CROSS BRED HENS UNDER SEMI SCAVENGING CONDITION IN BANGLADESH

Rahman Mahfuzar[1] Poul Sørensen[2] , Hans Askov Jensen[3 and Frands Dolberg

[1]Bangladesh Livestock Research Instute, Savar, Dhaka, Bangladesh

[2]Danish Institute of Agricultural Science, Research Centre Foulum, DK-8830 Tjele, Denmark

3 Team leader, Bangladesh Smallholder Livestock Project. Strindbergsvej104, 2500 Valby, Denmark

Department of Political Science, University of Aarhus C, Denmark

Introduction

Poultry production system in the rural areas of Bangladesh is characterized by smallholder free range scavenging operations. The indigenous hens (desi) in the existing scavenging operations have small body size (1141g Huque,1993) and produce 45 eggs per hen per year (Ahmed and Hasnath, 1983). They constitutes about 80% of country's chicken populations. The capacity of egg yield was investigated under optimale condition was found to be 64 eggs per hen per year with a behaviour of pronounced brooding (Sazzad,1986).

Desi birds are as such the ideal breeds for reproduction by natural brooding. However, in a semi-scavenging model with artificial hatching the egg yield is too low. Some experiments have been conducted concerning the introduction of exotic breed of hens of high yielding varieties (HYV) and their crosses to determine potentials and limitations in the scavenging and semi scavenging system (Ahmed et al., undated; Amin et al., 1992; Chandrasiri et al.,1994; Quader et al., 1989; Hossain et al., 1992; Mahbub et al.,1992; Paul et al., 1995; Sazzad,1992; roberts and Senarantne,1992 and Rahman et al., 1995) and they showed that HYV breeds have a higher egg yield than desi hens also under scavenging conditions.

A model for semi-scavenging poulty has been developed in Bangladesh comprising small units of rice husk hatcheries , breeders, chicken rearers and producers with a small flok of 10 hens. The model is described by Saleque and Mustafa 1996 and Jensen 1996.

The Directorate of Livestock Services,DLS, maintain breeds as White Leghorn, Rhode Isalnd Red and Fayoumi at the Government Poultry Farms and supply parent stocks to the breeders in flocks of 25 hens to each breeder. The most succesfull parent breeds are RIR male and Fayoumi females, Amber 1988 who named the cross between this two breeds as SONALI. The main constraint using Fayoumi as parent hens is the low egg yield only 141 eggs (El Salhia,1984; cited by Horst,1989).

Using commercial hybrids as parent hens and an improved breed as parent males, e.g. New Hampshire male, has been a commeon system for smallholders in countries with industrial poultry production including Denmark. The main advantage of susch a system is the low cost for parentstock and consequently lower cost for day old chickens.

Objectives

The constrain by using Fayoumi as parent hens in the semi-scavenging model in Bangladesh is the low egg yield . The small breeders keeps the hens in confinement and fed the them with balanced feed and consequently the production cost for hatching eggs is rather high.

Using commercial hybrids as parent hens will reduce the cost of day old chickens and by using an another breed as parent male it is still possible to transmit scavenging traits into the chickens used at village level.

The objectives with the experiment are:

1. Test a breeding system where hybrids parents are used as grand parents for female parents - female line.
2. Compare the performance of different breed combinations under semi scavenging conditions. The parameters determined will be used to further develop the semi scavenging system in Small holder Livestock Development Project.

Methodology

Parent stock and experimental chickens

Breeding for production of the chickens for the experiment was conducted at the DLS Central Poultry Farm, Mirpur, Dhaka with 1259 females and 177 males of Lohmann brown(AB), RIR, WLH, Fayoumi, A x RIR and RIR x Fayoumi as parent stocks. Artificial insemination was performed to produce experimental chicken of the eight breed combinations including one commercial hybrid as shown in table 1. Eggs were hatched in four batches with 11 weeks intervals in between. Chick rearing was carried out in selected chick rearing farms of experimental sites and grown in confinement up to 8 weeks of age in flocks of 250 chickens.

Pullet rearing

At eight weeks of age selected *key rearer* received about 6 pullets from a particular breed combination and some amount of feed to ensure gradual adoption of birds to the semi scavenging system.

