



## **Assessment of Snail Farming from Selected Villages in the Mount Cameroon Range, South West Region of Cameroon**

**Njoh Roland Ndah<sup>1,2\*</sup>, Celestine Fonyikeh-Bomboh Lucha<sup>3</sup>, Eugene Loh Chia<sup>4</sup>,  
Egbe Enow Andrew<sup>1</sup>, Tata Yengo<sup>2</sup> and Donald Ngwa Anye<sup>2</sup>**

<sup>1</sup>*Department of Botany and Plant Physiology, University of Buea, P O.Box 63 Buea, Cameroon.*

<sup>2</sup>*Forests, Resources and People, Limbe P.O.Box 111 Limbe, Cameroon.*

<sup>3</sup>*Department of Plant Biology, University of Dschang, P.O.Box 67 Dschang, Cameroon.*

<sup>4</sup>*ECO-CONSULT/GIZ-ProPFE, Yaounde P.O.Box, Cameroon.*

### **Authors' contributions**

*This work was carried out in collaboration between all authors. Authors NRN, TY and EEA designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Authors CFL and ELC managed the analyses of the study. Authors NRN and DNA managed the literature searches. All authors read and approved the final manuscript.*

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### **ABSTRACT**

This study examined the role of snail farming (Heliculture) as a potential tool for conservation and livelihood development in forest dependent communities around the Mount Cameroon National Park (MCNP). The villages selected for this study were Mapanja, Bonjongo, Mokunda and Boana based on their proximity to forest resources. Since it was a pilot study, farmers were selected based on their prior knowledge on snail farming or were currently farming snails locally. A total of 38 questionnaires were distributed to snail farmers of which were 18 males and 20 females in the four villages and we recorded a hundred percent respondents. The questionnaires were based on forest related activities such as collection of non timber forest products, agricultural practices and

\*Corresponding author: E-mail: rolandndah@yahoo.com;

collection of woody products. Observations, monitoring and progressive evaluations were made overtime on some behavioural changes (frequency to the forest for hunting, harvesting of forest products and snail meat consumption). Observations were made on the number of snails stocked, number of dead snails, number of eggs, and number of baby snails. The data were entered into excel and analyzed descriptively. We noticed that after the establishment of snail farms in these communities overtime, individuals covered less distances into the forest 2hrs/week in Mapanja, and less than 1hr/week in Bonjongo, Mukunda and Boana. The number of traps set reduced from 80% in Mapanja and Mokunda to less than 20% and 60% in Bonjongo and Boana to less than 20%. It was noticed that snail meat consumption increased after snails farms were established, Mapanja 29%, Bonjongo 37.5%, Mokunda 33.3% and Boana 29.2% when compared with other protein sources. It was concluded that if proper management of the snail farms around the MCNP can provide a better alternative of bush meat hunting, provide income and reduced human influence on the forest.

**Keywords:** Snail farming; conservation; livelihood; communities; Mount Cameroon National Park.

## 1. INTRODUCTION

Snail farming (Heliculture) has become an important activity in most communities of West and Central Africa [1]. In recent years, the demand for snail meat locally and internationally has increased based on its nutritive (good quality protein of dry weight of 69%, Potassium, Phosphorus, essential amino acids and vitamins C and B complex), medicinal, conservational and aesthetic values [2,3]. Heliculture has the potential to constitute an innovative and a viable agricultural activity with economic, social and environmental benefits [4]. Snail production requires low capital investment; low income earner could comfortably embark on the farming. [5] Reported that snail farming is a veritable enterprise for uplifting the living standard and purchasing power of the farmers.

In Cameroon, snail meat has become a delicacy based on its high iron content of the meat, free from cholesterol, contains vitamins needed in the body and above all, its palatability [3]. The high demand for this meat has caused most snails gatherers to collect snails in both protected and unprotected areas indiscriminately rendering pressure to the species.

