MINISTRY OF EDUCATION AND TRAINING

MINISTRY OF AGRICULTURE AND RURAL DEVELOPMENT

NATIONAL INSTITUTE OF ANIMAL SCIENCE

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SELECTION AND PURE BREEDING OF TWO EGG-ORIENTED D629 AND D523 CHICKEN LINES

Major : Animal Genetics and Breeding

Code number : 9 62 01 08

BRIEF INFORMATION OF PhD THESIS

Ha Noi-2021

The work was completed at National institute of animal science

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The dissertation will be defended at the National thesis council at: National institute of animal sciences,

Time: …h date ….. Month …… year of 20....

The dissertation can be found at:

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INTRODUCTION

1. Problem Statement

In order to achieve the strategic goals of livestock development and adaptive production system. In the past, our country has had access to high-yielding poultry genetic resources in the world, conducted selection and breeding and developed some exotic chicken breeds. At the same time, some high-productivity chicken lines, with oriented-eggs, has been selection and breeding.

Imported chicken breeds, which have high egg production,have been developed such as: Leghorn white, ISA brown, Brown nick, Goldline 54, Moravia, Hisex whiter, Hyline, etc. From exotic genetic resources, some authors have selected, crossbreeding (using the method of selection based on phenotypic value) to create lines for domestic production such as research Nguyen Huy Dat (1991) white Leghorn chickens; Phung Duc Tien et al. (2012) two chicken lines HA1 and HA2, Nguyen Quy Khiem et cs. (2016) four lines of GT chickens,…

In 2016, The framework of the bilateral cooperation program between Vietnam and the Czech Republic to development of Czech egg-oriented chickens in Vietnam have been selected and imported two lines of egg-oriented chickens, the white feathered D629 line and brown feathered D523 series from DOMINANT CZ. These are two purebred chicken lines with high egg production, good egg quality, and the yolk ratio of egg has around 28-30%, which is 2-3% higher than other high-yielding chicken line. According to the company's documents, egg yield/hen/68weeks of age and egg weight of line D629 reached 269.81 eggs and 59.90g, and line D523 reached 258.37 eggs and 61.50g.

Through studies on imported chicken breeds in our country, especially purebred lines, both egg yield and weight of these two lines have not been achieved as announced by the company. Thus, in order to effectively exploit the reproductive performance traits and develop the precious genetic resources of these two chicken lines in Vietnam, it is necessary to continue to select and purebred breed to maximize the genetic potential of the yield traits. At the same time, creating a hybrid between two lines with high egg yield and quality, eggshell color suitable to consumer’s tastes. Therefore, the study "Selection and pure breeding of two egg-oriented chicken lines D629 and D523" was selected as the thesis topic.

2. Objectives of the study

- Selecting and improving the egg yield of the D629 rooster line.
- Selecting and improving the egg weight of the D523 hen line.
- Evaluating the production ability of commercial crossbred chickens created between D629 rooster line and D523 hen line.

3. Scientific and practical significance of the study

3.1. Scientific meanings

- Successfully selected the D629 male line with high egg yield; D523 female line had high egg weight. From two egg-oriented D629 and D523 chicken lines, commercial hybrid chicken had been created with heterosisin egg production.

- The research results of the topic are a valuable scientific basis for the research on selection and breeding of livestock, as well as a valuable scientific document for teaching, learning, research at training institutions, poultry breeding establishments in general and egg-oriented chickens in particular.

3.2. Practical significance

- The research results of the thesis opened the possibility of application from two egg-oriented chicken lines (D629 rooster line and D523 hen line) to produce commercial chickens with high yield egg, good egg quality and high yolk ratio, especially the eggshell with pink-white color, suitable to consumer's tastes, contributing to providing a valuable food source for the society.

- Enrich the genetic resources of our country's egg-oriented chicken breeds.

4. New contributions of the dissertation

- The research results of the thesis have contributed to perfecting the method of selecting egg-oriented chicken breeds in our country based on breed value estimated by BLUP, have determined the genetic parameters analyzed by statistical model through the software PEST and VCE, have brought high efficiency in breed selection;

- On the basis of the estimated breed value on egg yield trait at 38 weeks of age for D629 rooster and egg weight 38 weeks old for D523 hen, has selected a breed of D629 rooster with high egg yield, reaching 263.87 eggs/hen/68 weeks of age, increasing 11.28 eggs compared to the starting generation and a breed of D523 hen with high egg weight, reaching 64.14g; increasing 2.27g compared to the starting generation;

- From 2 chicken lines D629 and D523, a commercial hybrid chicken DTP1 was created, with an outstanding hybrid advantage in egg yield of 4.22%. Eggs had good quality, yolk ratio reached 30.23%, eggshell color was pinkish white, suitable for consumer tastes. It has contributed to the enrichment of high-quality egg-oriented chicken breeds in Viet Nam.

5. Dissertation layout

The thesis includes: 114 pages, 3 chapters, 40 tables, 9 pictures, references 141 domestic and international documents (44 documents in Vietnamese and 97 documents in foreign languages). There are 3 published research paper related to the Thesis.

CHAPTER 1

LITERATURE REVIEW

1.1. Scientific knowledge for some performance traits in chickens

The research case of the thesis is based on the scientific knowledge of some yield traits in chickens, the selective method to estimate the breed value by BLUP, the scientific basis of economic hybridization and hybrid advantage.

1.2. Research statement in Vietnam and abroad

The thesis has assessed the research statement of international and domestic following contents: study on heritability and genetic correlation in chicken selection, study on selection in chickens:

The study on selection and breeding of chicken eggs in the country has also achieved encouraging results. Studies have focused on selection of morphology characteristics, egg yield, egg weight (Nguyen Huy Dat, 1991; Tran Cong Xuan et al., 1999; Phung Duc Tien et al., 2004 and 2012; Nguyen Quy Khiem et al., 2016;…). However, the method of selection by phenotypic value, mainly still uses the analysis of variance method to calculate genetic parameters. Recently, The selection base on color-oriented broiler chickens which has been applied to the modern method of selection by the BLUP method. Hoang Tuan Thanh (2017), selecting 2 chicken lines (LV4 and LV5 lines) showed that the heritability of egg yield trait traits was 0.46 and 0.15. Pham Thuy Linh and et al (2020), selection of 3 TN chicken lines (over 3 generations) showed heritability of egg yield trait 0.12-0.19. There has not been any report on selecting broiler chickens using the systematic BLUP method of selection based on breed value, perhaps a few new studies only evaluate through genotype value modeling and using methods to calculate genetic parameters using animal models.

In poultry breeding, in order to get high-yield breeds imported from abroad, only unisexual progenitor, parents and commercial products could be imported, the pure lines is difficult to import. On the other hand, according to studies on imported chicken and egg breeds in our country, it showed that egg productivity and egg weight have not been achieved as announced by the company. Since 1974, when Vietnam has supported a set of chicken breeds, specializing in white Leghorn chicken breed with X chicken line X and Y chicken line for high egg yield by Cuba. This is the second time that Vietnam has imported 2 lines of chickens D629 and D523 from Dominant company.

To select and maintain high productivity of 2 chicken lines (D629 and D523), it is necessary to select 2 lines with the aim of improving egg yield, stabilizing egg weight for the male line (D629) and improving weight eggs, stabilizing egg production for female lines (D523). Selection through generations based on the estimated breeding value by the BLUP method. Genetic parameters were estimated by the REML method on VCE 6.0.2 statistical software. Estimated breeding value was estimated by BLUP method on PEST 4.2.3 software. The statistical model using genetic analysis is a multi-trait animal model. In present, this is an advanced and highly effective method in poultry breeding. Genetic progress was obtained by regressing breed value over each generation and evaluating the selection response of 2 chicken lines. This is the research direction and implementation of this thesis.

CHAPTER 2
MATERIALS, CONTENTS AND METHODS

2.1. Materials, locations and content of the research

2.1.1. Materials

- Starting generation: two chicken lines (D629 and D523) were imported from the Czech Republic;
- Generation 1, 2, 3, 4 of two lines of chicken D629 and chicken D523
- Commercial hybrid chicken DTP1 which is a cross between two chicken lines (♂D629 x ♀ D523).

2.1.2. Research location

Pho Yen chicken research station - Dac Son commune - Pho Yen town - Thai Nguyen province, belonging to Thuy Phuong Poultry Research Center.

