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An Assessment of the Supply Chain for Marketing Medicinal Plants from the Rainforest Region of Nigeria

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ABSTRACT

Trade in traditional medicinal plants thrives in urban areas within the rainforest region of Nigeria. This paper evaluates the supply chains in medicinal plant trade and suggests measures to ensure the stability of habitats where medicinal plants are exploited for markets. Data were collected through a cross-sectional survey which combined a questionnaire with field observations and informal discussions with stakeholders involved in the marketing of medicinal plants. Data analyses revealed that the traders were specialists in plant product identification and were knowledgeable in traditional medicine. Traditional healers relied on these traders for the selection of medicinal products. The average net profit margins earned by a trader of medicinal plants per annum were N 26,750 (US$ 206.80) in leafy materials, N 22,454 (US $172.70) in barks, N 24,245 (US $186.50) in roots, N 24,578 (US$ 189.10) in fruits and seeds, and N 18,245 (US$ 140.30) in mixed products. (The Nigerian currency is the naira (N). The exchange rate of the naira during data collection between March 2003 and October 2004 was 1US$=N130.) Post-harvest losses in medicinal plants were observed to be a major problem for traders, resulting in income losses.

Keywords: Nigeria, medicinal plants, ecological knowledge, non-timber forest products, biodiversity, supply chains, marketing, land use rights, land tenure

Introduction

Dependence on Biodiversity

Rural communities in the rainforest region of Nigeria rely heavily on natural forests to meet their daily needs. High dependence on biodiversity in Nigeria is motivated by various reasons which include high poverty levels among rural communities and limited alternative sources of income (Osemeobo 2005a, 2001a), unfavorable land tenure systems which limit most people to family lands (Osemeobo 1997, 1999), taboos which restrict the use of plants for traditional medicine (Osemeobo 1992), and the low costs of exploiting plants from natural forests and traditional ecological knowledge of natural forests and medicinal plants (Osemeobo 2001b). Other reasons are the inherent economic benefits derived from exploiting plants, the socio-cultural pull of communities for traditional religious worship and rituals, and the performance of traditional rituals and ceremonies (Osemeobo 1998). It has become increasingly difficult for forests to meet the demands of the various communities in the absence of planned forest management.

Rural communities in the rainforest region of Nigeria depend primarily on traditional medicine for health care delivery. Over the past five years, however, there has been steady decline in forest species commonly used for traditional medicines; the continued absence of key plants for these uses is causing a near collapse in the nation's traditional health care delivery system (Osemeobo and Ujor 1999, Osemeobo 2005b). A similar situation can be observed in South Africa where Mander (1988) reports that biodiversity is also relied upon for daily household needs and that the demand for various species of medicinal plants "including choice species such as *Siphonochilus aethiopicus* and *Warburgia salutaris*" exceeds the supply because of over-harvesting to the point of extirpation outside protected forests. Similarly, Botah et al. (2004) report that rising demand for medicinal plants in South Africa is the main cause of pressures leading to near extinction of some indigenous species.

Harvesting and Sustainability of Medicinal Plants

Alternatives to the harvesting of medicinal plants are difficult to fathom. This is because different species of plants are used for different medicinal preparations among different practitioners. The loss of species has a significant and far-reaching negative impact on the management of traditional medicines. For example, the scarcity of certain species in local environments has led to setbacks for the treatment of patients for coughs, bone fractures, mental problems, and pregnancy complications (Sofowora 1993). Osemeobo and Ujor (1999) revealed that approximately 147 species of medicinal plants are traded in the Nigerian rainforest areas alone. This compares with species traded in open markets in Natal, South Africa, where the number of medicinal plant species totalled 176 cutting across 40 plant families (Botah et al. 2004).

Medicinal plants in Nigeria are seriously threatened by environmental, socio-economic, and institutional problems. The situation in Nigeria is similar to that of India, where a loss of medicinal plants is exacerbated by a vanishing of traditional knowledge (Pie 2001). Hoareou and DaSilva (1999) also report that increasing interest in traditional medicine in Asia is fueled by the rising cost of drugs in orthodox hospitals. This forces the poor to seek alternative cures in the form of traditional medicines derived from medicinal plants (Pie 2001). Falconer and Arnold (1991) conclude that easy access and exploitation of forest resources, as well as a lack of restrictions on the trade and marketing of these resources, are some of the factors leading to the over-harvesting of non-timber forest products in Asia, including medicinal plants. This situation also applies to Nigeria.

