Uganda Journal of Agricultural Sciences, 2003, 8 : 151 - 158 ISSN 1026-0919
Printed in Uganda

Performance evaluation of crossbred chickens at Serere

Ssewannyana E., Oluka J. and Masaba, J.
Serere Agricultural and Animal Production Research Institute (SAARI)
P.O.Soroti, Uganda.

Abstract

From 1994 to 2000, an experiment was started at Serere Agricultural and Animal Production Research Institute (SAARI) with an objective of improving the meat and egg productivity of indigenous chickens through crossbreeding with exotic cocks of Hybro, Arbor Acres and Bovans Brown breeds. Local chickens were used as the control. The birds were reared on deep litter in 3 x 3 metre pens and fed on commercial broiler mash at an average rate of 120 grammes per mature chicken per day and water was given a*d libitum*. The eggs were incubated naturally and the chicks hatched were recorded visa-vis those eggs not hatched to determine hatchability. The chicks were fed *ad libitum* on chick mash for 8 weeks then changed to broiler mash afterwards. The chickens were weighed from day 1 to sexual maturity (20 weeks) on a weekly basis. Routine vaccinations and prophylactic medication were done. All crossbreds performed better than local chickens in all aspects. The Bovans Brown breed performed best. The study also indicated that household income could be tremendously increased through chicken improvement.

Key words: Crossbreeding, performance, Arbor Acres, Hybro, Bovans Brown

Introduction

The majority of the rural communities in Uganda are smallholder farmers. In the eastern and northern regions of the country, most of the small-scale farmers are involved in mixed crop and livestock production. The major crops being annual cereals and pulses while livestock are cattle, goats and chickens. In the early 1980s and 1990s, the population of livestock in those areas was reduced due to insurgencies. The insurgencies and rustling resulted into poverty and malnutrition among the population in those areas. Attempts to alleviate this poverty was focussed on re-introduction of livestock through re-stocking programmes. However, restocking with cattle and goats was slow due to high investments. The rural populations were seen to value the chicken more due to its low investment costs. Further more, the chicken had more advantages in terms of faster reproduction and offtake due to its short generation interval. Therefore, the chicken was seen as the cheapest and easiest entry point for alleviation of poverty in rural households.

The chicken population in Uganda stands at 23 million of which 80% (18 million) are indigenous (MAAIF, 2000). The indigenous chickens are an important animal resource in most rural communities. They are easy to acquire, manage and their reproduction and production is high enough to realize faster income generation. The indigenous chickens can subsist on locally available feed resources while scavenging freely for food. At the same time, local chickens do resist some common diseases and are hardy to the tropical high temperature and water scarce conditions. In the traditional set up, indigenous hens brood eggs, hatch and rear their chicks thus providing a reduction in the management costs involved in artificial brooding. For these important attributes, the indigenous chicken has been the most preferred domestic animal resource widely owned by women and children. The chicken plays a significant role in providing a ready source of protein and income to the rural families. It can also be exchanged for goats (8-10 hens per goat) and the goats can be sold to purchase cattle. The market for free-range chickens i- enormous and these chickens are more preferred due to their "tasty" meat compared to that of the exotic birds.

However, in spite of the above useful attributes of indigenous chickens, these local birds are generally low producers of meat and eggs. This is mainly due to their

poor genetic potential for those production traits. The local chickens lay only 2-3 clutches of eggs per year with 10-12 eggs in each clutch after which they go broody. This production level gives about 36 eggs per year. Their growth rate is low as birds take long to mature. The adult mature weight is only about 1.5 – 2.0 kg. The egg size is small and small-sized chicks with low day-old weights are, therefore, hatched (Kitalyi, 1998).

In order to improve the production potential of the indigenous chickens for meat and eggs, high potential exotic cocks have been used for upgrading local birds through crossbreeding (Kitalyi, 1998; Ndegwa *et al.*, 1998). This practice rapidly increased the meat and egg production to levels which cannot be achieved by selection alone. Together with good disease control and adequate nutrition, crossbreeding greatly improved the productivity of indigenous birds (Kitalyi, 1998; Ndegwa *et al.*, 1998).