A total of 1272 selected pullets from 8 breed combinations were placed at 297 rural women farmers (key rearer - beneficiaries of BRAC) distributed on 3 districts. The hens were kept there until they were about 1.5 years old or had produced eggs for almost one year. At start of lay the number of pullets per key rearer ranges from 2 to 6 and was all of the same combination. The distribution of pullets / key rearer are shown in table 1.

Birds were allowed to scavenge during day time at the homestead and in the neigbourhood after the crop was harvested and they were kept in shelter at night and during unfavourable weather conditions. Farm byproducts(wheat bran, poor quality paddy, broken rice, rice polish, bran of pulse crops) or house hold waste(left over cooked rice after meal, dinning and kitchen waste) or small amount of grain or balanced diet for laying hens were offered as a supplement, either as a single or in a mixture of 2 to 3 ingredients. Birds were housed in a bamboo shelter when offered supplemented feed. There was a continuous supply of drinking water in the shelter and birds had easy access during scavenging period of the day.

Birds were dewormed every two months and vaccinated against New Castle and Fowl Pox diseases according to a program. Data regarding egg production, mortality and supplemented feed were recorded twice a week. The protein and energy content of the supplemented feed were calculated on the basis of book values. Supplementary feed cost and gross margin per hen were estimated on free market price basis.

Statistical methods

Data were subjected to analysis of variance by the least square principle using the SAS programming package, SAS(1990). The models to be used was as follows:

$$Y_{ijklm} = \mu + H_i + L_j + B_k + S_l + b_1 \bullet D_{ijkl} + e_{ijklm} \quad (1)$$

$$Y_{ijklm} = \mu + H_i + L_j + B_k + S_l + b_2 \bullet A_{ijkl} + e_{ijklm} \quad (2)$$

in which:

Y_{ijklm} is the observed value of the m^{te} farm mean having its start in the l^{te} month, belonging to the k^{te} breed combination situated in the j^{te} location from the i^{te} hatch .

H_i is the fixed effect of the i^{te} hatch . i = 1…4.

L_j is the fixed effect of the j^{te} location, j = Jessore or Manikgo or Rajshahi

B_k is the fixed effect of the k^{te} breed combination k = 1…8.

S_l is the fixed effect of the l^{te} month in start of lay, l = 1…….14,

D_{ijkl} is the fixed effect of duration of the productions in month

A_{ijkl} is the fixed effect of the age at start of lay in month

b_1 is the regression of the duration (D) on the observed production

b_2 is the regression of age at start of lay on the observed production

e_{ijklm} is the unexplainable residual

The effects were simultanously analysed by use of an analyse of variance using the GLM procedure of SAS (1990) and then tested by the F-test. Multiple comparisons among the various locations, breeds and hatches were tested by theire least square means corrected for other effects in the model.

Mortality was calculated according to the following:

$$Cmortd_t = \left(1 - \sum_{i=1}^{t-1} Cmortd_i - \sum_{i=1}^{t-1} Cmortp_i\right) \times mortd_t \quad (3)$$

Where

$mortd_t$ = numbers of chickens dead due to diseases during the t^{th} month/(numbers of chicks at beginning of the month - number of chickens sold in the month)

$Cmortd_t$ = Mortality due to diseases in the t^{th} month adjusted for mortality in ealier months

$Cmortp_t$ = Mortality due to predatory in the t^{th} month adjusted for mortality in ealier months

A similar equition was used for mortality due to predatory.

In order to calculate mortality to the same length of production the following was used:

$$Surv_t = (1 - \Delta Mort)^t \quad (4)$$

$$\Delta Mort = 1 - \left[Surv_t\right]^{1/t} \quad (5)$$

$$Surv_{12} = (1 - \Delta Mort)^{12} \quad (6)$$

Where

$Surv_t$ = 1 - $Cmortd_t$ - $Cmortp_t$ or the survivability in the actuel production period in a farm measured as t month

$\Delta Mort$ = is the geometric mean of mortality per month.

Cropping Pattern

The agricultural cropping patterns of experimental locations and crop harvesting seasons with monthly day length during experiment's period are shown in table 2 and 3

Results and discussion

The performance data of the hens are presented in table 4, 5 and 6, regarding breed combinations, the effects of seasons and locations.

Age of first egg

Birds from all combinations were late in starting egg production and the differences were insignificant, the under nourished conditions in the semi scavenging system during theire growing period might be one of the major reason for it.