This paper evaluates the supply chains in medicinal plant trade and suggests measures to ensure the stability of habitats where medicinal plants are exploited for markets. It first introduces the objectives of the study, presents the study methods, and then discusses the most salient results relating to supply chains in terms of the roles of stakeholders, steps in the supply chain, the economics of the medicinal plant trade, and strategies for the management and conservation of medicinal plants in the study area.

Objectives

The main objective of this paper is to assess the role of supply chains in the marketing of medicinal plants by smallholders in the rainforest region of Nigeria. The specific objectives of the survey were:

i. to evaluate the market functions and efficiency of the marketing system; and

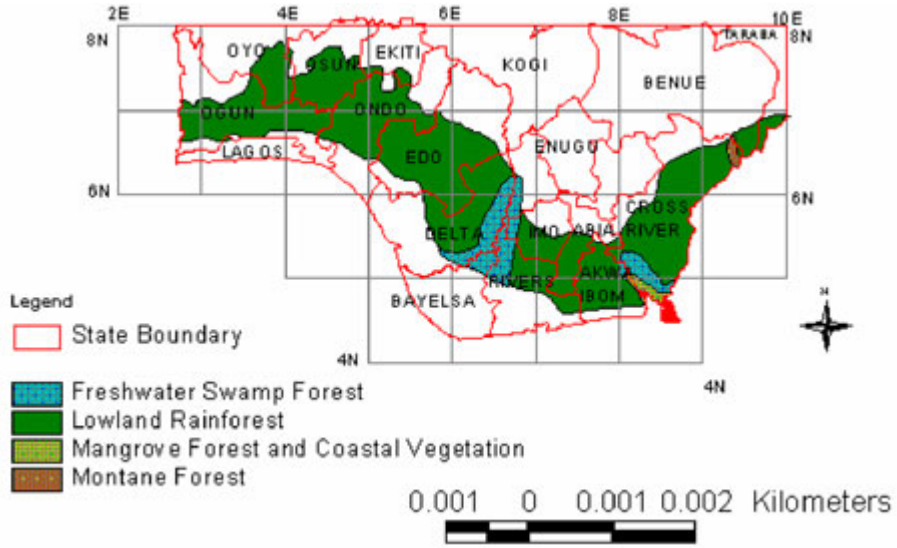
ii. to suggest measures for sustaining the medicinal plant trade.

Study Methods

The Study Area

The rainforest region of Nigeria is located in the southern part of the country between latitudes 40° 30´ N and 70° 30´ N and between longitudes 2°30´ E and 9° 30´ E. It is a relatively narrow strip of land of varying width (50 to 250 km^2) running east-west. Seven states (Abia, Akwa Ibom, Cross River, Edo, Imo, Ogun, and Ondo) have about three-quarters of their lands within the rainforests, while another three states (Delta, Oyo, and Rivers) have about one-quarter of their lands within the rainforest zone. The rainforests host a variety of biodiversity as seen in **Figure 1**.

Figure 1. The lowland rainforest zone of Nigeria.



Nigeria is endowed with about 7,895 plant species identified in 338 families and 2,215 genera (FME 2003). Approximately 50 percent of the plant species occur in the rainforest and they sustain the livelihoods of about 28 million people living in rural areas. The majority of the people in the rainforest region are poor and rely on farming and forest harvesting. The farming system is smallholder-based and is beset with inefficient integration of inputs into the production system.

Sampling

A list of state capitals within the forest zones in the country was compiled in alphabetical order. Ten state capitals including Abeokuta, Ado-Ekiti, Akure, Benin, Calabar, Enugu, Ibadan, Oshogbo, Owerri, and Uyo were selected using a table of random numbers. A reconnaissance survey was conducted in the major markets in each of the selected state capitals to assess the status of marketing of medicinal plants. A simple random sampling procedure was used to select major marketers of medicinal plants for interviews conducted between March 2003 and October 2004. The different locations where data were collected were revisited between October and November 2006 to identify and reconcile possible changes in prices of medicinal plant products.

