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Teija Reyes, Olavi Luukkanen, and Roberto Quiroz

Small Cardamom—Precious for People, Harmful for Mountain Forests

Possibilities for Sustainable Cultivation in the East Usambaras, Tanzania

131



Small cardamom (Elettaria cardamomum) is a valuable source of income for numerous resource-poor farmers inhabiting the East Usambara Mountains in Tanzania. Notwithstanding, the primary forests in

these mountains also have the highest ratio of endemic flora and fauna per 100 km² of all biodiversity hotspots in the world. Cardamom cultivation, under current growing practices, is radically changing the composition of the forest, thus threatening the endemic species within the forest. A comparative analysis of cardamom-growing practices, problems, and opportunities in the traditional cardamom-producing country, India, and in the world's largest cardamom producer, Guatemala, showed that deterioration is a common denominator. On-farm research, conducted as a complement to the project, demonstrated that organic cardamom could be profitably grown in homegardens. By implementing agroforestry systems, the harmful impact of cardamom cultivation on the forests might be dramatically reduced.

Keywords: Cardamom; *Elettaria cardamomum*; cash crops; agroforestry; rainforest; mountain ecology; Tanzania; India; Guatemala.

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Introduction

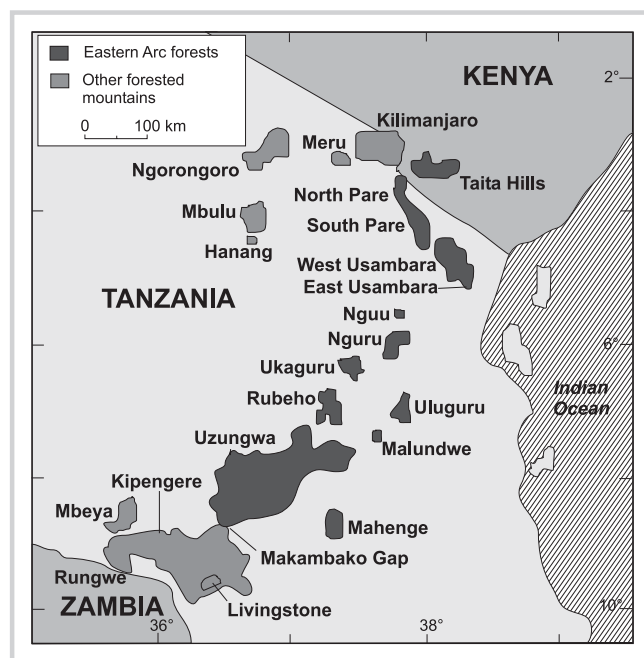
Small cardamom (*Elettaria cardamomum* Maton), one of the world's most ancient spices, was already mentioned in approximately 3000 BC in Sanskrit texts in India (Ravindran and Madhusoodanan 2002). This "Queen of Spices" belongs to the ginger family (Zingiberaceae) and is the third most expensive spice in the world, after saffron and vanilla. It grows as a native in the southern Indian forests of the Western Ghats. Owing to its sensitiveness to wind, drought, and water-logging, optimum yield is obtained on warm (10 to 35°C) and humid (with >1500 mm of well-distributed rainfall) mountain slopes at 600–1500 m elevation, under a canopy of evergreen trees. Cardamom has been commercially cultivated in the Western Ghats for 150 years, and India has had a virtual trade monopoly until recently. Cardamom and black pepper were also the primary reason for establishing the sea route from Europe to the Far East. At present, the largest

producers of true cardamom are Guatemala and India, and smaller producers include Tanzania, Sri Lanka, Papua New Guinea, El Salvador, Laos, and Vietnam. Cheaper substitutes to real cardamom (*Amomum* spp. and *Aframomum* spp.) are grown and used in some Asian countries (Nair and Kutty 2004).

India and Saudi Arabia consume more than half of the world's total cardamom production. In Arab countries and India, cardamom is a common flavoring ingredient for coffee and tea. In Scandinavia, as well as in Germany and Russia, it is used to flavor cakes, pastries, and sausages. It is popular in Indian and South Asian cooking and used to make spice blends, such as curries and *garam masala*. Chewing cardamom after a meal is recommended to aid digestion and to clean teeth. In Eastern medicinal practices it is used for curing such ailments as influenza, infections, asthma, bronchitis, cardiac disorders, diarrhea, nausea, cataracts, and for strengthening the nervous system. It is also said to have a cooling effect in hot climates. Ancient Greeks and Romans already used its delicate aroma to make perfume (Ravindran and Madhusoodanan 2002).

