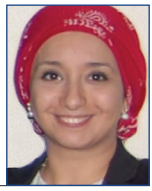
Evaluation of zootechnical and sanitary performances of broiler chickens in semi-arid conditions



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Abstract

This study aimed to determine zootechnical performance on a poultry farm located in a semi-arid zone in Algeria and to evaluate the level of breeding management. Over 64 weeks, a flock of 583 males and 5026 female reproducers was monitored. Zootechnical and sanitary parameters were recorded regularly (building, equipment, environmental conditions, production, harvest and storage of eggs, mortality rate). The results obtained showed that temperature, humidity and light intensity were unstable and difficult to control. The breeding farm did not offer granulated feed while nutritional supplements and preventive treatments were administered systematically between the 19th and 30th weeks. Antiparasitic treatments were limited to prevention only, this condition was aggravated by the danger linked to rodent movements among livestock. For reproduction management, the sex ratio was respected at the start, and was maintained during the production phase. The average mortality rate during the production phase was higher in males (42.92%) than females (8.84%). Laying performance was generally within standards (the start of laying was around the 24th week with a later peak around the 29th week). An acceptable level of livestock management and production was found, in compliance with standards. Given the problems reported during monitoring, we recommend the organisation of training days for all livestock staff.

Key words: *hens; reproducers; zootechnical; sanitary; performance*

Introduction

Poultry farming is the fastest growing agricultural sub-sector, especially in developing countries (Mottet and Tempio, 2017). Since 1960, overall chicken production has considerably grown more than that of any other type of meat in both developed and developing countries (Fouepe et al, 2017; Guergueb et al., 2021). In developing countries, eggs and chicken are considered an important source

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of animal protein (Guergueb et al., 2020; Naushad et al., 2021; Amroun et al., 2023). Most regions have experienced strong development in the production and consumption of poultry, which can be explained in part by changing dietary habits, health concerns, and the price of poultry products (Ammari et al., 2022).

In Algeria, the sector is expanding rapidly, particularly following national economic policies aiming to develop this sector (Mimoune et al., 2023). In this country as elsewhere, the industrialisation of poultry farming aimed at increasing animal production is an excellent example of an artificial environment that is sometimes accompanied by a lack of mastery in breeding (Brugère-Picoux and Silim, 1992; Guergueb et al., 2020). Faced with the known constraints in the field of breeding hens, despite the capacity of breeding centres and the sector's adjustment policies, the zootechnical results obtained in Algeria remain weak (Fouepe et al., 2017). It therefore appears necessary to improve breeding conditions in order to define standards for sustainable and economically profitable exploitation, thus contributing to food security (Fofana et al, 2018).

To do so, further investigations are necessary to acquire more knowledge about breeding systems. The current study aimed to perform a full follow-up of breeding to control the sanitary and zootechnical parameters of hens in line with universal standards. This study allowed us to collect information on the situation of breeding hens, and to assess breeder aptitudes to improve production. It also highlighted errors, enabling corrections to improve farming conditions with the goal of obtaining better products and minimising economic losses.

Materials and methods

Study area

The study was conducted on a poultry farm in the Tiaret region (western Algeria). The farm is at an elevation of 1150 m, belonging to the lower semi-arid bioclimatic stage with a cool winter, and a Mediterranean type climate characterised by two periods, a harsh winter and a hot and dry summer with an average temperature of 37.2°C. Generally, Tiaret receives 300 to 400 mm of rain per year, with a seasonal fluctuation in rainfall ranging from 157 mm in winter to 31 mm in summer. The total agricultural area includes 704,596 ha of useful agricultural land, including 14,561 ha irrigated land and one million hectares of steppe, rangeland, alfa and forests. It is dominated by the "cereals-livestock" system, the integration of which constitutes the bulk of agricultural production and economic growth (Achir and Hellal, 2016). The study period began in early March 2020 and continued until the end of June 2021, with farm visits taking place during this period.

Animals and livestock

Animals were monitored according to a technical outline developed on the basis of previous studies in the field and according to international parameters and standards of guides and labels of the ISA F15 breed especially during the production phase until reform. In total, 45,218 females and 5247 males were spread over nine breeding buildings. The monitoring of this flock was performed by 15 production agents, three watchmen, two electro-mechanics, one production manager, one centre manager and two veterinarians (duration of the production cycle: 41 weeks, age at reform: 64th week). Only building no. 7 was selected for monitoring parameters. Table 1 presents the breeding

Table 1. Breeding characteristics

Region	Tiaret
Chicken strain	ISA Hubbard F15
Number at the start of production in building 7	583 males 5026 females
Building area (m^2)	960
Number of buildings	9

characteristics followed for this present study.

