

RESEARCH ARTICLE

Engineering of the Battery Cage for Poultry Production

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ABSTRACT

The world population is on the increase even with a declining growth rate. The need for food will continue to be at high demand rate. A battery cage is a confining accommodative structure designed to conventionally house primarily female chickens that are producing eggs specifically for their remaining years. Battery Cage Layouts and Dimensions were outlined for production of Two-way battery cage system for layers and Two-way battery cage system for multipurpose. The wire mesh was used to form two by two (2 x 2) compartment (tier) and two (2) feet by two (2) feet standard sizes, coupled together with binding wires. Prior plumbing, the PVC Pipes were used to build a suspend able feed and water troughs. The square meshed cages were mounted on their stands. The battery cages produced were completed with good standard and are usable in poultry production of layers and other birds.

Keywords: Battery Cage; Poultry Production; PVC Pipes; Farm Power; Poultry Systems

Introduction

A battery cage is a confining accommodative structure designed to conventionally house primarily female chickens that are producing eggs specifically for their remaining years (about two years). They are explainable in different ways relative to caging system. Wikipedia (2023) explained that battery cages are a housing system used for various animal production methods but primarily for egg - laying hens. They can be used for other poultry farming purposes like meat production and pet housing. Battery cages are also used outside poultry. Battery cages are also used for mink, rabbit, chinchilla and fox inn fur farming; and most recently for the Asian palm civet for Kopiluwak production of coffee (Wikipedia, 2023).

A battery cage (especially for laying hen) has its feeding unit, drinking water unit, automated or manual egg collection unit, lighting unit, waste treatment unit,

environmental control management unit (temperature and humidity control to standardize chicken body conditions, etc.). These units enable easy running routine both privately and industrially. Cage farming saves feed and space. It reduces spread of diseases and infection. They reduce cannibalism and aggression effects among birds. The light or daylight hours can be altered to artificially induce the chickens to speed up production of egg. This is because chickens need 16 hours of this daylight made available in battery cage facilities for continuous laying. As of 2014, approximately 95 percent of eggs in the United States were produced in battery cages (Green and Cowen, 2014). In the United Kingdom, statistics from the department for environment, food and rural affairs (DEFRA) indicate that 50% of eggs produced in the UK throughout 2010 were from cages (45% from free – range, 5% from barns) (Wikipedia, 2023). In Nigeria, rates of poultry production for eggs and meat are over 80%.

The world population is on the increase even with a declining growth rate (Egharevba, 2009; Okolotu and Oluka, 2021). The need for meat and eggs consumption will continually increase. These rates for northern, Eastern, Central and Southern Nigeria are presented below;

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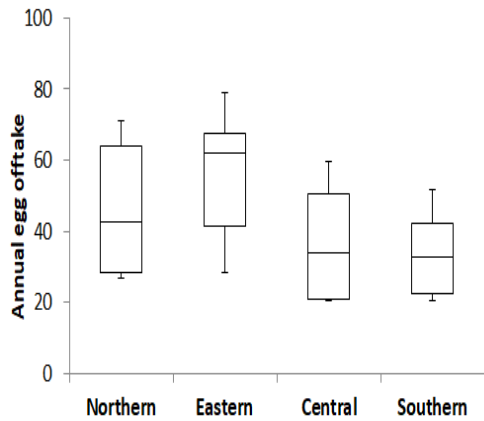


Figure 1: Median annual egg production rates (egg sold or consumed) (CSIRO, 2024).

The range of consumed eggs sold range up to 33 to 62 eggs per year. Though consumption is influenced by seasonal events (religious event like Christmas, Easter, etc.). For meat production, the consumption in relative to the production range from 3 to 7 birds per year.

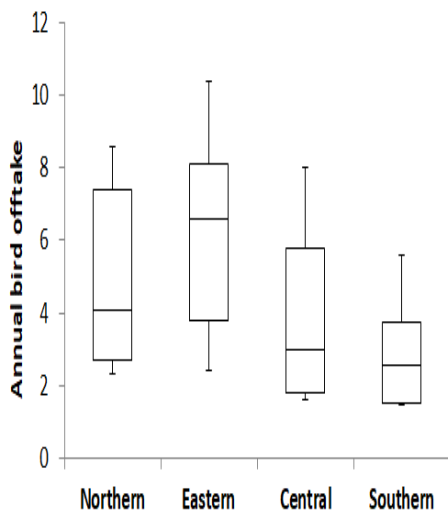


Figure 2: Median annual bird production rates (birds sold or consumed) (CSIRO, 2024).