This study was conducted at SAARI during the period 1994 to 2000 by crossbreeding Hybro , Arbor Acres and Bovans Brown exotic breeds of cocks with local hens in order to assess whether a broiler (Hybro, Arbor Acres) or layer breed (Bovans Brown) of cocks could be recommended to our farmers. This paper, therefore, presents, in the main, the results of the performance evaluation of the various crossbred chickens produced and reared under on-station conditions. Preliminary results for on-farm performance and household income are also presented.

Materials and Methods

Treatments

Treatment	Cock	Hen	Mating group	Offspring
1	HEC	LH	HEC X LH	F_1
2	AEC	LH	AEC X LH	F_1
3	BBC	LH	BBC X LH	F_1
4	BBC	F_1H	BBCX F_1H	F_2
5	BBC	F_2H	BBC X F_2H	F_3
6	LOC	LH	LOC X LH	Pure Local

Four breeds of cocks (three exotic and one local) were purchased, assembled and mated to indigenous local hens. The local chickens were purchased from Chapa and Arapai local markets while the exotic cocks were obtained from Kiyita Commercial Suppliers in Kampala city. During the period 1994 - 1997, two exotic cock breeds, viz. Hybro exotic cocks (HEC) and Arbor Acres exotic cocks (AEC) were used in the upgrading alongside local cocks (LOC) as control. For the period 1998 - 2000, one exotic cock breed, the Bovans Brown, (BBC) was used for the crossbreeding activity together with LOC as control. Local hens were randomly allocated and mated to the four cock breeds during the respective periods.

Six treatment groups were obtained from the mating groups. The control group was between the LOC and local hens (LH). Continuous upgrading was conducted resulting into F_1, F_2 (Hybro, Arbor Acres), F_3 (Bovans Brown) progeny of crossbred chickens from the various matings.

Management

The birds were managed under on-station conditions at SAARI and were reared on deep litter in 3 x 3 metre pens and fed on commercial broiler mash at an average rate of 120 grammes per mature chicken per day and water was provided *ad libitum*. The eggs were incubated naturally by the hens and the chicks hatched were recorded visa-vis those eggs not hatched to determine hatchability. The chicks were fed *ad libitum* on chick mash for 8 weeks then changed to broiler mash afterwards.

Disease control measures were provided through vaccinations against New Castle Disease, Gumboro and Fowl Typhoid. Endo- and ecto- parasites were controlled by use of antihelmintics and pye-grease/ pesticides, respectively.

Data collected

During the experimental period, data was taken on the number of eggs laid, size of eggs and number of chicks hatched. Records on live body weights of chicks at day 1 and at weekly intervals were taken until 20 weeks of age. Such records were taken on the progeny of the local as well as F_1 and F_2 hens. The weights of male and female chicks were taken combined since it was not possible to distinguish the two sexes at early ages.

Data analysis

The two groups of data, i.e. for the period 1994-1997 and 1998-2000, were combined and subjected to the statistical analysis of variance using least square means (LSM) of the generalised linear model under the Statistical Analysis Systems (SAS) programme of 1986. Duncan's test was used to differentiate the various means. The analysis model used was:

$$Yijk= U+Ci+Hj+(CH)ij+eijk$$

Where:

Yijk = record of the K^{th} chick from matings between the i^{th} cock breed and the j^{th} hen breed.

U = the general mean

Ci = the effect of the i^{th} breed of the cock = 1,2,3,4.

Hj = the effect of the j^{th} breed of hen =1,2,3

(CH)ij = the effect of the interaction between the different mating breeds of cocks and hens i.e.the j^{th} hen breed within the j^{th} cock breed.

eijk = the effect of the random error element associated with the record Yijk.

Other random and fixed factors like year of hatching, season of hatch and sex of chicks which are known to influence the performance of chickens were not included in the model for purposes of emphasizing on the effect of different breeds of cocks. The data analysis presented reflects, therefore, information on the effect of mating breed groups. The individual effect of breed of cock and hen *per se* were not included in the results tables since such output does not distinguish between the local, F_1, F_2 and F_3 progeny due to the compounding (pooling) effect of least square means.

