source of income and employment to people compared to other domestic animals (Ayo-Enwerem *et al*., 2017b). Poultry convert feed to egg and meat within a short period of time (Ahaotu *et al.*, 2019a).

Developing the poultry industry in Nigeria will be the fastest means of bridging the protein deficiency gap prevailing the country (Is-Haaq *et al.*, 2018). Whenever ambient temperature is high, chickens tend to have higher energy needs than when in thermo-neutral environments. Major losses result from a less efficient conversion of feed to meat; this also affects poultry health and productivity (Okonkwo and Ahaotu, 2019).

Poultry flocks are particularly endangered to climate change due to a range of thermal conditions which affects the animals' behavioural and physiological activities (Ayo-Enwerem *et al.*, 2017a). Hence, birds can only tolerate lowly temperature ranges to sustain the peak of their production for human consumption. The environmental conditions affecting the performance of chicken include temperature, relative humidity and light at a given time (Pragya *et al.*, 2014). Ambient temperatures significantly influence the survivability and performance of the poultry production (Ayo-Enwerem *et al.*, 2017b). Ahaotu *et al.*, (2019b) stated that as the ambient temperature increased to 34^{o}C, the mortality due to heat will be higher in broilers by 8.4%. As the feed consumption of the chickens decreases from 108.3g/bird/day at 31.6^{o}C to 68.9g/bird/day at 37.9^{o}C, the egg production will be reduced by 6.4% (Okonkwo and Ahaotu, 2019).

Understanding and controlling environmental conditions is crucial to successful poultry production and welfare. The purpose of this article is to review some of the effects of heat stress on poultry and to look at methods that can be used by the poultry producers to partially alleviate some of the detrimental effects of seasonal fluctuations on the poultry productivity.

Thermoregulatory Mechanism of Poultry Birds

The internal body temperature of domesticated gallinaceous birds (chickens) at 106°F to 108°F is measurably higher than that of mammalian livestock and humans (97°F to 102°F) (Ahaotu *et al.*, 2019c).

Methods of Heat Loss in Poultry

During the dry season, when daily temperatures reach at their extremes, it affects poultry production drastically. Poultry do not sweat and therefore must dissipate heat in other ways to maintain their body temperature at approximately 105°F. Body heat is dissipated to the surrounding environment through radiation, conduction, convection and evaporation (Ahaotu and Agunnanne, 2017). The proportions of heat lost due to seasonal fluctuations depend upon the temperature difference between the bird and its environment (Mack *et al*., 2013).

The purpose of poultry house ventilation is to maintain a high or low air velocity in the house so that the birds can maintain body temperature by sensible heat loss. Once the environmental temperature reaches approximately 77°F, the method of heat loss begins shifting from sensible to evaporative heat loss (Fig 1).

