THE ECONOMICS OF SPECIE ENDANGERMENT: AN APPLICATION TO SNAIL HUNTING IN EDO STATE, NIGERIA

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Abstract

The paper examines the exploitation of natural snail reserves in Edo State (Nigeria) using field data collected from rural snail hunters, traders and local consumers. The analyses reveal a high rate of exploitation which poses a threat to the sustainability of the biological resource. Among the proximate and underlying factors identified as responsible are rising population coupled with an increasing local and international demand for snail meat; high level of rural poverty and unemployment; the absence of a clearly defined property right and the inability of markets and governments to preserve ethically acceptable standards. The study explores various methods (hat could be used to regulate snail hunting in the State and suggests the cultivation of snails at subsistence and commercials levels as a means of reducing the pressure on natural snail populations and at the same time empowering rural households.

Introduction

In the last three decades, there has been a growing concern over the rapid depletion of the . world's biological resources with the United Nations predicting a decline in world's species present in the mid 1980's by as much as 25 percent by the year 2015 "or soon thereafter" (UNEP, 1992). This concern is borne out of the link between these resources and the functioning of ecosystems. Ecologists, generally agree that some level of biodiversity is essential to the proper functioning of ecosystems on which human production and consumption activities as well as existence depend (Barbier *et al,* 1995; Ehrlich and Daily, 1993; Perrings *et al,* 1992), (see Figure 1). Thus, attempt must be made to preserve existing biological species, more so when human knowledge of the role of particular species or groups in the generation of ecological functions and the value of biodiversity for human, agricultural, ethical, medical and social purposes is still very limited (Holling *et al,* 1995).

Many species of land snails are currently listed as endangered, threatened or extinct due to destruction or loss of natural habitation and over-exploitation of natural populations (COA Conch-Net Web Page, 1996). Stepozak (1992), shows, for example, that out of forty different snail populations studied over a period of eighteen years (1973-91), only one population could be studied consistently for sixteen years because commercial collectors disturbed others. Much of the literature on specie conservation with particular reference to land mollusc, have been centered on Europe, America and the Pacific. Little or no attention has been given to Africa even though the evidence suggests that massive overexploitation coupled with destruction of natural habitat poses a great threat to the population of many "African Giant land snails". This paper examines the exploitation of natural snail reserves in Edo State (Nigeria) using field data collected from rural snail hunters, traders and local consumers. It shows that, the present rate of exploitation may not be sustainable and examine various methods that could be used to regulate snail hunting and trading in the State.

The remaining part of the paper is divided into five sections. Section two presents a background review of the economic importance and hunting of snails in the State, while section three presents the theoretical framework. The methodology and analyses are presented in section four, while section five discusses the findings and implications for policy. Section six concludes.

Background

The predominant species of snails found in Edo State (Nigeria) is *Achachtina Marginata.* These species (also called the 'Giant African Snail') belong to the *Achatinidae* family which are irregularly distributed in Africa and some of its islands with a high concentration in the forest zone of West Africa and has been of great interest to scientists and shell collectors because of its relatively large size (Awah, 1994). *Achachatina Marginata* is found in forest reserves, plantations, farmlands, and sometimes in small bushes across the state. In the dry season (usually from November of one year to April of the following year), they go into hibernation, hiding inside the soil and sometimes

under wood particles or leaves of plants, and come out during rainy seasons to feed and procreate. Snail meat is believed to be "low in fat, rich in protein and iron, contain most of the amino acids needed for human nutrition and pharmacological properties useful in counteracting some types of ailments such as high blood pressure, anemia, kidney disease, tuberculosis, etc. (Awah, 1994). As such, it is generally consumed by many in the state.

Achachatina Marginala is hunted by local farmers/villagers in Edo State during the day as well as in the nights, using simple instruments such as cutlasses, sticks, and lamps. Sometimes, especially, during dry seasons, villagers employ bush burning in the search for snails. Though having a fairly long history, snail hunting has not been an attractive venture in the State until recently. Snails were generally available and cheap, and the demand for snail meat was not very high as most persons preferred beef. and fish. The situation has however, changed dramatically with snail hunting and trading emerging as a booming business and leading to a massive exploitation of snail reserves. Many are of the opinion that the present exploitation level of Achahcatma Marginata in Edo State, and perhaps in many other parts of Nigeria where the specie predominates, poses a threat to the sustainability of the natural population.