Methods

Data collection

Regular visits were made to the farm. The zootechnical and sanitary parameters implemented in this breeding were noted on special technical sheets. The first visits were devoted to familiarisation with the breeding, to record the fixed parameters of breeding (habitat, equipment, type of accommodation) and to collect other information to complete the technical monitoring sheets. The second part of the monitoring began from the age of 18 weeks until the last chicken reformed in the 70th week, and in this period the variable parameters of breeding (environmental conditions, production, harvest and storage of eggs and mortality rate) were recorded. Errors and problems encountered were recorded during the visits.

Data analysis

Statistical analysis was performed using STATISTICA software (Version 10, Stat Soft France, 2003). Statistical differences in the mortality rates between males and females were performed using Student's t-test. The results were considered significant when $P < 0.05$. The data relating to zootechnical performance and health criteria were compared with the strain standards (breeding guides) and international standards described in the bibliography.

Results and discussion

General building characteristics

The building plays a major role in the protection of animals against attacks from the external environment, and must meet the standards and have the necessary equipment for the comfort of the hens and for the good control of hatching eggs (HE) production. Table 2 presents the data on the building parameters and equipment.

Breeding conditions have a clear influence on the zootechnical and sanitary performances and on the onset of disease (Guechtouli et al., 2022). The fitting out of a specific building for the production phase is essential. The building should be parallel or slightly inclined to the prevailing winds to avoid drafts; non-compliance with such a condition exposes the chicks to respiratory problems and represents a source of pathogen transmission between buildings. Unlike the dark building, which facilitates control and compliance with the lighting program, the semi-dark building, where the light intensity depends on daylight is favourable during sunny days, though external fluctuations require special control to prevent disturbing the hens in full production, as any error in light stimulation affects laying performance (Deelstra and Girardet, 2000). On the oth-

Table 2. Description of the building and the equipment

Parameters and equipment	Observation
Production building other than the livestock building	Yes
Exposure to prevailing wind	Parallel
Building type	Obscure
Insulation	Yes
Linear feeders (hens / m)	15
Drinking equipment (fixed-level drinkers)	1 for 90
Lighting material	Lamps
Laying nests (hens / nest)	4
Extractors	10
Radiant	Absent

er hand, the unstudied stimulation affects the persistence of laying and promotes the laying of double and small eggs (Brillard, 1992). For this, it is necessary to control light intensity using a lux-meter. This approach helps to avoid behavioural disorders such as pecking due to an excess of light intensity (excitement) or brooding following a decrease in light.

A good insulation system makes the environment more controllable, and keeps the building climate independent from the outside. Animal husbandry encompasses this function and energy expenditure is thus minimised to maintain an ideal temperature.

A sufficient number of drinkers eliminates animal stress due to overcrowding. In conclusion, the breeding facility does not have all the necessary equipment but contains the essentials for the minimum control of the atmosphere in the buildings.

Breeding management

Ambient quality of buildings

The high density of hens in the building, the low air flow, and all the waste that makes the atmosphere of the building intolerable, make it necessary to respect the density and to control the atmosphere at the level of the hens. The quality of the building environment is noted in Table 3.

The humidity in the breeding was not controlled. Although this problem can be solved by maintaining good ventilation, the installation of a hygrometer is essential for the optimal use of ventilation equipment.

Temperature was not controlled and this may influence the thermoregulatory function of the animals, disturbing their food consumption, so that the increase in temperature affects laying and egg weight (Mahmoudi, 2001) as well as shell quality following the decrease in food consumption (Deelstra and Girardet, 2000). It also decreases the activity of hens and roosters, and this condition has a negative influence on their fertility. A drop in temperature leads to overconsumption of food which is an economic loss (Nambaté et al., 2018).

The poor insulation of buildings and insufficient ventilation and sometimes the failure of the cooling system can lead to an increase in temperature beyond the recommended 20°C, causing excessive stress on birds that die from hyperthermia (Sauveur and Picard, 1990).

Table 3. Atmosphere quality in the building

Ambience parameters	Observation
Temperature (°C)	21-23
Humidity (%)	Not taken
Density (hens / m^2)	6
Illumination duration (hours)	16

Table 4. Feeding regime on the studied farm

Method	Observation
Food presentation	Crumbs
Distribution program	once a day in the morning
Distribution method	Mechanical
Duration of distribution	Fast
Distinction between male/female food	No

In general, temperature, humidity and light intensity were unstable and difficult to control, resulting in the development of a particularly unfavourable state of stress, as cold reduces cell-mediated immunity and the transfer of passive immunity (Silim and Rekik, 1992).