Results

The LSMs obtained for live body weights, growth rates, egg number, number of chicks hatched and hatchability by mating breed groups of cocks and hens are presented. The LSMs for body weights of local, F_1, F_2 and F_3 chickens at day old, 4, 8, 12, 16 and 20 weeks are shown in Table 1. The growth rates for the same categories of

Table 1: Least square means for body weights of crossbred chickens from matings between local and crossbred hens and Hybro, Arbor Acres and Bovans Brown exotic cocks.

Mating Groups (Cock x Hen)	Offspring Genotype	Live body weights (gms)					
		Day old	Week 4	Week 8	Week 12	Week 16	Week 20
HECXLH	F_1	25.20±1.52^d	266.67±12.97^a	872.25±41.36^a	1841.25±51.82^a	2625.0±66.30^a	3050.0±74.73^a
AECXLH	F_1	28.48±0.76^c	155.73±6.49^c	705.64±16.88^b	1345.29±23.18^b	1937.58±29.65^b	2305.75±33.42^b
BBCXLH	F_1	32.38±0.71^b	183.80±4.52^c	589.38±17.90^b	983.43±35.68^c	1802.31±22.72^b	2184.38±30.20^b
BBCXF_1H	F_2	38.19±0.96^a	217.40±8.00^b	514.38±28.42^c	865.31±32.60^c	1581.66±35.34^c	1833.27±43.28^c
BBCXF_2H	F_3	38.19±0.96^a	217.40±8.00^b	514.38±28.42^c	865.31±32.60^c	1581.66±35.34^c	1833.27±43.28^c
LOCXLH	Pure Local	22.9±1.52^d	123.17±12.97^d	340.67±33.77^d	684.83±42.31^d	166.67±54.14^d	1550.0±61.02^d

Key: a,b,c,d values with similar superscript letters are not significantly different (P>0.05)
HEC X LH = Hybro exotic cocks mated to local hens
AEC X LH = Arbor Acres exotic cocks mated to local hens
BBC X LH = Bovans Brown cocks mated to local hens
BBC X F_1H = Bovans Brown cocks mated to F_1 crossbred hens
BBC X F_2H =Bovans Brown cocks mated to F_2 crossbred hens
LOC X LH = Local cocks mated to local hens

Table 2. Least square means for growth rates of crossbred chickens from matings between local and crossbred hens and Hybro, Arbor Acres and Bovans Brown exotic cocks.

Mating Groups (Cock x Hen)	Offspring Genotype	Growth rate (gm/day)				
		Day old	Weeks 5-8	Weeks 9-12	Weeks 13-16	Weeks 17-20
HEC X LH	F_1	8.62±0.46^a	22.22±1.07^a	34.61±1.62^a	27.99±1.97^a	15.18±1.48^a
AEC X LH	F_1	4.54±0.23^c	19.64±0.44^a	21.16±0.72^c	21.15±0.88^b	13.15±0.66^b
BBC X LH	F_1	5.41±0.29^b	14.49±0.82^b	27.24±1.09^b	14.07±1.29^c	13.65±1.14^b
BBC X F_1H	F_2	6.40±0.50^b	10.60±0.81^b	25.58±1.57^b	12.53±0.83^c	10.99±1.29^c
BBC X F_2H	F_3	4.87±0.36^c	11.12±0.86^b	13.69±0.85^d	13.27±1.57^d	11.40±0.12^c
LOC X LH	Pure local	3.58±0.46^d	7.77±0.87^c	12.29±1.32^d	17.21±1.61^b	13.69±1.21^b

Key: a,b,c,d values with similar superscript letters are not significantly different (P>0.05)
HEC X LH = Hybro exotic cocks mated to local hens
AEC X LH = Arbor Acres exotic cocks mated to local hens
BBC X LH = Bovans Brown cocks mated to local hens
BBC X F_1H = Bovans Brown cocks mated to F_1 crossbred hens
BBC X F_2H =Bovans Brown cocks mated to F_2 crossbred hens
LOC X LH = Local cocks mated to local hens

chickens are shown in Table 2; while the values for egg number, chicks hatched and hatchability are shown in Table 3.

