FEEDING BEHAVIOR, CONTROL STRATEGIES AND PERFORMANCE OF GIANT AFRICAN LAND SNAILS RAISED IN AN ENCLOSED FREE RANGE SYSTEM.

By

Oghenefejiro Praise EFEURHOBO (Miss)

AGR1700091

TO THE UNIVERSITY OF BENIN, FACULTY OF AGRICULTURE, DEPARTMENT OF ANIMAL SCIENCE.

SUPERVISOR: J.M OMOYAKHI.

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A PROJECT SUBMITTED TO THE DEPARTMENT OF ANIMAL SCIENCE, FACULTY OF AGRICULTURE, UNIVERSITY OF BENIN, IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF THE BACHELOR OF AGRICULTURE HONORS, DEGREE IN ANIMAL SCIENCE OF THE UNIVERSITY OF BENIN, BENIN CITY, NIGERIA.

October, 2023.

CERTIFICATION

This is to certify that **Oghenefejiro Praise EFEURHOBO** with matriculation number AGR1700091 carried out this project under the Department of Animal Science, University of Benin, Benin City, Edo State, Nigeria.

_____ _____

PROF J.M. OMOYAKHI Date

(Project Supervisor)

_____ _____

PROF J.A. IMASUEN Date

(Head of Department)

DEDICATION

This work is dedicated to Almighty God for his love, mercy and grace throughout my stay in the University of Benin. Glory be to God.

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TABLE OF CONTENTS.

CHAPTER THREE

CHAPTER FOUR

LIST OF PLATES.

LIST OF TABLES.

ABSTRACT.

In the experiment conducted on the feeding behaviour, performance and control strategies of *Achatina marginata,* 50 snails were used. The data obtained were subjected to one way analysis of variance (ANOVA) using SPSS 24.0 and the significant level was set at $p<0.05$ for all analysis.

The experiment lasted between March till August and all the snails received the same level of attention, feed and preventive measures put in place. Readings were taken on a weekly basis. The snails were fed twice weekly and carefully monitored to make sure they were eating adequately.

Snails showed a preference in feed type, opting more for watermelon and cucumber than unripe pawpaw. The snails also fed on the leaves of the cover crops planted within the experimental plot. Best growth was obtained when the snails fed on watermelon and cucumber. The performance of the snails was also seen to go hand in hand with their feeding patterns and preferences, with about 0.005kg and more, added to their body weight weekly.

Measures were put in place to stop and reduce the risk and the snails tendency to escape and also to prevent predators from getting into the experimental plot.

CHAPTER ONE.

1.0 INTRODUCTION

The Giant Land Snail belongs to the phylum Mollusca in the animal kingdom. The phylum Mollusca consists of over 100,000 living and fossil species. The land snail belongs to the class Gastropoda.

The Giant African Land Snail, scientifically known as Achatina *marginata*, is a species of large land snail native to West Africa. They belong to the Achatinidae family and are known for their size and distinctive spiral shells. Their shells typically range from brown to reddish-brown in color and can reach lengths of up to 20 cm or more.

Achatina *marginata* is native to West Africa, particularly countries like Nigeria, Ghana, and Benin. They are often found in humid tropical and subtropical regions (Brown,1994). Achatina *marginata* is mainly herbivorous, feeding on a variety of plant matter including leaves, fruits, and vegetables. These snails are hermaphroditic, meaning they possess both male and female reproductive organs. They lay large clutches of eggs, which hatch into juvenile snails (Santos et al., 2015).

Achatina *marginata* is often bred for commercial purposes, including the snail farming industry, due to its economic value as a source of protein, although they are considered invasive in many areas due to their voracious appetite for plants and potential to damage crops and natural ecosystems (Barker, 2002).

Achatina *marginata* are known for their voracious eating habits and unique behavior. These snails are detritivores, primarily feeding on decaying organic matter, fruits, vegetables, and calcium-rich materials like eggshells. Their feeding patterns significantly affect their growth, reproduction, and overall performance.

1. **Behavior and Eating Patterns.**

Giant African Land Snails exhibit nocturnal feeding behavior, foraging during the night to avoid predators and minimize water loss. They are generalist feeders, consuming a wide variety of plant materials and sometimes even non-plant substances like calcium-rich soils to meet their calcium needs for shell development (Okonkwo et Al., 2015.)

2. **Impact of Eating Patterns on Performance.**

The nutritional content and variety of the diet significantly influence the growth rate, shell development, and reproduction of Giant African Land Snails. Calcium intake is crucial for shell strength and growth, and a balanced diet improves overall performance (Attama & Okorie, 2006.)

3. **Management and Control.**

Managing and controlling the population of Giant African Land Snails is essential to prevent damage to crops and natural habitats. Strategies include manual removal, use of natural predators, and adopting bio-security measures to restrict their spread (Fagbuaro & Ajayi, 2004.)

1.1 JUSTIFICATION OF STUDY

Giant African land snails are an underutilized source of protein that could help address food security issues in many parts of the world. Traditional methods of raising giant African land snails have several limitations, such as poor quality of feed, high mortality rates, and low productivity. The study aims to address these limitations by investigating the available feeding strategies and control methods.

The results of the project will contribute to a better understanding of the feeding behavior and performance of Giant African Land snails (GALS), and could lead to the development of improved production systems.