Theoretical Framework

3. / The Growth Function of Renewable Natural Resources

Land snail is a renewable (regenerative) biological resource. Given a stable environment, the rate at which the resource rejuvenates (the natural rate of growth) denoted by H(s) is a function of the stock level (S_t) where t is a continuous time variable. In the absence of human encroachment, the ecological balance is defined by the equation:

dS,/dt =H(S,) (1)

Many studies on regenerative natural resources assume H(S) to be quadratic in S and to have the form:

H(S)= aS-j3S^2 (2)

Where a is a positive constant representing the percentage rate of growth and p > 0. Equation (2) implies that growth is always positive even when the stock (S,) is a very small positive number. However it shows that the rate of growth will increase rapidly, reach a maximum and begin to fall. In other words, S, will increase at a decreasing rate until it reaches the threshold level, after which it begins to decline. For regenerative species with lower biotic potentials, the quadratic equation will take the form: H(S) = a + (3S, - SSt^2 (3)
Where a, p and 5 > 0. The solution to (3) yields

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$$\underline{S} = \left[\beta - \sqrt{(\beta^2 - 4\alpha\delta)}/2\alpha\right] \quad (4)$$

and

$$S^{-} = \left[\beta + \sqrt{(\beta^2 - 4\alpha\delta)}/2\alpha\right] \quad (5)$$

Where S is the (minimum) threshold level below which there will be negative growth and the specie will run into extinction and S is the natural equilibrium level of stock which is attained when there is no harvest for a long period of time. The maximum sustainable yield (MSY) is achieved at the point where H(S) - /?/ 25 and corresponds to the 'golden rule of capital accumulation' in growth literature (Dasgupta, 1982: 125).

Equation (3) is often applied to fisheries and can be applied also to snails. Even though the latter are hermaphrodites, the size of the stock in a given habitat must be significant for effective reproduction to take place.

3.2 **Introducing Human Encroachment (Harvest)**

If we introduce human encroachment (harvest), the dynamic growth equation in (1) can be written as

dS/d, = H(SJ - X, (6)

X, (the harvest rate at time t) will depend on the stock of snails available in a given time (S_t) and the hunting effort (which includes labour and cost of necessary equipments). Mathematically

X, = X(S,, E) (7)

Where E is the hunting effort. The rate of harvest increases in stock and effort such that dX,/dS,, dX, /dEX).

Substituting (7) into (6), and (3) into the resulting equation yields

$dS/d, = a + f3S>^2 - X(S_h E)$ (8)

which when equated to zero and solved for X, gives the condition for a stationary harvest policy as one that ensures that H(S,) = X(S,, E), that is , the natural rate of growth is equal to the rate of harvest. In Fig. 2, the harvest curve X, = X(S_t, E) is super imposed on the growth curve H(SJ. This gives two points (S/, and S'_{tl}) at which the stationary harvest policy is realized. If Si, < S'/, , stock will decline but this would not portend any threat to the continuous existence of the specie. If however, S, < S/,, continuous harvest will lead to the ruin (exhaustion) of the biological resource. Also where the harvest curve does not intersect with the biological growth curve (e.g. if X, = X', as in Fig. 2), the stock will decline under free entry and in finite time leading to extinction.

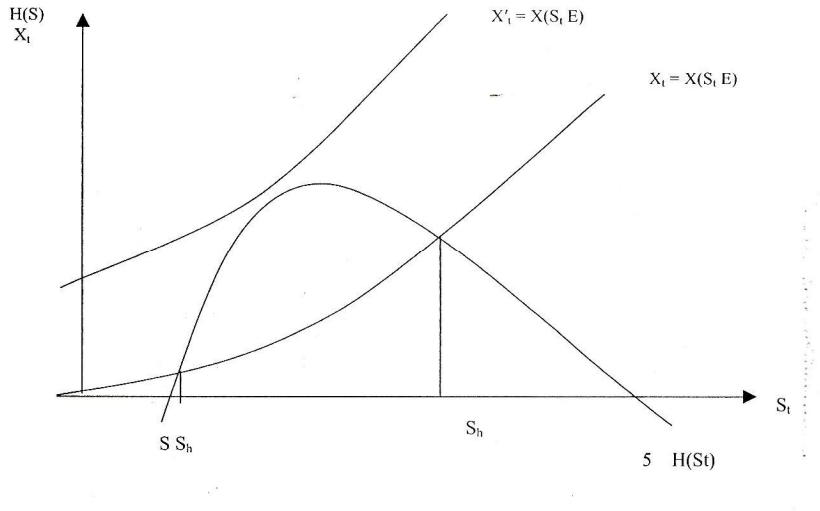

Fig. 2 Human Encroachment and the Growth Function of Regenerative Natural Resources
Source: Adapted from Dasgupta (1982),

