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Review Article

Snail farming in Nigeria: Tapping into the economic potential of heliculture. A review

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ABSTRACT: Heliculture, the practice of rearing snails for human consumption, commercialization, and industrial applications, is an emerging agribusiness with significant potential to contribute to food security, employment, income generation, and sustainable development in Nigeria. Despite its nutritional, medicinal, and economic benefits, snail farming remains underexploited compared to conventional livestock systems in Nigeria. This review explores the current status of heliciculture in Nigeria, examining its biological, economic, and socio-cultural dimensions. This article highlights the importance and prospects of snail farming in Nigeria, including agricultural transformation, industrial transformation, pharmaceutical transformation, and economic transformation. The paper also addresses key challenges facing the sector, such as temperature and climate, predators and pests, soil quality, disease management, reproduction challenges, and lack of capital. To fully harness the economic potential of snail farming in Nigeria, there is an urgent need for targeted research and development, supportive policy frameworks, capacity building, and enhanced value chain integration. The review concludes by advocating for the integration of heliciculture into formal educational curricula in Nigeria is also recommended to foster early awareness and promote future innovations in the sector. These interventions are critical for optimizing production efficiency, ensuring industry competitiveness, and positioning snail farming as a significant contributor to agricultural diversification and economic development in Nigeria.

Keywords: Agricultural diversification, food security, heliciculture, Nigeria, snail farming, sustainable livelihoods.

INTRODUCTION

Heliculture, or snail farming, involves the domestication of snails in controlled environments that closely replicate their natural habitats (Munywoki, 2022). Despite its notable profitability, snail farming remains underutilised within the agro-industry, primarily due to limited awareness of its economic value (Munywoki, 2022). In countries like Nigeria, the Republic of Benin, and other parts of West Africa, snail farming presents not only a promising business opportunity but also serves as an important source of high-quality animal protein, often regarded as a delicacy (Nnodim and Ekpo, 2019; Ibidapo *et al*., 2021).

Snails are invertebrates with bilateral symmetry and soft, segmented bodies enclosed in hard, calcareous shells (Etukudo and Okon, 2025). They belong to the phylum *Mollusca* and the class *Gastropoda* (Okon and Ibom, 2012; Etukudo, 2024). Several species of giant African land snails are distributed across the continent, including *Achatina achatina* in Ghana, *Archachatina marginata* in Nigeria, *Achatina fulica* in East Africa, and various *Limicolaria* species found in West African countries such as Guinea, Nigeria, Cameroon, and Gabon (Okon and Ibom, 2012; Etukudo, 2024). Among these, *Archachatina marginata*, particularly prevalent in the rainforest regions of Southern Nigeria, is especially valued for its commercial potential. This species can reach a mature weight of 500 to 800 grams, making it economically superior to other varieties (Ibidapo *et al*., 2021; Etukudo, 2024). As Uboh *et al*. (2014) highlight, *Archachatina marginata* plays a significant role in the diets of both rural and urban populations in Southern Nigeria, where it is widely consumed as both a delicacy and staple.

Despite increasing interest, much of the snail meat sold in Nigerian markets still originates from wild harvests by local inhabitants (Adewale and Belewu, 2022). The growing demand for snail meat, coupled with the diminishing availability of wild snails and the recognised benefits of heliculture, has fueled a renewed interest in domesticated snail farming as a sustainable agricultural venture (Adewale and Belewu, 2022). Snail farming entails raising snails in enclosed, controlled environments where essential resources such as food, water, and lime are provided to promote healthy growth (Etukudo, 2017). Upon reaching maturity, the snails are harvested, processed, and either consumed locally or sold. The seasonal nature of wild snail availability further underscores the need for organised, year-round farming operations at both small-scale and commercial levels (Etukudo, 2017).

According to Ikegwuonu (2013), snail farming is relatively simple to manage. Snails are seldom affected by various diseases, including parasitic, bacterial, and fungal infections, require minimal capital investment, and do not depend on commercial feed. Moreover, they reproduce prolifically; certain species can lay over 100 eggs per cycle, making them an efficient and profitable livestock option. However, successfully operating a snail farming enterprise for wealth creation demands the acquisition of key entrepreneurial skills (Nwarieji and Anene, 2013). These skills, defined as learned competencies that enable individuals to achieve goals efficiently, are vital for optimising resources, time, and energy (Nwarieji and Anene, 2013). As Nwarieji and Anene (2013) assert, entrepreneurial skills are the essential tools that empower individuals to initiate, manage, and scale a successful business.

While snail farming is gradually gaining global recognition, its growth in parts of Nigeria remains sluggish. Many farmers still depend on harvesting snails from the wild, a practice largely attributed to inadequate entrepreneurial competence (Odo, 2016). This challenge is compounded by environmental pressures, including deforestation, bush burning, and overharvesting, exacerbated by a growing population. These factors have led to a decline in wild snail populations, with many being collected before reaching maturity, thus threatening sustainability (Okon *et al*., 2012; Etukudo, 2017; Okon *et al*., 2017; Etukudo and Okon, 2025).

Although some individuals have begun domestication and small-scale breeding, large-scale adoption remains limited. Many youths continue to rely on traditional snail hunting, overlooking the substantial benefits of commercial snail production. This persists despite a consistently high market demand for snail meat, even in the face of widespread poverty and unemployment (Onah *et al*., 2021).

