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Assessment of plant species diversity of ancient tea garden communities in Yunnan, Southwest of China

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Abstract Ancient tea garden has existed in Lancang County, Yunnan Province for more than 1,300 years, and is regarded as the provenance of Pu'er Tea's seed source. The ancient tea garden ecosystem is a typical model that integrates conservation biodiversity and utilization of natural resources. In order to reveal the role of biodiversity conservation of this ecosystem, plant diversity and application value of ancient tea gardens, normal tea gardens and secondary forestry communities in Lancang County were surveyed and compared. 360 households investigation were also conducted by using household-based agro-biodiversity assessment (HH-ABA). The results showed: (1) Ancient tea garden communities have high biodiversity, whose plant species diversity ($H = 3.03$) is lower than that of secondary forestry ($H = 4.59$) and higher than that of normal tea garden ($H = 2.62$); (2) Life forms analysis of plant species showed the vertical structure of the ancient tea garden communities are intact, herbs, trees, shrubs, vines, epiphytes are included, which is similar to that of secondary forest, while normal tea garden is dominant by herbs and no trees; (3) A large number of protected species, including five endangered, seven vulnerable and three rare, is well conserved in the ancient tea garden, while no protected species were found in secondary forest and normal tea garden; (4) The analysis of agro-biodiversity revealed that 56 % of plant species in the ancient tea garden are effectively used by households, while no plant except tea trees is used in normal tea garden; (5) The integrated values of ancient tea garden and normal tea garden illustrated that both biodiversity conservation and economic income of ancient tea garden are higher than that of normal tea garden. We suggest that the local peoples' knowledge and experience on resource management and utilization should be well documented and encouraged, and effective conservation and reasonable utilization of ancient tea garden would be achieved through training and demonstration with the participation of the local government, research institution and farmer.

Keywords *Camellia sinensis* var. *assamica* · Agro-ecosystem · Agro-biodiversity assessment · Species diversity index · Management and utilization

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Introduction

Tea is one of the most popular covered drinking beverages, and also is an important economical crop in

the world, which is normally planted in gardens by destroyed natural ecosystems that causes the heavy losses of soil and water in the gardens. So it is important tasks to lower damage natural ecosystems and effectively utilize the natural resource in the meantime.

China is the earliest country that started to discover and utilize tea. Till now, tea is directly (or indirectly) introduced by many countries from China, so China owns the most important gene pool of tea. In China, Yunnan is one of the earliest Provinces in which tea trees are planted. For example, *Camellia sinensis* var. *assamica* originated from southern Yunnan (including Xishuangbanna, Simao, Lincang, etc.). It is recorded in the ancient books that large-scale planting of this type of tea in these areas began in Tang Dynasty (800 years ago), so most ancient tea gardens in these areas had been existed for more than 800 years (Long et al. 1997a). At that time, these areas were mostly covered by forests, tea trees were planted by wiping off understory plants and keeping upper-layer trees. The ancient tea gardens discovered recently are covered by subtropical evergreen forest canopy. The planting pattern that tea trees are planted under natural forest is a kind of imitation to the natural ecosystem (Guo and Christine 1995; Guo et al. 1996). Local residents are used to keep some trees in tea gardens to creat shade to tea trees which are commonly thermophilic, hygrophilous and shade-tolerant plants. Thus the ecosystem of ancient tea garden comes into being. And the growing status of tea trees and output of tea products will peak at 80 % light intensity (Feng et al. 1982).

Ancient tea gardens have great ecological and economical values including offering organism seeds for fallow agriculture around them, soil and water conservation, microclimate regulation, and offering economical products. For example, the fallow agriculture (which is a widely agricultural mode adopted in South Yunnan) around the ancient tea gardens has lost large amount of forests and biodiversity, which destroyed all of the plants before crops were planted. However several kinds of trees, shrubs and many herbs are still kept in the ancient tea gardens. The ancient tea gardens are seed banks of vegetation regeneration and play an important role in maintaining biodiversity, protecting ecosystem of local region, and avoiding the water and soil loss. In addition, tea trees offer local people with great economic benefit because it is natural and organic, which need little investment and offering more products for it is favored by people. So the protection and study on the ancient tea gardens in Yunnan is help to understand the developing history of local agricultural ecosystem, and to go deep into the origin of the tea trees' domestication and cultivating mode, especially the development of organic tea production.