2.1.3. Research duration

From May 2016 to April 2021.

2.2. Research content

Content 1: Determination of some morphology characteristics and peformance of two chicken lines (D629 and D523)

Content 2: Selection of 2 chicken lines (D629 and D523) through 4 generations

Selective D629 male chicken line for improvement egg production.

Selective D523 female chicken line for improvement egg weight.

Content 3: Evaluation of performance production of commercial hybrid chicken DTP1

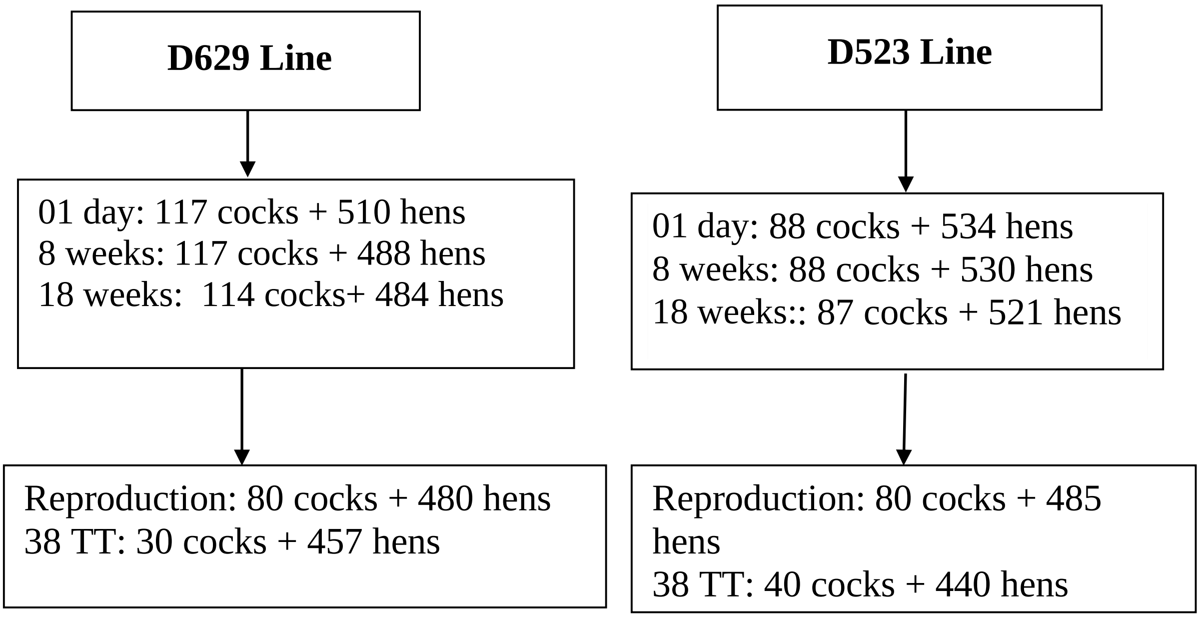
2.3. Research Methodology

2.3.1. Research Methodology 1

Determination of morphology characteristics and peformance of two derived chicken lines (D629 and D523)

Two lines of chickens were imported from the Czech Republic on May 27, 2016. The diagram of the number of chickens in the derived generation is as follows:

Diagram of the number of chickens in the starting generation (chickens)



+ Morphology characteristics: color of feathers, beak, legs and crest at 01 day of age and at 18 weeks of age using the method of observation with eye and taking pictures at: 01 day old and 18 weeks old by camera.

+ Evaluation of growth: body weight over weeks of age. At 8 and 18 weeks of age, the whole herd were weigh. Remove those that do not meet the standards such as clubfoot, crooked beak or some other deformity that moves to the laying hen stage. Feed consumption/herd/stage.

- Evaluation of reproductive traits: Monitor individual laying hen for egg production from laying the first egg to 38 weeks of age. Egg weight: weigh all eggs laid at 37-38 weeks of age, using an electronic balance with an accuracy of ± 0.5g.

Number of chickens taken to replace the flock of the next generation (according to the diagram above). Number of families in each line: D629 was divide in to 30 families, D523 was divide in to 40 families.

2.3.2. Research Methodology 2

Selection of 2 chicken lines (D629 and D523) through 4 generations.

Selective method:

- *Selection for growth trait:* Body weight at 8 and 18 weeks old: this criterion was selected to stabilize, taking roosters and hens whose weight was in the mean ± 2δ range. Combined with phenotype, remove individual that do not meet the standards such asclubfoot, crooked beak or some other deformities (applicable to both lines D629 and D523).

- *Selective reproductive traits*

+ Rooster D629:

Selection for the egg yield trait over 38-week-old was the most important: Individual monitoring of egg production from first egg laying to 38 weeks of age, selection for estimated breed value (EBV), selection of males and hens have a high to low EBV for egg production but not below the average breed value. To ensure stable egg weight, apply average egg weight as the standard, give preference to choose males and hens whose weight was around the mean value (Mean ± 2δ), until there are enough herd, The number of chickens per generation is shown in Table 2.1.

+ Hens D523:

Selecting the trait of egg weight at 38 weeks of age was the most important, to weigh all eggs laid at the age of 37-38 weeks, using an electronic balance with an accuracy of ± 0.5g; selection for estimated breed value (EBV), selecting roosters and hens with a high to low EBV in terms of egg weight. To ensure stable 38-week-old egg production with average egg production as the standard, priority should be given to selecting hens and hens whose egg production was around the mean value (Mean ± 2δ), until there are enough herd. The quantity and number of chickens per generation was shown in Table 2.1.

The selection method as above, through 4 generations, the number of selected chicken in flocks is shown in Table 2.1.

Table 2.1. Number of chickens used on the flock selected over 4 generations (heads)

Generation	Targets	D629 Line		D523 Line	
		Male	Female	Male	Female
G1	Number of chickens 1 day old	2824		3185	
	Number of chickens 8 weeks old	1371	1362	1524	1548
	Number of chickens selected at 8 weeks old	253	1162	418	1352
	Number of chickens 18 weeks old	245	1119	403	1302
	Number of chickens selected for spawning	101	978	212	1.180
	Number of chickens chosen to replace the flock (38 weeks old)	30	436	40	571
G2	Number of chickens 1 day old	2296		3140	
	Number of chickens 8 weeks old	1100	1109	1510	1525
	Number of chickens selected at 8 weeks old	270	998	444	1384
	Number of chickens 18 weeks old	260	965	430	1332
	Number of chickens selected for spawning	147	833	233	1199
	Number of chickens chosen to replace the flock (38 weeks old)	30	496	40	601
G3	Number of chickens 1 day old	2575		3140	
	Number of chickens 8 weeks old	1237	1253	1507	1520
	Number of chickens selected at 8 weeks old	355	1109	450	1379
	Number of chickens 18 weeks old	344	1069	433	1327

	Number of chickens selected for spawning	154	962	238	1163
	Number of chickens chosen to replace the flock (38 weeks old)	30	574	40	616
G4	Number of chickens 1 day old		2568		3242
	Number of chickens 8 weeks old	1236	1245	1564	1565
	Number of chickens selected at 8 weeks old	385	1121	450	1411
	Number of chickens 18 weeks old	375	1081	434	1365
	Number of chickens selected for spawning	174	927	238	1210
	Number of chickens chosen to replace the flock (38 weeks old)	30	556	40	644

Pure line breeding method

Using a closed cloning method, rotate the male across generations to avoid inbreeding. The D629 line has 30 families, each family consists of 1 cock and 13-20 hens. The D523 line has 40 families, each family consists of 1 cock and 12-17 hens (depending on the generation, shown in Table 2.1). Each family has 1 and 1-2 substitute chicken.

Methods of observationg and collecting data

Methods of collected eggs, incubationfor selection : collected and recorded eggs to incubate instead of flocks, numbering breeding eggs: using a pencil and typing as follows: numerator is family, denominator is mother (1/2) ; individual hatching: there is a tray to block the individual so that when stacking eggs, each mother is a separate cell. Chickens are marked with individual numbers from hatching time (individual numbers: 1, 2, 3, 4, ...) and recorded in the individual incubation book to track the pedigree of each generation.