Considering seasons, birds from hatch-3 started egg production at a significantly early age (28 weeks) which was followed by hatch-2 (30 weeks) and then hatch-1 (36 weeks) and hatch-4 (37 weeks) respectively. Birds from hatch-2 started significantly earlier egg production as compared to hatch-1 and 4 which did not differ significantly. The continuous increasing day length (natural photo period) starting from 10 weeks of age and the opportunity to scavenge the Boro rice(mostly HYV rice) harvesting based feed resources during growing period might be the reason of the early start of birds from hatch-3. The birds of hatch-2 started getting increasing day length from 20 weeks of age and had the opportunity to scavenge during both Aman rice and

wheat/pulse harvesting seasons and that could be the reason for significant second position for early egg laying. There was a decreasing day length during growing period for the birds of hatch-1 who had the opportunity to scavenge the Aman rice harvesting season for few weeks before their late start of laying. The birds of hatch-4 was facilitated by the Boro rice harvesting season but as they were newly shifted from intensive to semi scavenging system, their scavenging behaviour was not so well developed to take the opportunity of said rice harvesting season.

The same bird got another Aus rice harvesting season before their slow start of laying, where the amount of rice crop was far below than other type of seasonal rice crops.??????

Among locations, birds from the grain dominant Manikgonj district started theire egg production earliere compared to the grain/fibre Jessore district and the sugarcane based Rajshahi district and these differences were significant. The higher intensity of grain crop production and the consequent harvesting season in the Manikgonj district created better opportunity to scavenge more feed resources for the growing birds and that could be one of the important reason for early start of laying.

The effect of age at 1st eggs on productivity is investigated according to the statistical model 2 in which age in terms of months is regressed on the number of eggs after correction for effects of hatch, districts, breed combination and seasons. The results af the analyses were that postponing of the start of lay reduced the production by 5 eggs per month they was later. This figure was statistical significant ($P<0.02$) and seems also to be stricly linear. In other words, independent of other effects studied here and which may influence age at start of lay, its a large advantage that the hen starts as early as possible to lay.

Egg production

The average hen day egg production corrected to 12 months of egg production was highest in RIR x Fayoumi, intermediate in (RIR x Fayoumi) x AB, AB; WLH x AB and RIR x AB and lowest in RIR x WLH and Fayoumi x AB. To compare with are also shown the actual egg production in which almoust the same ranking is seen. The difference between breed combinations of highest and lowest egg production was significant. The results of highest egg production from the RIR x Fayoumi combination was in accordance with the findings of Rahman et al.,(1995) where the egg production for the same cross was higher than their parents under scavenging condition of Bangladesh.

The analysis of variance showed that a 46 % of the varation in the corrected hen day egg production could be explained by the effects of model 1 . The seasonal effect expressed by hatch, the location and duration of production had all a very high significant effect, while Breed combinations and month in start of lay had a moderate effect. Analysing the actual hen day egg production using model 1 and then omitting the D- effect (duration of production) showed that 40% of the variation could be explained.

Irrespective of breed combinations, the average hen day egg production per year was highest in hatch1 (May) followed by hatch3 (November), hatch4 (January) and hatch2 (August) was the lowest and the difference between highest and lowest production hatches was significant. Starting from first egg at 7th. month (December) of age, the egg production of the birds of hatch1 had been in an increasing trend and came to peak in 12th. month (May) when there was Boro rice (HYV) harvesting season and birds had easy access to scavenge more rice based feed resources. Although the peak egg production age or period in semi scavenging system are not yet

investigated, the birds of other hatches could not interact with Boro rice harvesting season like the birds of hatch1 due to age variations.

The average hen day egg production was highest in Manikgonj district dominated by grain followed by the grain / fibre area of Jessore district and significantly lower in the sugarcane / grain area of Rajshahi. Thus the agricultural cropping patterns in the various districts show a significant influence on egg production. The highest egg production came from grain dominants areas with 201 % cropping intensity and little lower eggs from grain / fibre cropping of 207 % intensity and the sugarcane / grain based cropping with 159 % intensity had a clear reflection on the birds for significantly lower egg production.

Mortality (excluding predator loss)

The mortality percentage due to diseases was calculated for a 12 month period from start of lay according to model 6. Even a large difference in mortality in between breed combinations can be seen no general statistic significanse was observed althoug the multiple range test showed that the difference between RIR x Fayomi and two other combination was significant. The average mortality seems high, and the most obvious reason is diseases from bacterial infection as a result of the "under nourished" conditions of the birds in the semi scavenging system. There was no significant difference of mortality among the birds hatched in four different seasons. However, mortality of birds always observed higher in the later hatches.