The conclusion drawn by many environmental and natural resources economists from theoretical models such as the one above is that if a biological resource is very valuable, free entry leads to excessive catch in the sense that the harvest rate exceeds the natural rate of rejuvenation even if the stock is very large. This means that the net rate of regeneration is negative and the resource is doomed. However, if otherwise, then for a range of stock levels, the harvest rate at which the industry's profit is zero is less than the current rate of natural regeneration. This enables the stock to grow (Cornes and Sandier, 1986; Dasgupta, 1982; Heady, 2000).

Enter the Hunter's Objective **Function**

Let B(X) denote the flow of social benefit enjoyed by the hunter when the harvest is X. If we assume that the market for snail is approximately competitive and that the market price (P) approximately reflects its value, then B(X) - PX. If we further assume that, the social rate of discount is a positive constant (/-) and that C (S, X) is the social cost of harvesting A" when the stock of snail is S, then we can write the flow of net benefit to the hunter at time (and the present discount value of this flow respectively as

$$N(S_t, X_t) = B(X_t) - C(S_t, X_t) \quad (9)$$

and $$N(S_t, X_t)e^{-rt} \quad (10)$$

The social objective function is derived by adding all present discounted values, i.e.,

$$\int_0^\infty N(S_t X_t)e^{-rt}dt \quad (11)$$

Within this framework, the hunter must decide the optimal level of hunting effort at each point in time taking cognizance of the effect on later stock levels. This is achieved at the point where the benefits of increased effort (the increased catch obtained) are just balanced by their costs (the immediate cost of extra efforts as evidenced in labour cost etc, and the fact that the number of snails left to hunt in the next hunting season is reduced). The following deductions can be made

1. A general increase in the prices of snails will have the effect of increasing the expected benefit from hunting effort IB(X,1] and hence provide an incentive (o increase the present rate of exploitation, and vice versa.
2. A low cost of effort (harvest) would lead to a high rule of resource exploitation at any given point in time.
3. For a resource with a very slow growth rate such as snails, (he present value of benefits to be derived from future catch would be low, and hence, it will be more attractive to hunt at any given time than to postpone hunting into the future.

Research Methodology and Analyses

Methodology

A combination of methods is used to source data and to examine the present level of snail hunting in Edo State. First, questionnaires were administered to snail hunters and traders in some parts of the state where snail hunting and trading are predominant. Thirty-four snail hunters and twenty-eight traders (different from the hunters) were interviewed in their local dialects. The objective of the questionnaire administration was to get information on such issues as the factors that motivate the local people into snail hunting and trading and the experiences of the hunters and traders over time (in terms of the ease/difficulty in hunting snails, the demand for the resource by traders and consumers, and price changes). In order to ascertain the changes in the price of snail over time, the analysis was divided into two-time period using 1995, as the separating year. This stemmed from the observation that the open-market retail price of snail in Fdo Stale began to witness remarkable increases in the year 1995. Thus in administering the questionnaires, the hunters and traders were encouraged to supply information relating to snail hunting and marketing based on their experiences and observations in the periods before and after 1995. liven (hough the dataset generated for the pre-1995 period draws heavily on respondents' memory and as such may not be perfectly reliable, the absence of official data on the subject-matter left no alternative. In addition, a number of checks were brought in to ensure the reliability of the data provided by respondents. For example, the information given by the hunters were compared with that of the traders (since both groups were interviewed separately and individually). In cases of disparities (most of which were not significant), averages of the two sets of data were taken. Also, a market survey was undertaken by the author to ascertain the retail prices and sizes of snails in the open market. This enabled a comparison between own observation of current prices and knowledge of prices in the pre-1995 period with information given by hunters and traders. Interviews were also held with individuals (buyers) to derive their opinions concerning the developments in the market. Simple percentage and comparative analysis were employed in

the analysis of the data obtained from all of these sources.