Set up a system of document and record data (number of chickens in the barn, number of animals lost, daily feed amount, number of eggs collected daily, body weight , egg weight, incubation book, etc.)

Methods of analyzing variance components and genetic parameters

Components of variance and genetic parameters of the selected trait were estimated by REML method on VCE 6.0.2 software. breed values were predicted by BLUP method on PEST software 4.2.3. Statistical model for genetic analysis of egg yield at 38 weeks of age (for D629) and egg weight at 38 weeks of age (for D523) as follows:

$$Y_{ijk}= \mu + TH_i + a_j + e_{ijk}$$

Where: Y_{ijk}: obtained value of observe trait; μ: mean value of the population; TH_i: fixed effect of generation factor (i = 1,4); a_j: cumulative genetic influence of the j.th individual; e_{ijk}: random error.

Method to determine the effect of fixed factors on yield traits

Determining the effect of generation factor on yield traits by General Linear

Model (GLM).

Statistical model: $Y_{ij} = \mu + TH_i + e_{ij}$

In which: Y_{ij}: obtained value of observe trait; μ: mean value of the population; TH_i: the influence of generational factors; e_{ij}: random error.

Methods for assessing genetic predisposition and genetic progress

The genetic propensity of the studied trait was evaluated based on the variation of the mean breeding values per generation.

The genetic progress of each trait was determined by linear regression of the generation mean through the regression equation: $y = a + bx$

In which: y: the same value as the studied trait; a: constant; x: generation (x = 1, 4), b: regression coefficient (increase/decrease of breed/generation value) is genetic progress.

2.3.3. Research Methodology 3

DTP1 commercial crossbred chickens were created from D629 male and D523 hens, obtained from generation 3. The experiment was arranged in a completely randomized one-factor design to evaluate commercial chicken performance. Total number of 1-day-old hens/group was 300 (repeated 3 times). Among the plots, there were similarities in age, care, nurturing, veterinary procedures for disease prevention. The only difference in experimental factors: experimental batches with different types of chickens. Research period: from July 2019 to April 2021.

Nurturing care methods

The chickens are cared for, and cleaned according to the egg-oriented chicken breeding process of the Thuy Phuong Poultry Research Center and the documents of Dominant CZ.

Breeding method: The chicks, broilers, broodstock and DTP1 commercial hybrids in the reproductive stage were raised in a coop with a cooling system. Laying stage: for 2 lines of chicken D629, D523 from starting generation to 4th generation chickens were raised on a cage system, modern equipment, 1 chicken/cage and applying artificial insemination.

Two lines of chickens D629, D523 and commercial chickens DTP1: from 01 day of age to 8 weeks of age, free feeding; period of 9-18 weeks of age with quantitative feeding; reproductive stage feed according to the rate of laying.

Determine of indexes

Monitoring indicators are determined by methods in poultry production (Bui Huu Doan et al., 2011).

Data processing methods

Statistical processing software such as EXCEL, Minitab 16.2.0. Presenting a table of results using 3 statistical parameters are sample size (n), mean value (Mean) and standard deviation (SD) (genetic parameters using standard error, SE), results take up to 3 decimal places. Using the method of analysis of variance (ANOVA) to evaluate the difference in body weight and egg productivity over generations. Compare percentage values with $\chi 2$ using MINITAB 16.2.0 software.

CHAPTER 3
RESULTS AND DISCUSSION

3.1. Determination of some appearance and yield characteristics of two derived chicken lines D629 and D523

3.1.1. Appearance characteristics of two chicken lines

Line D629: At 1 day old and 18 weeks old, cocks and hens have white feathers, yellow beak and legs, bright red single crests.

Line D523: At 1 day old and 18 weeks old, roosters and hens have brown feathers, yellow beak and legs, scarlet single crest.

3.1.2. Survival rate of two chicken lines

The survival rate of 2 chicken lines D629 and D523 at the age of 1 day and 8 weeks for roosters was 100.00% and hens was 95.69-99.25%. In the period of 9-18 weeks of age, the survival rate of roosters reached 97.44-98.86% and hens reached 98.30-99.39%.

Thus, two chicken lines D629 and D523 had good adaptability and disease resistance in Vietnam's climate.

3.1.3. Body weight of two chicken lines

Body weight at 8 weeks of age of line D629 rooster was 701.50g, hen was 574.74g; Compared with the Company, respectively, 97.43 and 96.19%. Line D523 rooster was 832.96g and hen was 631.23g; Compared with the firm, respectively, reached 101.58 and 98.63%.

The body weight of an 18 weeks old D629 rooster was 1,674.88g and hen was 1,271.79g (equivalent to 104.68 and 97.83% compared to the firm). The D523 rooster line was 2,046.53g and the hen was 1,477.07g (reaching 100.32 and 100.14% respectively compared to the company). Thus, chickens D629 and D523 had the same body weight compared to the firm.

Compared with the study of Pham Thuy Linh (2010), hens HA1 and HA2 at 8 weeks old reached 738.11-742.67g; At 18 weeks of age, reaching 1,409.44-1,436g, the result of the hen line D629 has a lower weight, the line D523 is higher.

3.1.4. Feed consumption of two chicken lines

Feed consumption/bird: 1NT-8 weeks old: line D629 rooster: 1,773.03g and hen: 1,666.49g; line D523 1,841.14 and 1,708.42g, respectively. In the period of 9-18 weeks of age, line D629 roosters 4,929.40g and hens: 4,722.20g; line D523 respectively 5,205.48 and 4,854.78g. Phase 1 day old -18 weeks old line D629 rooster 6,702.43g and hen 6,388.69g; line D523 7,046.62 and 6,563.20g, respectively. The results of feed consumption/head of the two chicken lines were lower than that of the study of Phung Duc Tien et al. (2012) HA cocks was 8.34 - 8.68 kg and hens was 7.24-7.41 kg.

3.1.5. Laying age, hen weight and egg weight at 5% laying rate, peak and 38 weeks of age of the two parent lines

The D629 line had a 5% laying age of 137 days and the D523 line was 139 days. The peak laying age of D629 chickens was 205 days; chicken line D523 was 209 days (week 30), suitable for domestic chicken breeds. Pham Thuy Linh (2010) reported that the peak laying age of HA12 chickens was 209 days, so the D629 line was 4 days earlier and the D523 line was similar. Weight of hens at 38 weeks of age: line D629: 1,762.00g; D523 line: 1,880.67g.

3.1.6. Yield of 38-week-old eggs of two primary-generation chicken lines

Table 3.1. Egg yield at 38 weeks of age of two lines D629 and D523 THXP

Herd	Target	D629 Line	D523 Line
Chicken population	Quantity	480	485
	Egg/hen yield	95.58	93.06
	SD	18.23	18.81
Population selected	Quantity	457	440
	Egg/hen yield	98.39	97.67
	SD	13.32	12.16

Egg yield/hen/38 weeks of age, the population of the D629 line reached 95.58 eggs, the D523 line reached 93.06 eggs; higher than the results of Phung Duc Tien et al. (2012) breeding through generations of egg-oriented chickens HA1 was 87.25-87.85 eggs, HA2 was 82.10-83.44 eggs.

3.1.7. Laying rate, egg yield and feed consumption/10 eggs of two chicken lines

The average laying rate/68 weeks of age of chicken line D629 was 73.64%, line D523 was 71.21%. Egg yield/hen/68 weeks of age of line D629 reached 252.59 eggs, compared to the firm's 93.61% and the line D523 reached 244.24 eggs, reaching 94.53% compared with the firm. Feed consumption/10 eggs average 68 weeks old of chicken line D629 was 1.71 kg; D523 line was 1.79 kg.

According to Pham Thuy Linh (2010), the egg yield/hen/68 weeks old, HA12 chickens reached 225.65 eggs; HA21 reached 219.48 eggs; HA1: 222.24 eggs; HA2: 216.42 eggs. Feed consumption/10 eggs 1.96; 2.02; 2.01 and 2.13 kg, respectively. Chickens D629, D523 have higher egg productivity and lower feed consumption/10 eggs.

3.1.8. Hatching results of the two generations of chickens

Following 5 incubators from 35 to 40 weeks old, the results of the D629 line showed an average embryo rate of 93.26%, hatching/total hatching rate of 78.38%, hatching/egg with embryos was 84.04%; line D523 was 94.34; 79.35, and 84.11%, respectively. Chickens D629 and D523 apply artificial insemination, on the other hand, two newly imported purebred chicken lines hatch in hot and humid climate in Vietnam, which also affects the hatching results more or less.

