academicJournals

Vol. 8(11), pp. 1457-1465, 2 May, 2013
DOI: 10.5897/AJAR2013.7036
ISSN 1991-637X ©2013 Academic Journals
http://www.academicjournals.org/AJAR

African Journal of Agricultural Research

Full Length Research Paper

The perception of climate and environmental change on the performance and availability of the edible land snails; a need for conservation

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Accepted 22 April, 2013

Gastropods are vulnerable to extremes of climate and could be useful indicators of climate change and environmental manipulations. The aim of this study was to determine the perceptions of producers and harvesters of snails on climate change and habitat destruction, their effects on snails and the availability of the snail's feed. Questionnaires (402) were distributed in the Buea, Tiko, Muyuka, Kumba, Tombel, Ekondo Titi and Mamfe areas of Cameroon. Most respondents confirmed that they have heard about climate change (91.2%) and habitat destruction (87.3%). High proportions of 90.4 and 77.6% have noticed recent negative changes in the population of snails and their production respectively. Asked if these changes affect snail feeds as well, respondents said yes (53.5%) or partially (17.3%), explaining that it brings about a reduction in their feed mostly in the wild (showing a need for more domestication). Respondents (62.6%) also indicated that these changes expose the snails to pests, parasites and diseases, with 56.9% saying that these changes affect the performance and availability of snails. It can be deduced from the responses that climate change and environmental manipulations have an influence on the performance and availability of snails in captivity and in the wild, which necessitates conservation measures.

Key words: Snails, climate change, environmental manipulations, feed, performance, South west region - Cameroon.

INTRODUCTION

Snail farming/gathering and consumption is becoming increasingly popular in Cameroon. It is an important source of livelihood for rural dwellers and a source of protein for both rural and urban dwellers in Tropical Africa in particular but also the rest of the world (FAO, 1986; Ngenwi et al., 2010). Most of the land snails of West African origin (*Archachatina* spp., *Achatina* spp., *Limcolaria* spp.) are forest dwellers found mostly along the coastal zone (Imevbore, 1990). The problem of malnutrition in humans, which has its roots from shortage of animal protein, has encouraged researchers to look for alternative sources of animal protein which can be gotten with little or no capital investment. Micro-livestock or non-conventional livestock such as snails, grass-cutters etc

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have been domesticated and a significant amount of research is ongoing, aimed at increasing their availability at an affordable price. Snails are an important source of animal protein in many parts of West and Central Africa (Blay et al., 2004), having good quality protein (69% dry weight) and being rich in potassium, phosphorus, essential amino acids and vitamins C and B complex (Baba and Adeleke, 2006, Okpeze et al., 2007). Snail farming is environmentally friendly and can be done with minimal skill (NRC, 1991; Akinnusi, 1998) and low capital requirement for establishment and running. Snails and snail farming are also characterized by very high fecundity and low mortality, low labor requirement, lack of noise and with readily available markets (Cobbinah, 1993; Baba and Adeleke, 2006).

Recently, the production of snails has not kept pace with demand (Etchu et al., 2008), with different environmental and technical factors implicated. Environmental manipulations (urbanization, deforestation, burning of biomass, the use of harmful chemicals) and climate change as well as lack of training on intensive snail rearing have been identified as impediments to increased snail supply from the wild and in captivity (Ngenwi et al., 2010). Climatic variables are among the determining factors in the survival, growth and sustenance of any organism in its niche, including Mollusks. The performance of an organism is directly or indirectly dependent upon the innate ability of the organism as well as the totality of its surrounding. Climate change is already having a negative impact on Africa through extremely high temperatures (IPCC, 2007), which are not favorable to snail growth and development. The scale of domestication and intensive management of the edible land snail is bound to increase and conservation is consequently needed. To date, research on climate change in the tropics has focused mostly on crops, less on livestock and little on biodiversity conservation. Change in species abundance can provide useful insights on climate change and drivers of this change. However, there is dearth of information on this in most parts of the tropics.