This study is important because it has the potential to improve the livelihoods of farmers who raise giant African land snails, and to improve food security in countries where they are commonly consumed.

1.2 OBJECTIVES.

The aim of this work is to;

- Study the behavior of the snails to know their feed preference and the availability of said feed.
- Know and understand the reason why they might escape, ways they escape and the control strategies that can be used to prevent the escape of snails from the farm.

- To gain insight on the performance and growth of the snails using body measurements indices like weight, length, etc.

CHAPTER TWO.

2.0 LITERATURE REVIEW

2.1 General morphology.

The presence of a shell is an attribute common to all snails. The body is equilateral, with one side of growth. They move slowly on the foot, a flat area of the body. A snail's body and shell are its two main components. The mantle epithelium secretes the shell, which is primarily made of calcium carbonate. The head, foot, and visceral mass are the three components that make up the body.

Two pairs of retractable sensory tentacles (that resemble antennas) are carried on the partially delimited head. The eyes are located in the round end of the longer pair of tentacles. There is a mouth with teeth-like features called radula at the dorsal region of the skull, with which the snails grasp their food. The long, muscular foot, like the head, is not clearly distinguished from the rest of the body when the snail is moving, occupying nearly the whole ventral surface.

The digestive, reproductive, and respiratory systems are housed in the visceral mass, which is located in the shell above the foot. The mouth, buccal cavity, oesophagus, salivary glands, crop, stomach intestine, and liver are all parts of the digestive system. All of these pulmonate snails have sophisticated reproductive systems and are hermaphrodites. The snail retracts its body within the shell whenever danger is present.

The shell of a snail contains calcium carbonate in amounts of 98%. A substantial calcareous shell, primarily composed of calcium carbonate, is secreted by the skin over the visceral hump. About a third of the body weight in the majority of species is made up of the shell. It serves as the shell of the snails. Additionally, snails have both male and female components, making them hermaphrodites. As is the case with Giant African land snails, most species of snails mate before depositing eggs.

2.2 A brief summary of the achatina *marginata* snail.

Achatina *marginata*, commonly known as the Giant West African Snail, is a species of air-breathing land snail native to West Africa. It is a popular choice for pet owners and has also been studied for its anatomy, physiology, and reproductive behavior. It belongs to the family Achatinidae.

Achatina *marginata* is classified under the phylum Mollusca, class Gastropoda, and family Achatinidae. It is characterized by its large size and distinctive spiral shell reaching up to 7 inches (18 cm) in length (Barker GM, 2002). The species is found in various West African countries, including Nigeria, Ghana, and Ivory Coast. They typically inhabit tropical and subtropical forests as well as disturbed areas such as gardens and agricultural areas (Barker GM, 2002). Achatina *marginata* is a hermaphroditic species, meaning each snail has both male and female reproductive organs. The snails lay eggs, and their life cycle includes stages such as egg, juvenile, and adult (Ibeh et al., 2009).

Achatina *marginata* is of economic importance in certain regions due to its consumption as a food source. However, it can also be considered a pest in agriculture, particularly in crop fields (Aisien et al., 2009). Achatina *marginata* is sometimes collected and reared for its meat, which is considered a delicacy in some regions (Okonkwo et al., 2009).

The conservation status of Achatina *marginata* varies by region, but it is generally not considered endangered. However, habitat loss and collection for the pet trade can pose threats (IUCN Red List, 2019).

2.3 Free range method of snail rearing.

Free-range snail rearing is an unconventional yet environmentally friendly approach to snail farming. In this system, snails are allowed to roam freely within a designated area resembling their natural habitat rather than being confined to pens or cages (Ademolu et al., 2005.) This method is well known for commercial snail breeding.

Free-range or extensive method is usually a method designed to ensure that snails live like though in their natural habitat like we have in the wild, providing them with access to suitable climate and a variety of plants. Free range system and Mini paddock system shares some common features.

This method can have several advantages, such as reduced feed costs as the snails obtain their food from natural sources, and improved snail health through natural foraging and diverse vegetation. Free range snail farming is also sustainable and eco-friendly as this system minimizes the environmental impact of snail farming. (Okoli et al., 2015.)

There are some limitations that can hinder the successful operation and management of the free range system and these are:

1. Predators: Protecting snails from predators like birds and rodents is essential.
2. Disease management: Regular monitoring and preventive measures are needed to maintain snail health.
3. Space requirements: Adequate space for snail movement and foraging is necessary.

However, free range has two major type, the open or closed free range method. In the open free range methods there is no enclosure or cover but for the Closed free range method there are enclosures. This method promotes a more natural and stress-free environment for snails, potentially leading to higher growth rates and better reproduction.

To keep snails from fleeing and to safeguard them from predators in an enclosed free-range system, the farmer must first construct a proper enclosure with a secure boundary. Depending on the intended snail farmer's demand for stocking or the amount of the land available, it is typically a fenced area up to 10 m or more.

To mimic the environment of the snails in their native setting, provide a variety of flora and appropriate shelter. The snails are frequently provided with food and shelter from the wind, sun, and rain by the plants, shrubs, and trees that are typically planted inside. In a free range system, you can grow plants like dwarf pawpaw, dwarf banana or plantain, cocoyam, and other shelter plants. The available natural vegetation is made available for the snails to graze on, providing supplemental feed as needed to ensure a balanced diet.

