# INVESTIGATION ON PRODUCTION TRAITS OF BREEDER HENS FROM THE NATIONAL GENE POOL USED FOR PRODUCTION OF SLOW-GROWING BROILERS

**Magdalena Oblakova**
*Agricultural Institute – Stara Zagora, Bulgaria*
*moblakova@abv.bg*

## ABSTRACT

The present study comprised the initial stage of the research aimed at development of protocols for production of slow-growing broiler chickens. It included investigation on the productive performance of breeder forms, maternal from the dual purpose type line NG (New Hampshire G), line E (Barred Plymouth Rock), line Ss (Sussex), line F (NG x Rod Rhode Island) and meat type breeders for production of conventional broilers from line L (White Plymouth Rock) and line M (Cornish)- (as control group in future tests). Line M was used as sire line for production of slow-growing broilers. The experiment was conducted in the breeder farm of the Hybrid Poultry Centre at the Institute of Agriculture– Stara Zagora. The best growth performance are conventional broiler breeders from line M and line L (p< 0.001 during the entire production period). The live weight of chickens from lines F and E at 18 and 36 weeks of age was substantially superior to the other two studied dual purpose lines. The analysis of results showed that the fertility of eggs from the different genotypes used in the experiment was high: line E - 95.68 %, line Ss- 94.89%, and hatchability of set eggs was from 90.22% (line NG) to 74% (line F). The heaviest chickens - 44.65 g in line M and 39.55 g in line F hatched from the heaviest incubation eggs (67.58 g and 63.86 g respectively). There were no statistically significant difference in the age of beginning of lat between dual purpose" line F with 179.56 days and line Ss - 182.18 days. Lines M and L were outlined with statistically significantly late beginning of lay at 222.36 and 203.41 days of age, respectively (p< 0.001). Front he four studied maternal lines for production of slow-growing broilers, the highest hen-day and hen-housed egg production was demonstrated in line F - 98.18 and 99.44 eggs, followed by line Ss - 996.51 and 98.86, but differences were insignificant. Birds with high live weight and good egg laying performance are appropriate for use as maternal dual purpose forms.

***Key words****: slow-growing broiler, growth performance, fast-growing genotype, hens, eggs, live weight, productivity, hatchability.*

## INTRODUCTION

The number of people inclined for paying more in return of consuming organic animal foodstuffs in Europe is continuously increasing (Bennet, 1996). Organic animal farming is regulated with Council Regulation (EC) 1804/1999 containing specifications about the conditions of rearing, feeding, breeding, reproduction and veterinary care. The regulation stimulates that with respect to the breed, its adaptation to local conditions, vitality and resistance to diseases should be considered. The used fast-growing broiler chicken hybrids are reared according to Label programme (Westgren 1999; Fanatiko and Born 2001) and European organic farming programmes (EEC,1991). Thus, fast-growing broilers could attain a high live weight. In some countries as France and Portugal, owners make investment in this type of product in order to obtain a quality certificate. The productivity of such birds, economic efficiency of farming and production technology are investigated.

In the USA, the fast-growing broiler genotypes adapted to conventional production systems are used for natural and organic meat production in the USA. Nevertheless, the appropriateness of these fast-growing broilers for a profitable outdoor production is not well studied (Fanatico A. C. Et. Al., 2005).

In Europe, a lot of slow-growing genotypes, whose efficiency is lower than that of fast-rowing hybrids, are available. Slow-growing chickens are better adapted to such production systems, and the quality of their meat is more suitable for the gourmet market (Lewis et al.1997; Castellini et al.2002; Gordon and Charls, 2002). The fitness of fast- and slow-growing genotypes to a variety of biological production systems and their compliance to consumers' needs should be investigated. The detailed research on the interaction of factors genotype, density, environment, pasture, would contribute to the improvement of free-range broiler production.

On the basis of her long-term experience with flocks from the gene pool, Gorbacheva (1986) concluded that many breeds are eligible for modern poultry farming because of their valuable traits – resistance to diseases, adaptation to organic farming conditions, eggshell colour and strength, body traits, meat and egg quality etc. An example is the Sussex breed, which apart being a maternal form of feather-autosexing brown eggshelled hybrids, could be used also as a maternal form for production of broilers due to the excellent flavour of meat and high meat protein content.

Taking into account the specific susceptibility of fast-growing broilers to diseases, the raring of slaw-growing broiler chickens for at least 81 days is recommended. Most of proposed birds are outlined with fast growth, good feed conversion and are selected for intensive rearing conditions (Reiter and Bessei, 1996).