Live body weight

The live body weights of F_1 day-old chicks for the mating groups of Hybro (HEC X LH), Arbor Acres (AEC X LH), Bovans Brown (BBC X LH) and Local (LOC X LH) were 25.20±1.52, 28.48±0.76, 32.38±0.70 and 22.90±1.52 gms, respectively. The F_1 chicks from Bovans Brown parent cocks were significantly heavier than those from Arbor Acres ($P<0.05$), Hybro ($P<0.01$) and Local ($P<0.001$) cocks on day 1 (Table 1). However, the body weights of F_1 chicks from HEC X LH were thereafter significantly heavier for the rest of the study period than those of the AEC X LH and BBC X LH. The weights of pure local chicks remained consistently lower than those of their crossbred contemporaries, especially at the early ages (Table 1). The highest day-old weights were registered by the F_2 and F_3 chicks from BBC cocks with values of 38.19±0.96g and 35.33±0.87g, respectively. There was no significant difference ($P>0.05$) between the day-old body weights of F_2 and F_3 chicks from BBC cocks. However, the F_2 chicks from BBC continued to have superior weights over F_3 chicks throughout the growth period up to 20 weeks (Table 1).

Growth rates

The growth rates of F_1 chicks from HEC, AEC and BBC cocks from day-old to week 4 were 8.62 ± 0.46, 4.54±0.23 and 5.41 ± 0.29, respectively. During the first 4 weeks of life, the F_1 chicks from the HEC cocks significantly grew faster than their contemporariess from the AEC ($P<0.05$), BBC ($P<0.001$) and LOC ($P<0.001$) cocks (Table 2). Throughout the growth period up to 20 weeks, the growth rate of HEC X LH F_1 chicks continued to be significantly higher than that of the AEC X LH and BBC X LH chicks (Table 2). The growth rate of local chicks was, generally lower than that of their crossbred contemporaries. However, all the chickens had a levelling up of their growth rates towards the 20th week (Table 2). The F_1 crossbred chickens from BBC cocks grew generally faster than the F_2 and F_3 chickens from the same cocks.

Egg number, chicks hatched and hatchability

The number of eggs laid by the F_1 hens from the HEC X LH, AEC X LH and BBC X LH mating groups and those from F_2 and F_3 hens from the BBC X F_1H and BBC X F_2H groups were 11.33±1.08, 15.25±0.54, 17.50±0.48, 19.40±0.75 and 18.00±0.84, respectively. The egg numbers from the F_2 hens from BBC cocks were significantly higher than those of the F_1 hens from BBC cocks, ($P<0.05$), HEC cocks ($P<0.01$) and AEC cocks ($P<0.05$). The local pure hens had an average production of only 9.00±1.08 eggs which was significantly lower than that of hens from the mating groups of BBC X LH ($P<0.01$), HEC X LH ($P<0.05$) and AEC X LH ($P<0.01$) (Table 3).

The absolute number of chicks hatched per clutch was highest (13.17+0.85) among the F_1 BBC crossbred hens and this was significantly different from those of HEC X LH ($P<0.05$), F_2 and F_3 BBC crossbred hens

Table 3. Least square means for egg production and hatchability among local and crossbred hens mated to Hybro, Arbor Acres and Bovans Brown exotic cocks.