The aim of the present study was to describe the effects of small cardamom cultivation on African natural mountain rainforest ecosystems and on the economy of local communities in the East Usambaras, Tanzania (Figure 1), as well as identifying possibilities for sustainable and profitable cultivation using agroforestry methods.

FIGURE 1 Location of the East Usambara Mountains in the Eastern Arc. (Source: <http://www.easternarc.org/html/map.html>)



Data were collected from 10 villages (Emau Hill, Shebomeza, Mlesa, Kisiwani, IBC, Antakae, Makanya, Kwezitu, Mashewa, and Kimbo) in the buffer zone of Amani Nature Reserve and the Derema corridor. The data were based on observations of cultivated areas, informal interviews, and questionnaires. An agroforestry field trial was conducted in the buffer zone of the Amani Nature Reserve in 2000, in order to assess possible intensive cardamom cultivation methods. Finally, a comparison, based on a literature review, was made with other cardamom-growing highland areas in India and Guatemala.

Cardamom cultivation in the East Usambaras

The East Usambara Mountains (4°48'–5°13' S and 38°32'–38°48' E) belong to the chain of the Eastern Arc Mountains (Figure 1), which have the highest ratio of endemic flora and fauna per 100 km² of all biodiversity hotspots in the world (Myers et al 2000). German settlers introduced cardamom to the area in the 1890s. In 1954, Amani Botanical Garden in the Usambaras distributed 10 seedlings to farmers who vegetatively propagated the material for other farmers. After one decade the cardamom business started to flourish. The local Washambaa people and immigrants from the nearby highlands are currently the main cardamom growers in the area. Cardamom stock in the East Usambaras belongs to three varieties ('Thwarites,' 'Malabar,' and 'Mysore') or their hybrids (Sah 1996).

Cardamom is mostly grown in the fragile higher parts of the mountains (above 850 m), and is expanding to less suitable sites. It is estimated that over 30% of

Eastern Arc Mountain forest species, including many endemic ones, have become extinct, or are under threat of extinction, due to agriculture. Cardamom is still grown inside forest reserves and conservation areas, even if this practice is illegal (Table 1). About 60% of the East Usambaras' original natural forest has been lost and only half of it is classified as dense. Local extinction of understorey birds has been claimed to be due to removal of understorey from forest cultivations (Newmark 2000). Reduced air humidity at higher altitudes has also been associated with forest clearance (Hamilton and Bensted-Smith 1989). About 26% of the forested area is assumed to be under cultivation, mainly of cardamom, but the estimates are ambiguous since cardamom cannot be easily distinguished by remote sensing techniques. Estimates of the area under cardamom cultivation vary from 11,000 ha (Johansson and Sandy 1996) to 17,000 ha (Sah 1996).

Cardamom cultivation is still mostly practiced in the forest after completely clearing the understorey and middle layer, and selectively thinning the tree canopy (Figure 2). Farmers leave 75–100 trees/ha standing to provide shade, increase soil moisture, and ensure variety in tree products (Masanyika 1995). Cultivation becomes unprofitable after about 7 years (Sah 1996), on some sites even after 1 production year (ie, after 3 years). A new site is then prepared for cardamom cultivation and the old area is cleared completely and converted to annual crops, such as sugarcane, cassava, or maize. When the field is finally abandoned, it degrades into *Lantana camara*, *Clidemia hirta*, and *Psidium guajava* scrub, which renders regeneration of other species very

TABLE 1 Distribution of forest types in the East Usambara Mountains. (Source: land use survey by Kari Hyytiäinen; see Hyytiäinen 1995)

Forest class/sub-class	Area (ha)	% of all forests	% of total area
Sub-montane rainforest	12,920	30.7	15.5
Dense forest	6940	16.5	8.3
Poorly stocked forest	470	1.1	0.6
Cultivation under forest^{a)}	5510	13.1	6.6
Lowland forest	26,480	62.9	31.7
Dense forest	15,180	36.0	18.2
Poorly stocked forest	5790	13.7	6.9
Cultivation under forest^{a)}	5510	13.1	6.6
Plantations	2720	6.5	3.3
Total	42,120	100.0	50.4

^{a)} Primarily cardamom cultivation: 11,020 ha in total, representing 26% of the forests (19% inside forest reserves; see Johansson and Sandy 1996).