Also, to understand the ecology and evolutionary biology of any given population, we need to understand how these populations respond to changes to an ideal environment (Maynard, 1989; Hoffman and Parsons, 1991; Peters and Lovejoy, 1992). The risk of extinction is eminent in populations that face the risk of, or are subjected to substantial environmental stress such as seen during colonization attempts, human-influenced introductions and reintroductions or the repercussions of the global climate change. Climate change is likely to have major impacts on poor livestock keepers and on the ecosystem services on which they depend.

Seasonal variations in land snail physiology and biochemical composition have been linked to annual cycles of photoperiod, temperature, humidity, water availability and reproduction (Machin, 1975; Riddle, 1983; Cook, 2001; Storey, 2002). Seasonal physiological data for land snails may be useful in understanding species-specific habitat requirements and in predicting their response to environmental changes. Of special interest are responses and adaptations of land snails to the climatically unpredictable ecosystems (Blondel and Aronson, 1999). However, there are relatively few informative, long-term field studies on aspects of the physiological ecology of land snails (Wieser and Wright, 1979; Riddle, 1983; Arad, 1993; Rees and Hand, 1993; Pedler et al., 1996; Arad and Avivi, 1998; Arad et al., 1998; Sinos et al., 2007).

While climate change is a global phenomenon, its negative impacts are more severely felt by poor people in developing countries who rely heavily on the natural resource base for their livelihoods. Agriculture and livestock keeping are amongst the most climate sensitive economic sectors and rural poor communities are more exposed to the effects of climate change (FAO, 2008, 2009). There are global health implications related to biodiversity loss and many of the anticipated health risks brought about by climate change will be caused by loss of genetic diversity (Cohen et al., 2002; ARD, 2008).

This study was therefore carried out to assess the human perception (snail famers and gatherers) about the effects of both climate change and man-made environmental changes (anthropogenic stressors) on the performance and availability of edible land snails (*Archachatina* spp. and *Achatina* spp.) both in the wild and under conditions of artificial propagation. We sampled the opinion of the snail farmers and gatherers because, firstly, they have been dealing with the snails for quite a while and secondly because they literally deal with the snails on a daily bases.

MATERIALS AND METHODS

This study was carried out in 5 {Fako (4° 9'N, 9° 13'E), Kupe Muanenguba (4° 50'N, 9° 40'E), Manyu (5° 45'N, 9° 18'E), Meme (4° 37'N, 9° 26'E) and Ndian (4° 36'N, 9° 5'E)} divisions out of the 6 divisions of the South west region of Cameroon between June and October, 2011. The South west region is a cosmopolitan region with many and different ethnic groups with different cultural values and it is exclusively a humid forest ecosystem characterized by a monomodal rainfall pattern. A total of 52 questionnaires were distributed to snail farmers and those who harvest the snails from the wild in each of six localities (Buea, Tiko, Muyuka, Kumba, Tombel, and Ekondo Titi). Mamfe, the chief town of snail consumption received 90 questionnaires.

The questionnaire carried both open and closed questions, with the open questions given tags during analysis. The questions were asked in order to obtain the candid opinion and experience of the respondents about climate change (CC) and environmental manipulations (EM), and the effects of the climate change and environmental manipulations on both the snails (their availability and performance), their feeds (generally), feed types (individual or the different feed types), and number of snails etc.

Data collected was analyzed using statistical package for social sciences (SPSS) software, standard version, release 17.0 (SPSS Inc. 2008). Descriptive statistics provided insights into the snail farmers' and gatherers' perceptions of climate change and anthropogenic stressors on the edible land snails. Measures of

Table 1. Climate change and habitat/environmental destruction awareness of snail farmers and gatherers in the different Divisions of the South West Region of Cameroon.