Data Collection

The data on which this study is based were derived from a cross-sectional survey which combined questionnaire interviews with field observations and informal discussions with stakeholders in the traditional medicinal sector. Data were collected from traditional medicine healers (users of traditional medicine), collectors (harvesters) of medicinal plants in rural areas, and sellers of medicinal products in urban areas. In total, 50 marketers of medicinal plants, 20 collectors of medicinal plants, 20 traditional medicine healers, and 20 members of landholding communities were interviewed with structured questionnaires; group discussions were held with a sub-sample of those interviewed (**Table 1**).

Table 1. Sample frame for the study.

States	Stakeholders interviewed				Total
	Marketers of medicinal plants	Collectors of medicinal plants	Traditional healers	Members of land holding communities	
Abeokuta	5	2	2	2	11
Ado Ekiti	5	2	2	2	11
Akure	5	2	2	2	11
Benin	5	2	2	2	11
Calabar	5	2	2	2	11
Enugu	5	2	2	2	11
Ibadan	5	2	2	2	11
Oshogbo	5	2	2	2	11
Owerri	5	2	2	2	11
Uyo	5	2	2	2	11
Total	50	20	20	20	110

Analytical Framework

Market prices were used to calculate the economic values of traditional medicinal products, including those that were bought, sold, and consumed, as well as those given as gifts or destroyed by pests. Incomes and expenditures were calculated on a weekly basis. Gross margin analysis was used to measure the suitability of the medicinal plant trade and the net income earned over time and is defined as gross profit minus total fixed costs (Dent and Young 1981). Marketing efficiency examined the contribution of inputs to the marketing system and was defined as the monetary value of inputs divided by the value of the outputs (Osuji 1978, Purcell 1979, Adeyokunnu 1980, Osemeobo 1987).

Results and Discussion

Actors Involved in the Supply Chain

Figure 2 presents five major players and the general flow of goods in the medicinal plant trade within the rainforest region of Nigeria. The roles of these supply chain stakeholders, determined by the field survey, are presented in **Table 2** and discussed in turn.

Figure 2. Supply chain for medicinal plants in the rainforest region of Nigeria.

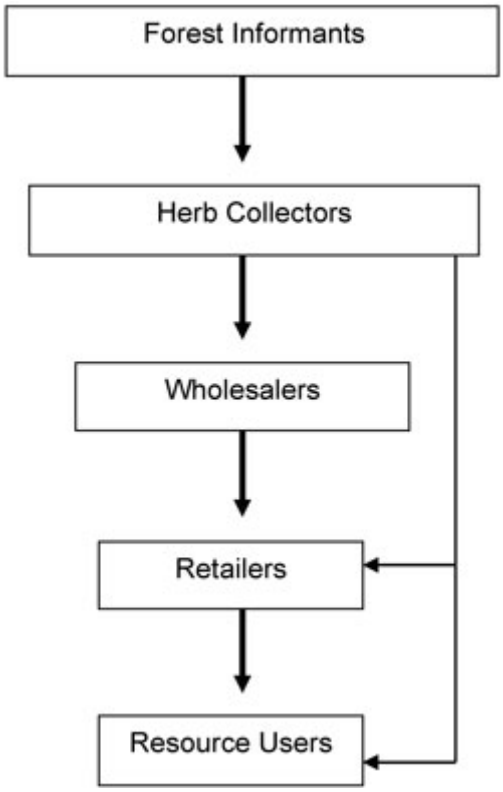


Table 2. Stakeholder roles in marketing of medicinal plants.

Target group	Average age	Roles of stakeholders
Forest informants	25+	Lead plant collectors into the forest. They live in the villages and assist the collectors in obtaining permits. Then, they take them to sites where medicinal plants are harvested.
Herb collectors	30+	Involved in harvesting of medicinal plant products, including whole plants, leaves, stems, flowers, fruits, herbs, and barks of trees/shrubs, roots, and gum. They live in the rural areas, but not necessarily the villages where the plants are harvested. They process materials, package them, and transport them to urban areas.
Herb sellers	40+	Wholesalers and retailers who sell medicinal herbs to customers. They live in urban areas. They process and store the plant products for marketing.
Resource users	30+	Traditional healers in urban areas. They are the buyers and end users of medicinal plant products used in traditional health care (preventive and curative).