Research Findings

The analyses reveal that the number of snails gotten per hunting hour in both wet and dry seasons has fallen drastically over the two time periods (with a percentage fall of 45.91 for the wet season and 63.54 for the dry seasons). The average number of snails gotten per hunting hour in the wet seasons was 8.32 (with a range of 1.43-13.3) for the pre!995 period compared with 4.5 (with a range of 0.33-10) for the post 1995 period. Similarly, the average number of snails gotten per hunting hour in the dry seasons was 3.73 (with a range of 0.57 S.3) for the pre-1995 period compared with 1.36 (with a range of 0.3 0 6.3} for the post 1995 period. In addition, the number of person constituting a hunting group (i.e. labour required per hunting assignment) has increased in the hunting groups in our interviews. More generally, efforts at snail hunting are more concentrated during the dry season (more labour and time is spent looking for snails), All snail hunters interviewed believed there is an emerging scarcity of snails in the forest and adduced this to increased hunting as a result of the high rate of urban and rural unemployment and bush burning. This thought is also shared by 78.57 percent of snail traders interviewed.

The emerging scarcity is reflected in the prices of snails in the local market. The average purchase price (price at which traders buy from hunters) for four medium-sized (adult) snails in the pre-1995 period, for example, was N16.27 in the wet season and N20.04 in the dry seasons. The figures were dwarfed by post 1995 figures of N172.ll for the wet seasons and N251.49 for the dry seasons. This represented a percentage increase of 952.84 in the wet season and 1154.94 for the dry season. When this is adjusted for inflation, the real percentage increases in prices are 281.00 and 352.00 respectively. The increases are even more pronounced in the case of large snails (Table 2). The selling price of snails (the price at which traders sell to consumers and other retailers) reflected greater increases. Nominal percentage increase for adult snails were 1264.30 and 1499.20 for the wet and dry season respectively while real increases were respectively 366.67 and 476 percent.

Another forceful indication of over-exploitation of Achachinata Marginata in the State is the growing trade in small live snails. 94.12 percent of hunters interviewed admitted that they hunt all sizes of snails ranging from the juveniles to the very large. Until recently, smaller-sized snails are rarely sold in the open market and when traded they are offered at give-away prices. But the trend appears to have changed as they are now freely traded and at fairly high prices too. For example, the real percentage increase in the price of four small Jive snails between 1995 and 2002 was 145.28 for the wet seasons and 264.62 for the dry seasons (Table 4). In addition, the between seasons variation in prices for the two periods were highest for small-sized snails. This suggests that the relative scarcity of snails especially, during the dry seasons makes trade in young snails attractive. This has serious implications for the sustainability of the specie, given that such snails have not yet performed their principal function of procreation.

A corollary of the above development is the increasing difficulty in getting large live snails. This size of snails is often preferred by corporate buyers (hotels and restaurants) and exporters and it is a general practice among traders to use them to sell off the smaller ones. In general, there has been a decline in the sizes of snails as well as in the overall quantities available, two unfavourable changes that accompany over-exploitation of natural snail populations (Stepozak, 1992). For example, 85.71 percent of traders interviewed revealed that on many occasions, they have not been able to get the desired quantity of snails to buy from the local villages. The remaining 14.29 percent attributed their often recorded success to the patronage they had established with the sellers/hunters over time as well as the practice of getting to the selling points ahead of others.

Discussion and Policy Implications of Findings

From the research findings, some factors stand out very clearly in explaining the massive exploitation of Achachatina Marginata in Edo State (Nigeria). The proximate factors include the rapid growth in population leading to an increasing aggregate demand; a growing army of unemployed and underemployed persons and the prevalent high level of poverty; and the devaluation of the national currency which has made snail exports lucrative. The underlying factors include institutional, market and policy failures.

The links between rapid population growth and environmental degradation and natural resource management and poverty are well documented in environmental economics literature (see for example, Kiessling and Landberg (eds), 1994; and Heady, 2000). On the one hand, poverty contributes to the degradation of natural resources (World Commission on Environment and Development, 1987; Duraiappah, 1996). On the other, the mismanagement of natural resources leads to further poverty since many poor communities, particularly in developing countries, rely heavily on natural resources for their livelihood and are therefore, very vulnerable to deterioration in the resources (Heady, 2000). Of the snail hunters interviewed, 88.24 percent were rural fanners (26.68 percent of these combined farming with trading), 5.88 percent were self-dependent students while the remaining 5.88 percent were variously employed in other sectors (mostly in private business). In addition, 53.34 percent of hunters interviewed either had more than one wife or were not the only wives of their husbands (in the case of female hunters). 17.64 percent of hunters interviewed (particularly those who were students) had no children while 29.41 percent had not more than four children. The remaining 52.94 percent had over seven children. For the female hunter (41.18 percent of hunters interviewed were females) who is not the only wife of the husband, the need to survive with

a large number of children is one primary motivation into snail hunting. In general, all hunters interviewed admitted that the need to make ends meet and the absence of an alternative employment that brings in regular income is the major reason for their involvement in snail hunting. Many agreed that while they are quite conscious of the ethical issues involved in hunting young snails, they are nevertheless forced to do it in the absence of a viable source of livelihood, given also the high demand for snail meat.