The introduction of snail farming in some villages at the periphery of the Mount Cameroon National park plays a paramount role in the conservation (reducing pressure on the forest) of natural resources and for livelihood development. Mount Cameroon, an active volcano which lastly erupted in 2002, is an important area for flora and fauna conservation on the aspect of its rich, diverse, and unique plant and animal species [6,7,8,9,10]. Mount Cameroon Range and surroundings contain around 4,000 higher plant species and about 50 of them are endemic to

Mount Cameroon [9]. Equally, the wildlife of the region is rich with populations of Cercopithecine primates, forest elephant (*Loxodonta africana cyclotis*) and chimpanzee (*Pan troglodytes elliotii*) [11], and at least two endemic birds [12].

Besides the indiscriminate gathering of wild snails, the inhabitants at the periphery villages of the Park are poor and still rely on forest resources such as bush meat, non timber forest products and timber for livelihood [13]. The encroachment to settlements (population growth) and poor agricultural practices ( slash and burn, bush fire, high inputs of fertilizers) has threatened most of the species pushing them to small forest stands where it is difficult to survive [11,14]. This study aimed at assessing snail farming as a potential tool for conservation and livelihood development in the mount Cameroon range in Cameroon.

## 2. DESCRIPTIONS AND SUITABILITY OF SPECIES

The *Achatina achatina* L commonly called the African giant snail belongs to a group of invertebrate animals known as Molluscs, Kingdom Animalia, Phylum Mollusca, Class Gastropoda, and Family Achantinidae [2]. It is a Species of very large air-breathing land snail terrestrial pulmonate gastropods. The shell is broadly ovate with regular conical spine and a narrow posterior end. The shell is brown with zigzag brown black stripes [2]. The fleshy part is dark with white patches. When mature it weighs about 600 g while the egg weighs between 0.3-0.7 g. *A. achatina* is widely distributed, thus easily adapts to environmental variations. It reproduces by self-fertilization, *A. achatina* lays about 100-300 eggs in each growing season with a relatively short incubation period of 2-3 weeks.

The hatchability of *A. achatina* is 100% favouring for snail farming. The high protein content of snail meat, iron, amino acids, cholesterol free and average softness makes palatable for most snail meat consumers [10].

Park is mountainous; soil type is basically volcanic making it suitable for agriculture and the growth of vegetation that provides enough snail food.

### 3. MATERIALS AND METHODS

#### 3.1 Study Areas

This study was carried out in four villages (Mapanja, Bonjongo, Boana and Mokunda) in the South West region of Cameroon (Fig. 1), between January 2009 and September 2014. These villages were located at the peripheries of Mount Cameroon National Park. The study area ranges between latitude 0404.331 and 0402.921 °N; and longitudes 00912.574 and 00912.936 °E. Mount Cameroon Range has a humid tropical climate that favours growth and production of snails. The annual rainfall of the area is about 2.800 mm, most of which is received between June and September [14, 10]. The mean annual temperature is 25°C at sea level and decreases by 0.45°C with every 100 m rise in altitude. A relative humidity average 70-80% at the coast and the annual sunshine varies between 900 and 1,200 hours at sea level [15]. The topography of Mount Cameroon National

#### 3.2 Experimental Design

##### 3.2.1 Selection of villages

Four villages Mapanja, Bonjongo, Boana and Mokunda were selected for this study. These villages were selected based on the following reasons. They are found at the periphery of the mount Cameroon national park and before dependent on the natural resources which have recently been restricted by the state as protected area. These villages have been farming snails at low scale and had baseline information which is needed for this study. Accessibility to these villages was taken into consideration since some of the villages are remote and difficult to reach the study sites. It is a pilot study and in future it will be done in the other villages.