Optimal temperature and humidity levels should be maintained to support the snails' growth and reproduction and there should be a regular monitoring of the health of the snails with necessary measures taken to prevent and treat any disease.

2.4 Feeding behavior.

Raising Giant African Land snails in an enclosed free range system involves providing a controlled environment while allowing them some freedom of movement. Feeding behavior often includes a diet of fruits, vegetables, and calcium-rich supplements to support their growth and shell development. Control strategies may

involve monitoring temperature, humidity, and providing adequate shelter to mimic their natural habitat. Performance can be assessed by tracking growth rates, reproduction, shell development, and overall health of the snails within this system (Barker, 2002.)

Creating a suitable enclosed free range system that mimics their natural habitat, providing ample space for movement and feeding, is crucial for optimal performance and overall well being of the Giant African Land Snails.

The feeding behavior of Giant African Land Snails (Achatina *marginata*) in an enclosed free-range system involves their consumption of a variety of vegetation available (including stems) within the enclosure, although these snails may have preferences for specific types of plants, with a tendency to consume softer leaves and fruits. Preferences can vary among individual snails and may depend on factors such as taste and nutritional content. These snails are known to be primarily herbivorous, feeding on leaves, fruits, and other plant materials.

Snails will actively forage, graze, and scavenge for plant matter within the enclosure, exhibiting nocturnal feeding behaviors (meaning they are more active at night as they tend to feed when the environmental conditions are more favorable, such as cooler temperatures and higher humidity.) Snails may also consume calcium-rich sources like crushed eggshells or limestone to support their shell development and maintenance. They may actively seek out sources of calcium, such as limestone, eggshells, or other calcium-rich materials, to supplement their diet (Fagbuaro et al., 2013.)

In some cases, snail farmers may provide supplemental feeds to ensure that the snails receive a balanced diet. These may include calcium supplements or specially formulated snail feeds.

2.5 Performance.

Studies on the growth rate of snails (mainly Achatina *marginata* in Nigeria) fed on different diets suggest that growth rates are influenced by the genetic make up of snails. The performance of snails can be observed and noted from their morphometric indices, as the length, weight and width of the snails show that the feed intake is being utilized.

Snails generally feed regularly, although the frequency can vary based on factors like temperature, humidity, and food availability. They may eat small amounts multiple times a day. Their feeding patterns are influenced by environmental conditions. Factors such as temperature, humidity, light, and the availability of food can affect when and how much they eat.

Feeding significantly impacts the growth and performance of Achatina *marginata* snails. Their diet affects their development, weight gain, reproduction, and overall health. A well-balanced and nutritious diet is essential for optimal growth and productivity in snail farming.

Achatina *marginata* snails are typically herbivores and feed on a variety of plant material such as leaves, fruits, vegetables, and sometimes calcium sources like limestone (Anyanwu & Anunobi, 2011.) The nutritional content of their diet, including protein, carbohydrates, vitamins, and minerals, plays a crucial role in their growth rates and reproductive capacity.

Fasakin et al., (2007) suggests that providing a balanced diet with appropriate protein levels can lead to better growth and weight gain in Achatina *marginata* snails. Additionally, incorporating calcium-rich foods or supplements is vital for shell development and overall health.

It's essential to monitor and adjust the snails' diet based on their growth stage, environmental conditions, and available food resources to ensure optimal performance.

2.6 Control strategies

Creating an effective control strategy for Achatina *marginata* snails in an enclosed free range system involves several considerations to manage their population and optimize their growth.

1. Habitat Management and Enclosure Design:

Ensure the enclosure is secure and minimizes escape opportunities for the snails (Fleming & Karanja, 2016) and optimize habitat conditions, including humidity, temperature, and substrate, to prevent stress and encourage healthy growth (Mochiah et al., 2018).

2. Regular Monitoring and Inspection:

Conduct frequent inspections to identify signs of disease, pests, or overcrowding (Ibeh et al., 2015). Snail behavior and growth rates should be monitored to detect anomalies and adjust management practices accordingly (Ademosun et al., 2013).

3. Disease Prevention and Management:

Implement bio-security measures to minimize the risk of introducing diseases to the snail population (Ikpo et al., 2012.) Quarantine new snails before introducing them to the existing population to prevent the spread of diseases and conduct regular health checks and promptly isolate and treat sick snails to prevent disease outbreaks (Ademolu et al., 2011.)

4. Pest Control:

Employ natural predators or biological control agents to manage potential pest infestations (Rasheed et al., 2014). Safe and approved pesticides should be utilized if necessary, ensuring they do not harm the snails or contaminate the environment (Daramola et al., 2017).

5. Feed Management:

Optimize feeding practices to ensure a balanced diet and adequate nutrition for the snails (Obasi & Abiaezute, 2014). Offer a balanced diet rich in calcium, as Achatina *marginata* snails require it for shell growth and monitor their food intake and adjust their diet as needed. A clean, uncontaminated feed should be provided to prevent digestive issues and maintain overall health (Ademolu & Osinowo, 2007).