Considering location effects, the mortality of birds in crop dominant Manikgonj area was significantly high compared to other locations. The seasonal riverian flood might be one of the reason for higher mortality in Manikgonj area, where maximum scavenging areas and some bird's house was submerged under flood water for more than week and the birds was suspected to be affected by post flood bacterial diseases with scarcity of scavenging feed.

Predator loss

Mortality of birds due to predator (wild animals) did not differ significantly among breed combinations. However, the varieties of plumage colour of the birds from the (RIR x Fayoumi) x AB combination might be more vulnerable to predators and made little more loss. Irrespective of breed combinations, there was no significant difference of predator loss of birds among hatches. Predator loss were increased with advancement of hatches. Considering location effects, predator loss in sugarcane based Rajshahi area was significantly high compared with other locations, the reason being that wild animals hunt scavenging birds from their sugarcane fields hide.

Energy supplementation

The energy content of supplemented feed was mainly dependent on the farmers usual practice. Birds from AB, (RIR x Fayoumi) x AB and RR x AB breed combinations were offered significantly more energy containing feed than (A x RIR) x Fayoumi and RIR x Fayoumi and the difference for other combinations was insignificant.

The energy content was highest for the birds of hatch1 followed by hatch2, 3 and 4 and the differences was significant except for hatch3 which did not differ significantly from hatch2 and 4. The energy content of supplemented feed was decreased with advancement of hatches. Farmers of grain / fibre Jessore areas offered more energy containing feed than other locations and the difference was significant. However, irrespective of breed combinations, hatches and locations the energy content of supplemented feed seems to around 40 % of the daily requirements of commercial chicken in captivity.

Protein supplementation

The amount of calculated protein was significantly higher in the supplemented feed of AB, RIR x AB, (RIR x fayoumi) x AB and Fayoumi x AB combinations compared to (A x RIR) x Fayoumi and RIR x Fayoumi and the difference for WLH x AB and RIR x WLH was insignificant. Considering seasons, birds from hatch1 was offered highest amount of protein containing feed followed by hatch2, 3 and 4 and the differences among hatches was significant except hatch3 which did not differ significantly from hatch2 and 4. The amount of supplemented protein was decreased with the advancement of hatches. Irrespective of breed combinations and hatches, birds from grain / fibre Jessore location was offered significantly highest amount of supplemented protein followed by grain dominant Manikgonj and sugarcane / grain Rajshahi areas and the differences were significant. However, the amount of supplemented protein in the semi scavenging system seems to around 30 % of the daily requirements of commercial hens in captivity.

Supplementary feed cost

The supplementary feed cost per bird per laying year was significantly higher in (RIR x Fayoumi) x AB, RIR x AB and AB breed combinations compared to (A x RIR) x Fayoumi and RIR x Fayoumi and the difference with other combinations was insignificant. Birds from hatch1 had the highest supplementary feed cost followed by hatch2, 3 and 4 and the differences among hatches was significant except hatch3, which did not differ significantly from hatch2 and 4. The supplementary feed cost was decreased with advancement of hatches. Considering the location effect, the supplementary feed cost was highest in grain / fibre Jessore area followed by sugarcane / grain Rajshahi and grain dominant Manikgonj area and the difference was significant.

Gross margin

Gross margin (Taka) per hen up to one year of production was highest in RIR x Fayoumi, intermediate in (A x RIR) x Fayoumi, lower in WLH x AB, RIR x WLH, AB and (RIR x Fayoumi) x AB and lowest in Fayoumi x AB breed combinations and the differences were significant except the intermediate one, which did not differ significantly from the highest and lower group of combinations. The amount of gross margin from birds of hatch4 was significantly higher than hatch2 and the difference with hatch1 and 3 was insignificant. Highest gross margin was found in grain dominant Manikgonj area followed by grain / fibre Jessore and sugarcane / grain based Rajshahi areas and the differences were significant.

