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DEVELOPMENT OF BIO-ECONOMIC MODEL FOR THE EVALUATION OF THREE GENOTYPIC GROUPS OF PHILIPPINE NATIVE CHICKEN

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ABSTRACT – A bio-economic model was developed using Structural Thinking Experiential Learning Laboratory with Animation (STELLA) Research Version 4.0.1 to determine and compare the productivity and profitability of Paraoakan, Bolinao and Banaba genotypic groups of Philippine native chicken production model of a 5:1 hen to rooster mating ratio under natural incubation, with feeding and semi-confinement scheme.

Model simulations revealed that Bolinao genotypic group had the most number of chicks laid but Paraoakan and Banaba groups had more marketable chickens after 18 weeks of rearing the chicks. The total liveweight and gross income realized by Paraoakan and Banaba groups were similar but were greater than those realized by Bolinao group. The net income derived from Paraoakan group was greater than those from Banaba and Bolinao group suggesting the advantage of Paraoakan over the two other genotypic groups.

Keywords: social media, disaster, southwest monsoon

INTRODUCTION

The value of native chickens does not lie on its direct effect on the economy of the country. Their economic role is to provide immediate sources of petty cash and high quality protein food for rural folks. Likewise, these animals are fitted and preferred to the recent trend of organic and "going back to basics" farming because they can subsists with very minimal production inputs and has the inherent ability to survive and reproduce under harsh environmental conditions with minimal care and marginal management. They are noted for their hardiness and resistance to diseases. These characteristics of native chickens make them suitable for food security because they can combat the adverse effects of climate change and global warming.

There are studies that characterized the native chickens and the production systems used in raising them (Magpantay et al, 2006; Celestino, 2010; Cabarles, 2012; Lopez et al, 2014). There are even studies that determined the performances of particular genetic groups of Philippine native chickens (Lambio and Grecia, 1998; Lambio et al, 1998). However, studies that looked into the comparison between the simulated performances and profitability of raising each genetic group of Philippine native chickens independently has not been carried out.

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Furthermore, the Bureau of Animal Industry initiated the Philippine Native Animal Development Program (DA Admin. Order # 15 Series 2010) to maximize the potentials and utilization of these animal genetic resources. But which of these genetic resources should the government use for their program in sustainable production models and technology transfers.

This study, therefore, was carried out to construct a bio-economic model that could be used to compare the performance and profitability of three genotypic groups of Philippine native chicken.

METHODOLOGY

Construction of a bio-economic model

A bio-economic model for native chicken production under natural incubation and semi-confinement production system was developed to evaluate the productivity of Paraoakan, Bolinao and Banaba genotypic groups of Philippine native chicken. Modeling was done with the use of the software Structural Thinking, Experiential Learning Laboratory with Animation (STELLA) Research Version 4.0.1 for Windows following the sequential steps in model building.

Structure of the Model

First, a deterministic model was initially developed to identify the different sectors that would influence productivity in native chickens. Menge et al (2005) was able to identify four categories in the input parameters including biological, management, nutritional and economic categories when he constructed a bio-economic model to support breeding of indigenous chicken in Kenya. In this model, five sectors which corresponded to the mentioned categories were determined. First, the population sector, showing the population of native chickens upon hatching, brooding, growing and at marketable age; the body weight sector, indicating the total weight of birds based on published records of gain in weights. These two sectors corresponded to the management and biological categories, respectively. The feed consumption sector represented the nutritional category was the feed intake of the birds based on phase feeding; the feed cost sector showing the expenses incurred in feeding the birds; and the economic sector represented the cost of feeds and the income generated from raising the native chickens.

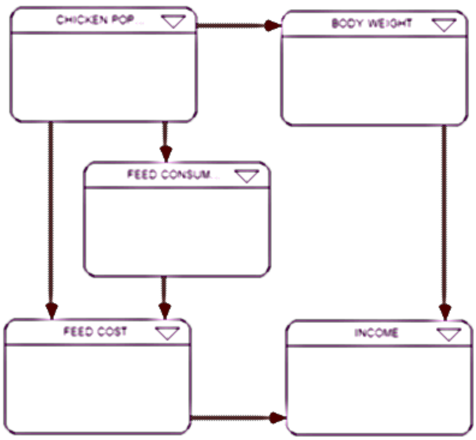

Figure 1 shows the five sectors and their interactions.