Forest Informants

Forest informants were men who were familiar with the sites where medicinal plants were harvested. Some of the participants were apprentices of traditional healers, while others were either hunters or farmers. They were knowledgeable about medicinal plants in terms of their habitats, taxonomy, and flowering/fruiting patterns. Forest informants lived in rural areas and assisted collectors of traditional medicines, who were not natives of the area, to obtain community consent (permits) for specified time frames and guided them to sites for herb collection within forests.

Herb Collectors

Herb collectors were directly involved in harvesting medicinal plants. They operated in more than one settlement; the decision to move to different settlements depended on the availability of desired species in forests where medicinal plants were harvested and the market demand for medicinal products in urban areas. Collectors of medicinal plants were trained herbalists knowledgeable in forest ecology and the taxonomy of medicinal plants. They lived in rural areas – the source of supply – and were involved in agricultural production. The collectors supplied medicinal plants to wholesalers, retailers, and even the resource users/traditional healers. Their motivation was based primarily on making money and they were less concerned with issues such as forest and species degradation.

Wholesalers

Wholesalers exerted a great deal of influence on the supply of medicinal plants from rural areas. They bought herbal products from rural areas to meet the demands of retailers. Respondents claimed that wholesalers were responsible for the rapid decline in the trade of medicinal plants over the past 10 years. The number of medicinal plant wholesalers varied from about four to nine in each market visited for this study. From the traders' perspective, wholesalers are experienced traders with adequate knowledge of the uses, ecology, and taxonomy of medicinal plant products sold in open markets.

The wholesale market was not open; its membership was drawn from local associations of traditional medicine suppliers. Respondents claimed that restrictions in membership were meant to protect the interests of consumers by preventing inexperienced people from recommending inappropriate medicinal plants to customers. The wholesale market was highly specialized. Wholesalers sorted, cleaned, processed, and preserved medicinal plants for sale. Consultations were also carried out for plants that were not easily recognized. In such cases, the products were withdrawn from the market until they were correctly identified. This study revealed that about 35 percent of traditional healers relied on the recommendations of wholesalers for the selection of herbs for health care delivery.

Retailers

Retailers of medicinal plants were primarily migrant women from rural areas. They were knowledgeable about forests, medicinal plants, the suitable seasons for their collection, and the main uses of different species in traditional medicine. Most retailers were either traditional healers who could not practice due to socio-economic factors, such as disagreement of their husbands to practice, a lack of regular customers, or the lack of alternative sources of income which forced them to sell medicinal plant products. The retailers employed the services of trained apprentices in the sale of medicinal plants. It was observed that there were about two to three apprentices working under each retailer. The average period for an apprenticeship varied from 24 to 36 months or enough time to cover both the wet and dry seasons as different products were harvested during the different seasons.

The average number of retail sellers of medicinal plants varied as follows: 15 to 20 at Itokun market in Abeokuta; 18 to 19 in Dugbe market in Ibadan; and 19 to 20 in Oba market in Benin. The numbers of buyers of medicinal plants from the retail markets varied from about 300 to 450 known customers per week. There were also buyers who were not regular customers. These included mobile healers who moved from one town to another, depending on invitations they received from clients.

Sometimes, retailers paid collectors in advance to cover the costs of permits, informants, and transport and processing of products. This also provided assurance to the collectors that the retailers would accept the requested products. Retailers were involved in backward-forward linkages with the collectors. They sold two categories of products: forest foods received from collectors such as fruits, seeds, mushrooms, snails, and vegetables and finished products from the cottage industry such as brooms, mats, baskets, mortar and pestle, trays, and woven ropes. In addition, herb collectors received finished goods to sell in rural areas from the retailers, such as rubber buckets, shoes, lanterns, soap, pomade, matches, knives, and axes.

Resource Users

Resource users were traditional medical practitioners based in urban areas. They relied on medicinal plants for preventative, curative, and magical purposes. The female resource users specialized mainly in gynaecology, paediatrics, and rheumatism, while the males specialized in physiotherapy, mental problems, and trado-medical medicine. The specializations among resource users led to differences in their choices of species of medicinal plants.

Steps in the Supply Chain

Payments for the Supply of Medicinal Plants

From the viewpoint of traders and other stakeholders in the supply chain, access to medicinal plants was assured only when the consent of landholding communities was granted. Traders would seek consent by verifying with landowners that the desired medicinal plants actually occurred in abundance in specific forest locations; they then would seek access rights to harvest specific medicinal plants. Payments were made at three levels:

i. payments of a consultation fee to the principal members of the landholding community;

ii. payments for permits to harvest medicinal plants on community land; and

iii. payments of a disturbance fee to landowners of existing farms where the medicinal plants were harvested.