3.2. Selection of two chicken lines D629 and D523 through 4 generations

3.2.1. Selective D629 rooster line improves egg production

3.2.1.1. Composition of variance and heritability of traits across generations

The egg yield trait is the most important used to genetically improve the D629 chicken line.

The trait of egg yield at 38 weeks of age: The cumulative genetic variance (σ^2_A) is the determining factor for the magnitude of the heritability coefficient and decreases markedly from the 1st generation (96.55) to the 4th generation (35.04), accounting for 28.67% in the 1st generation, then only 12.08% in the 4th generation compared with the phenotypic variance (σ^2_P). The estimated heritability also tends to decrease markedly through 4 generations of selection: the 1st, 2nd, 3rd and 4th generations are 0.29; 0.18; 0.15 and 0.12, respectively. This result shows that stabilizing the D629 lineage chickens after each generation of selection reduced the genetic variability, thereby reducing genetic variance, leading to decreased heritability across generations.

Table 3.2. Composition of variance and heritability of traits across generations

Generation	Parameters	BW 8 weeks age	BW 18 weeks age	38 weeks old egg yield	EW 38 weeks age
G1	n	2,733	1,364	978	978
	σ^2_A	1,158.39	6,027.55	96.55	11.92
	σ^2_E	2,631.30	12,032.70	240.30	14.30
	σ^2_P	3,789.60	18,060.20	336.80	26.20
	$h^2 \pm$ SE	0,31±0,036	0,33±0,045	0,29±0,06	0,46± 0,04
G2	n	2,209	1,225	833	833
	σ^2_A	799.70	3,048.67	56.43	9.36
	σ^2_E	2,542.10	10,737.40	257.80	16.70
	σ^2_P	3,341.80	13,786.00	314.20	26.10
	$h^2 \pm$ SE	0.24±0.02	0.22±0.03	0.18±0.04	0.36± 0.04
G3	n	2,490	1,413	962	962
	σ^2_A	1,026.25	3,484.19	48.38	7.36
	σ^2_E	2,092.76	9,599.01	265.41	14.35
	σ^2_P	3,119.00	13,083.20	313.80	21.70
	$h^2 \pm$ SE	0.33±0.029	0.27±0.032	0.15±0.03	0.34± 0.04
G4	n	2,481	1,456	927	927
	σ^2_A	849.01	3,220.17	35.04	6.13
	σ^2_E	2,258.98	9,707.54	254.93	12.30
	σ^2_P	3,108.00	12,927.70	290.00	18.40
	$h^2 \pm$ SE	0.27±0.026	0.25±0.035	0.12±0.03	0.33± 0.04

Note: n: number of chickens; BW: body weight, EW: egg weight, G: generation

3.2.1.2. Composition of variance of 4 generations of selection

Table 3.3. Composition of variance of 4 generations of selection

Parameters	BW 8 weeks age	BW 18 weeks age	38 weeks old egg yield	EW 38 weeks age
n	10518	6057	4180	4180
σ^2_A	991.57	4,892.35	85.43	9.93
σ^2_E	2,345.90	10,090.60	234.00	13.30
σ^2_P	3,337.40	14,982.90	319.40	23.30

The cumulative genetic variance for the 38-week-old egg yield trait was 85.43, equivalent to 26.75% of the phenotypic variance (σ^2P), so for the 38-week-old egg yield trait, the external variance occupied the highest level.

Therefore, in parallel with the selection to improve the genetic potential of egg yield, the external conditions such as care and management of the breeding stock, cages, food... need to be ensured at the best level to promote or retain the genetic potential of this trait.

3.2.1.3. Covariance for traits of body weight, egg yield and egg weight

Table 3.4. Covariance for traits of body weight, egg yield and egg weight

Targets	1	2	3	4
BW 8 weeks age (1)		1,181.75	-108.15	42.77
BW 18 weeks age (2)	2,467.60		-305.16	134.52
38 weeks old egg yield (3)	-179.90	-332.80		-17.47
EW 38 weeks age (4)	82.50	197.80	-2.30	

Note: Values above the diagonal are genetic covariances, below the diagonal are phenotypic covariances

The results showed that: there were 3 pairs of traits between body weight 8 with 18 weeks of age, body weight of 8 weeks of age with 38-week-old egg weight and 18-week-old body weight with 38-week-old egg weight genetic covariance is positive.

The pairs of 38-week-old egg yield with 38-week-old egg weight, 8-week-old body weight with 38-week-old egg yield, and 18-week-old body weight with 38-week-old egg yield were all covariates genetic error negative, so genetic variation between these traits tends to be opposite. The phenotypic covariance of the above trait pairs also tends to be similar to the genetic covariance. From the relationship between the pairs of traits make more accurate decisions when considering the trait selection for efficiency.

3.2.1.4. Heritability and genetic correlations for traits of body weight, egg yield and egg weight

In the D629 rooster, the heritability of the egg yield trait and the genetic correlation between egg yield and egg weight were the most important.

a. Heredity coefficient

The heritability of the 38-week-old egg yield trait in the D629 rooster line was 0.27. With standard error value of heritability of low egg yield trait (SE = 0.02), the estimated value had high confidence. This result was consistent with the study of Nguyen Quy Khiem et al. (2020) The genetic coefficient of Egyptian chickens in male lines was 0.23-0.27. Several studies in the world have been published, using the REML method with advanced software, the heritability of the egg yield trait was at different levels, ranging from 0.11 to 0. 54 (Nurgiartiningsih et al., 2002, 2004; Szwaczkowski, 2003; Luo et al., 2007).

Table 3.5. Heritability, genetic correlation and phenotypic correlation for traits of body weight, egg yield and egg weight

Targets	1	2	3	4
BW 8 weeks age (1)	**0.30±0.02**	0.54±0.04	-0.37±0.06	0.43±0.04
BW 18 weeks age (2)	0.35	**0.33±0.026**	-0.47±0.08	0.61±0.04
38 weeks old egg yield (3)	-0.17	-0.15	**0.27±0.02**	-0.60±0.07
EW 38 weeks age (4)	0.30	0.34	-0.03	**0.43±0.03**

Note: Diagonal (bold) is heritability, values above the diagonal are genetic correlations, below diagonal are phenotypic correlations.

The heritability coefficient for the 38-week-old egg weight trait of the D629 rooster line was 0.43, a high value. At the same time, the heritability of body weight traits at 8 and 18 weeks of age were 0.30 and 0.33, respectively and were stable.

Thus, the estimated value of the heritability of the egg yield traits of the D629 line was consistent with published domestic and foreign studies. At the same time, the standard error of heritability coefficients was low, the estimated value of heritability was reliable and the genetic stability was also quite high. Therefore, the main goal was to select for genetic improvement and keep the genetic potential of the egg yield trait promising and effective.

b. Genetic correlation coefficient

For broilers, the genetic correlation coefficient between egg production and egg weight was important. The results showed that the D629 line in the flock population was -0.60 and had a negative correlation, consistent with the research of some authors: (Adebambo et al., 2006; El-Labban et al, 2011; Oleforuh-Okoleh, (2011) Abdel-Ghany (2011) genetic correlation in Mandarah chickens over three generations was negative (-0.41). Le Thanh Hai et al. (2021) BT color feathered chicken line was -0.75.

The genetic correlation coefficient between body weight at 8 and 18 weeks of age was positive and quite close (0.54), body weight at 8, 18 weeks of age with egg weight at 38 weeks of age was also positive: 0.43 and 0.61. The corresponding phenotypic correlation was 0.35; 0.30 and 0.34. This result was consistent with the announcement of Dang Vu Binh (2002) that genetic correlation and phenotypic correlation of body weight and egg weight were 0.42 and 0.33.

The genetic correlation between body weight at 8 and 18 weeks of age and egg yield at 38 weeks of age was inversely correlated with a value ranging from -0.37 to -0.47. Identifying genetic correlation helps reference breeders to reduce the number of traits in selection to improve efficiency in breeding.