Egg production period

The actual average egg production period of the birds from different breed combinations was compared and the difference was found insignificant. However, the egg production of RIR x Fayoumi and (A x RIR) x Fayoumi combination were persisted for little more periods. Birds from hatch2 and 3 were in egg production for more significant period than hatch1 and 4 and the difference between hatch1 and 4 was also significant. Irrespective of breed and hatches, birds of grain / fibre Jessore areas had been in egg production for significantly longer periods than other locations.

Effects of parent stocks

The difference of the effects of four parent stocks (AB, RIR, WLH and Fayoumi) were estimated and compared for all production parameters and presented in table 7. The difference of the effects of AB and Fayoumi was highly significant for age of first egg, amount of supplemented energy and protein and feed cost and for total egg production period and gross benefit, it was significant and the same for other parameters was insignificant. However, the effects of Fayoumi on production parameters was much better than AB except little more predator loss.

The difference of the effects of AB and RIR was significant for supplemented protein and gross benefit and insignificant for other parameters. However, the effects of RIR was better than AB except a little more mortality due to diseases. The difference of effects of other parent stocks was found insignificant.

The effect of age at first egg on productivity is a decrease of 5 eggs per month per or 60 eggs in a 12 month period for each month delay in age at first eggs. The causes the the variation in age at maturity is the management in the period from the chickens are distributed at an age of 8 weeks from the chickens rearer, kept in confinement, and til start of lay. Improvet management in this period shall therefore have the highes priority in improving the semi-scavenging system.

Among breed combinations, birds from RIR x Fayoumi performed best results in all respects. RIR x Fayomi birds produced highest number of eggs at the cost of lower amount of supplementary feeds which indicates they did manage and utilize the scavenging feed resources in a better way. The higher egg production potentials of RIR and the sub tropical native (Egyptian) characters with medium egg productivity of Fayoumi hen might be enable their crosses to performed better under semi scavenging production system of Bangladesh.

Except for the combination RIR x Fayomi, the differences between breed combinations were insignificant and combination with commercial hybrids as parent hens had the same performance as RIR x whith Leghorn.

The seasson as well as the location have an effect of the performance which may be due to lighting and cropping pattern.

Acknowledgemt

The authors is grateful to Danida and IFAD for funding the Smallholder Livestock Development Projekt and to the staff of DLS, BLRI and BRAC for fruitfull discussions and cooperation. A special thanks to Danida Fellowship Center for support to this puplication.

References

Ahmed, A. and M. A. Hasnath, 1983. A study on the heritability estimates of body weights of indigenous chickens. Bangladesh Vet. J: 17: 19-24.

Amber, Jalil, 1988. Personal communications

Ahmed, N. U. R., Amin, N. P. Magor, N.I. Miah, N. Islam, A. Soha , A. H. Khan and H. Ali, nd. Livestock related FSR activities of the Bangladesh Rice Research Institute, Rice Farming Research Division, Bangladesh Rice Research Institute, Gazipur,PP.171.

Amin. R. M., M. M. Hoque, Q. M. S. Islam and M. M. R. Khan, 1992. The performance of cross bred and indigenous chicken under scavenging system. Bangladesh Journal of Animal Science, 21(1-2):77-81.

Chandrasiri, A. D. N., S. P. Gunaratne, S. H. G. Wickramaratne, J. A. Roberts, A. (ed.) Djajanegara and A. Sukmawati, 1994. The egg and meat production potential of village chickens under scavenging system. Sustainable animal production and the environment. Proc. of the 7th. AAAP Animal Science Congress, Bali, Indonesia, pp 73-75.

Horst, P.1989. Native fowl as reservoir for genomes and major genes with direct and indirect effects on the adaptability and their potential for tropically oriented breeding plans.Arch. Geflugelk. 53(3):93-101.

Hossain, M. B., M. B. Islam and M. A. Hossain, 1992. Introduction of chick rearing unit among the rural house hold of Bangladesh, Bangladesh Journal of Animal Science, 21(1-2): 15-19.

Huque, Q. M. E., 1993. Indigenous animal species, conservation versus intensive production in Bangladesh. Asian Livestock xviii (10):132-137.

Jensen, Hans Askov. 1996. Semi-scavenging Poultry Flock. Integrated Farming in Human Development. Proceedings of a Workshop. March 25-29, 1996. Tune landboskole, denmark

Mahbub, A. S. M., M. K. Uddin, A. K. M. Z. Hoque and Jahangir, 1992. Chick rearing unit as affected by different levels of rationing with partial scavenging at rural condition of Bangladesh. Bangladesh Journal of Animal Science, 21(1-2):119-121.

