improve body weight gain. Similarly, Amin *et al*. [51] shows the negative (-11.44 and-28.46) maternal effect for Alexandrian chicken at the age of 4 and 8 weeks, respectively, however, positive maternal effects were observed at day old age. Lalev *et al*. [49] indicates that maternal additive effects for body weights at early age of 2 and 4 weeks were significantly ($P<0.01$) negative (- 6.11 % and -2.94 %, respectively) however, at later age of 8, 26 and 30 weeks was positive ($P<0.01$) and ranges from 2.15 and 5.24 %. In contrast to the current report, Bothaina and Ensaf [52] shows that maternal effect was positive and highly significant for daily gain during all experimental periods of 0-4, 4-8, 8-12 and 0-12 and it rangs from 0.02 to 25.42%.

Estimates of heterosis effects (H^e) in the present study shows a substantial effect on body weight. At all age, estimates of H^e were positive and ranged from 3.28 to 21.89%. Highest present of contribution were reported at 4 weeks of age (21.89%). This happen may be due to heterotic and maternal effects can importantly influence early growth rate than at later age [53]. In addition, Lamont and Deeb [54] proved the magnitude of heterosis for body weight is age dependent.

The present report was in line with Iraqi *et al*. [50] that heterosis % for body weights was positive and these estimates ranged from 6.87% to 9.05% from 5 to 10 weeks of age. Similarly, Lalev *et al*. [49] shows the important of heterosis effect for body weights at different periods of life and it ranges from 3.76-22.33 % and other reports also found significant heterotic effect on body weight traits in chickens [55, 48]. On the contrary, Hanafi and Iraqi [56] showed non-significant heterotic effects on daily gain at 8 weeks of age. The current result indicates that cross breeding using local Horro and DRB have the highest effects of heterosis for growth traits.

CONCLUSION AND RECOMMENDATIONS

Genotype has significant effect on body weight gain and feed conversion potential and significantly higher performance was reported for pure line DRB strain but with higher mortality rate. Likewise, crossbred chicken of DRB×H genotype shows higher performance in growth traits next to pure line DRB and with lower mortality rate, which are desirable characteristics for village production system. Moreover, the positive additive effects and negative estimates of maternal effect on body weight suggested the use of DRB genotype in sire line and favor Horro ecotype in dam line to improve body weight gain in crossbreeding program, respectively. Moreover, highly positive and significant estimate of heterosis effect shows the substantial impact of crossbreeding program on body weight gain using DRB and Horro ecotype. Hence, DRB× H genotype resulting in best new line chicken for the future targets of improving growth performance in breed development program in village production system in Ethiopia. However, further studies are needed on adaptability of chicken in village production system.

ACKNOWLEDGEMENTS

The author acknowledges Ethiopian Institute of Agricultural Research, Debreziet Agricultural research center for funding and providing the research material for this work. The author also appreciates Addis Ababa University for partly covering the research work. The author also thanks the experts and technical assistance of poultry case team at Debreziet Agricultural Reseach Center. I would like to acknowledge and express my sincere appreciation to my Advisors Dr.Gebeyehu Goshu and Dr.Wondmeneh Esatu and Dr.Solomon Abegaz who were there for me when I needed help and that contributed to the completion of my work.

REFERENCES

1. Tadelle D. and B. Ogle, 2001. Village poultry production system in the central high lands of Ethiopia. Tropical Animal Health and Production, 33: 521-537.