3.2.1.5. Breed value, genetic predisposition and genetic progress for 38-week-old egg yield

Table 3.6. Value of egg yield trait 38 weeks old line D629

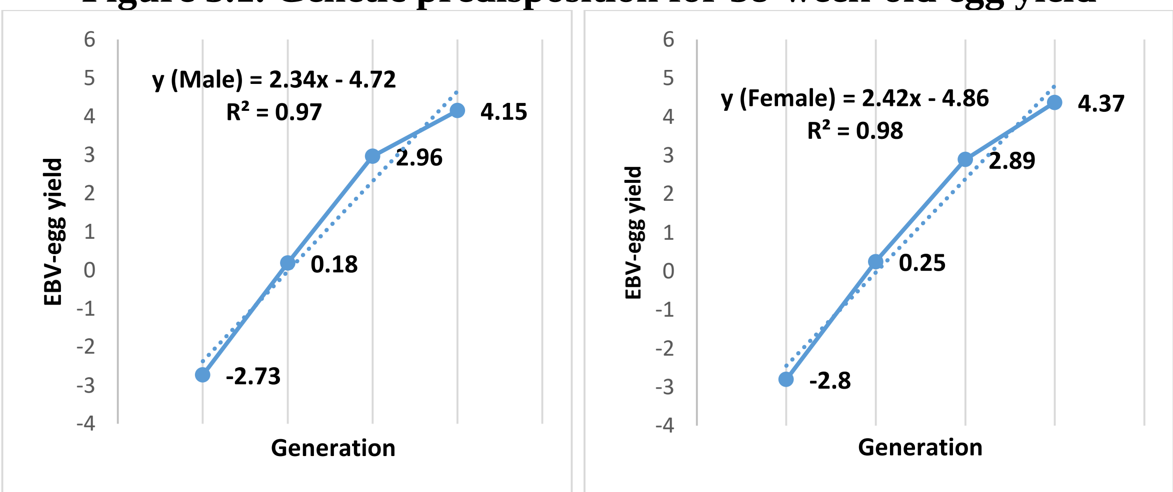
Generation	Male			Female		
	n	EBV	SD	n	EBV	SD
Chicken population						
1	1371	-2.73	3.37	978	-2.80	10.20
2	1100	0.18	3.72	833	0.25	10.02
3	1237	2.96	4.05	962	2.89	9.93
4	1236	4.15	4.77	927	4.37	9.09
Population selected						
1	253	2.46	2.74	436	5.80	4.67
2	270	4.13	2.29	496	6.53	6.54
3	355	6.45	3.21	574	9.07	6.47
4	385	6.93	3.17	530	9.82	6.69

Chicken line D629 has the same value of 38-week-old egg yield trait between roosters and hens, the difference was not significant and both increase through each generation of selection. The results indicated that the genetic improvement of the 38-week-old egg yield trait was quite good over 4 generations of selection.

Regression equation of 38-week-old egg yield by generation of roosters and hens D629 population: roosters: Y = 2.34X - 4.72 with $R^2 = 0.97$, hens: Y = 2.42X - 4.86 with $R^2 = 0.98$ (Y: same value and X: generation)

Figure 3.1 shows that the genetic predisposition tends to improve well over 4 generations of selection, which is even more evident through a positive linear regression line with a very high coefficient of determination (R^2) of 0.97- 0.98. Simultaneously, through the regression equation for the 38-week-old egg yield trait, the genetic progress of egg yield trait for roosters was 2.34 eggs/generation and hens was 2.42 eggs/generation.

Figure 3.1. Genetic predisposition for 38-week-old egg yield



3.2.1.6. Egg yield 38-week-old over 4 generations

The D629 chicken line, after selection according to the breed value of 38 weeks old egg yield, from which the corresponding egg yield phenotype value increased over the generations of selection ($P<0.05$). The 4th generation, 38 weeks old egg yield was 102.71 eggs, an increase of 2.42 eggs/generation compared to the starting generation. This shows that through generations, the selection of external factors has been optimally guaranteed, so phenotypically this trait has achieved good results, so the selective response to genotype and genotype values of this feature is equal.

3.2.1.7. Body weight at 8 and 18 weeks of age across 4 generations

Weight at 8 weeks of age of the population over 4 generations of roosters: 714.65-719.45g (reaching 99.26-99.92% compared to the company); hens: 595.63-600.35g (reaching 98.45-99.23% compared to the company), D629 chicken line is stable over generations ($P>0.05$). Weight of 18 weeks old rooster: 1,599.19-1,613.34g (reaching 99.95-100.83% compared to the company) and hen: 1,279.30-1,291.19g (reaching 99.17-100.00% compared to the company). Body weight of roosters and hens over 4 generations, the difference was not statistically significant ($P>0.05$). The weight selection of the herd is also equivalent to that of the population herd, consistent with the stable selection method. The uniformity in hens reached a high level of 80.16-81.13%; reflecting chickens with relatively even sexual maturity.

3.2.1.8. Survival rate and food consumption over 4 generations

The survival ratio of chickens of the D629 line over 4 generations was high at the following stages: 96.21-96.78% in the 1-day-old-8-week-old stage; in the 9-18 weeks old stage: 96.30-97.40%. Compared with the derived generation and the 4 selected generations, the survival ratio is similar ($P>0.05$). Food consumption/chicken over 4 generations is stable and is equivalent to that of the derived generation. In the period of 1 day -18 weeks old, chickens have low food consumption, rooster was 6,622.11-6,649.26g; hen was 6,419.11-6,446.26g; lower than the results of Tran Ngoc Tien (2019) on 4 lines of GT chickens: rooster was 8,123-8,328g, hen was 7,183-7,350g.

3.2.1.9. Laying age, hen weight and egg weight over 4 generations

The laying age of 5% of D629 lines through 4 selective generations is 129-131 days, compared with the derived generation, the laying age tends to be 3-5 days earlier.

At 38 weeks of age, hen's weight reached 1,725.44-1,748.33g, egg weight was 60.05-60.35g, hen's weight and egg weight between generations were relatively stable, the difference had no statistical significance ($P>0.05$).

3.2.1.10. Laying rate, egg yield, food consumption/10 eggs and hatching results over 4 generations

The average birth rate/68 weeks of age was 72.79% in the 1st generation, 75.39% in the 4th generation, 2.60% higher than in the 1st generation.

Egg yield/hen/68 weeks old reached 263.87 eggs, higher than the original generation 11.28 eggs (equivalent to 4.47%) and egg weight remained stable.

Table 3.7. Laying rate, egg yield, food consumption/10 eggs and hatching results over 4 generations

Explain	G1	G2	G3	G4
Birth rate at 68 weeks of age (%)	$72{,}79^{d}$	$74{,}30^{c}$	$75{,}01^{b}$	$75{,}39^{a}$
Yield of eggs/hen/68 weeks age (eggs)	$254{,}77^{d}$	$260{,}05^{c}$	$262{,}54^{b}$	$263{,}87^{a}$
Food consumption/10 eggs (kg)	$1{,}72^{a}$	$1{,}68^{ab}$	$1{,}66^{b}$	$1{,}65^{b}$
Rate of embryos (%)	$95{,}21^{c}$	$95{,}45^{c}$	$95{,}60^{c}$	$95{,}30^{c}$
Hatching rate/total hatching eggs (%)	$81{,}93^{b}$	$82{,}22^{b}$	$82{,}61^{b}$	$82{,}22^{b}$

Note: In the horizontal row, the mean values have different letters, the difference between them is statistically significant (P<0.05) and vice versa.

The difference in egg yield of line D629 over 4 generations was statistically significant with P<0.05. According to Tran Ngoc Tien (2019) on 4 lines of 3rd generation GT chickens with 242.06-248.33 eggs, chicken D629 has a higher egg yield of 11.72-17.99 (equivalent to 4.50-6.92%).

Food consumption/10 eggs over generations was 1.72; 1.68; 1.66 and 1.65 kg, respectively. The results showed that selectively increasing egg production reduced feed consumption/10 eggs.

Incubation results from 35 to 40 weeks of age through 5 incubations showed that the percentage of eggs with embryos through 4 selective generations reached 95.21-95.60%. The hatching rate/total hatched eggs reached 81.93-82.61%.