The production of slow-growing chickens is expensive, therefore many farmers use fast-growing forms with low feed conversion widely adapted to intensive production systems.

Yet, several slow-growing phenotypes selected by Katz, 1995; Saveur, (1997), as well as some pure breeds are suitable for such production systems. In our country, Gerzilov V. (2011) studied the egg productivity of birds included in the national gene pool grown in bio-friendly conditions.

The choice of a genotype is based upon the equilibrium between organic production and good conformation, but all depends on the purpose of birds. The aim of this study was to investigate the production traits of pure breeder lines (maternal and paternal) used for production of slow-growing broiler chickens: line Ss, line NG, line E, line F, line L, line M.

**MATERIALS AND METHODS**

The present study comprised the initial stage of the research aimed at development of protocols for production of slow-growing broiler chickens. It included investigation on the productive performance of breeder forms, maternal from the dual purpose type line NG (New Hampshire G), line E (Barred Plymouth Rock), line Ss (Sussex), line F (NG x Rod Rhode Island) and meat type breeders for production of conventional broilers from line L (White Plymouth Rock) and line M (Cornish) - (as control group in future tests). Line M was used as sire line for production of slow-growing broilers. The experiment was conducted in the breeder farm of the Hybrid Poultry Centre at the Institute of Agriculture– Stara Zagora between June 2012 and June 2013. Eggs from six pure lines were weighed and set for incubation. Four hundred unsexed chickens from each line were housed, marked and vaccinated against Marek's disease and coccidiosis. The chickens were reared in groups on permanent deep wooden shavings litter indoor and after joining the main flock – in 10 selection nests each with 15 hens and 2 cockerels at a density $<7/m^2$ , light day of 14 h and ad libitum access to compound feed and water. Feeding was done with standard commercial compound feeds according to the category and age of birds. In this farm the hens were reared until 48 weeks of age on deep permanent litter, with equal technological parameters (density, feeding and drinking width) for all groups.

**Table 1** – Selected nutrient and energy contents of feed

| | |
|---|---|
| Crude protein (%) | 15.00% |
| Metabolizable energy (kcal/kg) | 2742 kcal/kg |
| Crude fibre (%) | 4.26% |
| Calcium (%) | 2.11% |
| Available phosphorus (%) | 0.68% |
| Methionine (%) | 0.35% |
| Lysine (%) | 0.75% |

The following production traits of laying hens were determined:

**Reproduction performance on the basis of egg incubation traits.** Eggs laid by 40-week-old hens were collected over 7 days and set for incubation. Fertility rate was determined as ratio of fertile eggs and set eggs; the hatchability of eggs set (HS) – the relative share of hatched chickens from eggs set; the hatchability of fertile eggs (HF) – the relative share of hatched chickens from fertilised eggs, embryonic death rate between incubation days 0–6, 7–18 and 19–21 – as relative proportion of dead embryos from fertilised eggs.

**Egg production** – daily from egg lay beginning to 40 weeks of age. On this basis, the hen-day and hen-housed egg production were established.

**Average egg weight** – by weighing eggs laid by each group for the day at 2-week interval between 32 and 40 weeks of age.

**Live body weight** of day-old chicks groups was determined by weighing on a balance with precision of 2 g. At 8, 18, 36 weeks of age, hens were individually weighed on a balance with precision of 20 g.

**Livability** – in % until 18 weeks of age and throughout the entire production period.

**Age of sexual maturity (days)** –when 50% of egg production was attained in the different groups.

The results were submitted to statistical analysis (ANOVA-2000) to determine the significance of differences between sample means.

## RESULTS AND DISCUSSION

### *Live body weight*

The results from live weight monitoring of female chickens at 8 weeks of age are presented in Table 2 and Fig.1 and 2. The highest growth performance was exhibited by conventional broiler breeders from line M (1185 g) and line L (837.89 g); $p<0.001$. They were superior to the other studied birds with regard to body weight in line with their production type (Lalev, M, 2014). According to these results, line M could be used as paternal line for production of slow-growing broilers. Our purpose was to evaluate the growth performance of all-purpose hens vs conventional broiler breeders with respect to live body weight which is important in meat-type broiler production especially at an early age. The live weight of female chickens of line E attained 712 g which was superior to the three other lines (Ss - 524 g, NGc – 506.33 g and line F - 464 g; $p< 0.001$).

The same tendency was observed with male chickens (Fig. 2) from line M whose weight reached 1350.62 g at $p< 0.001$ vs line L with 1099.16 g. The differences between line E (844.4 g) and line NG (682 g), line Ss (620.5 g), line F (549 g) were also statistically significant.