Battery cages are classified in many ways. Based on the number of birds in a cage, it is classified as single or individual bird cage (only one bird in a cage), multiple bird cage (from 2 to 10 birds, usually 3 or 4 birds per cage), colony cages (holding birds more than 11 per cage), and based on number of rows (single deck, double deck, triple deck, four deck, and flat deck) (TNAU, 2023). Generally, battery cage types are classified based on number of rows as presented below;

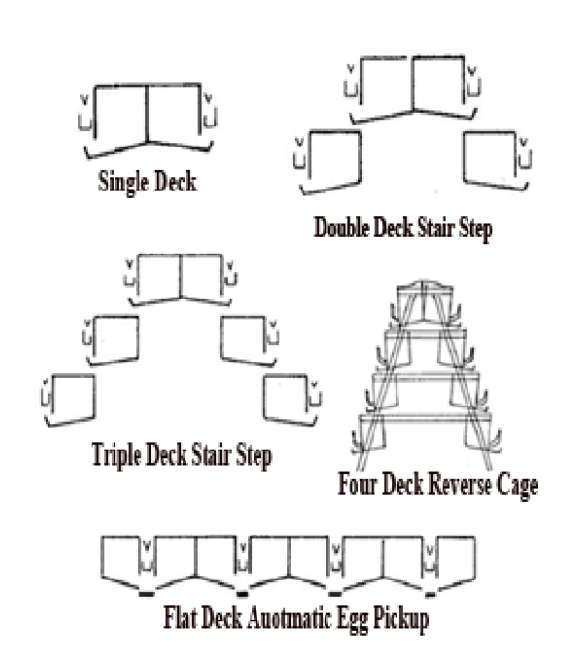


Figure 3: Battery Cages (TNAU, 2023)

Poultry: The term “poultry” covers a wide range of birds, from indigenous and commercial breeds of chickens to Muscovy ducks, turkeys, guinea fowl, geese, quail, pigeons, ostriches and pheasants (FAO, 2024). Among the breeds, chicken is the most widely spread poultry produce both locally and globally. Domestic chickens appeared more than 8000 years ago in Southeast Asia and were introduced to the rest of the world by sailors and traders; In 2020, the global chicken population was over 33 billion birds, providing 93% of the world egg production; 90 percent of world poultry meat production, followed by turkey with 5 percent, ducks with 4 percent and geese and guinea fowl with 2 percent (FAO, 2024).

Brazil, the United States, the European Union, and Thailand emerged as the major poultry exporters (Miller *et al.* 2022). Most African countries remain the major importers of these poultry products which can be evidently seen through the high imports of the frozen chickens and other frozen bird in many African countries despite the huge interest in the local manufacturing of these products. Brazil is the world’s leading poultry exporter and is projected to remain in the top position through 2031 (Miller *et al.* 2022). While other stated countries above are rated according to their exporting capacities respectively. Sub – Saharan African is projected to remain the top global importer of poultry at 2.54 million metric tons annually by the year 2031 (Miller *et al.* 2022). Nigeria being located in western part of African with huge percentage of poultry market availability makes venture of battery cage production a ready market in this sub – Saharan region. In 2020, chickens accounted for some 94 percent of the world’s poultry population followed by ducks (3 percent), and turkeys (1 percent) (FAO, 2024). USDA’s 10 year Agricultural “Baseline projections, based on the release of the October 2021 World Agricultural Supply and Demand Estimates (WASDE), indicate that by 2031 total meat imports will increase to 467 million metric tons (Miller *et al.* 2022). Poultry population percentage by agricultural zones is presented below;

