Evaluation of performance improvement strategies on commercial layers’ production in the hot and humid climates. 
O.A. Duduyemi1, D.I. Asiyanbola2, S.O. Oseni3 & O.G. Omitogun4

1234Department of Animal Sciences, Obafemi Awolowo University, Ile Ife, 220005, Osun State, Nigeria, 
1bunmid2000@yahoo.com (Corresponding Author)

Summary

Commercial laying system in developing countries will continue to sustain the future growth of its egg and meat production, hence, the need to review the performance improvement strategies for better production in hot, humid conditions. This condition is characterized as humid tropical and subjected to extended periods of high ambient temperature and relative humidity. Because the primary non-evaporative means of cooling for the commercial layers (radiation, conduction, convection) become less effective with rising ambient temperature, the birds becomes increasingly reliant upon evaporative cooling in the form of panting. High relative humidity compromises evaporative cooling, so that under hot, humid conditions, the birds cannot dissipate sufficient body heat to prevent a rise in body temperature. The need to design intervention measures to reduce losses (e.g. high mortality and decreased egg lay) associated with heat stress is apparent and urgent. Interventions such as cooling and ventilation systems for poultry houses can be used to decrease the effect of heat stress, but they involve high costs and in many cases, are neither economically appropriate nor available to farmers in developing countries in the humid and sub-humid tropics. A more sustainable strategy for mitigating the effect of heat stress on the performance of poultry in tropical regions is genetic intervention through breeding and selection of poultry stocks for heat tolerance. A good justification for this approach is the increasing proportion of poultry production in tropical and sub-tropical regions of the world, which makes it necessary to consider long-term selection strategy of today’s commercial poultry production for genetic merit for heat tolerance. Part of the preliminary steps for such a long-term strategy is to establish a procedure for the inclusion of heat tolerance genetic merit for the selection and genetic improvement of layer stock under hot and humid environment. Genetic selection for heat tolerance may be possible, but continued selection for greater performance in the absence of consideration for heat tolerance will result in greater susceptibility to heat stress. The nutritional needs of commercial layers change during heat stress, and ration reformulation to account for decreased egg production, the need to increase nutrient density, changing nutrient requirements, avoiding nutrient excesses and maintenance of normal body function is necessary. Hence, maintaining commercial layer performance in hot, humid climatic conditions in the future will require improved cooling capability, continued advances in nutritional formulation, and the need for genetic advancement which includes selection for heat tolerance or the identification of genetic traits which enhance heat tolerance. However, further research is required to quantify the genetic antagonism between adaptation and production traits to evaluate the potential selection response. With the development of molecular biotechnologies, new opportunities are available to characterize gene expression and identify key cellular responses to heat stress. This review showed that a variety of interventions can be used to minimize heat stress and improve the productive performance of commercial layers in sub-optimal conditions.
Keywords: performance, commercial layers, humid tropics

Introduction

Commercial laying system in developing countries will continue to sustain the future growth of its egg and meat production, hence, the need to review the performance improvement strategies for better production in hot, humid conditions. This condition is characterized as humid tropical and subjected to extended periods of high ambient temperature and relative humidity. Because the primary non-evaporative means of cooling for the commercial layers (radiation, conduction, convection) become less effective with rising ambient temperature, the birds becomes increasingly reliant upon evaporative cooling in the form of panting. High relative humidity compromises evaporative cooling, so that under hot, humid conditions, the birds cannot dissipate sufficient body heat to prevent a rise in body temperature.

Poultry offers the greatest scope for increasing the quantity and quality of animal protein. Poultry meat and eggs account for about 30% of total livestock output in Nigeria, of which eggs account for over 80 percent. Commercial poultry is little established in the country with barely substantial infrastructure (poultry houses, feed mills, hatcheries and processing plants) already on ground. However, most of these assets became idle for reasons associated with high cost of strategic inputs and working capital as well as competition from cheap imports. The challenge therefore, is how to improve performance of commercial layers at sustainable levels in order to bridge the protein supply gap in developing countries.

Their higher production performance and feed conversion efficiency make today's chickens more susceptible to heat stress than ever before. The increasing proportion of poultry production in tropical and subtropical regions makes it necessary to reconsider the long-term selection strategy of today's commercial poultry production (Cahaner, 2008).

Heat stress has a marked impact on performance, owing to their high metabolic heat output. High temperatures and relative humidity are a feature of most developing countries, and maintaining reasonable house temperatures and humidity is either too costly or simply not possible, owing to a limited or lacking power supply and other factors. As a result of this susceptibility to heat stress in commercial layer strains, it is standard practice in many tropical developing countries to market the birds at an early age and low weight, before heat stress becomes a major problem.