3.2.2. Selecting D523 hen line with improved egg weight

3.2.2.1. Composition of variance and heritability of traits across generations

The cumulative genetic variance component in the 1st generation was 16.85; 2nd generation was 9.43 generation 3 was 8.78; 4th generation was 5.21; accounting for 43.99; 30.13; 27.27 and 16.97%, respectively against phenotypic variance. The heritability of the 38-week-old egg weight decreased significantly from 0.44 in the 1st generation; 0.30 in 2nd generation; 0.27 in 3rd generation; down to 0.17 in 4^{th} generation.

This result showed that the egg weight trait of the D523 line has the ability to be passed on to the next generation with high efficiency in the first 3 generations, to the 4th generation at a low level, under great influence of external factors. Nguyen Quy Khiem et al. (2020) heritability coefficient of 38-week-old egg weight of female Egyptian hens gradually decreased over 3 generations of selection with 0.35; 0.32 and 0.28, respectively.

The cumulative genetic variance composition of 38-week-old eggs tends to decrease slightly over the respective generations: 73.39; 68.10; 52.99 and 36.70; heritability coefficients in generation 1, 2, 3 all reached values of 0.20 and 0.18 in generation 4. Body weight at 8 and 18 weeks of age, value of cumulative genetic variance component and system The genetic number tends to decrease from generation to generation, reaching the medium and low levels. The analysis results showed that the body weight of chickens of the D523 line was quite stable in the breeding conditions in Vietnam.

Table 3.8. Composition of variance and heritability of traits across generations

Generation	Parameters	BW 8 weeks age	BW 18 weeks age	38 weeks old egg yield	EW 38 weeks age
G1	n	3,072	1,705	1,180	1,180
	σ^2_A	1,929.43	8,121.82	73.39	16.85
	σ^2_E	2,573.40	15,534.30	290.60	21.50
	σ^2_P	4,502.90	23,656.10	364.00	38.30
	$h^2\pm$ SE	0.43±0.05	0.34±0.04	0.20±0.038	0.44±0.045
G2	n	3,035	1,762	1,199	1,199
	σ^2_A	1,586.06	5,547.52	68.10	9.43
	σ^2_E	3,194.50	16,016.40	266.70	21.90
	σ^2_P	4,780.50	21,563.90	334.80	31.30
	$h^2\pm$ SE	0.33±0.03	0.26±0.03	0.20±0.03	0.30±0.024
G3	n	3,027	1,760	1,163	1,163
	σ^2_A	1,255.59	4,190.07	52.99	8.78
	σ^2_E	3,321.90	13,792.70	217.10	23.40
	σ^2_P	4,577.50	17,982.70	270.10	32.20
	$h^2\pm$ SE	0.27±0.03	0.23±0.03	0.20±0.03	0.27±0.03
G4	n	3,129	1,799	1,210	1,210
	σ^2_A	1,012.15	2,911.08	36.70	5.21
	σ^2_E	2,725.40	13,102.80	167.00	25.50
	σ^2_P	3,737.60	16,013.90	203.70	30.70
	$h^2\pm$ SE	0.27±0.03	0.18±0.03	0.18±0.03	0.17±0.026

Note: n: number of chickens; BW: body weight, EW: egg weight, G: generation

3.2.2.2. Variance components of 4 generations of selection

Table 3.9. Variance components of 4 generations of selection

Parameters	BW 8 weeks age	BW 18 weeks age	38 weeks old egg yield	EW 38 weeks age
n	12,881	7,634	5,237	5,237
σ^2_A	1,633.39	4,681.00	66.39	16.07
σ^2_E	2,820.50	14,542.40	218.40	18.90
σ^2_P	4,453.90	19,223.40	284.80	35.00

The D523 line egg weight trait, the cumulative genetic variance was 16.07 at a high level, accounting for 45.91% of the phenotypic variance. It has been shown that selection to increase egg weight will be effective, because the heritability of this trait is very large.

For the 38-week-old egg yield trait, the cumulative genetic variance was 66.39, accounting for 23.31% of the phenotypic variance. It shows that the external influence of this trait is very large, in order to keep the egg yield stable, the external conditions need to be ensured at the optimum level. The cumulative genetic variance for the trait of body weight at 8, 18 weeks of age is on average, accounting for 36.67 and 24.35% compared to the phenotypic variance.

3.2.2.3. Covariance for traits of body weight, egg yield and egg weight

The results showed that: there were 3 pairs of traits between body weight 8 with 18 weeks of age, body weight of 8 weeks of age with 38-week-old egg weight and 18-week-old body weight with 38-week-old egg weight. genetic covariance is positive.

Table 3.10. Covariance for traits of body weight, egg yield and egg weight

Targets	1	2	3	4
BW 8 weeks age (1)		1,237.25	-149.92	97.87
BW 18 weeks age (2)	1591.70		-362.64	155.28
38 weeks old egg yield (3)	-68.50	-201.90		-27.67
EW 38 weeks age (4)	77.00	112.50	-2.90	

Note: Values above the diagonal are genetic covariances, below the diagonal are phenotypic covariances

The pairs of egg yield traits with 38-week-old egg weight, 8-week-old body weight with 38-week-old egg production, and 18-week-old body weight with 38-week-old egg production all had genetic covariances that are negative, genetic variation among these traits tends to be opposite. The phenotypic covariance of the above trait pairs also tended to be similar to the genetic covariance. From the relationship between the pairs of traits make more accurate decisions when considering the trait selection for efficiency.

3.2.2.4. Heritability and genetic correlations for traits of body weight, egg yield and egg weight

Table 3.11. Heritability and genetic correlations for traits of body weight, egg yield and egg weight

Targets	1	2	3	4
BW 8 weeks age (1)	**0.37 ± 0.02**	0.45 ± 0.055	-0.46± 0.06	0.60± 0.04
BW 18 weeks age (2)	0.17	**0.24 ± 0.02**	-0.65±0.06	0.57± 0.05
38 weeks old egg yield (3)	-0.06	-0.09	**0.23 ± 0.02**	-0.85± 0.04
EW 38 weeks age (4)	0.20	0.14	-0.03	**0.46 ± 0.03**

Note: Diagonal (bold) is heritability, values above the diagonal are genetic *correlations, below diagonal are phenotypic correlations.*

a. Heredity coefficient

The heritability coefficient for calculating the weight of 38-week-old eggs in the D523 line was 0.46, higher than that of Nguyen Quy Khiem et al. (2020) Egyptian hen line was 0.28-0.35; lower than Hoang Tuan Thanh (2017) 2 chicken lines LV4 and LV5 were 0.67 and 0.70 and Le Thanh Hai et al. (2021) chicken BT was 0.62.

The heritability of the 38-week-old egg yield trait in chickens of the D523 line was 0.23 (average), consistent with the study by Venturini et al. (2013) White Leghorn chickens from 0.22 ± 0.06 to 0.25 ± 0.06. Nguyen Quy Khiem et al. (2020) Egyptian rooster line was 0.23-0.27. In addition, the heritability coefficients of body weight at 8 and 18 weeks of age were determined, on average, at 0.37 and 0.24.

The results showed that the D523 line, which was a selective target for increasing egg weight, was suitable with good efficiency and high reliability.

b. Genetic correlation coefficient

Evaluation of the genetic correlation between egg yield and egg weight, many authors believe that there was a negative correlation between them. The pair of egg yield and 38-week-old egg weight traits in the D523 line in the population had a negative genetic correlation of -0.85, consistent with the study Le Thanh Hai et al. (2021) had a strong negative genetic correlation (-0.75). Hoang Tuan Thanh (2017) on LV4 and LV5 chickens had a high negative correlation (-0.87 and -0.95).

In addition, the evaluation of genetic correlations between other pairs of traits also showed that D523 hens have most of the similar correlations with studies on egg breeds in the world and in Vietnam.

3.2.2.5. Breed value, genetic predisposition and genetic progress of the 38-week-old egg weight trait

Table 3.12. Value for traits like egg weight 38 weeks old

Generation	Male			Female		
	n	EBV	SD	n	EBV	SD
Chicken population						
1	1.524	-0.56	0.75	1.180	-0.58	2.92
2	1.510	0.35	1.31	1.199	0.35	2.56
3	1.507	1.30	1.28	1.163	1.26	2.89
4	1.564	1.78	1.33	1.210	1.70	2.33
Population selected						
1	418	0.24	0.68	571	1.70	1.95
2	444	1.92	0.60	601	2.29	1.70
3	450	2.81	0.68	616	3.35	1.71
4	450	3.26	0.59	643	3.34	1.50

The results showed that the estimated breed value of the trait of egg weight in both populations and selected flocks increased through each generation of selection. This showed that the level of genetic improvement over each generation was quite good and quite even.