The components of the different sectors and their relationship are presented in Figure 2. The number of marketable native chickens at 18 weeks of age is dependent on the total number of eggs laid, percent hatchability of the eggs and mortality rates during brooding and growing stages. The total body weights of the marketable birds consider its dependencies with the gain in weights during brooding and growing phases. Feed consumption, on the other hand, is dependent on the feed intake of the birds in two different stages of production. Total feed cost depends on the cost of feeds incurred by the marketable chickens which in turn is dependent on the price of formulated feeds for the brooder and grower phases. The feed cost for the breeder is dependent on the feed cost for the growing stage. Gross income is affected by the total weight of the marketable chickens and price of liveweight when marketing them. Net income, in turn, relies on the gross income and the expenses incurred on feed cost.

Quantitative specification of the deterministic model

The following assumptions based on the productive performance of Paraoakan genotypic group of Philippine native chicken were specified in the components of the different sectors of the deterministic model (Table 1). These were derived from the data obtained from the studies of Lambio and Grecia, 1998, Lambio et al, 1998, and Lopez et al, 2014.

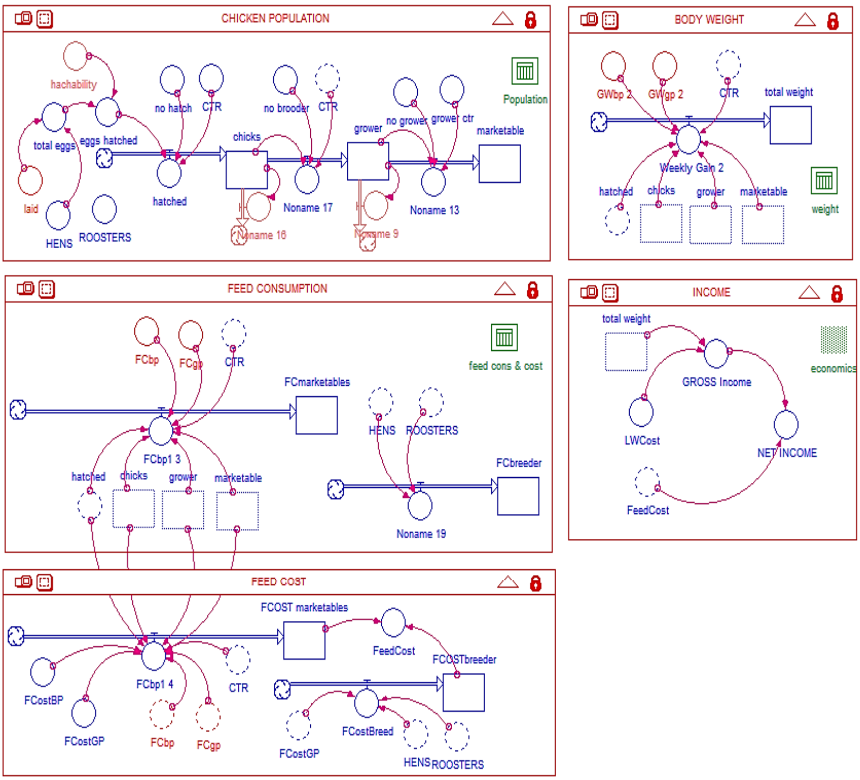

Figure 2.Components of the five sectors and their relationships.

Table 1. Productive performance of Paraoakan used to quantify the model

Parameters	Productive Performance
Eggs laid in a clutch, *pcs*	10.82
Hatchability, *%*	79.40
Weight of day-old chicks, *g*	24.3
Weekly gain in weight (brooding phase), *g*	50.4
Weekly gain in weight (growing phase), *g*	100.1
Feed Consumption (brooding phase), *g*	145.45
Feed Consumption (growing phase), *g*	443.83
Mortality rates (brooding phase), *%*	32.29
Mortality rates (growing phase), *%*	6.70

A 5 hen: 1 rooster mating model in semi-confinement with feeding and natural incubation production scheme was used with a basic time unit for the simulation of one week to consider the different phases of chicken production. Simulation was done for 18 weeks to complete one production cycle.

Sensitivity Analysis

The model was validated by altering the values of mortality rates at one time and percent hatchability in another and observing the effect on model behavior. This was done to look into the relative accuracy of the relationships among parameters. Upon observing that the model was sensitive to changes in mortalities and number of eggs hatched as indicated by the total marketable chickens, the model was developed.

The model was tested by running the simulation using productive data for Bolinao and then afterwards for Banaba genotypic groups of Philippine native chicken. The number of marketable Bolinao and Banaba native chickens at 18 weeks of age fell on the expected range. This signaled that the model is ready to be used for the comparison of the productivity of the three genotypic groups of Philippine native chicken.