Given this context, this review aims to shed light on the vast potential of snail farming as a sustainable and lucrative business model in Nigeria. It offers valuable insights for aspiring entrepreneurs, policymakers, and stakeholders seeking to promote commercial heliculture as a viable avenue for economic empowerment and food security.

METHODOLOGY

A methodology based on the 'best fit' framework, as described by Belluco *et al*. (2018) and Carroll *et al*. (2013), was employed to assess the current state of research on the promise of snail farming as a sustainable business model for Nigerians over the past decade. This approach utilised an interactive, step-by-step, and full-text coding process that enabled the identification of key themes to characterise the present state of snail farming in the field of micro-livestock.

An initial literature review was conducted using two major scientific databases; Web of Science Core Collection and PubMed, by applying variety of keywords and search terms, including: “Gastropods,” OR “molluscs,” OR “snails”, OR “snail farming”, OR “land snails”, OR “heliculture”, AND “snail production”, OR “economic potential of snail farming”. This search targeted review articles published in English between 2010 and 2023. A total of 25 reviews met the inclusion criteria and were grouped into related subject areas to form a preliminary framework.

A second round of literature searching was performed, using an expanded search string based on the categories identified in the initial framework. Eligible studies were those published in English within the last 13 years. Out of 202 papers retrieved, 150 were selected for full-text analysis after screening titles and abstracts using the Rayyan tool (Ouzzani *et al*., 2016).

Notably, research focused on freshwater snail farming was excluded, as the production, farming and feed characteristics for aquatic species differ significantly from those of land snails.

SNAILS FARMING IN NIGERIA: SPECIES, MARKET DEMAND, AND ECONOMIC OPPORTUNITIES

Only edible land snails should be selected for farming and business purposes. Some types of land snails harbour parasites that can cause diseases in humans. Many species of edible land snails are recognised in Nigeria. Among these, the giant African land snails are the most popular and economically important. These include *Archachatina marginata* (Figure 1), *Achatina achatina*

Figure 1. *Archachatina marginata* (Okon and Ibom, 2012; Etukudo, 2017).

Figure 2. *Achatina achatina.* (Okon and Ibom, 2012; Etukudo, 2017).

(Figure 2), *Achatina fulica* (Figure 3), and *Limicolaria* species (Figure 4) (Okon and Ibom, 2012; Etukudo, 2017).

Archachatina marginata

These species of giant African land snails (Figure 1) are typically found in regions where it is warm throughout the year (Etukudo, 2017). Under proper feeding and watering conditions, the snails can reach full size within 24 months. They lay between 5 and 30 eggs, four to eight times per breeding season. The main breeding season falls between May and October (the rainy season); however, with adequate water, food, and lime, reproduction can occur year-round (Okon and Ibom, 2012).

Their shells are characterised by a brown to pale brown colour with vertical streaks, zigzag lines, or blotches (Etukudo and Okon, 2025). Additionally, the shells feature a wide, bulbous, or dome-shaped apex. Aluko and Adisa (2014) observed that *Archachatina marginata* possesses a broad and wide apex. Similarly, Aluko *et al*. (2017) reported that the shell shapes of *A. marginata marginata*, *A. marginata suturalis*, and *A. marginata ovum* are consistently sinistral (100%).

Okon and Ibom (2012) observed that the body shell lengths of *Archachatina marginata* ranged from 8.70 to 11.60 mm at 2 days of age, 43.20 to 52.40 mm at 5 months, and 76.50 to 104.60 mm at 14 months. The same authors also reported shell widths ranging from 0.55 to 0.64 mm, while shell aperture lengths ranged from 0.54 to 0.69 mm at 14 months of age.

Etukudo *et al*. (2017) recorded morphological measurements of mature *A. marginata* snails collected from Osun, Ondo, and Oyo States in Nigeria. These included body shell lengths (14.43 cm, 16.07 cm, and 15.97 cm), body shell widths (8.07 cm, 8.63 cm, and 8.83 cm), mouth shell lengths (8.97 cm, 9.00 cm, and 8.87 cm), and mouth shell widths (5.50 cm, 5.47 cm, and 5.70 cm), respectively. These findings align with previous reports by Okon and Ibom (2012) and Etukudo (2017), which identified *A. marginata* as the largest known land snail species in Nigeria.

Qualitative characterisation of *A. marginata* varieties, including *A. marginata marginata* (Amm), *A. marginata suturalis* (Ams), and *A. marginata ovum* (Amo), in the derived savannah zone of Ogun State was conducted by Aluko *et al*. (2017). They found that these three varieties possess between 4 and 6 whorls. Etukudo *et al*. (2018;

2024a) recorded body weights for *A. marginata* based on the number of whorls: 1.210 g (2 whorls), 4.238 g (3 whorls), 96.410 g (4 whorls), and 124.141 g (5 whorls). Higher mean body weights of 6.9812 g and 10.2962 g were observed for black-skinned and white-skinned ecotypes with 2 whorls, respectively (Etukudo *et al*., 2024a). Similarly, the body weight of adult black-skinned *A. marginata* has been reported to range from 4.24 g to 7.93 g for a sample of 50 snails (Ibom, 2009; Okon and Ibom, 2012; Etukudo, 2017; Etukudo *et al*., 2024a).

