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Lacquer-based agroforestry system in western Yunnan, China

Chunlin Long[1,*], Kui Cai[2], Ken Marr[3], Xiaorong Guo[1,4] and Zhiqin Ouyang[5]
*[1]Chinese Academy of Sciences, Kunming Institute of Botany, Yunnan 650204 Kunming, China; [2]Yunnan University, Institute of Geography, Yunnan 650224 Kunming, China; [3]Royal British Columbia Museum, 675 Belleville Street, V8W 9W2 Victoria, BC, Canada; [4]Chinese Academy of Sciences, Xishuangbanna Tropical Botanical Garden, Yunnan 666303 Mengla, China; [5]Yunnan Introduction and Propagation Center for Rare & Endangered Plants, 650032 Kunming, China; *Author for correspondence (e-mail: long@mail.kib.ac.cn, or chunlinlong@hotmail.com; phone: (86)(871)522-3233; fax: (86)(871)515-0227)*

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Abstract

The lacquer tree (*Toxicodendron vernicifiuum*) based agroforestry system is a very important farming system with development potential in western Yunnan, southwest China. It is, however, less understood in scientific fields. The Lemo people (a branch of the Bai minority nationality) traditionally grow lacquer trees interplanted with upland food crops in swidden fields. During a 10–15 year fallow period, farmers can harvest various products from lacquer trees, including resin for selling or trading, leafy shoots for vegetable, pericarps for making wax, roots and leaves for pesticide, dry resin for medicine, and seeds for vegetable oil extraction. The Lemo people believe the lacquer tree is the most important crop in their community. The lacquer agroforestry system provides the Lemo people with food, cash income and environmental benefits. Further studies on the lacquer agroforestry system will be indispensable to improve this system so as to disseminate it to other communities.

Introduction

Lacquer is a kind of resin from *Toxicodendron vernicifiuum* F. A. Barkley (Anacardinaceae). It is an important non-timber forest product in China. Since 2200 BC, lacquer has been used as an antiseptic and as an antirust paint in China (National Union for Supply & Selling 1980). Today lacquer still plays a significant role in Chinese painting materials. The lacquer tree is fast-growing and is distributed widely in southern China. As a crop, the Chinese people have grown lacquer trees on dry terraces and uplands for over 2000 years.

There are hundreds of agroforestry systems in China. Unfortunately, no one has recorded the lacquer agroforestry system (Guo and Padoch 1995; Zou and Sanford 1990). The 'damar system', use *Shorea javanica* K. et V., and is a resin-producing agroforestry system in Indonesia, similar to the lacquer agroforestry system, and has been studied intensively (de Foresta and Michon 1993, 1994a, 1994b; Michon et al. 1996). In this paper, we present an outline of the lacquer agroforestry system practiced by the Lemo people in western Yunnan.

Materials and methods

Description of site and people

The Lemo is a tribe of about 6,000 who live mainly in Lushui County, Nujiang Prefecture, western Yunnan Province, Southwest China, and belong to the Bai nationality. They live mainly in the Nujiang Canyon (Salween River Valley) in western Yunnan. Two north-south mountains ranges, the Gaoligong Mountains in the west and the Biluo Snow Mountains in the east, are divided by the Salween River. Other ethnic groups, including Lisu, Nu, Dulong, Tibet, Yi and Dai also live in the same canyon.

There are very rich biological resources in the area where the Lemo people live. Located in the heart of

the Eastern Himalayas, western Yunnan is regarded as a connective region where two biodiversity hotspots, the Indo-Burma and South-Central China hotspots, meet together according to a recent study conducted by Myers et al. (2000). The Gaoligong Mountains alone, for example, harbor over 5,000 higher plant species, including 6 species of *Toxicodendron* (Li et al. 2000). Based on our recent ethnobotanical survey, the indigenous Lemo people collect about 300 species of wild plants for different purposes such as food, timber, medicine, fiber, ornament, weaving, fodder and resin (Long et al. 1999).