Recently, the ancient tea gardens in Yunnan have drawn abroad attention by all kinds of people. For example, Guo (2002) pointed out that the ancient tea garden is a special kind of ecosystem in the conversazione in which Yunnan ancient tea gardens applied for the world natural heritage; the ancient tea garden in Yunnan is the biggest one, and the population of ancient tea plants in Yunnan is the biggest in the world. Long et al. (1997a, b) studied the structure and function of Ji'no ancient tea garden and confirmed its multiple importance in keeping organisms. He et al. (2000) investigated the environment of the ancient tea gardens in southern Yunnan and traditional management ways used by local minority people, and found it can regulate microclimate. These works provide basic information for further studies on the ancient tea garden in Yunnan, while the knowledge about the value of these ecosystems in keeping biodiversity is scarce.

In the present study, two ancient tea garden communities, Mangjing (MJ) and Jingmai (JM) village's ancient tea garden, respectively located at Jingmai Mountains were selected, because these tea gardens are the largest, oldest and most complete ancient tea gardens in China. Furthermore, the two tea gardens have been managed by the same mode for more than 1,300 years. To obtain the information of biodiversity conservation and natural resources utilization in these ancient tea gardens, investigations of plant community and household-based agro-biodiversity Assessment (HH-ABA) (Guo et al. 2000a) are used as field method. The biodiversity was evaluated by comparing with the secondary forest and the normal tea in the same area. We would provide scientific theoretic basis for the protection and utilization of the ancient tea garden by comparing the species diversity of different tea plantations in this study.

Materials and methods

Study area

JM ancient tea garden (N 22°09′37″, E 100°00′57″) with the area of 1,800 hectares is located at Lancang

County of southern Yunnan Province, Southwest China (CCLLNACYP 1996). It is belonged to two administrative villages, with MJ village of Bu'lang nationality and Jingmai village of Dai nationality. Fourteen natural villages are included in the two administrative villages, and 11 of them are in possession of ancient tea gardens (Table 1).

The field research area is located at the south of the tropic of cancer, which has the subtropical monsoon climate of warm temperate zone, with abundant sunshine and rainfall. Its annual averaged temperate is 18.4 °C and the annual average precipitation is 1,689.7 mm (CCLLNACYP 1996). The typical zonal vegetation is lower subtropical monsoon evergreen broad-leaves forest, but the primary forest does not exist any more.

Field investigation

Community level

The community survey is according to UNU/PLEC BAG Guidelines (Zarin et al. 1999), and was carried at September, 2002. In total, 80 sample plots of ancient tea garden, which is 400 m^2 (20 × 20 m) in area, have been surveyed. In each plot, specie name, number, height, diameter at breast height (DBH) and crown diameter of trees with DBH ≥ 2.5 cm, and specie number, number and average height of young trees with DBH < 2.5 cm and shrubs were all investigated and recorded. To understand the growth conditions of tea trees, the height, base diameter (BD) and crown diameter of all sampled tea trees were recorded, too. In each large sampled plots (20 × 20 m), Five herb quadrats (1 × 1 m) were established in the centre and four corners of the samples to investigate the species and number of seedlings (<50 cm in height) and herbs. Specie number and individual number of interstratum plants were also recorded. Field investigation of utilized plants of ancient tea garden was accomplished at the same time.

The same methods were used in secondary forest and normal tea garden community, which are close to ancient tea gardens.

Household level

The determination of sampling plots is based on the HH-ABA (Guo and Long 1998; Guo et al. 2000a, b), the sampling plots were eventually determined. We conducted questionnaire of socio-economic characters of 60 % of households in the whole village; the households were selected in the residence booklet with the suggestion of local households. Questionnaire included the few parts of demographic and cultural aspects, land and crop yield, gender aspects, production and life input, income resource, and limitation factors. Twenty percent of the chosen households were randomly determined for plot survey as the research targets of ancient tea gardens (Table 1). Four samples plots of secondary forest (20 ×20 m) and eight samples of normal tea garden (5 × 5 m) were accomplished under this method.