6. Population Control:

Monitor population density to prevent overcrowding and implement population control measures such as culling excess snails to prevent overcrowding and competition for resources. Use manual removal or humane pest control methods like introducing natural predators if feasible.

7. Record-keeping and Data Analysis:

Maintain detailed records of snail population dynamics, growth rates, and health parameters (Fasina et al., 2016). Analyze the data to identify trends and adjust management strategies for improved efficiency (Ibeh & Chiejina, 2005).

8. Environmental Enrichment:

Implement strategies to enrich the environment to reduce stress and promote natural behaviors, which can enhance overall well-being and productivity.

9. Breeding and Reproduction:

Promote reproduction by maintaining optimal conditions for mating and egg-laying. Provide a suitable substrate for egg deposition.

10. Record Keeping:

Maintain detailed records of snail growth, health, and reproduction. This data can help identify trends and potential issues.

11. Market Research:

Continuously assess the market demand for Achatina *marginata* snails and adjust your breeding efforts accordingly.

CHAPTER THREE.

3.0 MATERIALS AND METHODS

3.1 Location of Experiment

The experiment was conducted at the Snailery unit of the University of Benin Teaching and Research Farm, Ugbowo, Edo State, Nigeria. The farm lies between latitude 6'.20' 1.32"N of the equator and longitude 5'.36' 0.54"E of Greenwich meridian, with mean annual temperature of 27.6°C. The area has an average annual rainfall and relative humidity of 2162mm and 72.5% respectively (Google Earth, 2021).

3.2 Site Preparation

The experimental unit underwent several repairs before the arrival of the snails (as well as the installation of wire mesh around each experimental plot.) The experimental site was cleared out (all weeds removed) and was sprayed with herbicides to kill and prevent the growth of weeds.

Potatoes and Cocoyam were then planted to serve as cover crops for the snails and Mucuna *bracteata* was also used as the cover crop for the experimental unit (although it wasn't planted like the others as it was already found in abundance in the unit.) The cover crops served as shade for the snails to protect them from direct sunlight and rainfall (although the potatoes planted didn't germinate.)

Each experimental plots were partitioned with wire mesh to stop (or reduce) the occurrence of escape by the snails during the entire course of the experiment. The size of the experimental plot was 16ft in length and 12ft in width. Fertilizer application took place two weeks after planting and there was regular watering (although it didn't happen as often as there was constant rainfall.)

During the period of growth and the establishment of the experimental plot, weeding was a vital necessity that wasn't skipped as it would have hindered the growth of the plants and slowed down the entire experiment.

All routine management practices as it relates to feeding, the snails performance and control were closely observed.

3.3 Management

The experiment lasted for five (5) weeks and a total of 250 Giant African Land Snails (Achatina *marginata*) were purchased from KING'S FARM, Benin City, Edo State. The management system employed was the extensive system of management.

On arrival, the snails were marked (on their shells) with red nail polish for easy identification (A letter first, followed by the respective numbers; e.g, F1, F2, F3, …, F50.) The weight of the snails were all recorded to take note of their growth rate at the course of the experiment.

The experimental plots (5 in total) were each inspected thoroughly for any escape routes and the snails were finally introduced into their plots (50 snails to each plot.) Water was sprinkled to the snails immediately they were introduced to the plot in order to reduce the incidence of heat stress and they were fed unripe pawpaw (Carica *papaya*.)

During the course of the experiment, the snails were fed unripe pawpaw (Carica *papaya*, and then cucumber and watermelon at the last week to observe their preference on the various feeds available. They also fed on the leaves of the Mucuna *bracteata* and dwarf banana.

The snails were fed twice a week with a thorough and critical inspection once a week to observe and take note of dead, sick or stressed snails and to take body measurements (growth rate.) The dead snails were removed and sick ones were monitored closely.

The leftover from the feeds were removed from the plot and fresh feeds were introduced. In the absence of rainfall, water was sprinkled on the plot to help maintain the soul temperature and moisture and the temperature of the snails.

Eggs laid by snails were incubated in moist soil in an enclosed pen (about 2mm deep to incubate the eggs.)

3.4 Experimental procedure

The experiment made use of the different feeds available for the snails against the performance and growth of the snails as well as control strategies implemented to keep the snails from escaping and keep predators out of the experimental unit. A sensitive weighing scale was used to check the weight of the snails on a weekly basis and a tape measure was used to measure their length and weight once in two weeks.

Most records are made by simply observing and careful watching and inspection of the snails and the plot.

3.5 Experimental Treatments

The treatment used for the experiment were feed preference and time against the growth rate of the snails, using five (5) samples for the experiment.

3.6 Experimental design

The experimental design used was the Complete Randomized Design (CRD) with a total of 250 snails used. The snails were randomly selected and distributed into 5 experimental plots (each testing and observing using different parameters) with 50 snails per experimental plot.

3.7 Statistical analysis

Statistical analysis was conducted using the SPSS 24.0 software. Data were subjected to relevant statistical tests, including analysis of variance (ANOVA) and the significance level was set at $p < 0.05$ for all analyses and the difference between the mean was determined.

3.8 Ethical Considerations

The research adhered to ethical guidelines for the treatment of animals. All procedures involving giant African land snails were approved by the Department of Animal Science, University of Benin, Benin City. The welfare of the snails was paramount, and measures were taken to minimize stress and discomfort during the study.