Achatina achatina

Achatina achatina (Figure 2) is native to West Africa, like *Archachatina marginata*, and is recognized for its commercial potential. These snails possess strong brown shells and, under optimal management conditions, can reach full maturity within two years. Notably, *A. achatina* exhibits high reproductive capacity, laying between 100 and 300 eggs once or twice per growing season, making it particularly advantageous for large-scale farming due to its prolific breeding rate (Etukudo, 2017).

Achatina achatina, like *Archachatina marginata*, is indigenous to West Africa and is well-regarded for its commercial potential. It is characterised by a distinct V-shaped apex, an elevated, serrated bump located at the tail end of the shell. The shell is typically conical and more pointed than those of other snail species (Jummai and Okoli, 2013; Etukudo, 2017). One of the distinguishing features of *A. achatina* is its shell aperture (mouth), which is low-spired and globose in shape, with a vinaceous-red columella (Etukudo, 2017).

When fully grown, *A. achatina* can reach impressive dimensions. Okon and Ibom (2012) reported that mature individuals can attain shell heights of up to 20 cm and maximum diameters of 10 cm. The species also exhibits variable times to sexual maturity, depending on management conditions. According to various studies, maturity can occur between 5 to 12 months: 7–11 months (Okon and Ibom, 2012), 7–12 months under extensive or wild conditions, and as early as 5–6 months under intensive management (Okon and Ibom, 2012); 9–10 months (Okon and Ibom, 2012); 8–12 months (Okon and Ibom, 2012); 6.32–7.02 months (Okon and Ibom, 2012); and 7–10 months (Etukudo, 2017).

Etukudo *et al*. (2017) provided detailed morphometric data on *A. achatina* snails at maturity from Osun, Ondo, and Oyo states in Nigeria. Recorded shell dimensions included body shell lengths of 12.77 cm, 12.70 cm, and 13.13 cm; body shell widths of 6.67 cm, 6.87 cm, and 6.93 cm; mouth shell lengths of 6.90 cm, 7.13 cm, and 6.93 cm; and mouth shell widths of 4.70 cm, 4.47 cm, and 4.37 cm, respectively. Additionally, Okon *et al*. (2017) and Etukudo *et al*. (2024a) reported the following measurements for mature *A. achatina* shells: aperture length (4.763 cm), aperture width (1.732 cm), body shell length (9.258 cm), body shell width (4.063 cm), spiral length (1.979 cm), and spiral width (0.705 cm).

Body weight data further highlight the variability in growth across regions and developmental stages. According to Okon *et al*. (2017), *A. achatina* snails with four shell whorls had body weights ranging from 83.00 g to 180.50 g (average 156.90 g), while those with five whorls ranged from 132.70 g to 272.80 g (average 138.95 g). In an earlier study, Ibom *et al*. (2014) reported lower average body weights for snails across the central (120.90 g), northern (107.50 g), and southern (72.00 g) agro-ecological zones of Delta State. Similarly, Etim (2017) observed average weights of 127.20 g for snails with four whorls and 182.00 g for those with five whorls.

Achatina fulica

Achatina fulica (Figure 3) is indigenous to East Africa, particularly Kenya and Tanzania, but has since been introduced to other regions through food trade and the pet industry (Rowson *et al*., 2010). Among the three major African land snail species, *A. fulica* is the smallest, characterised by its elongated and enlarged body whorls (Jummai and Okoli, 2013; Okon *et al*., 2017; Etukudo *et al*., 2024b). When fully matured, *A. fulica* possesses a narrow, conical shell with seven to nine distinct whorls, approximately twice as long as it is wide (Okon *et al*., 2017). The shell's colouration varies with environmental conditions and diet, but is typically reddish-brown with yellow vertical stripes.

Adult *A. fulica* individuals can attain shell lengths of at least 20 cm and widths of about 7 cm. The species is also notable for its high fecundity, producing relatively large eggs that range in diameter from 4.5 cm to 5.5 cm. Optimal hatching occurs at a temperature of around 15°C (Okon *et al*., 2017; Etukudo *et al*., 2017; Etukudo *et al*., 2024b).

Morphologically, the shell aperture (mouth) of *A. fulica* is ovate-lunate to round-lunate, with a sharp, unreflected outer lip (Okon and Ibom, 2012). The mantle is dark brown with a rubbery texture, and the head bears two pairs of tentacles: a shorter lower pair and a longer upper pair with rounded eyes located at the tips.

The shell of *Achatina fulica* is broadly ovate and sub-globular, featuring a regular conical spine and a narrow apex (Figure 3). Its overall shape is narrow and conical, typically about twice as long as it is wide, and it contains 7 to 9 whorls at full maturity. Morphometric data recorded by Etukudo *et al*. (2017) for mature *A. fulica* specimens collected from Osun, Ondo, and Oyo States in Nigeria include body shell lengths of 8.17 cm, 7.93 cm, and 7.83 cm; body shell widths of 4.40 cm, 4.30 cm, and 4.73 cm; mouth shell lengths of 4.93 cm, 4.97 cm, and 4.83 cm; and mouth shell widths of 2.87 cm, 2.57 cm, and 2.73 cm, respectively. Etta *et al*. (2015) reported additional shell parameters for mature *A. fulica* as follows: body shell length (10.440 mm), body shell width (5.087 mm), aperture

Figure 3. *Achatina fulica.* (Okon and Ibom, 2012; Etukudo, 2017).