##### 3.2.2 Selection criteria for snail farmers

The family must showed interest in snail farming. Probably they must have carried snail rearing

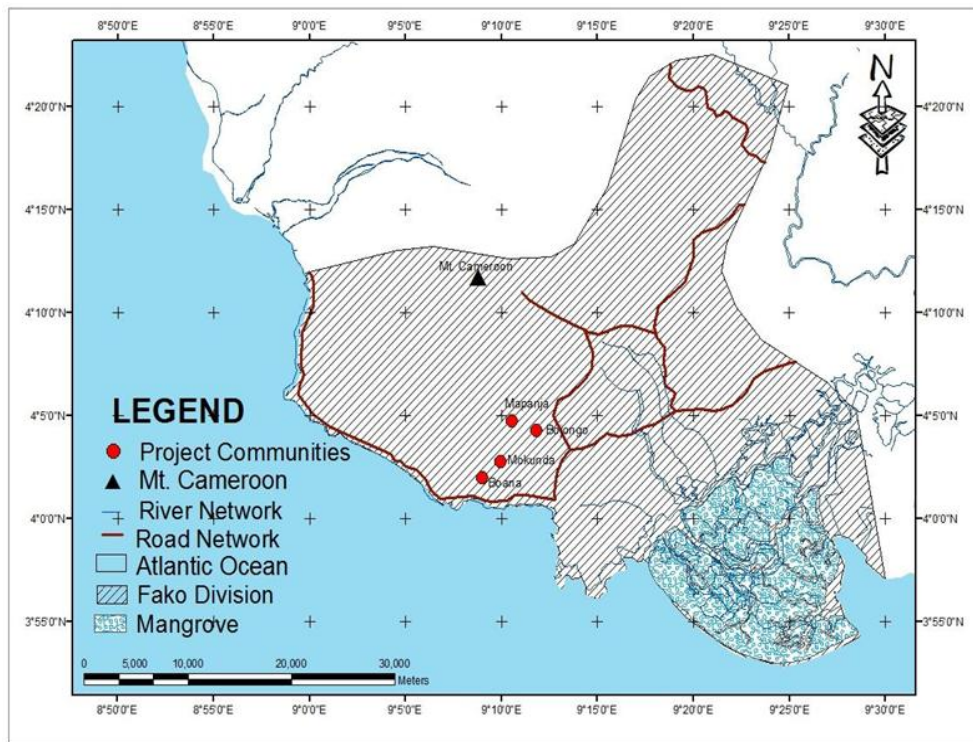


Fig. 1. Location map of study sites on Mount Cameroon Range in Africa

activities for some time or currently farming snails. There should be appropriate space which meet the conditions (besides a shelter, the soil moist and free from stones, covered to prevent direct rain droppings) for the establishment of snail farms and snail feeding materials available for free. They should be willing to form a group with the other families, mainly to ease information transfer to other inhabitants who were not selected and to other communities who may need to replicate the study in their respective communities in future.

### **3.2.3 Selection and collection of species**

The species selected was *Achatina achatina* L commonly called the African giant snail. This species was selected for the study based on its palatability and nutritional value [16]. The species is highly consumed around the region and beyond the nation. The species has high market value as buyers come from nearby Nigeria for snail meat. The species were collected from other snail farms during harvesting period for food and market. The species were collected at the age of three months old when they are mature and highly active [2]. The pens were stocked during the rainy season precisely during the early rains in the month of March.

### **3.2.4 Construction of snail pen and hatchery boxes**

Snail pens were constructed with a length of 2m and width of 60 cm. The boxes were placed on a pole of 1 m height and the entire box was covered by a plastic net to allow free circulation of air (Fig. 2). The pens were separated into two compartments for mature snails in one compartment and baby snails in the other. Soil rich in organic materials was placed 4 cm deep at the floor of the pen which allows the snails to dig and lay eggs. The hatcheries were 40 cm by 40 cm and the floor of the hatchery was made with soft fine earth in which the eggs were laid in cluster.

### **3.2.5 Feeding and management of snail farms**

The snails were fed with green leaves, fruits and tubers. Some of the green leaves were plantain leaves, paw-paw leaves, cassava leaves, and sweet potatoes leaves. The fruits which were commonly given were mangoes, avocado, and bananas and for the tubers they were given cassavas and sweet potatoes. The baby snails at

the early stages were mostly fed with juicy food substances; these were mainly paw-paw fruits and mangoes. Food substances from the kitchen were avoided for salts and oil which attracted predators. The snails were fed 3 times a week and cleaning of the pens were done 3 times as well.