Mukharjee, T. K. 1990. Breeding and selection programs in developing countries. In: Poultry Breeding and Genetics. Ed. R. D. Crawford (Elsevier). pp. 1049-1060.

Paul, D. C., Q. M. E. Huque and M. F. Haque, 1995. Growth pattern of exotic pullets under farmers management. Bangladesh Journal of Scientific and Industrial Research, 30(4): 15-20.

Quader, M. A., M.M. Rahman, M.G. Moula and M.R. Khan,1989. A comparative study on adaptability of different exotic and local breeds of poultry under two management systems of rearing. Research Report (Rabi 1988-89). On-farm Research Division, Region II , Bangladesh Agricultural Research Institute, Jamalpur.

Rahman, M.M., M. N. Islam, and N. R. Sarker, 1995. An adaptability study of three improved types of layer chicken under rural conditions at Naikhongchari FSR site. Bangladesh Journal of Livestock Research . paper accepted for publication.

Saleque, Md. A. and Mustafa, Shams 1996. Proceedings of a Workshop. March 25-29, 1996. Tune landboskole, denmark.

Sazzad, M. H., 1986. Reproductive performance of desi (indigenous) hens under scavenging and intensive systems of rearing. Proceedings of the First Annual Livestock Research Workshop, Bangladesh Livestock Research Institute, Savar, Dhaka, Bangladesh, pp. 63-67.

Sazzad, M.H., 1992. Comparative study on egg production and feed efficiency of different breeds of poultry under intensive and rural conditions in Bangladesh .Livestock Research for Rural Development, (4)3: 65-69.

SAS, 1990. SAS procedure's guide, Version 6, 3rd ED., SAS Inst. Inc. Cary. NC, USA

APPENDIX TABLES

Table 1. Basis of calculation of nutritive values and cost of supplemented feed ingredients.

Supplemented feed ingredients		C. P. %	M. E. Kcal / kg	Cost (Taka) / kg
F1	Wheat, Flour	12	3000	9 - 10
F2	Wheat bran, Paddy or small amount of Fish waste / Paddy / Snail / Cockroach / Earth worm	14 - 15	1500 - 1600	5 - 6
F3	Rice polish (contain 40 % rice husk)	7 - 8	1000 - 1200	3 - 4
F4	Broken rice	8	2300	6 - 7
F5	Cooked rice (contain 70 % moisture), left over after meal	8	2400	4
F6	Vegetables	.	.	.
F7	Balanced feed for layer (BRAC)	17	2550	9 - 10

Table 2. Basis of calculation of gross benefit

Sources	Items	Values (Taka)
Income	Egg (each)	2.50
	Spent hen (each)	70
Expenditure	Pullet (each)	35
	Supplemented feed / bird - Laying	As per calculation
	Supplemented feed / bird - Growing (9^{th}. week to age of first egg). Growing period supplementary feed /bird /day = 0.5 * Laying period supplementary feed /bird /day.	As per calculation
Gross margin = (Income - Expenditure)		

Table 1. Distribution of experimental pullets / farms (key rearer) on districts and seasons

Breed combinat-ions	Numbers of pullets / farms			Numbers of pullets / farms			
	Jessore	Manikgonj	Rajshahi	Hatch - 1 (May)	Hatch - 2 (August)	Hatch - 3 (Novemb -er)	Hatch - 4 (January)
1. Lohmann brown (AB)	29 / 10	66 / 19	58 / 10	26 / 10	58 / 10	40 / 9	29 / 10
2. (A x RIR) x Fayoumi	52 / 10	31 / 7	82 / 18	43 / 9	52 / 10	39 / 9	31 / 7
3. Fayoumi x AB	60 / 18	43 / 10	48 / 10	24 / 8	43 / 10	36 / 10	48 / 10
4. RIR x AB	32 / 10	33 / 7	88 / 17	56 / 10	32 / 10	32 / 7	33 / 7
5. RIR x Fayoumi	43 / 10	63 / 18	54 / 10	28 / 9	54 / 10	35 / 9	43 / 10
6. RIR x WLH	88 / 20	40 / 9	45 / 10	34 / 10	40 / 9	54 / 10	45 / 10
7. (RIR x Fayoumi) x AB	52 / 10	54 / 18	36 / 8	21 / 9	36 / 8	52 / 10	33 / 9
8. WLH x AB	52 / 10	45 / 10	78 / 18	40 / 8	52 / 10	45 / 10	38 / 10
Total	408 / 98	375 / 98	489 / 101	272 / 73	367 / 77	333 / 74	300 / 73
	1272 / 297			1272 / 297			

Table 2. Cropping patterns of districts during experimental period.