FIGURE 2 Cardamom cultivation in natural forest after selective thinning of tree canopy. East Usambaras, Tanzania. (Photo by Teija Reyes)



difficult (Stocking and Perkin 1992; Hamunen 1998) (Figure 3).

After two and a half years, small cardamom is ready for harvest, and the fourth year normally gives the highest yield, about 125 kg/ha. Farmers maintain their 1-ha cardamom farms by weeding and trashing (removing old and dry shoots). Only creamy/white cardamom is produced in the area nowadays; it is obtained by drying fresh cardamom fruits in the sun. First-grade green cardamom, which is fire-dried, is no longer produced due to lack of firewood. From 1950–1970, fire was the dominant method for drying the seeds, also because the climate in the mountains was moister than now. The capsules are usually dried on mats near a road, thus increasing the probability of finding impurities among the seeds.

Converting natural forest to cardamom cultivation has been identified as one of the main threats to the East Usambaran forest and its species (Newmark 2000;

CEPF 2005). The same problem has been noted in the cases of India (Kumar et al 1995) and Guatemala (Urquijo 2004). Regular pruning and cutting of trees and planting of fast-growing exotic tree species is practiced to provide the 40–50% shade needed for optimal productivity. The “cardamom hill reserves” in the Western Ghats are characterized by low tree density and floristic diversity, and by a single canopy layer consisting of tall trees. The absence of smaller trees suggests forest regeneration difficulties and opening of the canopy when the overstorey trees die (Kumar et al 1995).

The research carried out in the East Usambaran forest on cardamom areas 2–20 years after their abandonment concluded that succession in these areas is very slow if noticeable at all. A total of 24% of 177 sites studied did not have any seedlings, only a dense undergrowth thicket, and forest regeneration on these most degraded sites seemed almost impossible. There is a

FIGURE 3 A typical pattern of forest degradation following the planting of cardamom in the East Usambara Mountains. (Modified after Stocking and Perkin 1992; reproduced with permission of authors and courtesy of Blackwell Publishing)

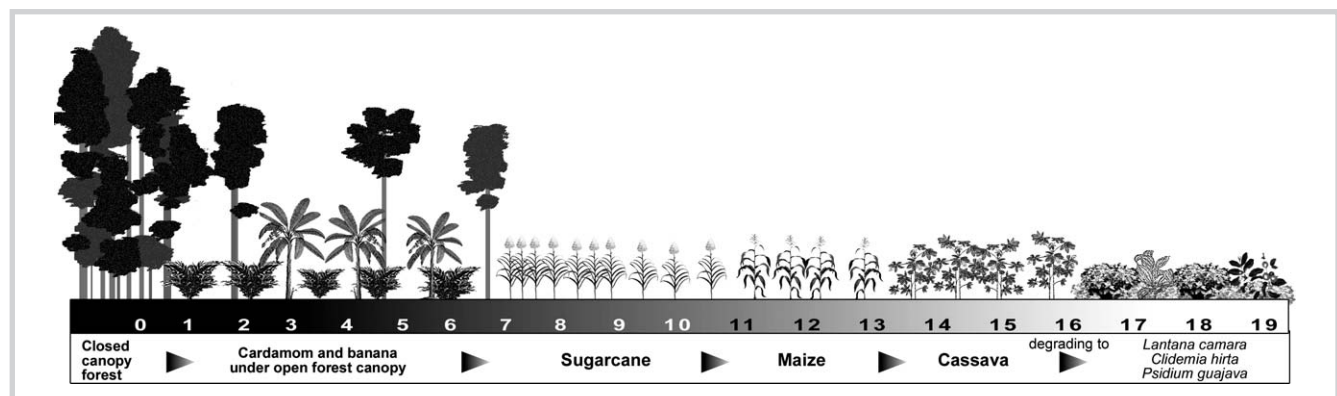


FIGURE 4 A local farmer picking mature cardamom capsules. East Usambaras, Tanzania. (Photo by Teija Reyes)



risk that these areas remain unproductive grasslands and thickets, if succession is not artificially facilitated by human intervention (Hamunen 1998).