Food

Feed management of feed on the farm is as important as the composition of feed. In reproducer breeding, feed is rationed to avoid fattening as this deteriorates ovarian function in hens and makes the rooster too heavy, causing difficulties in ticking and therefore consequences on fertility (Rossilet, 1998). Feeding largely conditions the achievement of good zootechnical performance (Guechtouli et al., 2022). Table 4 illustrates the feeding regime in effect on the farm.

For hens, which are grain-eaters, granulated feed is preferable. Indeed, the granulometry of the feed and its mode of presentation (flour, crumbs or granules) influence the level of ingestion (Al-Saffar and Rose, 2002) and is a determining factor of zootechnical success in poultry (Deelstra and Girardet, 2000). The advantage is to avoid sorting, and to ensure the acquisition of the entire ration by the animal. Unfortunately, the breeding farm did not have this type of feed which results in food waste.

Automated feed distribution in livestock is more advantageous than manual distribution. When feed distribution is slow, hens with the first access to feed may still eat the last feed available. In addition, the feed may overflow from the feeder and the roosters would then have access to it. To avoid this, the worker in manual feed farms makes an effort to distribute the feed as quickly as possible (10 to 12 minutes). The use of chicken feed for roosters provides them with a diet rich in energy, protein and calcium, which causes rapid testicular development and induces fertility that does not last over time (Sauveur, 1988). Some roosters eat the eggs (male aggression), and this may be due to a calcium deficiency. This problem has been significantly reported in recent years and the consequences of this pecking can be diminished with beak trimming, though this does not resolve the root problem (Fragoso et al., 2020). Therefore, good ra-

Table 5. Management of reproduction in the farm

Parameter	Observation
Sex ratio	12 males/100 females
Refill in roosters	Exists
Egg harvest	Manual
Egg collection frequency (times / day)	2
Egg sorting	Yes

Table 6. Egg storage conditions in the farm

Conditions	Observation
Special room	Yes
Temperature	15-18°C
Humidity	Not taken
Egg position	Point down
Storage time	Max. 2 weeks

tioning of roosters improves production and reduces economic losses.

Reproduction

Many authors have observed that the hen reproduction cycle is a "luxury" that develops when the conditions are suitable, and is one of the first functions to disappear when stress is present (Fragoso et al., 2020). Respect for the sex ratio is essential for the success of fertilisation, so it is necessary to have a limited number, maintained at one rooster for 10 hens (Brillard, 1992).

The frequency of egg harvesting is important to the reproduction and production of good HE quality (Deelstra and Girardet, 2000). This quality follows two factors: the quality of the embryo and its viability, and microbiological quality that influences hatchability and the quality of the chicken. The corresponding results are shown in Table 5.

The sex ratio is respected at the start, and is maintained during the production phase, posing no problems of reducing the fertility rate by having a high number of hens per rooster, which generates a ticking with poor sperm in spermatozoa, and develops a sorting behaviour among hens in the rooster. The manual method of harvesting eggs is applied in the farm. To avoid soiling of eggs, their consumption by roosters, and to foster development of the brooding instinct in hens, an increase in the frequency of harvesting by workers is necessary in the farm. Egg sorting is applied, which eliminates all downgraded eggs that have a double yolk, a thin, cracked or discoloured shell, or other deformations that interfere with incubation and embryonic development.

Storage of hatching eggs

The HE produced are generally stored for a variable time depending on the farm, pending incubation. This storage directly influences the quality of the HE; when poorly positioned or stored for too long (especially in hot or cold, dry or humid climates) they deteriorate and embryonic

mortality becomes high. The results of the egg storage conditions are presented in Table 6.

The arrangement of a special room for the storage of HE in the farm makes atmospheric control possible. Similarly, temperature is respected as is storage duration. Sauveur (1988) recommended a temperature between 14 and 15°C. While humidity was uncontrolled in this study, when it is low, drying causes embryonic mortalities, while when it is high, microbial and fungal growth deteriorate HE quality. The recommendations of Sauveur (1988) set an interval of between 75 and 85% humidity for a period not exceeding 5 to 6 days. The storage position is normally observed where the point is down, allowing the egg to breathe and to avoid ischemia.