Mating Groups (Cockx Hen)	Offspring Genotype	Number of eggs laid	Number of chicks hatched	Hatchability (%)
HEC X LH	F_1	11.33±1.08^c	7.60±1.62^b	67.52±11.30^b
AEC X LH	F_1	15.25±0.54^b	11.67±0.47^a	73.31±3.52^a
BBC X LH	F_1	17.50±0.48^b	13.17±0.85^a	75.18±3.50^a
BBC X F_1H	F_2	19.40±0.75^a	9.20±0.65^c	47.36±4.97^c
BBC X F_2H	F_3	18.00±0.84^a	4.50±0.73^d	24.10±5.45^d
LOC X LH	Pure Local	11.33±1.08^c	24.10±5.45^d	77.78±7.00^a

Key: a,b,c,d values with similar superscript letters are not significantly different ($P>0.05$)
HEC X LH = Hybro exotic cocks mated to local hens
AEC X LH = Arbor Acres exotic cocks mated to local hens
BBC X LH = Bovans Brown cocks mated to local hens
BBC X F_1H = Bovans Brown cock mated to F_1 crossbred hens
BBC X F_2H =Bovans Brown cocks mated to F_2 crossbred hens
LOC X LH = Local cocks mated to local hens

($P<0.01$) but not significantly different from those of the AEC X LH mating group (Table 3). On the other hand, the hatchability of the local hens was generally higher ($P<0.01$) than that of any of the crossbred hens (Table 3).

On-farm performance in five months

The performance of the various BBC crossbreds along with the pure local control chickens on-farm for a period of 5 months are presented in Table 4. The F_1 BBC crossbreds, with or without supplementary feeding using household grains and cassava flour, had higher mean body weights than their contemporary local chickens. The F_1 BBC crossbreds which received supplementary feeding had significantly higher mean body weights than those F_1 BBC crossbreds which never received supplementary feeding. The F_1 BBC crossbreds reared on station had significantly higher mean body weights than their contemporaries reared on farm.

The sale of sexually mature crossbred cocks at 5 months increased the average household income by 460% (34,500/= visa-vis 7,500/=) (Table 4).

Table 4. On-farm performance in 5 Months

Genotype	Mean Body Wt (gm)
Local Pure (LOC X LH)	1374.0
25% BB blood (F_1BBC X LH)	1482.3
50% BB blood (BBC X LH), (without supplements)	1715.2
50% BB blood (BBC X LH), (with supplements)	1978.1
50% BB blood (BBC X LH), (on-station)	2184.4

Household income from sale of cocks

Before the project	After the project	Extra Income
7,500/=	42,000/=	34,500/=

Discussion

The F_1 chicks from BBC X LH mating group were significantly heavier than those from AEC X LH ($p< 0.05$), HEC X LH ($p<0.01$) and LOC X LH ($p<0.001$) matings (Table 1). However, thereafter, the body weights of F_1 chicks from HEC X LH matings were significantly heavier for the rest of the study period than those of the AEC X LH and BBC X LH matings. This shift in body weight reflected the differences between a broiler breed (Hybro) and a layer breed (Bovans Brown) but also underscored the fact that among the two broiler breeds, the Hybro breed was a better provider of meat than the Arbor Acres breed. All the crossbred chickens had significantly higher mean body weights than their contemporary local chickens (Table 1). This emphasized the importance of genetic improvement through crossbreeding, exploiting the aspect of heterosis (hybrid vigour).

Noraziah and Engku Azahan (1995) and Engku Azahan and Noraziah (1996) reported on the performance of village fowl crosses in Malaysia reared under semi-intensive and intensive systems. Their results under the intensive system were very similar to our results with respect to the Arbor Acres crossbreds (e.g 1376gm vs 1345gm at 12 weeks; 1882gm vs 1937gm at 16 weeks). In their study, the crossbreds achieved live weights equivalent to those of commercial broilers at about 15-16 weeks. In our study, the Hybro crossbreds, behaved similarly, reaching a commercial weight of 3kg at 20 weeks. The Malaysian study and our study re-emphasize the importance of genetic improvement through crossbreeding and its attendant economic benefits.

The mean body weights of F_3 BBC crossbreds were consistently lower than those of F_2 BBC crossbreds. This observation has also been recorded in other livestock and re-emphasizes the fact that there is no advantage in upgrading from F_2 to F_3 generation with respect to performance. The best is to operate between F_1 and F_2 generations. This option maximizes heterosis in performance, disease resistance and general adaptability.