The Lemo's living environment is rather difficult. The Lemo villages are 900 to 2,800 meters above sea level. The land is quite steep, with most of their farming land at a slope of over 35 degrees. The steepest farming land reaches 60 degrees! However, the Lemo have developed their own agroforestry system to sustain and improve their livelihood, which can be formulated as *T. vernicifuum* (or *Alnus nepalensis* D. Don) + crops.

Because they live in a remote area, the Lemo still retain their traditions in religion, culture, production practices and lifestyles. The Lemo people are polytheistic. In particular, they worship forests, trees, lands, mountains and rivers. They have no written language. In the past, they used plant leaves to communicate. Nowadays, some young people still use plant leaves and branches to express love to their girlfriends or boyfriends (Long and Wang 1994). Their production activities include mainly swidden and paddy cultivation, timber and non-timber forest products harvest, and animal husbandry. Among these activities, swidden practice is the most important and oldest one in the Lemo community.

Investigation methods

This study was implemented from 1996 to 2000. Five field surveys were conducted during this project. Ethnobotanical methods were used to investigate the Lemo's agroforestry systems and indigenous knowledge of plants (Martin 1995; Pei and Long 1998). Socio-economic approaches were adopted for secondary data collection. Participatory Rural Appraisal (PRA) was the most important tool to gather information on agroforestry. The importance value assessment and scoring of cultivated plants were also from PRA methods (Chambers 1994; Long and Wang 1996b; Pei and Long 1998). Questionnaires were also used.

Results

Swidden cultivation of the Lemo

There are four types of farming land in the Lemo community, namely paddy field (*Nuoji* in Lemo language), dry field prepared by animal labor (*Ezuji*), dry land by human labor (*Xiduoji*), and swidden field (*Gaomuji*). The paddy fields in the community were built in flatter places after 1960's. The entire area of paddy is less than one hectare because little suitable land was available to build paddy. *Ezuji* with a slope of less 30 degrees can be prepared by plowing with cattle. *Xiduoji* is over 30 degrees and can only be prepared by human labor. The swidden fields with a slope greater than 30–45 degrees are the steepest type of land in the community, but its area is large. Swidden fields occupy 94% of the Lemo's farming lands.

According to our field surveys, about 75% of the Lemo's food and 60% of their cash income come from swidden cultivation. The Lemo grow food crops in their swidden fields, mainly corn, buckwheat (*Fagopyrum esculentum* Moench.), barley, potato, millet (*Setaria italica* Beauv.), bean (*Phasaeolus vulgaris* L.) and other vegetables. A few other plant species, especially lacquer, black alder, tung tree (*Aleurites fordii* Hemsl., seed oil for industrial uses) and hemp (*Cannabis sativa* L., harvested for clothes-making fiber only), are also cultivated in the swidden systems (Long et al. 1999).

The Lemo people divide swidden fields into three categories (Table 1) and call them *Tongkong, Shenji* and *Kongji* in the Lemo language. *Tongkong* means the swidden fallow land (with secondary forest) to be reclaimed by human labors, its altitude is between 800–1,700 meters above sea level. *Shenji* means the swidden fallow land to be burned, its altitude varies from 1,700 to 1,900 meters. *Kongji* means the land with cultivated lacquer and/or alder trees.

The *Tongkong* will be reclaimed by digging with simple tools such as wooden sticks and hoes from January to March. After one month, the dry grasses and shrubs on the fields will be collected and burned. And the *Tongkong* will be prepared for crop cultivation. April is the sowing season. Food crops (mostly corn, and some soybean or pumpkin) are grown on *Tongkong*. Corn will be interplanted with millet and pumpkin. If the soil is poor, *Tongkong* will be allowed to fallow after one year of cultivation. Some fields with richer soil can be used for 14–15 years (normally

Table 1. Characteristics of the swidden fields of the Lemo people in western Yunnan Province, China.