A large number of the rain forest fragments in the Anamalai Hills and in the Western Ghats that are under cardamom cultivation are doomed to disappear in the long run, due to the absence of any regeneration (Umapathy and Kumar 2000). Regeneration of indigenous trees can also be hindered by the fast-growing exotics planted at cultivation sites. The deforestation rates in Guatemala are alarming, especially in Alta Verapaz, due to commercial cultivation. Melgar (2003) estimates that if current deforestation rates were maintained, there would be no forests left in 40 years. Cardamom growers in India and Guatemala might be affecting the ecology and the water resources most seriously through the use of agricultural chemicals.

The economic importance of cardamom in the East Usambaras

About 60% of the highland farmers in the East Usambaras grow cardamom, and cardamom farms cover

approximately half of the total land area allocated to cash crops. The contribution of cardamom to average household income is about 30%, and it accounts for more than 50% of total cash-crop income. Cardamom growers are better off than other semi-subsistence farmers, but their income is still far below the national per-capita average. The farmers need income from cardamom to support their families even when they are aware of its negative impact on the forest.

Local farmers have limited formal education, generally attending only primary school, and education possibilities are scarce. The road network is poor. Health-care facilities are very few and inaccessible to most people; more than half of the population can only consult traditional healers. No chemicals or irrigation are used in cardamom cultivation, and improved planting material does not exist in Tanzania. There are no producer associations and no quality control mechanisms. Until 1984, a number of marketing societies and boards for cardamom existed in the East Usambaras (Sah 1996), but now produce is usually sold at a very low price to middlemen. Price fluctuations are large, and prices can suddenly drop to half of the previous month's level. During the study period, the average price for cardamom was US\$ 2.9 (US\$ 1=TZS 876.4, November 2001) per kg, varying from US\$ 2.3/kg (with poor access to markets) to US\$ 5.7/kg (when sold in Dar es Salaam).

The whole production is usually exported. Average annual cardamom yield in the East Usambaras is 80 kg/ha (Masanyika 1995); nonetheless, there is empirical evidence that under good land management and by adding manure it could easily reach about 1 kg per stump and year, giving an average of 300 kg/ha. In the mid-1970s, the East Usambaras were still producing about 760 t of cardamom per annum (equaling 20% of total world production), which made Tanzania the third largest producer after India and Guatemala. Guatemala took the leading position from India in 1980. In 1998, Guatemala already produced 64% of all cardamom traded worldwide, while India supplied 30% and the other cardamom-producing countries 6% (Ravindran and Madhusoodanan 2002). In 2002, Tanzania produced 560 t, which is very little compared with Guatemala's production of 19,000 t that year.

The initial investment is higher for cardamom than for other crops: US\$ 2.3 (TZS 2000) per ha, as compared to US\$ 0.006 (TZS 5) per ha for beans, or US\$ 0.009 (TZS 8) per ha for maize. Harvesting of cardamom is also labor-intensive, because mature capsules have to be collected manually, one by one, every 3 weeks for 6 months (Figure 4).

However, if cardamom is managed correctly, farmers can make a good profit, as is the case for farmers in the Western Ghats, India, where income from cardamom can be 7 times higher than that from timber harvesting

using selective felling in rain forests (Nair and Kutty 2004). Large cardamom (*Amomum* spp.) thrives in already disturbed forest, for example after selective logging, and prevents total forest destruction (CIFOR 2002). The soil erosion rate is lower with the cardamom crop covering the soil and some trees left for shading, as compared to land completely cleared for annual crops.

If fields are not completely cleared, ecosystem recovery depends on the existence of surrounding intact and undisturbed forests (Parthasarathy 1999), the size and number of mature trees on a site, and the intensity of man-made disturbance. If the site has been greatly disturbed, the resulting dense thicket will prevent regeneration of trees (Hamunen 1998). Complete clearing usually follows upon cardamom yields diminishing.