Division of residence		Have you heard about climate change?				Do you know what habitat destruction is?			
		Yes	No	Partially	Total	Yes	No	Partially	Total
Fako	n	106	7	0	113	110	5	1	116
	%	93.8	6.2	0.0	100.0	94.8	4.3	0.9	100.0
Kupe Muanenguba	n	44	0	1	45	34	6	3	43
	%	97.8	0.0	2.2	100.0	79.1	14.0	7.0	100.0
Manyu	n	85	11	2	98	71	13	13	97
	%	86.7	11.2	2.0	100.0	73.2	13.4	13.4	100.0
Meme	n	37	10	0	47	43	4	0	47
	%	78.7	21.3	0.0	100.0	91.5	8.5	0.0	100.0
Ndian	n	50	0	0	50	50	0	0	50
	%	100.0	0.0	0.0	100.0	100.0	0.0	0.0	100.0
Total	n	322	28	3	353	308	28	17	353
	%	91.2	7.9	0.8	100.0	87.3	7.9	4.8	100.0

association between variables were carried out using Chi-Square test of independence or of equality of proportions for nominal Vs nominal and nominal Vs ordinal variables and Sommers'd for Ordinal Vs Ordinal variables. Multiple response analysis for multiple-responses question (with possibility for more than one response to a single question).

RESULTS

From a total of 402 questionnaires sent to the field, 393 were returned and validated for data. Out of the 393 received, 358 questionnaires were effectively used for data analysis following exploratory statistics, with 35 questionnaires discarded due to lack of relevant information (because either the respondent did not complete the questionnaire or responses to questions were scanty) after exploratory statistics.

Table 1 gives a summary of the awareness about climate change by snail farmers and gatherers while Table 2 gives data on awareness of habitat or environmental destruction. For climate change awareness, the majority of the farmers or gatherers answered in the affirmative to having a knowledge on climate change (91.2%, n = 322) and partial knowledge (0.8%, n = 3) as opposed to those professing no knowledge on climate change (7.9%, n = 28) (Table 1). The knowledge on climate change also varied significantly between the different Divisions ($P < 0.05$). A majority (87.3% ± 4.8%) of the snail farmers and gat-herers have knowledge of habitat destruction (Table 1).

Also, a majority of the farmers and gatherers (90.4%, n = 321) have noticed a decline in the snail population recently and there is a significantdifference between those who responded "Yes" from those who said "No" ($\chi^2 = 38.351$, $P < 0.05$) (Table 2).

Slightly more than 85.8% of those interviewed have noticed changes in the wild (Table 3) and 56.9% believe it is due to the combined effects of climate change and habitat destruction (Table 3). Data in Table 4 reveals that 77.6% believe these climatic and environmental anomalies have greatly affected their production of snails and some 56.6% thinks that these changes also affect the performance of these animals significantly (Table 4). Asked if these changes affect the feed of the snails, 53.5% said that the changes do affect the snail feeds greatly and in a negative way (Figure 1). A total of 62.6% affirmed that these changes in the environment also expose their snails to pests, parasites and diseases, as the environment created is favorable for these pathogens to strive (Figure 2). Some negative effects of climate and environmental changes on the availability and performance of the edible land snails as seen by the farmers or gatherers, with more mortalities of snails (56.96%), harsh environment and reduction in

Table 2. Perceived changes in snail Population in recent times.

Division of residence		Have you noticed any changes on the snail population recently?		
		Yes	No	Partially
Fako	n	104	9	2
	%	90.4%	7.8%	1.7%
Kupe Muanenguba	n	36	1	8
	%	80.0%	2.2%	17.8%
Manyu	n	88	9	1
	%	89.8%	9.2%	1.0%
Meme	n	47	0	0
	%	100.0%	.0%	.0%
Ndian	n	46	0	4
	%	92.0%	.0%	8.0%
Total	n	321	19	15
	%	90.4%	5.4%	4.2%

water availability (47.34%), lack of food for the snails (43.68%), low production of snails and reduction in population (Av - 37.28%) and deforestation (which exposes snails to too much sunlight) at 36.10% (Table 5). The majority of snail farmers or gatherers have been involved in this activity for more than a year (Figure 3).