Prophylactic measures

Medical prophylaxis

Medical prophylaxis in breeding hens began on the first day of age of the chicks. Table 7 shows the measures applied from the eighteenth week of age. These measures are represented by the remainder of the vaccination protocol, preventive treatments and nutritional supplements added to the diet or distributed independently.

The use of a live lyophilised vaccine against Newcastle disease at week 27 promotes the reconstitution of antibodies in hens to give chicks passive immunity. Parasitic diseases, which sometimes exist in the breeding, require the establishment of preventive treatments that reduce their incidence, and these treatments are limited only to prevention. The use of nutritional supplements is done normally, thus avoiding deficiency diseases (Ammari et al., 2022).

Biosecurity

It is known that disinfection and the crawl space of the building between the strips are essential to reduce microbial load, but once the litter and the hens are installed, the workers walk around the farm. When the food arrives, the microbial load also increases over time. To avoid this, the application of strict biosecurity measures is mandatory in the farm to keep the microbism at the lowest possible level and to avoid contamination. Table 8 shows the level of applied biosecurity.

Rodents in livestock farming constitute a threat to the One Health approach (Schulze Walgern et al., 2023). The major danger linked to rodents still exists in breeding, despite the establishment of a control programme that exposes both hens and workers to infectious risks, plus increasing stress and discomfort among livestock (Witmer, 2022). The working staff do not follow a health monitoring programme, which consists of analysis of the respiratory system and coprology to avoid contaminating or being contaminated by hens.

Table 7. Medical prophylaxis measures applied in the farm followed from the eighteenth week of age

Measures	Observation
Vaccination	Vaccine against NC (La Sota)
Preventive treatments	Hepato-protective (at Week 30) Antibiotic prevention (Enrofloxacin at Week 20-23)
Nutritional supplements	Mineral-vitamin supplement and trace elements (at Week 19, 30)

Table 8. Biosecurity measures applied in the farm

Biosecurity measures	Observation
Cleaning of the building and crawl space	Yes
Rodent control	Insufficient
Staff cleanliness	Good
Sanitary barrier	Rotoluve, footbath, lime

Table 9. Hygiene measures applied to hatching eggs (HE)

Hygiene measures on HE	Observation
Nest cleanliness	Correct
HE cleaning	Yes
Disinfection of HE	Yes, in storage

The breeding uses the following products as a sanitary barrier: detergent/disinfectant based on iodine and acids, used in poultry breeding centres and for the disinfection of drinking water of animals, detergent/disinfectant based on quaternary ammoniums, quicklime.

Hatching Egg Hygiene

Table 9 shows the hygiene measures applied to HE to minimise contamination of eggs after laying. The speed of initiation of these operations is important to stop fixation and multiplication and even the penetration of germs into the egg.

Maintaining nest litter and its regular changing decreases soiling and contamination of HE. The practice of cleaning HE is done on the farm, the cleaning agents use rags, instead of using metal cloths, which weakens the shell.

Early disinfection of HE is only done in the farm, this is a good prophylactic measure against diseases transmitted by eggs (Guechtouli et al., 2022).

Breeding and production performance

Mortality rate

The mortality rate is the regression of the number over time reflecting the state

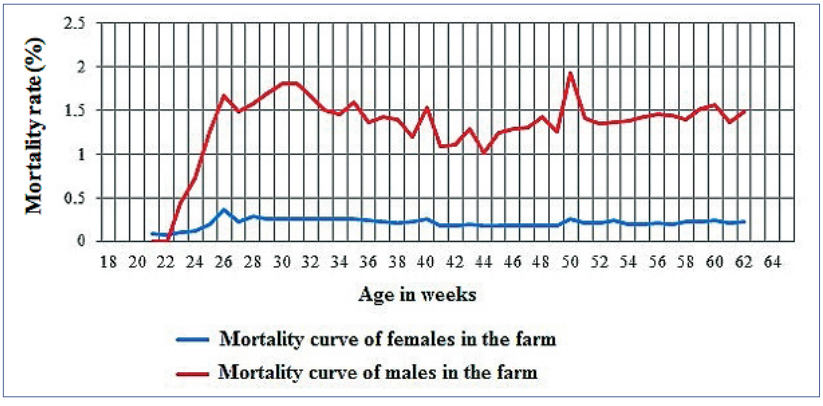

Figure 1. Mortality curve in the farm

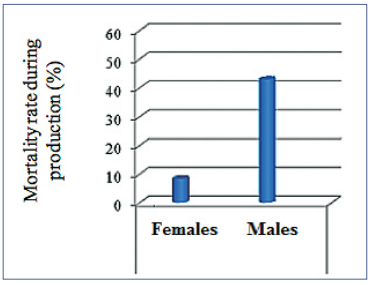

Figure 2. Mortality rate in the production phase

of the flock health. The results of the mortality rates recovered from the farm are presented in the Figures 1 and 2.