The most sustainable practices involve mixed cropping (Moench 1991), using agroforestry methods for cardamom growing (Singh et al 1989; Sharma et al 1994; Rao et al 2004). At least such combinations as areca nut + nutmeg + clove, coconut + black pepper + coffee, and *Grevillea robusta* + black pepper provide suitable shade for cardamom (Ravindran and Madhusoodanan 2002). By growing such valuable cash crops as small cardamom using improved agroforestry methods, farmers in the East Usambara Mountains have doubled their income (Reyes et al 2005). A dense multiple canopy and intercropping of cardamom with a variety of other crops and trees have been proven ecologically and economically sustainable and could even increase the fertility of already depleted soils (Moench 1991).

In our experiments with intensive agroforestry in Emau Hill in the East Usambaras, cardamom was intercropped with *Grevillea robusta* and black pepper. Annual production in the second production year was, on average, 730 kg/ha, increasing up to 960 kg/ha in the highest-yielding plots; production was more than 2 kg/plant. This is 10 times as much per hectare—and 5 times as much per plant—as the maximum yield obtained within the secondary forest nearby. Our site on old farmland was cultivated without manure application. Many farmers have already started to cultivate small cardamom in their homegardens, also due to the lack of forest areas suitable for cardamom cultivation.

Socioeconomic comparison of cardamom growers in India and Guatemala

There are many similarities between the East Usambaras, Tanzania; the Western Ghats, India; and Alta Verapaz, in Guatemala. In all cases, cardamom grows in moist tropical highland forest and its cultivation is of economic importance to the local population. Another common feature is the international concern regarding the survival of valuable forests in the world's 25 biodiversity "hotspot" areas (Myers et al 2000). There are,

however, considerable differences between cultivation practices and policies to support the cardamom agribusiness between these 3 cases.

Cardamom is the most important spice produced and traded by India, but only 2% of production is exported, because of large domestic demand (Ravindran and Madhusoodanan 2002). Previously, cardamom cultivation was restricted to harvesting a natural product in state-owned forests, where only the extracted product belonged to the farmer (Kumar et al 1995). Today, about 69% of the farms are privately owned. The Indian Cardamom Research Institute and the Indian Institute of Spices Research have improved the planting material and developed many high-yielding and disease-resistant varieties. Use of fertilizers, pesticides, and irrigation is widespread, and development of improved electric dryers and rub-cleaning machines is also advancing.

Cardamom producers in India are well educated and occupy the upper financial, social, and political strata of local society. They get financial assistance from various institutions and are well organized. Produce is sold through auction houses registered with the Spices Board, which also controls quality. Workers on cardamom holdings earn more and have steadier employment than those in other agricultural sectors. In cardamom-producing areas, this crop provides a livelihood to the majority of the population. People have education and health-care facilities, a high standard of living, and a good road network (Nair and Kutty 2004).

Recently, cardamom yields in India have declined due to forest exploitation and a longer dry season. India has lost its Middle East markets to Guatemala, because the higher-quality Indian cardamom is now more expensive. Prices in the Indian domestic market are higher than those abroad, which led to some Guatemalan cardamom being smuggled to India. Due to high prices of small cardamom (*Elettaria* spp.), cheaper large cardamom (*Amomum* spp.) is making inroads into specific domestic markets of India. The average price difference between the 2 types is reported to be around 300% (Tharian and Joby 2005).

Suitable conditions (well-distributed annual rainfall and sufficiently cool climate all year round) and rapidly expanding production have made Guatemala the world's foremost exporter of cardamom today. Under those conditions, cardamom can also grow on open land or with very little shade, which results in high yields. The maximum yield obtained in Guatemala, 366 kg/ha, is almost 2.5 times higher than that obtained in India. In Guatemala, constantly renewed and developed production technology, large drying capacity, and effective export companies all aim for good quality at the lowest prices. Production costs are reported to be only half of those in India (Ravindran and Madhusoodanan 2002).

