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Productivity and hatchability trends in A-33 Rhode Island White hens over five generations

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In Poland, there is a priceless collection of conservation breeds/stocks of hens that vary in morphological and qualitative characteristics (Cywa-Benko, 2002; Calik et al., 2012). Rhode Island White breed – A-33 stock play an important role among them. Rhode Island breed was formed as a result of cross-breeding of various hen breeds with Asian birds such as Cochins and Malaya game fowls and leading the selection towards higher laying performance (Verhoef and Rijs, 2003).

Phot. 1. Rhode Island White hens (A-33) (photo J. Calik)

In Poland, breeding works on Rhode Island White (A-33) breed were initiated in late 1970s. on a breeding farm in Pawłowice and then in Duszniki. The A-33 hens have white plumage and are less timid as well as mild-tempered (photo 1). They have different genetic structure and origin compared to other stocks kept in Poland, and show high degree of heterosis when cross-bred with other stocks. This breed of hens is particularly useful in extensive breeding, farmyard breeding and perfectly uses green pens. The principal goal for the conservation program of the A-33 hens is to restrict the occurrence of flock inbreeding and to preserve the specific features, characteristic for the population. In conservation flocks, production features show variability, thus the analysis of their formation in the course of several generations and performing periodical assessment of the effectiveness of the applied program in terms of the degree of implementation of the designated goals are very important.

The aim of the present study was to assess the formation of productivity and hatchability trends in A-33 Rhode Island White hens over five generations.

Material and methods

In 2013–2017 (generations 1–5) the studies included Rhode Island White A-33 stock hens that were protected against the influx of foreign blood and were also included into the program of conservation of animal genetic resources. Hens and cocks were kept at the ratio of 1 male : 10–12 hens on the farm in the Experimental Station of the National Research Institute of Animal Production in Chorzelów. Throughout the entire rearing and production periods, the birds were fed complete standard diets *ad libitum*. The hens and cocks were kept under optimal environmental conditions (at 16-18^{o}C, 60–80% relative humidity) on litter at a stocking rate of 5 birds/m^2.

Based on the breeding records that are conducted on farms and the performed measurements and analyses, the following productivity characteristics were determined: mortality and health-related culling of birds during the rearing and production periods, body weight of birds at the 20th week of life, sexual maturity of the flock (assessed by the number of days of birds' life since the day of hatching up to the achievement 30% and 50% laying performance by the flock), egg weight at the 33th and 53th week of hens' life and the number of eggs laid until the 56th week of hen's life. Stocks were also assessed in terms of parameters of hatchability, determining the percentage index of egg fertilization and hatchability of chicks from the set eggs and fertilized eggs. After the preliminary scanning of eggs with the use of an ovoscope, the eggs with cracked shells were removed. The remaining eggs were disinfected with a disinfecting formulation (Virkon), and then placed in a warehouse for the storage period that amounted to a maximum of 7 days. Hatching was conducted in *PETERSIME* (Belgium) incubator, according to all the recommendations concerning both the temperature and relative humidity.

Wright's formulas (1931) were applied to calculate the so-called effective population size (Ne) which is the rate of gene elimination as a result of random genetic drift, and an increase in flock heterozygosity (Fx), which is reverse proportional to the effective population size. In turn, linear regression formulations were used to determine time trends according to the formula:

$$y = a + bt$$

where:

t – time expressed in years (independent variable),
a – level of the characteristic in the zero period,
b – linear regression coefficient,
y – level of the characteristic (dependent variable).

Results and discussion of results

The program for the protection of genetic resources according to which the A-33 stock is maintained assumes the preservation of genetic identity of the stock and giving up the selection towards the improvement of functional characteristics, with the use of cock rotation and random mating in the reproduction of the following generations, thus the values of the characteristics mainly result from the genetic properties of the said stock and environmental conditions changing throughout the years.

In table 1 it is shown that the effective population size, dependent on the number of males (x = 93) and females (x = 864) in the flock of hens fluctuated from N_e = 316.46 (generation 2) to 345.52 (generation 4), and the level of inbreeding in flocks was low (F_x = 0.14–0.16). The analysis of the above-mentioned estimated indicators suggests that the mating system applied in the reproduction effectively protects the population of A-33 hens against the increase in its inbreeding level, which is consistent with the results of studies conducted in the other hen stocks included in the conservation program (Cywa-Benko, 2002; Krawczyk and Calik, 2010).