3.9 Limitations

When raising Giant African Land snails in an enclosed free range system, it may be difficult to control the environment completely and this could affect the results of the experiment. Also, since conditions and habitat designs can vary from one research study to another, these findings may not apply everywhere.

CHAPTER FOUR.

4.0 RESULTS

This chapter brings clear and detailed readings and observations recorded throughout the trajectory of the study. This study focused on the feeding habits and behaviors of Giant African Land Snails and the impact of their nutrition on their overall performance. Control and preventive measures were also factors that were brought to play in the management of the snails.

4.1 Eating habits.

The paddock was well established with cover crops (cocoyam and Mucuna *bracteata*) and also dwarf banana before the snails were introduced. The snails were fed with unripe pawpaw for two weeks before the introduction of watermelon and cucumber.

4.1.1 Supply and availability of feed.

The paddock was heavily dense with cover crops and the fruits fed to the snails weren't stringent, especially as feeding didn't take place daily. The unripe pawpaw given to the snails were readily available in the unit as trees of pawpaw have previously been established, and this served as the major feed given to the snails.

There was a regular feeding schedule (twice a week) and various feeds to pick from (either from the leaves of cocoyam, dwarf banana or Mucuna *bracteata* or watermelon, cucumber and unripe pawpaw.)

The feed given were of adequate quantity as well as fresh and clean, and the snails were monitored closely to make sure they were feeding on them.

4.1.2 Feed preference.

It was noted that the snails preferred watermelon to cucumber and unripe pawpaw. Watermelon and cucumber were introduced as a feed to them during the third week, and it had a significant effect on their performance and growth as their weights increased considerably, they consumed a lot of it faster than unripe pawpaw.

Watermelon was a much welcomed variety in the diet of the snails after two weeks as it has a high moisture content an natural sweetness, providing hydration and nutrients to the snails. The snails fed on all parts of the watermelon, including the seeds. Same goes for Cucumber as it was observed to be a good source of moisture for the snails.

Pawpaw on the other hand, especially unripe pawpaw, is firmer and less sweet than watermelon and cucumber and at first, some of snails did not readily accept the fruit as of the first week. Large leftover parts were obtained from the paddock, giving the suggestion that they did not enjoy the unripe pawpaw so well.

Ripe pawpaw was given to the snails by the fifth week and the snails were monitored for 24 hours, and it was observed (by the little remnants of pawpaw left) that they enjoyed and preferred ripe pawpaw to unripe pawpaw.

4.1.3 Attitude to stale feed.

Stale food/feed is not ideal for any living organism as both the texture and taste isn't appealing. When feeding the snails, leftover feeds were removed from the plot as the snails stopped feeding on them. Unripe pawpaw was sometimes sprinkled with water to make it moist and acceptable for the snails.

Failure to remove stale feed from the paddock leads to the snails avoiding areas were the feed is and the snails huddling or conjugating at a particular area were there's no stale feed, leading to overcrowding and then stress.

4.2 Control strategies.

Raising Giant African Land Snails in an enclosed free range system requires careful control measures to prevent the snails from escaping and keeps away predators from harming the snails. It was observed that the snails either escaped by crawling on the poles erected with the wire mesh around the plot or by burrowing the soil close to weak areas of the enclosure.

There were strategies put in place to stop and prevent them from escaping. One of such method was by making sure that a balanced diet and environmental enrichment within the enclosure was provided to keep the snails content and less likely to explore outside of the plot in search of food or stimulation.

Another strategy was by meeting their need for water, moisture and humidity. Giant African Land Snails require a humid environment. Proper humidity levels were maintained in the enclosure to discourage snails from attempting to escape in search of moisture. In the absence of rainfall (which served majorly as their primary source of water and moisture) the paddock was sprinkled with water till the soil was soft and moist.

Appropriate temperature conditions for Giant African Land Snails should be maintained within the enclosure. Extreme temperatures can prompt snails to seek cooler or warmer environments outside the enclosure. Try as much as possible to imitate the snails natural habitat in the wild, proving the right humidity level, temperature range, moisture and cover crops to stop the direct contact of sunlight.

The design of the plot (with chicken wire mesh) already made the plot a secure space for the snails to be in. Gaps and openings observed along the mesh were properly blocked and covered so that the snails would not squeeze through. Natural barriers like rocks or large sticks were also placed along the sides of the mesh to derail them from any escape attempt. The gate leading to the plot was also sealed shut to prevent them from crawling out.

The snails were also spread around the entire plot after every weekly inspection and not relegated to just one section of the plot where overcrowding would've been a issue, creating competition for resources and stress which would've led to the snails escaping.

Finally, there were regular inspections conducted to check for any signs of damage or weaknesses that could allow the snails to escape and all issues were repaired immediately. The most important control strategy to note is hygiene as the snails would seek cleaner areas if the plot isn't kept clean and well maintained.

4.3 Tendency to escape.

Outside of the experimental plot were areas were Mucuna *bracteata* grew densely and majority of the times, the snails were found in these areas or by the corners of the experimental unit. Once, a snail was observed crawling up a pawpaw tree. Two snails were seen trying to crawl up the wire mesh while over ten were seen crawling up the wooden poles. On a weekly basis, it was noted that at least five snails were noticed to be missing from the experimental plot.