Data analysis

Species diversity

Margalef' species richness index, Shannon-Weiner index, Pielou index and agro-species richness index were used to assess the species diversity (Ma 1994; Ma and Liu 1994; Guo and Long 1998). At the same time, the number and percentage of utilized species were measured. The Margalef's species richness index is given by $(S-1)/\ln(n)$, where S is the number of taxa, and n is the number of individuals (Margalef 1965). The species diversity index (H') was determined by using the method given by Shannon & Wiener (1963): $H' = -\sum P_i \ln P_i$ where, H' = Shannon-Weiner diversity index, P_i is the proportion of individuals in the ith species i.e. (ni/N); ni = importance value index of the species; and N = importance value index of all the

Table 1 General information of sampled villages in Jingmai and Mangjing of Lancang County, Yunnan, China

	Sampled Mangjing (Blang nationality)			Sampled Jingmai (Dai nationality)				Total
	Mangjing	Manghong	Wengji	Jingmai	Mengben	Manggeng	Mengben	
Households	110	172	74	167	78	44	124	769
Sample households	55	86	45	100	47	27	74	434
Sample plots	16	18	8	20	10	6	2	80

species. The evenness index (E) was calculated as $E = H'/\ln S$ following Pielou (1966); where, E is Pielou's evenness index, H' is Shannon-Weiner diversity index and S is total number of species.

Agro-species richness index

Similarity analysis

Whittaker index (Whittaker 1960) and Jaccard's coefficient index were used to compare the similarity of species composition (Guo and Long 1998). The similarity index of Jaccard (Jaccard 1908), based on the presence/absence of a species, rather than on its actual number, was used to quantify species associations in net plankton samples. It is symbolized as S (not to be confused with S in the Margalef expression) and calculated as: $S = 100\ a/(a + b + c)$, where a is the number of species present in both samples (pools); b is the number of species present in sample 1, but absent in sample 2; and c is the number of species present in sample 2, but absent in sample 1. The multiplier 100 expresses JI as a percent. Double absences were not considered.

Table 2 Comparison of species diversity among different communities

Ecosystem type	Area (m^2)	Species diversity index			
		Species richness	Margalef index	Shannon-Wiener index	Pielou index
Secondary forest	1,600	241	30.09	4.59	0.57
Ancient tea garden	1,600	244	27.1	3.03	0.34
Normal tea garden	200	84	9.98	2.62	0.32

Results

Species diversity

Compared to secondary forests and normal tea garden communities, ancient tea garden has high species diversity. For example, Species number of ancient tea garden (244) is higher than that of secondary forest (237) and normal tea gardens (85). Margalef index (27.15), Shannon-Wiener index (2.98) and Pielou index (0.34) of ancient tea garden are a little lower than those of secondary forest (30.09, 4.59 and 0.57) and much higher than that of normal tea gardens (9.98, 2.62 and 0.32) (Table 2).

The species diversity of different layer of these three ecosystems showed that ancient tea gardens have complete structures. For example, ancient tea gardens and secondary have four layers (tree, shrub, herb, liana), while normal tea gardens have only three (shrub, herb, liana) (Table 3). Ancient tea gardens have high plant diversity. For example, although the species diversity of tree and shrub layer of ancient are a little lower than that of secondary forest, liana layer is richer in ancient tea garden than in secondary forest, and it is derived from more epiphytes and parasites on ancient tea plants.

Life form and community structure

A comparison on the life form indicates that ancient tea garden have different types of life forms, and the different types of plant distributed evenly. For example, herbs (36.1 %), trees (24.1 %), shrubs (16.0 %), vines (15.6 %), and epiphytes & parasites (8.2 %), while secondary forest dominated by trees (38.5 %) and normal garden dominated by herbs (74.2 %) Table 4).