Both the consultation fee and the permit fees varied from one settlement to the other but the average fee for most settlements was about N3,000 (US$ 23.10) for three months and N5,000 (US$ 38.50) for six months, respectively.

Access to Medicinal Plants

Access to harvest medicinal plants was granted through indigenous land tenure regimes. Traditional land tenure is communal and the rights to medicinal plants are held as a group by landholding communities. The community acquired the right to:

i. revoke rights of access to harvest medicinal plants; and

ii. manage and control resource harvest under institutional arrangements based on closed season, open access, restricted access, and exclusive access to the forests.

Access to harvest medicinal plants in community forests was easy when the forest locations were managed through open access. Harvesting of medicinal plants in the forests was regulated to ensure that:

i. the number of permits granted for the harvesting of medicinal plants was not too high at a given period of time;

ii. plant harvest was efficient in terms of species degradation; and

iii. the harvesters of medicinal plants respected the tenure regimes controlling the management of the forests.

The requirements of resource users influenced the method of plant harvest. The main medicinal plant products were barks of trees and shrubs, roots, leaves (buds and matured leaves), flowers, fruits, roots, and exudates (gums). After harvest, plant products were sorted and processed by collectors to meet the requirements of wholesalers and retailers. Harvested products were packaged according to form and species type. Each collector supplied medicinal plants to five or more retailers, while a retailer was capable of hiring the services of three to five collectors at the same time. The reason for this was that different plant species were harvested from different locations depending on their availability. A main constraint in the supply channel was the low level of reliability of collectors. It was common for a collector to receive advance payment without supplying the materials. Sometimes some retailers deliberately frustrated the efforts of the collectors by rejecting their supply or by paying low prices for the goods.

Transportation of Medicinal Plants

Medicinal plants were transported to the market first from harvesting sites to collection points by foot and from the collection points to the villages by motorcycles. Lorries or trucks were used to transport the plants from the villages to urban areas. Transportation posed a problem in the wet season when feeder roads in rural areas were inaccessible. The cost of transportation was determined by:

i. the number of passengers the vehicle could carry;

ii. the number of vehicles on the roads; and

iii. the price of fuel, the cost of vehicle maintenance, and the volume of the load carried by the vehicle.

The costs of transportation in the wet season were higher than in the dry season. A collector transporting medicinal plants from Ijaiye to Ibadan (a distance of about 200 km) during the time of data collection paid approximately N400 (US$ 2.30) per 100 kg of medicinal plants in the dry season and approximately N500 (US$ 3.80) for the same product in the wet season.

Processing of Medicinal Plants

The processing of medicinal plants was carried out by collectors, wholesalers, and retailers. This involved the extraction of seeds from fruits, cleaning of products, and drying. The technology applied to

processing medicinal plants was traditional, and there were no fixed standards and regulations for the market.

According to marketers of traditional plants, processing of materials was carried out to:

i. reduce the bulk of waste materials (and thereby reduce the weight of the product);

ii. reduce the costs of transportation;

iii. ensure that the limited spaces in silos were used efficiently;

iv. ensure high grades of products;

v. reduce the water content of products; and

vi. reduce post-harvest losses in forest products arising from infection due to bacteria, fungi, insects, and the sprouting of roots and tubers.

Storage of Medicinal Plants

The duration of storage of medicinal plants was determined by the inherent composition of the plant material and the level of processing that could be carried out without damaging the material for use as traditional medicine. Retailers stored medicinal plants when specific plants for traditional medicine were scarce and collection was distorted from various sites. This enhances the price and the economic value of the product. Storage of medicinal plants at the village level was common for rare plant products such as flowers, fruits, or seeds. Storage in the market places was unavoidable for retailers. The period of storage for medicinal plant products varied from one week to 12 months or more; storage for fresh leaves varied from about one week to four weeks, while seeds of *Canarium schweinfuethii* were stored for up to 48 months.