4.4 Factors encouraging escape.

The major factor that encouraged the snails to escape was believed to be inadequate feed supply as they were being fed only twice a week. Also, being that fifth snails were housed in a 16×12 enclosure, they might've moved out because of overcrowding.

It was also noticed that at a time where there was no rainfall, the snails tended to escape more frequently, giving rise to the notion that the environment became inadequate for them as the soil was dry and the weather hot.

Spaces and holes in the wire mesh also gave the snails the opportunity to crawl out (until it was sealed shut.)

4.5 Locating the snails in the paddock.

Weekly, the snails took an average of two hours for all to be accounted for. It was noticed that the snails burrowed into the soil, making it more difficult for them to be seen. The snails also burrows beneath debris and dying leaves, masking themselves with the brownish leaves that made it hard to clearly see them.

It was easier to locate snails situated around areas with a high concentration of snail feces or areas where fresh feed was just introduced. Snails tended to stay away from stale and unfit feeds and could also be found in areas with dense cover and very moist soil in the enclosure.

4.6 Mortality.

The mortality of the Giant African Land Snails raised in an enclosed free range system might be based on either environmental conditions, predation and diseases, or handling and disturbances. Feeding can also be a cause of death for some of the snails as some might've refused or rejected the available feeds.

It was noted that although there were stressed snails by the first week when taking readings for the snails, sightings of dead snails were noticed from the second week. The table below shows the number of snails that died weekly:

Table 1: Mortality of Giant African Land Snails raised in an enclosed free range system.

WEEK	NUMBER OF SNAILS
1	Nil
2	2
3	4
4	1
5	4

4.7 The fecundity of snails.

The first eggs (3) noted were on the second day after being introduced into the paddock. The eggs laid in the first week were seen to be already cracked (not hatched) and they were removed from the plot and thrown away. The other eggs laid were removed from the paddock (with a rubber plate) and incubated with loose and moist soil.

Table 2: The fecundity of snails.

WEEK	NUMBER OF EGGS
1	3
3	4
4	2

Plate 1: Snails eggs laid.

4.8 Growth parameters.

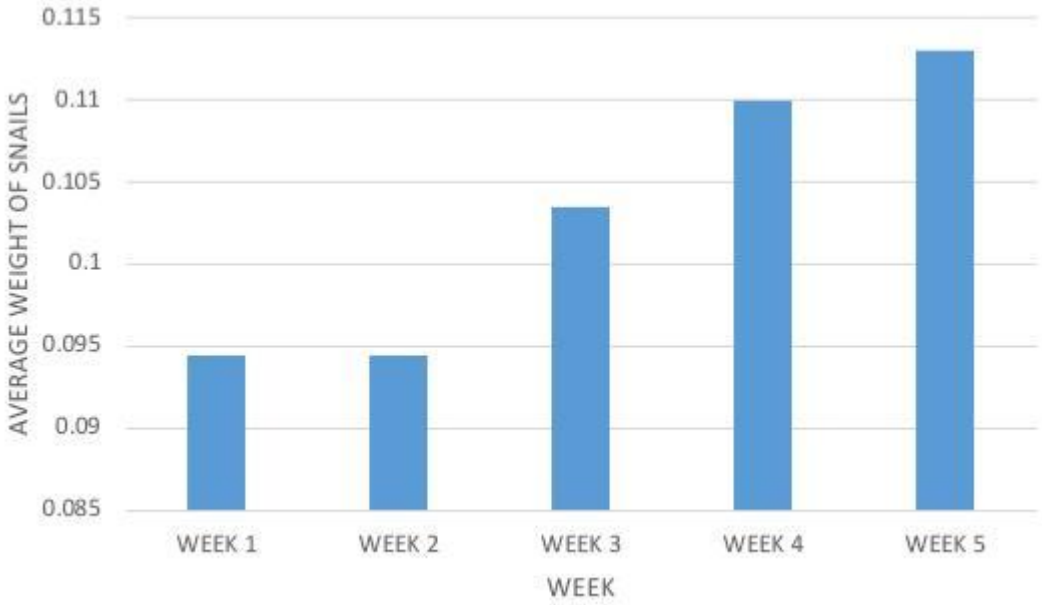
4.8.1 Weight of the snails on a weekly basis.

The weight of the snails were taken on a weekly basis to note their growth rate, performance and the impact of their feed on their growth. Ten replicates (snails) were used and their weights were taken weekly, after which, the average mean weight was actualized to be 0.1031kg during the entire course of the experiment.

Table 3: Weight of Giant African Land Snails raised in an enclosed free range system on a weekly basis.