Land category	*Tongkong*	*Shenji*	*Kongji*
Altitude (m)	800–1,700	1,700–1,900	800–2,300
Land preparation	Digging, burning	Slashing & burning	Slashing & burning, or digging
Crops	Corn, soybean, millet, pumpkin	Corn, millet, pea	Corn, millet or pumpkin
Farming duration	1(–15) years	1(–3) years	3–4 years
Fallow duration	3–4(–7) years	4–5(–10) years	7–16(–18–20) years
Tenure	Common property	Common property	Private property
Fallow management	None	None	Growing lacquer/ alder trees

3–4 years). The fallow period is usually 3–4 years, or sometimes more.

The *Shenji* will be cleared by cutting trees and shrubs in January. The dry trees, shrubs and branches will be burned in April. The sowing time is 2–4 days after burning. Food crops grown in *Shenji* are usually corn, millet and pea. The cultivated period is one year, and the fallow duration is 4–5 years. If it will be cultivated the next year, the field should be prepared again. The process is similar to that of *Tongkong*, however, the fallow period will be more than 10 years.

The *Tongkong* and *Shenji* land management systems can become *Kongji* when lacquer and/or alder are cultivated on them. The Kongji can be cleared by using the same methods as either *Tongkong* or *Shenji*. In March, lacquer and/or alder seedlings will be planted in *Kongji*. Food crops like corn, millet or pumpkin will be interplanted with the seedlings. After 3–4 years, when the seedlings grow up, the fallow period begins. The fallow duration will be 7–9 years if alder trees are planted, or 16–20 years if the lacquer trees are grown. The Lemo people believe the alder trees will enrich their swidden fields.

Cultivation and management of lacquer trees

Seed collecting

In November and December, the leaves of lacquer trees become yellow and fall off. At this time, the seeds of lacquer trees are mature. The Lemo men climb up the lacquer trees to collect all the seeds from each tree. Bigger and healthier seeds will be kept to raise seedlings, the others will be used to extract oil.

Raising seedlings

Every Lemo household will establish a nursery to raise lacquer seedlings. The nursery has to be selected in the highlands with very rich soil, which is usually more than 2,000 meters above sea level. In the winter, the field for the nursery will be cleared through cutting trees (including lacquer trees that are too old to produce lacquer), shrubs and grasses. When they are dry, they will be burned and the ash will be scattered in the nursery. Then the land will be prepared by digging slightly. If it is convenient, some animal manure will be used. The sowing season is in February or March. The seed density sown in nurseries varies between 30 and 60 per square meter. After sowing, the field will be irrigated slightly if the land is too dry. The lacquer seeds will germinate when the rainy season comes usually towards the end of April.

Transplanting seedlings

The following years, in March or April, the lacquer seedlings will have grown to as high as about 50 cm. At this time, the seedlings will be transplanted to *Tongkong* or *Shenji*. Such land will become *Kongji* after planting lacquer or alder trees. The Lemo use the same methods to raise and transplant alder seedlings as those of lacquer seedlings. They will finish transplanting before rainy season comes. About 600–800 seedlings can be planted on one hectare of land with rich soil, and 700–900 seedlings on land with poor soil. The hole for a lacquer seedling is about 20 cm^3. Sometimes the Lemo people also plant alder seedlings altogether with lacquer seedlings in the same field. One or two months later, food crops (mainly corn) will be planted between the lacquer seedlings.

Managing lacquer trees

During the initial year of intercropping phase, corn, millet and pumpkin will be grown between the lacquer seedling spaces. While the Lemo people are tending their food crops, young lacquer trees are also managed by weeding, simple pruning, and fertilizing with ash from burned shrubs and grasses. After 3–4 years, when the seedlings are larger, people do not

Table 2. Scoring, importance value assessment and rank of cultivated plants in Lemo's farming systems in Yunnan Province, China, according to the Participatory Rural Appraisal procedure.