At 18 weeks of age (Table 3), body weight was the highest in female chickens from line F-2.85 kg with statistically significant difference vs line L- 2.21 kg. Female birds from line E weighing 1.98 kg had a better growth performance than lines Ss (1.54 kg) and NG (1.38 kg).

Cockerels from line M had the highest live weight at that age: 3.36 kg at $p< 0.001$, followed by line L with 3.01 kg. Birds from line E weighing 2.93 kg were heavier than lines F, Ss, and NG ($p< 0.001$).

At 36 weeks of age (Table 4) the trend in live weight of birds was preserved – those from line M attained 3.41 kg, with insignificant differences vs line L (3.38 kg) and line F (3.23 kg). Line F was substantially heavier than line E - 2.44 kg, line Ss - 2.21 kg and line NG - 2.12 kg. Dual purpose cockerels (Fig. 2) from line F and E with 3.2 kg were statistically significantly heavier than lines NG and Ss with 2.86 kg and 2.85 kg, respectively.

### *Reproduction traits of slow-growing broiler breeders*

The results from biological control, in particular for egg fertility and hatchability percentages reflecting the reproduction performance of birds are presented in Table 5. These parameters are important for the efficiency of production of both stock broilers and breeders. The reproduction traits of hens from the gene pool are characterised with high egg fertility. The analysis of results showed that egg fertility percentages of the different genotypes included in this experiment were as followed: line E - 95.68 %, line Ss - 94.89%, line NG - 94.42%, line L - 94.73, line M - 93.03%, line F - 84%. Many factors as embryonic death rate influence the incubation results, and more specifically, the hatchability of fertile eggs. Embryonic death rate could be attributed to a number of factors (Fasenko et al. (1992). For the different dual purpose lines, this percentage ranged from 90.22% (line NG) to 74% (line F), or by 16.22% lower. In broiler lines, it was 84.34% and 76.82%. These data correspond to percentages reported by Thorne et al. (1991) within the range 9.8-26.8 % (average 16.4 %), for egg-laying lines: 8–27.9 % (average 11.9 %).

The results from the different investigations showed a definite relationships between egg weight and their fertility and hatchability. Eggs set for incubation were from the M size from 53 g to 63 g. According to some studies (Asukio, 1993) the hatchability of medium-size eggs was better as compared to very large or small eggs, and in the view of Narushin and Romanov (2002) lighter eggs exhibit higher hatchability percentages.

In our experiment, incubation eggs from line M (meat-type) used as paternal line for production of slow-growing broiler chickens were an exception. They weighed 67.58 g and were superior to the other eggs from the five lines at a high level of statistical significance ($p < 0.001$). Significantly heavier eggs for incubation were produced by line F - 63.86 g vs line E – 60.72 g (at $p < 0.001$). The lowest weight was demonstrated of line Ss eggs - 54.04 g.

The heaviest chickens hatched from the heaviest eggs (line M) - 44.65 g, which were used as paternal form for production of slow-growing chickens, followed by day-old chickens from line F (39.55 g). The weight of chickens at hatch ranged between 67.72% – 61.93 %, corresponding to the range of 62–76% published by Halaj and Veterani (1998).

***Egg production***

As the age of sexual maturity is a characteristics of egg productivity of hens, these values are a good indicator in studied lines because according to some authors (Kunev, 1990) the optimum age of lay beginning was 161–190 days and that was when hens laid the heaviest eggs. With respect to this trait, there were no statistically significant differences between hens from the dual purpose type: the beginning of egg lay occurred at 179.56 days of age in line F, 180.18 days of age in line NG, 181.51days of age in line E, 182.18days of age in line Ss. Meat-type lines M and L began to lay eggs at 222.36 and 203.41 days of age, respectively ($p<0.001$). According to Kunev (1990) 186.95 days of age is a late age for beginning of lay, but it is typical for this production type. In our experiments, line Ss began laying later, at 182.18 days of age, but produced the lightest eggs which was not in agreement with the data of King et al. (1985) who affirmed that the very early beginning of the lay (150 days of age that decreased the growth period and increased productive life) reduced the weight of eggs.

The weight of eggs was important for the weight of newly hatched chickens and for their further development (Halaj and Veterani, 1998). The weight of line M eggs was 64.80 g, which was superior to that in line E - 60.74 g and line F - 60.29 g at $p< 0.01$, and to weights of eggs produced by line NG (58.34 g) and line Ss (52.85 g) at $p< 0.001$. The weight of eggs of lines E and F (60.74 g and 60.29 g respectively) were not statistically significantly different; also, there was no difference vs line NG -58.34 ($p> 0.001$).