Fig.1. Changes in present hen/day production with age of laying birds

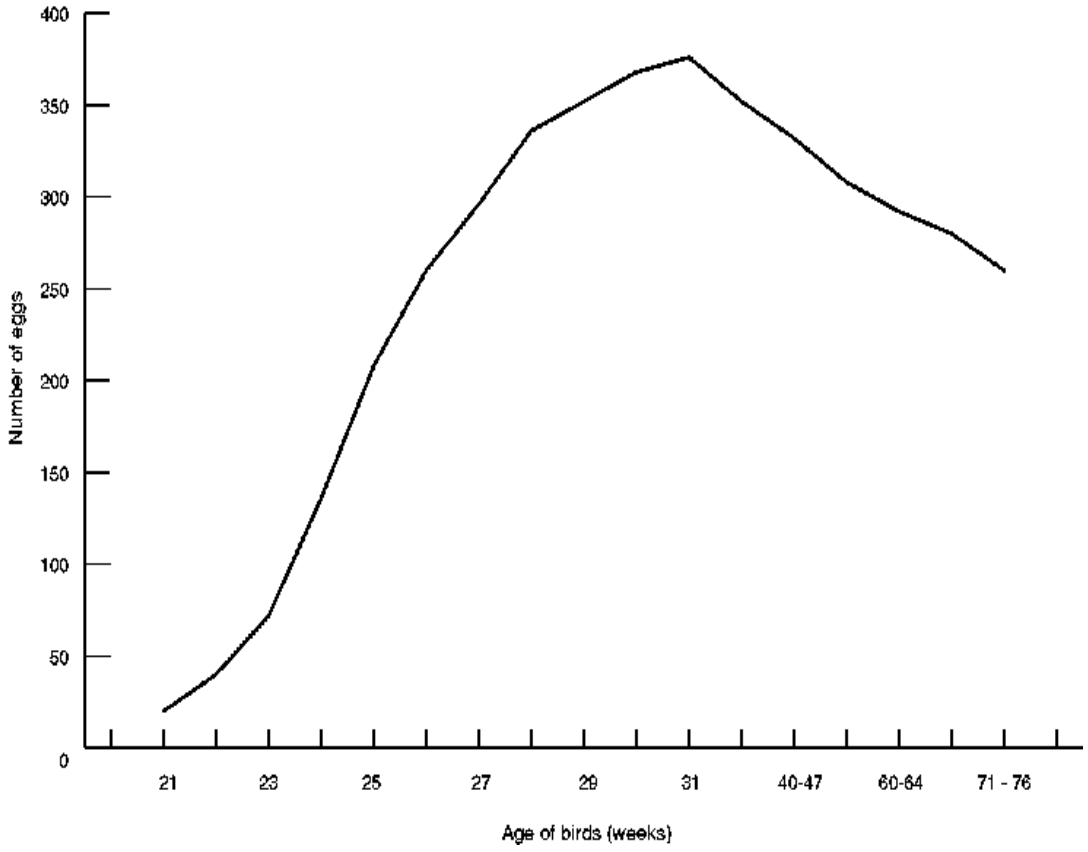
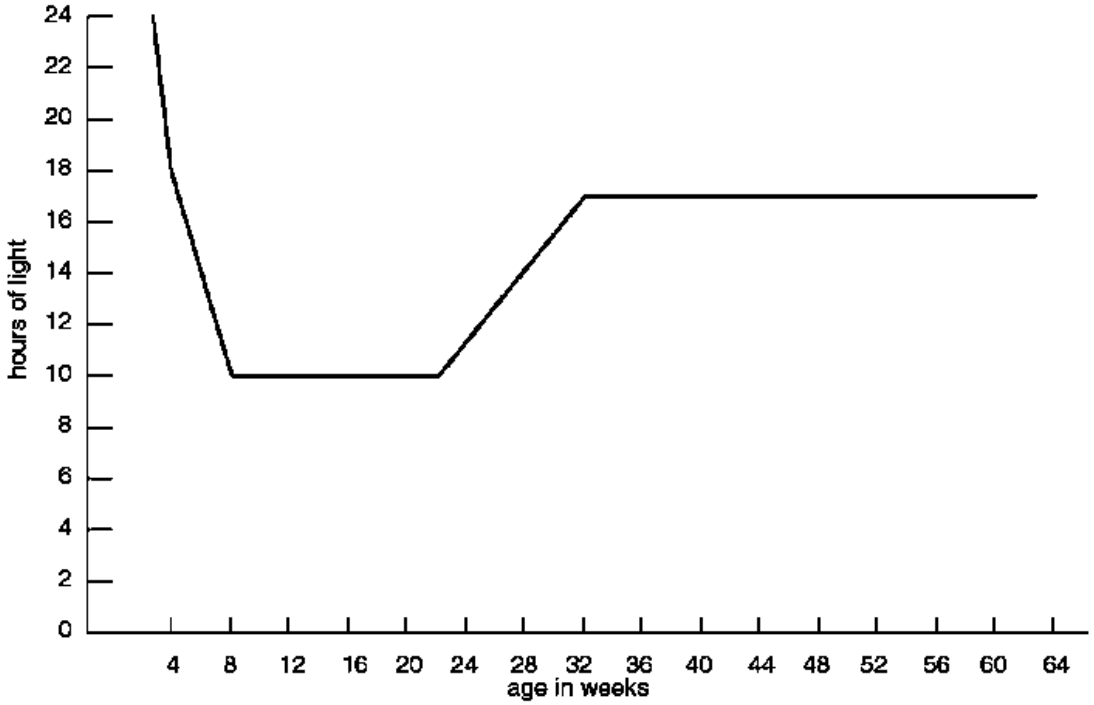


Fig 2: Lighting Schedules



Lighting schedule. Egg production is stimulated by daylight; therefore, as the days grow longer production increases. In open houses, found commonly in the tropics, artificial lighting may be used to increase the laying period. When darkness falls artificial lighting can be introduced for two to three hours, which may increase egg production by 20 to 30 percent. In closed houses, where layers are not exposed to natural light, the length of the artificial day should be increased either in one step or in a number of steps until the artificial day reaches 16 to 17 hours, which will ensure constant and maximized egg production. Effective day length should never decrease during the laying period (Ahaotu and Agunnanne, 2017).