Table 1. Number of cocks and hens, effective population size (N_e) and coefficient of inbreeding ($F_{x\,\%}$)

Item	*Number of cocks and hens*		N_e	F_x
	♂	♀		
1	91	861	329.21	0.15
2	87	873	316.46	0.16
3	96	859	345.40	0.14
4	96	862	345.52	0.14
5	95	863	342.32	0.15
Mean	**93**	**864**	**335.78**	**0.15**

In the rearing period, i.e. from the 1st day of life up to the 20th week of life of birds, the survival rate was high and amounted to between 97.50 to 100% in males, whereas in females it fluctuated from 98.18 to 99.45% (table 2).

Table 2 . Mortality and health-related culling of hens and cocks (%)

Item	*Rearing period (0–20 weeks)*		*Production period (21–56 weeks)*	
	♂	♀	♂	♀
1	0.00	0.57	1.15	0.57
2	0.00	1.25	1.04	0.93
3	1.67	0.55	0.00	0.35
4	2.50	1.82	1.04	0.46
5	0.83	1.27	0.00	0.46
Mean	**1.00**	**1.09**	**0.65**	**0.55**

During the 36-week production period, the health status of birds was high as well (♂ = 0.00–1.15%; ♀ = 0.35–0.93%). In the view of the previous studies by Krawczyk and Calik (2010) – an improvement in health status of A-33 hens that has been observed for the recent several years resulted from the effect of the improved environmental conditions in which they were kept. A transfer of the A-33 flock to the Experimental Station in Chorzelów had a positive effect on the improvement of both the health status and utility of hens. The obtained data indicate good environmental conditions in which the birds were kept, proper nutrition and, above all, appropriate veterinary prophylaxis.

After the end of the rearing period, the birds were transferred from the rearing house to the henhouse and the assessment of functional characteristics was performed. The mean body weight of cocks (fig. 1) fluctuated from 1687 g (generation 2) to 1911 g (generation 4), exhibiting a slightly increasing trend. Hens were lighter than cocks by on average 320 g and their body weight showed a stable trend. As reported by Calik (2008), body weight is the main characteristic of breeding pattern and its stability in the period of several years confirms the appropriate selection of birds to the herd rotation in the generations.

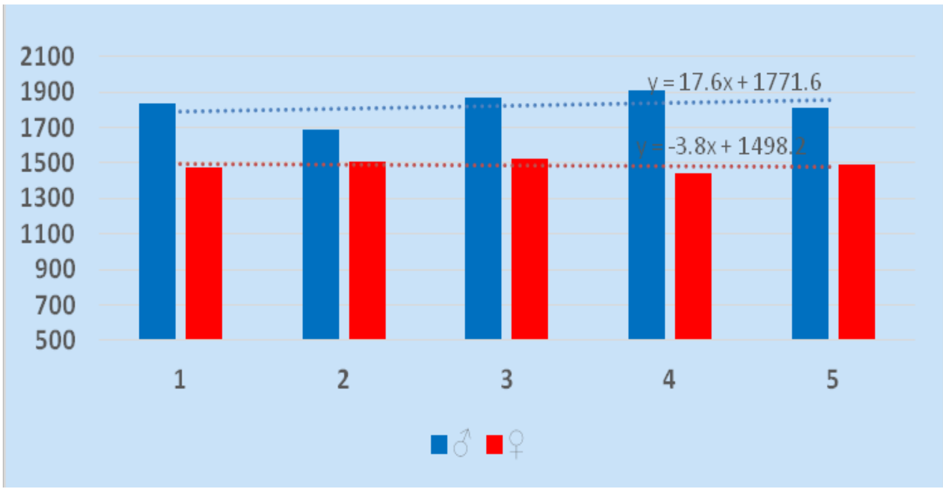

Fig. 1. Body weight (g)

Mean egg weight assessed in the 33rd week (fig. 2) fluctuated from 54.20 (generation 1) to 56.30 g (generation 4), showing an increasing time trend. On the other day of assessment (53rd week), egg weight was more stable and amounted to from 59.80 to 60.80 g. Data from the subject literature suggest that statistically significant differences in body weight of birds and egg weight that is highly correlated with it result from genetic predispositions (Anang et al., 2000; Singh et al., 2000). Szwaczkowski (2003) reported that heritability index for these characteristics is high (h^2>0.5–0.6). Moreover, as indicated by Hocking et al. (2003), the weight of eggs from young hens is less balanced but it stabilizes after the achievement of stable laying performance by laying hens, which was also observed in author's own studies.