Materials used for storing medicinal plants were locally sourced. These included sealed clay pots, gourds, baskets (made from oil palm fronds), jute bags, and containers (from carved wood). About 98 percent of the traders stored medicinal plants. About 60 percent of medicinal plants that were stored were kept in the homes while the remaining 40 percent were stored in market stalls. Respondents claimed that losses due to storage were about 2.5 to 4.5 percent of all leafy products, 1.5 to 2.5 percent in fruits and seeds, and 0.2 to 2.4 percent in roots and bark of plants. The post harvest losses in storage were caused by fungi, virus, insects, and nematodes.

Poor processing of medicinal plants and inadequate storage facilities were common causes of loss in stored products. The challenges the traders faced were:

i. a lack of sufficient space in market places to display products and store medicinal plants; and

ii. exposure of medicinal plants to direct sun and rain negatively impacting the quality of the products.

Deterioration in medicinal plants generally took the forms of changes in appearance and texture or the presence of contaminants.

Market Information for Medicinal Plants

Market information was not documented but it was made available upon inquiry. Market information focused on the volumes of stock, current prices, and supply and demand trends. During the survey, the retailers claimed that the most promising medicinal plants (in high demand) were *Byrsocarpus coccineus, Phyllantus muellerianus, Sansevieria liberica, Cissus aralioides, Acanthus montanus, Desmodium scopiurus, Nauclea latifolia, Sida urens, Triclisia patens, Desmodium velutium,* and *Aphania senegalensis*. The medicinal plant products that were scarce in the markets included leaves, barks, roots, flowers, and seeds of *Acanthospermum hispidum, Vernonia amygdalina, Gloriosa superba, Psychotria vogelii, Aldornea cordifolia, Cissus arabides, Costus afer,* and *Cyclosonus afer*. Other scarce species were *Alchornea cordifolia, Spondias mombin, Combretum racemosun, Hannoe undulata,* and *Cassia rotundifolia*. The markets lacked standardized measurements for the sale of medicinal plants, leading to price discrimination and difficulties in determining the quality of products in the market. Relationships with customers were cordial; some sellers accepted sales on credit from customers with whom they were familiar.

Pricing of Medicinal Plants

The market forces of supply and demand, such as information on species scarcity and its importance in health care, influenced the prices of medicinal plant products. Lower prices were experienced when the supply was at its peak, while high prices were experienced in slack periods occurring between the peak periods. The prices paid by buyers of medicinal products were not fixed but were based on the bargaining power of buyers. Moreover, market prices were not perfect because the same quality and quantity of products sold for different prices between different retailers. The prices at which products were bought were influenced by many factors including:

i. familiarity with sellers;

ii. scarcity of products;

iii. the ability of buyers to bargain;

iv. the frequency with which a known customer bought products from a seller; and

v. the ability to speak in the dialects of the sellers.

Other reasons were the volume of products available, numbers of buyers present in the market at the time of buying, market information on the part of the buyer, the physical condition of the product, and the seller's knowledge of what the products would be used for by traditional healers.

Customer preferences for medicinal plant products influenced market prices. There were many sellers and buyers and each participant could not, therefore, manipulate the prices of commodities except when a commodity was scarce. But, because some of the herb collectors were given advance access to harvest medicinal plants on agreement of selling specified products to them, the retailers dictated the prices of medicinal plants to collectors. This scenario reduced the bargaining power of collectors. Forecasting of prices was based on conjectures of unforeseen environmental factors that could not be predicted (e.g., climatic, ecological, and human factors). Consequently, market prices of medicinal plants varied from season to season.

Economic Evaluation of Trade

Table 3 presents the average values of marketing margins per annum for wholesalers of medicinal plants based on the field survey. Medicinal products are listed by type and their values in terms of procurement, storage, and labor are given in naira.

Table 3. Average values of annual marketing margins for wholesalers of medicinal plants.

Medicinal products	Wholesale values	Storage costs	Labor cost for retailers	Total costs	Total sales	Net margins
	(N)[a]					
Leafy materials	3,366	346	4,534	8,246	34,996	26,750
Barks	3,237	340	3,765	7,342	29,796	22,454
Roots	3,092	256	3,436	6,784	31,029	24,245
Fruits/ seeds	2,090	243	3,134	5,465	30,042	24,578
Mixed products (no specialization)	2,075	564	4,456	7,895	36,140	28,245

[a] $US 1 = N 130 at the time of data collection.