From the four studied maternal lines for production of slow-growing broilers, the highest hen-day and hen-housed production were observed in line F - 98.18 and 99.44 eggs followed by line Ss - 996.51 and 98.86 eggs, and differences were not statistically significant. Hen-housed egg production values in meat-type hens from lines E and M were 83.05 and 68.48 eggs respectively.

The highest liveability was recorded in chickens from line F - 98.01% at $p< 0.001$.

Birds with high live weight and good egg laying performance are appropriate for use as maternal forms.

**Conclusion**

The analysis of obtained results allowed making the following conclusions on phenotype differences between the lines:

1. The best growth performance are conventional broiler breeders from line M and line L (p< 0.001 during the entire production period). The live weight of chickens from lines F and E at 18 and 36 weeks of age was substantially superior to the other two studied dual purpose lines.
2. The analysis of results showed that the fertility of eggs from the different genotypes used in the experiment was high: line E - 95.68 %, line Ss - 94.89%, and hatchability of set eggs was from 90.22% (line NG) to 74% (line F). The heaviest chickens - 44.65 g in line M and 39.55 g in line F hatched from the heaviest incubation eggs (67.58 g and 63.86 g respectively).
3. There were no statistically significant difference in the age of beginning of lat between dual purpose line F with 179.56 days and line Ss - 182.18 days. Lines M and L were outlined with statistically significantly late beginning of lay at 222.36 and 203.41 days of age, respectively (p< 0.001)
4. Front he four studied maternal lines for production of slow-growing broilers, the highest hen-day and hen-housed egg production was demonstrated in line F - 98.18 and 99.44 eggs, followed by line Ss - 996.51 and 98.86, but differences were insignificant.
5. Birds with high live weight and good egg laying performance are appropriate for use as maternal dual purpose forms.