The ancient tea garden usually consists of four vegetation layers as tree layer, shrub layer (including

Table 3 Comparison of species diversity indices among different layers in different ecosystems

Ecosystem type	Secondary forest				Ancient tea garden				Normal tea garden			
Layers	Tree	Shrub	Herb	Liana	Tree	Shrub	Herb	Liana	Tree	Shrub	Herb	Liana
Species number	84	106	47	51	29	74	90	62	0	1	67	4
Individuals number	367	1,139	284	1,431	73	749	6,140	754	0	485	4,550	13
Margalef index	14.06	14.92	8.14	6.88	6.53	11.03	10.2	9.21	–	0	7.84	1.17
Shannon-Wiener index	3.94	4.05	1.89	2.73	3.09	3.82	1.98	3.36	–	0	2.55	1.16
Pielou index	0.89	0.87	0.49	0.87	0.92	0.89	0.44	0.81	–	–	0.61	0.83

Table 4 Comparisons of biological spectrums among different ecosystems

Ecosystem type	Life form				
	Tree	Shrub	Herb	Liana	Epiphyte and parasite
Secondary forest	38.50	22.99	20.32	17.65	0.53
Ancient tea garden	24.05	16.03	36.07	15.62	8.22
Normal tea garden	4.49	15.73	74.16	5.62	0

tea trees), and herb layer and interlay plants with epiphytes, vines and parasitic plants (Fig. 1). The top layer (15–25 m) mainly includes trees such as *Schima argentea*, *Docynia delavayi*, *Choerospondias axillaris* and *Toxicodendron sussedaneum*. The middle layer (1.5–8 m) includes tea trees, other smaller trees and shrubs belonging to Euphopbiaceae, Rubiaceae, Moraceae, Verbenaceae and so on. The ground layer (0–1.5 m) consists mostly of plants belonging to Agrostidoideae, Compositae, Labiatae and Papilionaceae. interlayer plants is found in ancient tea garden and plants such as Magnoliaceae, Dioscorea, Smilacaceae, some ferns etc.

Protection plants

Many rare and endangered plants are conserved in the ancient tea gardens. E.g. according to *The Red Data Book of China's Plant: Rare and Endangered Plants* (Fu and Jin 1992) and the *List of Higher Plants in Xishuangbanna* (Li et al. 1996), five endangered, seven vulnerable and three rare species are distributed in ancient tea garden (Table 5). Trees such as *Toona ciliata*, *Dalbergia fusca* var. *enneandra* and *Premna szemaoensis*, are high-grade timber; *Calophyllun polyanthum* and *Helicia terminalis* are traditional medicine; *Cinnamomum mollifolium* is a kind of famous spidery. These species have been destroyed in secondary forests but still existing in ancient tea garden. While no rare and endangered plants was found in secondary and normal tea gardens in our investigation.

Plant utility of ancient tea garden

Many species in the ancient tea garden can be used effectively (Fig. 2). According to 18 sampled households ancient tea gardens, there are 386 species altogether, and 216 of which is utilized (56.0 %) and 29.7 % of individuals are used (Table 6). While the

Fig. 1 Photo of ancient tea garden community

Table 5 Protected plants found in the ancient tea garden

Category	Species name	Main use
Endangered	*Carallia lanceaefolia*	
	Toona ciliata	Timber and medicine
	Cinnamomum mollifolium	Spicery and timber
	Cyclobalanopsis rex	
	Magnolia henryi	
Vulnerable	*Canarium subulatum*	Timber
	Hovenia acerba	Medicine
	Calophyllun polyanthum	Timber and medicine
	Dalbergia fusca var. *enneandra*	Timber
	Helicia terminalis	Medicine
	Paramichelia baillonii	Timber
	Premna szemaoensis	Timber
Rare	*Protium yunnanensis*	Medicine
	Zingiber menghaiense	Medicine
	Pellacalyx yunnanensis	Timber

Note Data from *The Red Data Book of China's Plant: Rare and Endangered Plants*

plant of normal tea garden apart from tea tree is not used effectively (Qi Danhui personal investigation).

At the same time, the average value of the agro-species diversity indices in the ancient tea garden among 12 sampled households is 5.0, and the maximum is 48 % more than the average, the minimum is 49 % less than the average. This is because there are differences in knowledge and usage of plant species among households. One example, farmer no. 44, 45, 47, 48, 70 and 75 all used *Measa macilentoides* as a wild vegetable, however, farmer no. 65 and 73 did not use it; Another example, *Stemona tuberosa* was founded in eight sampling plots but only farmer no. 68, 69, 76 used it as a kind of medicine; farmer no. 44, 46, 64 and 70 used *Dichrocephala benthamii* but only farmer no. 46 and 64 knew the local name (Table 6).