The case of snail hunting and trading in Edo State raises many fundamental questions: who owns the forest reserves from which snails are exploited, and so who can regulate its use? Why should people be allowed to hunt snails that have not reached the age of maturity? Worse still, why should people purchase small snails from hunters/traders knowing that such snails have not reached adulthood? The non-integration of the economic value of bio-diveisity into agents' decision-making processes is a reflection of either market or government failure, or both, and often leads to excessive harvest (Barbier et al., 1994). To the snail hunter in Edo State, snail hunting is relatively riskless. It is also costless (especially in view of the vast army of unemployed and under-employed persons in the rural area). The same is true for snail trading where there is little or no constraint on entry. The result is the presence of excessive rent (especially for hunters) which creates massive incentive for entry and over-exploitation. Majority of hunters interviewed view the forests from which snails are hunted as belonging to no one in particular. Some (about 11.76 percent) feel they ought to belong to the government while a few perceived they are owned by the communities concerned or by some families. Thus there is no well defined property right as far as the resource is concerned.

Direct and market based tools (instruments) are often employed for biodiversity conservation or for the protection of environmental and natural resources. One of the most popular instruments of direct control is the application of the Safe Minimum Standard (SMS) concept. Under this approach, a sufficient habitat area is preserved to ensure the survival of the species in question or the ecosystem (when the cost of doing that is not unbearably high). In some countries, this has been applied to snail hunting. For example, to protect natural colonies of H. pomatia from over-exploitation in Poland, certain legal limits are set for collectors. First collection is allowed only during the spring period as the buying points are opened during this period only. The second restriction relates to the size of the animals. The buying points accept only those snails that fail to pass through a 30mm diameter hole. This prevents hunters from collecting small snails for safe. Thirdly, snail collectors were not allowed to exploit snails from the same natural population for more than two periods. Akin to the technique of shifting cultivation practiced in crop farming, after collecting from the same population for two consecutive periods, hunters are required to move to other populations. This allows the initial population to rejuvenate (Stepozak, 1992).

There may however be difficulties in applying the same rules (or other direct controls) to snail hunting in Edo State given the absence of a well-defined property right. Attempts to regulate the sizes of snails hunted and traded may be unsuccessful too because of the widespread poverty and the very low level of enlightenment as regards natural and environmental resource values. In general, the design of policies to both manage natural resources in a sustainable manner and at the same time reduce poverty is very often difficult (Heady, 2001), and may not meet the requirement of political and equity efficiency because such methods may further impoverish rural dwellers who depend on those resources to generate income. In addition, an attempt to control the sizes of snails hunted and traded through direct method as described by Stepozak (1992), quite often leads to injuries which may have serious biological consequences on the snails. Also direct control methods of conservation are usually expensive and difficult to enforce because of the poorly functioning judicial, administrative and monitoring/enforcement procedures in many countries.

The use of market-based instruments to adjust private costs and benefits to reflect the social cost of environmental or natural resource degradation is also limited by poor functioning market systems. Consequently, many authors call for institutional reforms such as the improvement or establishment of properly and resource right regimes. This however, may not solve the problem in the case of regenerative resources, especially where the right to property is vested in the It would appear that a more realistic and lasting solution to the problem of over-exploitation of Achachatina marginata in Edo State (Nigeria) is for the government to encourage individuals and organizations to cultivate this resource. This solution has been applied in many places to different biological resources at different times (e.g fisheries) (Barbier ct oL. 1994). In the same connection, the growing demand for snail meat across the globe has prompted attempts to cultivate snails which have been largely successful in many counlries. Tins could also serve as a means of economic empowerment to many who are presently below the poverty line. In general, alleviation of poverty through improvement in natural resources stands to benefit from the positive feedback from reduced poverty to further resource improvement (Heady, 2000).