**Figure 1- Live body weigth of male, kg**

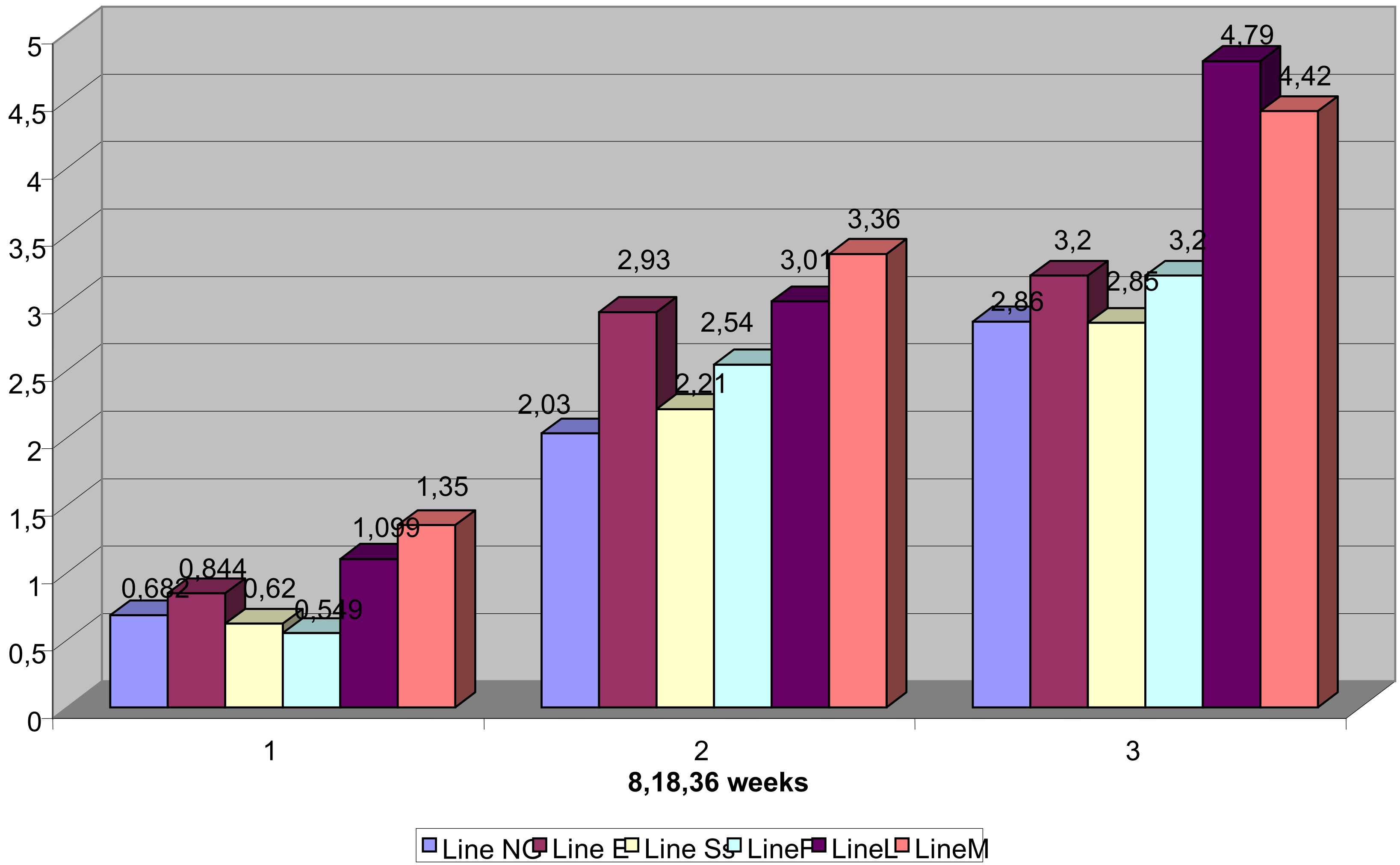

**Figure 2- Live body weight of laying hens,kg**

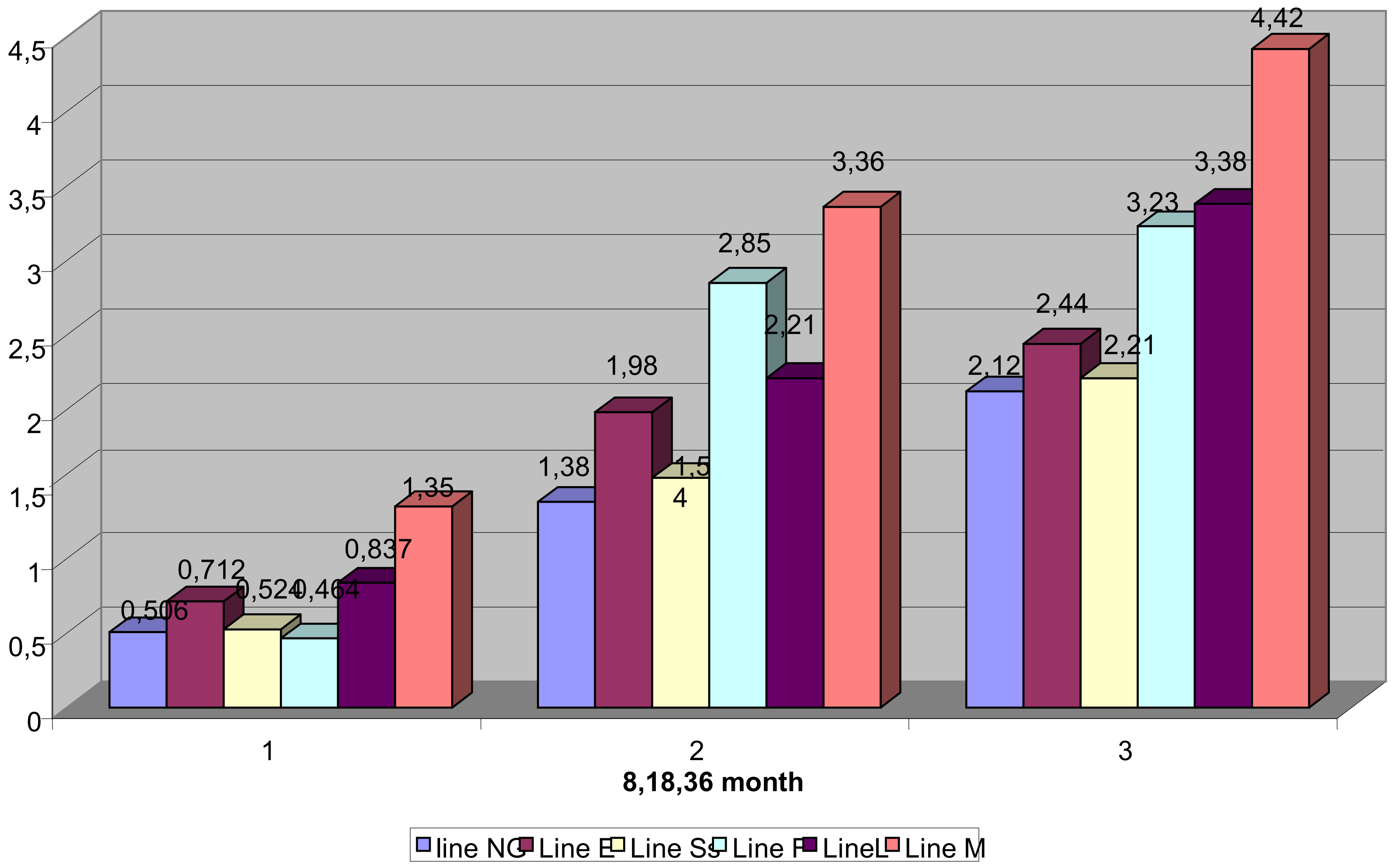

**Figure 3- Reproductive trains of breeder lines**

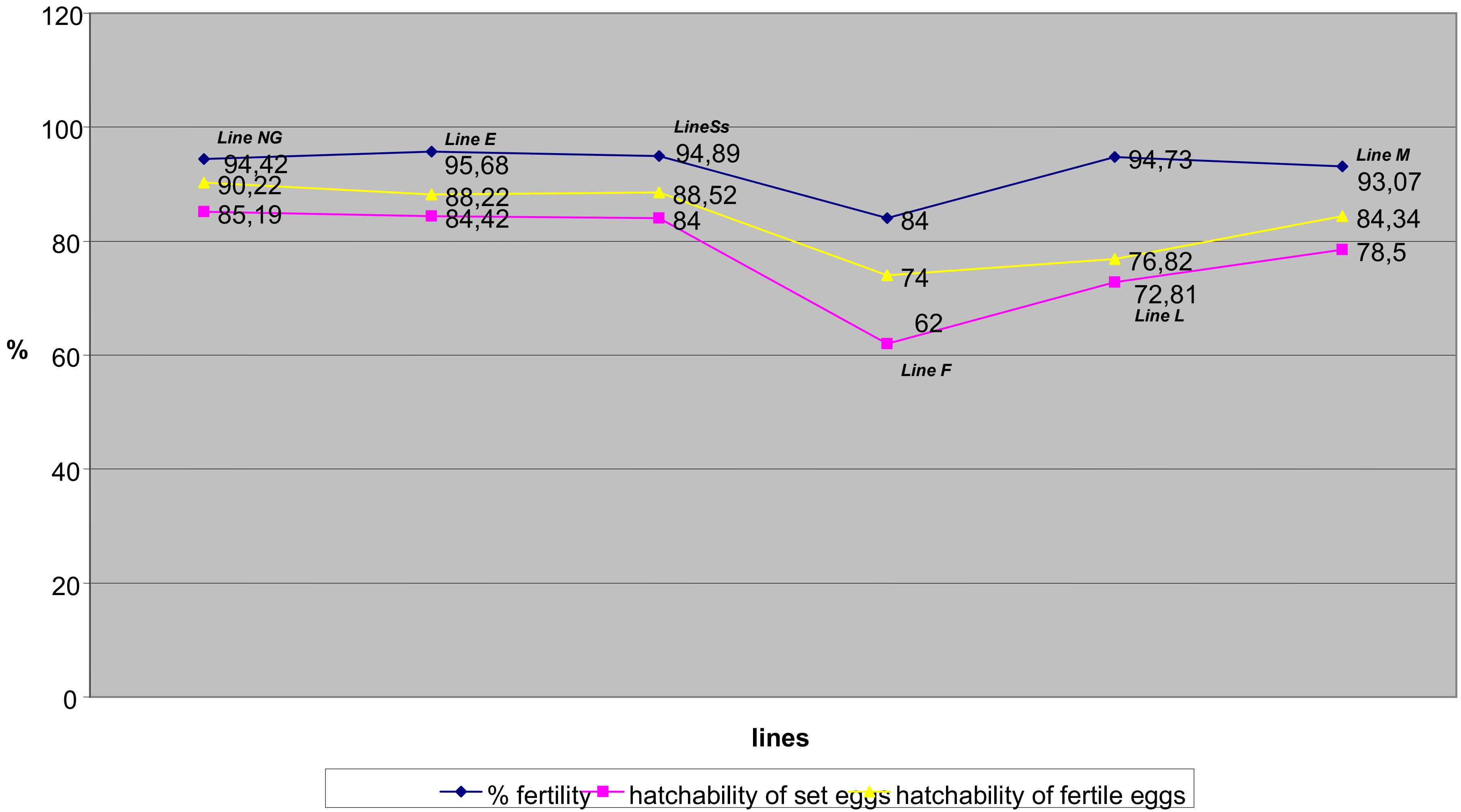

**Table 2** - Live body weight of parents for slow-growing broiler at 8weeks of age

| Line | Live body weight female (g) | Live body weight male (g) |
|---|---|---|
| ***Dual purpose*** | | |
| Lin***e*** NG | 506,33±14,53 | 682±13,75 |
| Line E | 712±17,61*** | 844,4±20,10*** |
| Line Ss | 524±10,8 | 620,5±14,59 |
| Line F | 464±15,85 | 549±21,54 |
| ***Meat-type*** | | |
| Line L | 837,89±12,22*** | 1099,16±37,44*** |
| Line M | 1185±23,83*** | 1350,62±26,68*** |

***At p< 0.001

**Table 3 -** Live body weight of parents for slow-growing broiler at 18 weeks of age

| Line | Live body weight female (кg) | Live body weight male (кg) |
|---|---|---|
| ***Dual purpose type*** | | |
| Line NG | 1,38± 0,06 | 2,03±0,06 |
| Line E | 1,98±0,02 | 2,93±0,05*** |
| Line Ss | 1,54±0,02 | 2,21±0,08 |
| Line F | 2,85±0,055 *** | 2,54±0,047 |
| ***Meat -type*** | | |