### **3.2.6 Data collection and analyses**

Data were collected in two different periods. Firstly, a recognizance survey was carried out in the study area to ensure the feasibility of the study. Basic information was collected before the introduction of the snail farms in the communities around the Mount Cameroon National Park. Semi structured questionnaires were used to collect information. Questions were designed to provide background and present information on their activities in relation to the forest and livelihood before and after the establishment of snail farmers around the surrounding of Mount Cameroon National Park. Questions were asked on the use of forest (such as the collection of non timber forest products), agricultural practices (such as their farming methods and techniques) and collection of woody products (logging). Other questions were asked on the number of traps set before and after the snail farms were established, the type of main animal proteins consumed by farmers as well as the behavioural changes were closely monitored and evaluated in relation.

Information were collected on the different protein sources consumed (cow meat, fish, wild snails, bush meat, chicken, and reared snails) before the establishment of snail farms in their communities. Questionnaires were made to capture the quantity of animal proteins consumed before and after snail farm establishment. Questions were stated as follows: list the different animals protein consumed, which of the animal protein stated was highly consumed before establishment of snail farms. Rank the different animal protein consumed before snail farms were established, which of the protein was most consumed before snail farms were established, which of the animal protein was the least consumed before snail farm establishment. In the other hand after the establishment of snail farms and harvesting of snails, the following questions were asked. Rank the different animal protein consumed after snail farms were established, which of this protein was mostly consumed, which was least consumed after snail farms establishment.





Gathering of snail stock from existing farms



Stocking of snails in farmers pen



Feeding of stocked snails with potatoes leaves



Hatchery with snail eggs



Hatched snails



Snail soya for livelihood

Fig. 2. Processes of snail development and management in the different villages in the Mount Cameroon Range

to other forest related activities. Information were recorded on the number of snails introduced, number of dead snails, the number of eggs, and the number of baby snails. Data was keyed into Excels and analyzed descriptively.

**4. RESULTS AND DISCUSSION**

**4.1 Demographic Characteristics of the Study**

A total of 38 farmers were recorded in the four villages of the study. Eighteen (18) were males and twenty (20) were females. Most of the farmers within the study sites had completed primary seven with certificates. A total of 38 farmers responded to the questionnaires recording one hundred percent (Table 1).

**4.1.1 Snail collection practices**

Fig. 3 shows the mean distances covered by snail gatherers per week before and after the establishment of snail farming in the Mount Cameroon range and after the five years of pen

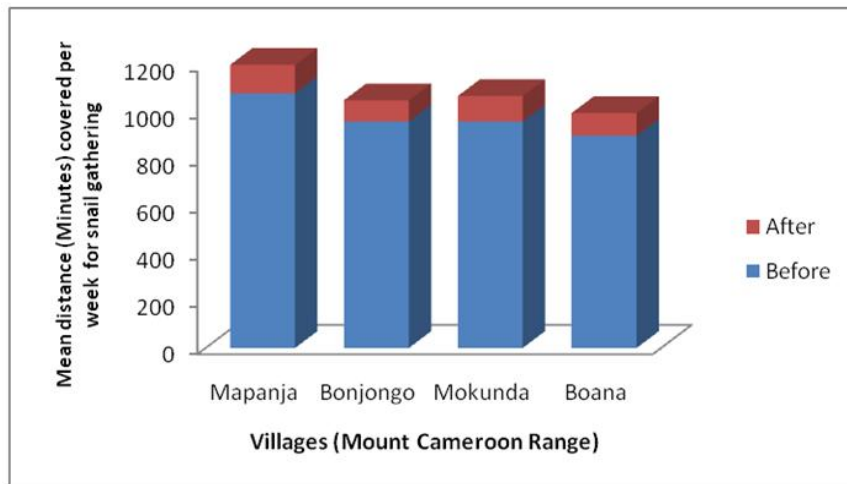
stocking. Before the establishment of the snail farms in the four communities most of the gatherers covered a distance of 20 hrs /week (10 km/week) to search and gather forest snails (Fig. 3). The long distances covered per week by snail gatherers showed the importance of snail meat for income and household subsistence. After the establishment of snail farms within the communities the distances covered by snail gatherers reduced to 2hrs/week (1 km/week) in Mapanja and above an hour in Bojongo, Mokunda and Boana (Fig. 3). Probably this could be due to the training carried out within the four communities that farmers can farm snails behind their houses and save time for other household activities. Snail farmers could generate income from the sale of snails from their pen and harvest some for household protein [1].