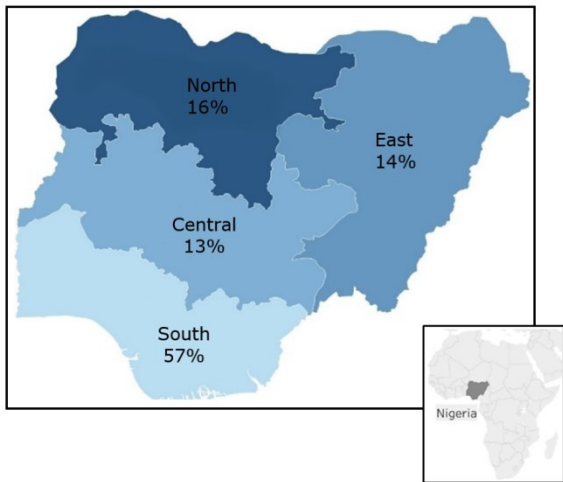


Figure 4: Total poultry population by agricultural zone (data from 2016 – 2017 livestock census) (CSIRO, 2024). Also, chicken types are presented below;



Figure 5: Chicken types (TNAU, 2024)

Farm Power: Farm power is the ability provided by various sources to carry out farm work. These sources include; Human power: This is known as manual labour. It is used for operating small implements and tools, stationary work like lifting, watering, chaff cutting, threshing, winnowing, etc. Mechanical power: This is known as the machine power. It includes; stationary oil engines, tractors, power tillers, self-propelled combines, etc. Animal Power: This involves use of animals in providing power for agriculture. They are used for crop threshing, transport, land preparations, weed management, etc. Examples include; buffalo, oxen, bullocks, horses, donkeys, camels, mules, etc. Electrical power: These are known as power from electrical motors in the farm. They are used for pumping water, cold storage, farm product processing, diary industry, fruit industry, etc. Renewable energy power: These are power from energy sources like solar, wind, biogas energy, etc. They are used for cooking, lighting, water heating, space heating, food processing, pumping water, electric generator, water distillation, etc.

Instrumentation: Instrumentation refers to the calibration of equipment and instruments through scientific and engineering methods (Okolotu *et al.*, 2018). Instrumentation has been used in the making of mechanical power equipment usable in agricultural sector. Agricultural engineers have deployed this mechanism towards increasing output in agricultural fields. This is otherwise known as agro technology instrumentation (Okolotu *et al.*, 2018).

Poultry Systems: Poultry production systems are basically of three types: Slatted floor system (chickens are housed in shed or barn in a slatted floor, allowing manure falling to a collection unit), deep litter system (chickens are housed in a shed or barn with deep bedding of organic materials like sawdust or straw), and battery cage system (chickens are housed in wire cages). These are presented below;



Figure 6: Slatted floor system (i), deep litter system (ii), and battery cage system (iii) (FAMTECH, 2023)

Materials

Farm power laboratory (Department of Agricultural engineering, Delta State University of Science and Technology), Wire Mesh, Angle bar (for tripod stand), hand drill, Four inch (4'') PVC Pipe (for feeding trough), Three inch (3'') PVC Pipe (for water trough), Four inch (4'') and three inch (3'') pipe Caps, four inch (4'') pipe Caps, PVC gum, Set of pinchers, Binding wires, Bolt and nuts, hand gloves, cutters, pliers, quarter rods, etc.

Methods

The wire mesh was cut into sizes of two by two (2 x 2) tier (compartment) and two (2) feet by two (2) feet standard sizes and was coupled together with binding wires. The PVC Pipes was cut into desired shapes (one third) to accommodate feed and water troughs. With the aid of bolts and nuts the engineered square meshed cage was mounted on the stand. Each side of the feeding trough was covered with the aid of the PVC gum. The angle bar was cut to a length of 6 feet to hold the cage at waist level to create reinforcement and standing. Holes were bored at desired points on the angle bar with the aids of bolt and nut, to hold the stands and also serve as reinforcement for the cage. The quarter rods were used to form hangers for the troughs and door rollers.