| Line L | 2.21±0.046 | 3.01±0.018 |
| Line M | 2.53±0.020 | 3.36±0,058*** |

***At p< 0.001

**Table 4**- Live body weight of parents for slow-growing broiler at 36 weeks of age

| Line | Live body weight female (kg) | Live body weight male (kg) |
|---|---|---|
| ***Dual purpose type*** | | |
| Line NG | 2,12±0,45 | 2,86±0,079 |
| Line E | 2,44±0,65 | 3,2±0,03 |
| Line Ss | 2,21±0,76 | 2,85±0,14 |
| Line F | 3,23±0,72*** | 3,2±0,11*** |
| ***Meat -type*** | | |
| Line L | 3,38 ± 0.056 | 4,79 ± 0.026 *** |
| Line M | 3,41±0,026*** | 4,42±0.18 |

***At p< 0.001

**Table 5** - Reproductive traits of breeder lines

| Line | Egg mass for incubation (g) | Mass of Hatchad chicken (g) | Mass of Hatchad chicken from Egg mass % | Fertility (%) | Hatchability /set eggs/, % | Hatchability /fertile eggs/, % |
|---|---|---|---|---|---|---|
| ***Dual purpose type*** | | | | | | |
| line NG | 61,63±0,80 | 38,3 | 62,14 | 94.42 | 85.19 | 90.22 |
| line E | 60,72±0,46 | 39,2 | 64,55 | 95.68 | 84.42 | 88.22 |
| line Ss | 54,04±1,28 | 36,60 | 67,72 | 94.89 | 84 | 88.52 |
| line F | 63,86±0,67*** | 39,55 | 61,73 | 84 | 62 | 74 |