Crop	Edibility	Cash score	Other score	Importance value	Ranking
Corn	8	–	7	0.482	2
Buckwheat	4	2	4	0.389	5
Pulses	5	3	3	0.460	3
Potato	3	3	3	0.391	4
Cannabis	–	–	1	0.029	9
Millet	2	–	2	0.128	8
Pumpkin	3	2	4	0.354	6
Lacquer tree	4	7	6	0.781	1
Black alder	–	–	4	0.256	7

grow any food crops in the lacquer-based agroforestry system. It is necessary to till the soil. Before the lacquer can be harvested, the land needs to be re-tilled 3–5 times. A few lacquer trees may be affected by insects or diseases. They will be cut down and used for fuelwood or burned on the land. Our field survey indicated that the Lemo people used very little pesticide in lacquer-based agroforestry systems. When the lacquer trees become too old to harvest lacquer, after 16–20 years, they will be cut down for the next swidden cultivation. Some healthy and productive trees will be treated with a different method. Their trunks will be cut 20–30 cm above the ground to allow for natural regeneration. The Lemo people believe that through this method they can receive benefits from the lacquer trees in a shorter time than from seedlings.

Harvesting lacquer

Lacquer trees can yield resin for 7–10 years when they are regularly tapped. After the seedlings are transplanted, 6–8 years may elapse before the first tapping, which is when the trunk diameter reaches about 15 cm. In June, the Lemo men tap the lacquer tree near the base of the trunk. At this stage liquid from the trunk will not be collected because the Lemo believe there is little resin in it. The best time to collect lacquer resin is from July to October when less liquid comes out from the trunk. Some people are allergic to lacquer if they get too close to it. Many species of Anacardinaceae cause dermatitis in humans. These men will cover their bodies with walnut (*Juglans regia* Linn.) oil to protect them from this allergic reaction, before they get to tap and collect lacquer resin. The Lemo tap the trunk upward year by year. Some people put a small jar connected to the trunk to collect resin from the steeper tapping incisions. Some use a hairy cattle tail to absorb resin from the flatter tapping incisions. They squeeze the tail and gather the resin in a container. The tapping incisions are different if they adopt different collecting methods. The resin can be harvested for about 6–7 days after each tapping. Two taps will be made in a year during the harvesting period.

Benefits from lacquer agroforestry system: economy and environment

Although corn is the Lemo's staple food crop, the lacquer tree plays the most important role in Lemo's economy according to our results through PRA method (Table 2). It is the unique cash crop in Lemo society. Some twenty years ago, lacquer resin was the only source of cash income. The Lemo people relied on resin to buy or to barter for clothes, salt, iron tools and items for daily use. Today, lacquer resin is still the Lemo's main source of cash income. The PRA methods were used to quantity local people's perspectives on their crops. As shown in Table 2, lacquer in the most important, followed by corn, pulses, potato and other cultivated plants.

Western Yunnan, where the Lemo people live, is a poverty region according to the national criteria. The GDP was only 732 Chinese Yuan (about $ US 90, 1US$ = 8.20 Chinese Yuan, December 2001) per capita in 1999 (Editorial Committee of Yunnan Statistics Yearbook 2000). Their cash income was as low as 224 Chinese Yuan (about $ US 30) per capita (or $ US 120 per household) in 2000, of which most was from selling lacquer resin. An average individual Lemo household maintains one third hectare of land covered with 250 lacquer trees. Each tree can produce 200 grams of resin in a yield year, therefore 50 kg of

Table 3. The species composition, component and structure of fallow *Kongji* (a landuse type of swidden cultivation) in Lemo community, Yunnan Province, China.

Layer	Height	Representative plants
Layer 1	10–22 m	*Toxicodendron vernicifuum, Alnus nepalensis*
Layer 2	3–10 m	*Rhus chinensis, Castanopsis* spp. and *Eurya* spp.
Layer 3	< 3 m	*Pueraria penduncularis, Iris* spp., *Ainslinaea triflora*, ferns

resin can be collected from the lacquer agroforestry system per year. The selling price was 11 Yuan/kg in 1999, thus 550 Yuan (about $ US 70) cash can be received in a year per household by selling the lacquer resin on the local markets. From this point, it is not surprising that the Lemo people treat the lacquer tree as number one among all their cultivated plants.