The Battery Cage Layouts And Dimensions: The battery cage layout and dimensions are presented in figure six (6) to nine (9) below:

i. Two-way Battery Cage Layout For Layers: The layouts with dimensions are presented below;

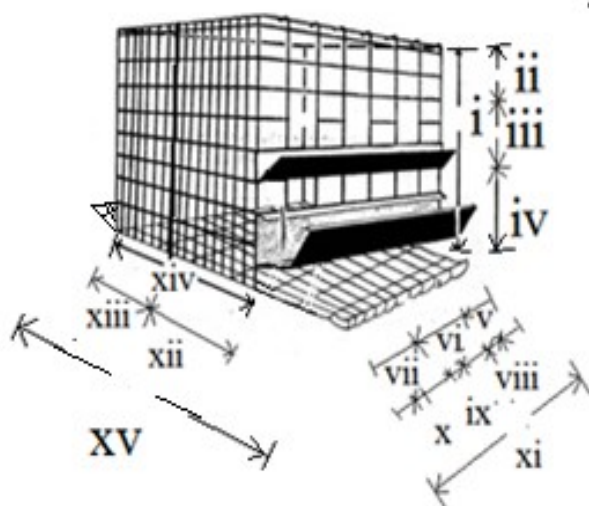


Figure 7: Two (2) way battery cage layout and dimensioning for layers

Where:

i = 1.7m, ii = 0.35m, iii = 1m, iv = 0.35m, v = 2m, vi = 2m, vii = 2m, viii = 1m, ix = 1m, x = 1m, xi = 6m, xii = 1.7m, xiii = 1.7m, xiv = 3.4m, xv = 4.8m.

ii. Two-way Battery Cage Layouts: Two (2) way battery cage layout and dimensioning for general purpose is presented below;

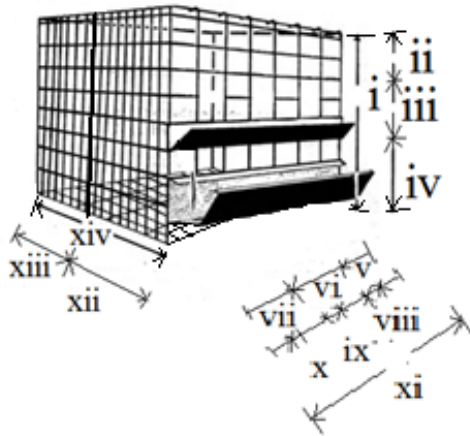


Figure 8: Two (2) way battery cage layout and dimensioning for general birds.

Where:

i = 2m, ii = 0.5m, iii = 1m, iv = 0.5, v = 2m, vi = 2m, vii = 2m, viii = 1m, ix = 1m, x = 1m, xi = 6m, xii = 2m, xiii = 2m, xiv = 4m.

iii. Feeding And Drinking Troughs Layout: Feeding and Drinking Troughs dimensioning and layout for the feeding and drinking system are constructed similarly. One third of the diameter is being cut off to form an opening. These are illustrated below;

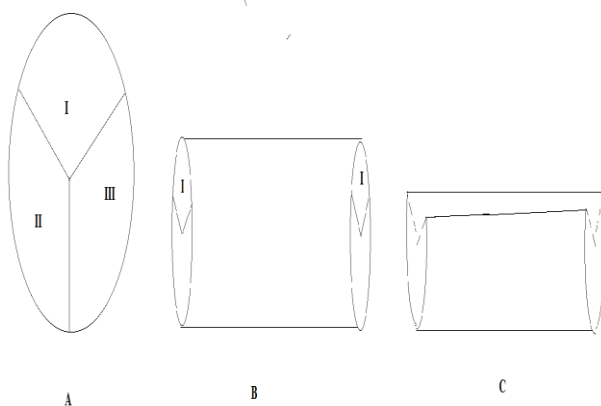


Figure 9: PVC Pipe layout for construction of feeding and drinking systems

iv. Stand Layout: The layout for angle bar stand is presented below;

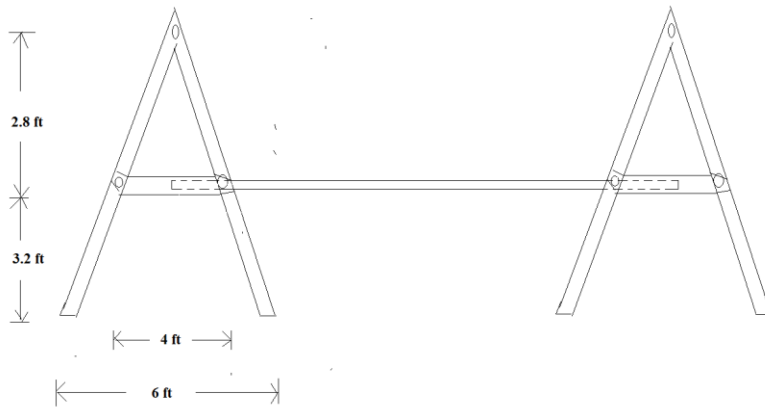


Figure 10: Layout for angle bar stand

IV. RESULTS

The result of the designed and produced two (2) way battery cages both for layers and general birds are presented below;