Seasonal Fluctuations

Seasonal Fluctuations is a worldwide problem in poultry production, especially in broiler and layer lines. Seasonal fluctuations begin when the ambient temperature climbs above 80^{o}F and is readily apparent above 85^{o}F (Adesiji *et al.*, 2013). When a bird begins to pant, physiological changes started within its body to dissipate excess heat.

High ambient temperatures can be devastating to commercial broilers; coupled with high humidity they can have an even more harmful effect. Seasonal Fluctuations interferes with the broilers comfort and suppresses productive efficiency, growth rate, feed conversion and live weight gain (Okonkwo and Ahaotu, 2019). In poultry production, seasonal fluctuations can be described as acute or chronic. Acute heat stress refers to short and sudden periods of extremely high temperature, whereas chronic heat stress refers to extended periods of elevated temperature.

Chronic stress also has deleterious effects on birds reared in open-sided houses mainly through reducing feed consumption and increasing water consumption. Most of the reduction in feed consumption will be due to reduced maintenance requirement. In broilers, growth rates, feed efficiency and carcass quality are negatively affected (Odey *et al.,* 2019).

In breeders, high ambient temperature coupled with high humidity decreases fertility resulting in low hatchability. Seasonal fluctuations period has a negative effect on gamete formation and the fertilization process.

Clinical Signs and Symptoms of Seasonal Fluctuations

Poultry subjected to high environmental temperatures exhibit many behavioural and physiological changes which allow them to re-establish heat balance with their surroundings. As ambient temperature increases, chicken spend less time in feeding, more time in drinking and panting (Mack *et al*., 2013). Usually, their wings are spread away from the body to promote cooling by reducing body insulation and they splash water on their combs and wattles in order to increase evaporative cooling from these surfaces (Ahaotu and Agunnanne, 2017).

Effect of Seasonal fluctuations on Poultry Production System

Birds exposed to high environmental temperature generate behavioral, physiological and immunological responses which causes more harm to their performance and productivity. Hot climate can have a severe impact on poultry performance thus resulting to heavy economic losses on poultry production as a result of stunted growth (Ahaotu *et al*., 2017), decrease in hen-day production (Ononiwu *et al*., 2017), higher cost of production, higher mortality due to depressed immunity and reproductive failure (Nkwocha *et al*., 2018).

Growth and Production Efficiency

Seasonal fluctuations depress growth rate and production as a result of a down-turn in voluntary feed intake in birds (Sohail *et al*., 2012). It is apparent that the inhibition of growth and production in heat-stressed broiler birds is mediated via the stress hormones, especially the corticosteroids.

Seasonal fluctuations further results to decreased feed consumption and increased water consumption. As temperature rises, the bird has to maintain the balance between heat production and heat loss and thereby reducing its feed consumption. to reduce heat from metabolism. Imik *et al*., (2012) in their study showed that impaired growth performance in broilers is subjected to seasonal fluctuations**.**

Egg Quality

Seasonal fluctuations limits the productivity of laying hens, as reflected by egg production and egg quality, as the bird diverts feed metabolic energy to maintain its body temperature constant, resulting in lower egg production, and particularly in lower egg quality (Okonkwo and Ahaotu, 2019). Under high environmental temperatures, layer respiratory rate increases from eases from approximately 29 cycles per minute (mild environmental temperatures) to more than 100 cycles per minute (environmental temperatures above the thermo neutral zone). The resulting hyperventilation decreases Carbondioxide blood levels, which may decrease eggshell thickness in approximately 12% (Ahaotu and Agunnanne, 2017). Carbondioxide is responsible for eggshell quality improvement, as it may promote acidosis, which is subsequently compensated by kidney uptake of bicarbonate. Therefore, seasonal fluctuations causes losses in egg weight, egg shell percentage, egg shell weight, and egg specific gravity (Onyekwere *et al.,* 2016).