Economic and ecological value of ancient tea garden

From the diversity index of the sample households, the economic value of the biological resource in ancient tea garden exceeded that of normal tea gardens. The market value of non-tea utilized species in ancient tea

Fig. 2 Photo of local people pick tea tree-leaves in ancient tea garden

Table 6 Comparison of species diversity in 400 m^2 of ancient tea garden of households in Jingmai, Yunnan, China

Sampled households and plots	No. of species	No. of individuals	No. of utilized species	No. of utilized individuals	(%) Utilized species	(%) Utilized individuals	Margalef species diversity index	Agro-species diversity index
44	87	1,063	36	660	41.4	62.1	12.3	5.4
45	90	1,851	21	76	23.3	4.1	11.8	4.6
46	82	1,859	34	347	41.5	18.7	10.8	5.6
47	106	1,971	27	1,218	25.5	61.8	13.8	3.7
48	98	1,541	34	831	34.7	53.9	13.2	4.9
49	102	2,321	23	207	22.5	8.9	13.0	4.1
64	72	656	31	428	43.1	65.2	10.9	5.0
65	69	733	16	364	23.2	49.7	10.3	2.5
68	72	681	24	194	33.3	28.5	10.9	4.4
69	69	1,243	28	235	40.6	18.9	9.5	4.9
70	76	1,088	40	436	52.6	40.1	10.7	6.4
72	62	780	27	136	43.5	17.4	9.2	5.3
73	94	1,047	24	203	25.5	19.4	13.4	4.3
74	74	906	23	158	31.1	17.4	10.7	4.3
75	105	1,062	39	231	37.1	21.8	14.9	7.0
76	104	1,078	47	488	45.2	45.3	14.8	7.4
77	102	1,075	17	36	16.7	3.3	14.5	4.5
78	109	1,185	36	327	33.0	27.6	15.3	6.0
Total	386	22,140	216	6,575	56.0	29.7	38.5	24.5

garden is not available; therefore the economic value in this case only refers to the market value of tea. The economic value may influence the germplasm selection, cultural methods, soil and water management, and the biodiversity in ancient tea garden. The price of organic tea is 5–6 times more than normal one, although the production is 2/3 of the normal tea garden. Moreover, the ancient tea garden can supply other material for the use of family.

Figure 3 demonstrates that farmer no. 60 obtained the highest economic value at the condition of relatively low biodiversity in its field, while most of those, who keep or develop high biodiversity, obtained low economic benefit. However, there is no obviously inverse correlation between economic value and biodiversity from the information of the middle-ranking farmers no. 43 and 55 (Fig. 3). It is clear that all ancient tea gardens gain higher economic value than the normal tea and the utilized non-tea species are of supplementary value.

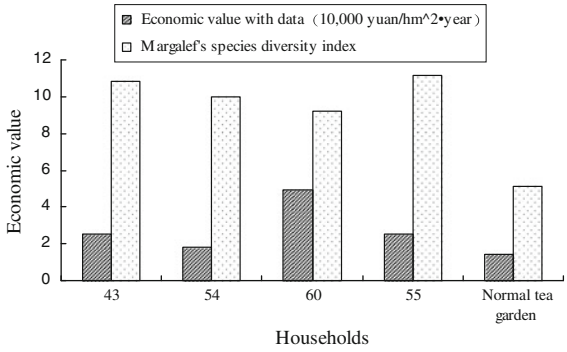

Fig. 3 Changes in economic value and diversity index of four ancient tea gardens and a normal tea among different households in Jingmai

Discussion

Plant species diversity

The contribution of plant species diversity is the result of selection and management by the local farmers. According to our results, ancient tea garden can conserve more biodiversity than normal tea garden. In addition, many other factors influence the farmers' decision, such as ethnic tradition, history, management and the national or local policies.

Impacts of ethnic tradition

Local people have their own tradition to select and protect the shade-tolerant tree species in the ancient tea garden, which have some economic or culture values.