DISCUSSION AND CONCLUSION

Climate change is well known to farmers or gatherers of edible land snails, who show considerable awareness of the phenomenon. Habitat or environmental destruction which is a man-made phenomenon has also been noticed by farmers or gatherers of snails. Both phenomena influence to a great extent the performance and availability of the edible land snails as has been observed by farmers and gatherers of the snails. Naturally, snail production and availability is higher in the rainy season than in the dry season, as there is readily available and more feed in an environment conducive for habitation which ensures effective performance of the snails. This is confirmed by studies by Marcelo (2000), who reported that snails consistently respond to changes in their physical environment. Environmental and climatic factors play an important role in determining the survival (production and availability) and performance of snails, as these not only affect the snails directly but also indirectly via the introduction of new pests, parasites and diseases (Ngenwi et al., 2010) as well as influencing their feed (Clarke, 1998; Sternberg et al., 1999). Environmental factors such as deforestation, increased temperatures with low rainfall, slash and burning (bush fires), uncontrollable collection from the wild, high use of agrochemicals and lack of training on intensive snail farming are all impediments to increase snail supply both from the wild and in captivity (Ngenwi et al., 2010), in response to increasing demand. All these factors can cause a decline in the population of the edible land snails (Amusan and Omidiji, 1998). Climatic factors are among the determining factors of growth and survival of mollusks. Land snails prefer humid environments for optimum performance in the presence of their choice feed (Ejidike et al., 2004).

Decreasing rainfall and increasing temperatures would have an adverse effect on the conditions necessary for adequate development and reproduction. Temperatures in West Africa have changed faster than the Global trend, with increases in the range of 0.2 to 0.8°C from the late 1970s (ECOWAS-SWAC/OECD, 2008). There is therefore a need for conservation of snails via the improvement of feed or alternative feed (Agbogidi et al., 2008; Ngenwi et al., 2010), promotion of aforestation, moderation of collection and the creation of awareness among people about the need for conservation of natural resources (snails).

The present study focused on local observations of snail farmers or gatherers on the consequences of climate change and environmental perturbation. This study is the first step towards understanding the complexity of the interactions of snails and their environments under conditions of global climate change.

Table 3. Observed changes in the wild and reasons for observed changes in the wild; distribution by division of residence.

Division of residence		In the wild, have you noticed such changes?				Are these changes in the wild related to climate change or habitat destruction?				
		Yes	No	Partially	Total	Climate change only	Habitat destruction only	Both climate change and habitat destruction	None	Total
Fako	n	98	4	3	105	10	33	58	8	109
	%	93.3	3.8	2.9	100.0	9.2	30.3	53.2	7.3	100.0
Kupe Muanenguba	n	19	6	14	39	1	3	39	0	43
	%	48.7	15.4	35.9	100.0	2.3	7.0	90.7	0.0	100.0
Manyu	n	77	16	3	96	8	26	40	18	92
	%	80.2	16.7	3.1	100.0	8.7	28.3	43.5	19.6	100.0
Meme	n	45	2	0	47	1	7	21	18	47
	%	95.7	4.3	0.0	100.0	2.1	14.9	44.7	38.3	100.0
Ndian	n	50	0	0	50	13	0	36	1	50
	%	100.0	0.0	0.0	100.0	26.0	0.0	72.0	2.0	100.0
Total	n	289	28	20	337	33	69	194	45	341
	%	85.8	8.3	5.9	100.0	9.7	20.2	56.9	13.2	100.0