Meat Quality

Seasonal fluctuations could affect meat quality by either direct effect on organ and muscle metabolism during heat exposure which can persist after slaughter. For example seasonal fluctuations can increase the risks of pale-soft-exudative meat in turkeys, heat shortening in broilers and dehydration in most species. Also changes in poultry management practices in response to hazards that stem from seasonal fluctuations could indirectly lead to changes in meat quality (Uzoma *et al*., 2019).

Pre-conditioning broilers to seasonal fluctuations to encourage better survival during transport could lead to more variable breast meat pH. The impacts that short term seasonal fluctuations could have will vary between regions (Dai *et al*., 2012). It has been reported that chronic heat exposure negatively affects fat deposition and meat quality in broilers, in a breed-dependent manner (Uzoma *et al*., 2019). In fact, recent studies demonstrated that heat stress is associated with depression of meat chemical composition and quality in broilers (Zhang *et al*., 2012).

Reproductive Performance

Seasonal fluctuations caused decreased production performance, as well as reduced eggshell thickness, and increased egg breakage (Ebeid *et al*., 2012). Additionally, seasonal fluctuations has been shown to cause a significant reduction of egg weight (3.24%), egg shell thickness (1.2%), eggshell weight (9.93%), and eggshell percent (0.66%) (Uzoma *et al*., 2019).

Seasonal fluctuations affect all phases of semen production in breeder cocks (Ahaotu *et al*., 2018). Although limited high temperature stimulates testicular growth in the early phase and promotes increased semen volume and concentration, a subsequent rise suppresses reproductive capacity as a result of a decrease in seminiferous epithelial cell differentiation, which is manifested in decreased semen quality and quantity with time (Onyekwere *et al.*, 2017). Ahaotu *et al*. (2016) showed that the fertility of broiler male declined to 42% exposed to a temperature of 32°C.

Embryonic Development

The incidence of adverse effects of seasonal fluctuations on embryonic growth has been reported by various workers. Uzoma *et al.*, (2019) showed that over-heating fertile eggs during incubation resulted in differential tissue growth at different stages of incubation. The finding further showed asymmetries in skeletal development during the early and late stages of embryo development.

Immunity

In poultry, several studies have investigated the effects of seasonal fluctuations on the immune response in recent years. In general, all studies showed an immunosuppressing effect of seasonal fluctuations on broilers and laying hens. Lower relative weights of thymus and spleen has been found in laying hens

subjected to seasonal fluctuations also reduced lymphoid organ weights and reduced liver weights have also been reported in broilers under seasonal fluctuations conditions (Ghazi *et al*., 2012).

Disease Incidence

Uzoma *et al*. (2019) reported that seasonal fluctuations will alter global disease distribution. High temperature has tremendous effect on prevalence of zoonotic diseases as well. Seasonal fluctuations may also increase the insect vectors, prolong transmission cycles, increase the importation of vectors and animal reservoirs. It may also have an adverse effect on biodiversity, distribution and migratory pattern of birds which may lead to emergence of disease outbreaks.

Seasonal fluctuations could also alter bird migration, influence the avian influenza virus transmission cycle and directly affect virus survival outside the host. In domestic poultry, the direct effect of environmental factors on highly pathogenic avian influenza transmission and persistence allows inference to have possible effect of seasonal fluctuations.

Seasonal fluctuations alters global disease distribution, affects poultry feed intake, encourage outbreak of diseases which invariably affects poultry output (egg and meat) and also cost of production (Uzoma *et al.*, 2019).

Conclusion

Effects of seasonal fluctuations which results in increased in sunshine intensity and global warming has a negative effects on poultry production which many at times results to high mortality rate of the chickens, low egg and meat production and prices of feed grains are usually high in hot and dry seasons as result of effects of seasonal fluctuations which may affect cost of production and number of birds to raise for egg and meat production in the farm.

Egg and meat production pattern are affected by seasonal fluctuations because periods of high temperature and sunshine intensity makes the birds to drink more water and reduce feed intake which many at times results to high mortality of the chickens, low egg production and low feed conversion ability of the birds to meat, hence, low meat production.

The review also revealed that seasonal fluctuations influence the emergence of new poultry diseases and increased its distribution. There is need to intensify awareness campaign to poultry farmers on how to reduce the effects of seasonal fluctuations on poultry production. Extension agents and other development

agencies need to educate the poultry farmers more about the effects posed by seasonal fluctuations on poultry production.

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