**4.1.2 Trapping activities before and after snail farming**

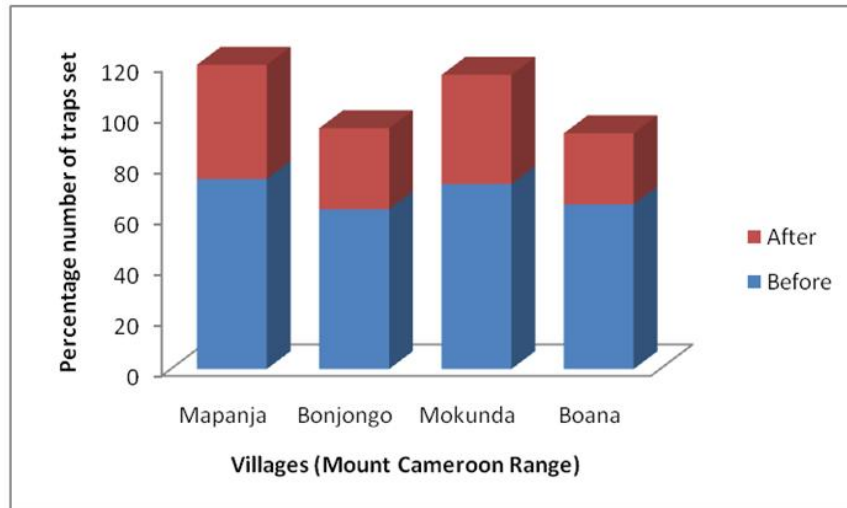
The number of traps set by hunters before and after the establishment of snail farms varied across the communities (Fig. 4).

**Table 1. Shows the demographic characteristics of the farmers in the four villages of the study sites**

Village	Age ranges	Gender		Education	Occupation	Number of persons interviewed	Percentage of respondents
		Male	Female				
Mapanja	30-60	4	4	Primary 7	Farming	8	100
Boana	25-60	5	6	Primary 7	Farming	11	100
Bojongo	28-60	5	5	Primary 7	Farming	10	100
Mokunda	30-60	4	5	Primary 7	Farming	9	100
<b>Totals</b>		<b>18</b>	<b>20</b>			<b>38</b>	<b>100</b>



**Fig. 3. Mean distance (minutes) covered per week for snail gathering before and after five years of establishment of snail farms in the communities**



**Fig. 4. Percentage number of traps before and after the five years of snail farming in the communities**

Before the establishment of snail farms in the communities it was noticed that the number of traps set in the forest were higher. This may be due to the fact that they relied on the forest for their income and protein source (Fig. 4) [17], confirmed that most forest dependent communities relied on the forest for their income and protein sources. After the establishment of the snail farms in the different communities the number of traps set in the forest reduced. This could be due to the fact that snail farms supplied household with some snails. This could reduce some pressure on bush meat harvesting (Fig. 4). Probably the reduction in the number of traps set after the snail farms were established over the years could be as a result of the different sources of proteins. [18], reported that snail farming improved livelihood in communities as it provides snail meat and income from the sale of snail meat.