This can then be extrapolated to other vulnerable organisms. Further experimental investigations of other invertebrates, with their intrinsic characteristics and interactions with other organisms and their respective environments, will provide useful tools to test predictions of the responses of snails to climatic and environmental changes. It can be deduced from the responses of the respondents (that climate change and manipulation of the environment may have an influence on the performance and availability of the edible land snails. The awareness of climate change and environmental changes match with the devastating effects of these phenomena on the edible land snails of the genus *Archachatina.* Both these processes create conditions that are unfavorable for the development and reproduction of the snails both in captivity and in the wild. As a result of these, there is a gradual but steady decline in the population of this highly priced non-conventional livestock, both in captivity and the wild, whereas its value and consumption rate are on a sturdy increase. Therefore, there is a need for conservation via the use of improved feed or alternative feed that can last throughout the year, training of farmers to intensify and improve management practices of their snail farms as well as the discouraging of practices that promote or enhance climate change and habitat destruction. The latter includes slash and burning (bush fires), deforestation, and the use of agrochemicals. This can only be achieved by creating awareness among the local population of farmers and collectors.

Table 4. Effects of climate change and environmental destruction on production and performance of snails both in captivity and the wild; distribution by divisions of the south west province of Cameroon.

Division of residence		Do these changes affect your production?				Do these changes affect their performance?			
		Yes	No	Partially	Total	Yes	No	Partially	Total
Fako	n	90	17	3	110	80	20	10	110
	%	81.8	15.5	2.7	100.0	72.7	18.2	9.1	100.0
Kupe Muanenguba	n	24	5	16	45	14	6	23	43
	%	53.3	11.1	35.6	100.0	32.6	14.0	53.5	100.0
Manyu	n	66	20	6	92	47	29	18	94
	%	71.7	21.7	6.5	100.0	50.0	30.9	19.1	100.0
Meme	n	42	4	1	47	42	3	1	46
	%	89.4	8.5	2.1	100.0	91.3	6.5	2.2	100.0
Ndian	n	45	2	3	50	11	6	33	50
	%	90.0	4.0	6.0	100.0	22.0	12.0	66.0	100.0
Total	n	267	48	29	344	194	64	85	343
	%	77.6	14.0	8.4	100.0	56.6	18.7	24.8	100.0