Particulars	Grain dominant (Manikgonj)	Grain / fiber (Jessore)	Sugarcane / grain (Rajshahi)
A. Agro-ecological zone	Low Ganges river flood plain.	Medium high	High Ganges flood plain
B. Seasonal flood	Yes	No	No
C. Cropping intensity	200 %	207 %	159 %
D. Major cropping patterns	1. Rice (B. Aman +B.Aus) - Onion. 2. Rice (B. Aman +B.Aus) - Mustard. 3. Mustard - Rice (Boro). 4. Rice (Boro) - Rice (Local) - B.Aman (transplanted). 5. Rice (B.Aus+B. Aman) / Jute - Khesari. 6. Rice (B.Aus+B. Aman) - Wheat / Potato / Mustard. 7. Rice (B.Aman) - Ground Nut. 8. Rice (B.Aman) - Sesame.	1. Rice (B.Aus) / Jute - Rice (T.Aman). 2. Rice (B.Aus) / Jute - Rice (T.Aman) - Wheat / Pulse / Oil seed. 3. Rice (B.Aus) - Rice (T.Aman) - Rice (Boro). 4. Rice (B.Aus) / Jute - Wheat / Pulse - Oil seed / Vegetables.	1. Sugarcane - Lentil. 2. Sugarcane - Onion / Garlic. 3. Rice (B.Aus)- Wheat. 4. Rice (B.Aus) - Lentil / Mustard. 5. Rice (B.Aus) - Potato/Maize. 6. Rice (Boro). 7. Rice (T.Aman) - Wheat. 8. Rice (T.Aman) - Vegetables/Maize.

Table 3. Average day length (natural) and major grain crop's harvesting seasons of experimental sites by months

Parameters	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.
Average day length (Hours.)	11.0	10.7	10.8	11.3	11.9	12.6	13.1	13.5	13.4	12.9	12.3	11.6
CROPS 1. Aman (rice)		j m r										
2. Aus (rice)									r	j m		
3. Boro (rice)						m	j	r				
4. Wheat					j	m r						
5. Pulse .					j m r							
6. Oil seed			j	r		m				m		
7. Maize	r				r				r			

Sites: j = Jessore, m =Manikgonj, and r = Rajshahi

Table 4. Performance of experimental hens reared under semi scavenging condition according to breed combinations.

Parameters	Breed combinations (Least square mean values)							
	AB (Lohman n brown)	(Ax RIR) x Fayoumi	Fayoumi x AB	RIR x AB	RIR x Fayoumi	RIR x WLH	(RIR x Fayoumi) x AB	WLH x AB
1. Age of first egg (week)	34.5	32	32	34	33	32	32.5	34
2 Eggs / hen / year * (hen day).	140^{ab}	137^{b}	125^{b}	139^{ab}	156^{a}	128^{b}	141^{ab}	139^{ab}
Actual no of eggs per hen. (hen day)	86^{b}	104^{ab}	86^{b}	105^{ab}	119^{a}	97^{b}	86^{b}	99^{ab}
3. Mortality % (excluding predator loss)	22.14^{ab}	35.04^{b}	27.59^{ab}	32.64^{b}	15.98^{a}	25.21^{ab}	21.20^{ab}	22.88^{ab}
4. Mortality % due to predator	1.38	0.87	1.40	2.71	2.09	0	5.31	2.61
5. Supplementary energy Kcal. / bird / day	146^{b}	122^{a}	136^{ab}	144^{b}	130^{a}	134^{ab}	146^{b}	135^{ab}
6. Supplementary protein (g) / bird / day	7.3^{b}	6.0^{a}	6.9^{b}	7.2^{b}	6.4^{a}	6.6^{ab}	7.1^{b}	6.6^{ab}
7. Supplementary feed cost (Taka) / bird / laying year	202.51^{b}	177.44^{a}	193.72^{ab}	203.18^{b}	184.20^{a}	190.62^{ab}	205.32^{b}	192.10^{ab}
8. Gross margin (Taka) / hen up to one laying year (Income - Cost)	134.66^{b}	169.83^{ab}	113.08^{c}	133.13^{b}	205.17^{a}	145.53^{b}	132.09^{b}	154.65^{b}
9. Egg production period (Months)	8.54	9.84	9.17	9.37	9.84	9.13	8.74	8.97

Figures with same or no superscript in a row are not significantly different ($P<0.05$).