#### **4.1.3 Behavioural changes in forest related activities in the communities**

Collection of Non Timber Forest Products (NTFPs) such as bush meat harvest, honey, eru, prunus barks and roots, wild snails and forest fruits reduced from high, medium to low over the five years of monitoring and evaluation (Table 2). The harvesting of bush meat and wild snails from the forest was recorded from high to low over the five years of monitoring and evaluation (Table 2). Probably the low harvesting of bush meat and wild snails within the communities could be

attributed to the establishment of snail farms within the communities which provided snail meat for the communities. [18] mentioned in their work that snails produce faster and will provide sufficient snail meat in the communities. [16], reported that snail meat is rich in protein, high in water content and low fat values over beef, chicken, pork and lamb. Probably, these qualities make it preferred over other protein sources and its availability. *Prunus*, honey and eru were noticed from high to medium in the communities (Table 2). Perhaps the medium level observed over the five years period could be linked to the fact that *Prunus*, honey and eru apart from being used as food, also have medicinal properties within the communities. [19, 20], mentioned the uses of *Prunus* as medicinal plants in the Mount Cameroon area and in the Adamawa region of Cameroon respectively.

The collection of NTFPs such as bush mango, bitter kola, kola, cashew nuts were still high at particular seasons during the monitoring and evaluation in the communities. The collections of fruits were still high in all the communities. This may be due to the fact that at peak seasons households gathered these fruits from the forest for income and subsistence. [13], noticed that forest products play a major contribution in household income and subsistence in forest communities around the Mount Cameroon National Park (MCNP).

**Table 2. Behavioural change in forest related activities after five years of introducing snail training and farming in the Mount Cameroon Range**

Forest activities	Mapanja			Bonjongo			Mokunda			Boana		
	High	Medium	Low	High	Medium	Low	High	Medium	Low	High	Medium	Low
<b>Collection of NTFPs</b>	-	-	√	-	-	√	-	√	-	-	-	√
Bush meat harvest	-	√	-	-	-	√	-	√	-	-	-	√
Honey	-	√	-	-	-	√	-	√	-	-	-	√
Eru ( <i>Gnetum africanum</i> )	-	√	-	-	√	-	-	√	-	-	√	-
Prunus ( <i>Prunus africana</i> )	-	-	√	-	-	√	-	√	-	-	-	√
Wild snails gathering	-	-	√	-	-	√	-	-	-	-	-	√
Fruits	√	-	-	-	√	-	-	√	-	-	√	-
<b>Agricultural practices</b>												
Bush fire	-	-	√	-	-	√	-	-	√	-	-	√
Slash-and burn	-	-	√	-	-	√	-	-	√	-	-	√
Shifting cultivation	-	-	√	-	-	√	-	√	-	-	-	√
Snail farming	√	-	-	√	-	-	-	-	√	√	-	-
Chemical application	-	-	√	-	-	√	-	-	√	-	√	-
Agro-forestry	-	√	-	-	√	-	-	√	-	√	-	-
Mixed farming	√	-	-	√	-	-	√	-	-	√	-	-
<b>Collection of WFPs</b>												
Logging	-	-	√	-	-	√	-	-	√	-	-	√
Fuel wood extraction	-	√	-	-	√	-	-	√	-	-	-	√
Charcoal	-	-	√	-	√	-	-	-	√	-	√	-

\*Based on monitoring and observation by the research team

**Table 3. Main animal protein consumed before and after snail farm was established**

Main animal protein consumed by farmers	Mapanja		Bonjongo		Mokunda		Boana	
	Before snail farm	After snail farm	Before snail farm	After snail farm	Before snail farm	After snail farm	Before snail farm	After snail farm
Cow meat	12.5%	8.3%	16.7%	16.7%	16.7%	12.5%	16.7%	12.5%
Fish	25%	16.7%	25%	16.7%	29.2%	16.7%	25%	20.8%
Wild snail	16.7%	8.3%	16.7%	12.5%	12.5%	12.5%	20.8%	12.5%
Bush meat	20.8%	12.5%	25%	4.2%	20.8%	8.3%	20.8%	8.3%
Chicken	20.8%	16.7%	4.2%	12.5%	16.7%	16.7%	12.5%	16.7%
Reared snails	4.2%	29.2%	-	37.5%	4.2%	33.3%	4.2%	29.2%