Many agroforest ecosystems are similar to natural forests. For example, the 'damar' agroforests in Sumatra of Indonesia and traditional tea-gardens in southern Yunnan of China are somewhat similar to typical forests in structure and function (de Foresta and Michon 1994a, 1994b; Garrity 1993; Long and Wang 1996a; Saint-Pierre 1991).The lacquer agroforest is a very impressive landscape in the Lemo community. The vertical structure of the vegetation of Lemo's fallow *Kongji* consists of 2–3 layers. The canopy layer is 10–22 meters high. *Toxicodendron vernicifuum* and *A. nepalensis* (natural regenerates because the seeds have wings and can be easily brought into *Kongji* by wind), of course, are the main species. Young alder trees, *Rhus chinensis* Mill., *Castanopsis* spp. and Eurya spp. occupy the second layer, at a height of 3–10 meters. The third layer is less than 3 meters. The representative plants are *Pueraria penduncularis* R. Grah., *Desmodium* spp., *Iris* spp., *Ainsliaea yunnanensis* Franch and ferns (Table 3).

The lacquer agroforests afford environmental benefits for the local community. Over 95% of their farm lands are very steep. Monoculture on such steep fields can easily result in soil erosion. The lacquer agroforestry system can protect the soil resources from erosion. In addition, more organic matter can be produced in the agroforestry systems than in monoculture fields. Thus the soil structure and biophysical environment for food crops can be improved in the area.

Ethnobotany of lacquer trees

Lacquer trees have multiple purposes in the Lemo community and other ethnic groups in western Yunnan. Every part of the lacquer tree is useful. The Lemo's knowledge of *T. vernicifuum* enriched our understanding of this so-called 'poisonous tree'. Some of these uses are listed as below:

Roots – to make traditional pesticides.

Bark – to tap resin when fresh, and to extract tannin after cutting down the tree.

Timber – to make furniture, farming tools and timber for house construction, which is insect resistant.

Old leaves – to make traditional pesticide and to extract tannin.

Leafy shoots – as a vegetable, can be either fried or eaten fresh in a salad.

Resin – used as a fine medicine to stimulate the menstrual flow, to prevent insects, to ease cough, and as a traditional paint material.

Pericarp – to extract wax for making crayons, waxpaper and candles.

Seeds – to extract oil. The seed oil is in fact a kind of plant fatty matter. The color is yellowish white. If it from immature seeds, the color is black. The reason to cause different colors is the contents of non-saturation fatty acids. More these contents exist in the black one. The Lemo people believe that the nutrition of black seed oil is much higher than that of white oil, while the lacquer seed oil is the best one. When a woman reproduces a baby, she will only use the lacquer seed oil to cook food for herself for three years, instead of any other oil or fat. The seed oil is also used to make soap, ink, and other industrial products.

Lacquer is also significant in Lemo people's traditional culture. Because lacquer is so important in their life, many folk songs and poems about lacquer can be heard and collected in the community. When a young man falls in love with a young woman, she will check his ability to grow and manage lacquer trees, and his skill to tap lacquer resin. There is a saying in Lemo community, 'a man who is not skilled in lacquer tree cultivation cannot find love and happiness'.

Discussion

Kongji, *private property*

Before the 1950's, forests and land were the common property of a clan or a village in Lemo society. An individual household did not need to get permission from the headmen and could clear any forest land for swidden cultivation. But the land with artificial lacquer trees was private, i.e. *Kongji* was a private property. Who ever grew lacquer trees in swidden fields, would have the ownership of these fields.

During the People's Commune from 1960 to 1983, all resources in China were allocated to the state and collectives. The Lemo's *Kongji*, at that time, was the property of Production Collectives. The change of tenure affected the traditional lacquer agroforestry system. The cultivators of lacquer trees could not collect lacquer resin so they gave up plantations and management of lacquer trees, and the harvest of lacquer resin. As a result, the traditional lacquer agroforestry system became degraded.