* Corrected for 12 months egg production period.

Table 5. Performance of experimental birds reared under semi scavenging condition in four different seasons (hatch).

Parameters	Least square means			
	Hatch - 1 (May)	Hatch - 2 (August)	Hatch - 3 (Nov.)	Hatch - 4 (Jan.)
1. Age of first egg (week)	36^{c}	30^{b}	28^{a}	37^{c}
2 Eggs / hen / year (hen day)	154^{a}	121^{b}	139^{ab}	138^{ab}
3. Mortality % (excluding predator loss)	13.33	19.72	30.12	38.17
4. Mortality % due to predator	0	1.67	3.12	6.07
5. Supplementary energy Kcal. / bird / day	154^{c}	137^{b}	131^{ab}	125^{a}
6. Supplementary protein (g) / bird / day	7.6^{c}	6.8^{b}	6.5^{ab}	6.1^{a}
7. Supplementary feed cost (Taka) / bird / laying year	215.67^{c}	194.89^{b}	187.97^{ab}	176.02^{a}
8. Gross margin (Taka) / hen up to one laying year (Income - Cost)	158.73^{ab}	128.03^{b}	144.06^{ab}	163.25^{a}
9. Egg production period (months)	8.75^{b}	10.50^{a}	9.90^{a}	7.66^{c}

Figures with same or no superscript in a row are not significantly different ($P<0.05$).

Table 6. Performance of experimental birds reared under semi scavenging condition at three different locations.

Parameters	Least square mean		
	Grain / fiber (Jessore)	Grain dominant (Maikgonj)	Sugarcane / grain (Rajshahi)
1. Age of first egg (week)	34^{b}	31^{a}	34^{b}
2 Eggs / hen / year (hen day)	154^{a}	157^{a}	103^{b}
3. Mortality % (excluding predator loss)	12.29^{a}	43.90^{b}	19.81^{a}
4. Mortality % due to predator	0.30^{a}	0^{a}	6.27^{b}
5. Supplementary energy Kcal. / bird / day	146^{b}	130^{a}	134^{a}
6. Supplementary protein (g) / bird / day	8.3^{c}	6.4^{b}	5.6^{a}
7. Supplementary feed cost (Taka) / bird / laying year	243.17^{c}	159.55^{a}	178.19^{b}
8. Gross margin (Taka) / hen up to one laying year (Income - Cost)	140.53^{b}	224.73^{a}	80.29^{c}
9. Egg production period (months)	10.36^{a}	8.62^{b}	8.62^{b}

Figures with same superscript in a row are not significantly different ($P<0.05$).

Table 7. The estimated difference of effects of parents on production parameters

Parameters	Estimated difference of effects of parent stocks					
	AB vs Fayoumi	AB vs RIR	AB vs WLH	Fayoumi vs RIR	Fayoumi vs WLH	RIR vs WLH
1. Age of first egg (week)	1.20**	0.68	0.46	-0.51	-0.73	-0.22
2. Eggs / hen / year	-2.06	-3.07	4.16	-1.01	6.22	7.23
3. Mortality % (disease)	0.38	-0.42	0.94	-0.80	0.56	1.36
4. Predator loss %	-0.26	0.02	1.02	0.28	1.28	1.00
5. Supplementary energy / hen / day (Kcal)	8.59**	4.86	5.91	-3.73	-2.68	1.05
6. Protein (g) / hen / day	0.47**	0.28*	0.35	-0.19	-0.12	0.07
7. Supplementary feed cost (Taka) / hen / year	10.16**	5.82	6.80	-4.34	-3.36	0.98
8. Gross benefit (Taka) / hen / up to one laying year	-21.83*	-22.21*	-13.60	-0.38	8.23	8.61
9. Egg production period (months)	-0.53*	-0.45	-0.09	0.09	0.44	0.36

* Significant (P <0.05)
** Significant (P<0.01)