Summary and Conclusion

This paper reveals an on-going massive exploitation of snail reserves in Edo State which if left uncontrolled, may endanger the natural stock, and calls for policies aimed at achieving a more effective management of the biological resource. It examines the merits and feasibilities of various options within the context of existing rural poverty and dependence on the natural resource base by many rural dwellers, and suggests a course of action that can help preserve the specie's natural populations and at the same time empower rural households. Apart from the often-cited justification on the ground of ensuring sustainable living standards and respeci for nature, the concern for the eradication of rural poverty makes such policies inevitable given the two-way linkages

between poverty and natural resources management.

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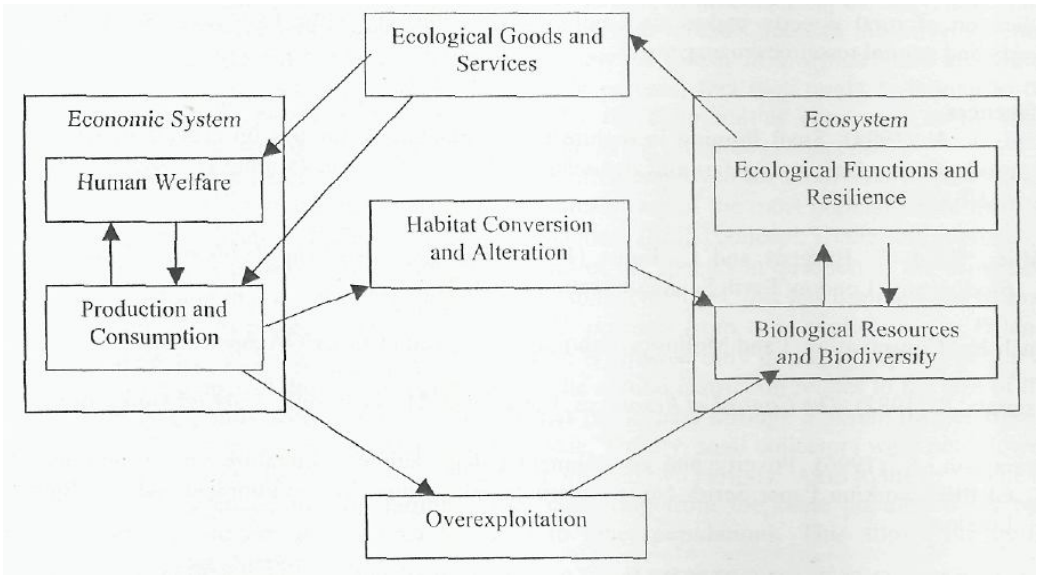

Fig. 1 Interdependence between Ecosystems and Economic Systems
Source: Barbier et al (1994: 20)

Table 1 Harmonized Average **Purchased Price of Snnils in Eclu State (in Nigerian Naira)**

SIZE OF SNAILS	PRE-1995		POST-1 995 (as at 2002)	
	SEASONS			
	Wet	Dry	Wet	Dry
Small	5.07	6.39	42.69	59.69
Very large	25.20	30.32	327.50	470.60
Medium (adult size)	16.27	20.04	J72JJ_	251.49

Note: Purchased price is price at which traders buy from hunters. The price is given for four Live Snails.
Source: Author's field survey, 2002.

Table 2 Nominal and Real Percentage Increase in Purchase Price of Snails in the Wet and Dry Seasons over the Two Time Periods

SIZE OF SNAILS	*NOMINAL*		*REAL*	
	Wet	*Dry*	*Wet*	*Dry*
Small	*742.01*	*834.12*	*203.34*	*236.46*
Very large	*1199.60*	*1452.11*	*368.10*	*461.26*
Medium	*954.84*	*1154.94*	*281.00*	*352.00*

Source: Computed from Table 1.

Table 3 Average Selling Price ofjinai|s in the Local Market

SIZE OF SNAILS	PRE-1995		POST-1995 (as at 2002)	
	SEASONS			
	WET	DRY	WET	DRY
Small	5.30	8.00	36.09	80.99
Very large	30.00	36.63	433.81	596.93
Medium	18.57	25.00	253.35	399.80

Source: Author's field survey, 2002

Table 4 Nominal and Real Percentage Increase in Selling (Open Market) Price of Snails in the Wet and Dry Seasonsjover the Two Time Periods

SIZE OF SNAILS	NOMINAL		REAL	
	Wet	Dry	Wet	Dry
Small	580.94	932.38	145.28	264.62
Very large	1346.00	1530.36	420.83	486.95
Medium	1264.30	1499.20	366.67	476.00

Source: Computed from Table 3