SNAIL NUMBER	WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 5	AVERAGE MEAN WEIGHT
1	0.085kg	0.085kg	0.095kg	0.100kg	0.105kg	0.094kg
5	0.095kg	0.095kg	0.100kg	0.110kg	0.115kg	0.103kg
8	0.090kg	0.090kg	0.100kg	0.105kg	0.105kg	0.098kg
11	0.100kg	0.100kg	0.110kg	0.115kg	0.120kg	0.109kg
12	0.080kg	0.080kg	0.095kg	0.095kg	0.100kg	0.090kg
16	0.080kg	0.080kg	0.090kg	0.105kg	0.105kg	0.092kg
20	0.100kg	0.100kg	0.105kg	0.115kg	0.115kg	0.107kg
24	0.090kg	0.090kg	0.100kg	0.105kg	0.110kg	0.099kg
29	0.110kg	0.110kg	0.120kg	0.125kg	0.125kg	0.118kg
40	0.115kg	0.115kg	0.120kg	0.125kg	0.130kg	0.121kg
AVERAGE MEAN	0.0945kg	0.0945kg	0.1035kg	0.1100kg	0.1130kg	0.1031kg

Plate 2: A graph showing the mean/average weight of snails grown in a period of 5 weeks.



4.8.2 Length, height and width of the snails.

The length, height and width were also measured, first at the third week and then at the fifth week to take note of their body measurements.

Table 4: Body measurements (Height, Width and Length) of Giant African Land Snails raised in an enclosed free range system.

WEEK 3	SNAIL NUMBER	HEIGHT (cm)	WIDTH (cm)	LENGTH (cm)
	8	5	2.7	9
	11	6	4	10
	12	5.6	3.2	9
	16	6.5	3.78	9.5
	29	6.5	4.4	10
WEEK 5	8	5.2	3.1	9
	11	6.5	4.2	10.5
	12	6	3.6	9
	16	6.6	4	10
	29	6.7	4.7	10.2

CHAPTER FIVE.

5.0 DISCUSSION

The growth performance Achatina *marginata* raised in an enclosed free range system were measured by the weight gain, shell length increment and shell width increment.

The variety of feed and the influence it played on the growth of the snails is also in agreement with Akintomide (2004), that Giant African land snails like other farm animals prefer to be fed on a combination of feeds rather than just feeding on a particular type of feed.

The shell length and shell width increment of the snails in the extensive management system could be due to the spacious environment in which the snails were exposed to. When their surroundings are roomy and they have unrestricted access to food, snails thrive. This is in agreement with the findings of Ayodele and Asimalowo (1999) that the performance of snails is affected by space and number.

5.1 Feed preference and the impact on the performance of GALS (Giant African Land snails.)

The feed preference of Achatina *marginata* significantly impacts their performance and growth as the snail's preference for certain types of feed, including leaves, fruits and vegetables, positively influences the growth and development of Achatina *marginata*, leading to improved weight gain and overall size (Ibe, 2014).

The nutritional content of preferred feeds (in this case, watermelon, cucumber and ripe pawpaw) meet the specific requirements of Achatina *marginata,* contributing to the optimal growth and development of the snails (Ademolu & Idowu, 2010).

Leaves and fruits are commonly preferred due to their rich nutritional composition, providing essential nutrients such as proteins, carbohydrates, vitamins, and minerals (Agboola, 2013).

It was noted that the snails preferred moist fruits or fruits with high water content as they are good sources of hydration. Both Cucumber and Watermelon are rich in water, energy, carbohydrates, protein, sugars, dietary fiber, fat, vitamins A and C and Minerals (potassium and magnesium.)

Adequate nutrition from preferred feeds positively influences the reproductive performance of Achatina *marginata*, leading to increased egg production (Ogunji et al., 2013) and this was noted by the number and amount of eggs laid during the period.

Snails exhibit varied behavioral responses to different feed types, indicating a clear preference for certain feeds over others (Oladimeji & Ademolu, 2015). Achatina *marginata* showed a favorable interest in watermelon as they fed on both the juice and softer parts of the watermelon. For cucumber, all parts were eagerly eaten as every part of cucumber is soft and moist and easily digestible for the snails. The scent of pawpaw attracts the snails to it and they'd feed on the pawpaw if it is soft (or they'd feed on the softer parts.)

Understanding their behavioral responses aids in tailoring the diet to their preferences, ultimately improving feed consumption and growth (Aisagbonhi & Enobakhare, 2011).

Feeding frequency and quantity significantly influence the growth and performance of Achatina *marginata*; providing feeds in appropriate amounts at regular intervals is crucial for optimal results (Onabowale et al., 2014). The amount of feed given was done abundantly as any leftover feed could easily be removed from the paddock, which is better than providing minimal and insufficient feed, leading to hunger for the snails as this would negatively impact growth rates leading to health issues. This is also in accordance to the findings of Ibe (2014.)

5.2 Control strategies of gals.

Achatina *marginata*, commonly known as the giant West African snail, can be raised in an enclosed free-range system using various control strategies to optimize their growth and health. These strategies include proper housing, temperature and humidity control, nutrition, sanitation, and predator control

Providing suitable housing structures with adequate space, shelter, and substrates is crucial for the well-being of Achatina *marginata* (Ibeh, 2005). Properly designed enclosures that mimic their natural habitat are essential as was seen during the start of the project when cover crops were being planted to create and enticing and natural habitat for the snails.

Maintaining optimal temperature and humidity levels within the enclosure is essential for the health and growth of Achatina *marginata* (Fasakin et al., 2013). Monitoring and regulating these parameters ensure a conducive environment for the snails. Temperature and humidity levels were maintained by the constant rainfall and in the absence of this, spraying water in the paddock.