| ***Meat -type*** | | | | | | |
| line L | 63,59±0,57 | 42.15 | 66,78 | 94.73 | 72.81 | 76.82 |
| line M | 67,58±0,92*** | 44,65 | 66,06 | 91,86 | 73 | 82,54 |

***At p< 0.001

**Table 6** – Egg production on 10 month old laying hens and start of egg laying

| Line | Age of sexual maturity, day | Average egg production for 150 days Hen housed | Average egg production for 150 days Hen day | Average egg mass (g) | Livability (%) at 4 month | Livability (%) at 10 month |
|---|---|---|---|---|---|---|
| ***Dual purpose type*** | | | | | | |
| line NG | 180.18±1.43 | 94.81±2.16 | 96.38±1.93 | 58.34±0.86 | 94.71±1.37 | 97.13±2.04 |
| line E | 181.51±1.88 | 95.67±2.08 | 97.01±1.35 | 60.74±0.98*** | 95.16±1.67 | 96.58±2.10 |
| line Ss | 182.18±1.86 | 96.51±1.57 | 98.86±2.03 | 52.85±0.96 | 94.83±2.03 | 97.37±2.34 |
| line F | 179.56±1.17 | 98.18±1.72 | 99.44±1.67 | 60.29±0.81 | 96.76±1.18 | 98.01±1.37*** |
| ***Meat -type*** | | | | | | |
| line L | 203.41±1.36 | 81.75±2.68 | 83.05±2.13 | 62.00±0.44 | 93.50±1.61 | 96.79±2.04 |
| line M | 222.36±1.03*** | 68.48±1.84 | 70.26±2.43 | 64.80±0.89*** | 92.86±1.24 | 94.84±2.44 |