Comparative analysis of the productivity of genetic groups of Philippine native chicken

Assumptions for the productive parameters

To compare the productivity of Banaba, Bolinao and Paraoakan genotypic group of Philippine native chicken, data for the productive performances (initial weight of chicks, gain in weight, feed consumption and mortality rates)of each of the genotypic group were based from the work of Lambio et al., 1998. On the other hand, data on the reproductive performances (number of eggs laid by a hen in a clutch and percent hatchability) used data generated from studies in the native chickens of Dolores, Quezon (Magpantay et al, 2006) to represent Banaba, Nueva Ecija (Celestino, 2010) for Bolinao and Palawan (Lopez et al, 2014) for Paraoakan (Table 2). Prevailing market prices for feeds, and liveweight in Palawan were assumed.

Table 2. Productive performances of the three genotypic groups of Philippine native chickens

Parameters	**Banaba**	**Bolinao**	**Paraoakan**
Eggs laid in a clutch, *pcs*	11.42 ± 2.55	11.97 ± 7.11	10.82 ± 1.97
Hatchability, *%*	72.63 ± 18.41	74.67 ± 16.41	79.40 ± 13.48
Weight of day-old chicks, *g*	26.4	25.8	24.3
Weekly gain in weight (brooding phase), *g*	56 ± 2.1	46.9 ± 2.8	50.4 ± 2.8
Weekly gain in weight (growing phase), *g*	80.5 ± 2.1	73.5 ± 2.8	100.1 ± 3.5
Feed Consumption (brooding phase), *g*	142.53 ± 29.72	180.55 ± 38.35	145.45 ± 38.35
Feed Consumption (growing phase), *g*	460.83 ± 13.56	588.53 ± 38.35	443.83 ± 23.49
Mortality rates (brooding phase), *%*	17.20	64.48	32.29
Mortality rates (growing phase), *%*	15.03	27.88	6.70

Simulated experimental production cycles

To compare the simulated productivity of the three genotypic groups, a Completely Randomized Design with three treatments: T1: Paraoakan genotypic group; T2: Bolinao genotypic group; and T3: Banaba genotypic group was assumed. One run of the model included the simulations for the three groups at the same time.

Thirty replications were done based on the formula for determining sample size:

$$n = \left[\frac{z_{\alpha/2}\sigma}{E} \right]^2$$

where $z_{\alpha/2}$ is known as the critical value

σ is the population standard deviation

E is the margin of error set at 5%

Each replication equals the number of runs or simulations in the bio-economic model. Each run equaled one production cycle in the native chicken production model. This was vital in the statistical comparison between the performances and profitability of the genotypic groups.

Data analysis and interpretation

Data on all parameters were subjected to one-way analysis of variance using MINITAB version 15 statistical software. Significant differences among Treatment means were determined using Tukey's test.

RESULTS

The productivity and profitability of production

Table 3 shows the means and standard deviations of the number of day-old chicks (hatched), number of marketable chickens and total liveweight of the marketable chickens in the three genotypic groups of Philippine native chickens from thirty runs/simulations of the bio-economic model.

Results of the study show that an average of 42.88 ± 8.35 day-old chicks is hatched from the eggs laid and incubated by five Paraoakan hens. In Bolinao genotypic group, an average of 54.31 ± 17.41 day-old chicks is hatched while around 41.86 ± 10.49 chicks are hatched by five Banaba hens.

Results further revealed that the number of day-old chicks hatched by Bolinao genotypic group is significantly higher than those hatched by Paraoakan and Banaba groups considering the same number of hens. This can be attributed to high number of eggs laid by native chickens in Pangasinan(Celestino, 2010) where Bolinao genotypic group is located compared to those in Palawan (Lopez et al, 2014) and Batangas or Quezon (Magpantay et al, 2006).

Paraoakan appears to catch-up in the number of eggs hatched (day-old chicks) even though the hens in Palawan laid the fewest number of eggs because the hatchability of the eggs laid by native chickens in Palawan where Paraoakan predominates is relatively higher. Lopez et al (2014) noted the hatchability of eggs laid by Paraoakan hens to be around 79.38 ± 13.48 %, Celestino (2010) only noted a hatchability of 74.67±16.41% for hens in Nueva Ecija while Magpantay et al (2006) noted a percent hatchability of 72.63±18.41 for the eggs laid by hens in Dolores, Quezon.