2. Halima, H.M., 2007. Phenotypic and genetic characterization of indigenous chicken populations in Northwest Ethiopia. PhD Thesis, South Africa university of Free State, Bloemfontein, South Africa.
3. Dana, N., E.H. Vander Waaij and J.A. M. Van Arendonk, 2011. Genetic and phenotypic parameter estimates for body weights and egg production in Horro chicken of Ethiopia. Tropical Animal Health and Production, 43: 21-28.
4. Matiwos H., A. Negassi and D. Solomon, 2013. Production performance of local and exotic breeds of chicken at rural household level in Nole Kabba Woreda, Western Wollega, Ethiopia. African Journal of Agricultural Research, 8(11): 1014-1021.
5. Alem T., 2014. Production and Reproduction Performance of Rural Poultry in Lowland and Midland Agro-Ecological Zones of Central Tigray, British Journal of Poultry Sciences, 3(1): 06-4.
6. Wondmeheh, E.W., 2015. Genetic Improvement in Indigenous Chicken of Ethiopia. Ph D Thesis, Wagening University, The Netherlands.
7. CSA. 2018. Agricultural sample survey (2017/18[2010 E.C.]. Report on livestock and livestock characteristics (Private Peasant Holdings). The Federal Democratic Republic of Ethiopia, Statistical Bulletin 587,V-II Central Statistical Authority (CSA), Addis Ababa, Ethiopia, April 2018
8. Permin, A., 2008. Good practices in small scale poultry production: A manual for trainers and producers in east Africa. A Consultancy Report to FAO, FAO ECTAD Regional Unit Eastern Africa, Nairobi, Addis Ababa, Ethiopia.
9. Shapiro, B.I., G. Gebru, S. Desta, A. Negassa, K. Nigussie, G. Aboset and H. Mechal, 2015. Ethiopia livestock master plan: Roadmaps for growth and transformation. A contribution to the Growth and Transformation Plan II (2015-2020). ILRI Project Report. Nairobi, Kenya: International Livestock Research Institute (ILRI), pp: 91-100.
10. Saadey, S., A. Mekky, H.I.Z. Galal and A. Zein El-Dein, 2008. Diallel crossing analysis for body weight and egg production traits of two native Egyptian exotic chicken breeds. International Journal of Poultry Science, 7(1): 64-71.
11. Adebambo, A.O., M. Adeleke, M.W.S. Peters, C. Ikeobi, M. Ozoje, O. Oduguwa and O.A. Adebambo, 2010. Combining abilities of carcass traits among pure and crossbred meat type chickens. Int. J. Poult. Sci., (9): 777-783.
12. Adebambo, A.O., 2011. Combining abilities among four breeds of chicken for feed efficiency variation: a preliminary assessment for chicken improvement in Nigeria. Trop. Anim. Health Prod., (43): 1465-1466.
13. Padhi, M.K., 2016. Importance of Indigenous Breeds of Chicken for Rural Economy and Their Improvements for Higher Production Performance. Review Article. Academic Eds, Sveinn Are Hanssen Hindawi. Publishing Corporation Scientifica, pp: 9.
14. DZARC, 2003. Debre Zeit Agricultural Research Center. Annual Research Report 2002/2003. Institute of Ethiopian Agricultural Research, DebreZeit, Ethiopia.
15. SPSS, 2012. IBM SPSS Statistics for Windows, Version 21.0. Armonk, NY: IBM Corp.
16. Wolf, J., 1996. User's Manual for the Software Package CBE, Version 4.0 (A universal program for estimating crossbreeding effects). Research Institute of Animal Production, Prague-Uhri neves, Czech Republic.
17. Dickerson, G.E., 1969. Experimental approaches in utilizing breed resources. A. B. A, 37: 191-202.
18. Halima H., F.W.C. Neser, A. de Kock and E. Van Marle-Köster, 2006. Growth performance of indigenous chickens under intensive management conditions in Northwest Ethiopia. South African Society for Animal Science Peer-reviewed paper: Proc. 41st Congress of the South African Society for Animal Science, 71. South African Journal of Animal Science, 36(5): 1.
19. Dana, N., 2011. Breeding programs for indigenous chicken in Ethiopia: Analysis of diversity in production systems and chicken populations. PhD thesis, Wageningen University, The Netherlands (2011).
20. Keambou, T.C., S. Mboumba, B.A.H. Touko, C. Bembide, T.M. Mezui, A.M.Y. Tedongmo and Y. Manjeli, 2015. Growth performances, carcass and egg characteristics of the local chicken and its first generation reciprocal crossbreds with an exotic strain in Cameroon. Adv. Anim. Vet. Sci., 3(10): 507-513.
21. Teketel, F., 1986. Studies on the meat production potential of some local strains of chicken in Ethiopia. Ph.D Thesis, J. L. Giessen University.
22. Haq, R., E. Haq and M.F. Khan, 2011. Correlation between body weight & egg weight of Dokki and Fayoumi hen in Pakistan. Journal of Basic and Applied Sciences, 7(2): 165-168.