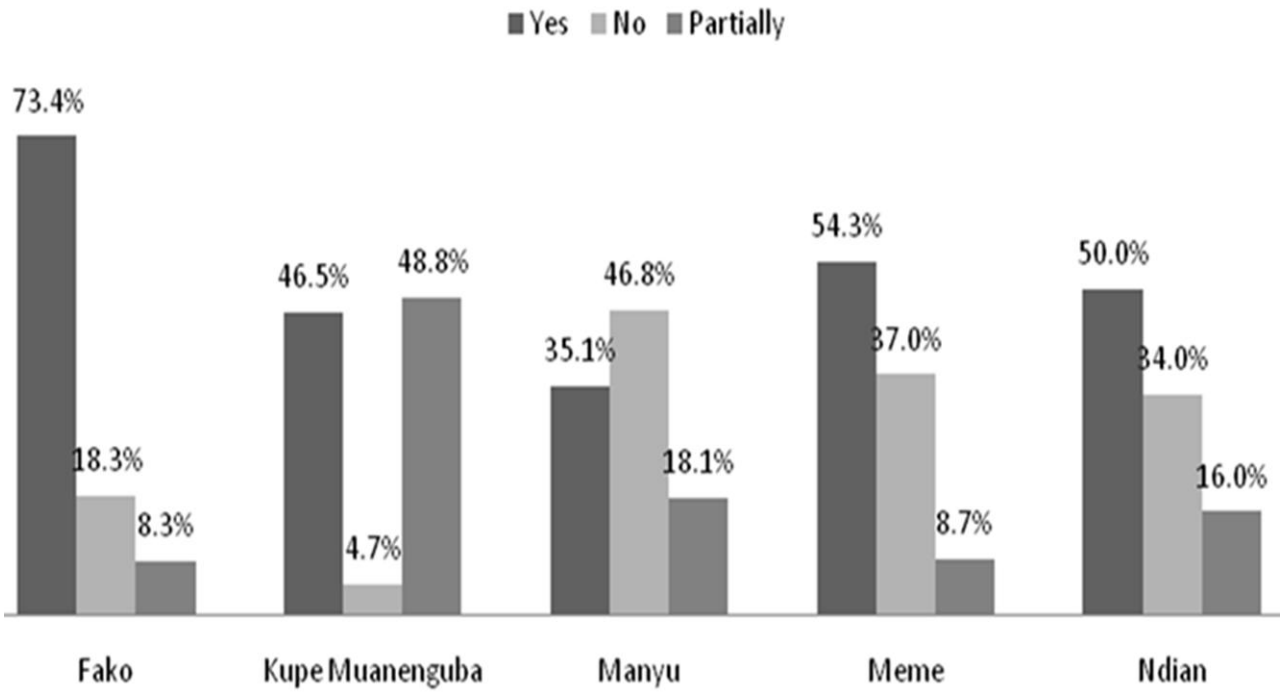

Figure 1. Effects of changes on feeds as perceived be farmers/gatherers of the edible land snails.

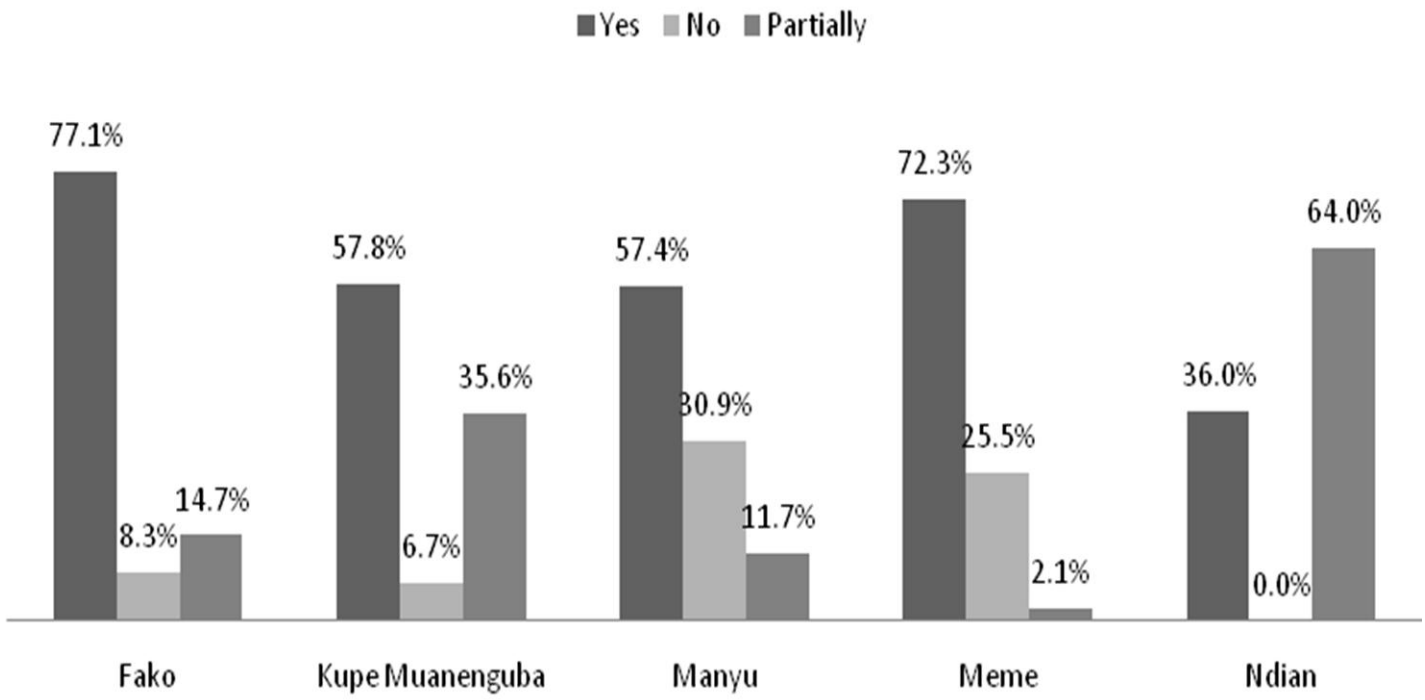

Figure 2. Exposure of the edible land snails to pests, parasites and diseases?