Figure 4. *Limicolaria flammea.* (Okon and Ibom, 2012; Etukudo, 2017).

length (5.291 mm), and aperture width (2.990 mm). Similarly, Okon *et al*. (2017) and Etukudo *et al*. (2024b) provided further measurements, documenting aperture length (3.243 cm), aperture width (1.061 cm), body shell length (6.786 cm), body shell width (2.661 cm), spiral length (1.118 cm), and spiral width (0.261 cm).

Adult *A. fulica* snails have been reported to reach body weights of up to 32 g under natural conditions (Etukudo, 2017). When classified by the number of shell whorls, *A. fulica* snails with five whorls have been recorded to weigh 59.58 g, 61.20 g, and 65.05 g (Etukudo, 2017). Okon *et al*. (2017) observed body weights for snails with four whorls ranging from 30.60 g to 85.20 g (average 49.70 g), and those with five whorls ranging from 50.60 g to 119.30 g (average 59.58 g). Ibom *et al*. (2014) reported mean body weights of 93.70 g, 109.70 g, and 73.00 g for *A. fulica* snails collected from the central, northern, and southern agro-ecological zones of Delta State, respectively. In a separate study, Okon *et al*. (2012) recorded a mean body weight of 138.60 g for *A. fulica* with four whorls. Etim (2017) reported slightly lower averages of 48.85 g and 65.05 g for snails with four and five whorls, respectively, while Etta *et al*. (2015) noted a higher mean weight of 137.50 g for snails with four whorls.

***Limicolaria* species**

Limicolaria flammea (Figure 4) is a terrestrial gastropod native to West Africa, with a range extending from Ghana to Angola. It has been introduced to Southeast Asia, specifically Singapore, where it is currently displacing the previously established population of *Lissachatina fulica* (Tan and Clement, 2011; Odafe-Shalome and Omoyakhi, 2020).

The shell of *L. flammea* is perforate, ovate-elongate, and relatively thin. Its colouration is tawny white, marked with broad, wavy chestnut streaks. The spire is long and conical, terminating in an obtuse, white apex. The shell comprises 7½ slightly convex whorls, which are granulose-decussate above and smooth below the periphery. The last whorl is not swollen and constitutes approximately three-sevenths of the total shell length. The columella is slightly arcuate and lilac-tinted (Tan and Clement, 2011; Odafe-Shalome and Omoyakhi, 2020).

The aperture is nearly vertical, subrhombic to semi-oval in shape, with an angular base. The interior of the shell is bluish, allowing the external streaks to show through. The peristome is simple and unexpanded, with the columellar margin dilated toward the base and partially reflected over the umbilicus (Tan and Clement, 2011; Odafe-Shalome and Omoyakhi, 2020).

Several species of *Limicolaria* are commonly found in Nigeria, including *L. flammea* (black and white) (Figure 4), *L. numidica* (yellow-brown), *L. martesiana* (brown), *L. aethiops* (brown), *L. feline* (white), and *L. aurora* (white and black) (Odafe-Shalome and Omoyakhi, 2020). While *Limicolaria* species generally exhibit similar shell shapes, they differ notably in shell colouration and the number of whorls. Each species displays a distinct pattern of stripes, with no two species sharing the same pattern, highlighting a key morphological differentiator among them.

Shells of *Limicolaria* species are typically conical in shape. However, variations exist: *L. numidica* and *L. aurora* tend to have slender, narrow cones, whereas other species display broader, more ventricose forms (Odafe-Shalome and Omoyakhi, 2020). Shell colouration is equally diverse, *L. flammea* features black and white bands; *L. aurora*, white and brown bands; *L. feline* is entirely white; *L. martesiana*, entirely brown; and *L. numidica*, yellow-brown.

Odafe-Shalome and Omoyakhi (2020) further reported morphological data on *Limicolaria* species collected from the Benin metropolis. At maturity, *L. flammea* exhibited an average live weight of 48.6 g, a shell length of 7.5 cm, and 7 whorls. *L. martesiana* had a live weight of 46.3 g, a shell length of 5.0 cm, and 7 whorls. *L. numidica* recorded a live weight of 42.8 g, shell length of 5.5 cm, and 7 whorls, while *L. aurora* weighed 40.9 g, with a shell length of 5.0 cm and 9 whorls.

SNAIL FARMING METHODS

Semi-Intensive (Paddock) system

This method of snail farming seeks to replicate the snails' natural habitat while incorporating enhancements that promote productivity. Snails are kept within a fenced enclosure that includes a variety of grazing plants, accessible water sources for drinking, and suitable soil conditions for egg-laying (Figure 5). Vegetables grown within the enclosure not only provide nourishment but also offer shade, protecting the snails from direct sunlight. Watering can be managed either manually with a watering can, feasible for small enclosures but physically demanding, or more efficiently with a sprinkler system. Compared to intensive farming systems, this open environment approach is less labour-intensive (Okon and Ibom, 2012; Etukudo, 2017).

Intensive (Cage) system

In intensive snail farming systems, snails are bred and raised in enclosed spaces, such as cages (Figure 6) or dedicated buildings, under carefully controlled environmental and feeding conditions. This setup supports higher stocking densities and promotes faster growth and reproduction. Cages, in particular, allow for efficient space utilisation, with stocking rates reaching 30 to 40 snails per square meter, depending on management capacity. However, this method demands significant labour for tasks such as feeding, cleaning, and health monitoring. Effective hygiene practices are critical and should include prompt removal of faeces, maintaining a cool environment, and implementing robust pest control measures. Cage systems may be designed as single-layered units or multi-tiered structures to further optimise space (Okon and Ibom, 2012; Etukudo, 2017).