About 70% of the cardamom in Guatemala is grown by 200,000 farmers living in poverty, on less than 4 ha of land. The department of Alta Verapaz, for example, has the lowest development indicators in Guatemala. Families often suffer from lack of food, health services, and education. They survive on limited cash income from coffee and cardamom production and by growing maize for subsistence. Cardamom-producing areas are on fragile mountain slopes degraded by slash-and-burn agriculture. Land distribution in Guatemala is highly unequal, with only 2.6% of the population owning 65% of all arable land (Urquijo 2004).

Cardamom is Guatemala's fifth largest export product, but it has recently faced many unexpected problems. The rains and landslides caused by Hurricane Mitch in 1998 significantly reduced all crop production (primarily in coffee, cardamom, and maize). In 1999, a combination of low coffee prices and favorable cardamom prices encouraged producers to plant more cardamom. In 2002, the harvest totaled 19,000 t, but instability in the Middle East (Iraq) caused prices to drop by half. Furthermore, Saudi Arabia, which typically purchases 90% of Guatemala's cardamom, canceled all cardamom imports, which led to oversupply (Stewart 2004). Moreover, middlemen, generally from the consumer countries, always receive higher profits than the producers.

Future visions and recommendations for Tanzania

India and Guatemala are committed to finding more productive, drought-tolerant, and disease-resistant cardamom varieties through genetic improvement. Production expansion is no longer driven by increasing cultivation area but by improving productivity. Average yields have increased more than fourfold in India (from 46 kg/ha to 206 kg/ha) in the last 35 years (John 2005). To date, the entire world production of cardamom has always been consumed the same year. In the last 15 years, global production and consumption have increased almost 2.5 times, and it appears that cardamom has a bright future, facing a steady increase in demand and supply. Prices are also expected to remain steady or even to go up. Intensive promotion of traditional and new uses of cardamom is being carried out (in cough and cold medicines and in substitutes for cigarettes; in biscuits, candies, and soft drinks), especially in India (Ravindran and Madhusoodanan 2002).

In this study it was shown that cardamom growing in natural primary forest is not sustainable in the long run. It also accelerates forest clearance, since farmers argue that forest areas already thinned for cardamom cultivation are easier to clear completely afterwards for annual crops (eg by girdling the trees). Cardamom

crops are still economically so tempting in the East Usambaras that sustainable cultivation methods available should be considered seriously to prevent further land degradation and aggravation of poverty.

There is already a growing trend to shift cultivation from forests towards homegardens in the Usambaras, and in many villages farmers confirm that cardamom production is improved with the help of manure and better management. Our on-farm experiments also show the potential for cardamom production in agroforestry systems. There are many other examples of cardamom intercropping in mountain areas that have proven to be both productive and sustainable. Agroforestry elements are useful complements to, but not substitutes for, the original ecosystem. A combination of well-managed multiple-use agroforestry with protected natural forests, and additionally perhaps with intensively managed forest plantations, could contribute both to better livelihoods and to better maintenance of biodiversity that depends on primary forest and is still directly threatened by cardamom cultivation.

The finding that well-distributed moisture throughout the year is more important for cardamom production than total amount of annual rainfall highlights the value of maintaining permanent forest cover. The main recommendation deriving from the present study is to keep the field as diverse as possible and to save the surrounding forest to maintain an appropriate microclimate. A change from simple to more diverse agroforestry methods has potential in the East Usambaras. Traditional agroforestry systems at some sites contain 50–80% of the plant species diversity found in comparable natural forests while providing most of the products needed by local families (Huang et al 2002). Cardamom farmers in the East Usambaras urgently require external support from district authorities and the national government for developing the whole agriculture-based economy in the area. Strong producer associations will be needed for developing the markets, stabilizing the prices, and helping to develop drying technology and provide training for farmers to improve quality.

Today, most of the world's cardamom is cultivated using chemical fertilizers and pesticides. In the East Usambaras, where smallholder farmers do not use mineral fertilizers or agricultural chemicals, the promotion of organic cardamom cultivation would additionally raise the value of the product on the market by up to 30–40%. Certification of organic products has already started in some villages. Demand exceeds supply, and markets in the USA and Europe are expanding. East Usambaran farmers can compete neither with amounts nor with prices in the global cardamom markets, but they can be successful competitors by supplying organic, sustainably produced cardamom and thus secure a satisfactory livelihood income.

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