In 1983, when a change in the policy on land use was implemented by the Chinese Government, the Lemo re-allocated their swidden fields for planting lacquer and/or alder trees. Now the lacquer agroforests in Lemo community are developing very well. Yet, the ownership of modern *Kongji* is different from the traditional one, because the swidden fields do not belong to individual households for a long time. People have the use right for only 30–50 years by contracts between the local government and individual household.

Lacquer tapping, men's rights

Only the men have the rights to plant lacquer seedlings and harvest lacquer resin. The Lemo men look after all the process related to lacquer cultivation, management, tapping, transportation and selling. Every man has to master the skills of planting and tapping.

The boys have to learn the skills from their fathers to cultivate and manage lacquer trees and harvest resin when they are 12 years old. The Lemo girls pay more attention to the boys with skills of lacquer cultivation and tapping. These skills are the criteria to identify good men according to the Lemo's tradition.

The Lemo women are not permitted to plant lacquer seedlings, harvest lacquer resin, or collect lacquer seeds. During the farming period of the lacquer agroforestry system, women can manage the lacquer seedlings while they grow, manage and harvest other food crops. They can also dry the seeds for oil extraction. Only in those households without a son can a women tap lacquer resin.

A comparison between tamar and lacquer based agroforestry systems

There are similarities between tamar tree and lacquer tree based agroforestry systems. Table 4 shows the details according to the authors' investigation and the results of 'tamar' researchers (de Foresta and Michon 1993, 1994a, 1994b; Michon et al. 1996).

Further studies on lacquer agroforestry systems

Other ethnic groups in the area such as the Lisu, Nu and Yi also grow lacquer trees in their farming fields. They collect leafy shoots as a vegetable and gather seeds for vegetable oil extraction, but do not tap resin from the lacquer trees. These trees are not grown in their swidden fields but on permanent farming land. This also follows the agroforestry model formulated by 'Lacquer trees + Corns/Vegetables'. To be comparable to the Lemo's lacquer agroforestry system, it is necessary for these other ethnic groups to improve in resin collection, cultivation methods, management experiences and techniques, and seed production. Thus the Lemo's indigenous knowledge of lacquer agroforestry system can be disseminated to their neighboring communities through the farmer-to-farmer approach (Long and Wang 1996b). Before such activities are implemented, however, further studies may be indispensable. These studies are described here.

1). Density of lacquer seedlings. In Lemo's lacquer agroforestry system, some 250 lacquer trees were grown on one hectare of swidden field. In other communities in the Salween Valley, people grow lacquer trees on permanent land where the slope is not very steep. Furthermore, food crops will always be interplanted with lacquer trees on their farming land. Therefore, the density of lacquer seedlings should be different from that of the Lemo's. This will be new project to be researched.

2). Impact on soil. Both Lemo and other ethnic people believe their land will become richer after growing lacquer trees, although it is not as good as the land where black alder trees were grown. A comparative study between soil from land without lacquer

Table 4. A comparison between lacquer (in western Yunnan, China) and tamar (in Sumatra, Indonesia) based agroforestry systems.

Categories	Lacquer tree (*Toxicodendron vernicifiuum*)	Tamar tree (*Sorea javanica*)
Location	Western Yunnan, China	Sumatra, Indonesia
Starting point	Shifting cultivation	Shifting cultivation
End result	Next swidden cultivation	Permanent forest cover
Objectives to grow	Collecting lacquer resin, young leaves, seeds, and timber	Collecting tamar resin, fruits, and other NTFPs
Other trees growing in the system	Black alder (*Alnus nepalensis*)	*Durio zibethinus, Lansium domesticum*
Cultivation duration	3–4 years	10–15 years
Crops in system	Corn, millet, pumpkin	Wet paddy rice, coffee, pepper
Unproductive time	3–4 years	5–10 years
Yield duration	7–10 years	30–50 years
Harvesting method	Tapping by making incisions	Tapping by making incisions
Agroforest community structure	2–3 layers	4–5 layers
Ownership	Private, practiced by individual households	Private, practiced by smallholders
Economic benefit	Major cash income source	Major cash income source
Ecological benifit	Erosion control, and biodiversity conservation	Erosion control, and biodiversity conservation

or alder and those with lacquer trees or black alder trees will be necessary. Species of *Alnus* are able to fix nitrogen, thus it is not surprising that the Lemo have noted that the fertility of the soil is restored more quickly on land where *Alnus* is planted.