Hybrid system

In this semi-intensive snail farming system, breeding and hatching occur in controlled environments such as buildings or plastic tunnel houses. Once the juvenile snails reach a certain stage of development, they are transferred to outdoor pens for continued growth and maturation. This approach combines the benefits of controlled early-stage breeding with the natural advantages of outdoor rearing, optimising both survival rates and growth efficiency (Okon and Ibom, 2012; Etukudo, 2017).

SNAILERY MANAGEMENT

According to Okon and Ibom (2012) and Etukudo (2017), four key factors must be considered in the successful production of any animal, including snails:

1. The Animal (Snail): The choice of breed, its growth rate, and overall health status are crucial to productivity and sustainability.
2. Housing and Facilities: Structures must be well-designed to offer protection from predators such as rodents and other pests. Secure and hygienic housing enhances survival and performance.
3. Feeding: Perishable feed should be removed daily to prevent spoilage and contamination. More durable feeds, such as *eba*, cake, formulated diets, and certain leaves, can remain for up to three days. However, best practice is to provide fresh feed once daily to ensure hygiene and palatability.
4. The Environment: Adequate ventilation, well-draining (porous) soil to prevent waterlogging, and protection from excessive heat are essential. Since snails naturally thrive in cool, moist environments, mimicking these conditions is key to successful farming.

Paddock management

The paddock system offers a cost-effective approach to snail farming, especially in terms of feeding, as snails can graze on naturally grown vegetation. However, it presents challenges in monitoring the snails and maintaining hygienic

Figure 5. Source: Afrimash (https://afrimash.com/snail-farming-all-you-need-to-know/2/)

Figure 6. Source: Afrimash (https://afrimash.com/snail-farming-all-you-need-to-know/2/)

conditions (Okon and Ibom, 2012; Etukudo, 2017). To ensure effective use of this system, the following best practices are recommended:

1. Prepare the Paddock Before Stocking: Allow the vegetation within the paddock to grow lush and fresh before introducing snails. This ensures sufficient natural food and cover.
2. Introduce Adult Snails: Transfer mature snails into the prepared paddock and provide water either through

sprinklers or shallow ditches to maintain adequate moisture.

3. Feeding Schedule: While the paddock provides natural forage, supplemental feeding can be done on alternate days or 2–4 times a week, depending on your management goals.
4. Rotation and Harvesting: Allow adult snails to remain in the paddock for a calculated period, typically 2 to 3 months, after which they should be removed and either transferred to another pen or sold.
5. Juvenile Development: Leave hatchlings or juveniles in the paddock for an additional 6 to 8 months to allow them to grow and reproduce at least once before harvesting. Their growth depends heavily on diet quality and care.

Soil considerations

Avoid using clay soils, as they tend to compact (cake), trap snail eggs, and retain excessive moisture, leading to waterlogging. A sandy-loamy soil is ideal, offering proper drainage and burrowing conditions. Before planting vegetation in the paddock, fertilise the soil appropriately. Well-composted poultry manure can be used, but it must come from a verified, disease-free source to prevent contamination and disease transfer (Okon and Ibom, 2012; Etukudo, 2017).

Cage management and record keeping

Cage-based snail farming supports efficient record keeping, similar to poultry production systems. Adult snails can be hand-picked for transfer, sale, or observation, while juveniles (snaillets) are left undisturbed. Where possible, juveniles should also be collected and counted to maintain accurate stock records (Okon and Ibom, 2012; Etukudo, 2017).

Egg incubation and hatching management

Snail eggs are typically incubated under artificial conditions to improve hatching success. Simple setups, such as boxes placed in warm locations (e.g., garages), can serve this purpose. It is crucial to use sandy-loamy soil, which is porous and well-draining, to support proper egg development.

If a decline in hatching rate is observed, the incubation soil should be either disinfected or completely replaced. Optimal hatching conditions require: well-drained, low-bacteria soil, consistent humidity, and a warm temperature range of 25-35°C.

Higher temperatures generally accelerate hatching and improve survival rates. However, care must be taken to prevent desiccation, a challenge similar to that encountered in poultry hatcheries (Okon and Ibom, 2012; Etukudo, 2017).

Breed selection for genetic improvement

Selecting genetically superior snails is vital for maximising productivity and profitability. When choosing breeding stock: Evaluate length, weight, and shell development, compare snails of similar size or length; those with fewer shell sutures (or shell turns) are considered genetically superior, as they grow faster, group harvested snails by size and then identify individuals with fewer sutures relative to their size, weight can also be compared with length to assess overall growth efficiency (Okon and Ibom, 2012; Etukudo, 2017).

DETERMINING SNAIL MATURITY: KEY INDICATORS

A reliable method for determining the maturity of snails is by counting the number of shell whorls (also known as shell turns). According to Okon and Ibom (2012) and Etukudo (2017), A snail with 5¼ shell whorls is approaching reproductive maturity and is about to begin laying eggs, and at 5½ whorls**,** the snail is considered sexually mature and should already have begun egg-laying.