23. Sola-Ojo, F.E., A.A. Toye, K.L. Ayorinde and O.F. Afolayan, 2011. Relationship between egg weight, hatch weight and subsequent body weight in Fulani ecotype chicken. Global Journal of Agricultural Sciences, 10(2): 103-109.
24. Wilson, H.R., 1991. Inter relationships of egg size, chick size, post-hatching growth and hatchability. World's Poult. Sci. J., 47: 5-20.
25. Taha, A.E., F.A. Abd El-ghay and M.M. Sharaf, 2010. Strain and sex effects on productive and slaughter performance of developed local Egyptian and Canadian chicken strains, Egyp. Poultry Science, 30: 1059-1072.
26. Olawumini, S.O. and Fagbuaro, 2011. Productive performance of three commercial broiler genotypes reard in the derived Savannah Zone of Nigeria. International Journal of Agricultural Research, 6: 798-804.
27. Binda, B.D., I.A. Yousif, K.M. Elamin and H.E. Eltayeb, 2012. A comparison of performance among exotic meat strains and local chicken ecotypes under Sudan conditions. International Journal of Poultry Science, 11(8): 500-504.
28. Munisi, W.G., A.M. Katule and S.H.M. Baga, 2015. Comparative growth and livability performance of exotic, indigenous chickens and their crosses in Tanzania. Livestock Research for Rural Development, 27(4).
29. Mikulski, D., J. Celej, J. Jankowski, T. Majewska and M. Mikulska 2011. Growth performance, carcass traits and meat quality of slower-growing and fast-growing chickens raised with and without outdoor Access. Asian-Australian Journal of Animal Science, 24(10): 1407-1416.
30. Tadelle, D., C. Kijora and K. Peters, 2003. Indigenous chicken ecotypes in Ethiopia: Growth and feed utilization potentials. International Journal of Poultry Science, 2: 144-152.
31. Adedokun S.A. and E.B. Sonaiya, 2002. "Crossbreeding Nigeria indigenous with the dahlem red chickens for improved productivity and adaptability," Archiv Tierzucht Dummerstorf, 45(3): 297-305.
32. Padhi, M.K., S.P.S. Ahlawat, S. Senani, S.K. Saha and A. Kundu, 2004. Comparative evaluation of White Leghorn, Brown Nicobari and their crossbred in A&N Islands, Indian Journal of Animal Sciences, 74(5): 557-558.
33. Kayitesi, A., 2015. Management systems and location effects on growth and carcass traits of kuroiler and local chickens. MSc thesis, Makerere University, Ugada, pp: 86.
34. Aly, M.A. and, N.Y. Abou El-Ella, 2006. Effect of crossing on the performance of local strains. Estimates of pure line difference, direct heterosis, maternal additive and direct additive effects for growth traits, viability and some carcass traits. Egyptian Poultry Science, (26): 53-67.
35. Abraham, L. and T. Yayneshet, 2010. Performance of exotic and indigenous poultry breeds managed by smallholder farmers in Northern Ethiopia. Livestock Research for Rural Development, 22(7). Article no 133.
36. Iraqi, M.M., M.H. Khalil and M.M. El-Attrouny, 2013. Estimation of crossbreeding components for growth traits in crossing Golden Montazah with White Leghorn chickens. International conference balnimalcon Tekirdag, Turkiye.
37. Alewi, M. and M. Aberra, 2013. Evaluating the growth performance of local kei chickens and their f1-crosses with Rhode Island Red and Fayoumi breeds in watershed areas of *Guraghe* administrative zone, southern Ethiopia. Tropical and Subtropical Agroecosystems, 16: 39-50.
38. Ramkrushna, N.P., 2011. Evaluation of production potential of three breeds of chicken and growth performance of their crossbred progenies suitable for rural farming. MSc. thesis. Anand Agricultural University, Anand, Gujarat.
39. Maliwan P., S. Khempaka and W. Molee, 2017. Evaluation of various feeding programmes on growth performance, carcass and meat qualities of Thai indigenous crossbred chickens. South African Journal of Animal Science, 47(No.1).
40. Aengwanich, W., 2007. "Effects of high environmental temperature on the productive performance of Thai indigenous, Thai indigenous crossbred and broiler chickens," International Journal of Poultry Science, 6(5): 349-353.
41. Padhi, M.K., S.P.S. Ahlawat, S. Senani, S.K. Saha and R.B. Rai, 2001. Comparative production performance of Black Nicobari, White Nicobari, synthetic broiler and their crossbreds, Indian Journal of Animal Sciences, 71(11): 1073-1074.