3). Resin-tapping technique improvement. The major product from lacquer trees in Lemo society is resin, but their harvesting method is primitive and may not be as productive as it could be. The harvesting techniques suggested by authorities will increase lacquer resin yield. Thus training courses on resin-harvesting techniques need to be held in the Lemo community first and then extend to other neighboring communities.

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References

Chambers R. 1994. Participatory Rural Appraisal. Cambridge University Press, London.

National Union for Supply & Selling 1980. Lacquer Tree and Its Resin. China Agriculture Press, Beijing.

de Foresta H. and Michon G. 1993. Creation and management of rural agroforests in Indonesia: potential application in Africa. Man and Biosphere Series: Tropical Forests, People and Food 13: 709–724.

de Foresta H. and Michon G. 1994a. From shifting cultivation to forest management through agroforestry: smallholder damar agroforests in West Lampung (Sumatra). APANews 6/7: 12–16.

de Foresta H. and Michon G. 1994b. Agroforests in Sumatra: where ecology meets economy. Agrofor Sys 12: 12–13.

Editorial Committee of Yunnan Statistics Yearbook 2000. Yunnan Statistics Yearbook – 2000. Yunnan People's Publishing House, Kunming.

Garrity D.P. 1993. Sustainable land use systems for sloping uplands in Southeast Asia: technologies for sustainable agriculture in the tropics, ASA Special Publication 56.

Guo H.J. and Padoch C. 1995. Patterns and management of agroforestry systems in Yunnan: an approach to upland rural development. Global Environment Change 5(4): 273–279.

Li H., Guo H.J. and Dao Z.L. 2000. Flora of Gaoligong Mountains. Science Press, Beijing.

Long C.L. and Wang J.R. 1994. On social and cultural values of ethnobotany. Journal of Plant Resources and Environment 3(2): 45–50.

Long C.L. and Wang J.R. 1996a. Studies of traditional tea-garden of Jinuo nationality, China. In: Jain S.K. (ed.), Ethnobiology in Human Welfare. Deep Publications, New Delhi, pp. 339–344.

Long C.L. and Wang J.R. 1996b. Participatory Rural Appraisal: An Introduction to Principle, Methodology and Application. Yunnan Sci & Tech Press, Kunming.

Long C.L., Li H., Dao Z.L. and Zhou Y.L. 1999. Ethnobotanical studies in Gaoligong Mountains: I. the Lemo people. Acta Botanica Yunnanica (suppl X): 131–136.

Martin G.J. 1995. Ethnobotany: A Methods Manual. Chapman & Hall, Longdon.

Michon G., de Foresta H. and Aliadi A. 1996. Damar resins, from extraction to cultivation: an 'agroforest strategy' for forest resource appropriation in Indonesia. In: Jain S.K. (ed.), Ethnobiology in Human Welfare. Deep Publications, New Delhi, pp. 454–459.

Myers N., Mittermeier R.A., Mittermeier C.G., da Fonseca G.A.B. and Kent J. 2000. Biodiversity hotspots for conservation priorities. Science 403: 853–858.

Pei S.J. and Long C.L. 1998. Applied Ethnbotany. Yunnan Nationality Press, Kunming.

Saint-Pierre C. 1991. Evolution of agroforestry in the Xishuangbanna region of tropical China. Agrofor Sys 13: 159–176.

Zou X.M. and Sanford R.L. 1990. Agroforestry systems in China: a survey and classification. Agrofor Sys 11: 85–94.