The data in **Table 3** demonstrate that:

i. There was some degree of specialization in the sale of medicinal plants. Specialization of products occurred in the sales of leafy products, barks of trees, roots of plants, fruits and seeds. Sales of mixed products from the forests also took place. Wholesalers who did not specialize in the sale of medicinal products, however, accounted for less than 40 percent of the total number of sellers in all of the markets visited during the survey.

ii. The highest average cost was incurred in leafy products (N 8,246), while the lowest average cost was in fruits and seeds (N 5,465).

iii. The average net margins per season were N 26,750 in leafy materials, N 22,454 in barks, N 24,245 in roots, N 24,578 in fruits and seeds, and N 18,245 in mixed products.

iv. Average storage costs were highest for retailers that sold mixed products (N 564) and lowest in fruits and seeds (N 243). Labor costs were highest in leafy materials (N 4,534) and lowest in fruits and seeds (N 3,134). Procurement costs of medicinal plants was highest in leafy materials (N 3,366) and lowest in mixed products (N 2,075).

One of the implications of this analysis is that traders selling traditional medicines are among the urban dwellers who depend on forests for sustenance. But, when the total annual average net margins were compared with the national wage rate of N 7,000/month (US$ 53.85), the highest amount that a trader earned was N 4,707.50/month (US$ 36.21), while the lowest amount was N 3,742.30/month (US$ 28.79). In other words, traders of medicinal plants were poor, low-income earners even though they provided employment. During the survey, it was observed that the traders combined the sale of medicinal plants with other items from rural areas, indicating that the sale of medicinal plants was not a full-time occupation.

The marketing system was not integrated, with some sellers of medicinal plants marketing specialized commodities individually (leaves, barks, roots, and fruits and seeds). The marketing system was beset with problems including:

i. insufficient working capital;

ii. poor storage facilities;

iii. high labor inputs;

iv. high costs of raw materials and low profit margins;

v. low-level technologies; and

vi. a lack of documented market information.

Table 4 presents the input-output coefficients for specialized medicinal plant products in the market. The coefficient for leafy products was highest at 0.065, indicating that 6.5 percent of the profit margin in the marketing system was derived from leafy products. Similarly, 5.8 percent, 5.3 percent, 4.3 percent, and 6.2 percent of profit margins were derived from barks of trees/shrubs, roots, fruits and seeds, and mixed products, respectively. This indicates that market specialization in leafy products provided the greatest benefits to the marketing system, followed closely by mixed products.

Table 4. Profit coefficients of market products.

Marketing specialization	Input-output coefficients
Leafy products	0.065
Barks	0.058
Roots	0.053
Fruits and seeds	0.043
Mixed products	0.062

The input-output coefficients of the market functions in **Table 5** showed that 10.9 percent, 13.0 percent, and 15.3 percent of benefits derived from the marketing system were from the procurement of medicinal plant products, storage facilities, and labor, respectively. This indicates that the profit margins in the marketing system could be improved if labor costs were reduced.

Table 5. Profit coefficients of factors in the marketing system.

Market system	Input-output coefficients
Procurement of medicinal products	0.109
Storage	0.013
Labor	0.153
Total	0.275

Sellers of medicinal plant products generally do not have standardized measures of quality in place (**Table 6**). The consequences of this were varied and included:

i. the sale of low quality of products at low prices; and

ii. a high reliance on bargaining in the marketing system.

The market was not open to all interested members because limited numbers of people acquired skills in various aspects of traditional medicines and medicinal plants. Entry into the trade of traditional plants required the acquisition of special skills related to traditional ecological knowledge, taxonomy of traditional plant products, forest ecology, and traditional medicine.

Table 6. Efficiency of marketing functions.

Functions	Level of efficiency
Market integration	Not in place
Prices	Not perfect, but elastic
Processing	Based on low technology, low efficiency
Storage	Based on low technology, low efficiency
Transportation	Not efficient, operates on bad roadsy
Market information	Available to few, not efficient
Standardized quality of products	Not in place

The field survey revealed that some buyers paid lower prices for commodities and others were allowed to purchase some commodities on credit. Retailers and wholesalers allowed new entrants to collect commodities, sell them, and return the capital after the sales took place. Not all of the forest products were attractive to new entrants because of market instability, post harvest losses in medicinal plants, and lack of access to capital.