42. Cruz1, F.L., L.K. Saraiva, G.E. Silva, T.M. Nogueira, A.P. Silva and P.B. Faria, 2018. Growth and carcass characteristics of different crosses of broiler chickens reared under an alternative system. Ciências Agrárias, Londrina, 39(1): 317-328.
43. Nawar, M.E. and F.H. Abdou, 1999. Analysis of heterotic gene action and maternal effects in crossbred Fayoumi chickens. Egypt. Poult. Sci., 19: 671-689.
44. Nawar, M.E., O.M. Aly and A.E. Abd El-Hamid, 2004. The effect of crossing on some economic traits in chickens. Egypt. Poult. Sci. J., 24: 163-176.
45. Iraqi, M., E.A. Afifi, A.M. Abdel-Ghany and M. Afram, 2005. Diallel crossing analysis for livability data involving two standard and two native Egyptian chicken breeds. Livestock Research for Rural Development, 17(7).
46. Sunett, J., 2013. The effect of genotype and rearing system on chicken meat quality. MSc. Thesis. Stellenbosch University, South Africa.
47. Awobajo, O.K., R.T. Akinrolabu, A.A. Mako, A.O. Igbosanu and O.T. Olatokunbo, 2007. The mortality rate of two different breeds of broilers after brooding stage to maturity Middle-East Journal of Scientific Research, 2(1): 37-42.
48. Iraqi, M.M., M.S. Hanafi, A.F. El-labban and EL-Sisy, 2002. Genetic evaluation of growth traits in a crossbreeding experiment involving two local strains of chickens using multi-trait animal model. Livestock Research for Rural Development, 14(5): 2002.
49. Lalev, M., N. Mincheva, M. Oblakova, P. Hristakieva and I. Ivanova, 2014. Estimation of Heterosis Direct and Maternal Additive Effects from Crossbreeding Experiment Involving Two White Plymouth Rock Lines of Chickens. Institute for Animal Husbandry, Belgrade-Zemun. Biotechnology in Animal Husbandry, 30(1): 103-114.
50. Iraqi, M.M., M.S. Hanafi, G.M. EL-Moghazy, A.H. El-Kotait and M.H. Abdel A'al, 2011. Estimation of crossbreeding effects for growth and immunological traits in a crossbreeding experiment involving two local strains of chickens. Livestock Research for Rural Development, 23(4).
51. Amin, E.M., M.A. Kosba; Amira, E. El-Dlebshany and M.A. El-ngomy, 2013. Heterosis, Maternal and Direct Additive Effects for Growth Traits in the Alexandria Chickens. Egyptian Poultry Science Journal. ISSN: 1110-5623 - 2090-0570 (On line) Egypt. Poult. Sci., (33) (IV): (1033-1051) (1460).
52. Bothaina, Y.F.M. and E.A. El-Full, 2014. Crossbreeding components for daily gain and growth rate traits in crossing of Rhode Island Red with Gimmizah chickens. Egyptian Poultry Science Journal, 34(I): 151-163.
53. Fairfull, R.W., 1990. Heterosis. In: Poultry breeding and genetic. Eds., Crawford R.D. Elsevier Science publishers B.V. Amsterdam, Netherlands, pp: 913-933.
54. Lamont, S.J. and N. Deeb, 2001. Genetics of body composition in a novel broiler cross. In: Proceedings XV European Symposium on Quality of Poultry Meat. WPSA Turkish Banch, Ege University, Izmir, Turkey, pp: 23-28.
55. Khalil, M.H., I.H. Hermes and A.H. Al-Homidan, 1999: Estimation of heterotic components for growth and livability traits in a crossbreeding experiment of Saudi chickens with White Leghorn. Egyptian Journal of Poultry Science, 19: 491-507.
56. Hanafi, M.S. and M.M. Iraqi, 2001. Evaluation of pure breeds heterosis, combining abilities, maternal and sex-linked effects for some production and reproduction traits in chickens. Second International Conference on Animal Production and Health in Semi-Arid Areas,4-6Sep., Organized by Faculty of Environmental Agricultural Sciences, Suze Canal Univ., El-Arish- North Sinai, Egypt, pp: 545-555.