**REFERENCES**


1. Asukio V., 1993, Effects of age in lye and eggs size on fertility and hatchability of chicken eggs, *Niger J. Anim. Prod.,* 20:122- 131
2. Benet, R.M., 1996. Willingness-to-pay measures of public support for farm animal welfare legislation. Vet. Rec. 139:320-321.
3. Castellini Cesare, Alessandro Dal Bosco, Cecilia Mugnai, Marcella Bernardini, 2002.Performance and behaviour of chickens with different growing rate reared according to the organic system ITAL.J.ANIM.SCI. VOL. 1, 291-300
4. European Economic Community. 1991. Council Regulation (EEC) 2092/91 on organic production of agricultural products and indications referring thereto on agricultural products andfoodstuffs. http://europa.eu.int/eur-lex/en/consleg/pdf/1991/en_1991R2092 do 001.pdf. Accessed June 2005.
5. European Economic Community, 1999. Concil Regulation 1804/1999 supplementing Regulation 2092/91 on organic production of agricultural products and indication referring thereto on agricultural products and foodtuffs to include livestock production.Celex –EUR official Journal, L222, 24 august 1999, pp.1-28.
6. Fanatico A. C. , P. B. Pillai, L. C. Cavitt, C. M. Owens, and J. L. Emmert2 2005. Evaluation of Slower-Growing Broiler Genotypes Grown with and Without Outdoor Access: Growth Performance and Carcass Yield1, Poultry Science 84:1321–1327
7. Fanatico, A. C., and H. M. Born. 2001. *Label Rouge*: Pasture-Raised Poultry in France. ATTRA publication. National Centerfor Appropriate Technology, Fayetteville, AR.
8. Fasenko, G., Robinson, F., Hardin, R., Wilson, J. 1992. Research note: Variability in preincubation embrionic development in domestic fowl. 2. Effects of duration of egg storage period. *Poult. Sci*., 71 (12): 2129 – 32.
9. Gersilov V., 2011. Egg productivity in some Fowl strains from the national gene pool reared under bio- friendly conditions, Agricultural Sciences,Agricultural University , Plovdiv, v.III, issue 6, 105-111.
10. Gordon, S. H., and D. R. Charles. 2002. Niche and Organic Chicken Products. Nottingham University Press, Nottingham , UK
11. Gorbatchova, H. 1986. Conservation and use of the gene pool of small breeds of chickens – *Poultry,* 9 : 14-17
12. Halaj, M. and L. Veterani. 1998. The effect of hen egg weight on hatching losses and hatched chick weight. *Czech. Journal of Animal Sci.* 43: 6, 263 – 266.
13. Katz, Z., 1995. Breeders have to take nature into account.World Poultry Sci. 11:124-133 King, L., Hawes, R., R. Gerry. 1985. Poultry Sci., 64, 6.

14. Kunev, K. 1990. Sexual maturity as selectional sing in New Hampshire chicken hens of the breed. Material of HIS: *Interaction genotype - environment in the poultry sector,* Varna, p. 11 – 19.

15. Lewis, P. D., G. C. Perry, L. J. Farmer, and R. L. S. Patterson. 1997. Responses of two genotypes of chicken to the diets and stocking densities typical of UK and “Label Rouge” systems: I. Performance, behaviour and carcass composition. Meat Sci.45:501–516.

16. Lalev, M., 2014.Create news base lines hens in broiler and eggs production, Stara Zagora, p.5-152.

17. Narushin, V. and M. Romanov. 2002. Physical characteristics of chicken eggs in relation to their hatchability and chick weight. *Paper number 026066*, ASAE Annual Meeting.

18. Reiter, K., Bessei, W., 1996. Effect of the distancebetween feeder and drinker on behaviour and leg disorders of broilers. Page 131 in Proc. 30th Int. Congr. Applied Ethology, Guelph, Canada.

19. Saveur, B., 1997. Les critères et facteurs de la qualité des poulets Label Rouge. Prod. Anim. 10:219-226.

20. Thorne, M. H., Collins, R. K., Sheldon, B. L. 1991. Chromosome analysis of early embryonic mortality in layer and broiler chickens. *British Poult. Sci.* 32 (4): 711 – 22.

21. Westgren, R. E. 1999. Delivering food safety, food quality, and sustainable production practices: The *Label Rouge* Poultry System in France. Am. J. Agric. Econ. 81:1107–1111