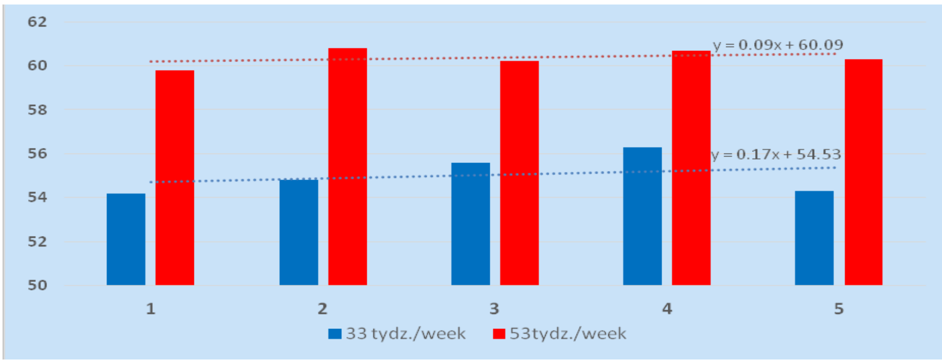

Fig. 2. Egg weight (g)

Great differences in the age of achieving sexual maturity by hens, assessed at laying performance of 30 and 50%, were observed between the generations (fig. 3). Hens from the generations 3 and 4 achieved laying performance the earliest, i.e. on average on the 139th (30%) and on the 142th (50%) day of life, whereas in the generation 2, the hens achieved this level of laying performance only on the 144th and 149th day of life, with negative time trends.

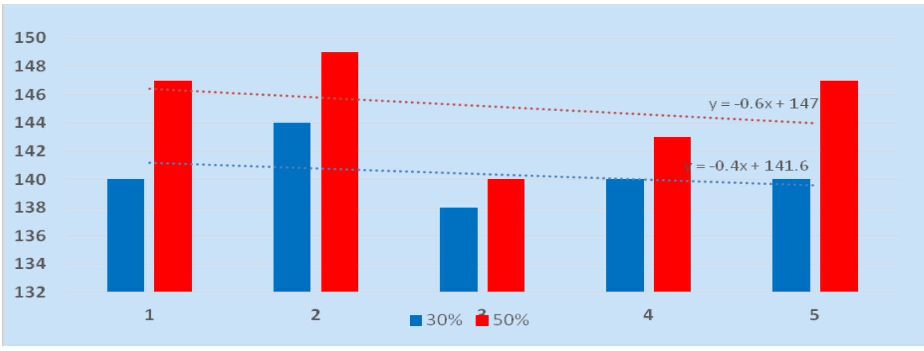

Fig. 3. Sexual maturity (days)

This had a direct effect on laying performance of hens (fig. 4), which was the highest in the generations 3 and 4 (166.50–173.47 pcs/hen), with a positive time trend. Anang et al. (2000) indicated that hens which achieve maturity earlier, show genetic predispositions to higher laying performance at the same time, which is supported by usually negative correlations between the age of sexual maturity and the number of eggs.

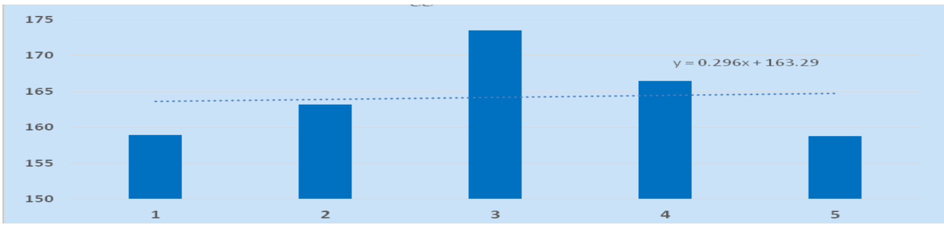

Fig. 4. No. of eggs from housed hen (pcs)