Implementing a well-balanced diet rich in calcium, protein, and essential minerals is vital for the growth and development of Achatina *marginata* (Fasakin et al., 2013). Providing a variety of food sources contributes to their overall health, like the availability of Mucuna *bracteata*, dwarf banana, cocoyam, pawpaw, cucumber and watermelon.

Regular cleaning and maintenance of the enclosure are necessary to prevent the build-up of waste, maintain hygiene, and reduce the risk of diseases (Nwoke et al., 2003). Proper waste management practices are important and were carefully carried out as a build of disease leads to the death of snails. Dead snails and stale feed were taken out of the experimental unit to maintain a healthy snail population.

CHAPTER SIX.

6.0 CONCLUSION AND RECOMMENDATIONS

Based on the results of this study, it was concluded that feeding can greatly impact the performance of giant African land snails in enclosed free-range systems. Suggestions were also given to help control and manage their diet for optimal effectiveness.

6.1 Conclusion.

The critical analysis of the results underscores their significance and implications for snail farming practices. In conclusion, managing Achatina *marginata* snails in an enclosed free-range system involves understanding their feeding behavior, implementing effective control strategies, and ensuring optimal performance.

Feeding Behavior:

Achatina *marginata*, like other snails, exhibit a herbivorous feeding behavior, primarily consuming a variety of plant materials. Their diet should be well-balanced, rich in essential nutrients like calcium and protein, to support growth and reproduction. Incorporating diverse food sources into their diet contributes to their overall health and productivity.

Control Strategies:

Implementing appropriate control strategies is vital to ensure the well-being of Achatina *marginata* snails in an enclosed free-range system. This includes providing suitable housing with proper temperature and humidity control, maintaining hygiene through regular cleaning and waste management, and protecting the snails from potential predators. Adequate nutrition, sanitation, and predator control measures play crucial roles in optimizing their growth and survival.

Performance:

Optimal performance of Achatina *marginata* snails can be achieved by combining a thorough understanding of their feeding behavior with effective control strategies. Properly managed feeding practices, suitable environmental conditions, and adequate

protection against threats contribute to their growth, reproduction, and overall productivity. Monitoring their performance and adjusting management strategies accordingly is essential for maximizing their potential in a free-range system.

In summary, a holistic approach considering feeding behavior, control strategies, and performance is essential for successfully raising Achatina *marginata* snails in an enclosed free-range system. By focusing on their specific dietary needs, appropriate environmental conditions, and efficient management practices, farmers can ensure the well-being and productivity of these valuable gastropods.

6.2 Recommendations.

Raising Achatina *marginata* snails in an enclosed free-range system requires careful attention to feeding behavior, control strategies, and overall performance to ensure optimal growth and health and promoting their well-being and productivity.. Here are recommendations for each aspect based on the findings from the study:

1. Feeding Behavior:

- Balanced Diet: Offer a well-balanced diet that includes a variety of leafy greens, vegetables and fruits. A diverse diet helps meet their nutritional needs and promotes healthy growth.

- Dietary Diversity: Provide a diverse diet to meet the nutritional needs of Achatina *marginata*. Include a mix of vegetables, fruits, and calcium-rich sources like cuttlebone or eggshells to ensure proper growth and shell development.

- Proper Feeding Schedule: Establish a consistent feeding schedule to regulate their feeding behavior and prevent overfeeding. Monitor their consumption patterns to adjust feeding amounts accordingly.

- Avoid Overfeeding: Be cautious not to overfeed the snails, as excess food can lead to waste buildup and attract pests. Snails have slow metabolic rates, so they do not require large amounts of food.

- Monitor Consumption: Pay attention to the snails' feeding habits and preferences. Adjust the diet based on their consumption patterns to ensure they receive adequate nutrients.

- Clean Feeding Area: Keep the feeding area clean and free of old or spoiled food to prevent contamination and maintain a hygienic environment.

2. Control Strategies:

- Temperature and Humidity Control: Monitor and maintain appropriate temperature and humidity levels within the enclosure to optimize snail health and growth. A sprinkler or spraying system can be used to regulate the environment.

- Pest and Predator Control: Implement measures to deter or control potential pests and predators, such as birds, rodents, or insects, to protect the snails from harm. Install barriers around the enclosure to prevent unauthorized access and minimize predation risks.

- Health Monitoring: Regularly inspect the snails for signs of diseases, parasites, or stress. Isolate and treat affected snails promptly to prevent the spread of illness.

-Bio-security Measures: Enforce strict bio-security protocols to prevent the introduction and spread of diseases. Limit access to the snail enclosure and maintain proper hygiene and sanitation practices.

3. Performance:

- Growth Monitoring: Keep track of the snails' growth rates, weight gain, and shell development over time. Adjust feeding and environmental conditions to optimize growth.

- Record Keeping: Maintain detailed records of feeding schedules, environmental conditions, and any changes in the snails' behavior or health. Use these records to analyze trends and make informed decisions to improve performance.

- Environmental Enrichment: Provide environmental enrichment by adding hiding spots, climbing structures, and other elements to the enclosure. This can stimulate natural behaviors and promote the well-being of the snails.

- Research and Continuous Learning: Stay informed about the latest advancements in snail farming, research, and best practices. Continuously educate yourself and your team to adapt and optimize the performance of the snail farming system.

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