Our data showed dissimilarity between the mortality of males and females (P<0.05). Male mortality was high from onset until the 26th week, with a rate reaching 1.66%. This value presents fluctuations and is more or less maintained until the cull of the flock, with a peak of 1.93% at the 50th week. The female mortality curve was straight, with low values. The mortality curve of males was higher than that of females in general, and both sexes were affected by mortality at the same time, which may mean the contraction of pathology at the level of the production building, but provided more important information on the immune status of females which is higher than that of males. According to previous reports (Larbier and Leclerq, 1992), males are more sensitive to the effects of heat (stress) compared to females.

The mortality rate during the production phase varied between males and females. The breeding showed higher mortality of males (42.92%) than females (8.84%) (P<0.05). The rate has grossly exceeded the standards. According to several data, the stress generated by males chasing females can be related to the higher mortality observed. A stressed flock is more susceptible to any kind of infectious diseases due to immunodepression (Fragoso et al., 2020; Guechtouli et al., 2022).

Feed consumption

The amount of feed consumed by the breeding stock varies over time. Depending on the state of fattening and egg production, the amount of feed should be adjusted. Otherwise, the economic losses linked to the increase in feed consumption and the decrease in production performance become significant (Mimoune et al., 2023).

Figure 3 shows two curves, one representing the actual consumption of hens, and the other the normative consumption obtained by calculation, following the rec-

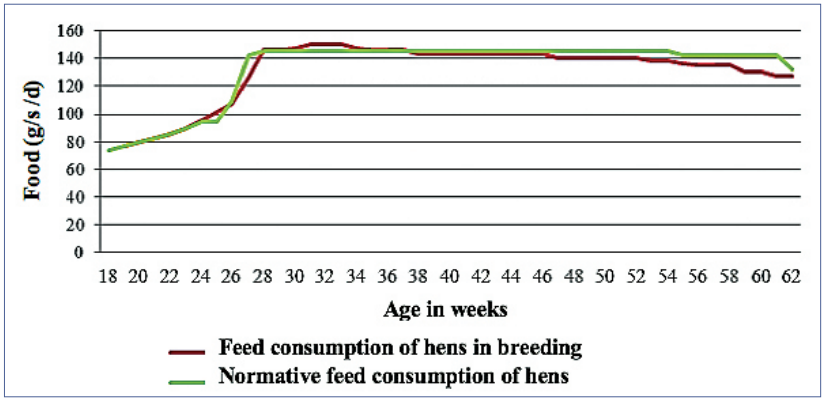

Figure 3. Feed consumption rate in the farm

ommendations of the Hubbard F15 guide.

The evaluation of feed consumption data on the farm leads to the development of a curve representing consumption. In comparison with the normative feeding standards, rationing of hens was found to be in line.

Laying performance

In breeding stock, the laying performance to be recorded is the age of onset, the age and persistence of the laying peak, and the spawning rate, which is calculated according to the following formula:

(Total number of eggs laid over a period) / (Number of hens over the same period) × 100

The corresponding results are shown in Table 10 with the relative spawning curves (Figure 4).

An early onset of laying is detrimental to the persistence of laying and the maintenance of the peak. The breeder was able to control this parameter by controlling the lighting program in the dark building. The peak appeared six weeks after the onset of lay, which is quite normal.

The breeding curve of the farm showed a general appearance similar to that of the Hubbard F15 curve, though with a slightly lower peak, somewhat persistent, and the regression tends to separate from the reference, and does not maintain the expected values. The difference between the two curves increases with flock age. This is because the strain misses its peak, which consequently affects the subsequent production of the hens. In addition, the declared mortalities reduce the profitability of breeding (Ammari et al., 2022).

Age of reform

The decision to reform the breeding flock is linked to its profitability, so it is purely economic. Thus, a high mortality or a disease that deteriorates laying at the end of production requires this decision to be made. Reform began in the 62nd week. Female mortality at this age did not decrease, resulting in considerable losses, and a laying rate of around 5.1%. The need for reform is an economic obligation (Amroun et al, 2023).