Agricultural practices such as bush fire, slash-and-burn, shifting cultivation and high use of chemical application have shifted from high to low in the respective communities over the five years of monitoring and evaluation (Table 2). This could be due to the knowledge communities acquired on conservation and land use management during the snail project implementation. The shift could be related to the low output realized from their harvest over the past years. Other agricultural practices such as agro-forestry and mixed farming were encouraged and ranged from low to high over the five years of monitoring and evaluation within the communities (Table 2). The favourable agricultural practices such as agro-forestry, analog forestry and mixed farming could have led to improved yield of crops and improved income for livelihood activities. [20], noted that improved agricultural practices around protected areas could improve their yields and livelihoods.

Collection of woody forest products was observed to reduce from high to low in the different forest communities (Table 2). Timber logging and charcoal production was noticed to be low over the five years of monitoring and evaluation. Probably the low extraction of timber and charcoal production in the communities could be due to the re-enforcement of forest guards and the forested areas. Fuel wood was observed to be medium to high in consumption in some communities (Table 2). This could be attributed to the fact that it is the main source of energy for food preparation. Other communities were noticed with kerosene cookers and gas cookers as a substitute source of energy.

## **5. LIVELIHOODS**

### **5.1 Percentage of Main Animal Proteins Consumed**

The main animal proteins consumed in the different communities were cow meat, fish, wild snails, bush meat, chicken and reared snails (Table 3). Before the establishment of snail farming in the different communities, the main animal proteins consumed were bush meat and fish (Table 3).

Before the establishment of the snail farms bush meat was recorded as the highest main animal protein consumed in Mapanja with 20.8%, Bonjongo with 25% and Mokunda with 25%. The high percentage of bush meat consumption in

these communities could be attributed to their close proximity to the forest. [20], confirmed that communities close to tropical forest obtained most of their resources from the forest. The high percentage recorded for fish consumed before snail rearing establishment in Mokunda with 29.2% and in Boana 25%. The high percentages recorded for fish may be due to availability and affordability of this protein since traders of fish visited the communities. After the establishment of the snail farms in the different communities, it was noticed that reared snails were the highest protein consumed over other protein sources (Table 3). It was also noticed that the consumption of fish was also high (Table 3).

The percentages of reared snails consumed after the establishment of snail farms were Mapanja 29.2%, Bonjongo 37.5%, Mokunda 33.3% and Boana 29.2%. The high percentages of snails consumed in all the communities after the snail farms were established could be attributed to the fact that most of the farmers harvest snails from their farms. The knowledge obtained on the protein content over other protein sources enable farmers to consume more snails. [16], found out that snail meat is rich in protein and carbohydrate.

## **6. CHALLENGES FACED BY FARMERS**

The main challenges farmers faced are mostly during the dry season where the soils are dry and moisture is less. Most of the snails aestivated and others desiccated and died, thereby reducing production. Another challenged farmers faced was the invasion of predators in the pens. Some of the common predators are soldier ants, centipedes and lizard. Food availability during the dry period is another challenge farmers encountered. Farmers will have to move longer distances to search for snail food to feed the animals.

## **7. CONCLUSION**

This study examined snail farming as a potential tool in forest resources conservation and livelihood improvement in communities at the periphery of a protected area. These communities relied for their subsistence and income generation from resources gathered from the protected area. It was noticed that with the establishment of snail farms in these communities, gathering of wild snails and other forest resources in the National Park have

reduced. The distances covered in search of bush meat as source of protein was also reduced since snail meat was readily available and provided better nutrient values over other sources of protein. The number of traps set in the forest and other related hunting activities dropped over the years of monitoring and evaluation. Snail meat was a good substitute over other sources of meat harvested from the forest. It was noticed that after the establishment of snail farms, most of the indigenes consumed more of snail meat over other sources of protein. Based on our results we recommend that snail farming could be use as a potential tool for conservation and livelihood improvement in other communities closer to protected sites.

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### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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