Genetic progress was determined by regression of breed value through the regression equation of 38-week-old egg weight breed value by generation of hens and hens of the line D523 population as shown in Figure 3.2.

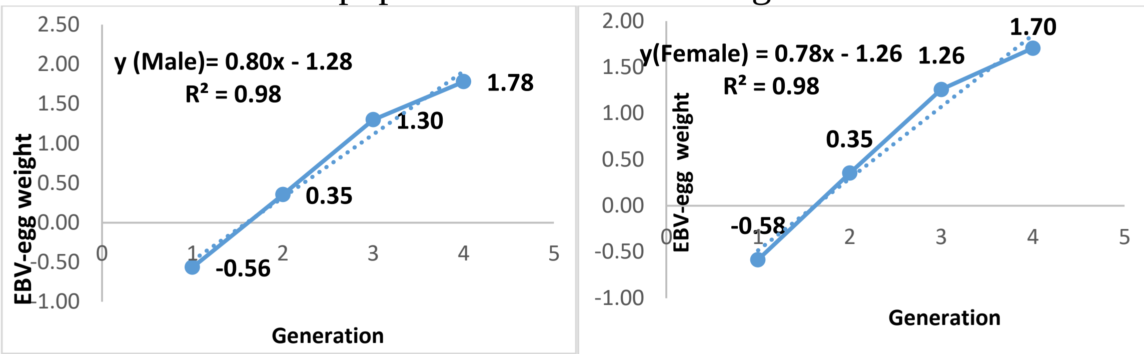


Figure 3.2. Genetic predisposition for 38-week-old egg weight

Regression equation for 38-week-old egg weight by generation rooster: Y = 0.80X-1.28; hens: Y = 0.78X-1.26; with a regression coefficient of 0.80 in roosters, 0.78 in hens, showed genetic progress, rooster egg weight was 0.80g/generation, hen was 0.78g/generation, coefficient of the very high setting was 0.98. Selective weight of 38-week-old eggs of line D523 had good effect.

3.2.2.6. Weight of 38-week-old eggs over 4 generations

Line D523, after selection according to the breed value of 38-week-old egg weight, from which the corresponding egg weight phenotype value increased over the generations of selection ($P<0.05$). The 4^{th} Generation, 38 weeks old egg weight was 64.14g, an increase of 2.27 g compared to the starting generation. Select the weight of the 4th generation eggs, the selective efficiency was 0.62g/generation. The D523 hen line, under the influence of selection by the estimated breed value, improved the increased egg weight and by the 4th generation was relatively stable under breeding conditions in Vietnam.

3.2.2.7. Body weight at 8 and 18 weeks of age across 4 generations

Weight at 8 weeks of age of roosters population reached 815.18-819.02g, hens reached 641.70-646.14; weight at 18 weeks of age of roosters and hens of the rooster population reached 2,030.00-2,058.89g, hens reached 1,454.85-1,463.98g, there was no difference between generations ($P>0.05$) . High uniformity at laying reached 80.41-83.22%.

Thus, over 4 generations, the weight of chickens at 8 and 18 weeks old was quite stable.

3.2.2.8. Survival rate and food consumption over 4 generations

The survival rate of chickens of the D523 line across generations was high at the following stages: 96.34-96.66% in the 1-day-old-8-week-old stage, in the 9-18-week-old stage: 96.22-96.85%. Compared with the derived generation and the selected 4 generations, the survival rate was similar ($P>0.05$). Feed consumption/individual through stages in 4 generations was similar (with $P>0.05$). For the whole period of 1 day old -18 weeks old, the feed consumption per rooster was 6,914.86- 6,954.71g; hen was 6,587.75- 6,632.71g.

3.2.2.9. Laying age, hen weight and egg weight over 4 generations

The laying age of 5% of the D523 line through generations was 133-135 days old, compared with the derived generation, the laying age is 4-6 days earlier and the domestic egg-oriented breeds have been announced (Pung Duc Tien et al., 2012; Tran Kim Nhan et al., 2010; Tran Ngoc Tien, 2019).

Hen weight and egg weight increased gradually with laying age from 5% laying rate to 38 weeks of age. The weight of hens at all stages was relatively stable over 4 generations, there was no statistical difference (P>0.05). In contrast, the egg weight when laying hens reached the laying rate of 5%, the peak laying rate was different over 4 generations (with P<0.05), this is suitable for choosing to increase egg weight in the line this.

3.2.2.10. Laying rate, egg yield, food consumption/10 eggs and hatching results over 4 generations

Table 3.13. Laying rate, egg yield, food consumption/10 eggs and hatching results over 4 generations

Explain	G1	G2	G3	G4
Birth rate at 38 weeks old (%)	67.27	66.77	66.66	66.47
Birth rate at 68 weeks of age (%)	70.52[a]	70.44[a]	70.38[a]	70.29[a]
38-week-old egg yield (eggs)	94.18[a]	93.47[a]	93.32[a]	93.05[a]
Yield of 68-week-old eggs (eggs)	246.83[a]	246.55[a]	246.31[a]	246.02[a]
Food consumption/10 eggs (kg)	1.78	1.78	1.78	1.77
Rate of embryos (%)	94.67[a]	94.20[a]	94.75[a]	94.43[a]
Hatching rate/total hatching eggs (%)	80.24[c]	79.94[c]	79.71[c]	79.57[c]

Note: follow the row, average values have same character that the different doesn't have statistical significance with P>0,05

Line D523, egg productivity/hen/38-week-old through 4 generations were stable, had tendency to decrease slightly from 94.18 eggs (first generation) down to 93.05 eggs (the fourth generation), but the difference had no statistical significance (P>0.05). Average parturition rate of 68-week-old through 4 generation was 70.29-70.52%, egg productivity/hen/68-week-old get 246.02-246.83 eggs; higher Tien Ngoc Tran's research (2019) GT3 chicken: 244.92 eggs; GT4:242.06 eggs. So that D523 in 4 selective generation increases egg weight that egg productivity to 68-week-old had tendency decrease when increase egg weight, but the difference didn't have statistical significance with P> 0,05

Food consumption/10 eggs of D523 through 4 generations get 1.77- 1.78 kilogram and the difference had no statistical significance with P>0,05.

Result of hatching, through 5 hatch stages in each generation, showed that embryo rate pretty stable through selective generation ger 94.2-94.75% (P> 0,05); Hatching rate/total egg hatch had tendency decrease through generation, compare is 80.24; 79.94; 79.71 and 79.57%, but the differences was meaningless (P>0.05).

3.3. Evaluating production ability of DTP1 commercial hybrid chicken

3.3.1. Physical appearance

1-day-old chicken: Chicken has white feathers, some have black dots on the back. 18-week-old chicken: white feather, has a small black dot on back. Beak and leg are yellow, and the flag crest was bright red.

3.3.2. Sustain life rate

Results showed that the sustained life rate of D629, D523 and DTP1 line in stage 1 day old – 8 weeks old reached 96.33-96.67%, stage 9-18 weeks old reached 96.19-96.9%.

Follow Tien Duc Phung et al. (2012) HA1 and HA2 chicken had sustain rate in stage 1-day-old – 9-week-old were 95.3-97.59%, stage 10-19-week-old was 95.56-98.69% that research chicken had sustain life rate get equivalent.

3.3.4. Body weight, food consumption

Table 3.14. Body weight, food consumption

(Unit: g; n=3)

Target (week -old)	**D629**	**D523**	**DTP1**	P-Value
	Mean ±SEM	**Mean ±SEM**	**Mean ±SEM**	
Body weight				
8	603.56^{b}±0,91	628.56^{a}±1.16	621.00^{a}±1.64	0.000
18	$1,322.78^{c}$±1.94	$1,464.67^{a}$±2.40	$1,384.44^{b}$±1.83	0.000
Food consumption				
01day-8	$1,665.74^{c}$±3.17	$1,718.54^{a}$±3.57	$1,688.93^{b}$±2.34	0.000
9 -18	$4,725.00^{c}$±4.04	$4,851.00^{a}$±4.04	$4,778.67^{b}$±6.17	0.000
01day-18	$6,390.74^{c}$±6.97	$6,569.54^{a}$±7.60	$6,467.60^{b}$±5.43	0.000

Note: Values in the same row with different letters are different with P <0.05; n is number of repetition.