In agreement with the mean body weights shown in Table 1, the growth rates presented in Table 2 clearly show that the crossbreds performed better than the local control chickens except during the period of week 12 – 16 when the local chickens had compensatory growth. However, all the chickens had a leveling up of their growth rates towards the 20th week (Table 2). This observation would mean that between week 16 and week 20 the faster- growing chickens grow a lot less allowing the slow growers to catch up through compensatory growth.

Although the F_2 BBC hens laid more eggs than any other crossbreds, their hatchability was far lower than that of F_1 BBC, F_1 AEC and F_1 HEC crossbreds (Table 3). Looking at F_1, F_2 and F_3 BBC crossbreds, the F_1 had the best hatchability indistinguishable from that of the local hens and the F_3 BBC crossbred hens had the poorest hatchability. Again this fact re-affirms the earlier observation that there is no advantage in upgrading beyond F_2 generation. It should be noted that while BBC crossbred hens could become broody, incubate their eggs for 21 days and produce even F_3 chickens, the AEC F_1 crossbred hens could only produce a few F_2 chicks and those of HEC F_1 crossbreds never produced any F_2 chicks. They would become broody but lose their broodiness within 10 days and therefore could not hatch

the eggs. The F_2 and F_3 also tended to lose broodiness, pecked and ate their eggs although some individual chickens among them could have hatchability as high as 63.6%. There was some idiosynchracy among them.

On-farm performance in five months

Table 4 revealed that tremendous improvement could still be achieved on-farm through crossbreeding. The fact that a 5 months cock could attain almost 2kg with supplementary feeding using household feeds underscored the importance of good feeding. But even without supplementary feeding, F_1 BBC crossbred cocks had 341gm more than the local cocks.

The average household income from the sale of cocks alone at 5 months increased by 460%. This was tremendous contribution towards poverty reduction in the individual households. The study on-farm introduced a regular cycle of selling cocks every 5-6 months so that they did not have to mate with their sisters. So, the farmers had the benefit of selling many cocks at once instead of selling one at unspecified intervals.

Conclusions

The study demonstrated that crossbreds performed better than local chickens and highlighted the fact that there is no advantage in performance by crossbreeding beyond the second generation. Bovans Brown breed performed best on an overall basis considering all aspects, i.e. growth, egg numbers, hatchability and retention of broodiness to produce a good number of F_1s and F_2s. That breed had been recommended for on-farm trials based on its good performance but also because it is a coloured breed. The preliminary on-farm results indicated that genetic improvement of chickens' performance through crossbreeding could be very rewarding and was one way of reducing poverty in rural households.

Acknowledgements

The study was carried out under the auspices of NARO/ World Bank Project on Agricultural Research and Training and formed the basis for the on-going NARO/ DANIDA and NARO/DFID adaptive research projects on chickens in Soroti and Kumi/Apac districts, respectively. The authors are very grateful to Mr. G.W. Egemu for management of the chickens on-station and data collection.

References

Engku Azahan, E.A. and Noraziah, M. 1996. Efficiency of feed utilisation for growth in the improved Kampung chicken. Proceedings of Silver Jubilee MSAP Conference, Kuching, pp. 275-276.

Kitalyi Aichi J. 1998. Village chicken production systems in rural Africa: Household food security and gender issues. FAO Animal Production and Health Paper 142, 1-32, Rome Italy.

Ministry of Agriculture, Animal Industry and Fisheries. MAAIF. 2000. Annual Report.

Ndegwa, J.M., Tchombe, T., Kabuage, L. W., Mukiibi-Muka, G. and Kosgey, I.S. 1998. Improvement of indigenous poultry production in Sub-Saharan Africa. A paper presented at the International Course on Intensive Poultry Production , Centre for International Agricultural Development Cooperation (CINADCO), Kibbutz Shefayim, Tel-Aviv, Israel.

Noraziah, M. ands Engku Azahan, E.A. 1995. Growth performance of Kampung chicken crosses. Proceedings of the 17th MSAP Annual Conference, Penang, pp. 165-166.