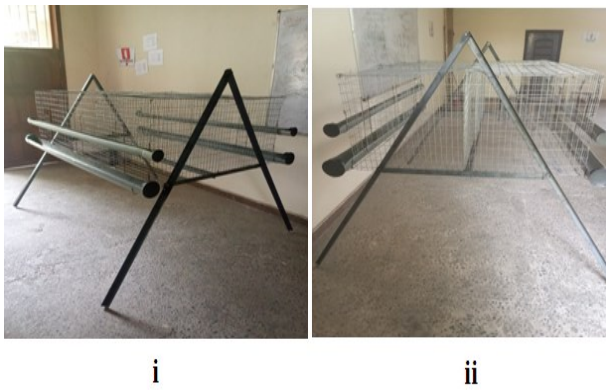


Figure 11: Side view of designed and built two (2) ways battery cage with three compartments (tiers) for general birds



Figure 12: Front view of designed and built two (2) ways battery cage with three compartments (tiers) for general birds



Figure 13: result of two-ways battery cage with three compartments (tiers) for layers.



Figure 14: Side view of two-way battery cage for layers showing the feeding, drinking and automated egg collection unit



Figure 15: Front view of two-way battery cage for layers

Discussions

The cross sectioned reinforcement (below the cage) helps in standing (Connects the two standing feet made of angle bars) and also in holding the cage compartments.

The battery cages produced in this research was fastened using the binding wire to minimize cost instead of the use of welding which would have been more expensive. However the binding wire produced acceptable agility and firmness.

Conclusion

The battery cages engineered were completed with good standard and can be used in poultry production of layers and other birds.

References

- CSIRO. (2024). Poultry production in Nigeria. Commonwealth Scientific and Industrial Research Organisation (CSIRO). <https://research.csiro.au/livegaps/findings/livestock-production/poultry-production-in-nigeria/>
- Egharevba, N. A. (2009). Irrigation and drainage engineering principles, design, and practices. Jos University Press.
- FAMTECH. (2023). Three ways of chicken farming: Battery cage system, slatted floor system, deep litter system. FAMTECH International. <http://www.chickenscage.com/news/three-ways-of-chicken-farming-battery-cage-system-slatted-floor-system-deep-litter-system.html>
- FAO. (2024). Gateway to poultry production and products. Food and Agriculture Organization of the United Nations. <http://www.fao.org/poultry-production-products/production/poultry-species/en>
- Green, J. L., & Cowen, T. (2014). Table egg production and hen welfare: Agreement and legislative proposals (CRS Report No. 42534). Archived and retrieved in 2017.
- Miller, M., Gerval, A., Hansen, J., & Grossen, G. (2022). Poultry expected to continue leading global meat import as demand rises. US Department of Agriculture (USDA) Economic Research Service. <https://www.ers.usda.gov/amber-waves/2022/august/poultry-expected-to-continue-leading-global-meat-imports-as-demand-rises/#>
- Okolotu, G. I., & Oluka, S. I. (2021). Shore reclamation for agricultural use, a combat to shoreline erosion. *Advance Journal of Science, Engineering and Technology*, 6(05), 14.
- Okolotu, G. I., Oluka, S. I., & Eje, B. E. (2018). Instrumentation of the rain gauge for rainfall measurement. *American Journal of Engineering Research*, 7(10), 1. <http://www.ajer.org>
- TNAU. (2023). Poultry house construction. Tamil Nadu Agricultural University Agritech Portal. http://www.agritech.tnau.ac.in/expert_system
- TNAU. (2024). Chicken breeds. Tamil Nadu Agricultural University Agritech Portal. Animal Husbandry. http://www.agritech.tnau.ac.in/animal_husbandry/ani_chik_breeds%20of%20chicken.html
- Wikipedia. (2023). Battery cage. https://en.wikipedia.org/wiki/Battery_cage