Methodology

The genetic stock, from which the large majority of commercial layers in developing countries were derived, are selected for production under relatively ideal management conditions in temperate climates (Duduyemi and Oseni, 2013). Little emphasis has been given to tolerance to high temperatures or to sub-optimal management and feeding conditions. High ambient temperature and relative humidity are probably the main factors limiting the performance of commercial layers in medium to large-scale production units in tropical developing countries. The need to design intervention measures to reduce losses (e.g. high mortality and decreased egg lay) associated with heat stress is apparent and urgent.

Management Interventions

Other factors can be addressed at moderate cost by establishing appropriate management
strategies, but the cost of facilities and the availability of a secure and reliable electricity supply make cooling problematic. Interventions such as cooling and ventilation systems for poultry houses can be used to decrease the effect of heat stress, but they involve high costs and in many cases, are neither economically appropriate nor available to farmers in developing countries in the humid and sub-humid tropics. During heat challenge, dual feeding reduces the body temperature and mortality (Basilio et al., 2001). In laying hens, partial feed restriction or controlled feeding regime alleviates the harmful effect of heat stress on laying performance (MacLeod and Hocking, 1993). Changing the feeding time from twice to one time daily is also favourable to the performance of laying hens and the best time is in the afternoon (18:00) (Samara et al., 1996). For example, in laying hens, stocking density should be reduced under warm Ta to avoid the accumulation of radiant heat between the animals and excessive heat stress (Burmeister et al., 1986). In addition, during the hottest periods of the day, additional stress on animals must be avoided. Consequently, animals should not be manipulated during hot spells to avoid stress-related mortality (Amand et al., 2004). Finally, heat can be minimized by adopting simple and basic rules for designing animal facilities (shape, orientation, thermo-physical properties of construction materials, ventilation, opening facilities, etc.).

Genetic Interventions

A more sustainable strategy for mitigating the effect of heat stress on the performance of poultry in tropical regions is genetic intervention through breeding and selection of poultry stocks for heat tolerance. A good justification for this approach is the increasing proportion of poultry production in tropical and sub-tropical regions of the world, which makes it necessary to consider long-term selection strategy of today’s commercial poultry for genetic merit of heat tolerance. Part of the preliminary steps for such a long-term strategy is to establish a procedure for the inclusion of heat tolerance genetic merit for the selection and genetic improvement of layer stock under hot and humid environment. Genetic selection for heat tolerance may be possible, but continued selection for greater performance in the absence of consideration for heat tolerance will result in greater susceptibility to heat stress. A relatively simple approach to improving heat tolerance in commercial stock, without having to develop separate full selection lines, is to incorporate single genes affecting feather cover into the parent lines of stock to be used in high-temperature regions. Reduced feather cover facilitates loss of body heat. Genes shown to be effective in conferring heat tolerance include naked neck (Na), scaleless (sc) and frizzle (F) (Cahaner et al., 2008).

Nutritional Interventions

The nutritional needs of commercial layers change during heat stress, and ration reformulation to account for decreased egg production, the need to increase nutrient density, changing nutrient requirements, avoiding nutrient excesses and maintenance of normal body function is necessary.

Studies have demonstrated genotype-environment interactions by measuring the growth or egg laying performance of different strains when subjected either to good management, high-input conditions or too harsh, low-input conditions (Besbes, 2008). Nutrient intake is typically one of the major differences between the two conditions. In almost all the cases studied, commercial stock performed considerably better than indigenous stock under good conditions, but only marginally better, or the same, under low input, harsh conditions.
(Tadelle, Alemu and Peters, 2000; Singh et al., 2004). An example of this is the comparison of egg laying performance between Lohmann Brown and Sonali hens under optimal (German Random Sample Test) and semi-scavenging conditions (Sorensen, 1999).

**Conclusion**

The non-genetic factors mitigating against good performance from commercial poultry in developing countries typically include: high temperatures; sub-optimal nutrition; increased disease challenge; sub-optimal housing and management conditions. All genotypes are affected by these factors. Alongside efforts to improve the physical environment, possible genetic approaches include: selection in commercial genotypes for improved tolerance to prevailing conditions; cross-breeding between commercial and indigenous genotypes; introgression of genes from commercial genotypes, via backcrossing or cockerel exchange programmes; selection for improved performance in indigenous genotypes.

Hence, maintaining commercial layer performance in hot, humid climatic conditions in the future will require improved cooling capability, continued advances in nutritional formulation, and the need for genetic advancement which includes selection for heat tolerance or the identification of genetic traits which enhance heat tolerance. However, further research is required to quantify the genetic antagonism between adaptation and production traits to evaluate the potential selection response. With the development of molecular biotechnologies, new opportunities are available to characterize gene expression and identify key cellular responses to heat stress. This review showed that a variety of interventions can be used to minimize heat stress and improve the productive performance of commercial layers in sub-optimal conditions, however, management interventions are not appropriate if nutrition, disease control or breeding factors limiting layers performance are not optimal.

**List of References**


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