NUTRITIONAL AND ECONOMIC POTENTIAL OF GIANT AFRICAN LAND SNAILS

Giant African Land Snails (GALS) farming presents a promising opportunity, offering a low-cost and economically viable business model that can generate substantial income while providing a valuable food source. These snails are increasingly attracting the attention of both researchers and farmers due to their capacity to provide an affordable and sustainable source of animal protein. As global populations grow and protein sources become more strained, snails offer an alternative that is accessible, especially to rural communities (Olomu, 2011; Odafe and Olomu, 2011; Okon and Ibom, 2012; Etukudo *et al*., 2024c, d).

In addition to being rich in protein, snail meat is also a valuable source of essential minerals, making it a useful component of the human diet in many parts of the world. The cost of snail production is relatively low, making it an attractive enterprise for smallholder farmers and rural households alike.

Snails are herbivorous and feed on a wide range of plant species. Reported dietary preferences include the leaves of oil palm, pawpaw, yam (*Dioscorea* spp.), black pepper, cucumber, okra, sweet potato, and various legumes (Olomu, 2011; Okon and Ibom, 2012; Welter, 2015; Etukudo, 2017; Etukudo *et al*., 2024c, d). They are nocturnal al feeders, seeking shelter during the day and becoming most active in warm, moist conditions, typically thrive in heavy, well-moisturised soils (Etukudo, 2017; Etukudo *et al*., 2024c, d).

However, snails may also act as pests in some agricultural settings. Odafe-Shalome and Omoyakhi (2020) observed that snails can cause damage to young pawpaw, potato, and cucumber plants, particularly in home gardens. Their presence is often concentrated where such plants are abundant, posing a threat to seedlings and newly planted crops. Despite this, integrating pomology (fruit cultivation) with snail farming could yield substantial benefits, as the two can be managed synergistically for mutual advantage (Odafe-Shalome and Omoyakhi, 2020).

With Nigeria's population exceeding 200 million, the country is facing increasing challenges in meeting protein demands (Odafe and Olomu, 2011). The rising demand for giant African land snails, particularly in rural markets during the rainy season when they are readily available, demonstrates their growing relevance as a supplementary protein source.

To further unlock the potential of snail farming, continued research is recommended in areas such as reproduction patterns, genetics, and biodiversity of snail species. These studies could support their formal inclusion in mini-livestock programs. Additionally, further exploration into the economic value of snail by-products, such as shells and slime, is warranted. Early evidence suggests that snail slime may hold promise for commercial use, particularly in the cosmetics industry (Odafe and Olomu, 2011; Okon and Ibom, 2012).

ECONOMIC POTENTIAL AND MARKET OPPORTUNITIES

Feasibility study on snail farming in Nigeria

Snail farming is a viable and accessible agribusiness in Nigeria, suitable for individuals across various socio-economic backgrounds. Although minimal technical training is required to initiate small-scale snail farming, prospective farmers are encouraged to seek formal or informal training to acquire essential knowledge on snail biology and farm management practices (Afolabi, 2013). Numerous resources, including online platforms and established snail farms, offer training opportunities. The initial capital outlay depends largely on the intended scale of operation, with backyard farming requiring minimal investment, whereas commercial-scale production necessitates substantial funding (Odeyinka, 2014).

Site selection for snail farming is flexible, ranging from residential backyards to dedicated farmland. However, larger operations require sufficient space to accommodate snail populations while ensuring protection from predators such as snakes, rodents, and ants. Secure enclosures are essential to prevent snail escape (Okon and Ibom, 2012). Housing designs vary based on farmers' preferences and available resources, including free-range systems with natural vegetation for shade and feed, as well as controlled environments like cages, boxes, or concrete pens. Crucially, snaileries must prevent overcrowding, as high stocking densities negatively impact reproduction and growth rates (Okon and Ibom, 2012). Environmental factors such as temperature, humidity, and airflow must be carefully regulated; excessive heat and low humidity induce dehydration and prolonged hibernation, while strong winds exacerbate moisture loss (Odeyinka, 2014).

Species selection significantly influences farm productivity. In Nigeria, the predominant species farmed are *Achatina marginata*, *Achatina achatina*, and *Achatina fulica*, with *Achatina marginata* (Giant African Land Snail) being the most commonly cultivated. Wild-collected specimens are generally preferred over market-sourced snails due to their higher survival rates and reproductive performance (Okon and Ibom, 2012). Alternatively, farmers may procure breeders or eggs from established snail farms.

Feeding is relatively cost-effective, as snails exhibit a broad dietary range, consuming vegetables, fruits, and kitchen waste with low salt content. Adequate hydration is critical, necessitating constant access to clean water. Calcium supplementation is essential for proper shell development, often provided through calcium-rich feeds or soil amendments. Soil quality is another key determinant of snail health and productivity (Okon and Ibom, 2012). A well-drained, sandy-loamy soil with neutral pH is recommended, facilitating egg-laying and preventing dehydration. The inclusion of limestone in the soil can enhance calcium availability. Regular monitoring and maintenance of soil conditions are necessary to ensure optimal snail growth (Odeyinka, 2014).

Reproduction in snails predominantly occurs during the rainy season, from April to October (Okon and Ibom, 2012). The *Achatina* species are highly prolific, with females capable of laying between 100 to 400 eggs per breeding cycle, depending on environmental suitability. Eggs typically hatch within two to six weeks, with snails reaching marketable maturity within 18 to 24 months (Okon and Ibom, 2012). Maturity is indicated by the thickening of the shell's brim. Harvesting should be timed to coincide with full maturity to maximise product quality and market value. Post-harvest, snails may be sold live, processed, or frozen, depending on market demands (Odeyinka, 2014).

