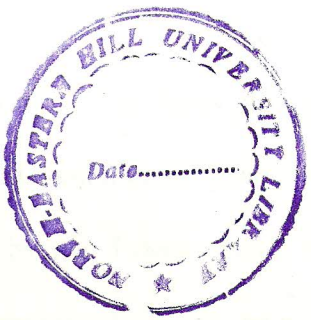
REGENERATION ECOLOGY AND SUSTAINABILITY OF HARVEST OF BAY LEAF, *CINNAMOMUM TAMALA* FR. NEES (LAURACEAE) IN MEGHALAYA



BY

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DECLARATION

I, Ms. Biswarupa Ghosh, hereby, declare that the subject matter of this thesis entitled, "Regeneration ecology and sustainability of harvest of bay leaf, C*innamomum tamala* Fr. Nees (Lauraceae) in Meghalaya" is the record of work done by me. I declare that the contents of this thesis did not form basis of the award of any previous degree to me or to the best of my knowledge to anybody else, and that the thesis has not been submitted by me for any research degree in any other University/Institute.

The thesis is being submitted to the North-Eastern Hill University for the degree of Doctor of Philosophy in Botany.

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Shillong
Date

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Chapter I

General Introduction

Forest dwellers all over the world have depended on a variety of forest products for livelihoods. They have utilized both timber and non-timber products. The latter are commonly known as NTFPs. In general, NTFPs contribute substantially to the livelihoods and income of the people living in and around forests. Of all the NTFPs used by the people, many are traded to augment income and several have been commercialized. Not all people depending on NTFPs are however involved in its trade and commerce. It is estimated that nearly 1.2 billion people use various tree species to generate food and cash in developing countries (World Bank 2002). About 350 million people are directly dependent on forest resources for subsistence and/or income generation and another 60 million depend highly on rainforests of Latin America, Africa and Southeast Asia.

Extraction of NTFPs has been debated in scientific parlance for sustainability. It is believed that not many NTFPs are harvested on a sustained-yield basis. Examples of many NTFPs such as *Prunus africana* (Cunningham and Mbenkum 1993), *Bertholletia excelsa* (Peres *et al.* 2003) and others from several countries do confirm that extractions of NTFPs are unsustainable.

Sustainable harvest of NTFPs depends on the part of the plant that is harvested. If an entire plant is harvested, as generally is the case with the herbs, the populations are most threatened. For example, *Allium tricoccum* (Nantel *et al.* 1996), *Panax quinquefolium* (Nantel *et al.* 1996), *Aechmea magdalenae* (Ticktin *et al.* 2002). In some cases, harvest of

entire tree as in case of *Aquilaria malaccensis* (Soehartono and Newton 2001, Paoli *et al.* 2001) has driven the species to threatened category. Similarly, if fruits and seeds are harvested in large quantities, seed banks may diminish to the extent that the regeneration of species does not occur as in *Brosiumum alicastrum* (Peters 1992) and *Grias peruviana* (Peters 1991). Notwithstanding, if the leaf is the commodity in demand, the possibilities of sustainable harvests are enhanced. This however may vary substantially with the species. In case of *Livingstonia rotundifolia*, the leaf harvest is unsustainable beyond 20% (O'Brien and Kinnaird 1996). On the other hand, rattan harvest from *Calamus zollingeri* may be ecologically sustainable in tropical rainforests of Sulawesi as nutrient levels are significantly higher in the foliage than the cane and the foliage is left on the ground after harvesting (Siebert 2001). Incidentally, both these species mentioned for leaf extraction belong to palms. Studies on sustainability of leaf harvests from tree species are hardly known (Ticktin 2004).

Sustainable harvest of NTFPs also depends on the technique of harvest. Hall and Bawa (1993) argued that harvesting of branches and leaves from the adult trees may not only divert resources meant for reproduction to regenerate branches, but also the number of sites of reproduction may be reduced and fruit production interrupted until the branches regrow. Continued pruning may lower reproductive output of affected individuals so severely that recruitment of new individuals in the population would be deterred. Overextraction of leaf may decrease the photosynthetic capacity of the harvested individual rendering it susceptible to disease and reduced reproductive vigor. In fact, defoliation is known to alter carbon content, C: N ratio and chlorophyll content in new

leaves, making them more susceptible to herbivores and decreasing photosynthetic capacity over the long term (O'Hara 1999).

Sustainable harvest of a NTFP also depends on life-history traits. Regeneration in natural conditions is determined by the successful completion of several events in the tree life cycle, such as seed production, dispersal to safe sites, seed germination and seedling emergence, establishment and onward growth. Seed production of trees may be limited by various extrinsic factors such as resource availability, pollinator abundance and predation of flowers, fruits and leaves, by climatic conditions as well as by intrinsic factors such as age and size of the plant and its genetic constitution (Winn and Werner 1987). Hence, regeneration of tree species is greatly influenced by the interaction of biotic and abiotic factors of the environment (Boring *et al.* 1981, Aksamit and Irving 1984, Khan *et al.* 1986). These factors may affect recruitment, survival and growth of tree seedlings and sprouts (Tripathi and Khan 1992). The presence of sufficient number of seedlings, saplings and young trees in a given population is considered as an indicator of good regenerability of a species (Saxena and Singh 1984a).