Conclusions

This study on the monitoring of breeding hens found a variable level of compliance with the standards and with production. Breeders were found to use materials in an acceptable way. No significant problems concerning illumination were

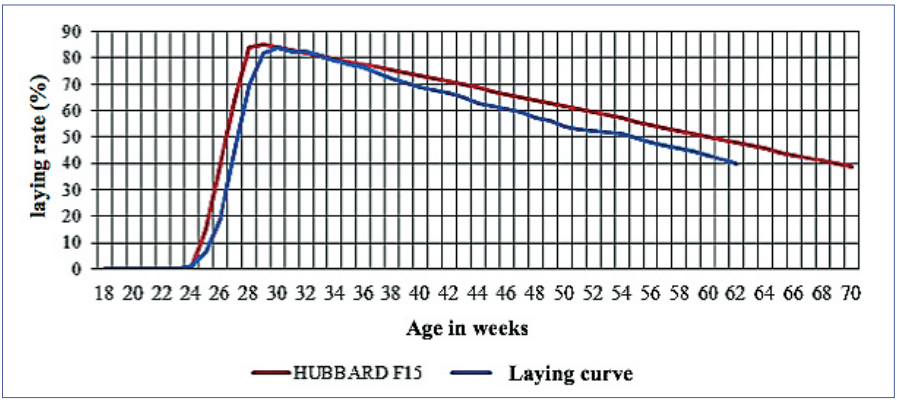

Figure 4. Laying curve recorded in the farm

observed. The type of building, completely dark, facilitates the control of the corresponding parameters. The texture of feed (in crumbs) can be considered a cause of economic losses, and the use of feed specific to the females in the ration of males further accentuates these losses. However, it is considered that these losses are not highly significant since less feed is distributed for males than for females. Hygiene standards and prophylaxis were generally observed except in the case of parasite control. Male mortality was higher than in females. Although the production of HE in livestock is acceptable, it has not reached a desirable level. The critical points are to be located at the level of several factors, one of which is that the farmer has an objective of producing HE during the year, or his economic capacities have been limited, or he has a low level of education. The feed problem is often acute. The recommended solution would be full integration, with the possibility of making feed onsite. At the end of this present study and given the problems reported during the monitoring of this breeding, we recommend the organisation of training days for all livestock staff (veterinarian, breeder, agents specialising in poultry farming).

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Procjena zootehničke i sanitarne učinkovitosti tovnih pilića u polusušnim uvjetima

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Cilj je ove studije bio utvrditi zootehničku učinkovitost na farmi peradi koja se nalazi u Alžiru, polusušnoj zonu te procijeniti razinu upravljanja uzgojem. Tijekom 64 tjedana nadzirano je jato pilića sastavljeno od 583 mužjaka i 5026 ženki za rasplod. Redovito su bilježeni zootehnički i sanitarni parametri (zgrada, oprema, uvjeti okoliša, proizvodnja, prikupljanje i skladištenje jaja, stopa mortaliteta). Dobiveni rezultati su pokazali da su temperatura, vlažnost i intenzitet svjetlosti bili nestabilni i bilo ih je teško kontrolirati. Rasplodna farma nije nudila granulirano krmivo, dok su dodatci prehrani i preventivno liječenje sistematski primjenjivani između 19. i 30. tjedna. Suprotno tome, tretiranje protiv parazita bilo je ograničeno samo na antibiotsku prevenciju, a ovo je stanje dodatno otežano opasnostima povezanima s prisutnim kretanjem glodavaca u blizini peradi. Za upravljanje parenjem, na početku je ispoštovan omjer spola te je isti održavan tijekom faze proizvodnje. Prosječna stopa mortaliteta tijekom faze proizvodnje bila je visoka (u mužjaka 42,92 % u usporedbi s onom u ženki 8,84 % – $P<0,05$). Učinkovitost lijeganja jaja bila je uglavnom unutar standarda. (Početak lijeganja bio je oko 24. tjedna, a vrhunac je bio kasno – oko 29. tjedna). Prema ovoj studiji posvećenoj nadziranju rasplodnih kokoši, rezultati su pokazali prihvatljivu razinu upravljanja peradi u skladu sa standardima, kao i onu proizvodnje. Na kraju te s obzirom na probleme prijavljene tijekom nadziranja ovog uzgoja, preporučujemo organiziranje dana uvježbavanja za svo osoblje koje se bavi uzgojem peradi.

Ključne riječi: *kokoši, rasplodne životinje, zootehničko, sanitarno,* **učinkovitost**