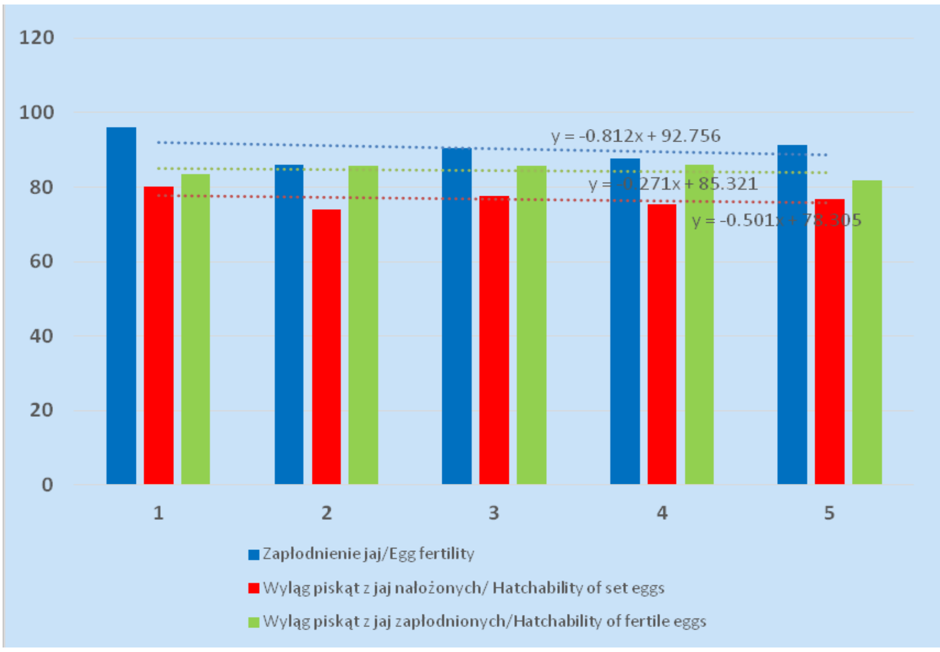

Fig. 5. Parameters of hatchability (%)

The parameters of hatchability are shown in figure 5. Within 5 generations, the level of egg fertilization was good (on average above 90.8%), with satisfactory results of hatching of healthy chicks from the set eggs (76.80%) and the fertilized eggs (84.51%). Borzemska and Kosowska (1997) reported that clutch loss amounting to from 7.5 to 20%, depending on the species, breed and the direction of the use of birds, is considered as physiological. As indicated by Szwaczkowski (2003), one of the main factors that influence the effectiveness of hatching the eggs, is the genotype of birds, and the hatchability parameters are characterised by low heritability indices (h^2<0.2).

Summary

Based on the obtained results it was concluded that over the five generations, A-33 hens were characterized by high survival (above 97.50%) during both rearing and production period. The analysis of productivity results and trends for the A-33 hens showed that the goals of the implemented conservation programme are being met and the random mating system used for flock reproduction effectively protects the population from increased inbreeding.

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PRODUCTIVITY AND HATCHABILITY TRENDS IN A-33 RHODE ISLAND WHITE HENS OVER FIVE GENERATIONS

Abstract

The aim of the study was to evaluate productivity and hatchability trends in five generations (2013–2017) of A-33 Rhode Island White hens included in the genetic resources conservation programme. Hens and cocks were kept with a sex ratio of 1 cock to 10–12 hens at the Chorzelów Farm of the National Research Institute of Animal Production. Throughout rearing and production periods, birds were fed complete standard diets *ad libitum*. Hens and cocks were kept under optimal environmental conditions (16-18°C, 60–80% relative humidity) on litter at a stocking rate of 5 birds/m^2. It was concluded from the results obtained that over the five generations, A-33 hens were characterized by high survival (above 97.50%) during both rearing and production. The analysis of productivity results and trends for the A-33 hens showed that the goals of the conservation programme are being met and the random mating system used for flock reproduction protects the population from increased inbreeding.

Key words: Rhode Island hens and cocks, productivity and hatchability trends