Implications and Recommendations for Sustainable Forest Management

Medicinal Plant Harvest

Typical methods of harvesting medicinal plants in the study area included:

i. uprooting of tree seedlings and herbaceous plants (e.g., *Alchornea cordifolia*);

ii. debarking (e.g., *Khaya senegalensis*);

iii. harvesting mature and apical leaves (e.g., *Gloriosa superba*);

iv. cutting of tree roots (e.g., *Hannoe undulata*);

v. harvesting flowers and immature fruits (e.g., *Elaeis guineensis*); and

vi. collecting exudates (gum) (e.g., *Khaya grandifolia*).

Previous research has shown that herbal collectors with access to medicinal plants through systems of traditional land tenures and payments of permits show little concern about the degradation of forest sites and species (Cunnigham 1994, Brickman 2004). It has also been noted that destructive harvesting methods and poor management of the forests combine to threaten the survival of rare species (Shiva 2004). In this study area, the debarking of *Okoubaka aubrevillei*, an endemic species with a population of less than 20 stands, has posed a major concern for *in-situ* conservation of medicinal plants.

The harvesting of medicinal plants using traditional technologies conflicts with the principles of plant conservation as it has endangered the existence of traded species within the natural forests. Because the ecology and biology of most of the medicinal species occurring in the rainforest zone of Nigeria are not fully known and documented, appropriate policy and silvicultural practices for their conservation have not been put in place. Field observations in this study revealed that the harvesting of medicinal plants was not based on management plans, meaning that:

i. most medicinal plants have been over-harvested and some endemic species may have been lost; and

ii. sustainable *ex-situ* conservation of medicinal plants is limited.

It is not known if all of the medicinal plant species traded in the open markets could be successfully conserved *in-situ* (BDP 2001). Moreover, the number of species that meet the recommendations of the National Academy of Sciences (1980) for sustainable *in-situ* conservation is not known either. These generally include species that:

i. are adapted to different habitats;

ii. can establish easily with little silvicultural care;

iii. are suitable to difficult environments such as steep hill slopes or low nutrient soils;

iv. have the ability to fix nitrogen, coppice, and grow rapidly and successfully in wide range of environments; and

v. are less disturbed by livestock.

The land available for *in-situ* conservation is being reduced on an annual basis by government and landholding communities. For example, about 4,535 km^2 of protected forests (mainly in the rainforest zone) were deactivated for the purposes of agricultural production between 1960 and 2003 (Osemeobo 2004).

Habitat Stability

Habitat stability in this study refers to the ability of the natural forests to support medicinal plant trade, regenerate sustainably, and withstand the pressures of harvesting. The question is how can habitat stability be attained under the present circumstances of poor forest management? It is important to protect the forests from loss of species and species diversity through effective management. Habitat stability could ensure economic success of the medicinal plant trade and reduce poverty among the stakeholders in the marketing supply chain. Based on the tenure structure as it

relates to access to medicinal plants, habitat stability may succeed when it is community-driven. This would require five key steps. The first step would be to compile a working list of all traded medicinal plants, document maps of their natural habitats, and compile known research carried out on each of the identified plant species. The second step would be to effectively protect the forests through community-based land use plans and monitoring of forest exploitation sites. The third step would be to revegetate impacted forest locations with native species through enrichment planting and support the forest stock with *ex-situ* conservation of medicinal plants in gardens. The fourth step would to carry out research on plant genetic diversity, conservation biology, and socio-economic and cultural factors that may impact the sustainability of medicinal plant species. The fifth and final step would be to empower and train stakeholders on sustainable practices for harvesting, processing, storage, and packaging of medicinal plant products for the market.

Conclusion

This study has shown that some of the low-income earners in urban areas are forest dependent, relying on supply chains for medicinal plants. Therefore, forest conservation should be seen as a key strategy for rural-urban integration and poverty reduction in Nigeria. But, the future of over-harvested medicinal plants occurring in the natural ecosystems of the Nigerian rainforest is bleak. This is due to many factors. For instance, there are few privately owned medicinal gardens, and where they exist, they are not meant for the market and they are not properly stocked in terms of species diversity. There is also a general lack of training and skills for those involved in the harvesting of medicinal plants and insufficient monitoring of field activities by government agencies responsible for forestry matters (such as Forestry Departments within the tiers of government – local, state, and federal). It is suggested that the Forestry Research Institute of Nigeria and the various universities offering courses in forestry devise improved technologies and training for harvesting, processing, and storage of medicinal plants.

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