Table 5. Some major effects of climate and environmental changes on snails' availability and performance in the different study sites.

Effects		Division of residence					
		Fako	Kupe Muanenguba	Manyu	Meme	Ndian	Average percentage
Increase diseases	n	0	2	9	0	44	
	%	0.0	7.1	12.9	0.0	91.7	22.34
Low production of snails and reduction in population	n	20	15	18	0	40	
	%	23.8	53.6	25.7	0.0	83.3	37.28
Reduction in size	n	4	3	0	0	0	
	%	4.8	10.7	0.0	0.0	0.0	3.1
More dead of snails	n	52	15	49	39	2	
	%	61.9	53.6	70.0	95.1	4.2	56.96
Lack of food for the snails	n	52	9	13	34	11	
	%	61.9	32.1	18.6	82.9	22.9	43.68
Harsh environment makes habitation difficult and reduce water availability for snails	n	54	5	10	31	31	
	%	64.3	17.9	14.3	75.6	64.6	47.34
Deforestation exposes snails to too much sunlight	n	49	6	4	39	0	
	%	58.3	21.4	5.7	95.1	0.0	36.10

Table 5. Contd.

Inadequate soil texture	n	2	6	3	0	0	
	%	2.4	21.4	4.3	0.0	0.0	5.62
Toxic waste disposal that kill snails	n	2	0	0	0	0	
	%	2.4	0.0	0.0	0.0	0.0	0.48
Soil erosion	n	4	0	0	9	0	
	%	4.8%	0.0%	0.0%	22.0%	0.0%	5.36
Snails are burnt during slash and burning	n	2	0	2	0	0	
	%	2.4%	.0%	2.9%	0.0%	0.0%	1.06
Total	n	84	28	70	41	48	
	%	31.0%	10.3%	25.8%	15.1%	17.7%	

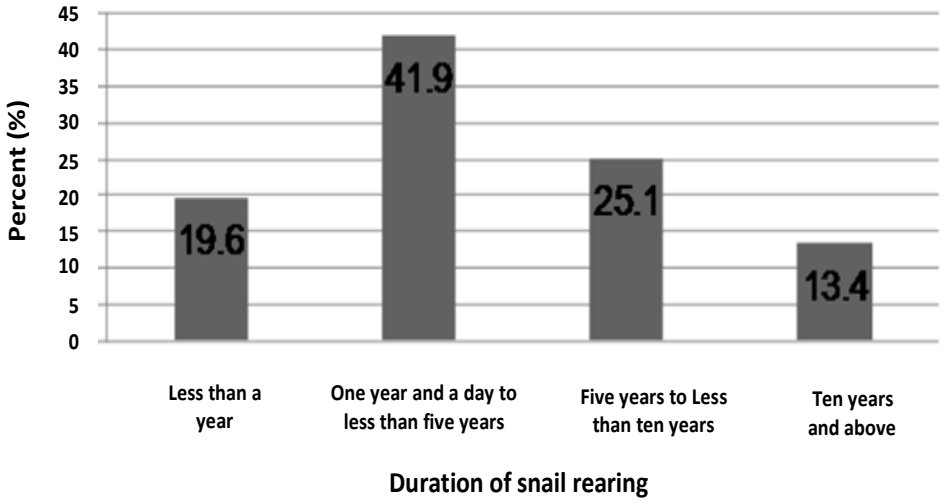

Figure 3. Duration of activity of the snail's farmers/gatherers.

ACKNOWLEDGEMENT

We acknowledge the enumerators who patiently distributed the questionnaires as well as a very big 'thank you' to the respondents who made this study possible.

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