The number of marketable chickens is also presented in Table 1. After 18 weeks of rearing, there are around 27.015 ± 5.259 heads of Paraoakan, 18.294 ± 5.870 heads of Bolinao and 29.545 ± 7.403 heads of Banaba ready for market. Statistical analysis revealed that the differences in the number of marketable chickens between genotypic groups are significant. Furthermore, Bolinao genotypic group has the fewest marketable chickens and is significantly different from Paraoakan and Banaba group. The numbers of marketable Paraoakan and Banaba chickens are statistically the same.

Results suggest that even though Bolinao genotypic group hatch more chicks than Paraoakan and Banaba, the number of marketable heads after 18 weeks is more for Paraoakan and Banaba. This is due to the differences in mortality rates during brooding and growing stage. Lambio et al, 1998 previously determined that Bolinao genotypic group had the highest mortality rates during brooding at 64.48% compared to the other genotypic groups. Similarly, Bolinao has a mortality rate of 27.88% which is relative higher than the other groups. Paraoakan had a mortality rate of 32.29% during brooding and 6.70% during growing. These differences could possibly be addressed by appropriate production and technological interventions.

Furthermore, the total liveweight of the marketable chickens is significantly higher in Paraoakan and Banaba compared to Bolinao group while the means of the total liveweight is statistically the same between Paraoakan and Banaba. This is due to the dependency of liveweight to the number of marketable chickens and the gain in weights during brooding and growing periods.

Initially, day-old Bolinao chicks weighed around 25.8g, gains around 6.7g daily during brooding (0-6 weeks of age) and 10.5g daily during growing period (6-18 week of age). Banaba day-old chicks weighed around 26.4g and gains 8.0g daily during brooding and 11.5g during growing period. Day-old Paraoakan chicks weigh around 24.3g, gains 7.2g and 14.3g during brooding and growing periods, respectively. Paraoakan had the highest average daily gain during the growing period (Lambio et al, 1998).

Table 3. Means and standard deviations on the number of day-old chicks, marketable chickens and liveweight between genotypic groups from30 simulations of the bio-economic model

	PARAOAKAN	**BOLINAO**	**BANABA**
Day-old chicks, hds	42.88 ± 8.35^{b}	54.31 ± 17.41^{a}	41.86 ± 10.49^{b}
Marketables, hds	27.015 ± 5.259^{a}	18.294 ± 5.870^{b}	29.545 ± 7.403^{a}
Liveweight, kgs	45.054 ± 8.73^{a}	31.696 ± 10.130^{b}	44.536 ± 10.774^{a}

Row means with different superscripts differ significantly (P<.005)

Presented in Tables 4 and 5 are some economic aspects of native chicken production including feed cost, gross income and net income.

The gross income realized after 18 weeks of raising all of the chicks hatched by Paraoakan hens is around Php 6758 ±1309 while those realized by Bolinao is around Php 4755±1520 and around Php 6678±1614 from the Banaba. Statistical analysis revealed that Paraoakan and Banaba had the same mean earnings but they earned more than Bolinao native chickens.

When the expenses for the feed consumption of the chickens were subtracted from the gross income, the net income realized from native chicken production using breeder stocks composed of 5:1 hen to rooster mating ratio under natural incubation and semi-confinement scheme appeared to favor Paraoakan than the two other genotypic groups of Philippine native chicken. The mean net earnings of the Paraoakan group is around Php 2272.0 ± 618.32 followed by the Banaba group with Php 1645.9 ± 626.8.The Bolinao group has a loss of Php 310.2 ± 372.10 from raising all the eggs hatched by five hens and feeding them with formulated feeds whose cost are based on prevailing prices of raw materials.

Analysis of variance revealed significant differences between the mean earnings (net income) of the three genotypic groups indicating that the mean net income realized by Paraoakan genotypic groups is statistically higher than the mean earnings by Boliano and Banaba genotypic groups.