The market potential for snail products is extensive, encompassing local sales to traders, restaurants, and hotels, as well as international export opportunities. In addition to meat, value-added products such as snail slime, shells, and eggs offer supplementary revenue streams (Afolabi, 2013). Early-stage sales of juvenile snails to other farmers also present alternative income sources. While snail farming is generally characterized by low operational risks, successful ventures require diligent management practices to maintain a safe, clean, and conducive farming environment, thereby ensuring profitability and sustainability (Odeyinka, 2014).

How farmers can make profit from the snail value chain

Snail farming presents a significant opportunity for farmers to generate substantial income, provided that certain critical factors are addressed. Afolabi (2013) emphasised that adequate training is essential for farmers before venturing into the sector. A thorough understanding of snail biology, including their reproductive behaviour, housing needs, and nutritional requirements, is crucial for effective farm management (Okon and Ibom, 2012). Many farmers fail to achieve profitability due to inadequate knowledge, which leads to improper housing systems and insufficient feeding practices. Additionally, successful participation in the snail value chain requires intensive capital investment, particularly for the extraction of snail slime, a process that is both equipment- and labour-intensive. Limited access to funding often hampers farmers' ability to acquire the necessary machinery, restricting their ability to diversify income streams (Okon and Ibom, 2012). Given that snails are hermaphroditic and reproduce rapidly, farmers can achieve high production volumes and quick returns on investment (Okon and Ibom, 2012; Afolabi, 2013). Diversifying into areas such as slime extraction, shell utilisation, and breeding services can significantly enhance profitability, allowing farmers to fully exploit the economic potential of snail farming (Odeyinka, 2014).

TRANSFORMING NIGERIA THROUGH SNAIL FARMING: A MULTI-SECTORAL APPROACH

The agricultural transformation programme in Nigeria is designed to enhance the availability of food, animal products, and raw materials for industrial use, while also generating employment opportunities and increasing national income (Okon, 2015).

The nutritional profile of snail meat is comparable to that of conventional livestock, with particularly high levels of iron, which is beneficial in managing health conditions such as anemia, ulcers, and asthma (Okon and Ibom, 2012; Etukudo, 2017).

In West Africa, especially within the forest zones, snail meat has traditionally been a key component of local diets (Okon and Ibom, 2012; Okon, 2015; Etukudo, 2017). Although detailed consumption statistics are lacking in Nigeria, the demand for snail meat significantly exceeds the supply.

In modern-day Nigeria, molluscs, including snails, constitute an essential dietary component among the people of Cross River and Akwa Ibom States, as well as among the Itsekiri, Yoruba, and various other coastal ethnic groups (Okon, 2015). Given these dynamics, the promotion and expansion of snail farming could play a vital role in advancing Nigeria’s agricultural transformation objectives, as it is considered a sustainable agribusiness in Nigeria, requiring relatively low investment and offering high returns, making it an attractive option for farmers.

As previously noted, every part of the snail possesses utilitarian value. The shell, in particular, has significant industrial applications. For example, in livestock feed production, snail shells serve as a viable source of essential minerals such as calcium and phosphorus (Okon and Ibom, 2012; Okon, 2015; Etukudo, 2017).

Adewuyi (2014) asserts that snail shells can also be utilized in the construction industry, advocating their use as a sustainable waste management strategy. Similarly, Nkwendem *et al*. (2023) contend that the chemical composition of snail shells makes them suitable for various civil engineering applications. This underscores the importance of promoting further research into these industrial uses, as doing so could reduce reliance on imported raw materials such as calcium supplements and cement, ultimately increasing government revenue through local production and potential export opportunities (Okon, 2015).

In addition to their industrial value, snail shells possess natural aesthetic appeal. Through polishing, painting, and artistic design, these shells can be transformed into decorative art pieces. According to Amubode and Fafunwa (2014), their ornamental significance is widely acknowledged, as they are frequently used for interior decoration in hotels and homes, displayed in museums, and featured in cultural events such as traditional weddings and festivals. With appropriate policy support, government initiatives could harness this creative potential to promote youth employment and stimulate economic growth in the creative sector (Okon, 2015).

The pharmaceutical potential of the giant African land snail is diverse and multifaceted (Okon, 2015). Its meat is characterised by low sodium and cholesterol levels, alongside a high potassium content, making it beneficial in the management of arteriosclerosis, anemia, hypertension, and various lipid-related health conditions. Additionally, snail meat is reputed to alleviate hemorrhoids and constipation, while also enhancing vitality and sexual function (Okon and Ibom, 2012; Okon, 2015; Etukudo, 2017).

In traditional medicine, snail meat features prominently in the preparation of herbal remedies. These include treatments for easing labour pain, minimising postpartum blood loss, and concoctions aimed at restoring harmony within polygamous households or between estranged spouses. Folkloric evidence also suggests its therapeutic use in treating ailments such as diabetes, ulcers, smallpox, pneumonia, impotence, and whooping cough (Adikwu, 2012; Okon and Ibom, 2012; Okon, 2015).