Body weight: 8 weeks old DTP1 chicken was 621g; 18 weeks old was 1,384.44; higher than D629 and lower than D523, the difference had statistical significance (P<0,05).

Food consumption/Chicken 01 day old – 8 weeks old stage, DTP1 chicken was 1,688.93g; D629 was 1,665.74g and D523 was 1,718.54g; Food consumption /chicken of DTP1 line lower than D523 line and higher then D629 line, the difference has statistical significance (P<0,05). In the 9-18 weeks old stage of D523 line higher than D629 line, the difference had statistical significance (P<0,05).

3.3.5. Parturition age, hen weight, egg weight

Parturition age 5 percent of DTP1 line was 130 days, D629 was 129 days, D523 was 133 days. Corresponding with the highest parturition age was 203, 205 and 208 days (29-30 weeks old), suitable for Tetra-SL’s chicken egg; Dominant Leghorn D229 line; Dominant Brown D192 highest parturition age was 29-30 weeks old.

Hens' weight increases through parturition stages. Up to 38 weeks old, D629, D523 and DTP1 line correspond with egg weight 60.46; 63.89 and 62.48g (P<0.05).

3.3.6. Parturition rate, egg productivity, food consumption per 10 eggs

Table 3.15. Parturition rate, egg productivity, food consumption per from 10 eggs to 80-week-old (n=3)

Targets	D629	D523	DTP1
	Mean±SEM	**Mean±SEM**	**Mean±SEM**
Parturition rate(%)	73.19^{b}±0.04	68.11^{c}±0.04	73.63^{a}±0.02
Egg productivity/hens(egg)	317.64^{b}±0.16	295.60^{c}±0.15	319.55^{a}±0.06
Heterosis(%)			4.22
Food consumption/10 eggs(kg)	1.59^{b}	1.72^{a}	1.57^{c}
Heterosis(%)			-5.14

Note: Values in the same row with different letters are different with P <0.05.;n is the number of repetition.

The average laying rate of DTP1 chickens at 80 weeks of age reached the highest of 73.63%, followed by D629 chickens at 73.19% and the lowest D523 (68.11%) with P<0.05.

DTP1 chickens with egg/hen yields/80 weeks of age reached a peak of 319.55 eggs, followed by D629 chickens at 317.64 eggs and D523 chickens at 295.60 eggs, statistically significant differences (P<0.05). The hybrid advantage of egg productivity of DTP1 chickens over the average parent was 4.22%. This result was 2.00% higher than the study of Tran Ngoc Tien (2019) on chicken GT1234.

Food consumption/10 eggs in stage 19-80 weeks old of DTP1 chicken was 1,57kg, with a hybrid advantage of -5.14%. This result was lower than that in Tien Ngoc Tran's research et al. (2012) commercial AC12 chickens with a hybrid advantage of -2.55%.

3.3.7. Egg equality

Quality survey of DTP1 line eggs in 38 weeks old, with each research was 30 eggs/research.

Table 3.16. Some target to evaluate DTP1 chicken egg quality

Target	ĐVT	D629	D523	DTP1	P-value
		Mean ± SE	**Mean ± SE**	**Mean ± SE**	
Eggshell color		White	Brown	White pink	
Egg weight	g	60.79^{b}±0.440	64.23^{a}±0.570	62.51^{ab}±0.527	0.005
Appearance index		1.30±0.007	1.30±0.008	1.30±0.009	0.972
Yolk rate	%	29.20^{a}±0.300	30.10^{a}±0.274	30.23^{a}±0.360	0.143
Whites rate	%	58.71^{a}±0.384	56.08^{b}±0.363	56.44^{b}±0.420	0.018
Shell rate	%	12.09^{b}±0.146	13.82^{a}±0.142	13.33^{a}±0.141	0.001
Yolk index		0.086±0.002	0.090±0.002	0.093±0.002	0.677
Shell thickness	mm	0.32±0.003	0.33±0.002	0.33±0.002	0.060
Haugh		83.61^{a}±0.709	84.19^{a}±0.796	85.09^{a}±0.643	0.599
Yolk color		11.32^{a}±0.153	11.48^{a}±0.158	11.82^{a}±0.108	0.268

Note: Values in the same row with different letters are different with P <0.05.

DTP1 chicken egg weight was 62.51g; yolk rate reached 30.23%; egg white rate was 56.44%; shell rate was 13.33%; yolk index was 0.093; shell thickness was

0.33mm and Haugh index was 85.09; yolk color was 11.82. So that commodity DTP1 hybrid chicken had good quality, eggshell color was white pink, and eggs had a pretty yolk response of VietNam consumers' favourite.

3.3.8. Economic efficiency of raising DTP1 commodity hybrid chicken

Result showed that, feeding 300 DTP1 commodity hybrid chickens till the end of reproductive stage, at the 80 weeks old, total cost was 212.74 million/egg. DTP1 commodity hybrid chicken had a price of 2800 VNĐ/egg. Primary accounting of rawasing DTP1 commodity hybrid chicken difference between revenue and expenditure was 35.07 million VNĐ, income/100 chicken was 11.69 millions VNĐ, bringing high economic efficiency.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

1. Starting generation: D629 line at 01 day old and 18 weeks old which had white feathers, yellow legs and beak, bright red single comb, egg yield/hen/68 weeks of age reached 252.59 eggs, compared to the firm's 93.61%. D523 line at 01 day old and 18- week-old which had brown feathers, yellow legs and beak, egg yield/hen/68 weeks of age reached 244.24 eggs, reached 94.53% compared with the firm.

2. Successfully selecting of two chicken lines D629 and D523 through 4 generations:

- The D629 male chicken line was improved egg production. Egg yield/hen/68 weeks of age reached 263.87 eggs, an increase of 11.28 eggs compared to the starting generation, equivalent to 4.47% and egg weight reached 60.08g. At the 38 weeks old, the heritability coefficient of egg yield over 4 selected generations was 0.27; and the corresponding genetic progress was 2.42 eggs/generation.

- The D523 female chicken line: had increased the weight of eggs, it reached 64.14 g at 38 weeks old, an increase of 2.27g compared to the starting generation; egg yield/hen/68 weeks of age reached 246.02 eggs. The heritability coefficient of egg weight was 0.46; genetic progress of egg weight was 0.78g/generation.

3. The DTP1 commercial crossbred chicken: The average laying rate was 73.63% up to 80 weeks of age, egg yield/hen/80 weeks of age reached 319.55 eggs with 4.22% of heterosis. Feed consumption/10 eggs of D629 chiken line is 1.59 kg; D523 chicken line is 1.72 kg; DTP1 chicken line is 1.57 kg; the advantage is -5.14%. The egg weight reached 62.51 g, the yolk ratio was 30.23% and shell egg has pinkly-white, which is appropriate to consumer tastes. Preliminary accounting showed that commercial hybrid chickens (DTP1 chicken line) brings more economic efficiency.

Recommendations

From 2 selective chicken line (D629 and D523) can be used to hybrid with some domestic chicken for making hybrid combination chicken, whichhave high productivity, good quality and adaptive production system and suitable for Vietnam consumers tastes.

PUBLISHED SCIENTIFIC WORKS RELATED TO THE THESIS

1. Pham Thuy Linh, Nguyen Quy Khiem, Nguyen Huy Đat. 2021. *Selection two chicken breeds D629 and D523 through four generations.* Journal of Animal Science and Technology, No. 125, July 2021, pp. 2-12.

2. Pham Thuy Linh, Nguyen Quy Khiem, Nguyen Huy Đat. 2021. *Genetic parameters for egg production traits in D629 chicken line*. Journal of Animal Husbandry Science and Technics, No. 270, October 2021, pp. 7-12.

3. Pham Thuy Linh, Nguyen Quy Khiem, Nguyen Huy Đat and Nguyen Thi Nga. 2021. *Evaluation of production ability of DTP1 commercial crossbred chickens which was crossing between two lines of rooster D629 and hen D523*. Journal of Animal Husbandry Science and Technics, No. 270, October 2021, pp. 13-17.