Table 4. Means and standard deviations on the cost of feed, gross income and net income between genotypic groups from 30 simulations of the bio-economic model

	PARAOAKAN	**BOLINAO**	**BANABA**
Feed Cost, Php	4477.2 ± 680.1	5118.2 ± 1205.2	5032.7 ± 989.8
Gross income, Php	6758 ± 1309[a]	4755 ± 1520[b]	6678 ± 1614[a]
Net income, Php	2272.0 ± 618.32[a]	-310.2 ± 372.10[c]	1645.9 ± 626.8[b]

Row means with different superscripts differ significantly (P<.005)

The cost of feed considered the feed consumption of the chickens on the two stages of production, brooding and growing which differ between genotypic groups. It also includes the cost coming from the feed consumption of the breeder stocks. However, these breeders could produce another clutch in around two months and would realize separate incomes from the two batches. In Western Visayas which is number one in native chicken inventory in the Philippines, recorded a clutch interval of77.87±4.14 days (Cabarles, 2012). The two clutches could share the expenses on the feeds of the breeder possibly leading to higher net income for each clutch/batch. For simplicity, we considered removing feed cost coming from the breeders and only included in the income analysis the cost of feeds of the marketables. The net income for the three genotypic groups had increased as shown in Table 5. Bolinao genotypic group, from having a loss, now realized an income amounting to an average of Php1012.9 ± 384.5.Paraoakan genotypic group now had a net income averaging Php 3265.4 ± 629.4 while Banaba had Php 2678.5 ± 634.4.

Statistical analysis further revealed that the differences between the mean net income were significant indicating that the net income of Paraoakan is highest. The net income realized by Banaba group is lesser but is significantly higher than the net earnings of Bolinao group.

Table 5. Means and standard deviations on the cost of feed (excluding the consumption of the breeders), gross income and net income between genotypic groups from 30 simulations of the bio-economic model

	PARAOAKAN	**BOLINAO**	**BANABA**
Feed Cost of Marketables, Php	3492.8 ± 688.6	3741.6 ± 1171.6	3999.8 ± 986.6
Gross income, Php	6758 ± 1309[a]	4755 ± 1520[b]	6678 ± 1614[a]
Net income, Php	3265.4 ± 629.4[a]	1012.9 ± 384.5[c]	2678.5 ± 634.4[b]

Row means with different superscripts differ significantly (P<.005)

CONCLUSION

The constructed bio-economic model can be used to determine the productivity of genotypic groups of native chicken in terms of number of marketable chickens and net income after 18 weeks of production.

The productivity in terms of number of marketable chickens after 18 weeks of rearing and total liveweight of these chickens of a 5hen:1 rooster native chicken model in semi-confinement with feeding and under natural incubation scheme is significantly lower in the Bolinao genotypic groups of Philippine native chicken than those observed in Paraoakan and Banaba groups. Paraoakan and Banaba group had similar productivity. The gross income realized after one production cycle is the same between Paraoakan and Banaba groups. Bolinao would have a loss. However, raising Paraoakan would be more profitable than Banaba and Bolinao group when the cost of feeds is considered.

STATEMENT OF AUTHORSHIP

The author conceptualized the study and constructed the bio-economic model.

LITERATURE CITED

Cabarles J. 2012. Production potentials of native chickens (Gallus gallus domesticus L.) of Western Visayas, Philippines. Trop Anim Health Prod.doi10.1007/s11250-012-0230-1.

Celestino E.F. 2010. Native chicken (Gallus gallus domesticus L.) production and marketing under various agro-ecosystems in Nueva Ecija, Philippines. MS in Animal Science. University of the Philippines Los Baños College Laguna.140 p.

Lambio, A.L. and M.C. Grecia. 1998. Reproductive performance of five genetic groups of Philippine native chickens under semi-confinement condition. Proceedings of the PSAS 35th Annual Convention. p. 187-189.

Lambio, A.L., O.L. Bondoc and M.C. Grecia. 1998. Brooding and growing performance of four genetic group of Philippine native chickens. Philippine Journal of Veterinary and Animal Sciences 24(1-2):1-7

Lopez, R.V., A.L. Lambio, R.S.A. Vega, A.P.O. De Guia. 2014. Management practices of native chicken (*Gallus gallus domesticus* Linn.) production in Palawan, Philippines. Philippine Journal of Veterinary and Animal Science 40(2):109-120.

Lingaya, R.A.I.N., M.C.R. Oliveros and V.A.Magpantay. 2007. Production performance and marketing of native chicken in the first and fourth districts of Iloilo. Philipp J Vet Anim Sci 32 (2): 163-171.

Magpantay, V.A., E.P. Supangco, A.Y. Pacificador Jr, C.C. Sevilla, A.L. Lambio and E.C. Gayeta. 2006. Characterization of native chicken production system in a coconut-based farming system in Dolores, Quezon. Philippine Journal of Veterinary and Animal Sciences 32(2): 195-202.

Menge, E.O., I.S. Kosgey and A.K. Kahi. 2005. Bio-economic model to support breeding of indigenous chicken in different production systems. International Journal of Poultry Science 4(11): 827-839.

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