Two most important intrinsic factors that are of ecological importance in NTFP collection are the resource stock and the regenerability of the product. The natural populations of an NTFP constitute its resource stock that may decline due to deforestation or increase by proper management and cultivation on a temporal scale. The regenerability of an NTFP apparently depends on population size, reproductive potential, conducive microhabitat and anthropogenic pressures (Hall and Bawa 1993).

Fortunately, NTFPs offer enormous potential in improving rural economy without degrading the forests through the down-to-earth involvement of the people in practicing

sustainable means of harvesting and hence conserve biodiversity (Hedge *et al.* 1996, Murali *et al.* 1996, Uma Shankar *et al.* 1996, 2001). Godoy and Bawa (1993) hypothesized that NTFPs can be harvested on sustained yield basis from year to year for many years. However, overextraction may lead to local extinction of populations or to the domestication of the species if the product is demanded and a channel of marketing is developed.

NTFPs form an integral part of Indian culture and traditions for millennia. About 700 million rural Indian people depend on NTFPs for sustenance (Bhat *et al.* 2001). The Ayurveda system of medicine, which originated in India, is predominantly dependent on NTFPs such as *Centella asiatica*, *Artemisia meritima*, *Swertia chirayita*, *Juglans regia*, *Aconitum* spp.. In India, any festival is incomplete without the use of a variety of NTFPs.

In Meghalaya, the major tribes, namely, Khasi, Garo and Jaintia harvest many timber and NTFP species. Broomgrass, bay leaf and torchwood top the list of NTFPs traded in Meghalaya (Figure 1.1). These NTFPs have been notified by the Government of Meghalaya since a tax is levied on export out of the State. Other common NTFPs are fruits and berries (*Myrica esculenta, Elaegnus* spp., *Rubus* spp., *Castanopsis* spp., *Prunus nepaulensis*), mushrooms, rattan and canes, edible medicinal herbs (*Centella asiatica, Houttuynia cordata,*), medicinal plants (*Drymeria cordata, Costus specious, Meyna spinosa).*

Of the three major NTFPs in Meghalaya, bay leaf is derived from *Cinnamomum tamala* Fr. Nees. (Lauraceae) found predominantly in subtropical mixed evergreen forests. *C. tamala* is an evergreen tree mostly occurring in the sub-canopy. The harvest and trade of bay leaf has steadily increased in Meghalaya during last 10-12 years. It is believed that

the ban on timber harvest by the Supreme Court of India in 1996 from the forests in northeastern region of India triggered people shifting to NTFPs. Of late, *C. tamala* has been cultivated in some parts of Meghalaya.

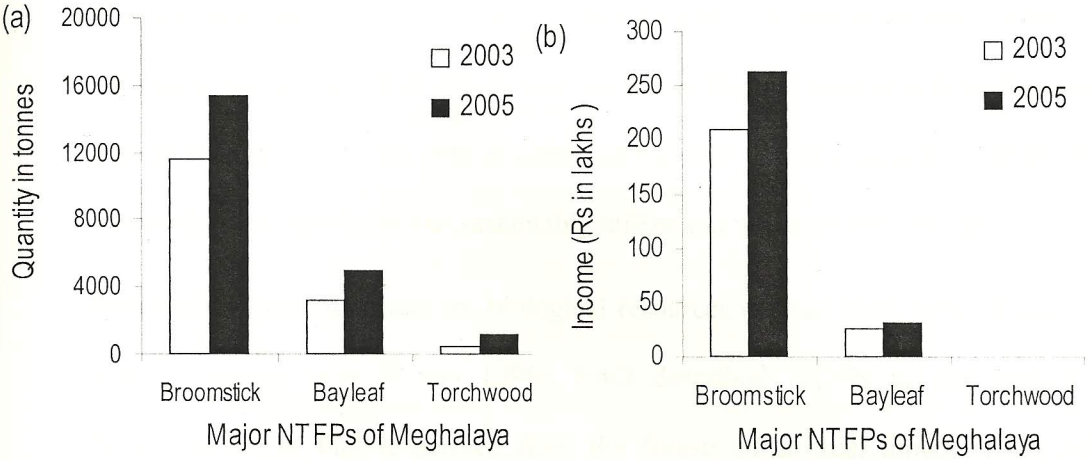

Figure 1.1. The maximally traded non-timber forest products of Meghalaya. Data from Mawiong Regulated Market, Shillong for collection quantities (Figure a) and revenue generated by the sale of NTFPs collected (Figure b). The revenue figures for torchwood were not available.

The studies on population ecology, regeneration, sustainability of harvest and trade are the prerequisites for evolving an effective conservation strategy for any NTFP while providing economic benefits to the rural people. The extraction of bay leaf from *C. tamala* offers a potential system for studying sustainability of leaf harvest from a tree. The present study is focused to investigate the community organization of the systems that house *C. tamala* trees, regeneration of *C. tamala*, sustainability of bay leaf harvest, and profitability of trade of bay leaf in Meghalaya. Hence, the objectives of the present study are to (i) study the regeneration ecology of *C. tamala* and (ii) examine the sustainability of the current harvest practices and trade of bay leaf in Meghalaya.