Further pharmaceutical interest has been drawn to snail mucin, the slime secreted by snails, which is rich in glycosaminoglycans. Ajibola *et al*. (2013) report that this high molecular weight polysaccharide exhibits antibacterial, anti-inflammatory, local anaesthetic, and cation-binding properties. Due to its viscous and hydrophilic characteristics, snail mucin shows promise in managing cardiovascular conditions such as hypertension, arrhythmia, and angina pectoris.

Elemental analysis of the snail’s hemolymph (bluish body fluid), conducted by Etukudo (2017), revealed substantial concentrations of magnesium, calcium, potassium, and phosphorus. This suggests that snail hemolymph may be a viable source of dietary supplements, akin to the role currently played by cod liver oil (Fred-Jaiyesimi, 2014).

Given these findings, a strong collaboration between the private sector, academic institutions, and government is essential to further explore and harness the pharmaceutical applications of snail meat and its by-products (Okon, 2015).

Nigeria's economic recovery strategy calls for a fundamental transition from over-reliance on government employment to a greater emphasis on self-employment initiatives. One particularly promising avenue in this regard is snail farming (heliculture), which not only offers lucrative income opportunities but also provides a valuable source of protein to complement the country's predominantly carbohydrate-based diet. However, realising the full potential of this sector requires deliberate and sustained policy support. Without strong political commitment, meaningful progress is unlikely (Okon, 2015).

Although precise data on snail consumption in Nigeria is lacking, the disparity between demand and supply indicates a significant market opportunity. Snail meat presents a viable and nutritious alternative to more conventional sources of animal protein (Okon and Ibom, 2012; Okon, 2015). Many of the snail-based dishes now served in Nigerian restaurants are inspired by European culinary traditions (Okon, 2015). Globally, millions of kilograms of snails are consumed annually, underscoring the international demand. Notably, May 24th is recognised worldwide as National Escargot Day, a celebration that highlights the global cultural and gastronomic appreciation for snails (Odeyinka, 2014).

CHALLENGES OF HELICULTURE AND MEASURES TO OVERCOME THEM

Snail farming in Nigeria presents numerous opportunities for sustainable agribusiness development; however, several challenges hinder optimal production (Okon and Ibom, 2012; Afolabi, 2013; Etukudo, 2017). A critical limiting factor is the sensitivity of snails to environmental conditions, particularly temperature and humidity fluctuations. In many regions, maintaining optimal climatic conditions is challenging, leading to reduced activity and productivity. To mitigate this, farmers are advised to implement microclimate control strategies, including the use of shade-providing structures, misting systems, and small-scale greenhouse enclosures to stabilize temperature and humidity levels within snaileries (Ngenwi *et al*., 2010).

Predation poses another significant threat to snail farms. Natural predators such as insects, rodents, birds, and even ants can cause substantial losses if not properly managed. Effective protective measures include the installation of fine mesh screens, safety netting, and secure enclosures to minimise access by predators (Nkwendem *et al*., 2023). Additionally, physical barriers and regular monitoring are essential components of an integrated pest management strategy (Ngenwi *et al*., 2010).

Soil quality is a fundamental determinant of snail health and reproductive success. Snails require well-draining, organically rich soil to facilitate burrowing and oviposition. Sandy-loamy soils are preferred due to their moisture retention capacity without becoming waterlogged (Okon and Ibom, 2012). Regular soil amendments with organic matter and limestone can enhance soil structure and calcium availability, thereby supporting snail growth and shell development (jbbagric.com, 2023).

Disease outbreaks, though less common, can significantly impact snail populations, leading to stunted growth and increased mortality. To address this, strict hygiene protocols must be maintained within the farming environment (Okon and Ibom, 2012). Regular cleaning of snaileries, proper waste disposal, and the implementation of biological pest control methods are recommended to reduce disease incidence and promote overall farm biosecurity (Ngenwi *et al*., 2010).

Reproductive efficiency also presents challenges, as snails require specific environmental conditions to initiate and sustain mating behaviour. Factors such as temperature, humidity, and calcium availability directly influence reproductive output (Okon and Ibom, 2012). To enhance breeding success, farmers should create an environment conducive to mating by ensuring optimal microclimatic conditions and providing consistent access to calcium-rich materials necessary for shell formation (Ngenwi *et al*., 2010).

By addressing these challenges through targeted interventions, snail farmers in Nigeria can improve productivity, reduce losses, and maximise profitability, thereby contributing to the growth of the country's emerging snail farming industry (Okon and Ibom, 2012; Afolabi, 2013; Nkwendem *et al*., 2023).

CONCLUSION

Heliciculture (snail farming) is increasingly gaining global attention as a viable agribusiness, driven by the nutritional, aesthetic, and medicinal value of snails. However, to fully realize the potential of this emerging industry, comprehensive research and development efforts are essential to establish a strategic framework for its sustainable growth. Major priorities include capacity building for both small-scale and commercial snail farmers, with emphasis on training, technical support, and the provision of subsidies to enhance productivity. Furthermore, the sustainable commercialisation of snail farming requires the development of appropriate processing infrastructure, alongside coordinated infrastructural and organisational planning at both national and international levels. Integrating heliciculture into formal educational curricula in Nigeria is also recommended to foster early awareness and promote future innovations in the sector. These interventions are critical for optimising production efficiency, ensuring industry competitiveness, and positioning snail farming as a significant contributor to agricultural diversification and economic development in Nigeria.

CONFLICT OF INTEREST

There is no conflict of interest involved in writing the paper.

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