Some common pioneer species in the secondary forest, for instance, *Macaranga denticulate* and *M. indica*, are considered as low values and cleaned out at the early growth stage. But *Schima argentea*, *Docynia delavayi*, and *Toxicodendron sussedaneum* are maintained due to the protection by the village rules (Long et al. 1997b). There didn't seem obvious difference between the two nationalities (Blang nationality and Dai nationality).

Impacts of historical situation

Several large-scale destructions in ancient tea garden had occurred since 1950 s. A large amount of trees were logged for the need of army construction during 1955–1956. According to the old memory (Dao Zhiling personal investigation), more than 500 trees with diameters over 2 m, which were belonged to ancient tea garden, were cut down at that time. In 1962, the barks of *Paramichelia baillonii* were used to evaporate oil, which resulted in at least 200 trees died. In the early of 1970 s, a fire spread in Jingmai led more than 80 houses to be devastated and at least 1,000 trees with DBH more than 1 m were cut as materials for rebuilding. Since 1980 s, the woods, suitable for rebuilding, were mostly taken from ancient tea garden. With the development of tea factories (state or private owned), large areas of secondary forests were chopped in the early 1990 s. With the population increase and tea industry development, some farmers began to cut trees of ancient tea garden as fuel woods. All these incidents reduced plant diversity in the ancient garden.

Management impacts

The ancient tea garden was one of the ways for extensive management in past days. Fertilizer, plant diseases and insect pest prevention were no need to consider. The tea trees had rich nutrients from the canopy, and ancient tea garden system had strong resistance to diseases and insect pests (Long et al. 1997a). The main management was weeding to eliminate dense saplings one or two times every year. With the social and economic development, the need of organic foods is rising and the price of old tree tea increases sharply, which resulted many people came to pay more attention to ancient tea garden. As a result, lots of people strengthened pray for their gardens. The weeding frequency increased to 2 to 4–5 times every year. Original falchion cutting has been changed to hoe weeding, even ground was turned over. However, the no economic value herbs and some shrubs, which don't affect tea tree growing, should be maintained to keep the community stability (Baskin 1995). Beside this, species losing might induce the collapse of ecological balance (Dao et al. 2001). Therefore, weed in the ancient tea garden should be rationally utilized to keep ecological balance. The reasonable management for the ancient tea garden should be considerate to keep the balance between economic benefits and biodiversity protection.

Impact of Government policies, as well as science and technology

During 1960 s and early 1970 s, technical staffs of Lancang agricultural technology research institution carried out the ancient tea garden reconstruction experiments to increased the output of tea, because there didn't exist any difference in price between ancient tea garden and normal tea garden, while the output of normal garden exceeded that of ancient one. The methods included reclaiming, seedling compensation, mowing and so on (CCLLNAC 1996); however, these brought negative effects on tea tree and other plant to a degree. After 1970 s, the property right of ancient tea garden shifted from state owned to household, government intervention had reduced; the peasant household managed it according to traditional mode. And this measure is helpful for tea garden restoration.

Protection values of Jingmai ancient tea garden

The history of tea cultivating has more than 3,000 years in China, and Southwest China is the original tea cultivating region in the world (Liu et al. 2010). Ancient tea plants is grown in the area of middle and lower reaches of Lancang River including Pu'er, Xishuangbanna, Lincang, Baoshan and so on (Shen et al. 2007). Tea plantation within natural forest in southern Yunnan, China is not only a world heritage agro-ecosystem with cultural landscape value, but also the evidence of domestication of tea from forest to the farming land, as well as old farming system of tea plantation. Tea plantation within natural forest is an old method, which is kept by Jingmai ancient tea garden and other areas in Yunnan, Southwest of China. The ancient tea garden distributed within

natural forest provides an important approach for organic agriculture development, with mechanisms of both self-control of pests and self-sustained soil fertility. Application of the approach with biodiversity will benefit for the human being nutrients without chemicals, and the philosophy could be extended to other agricultural systems. The production in Jingmai ancient tea garden is authentic natural organic tea. If it can be explored rationally, the great potential for developing the local organic tea production base will be achieved. For instance, broadleaf tea is a special genetic resource type from common, which has been domesticated for many years (Long et al. 1997b). Long history of cultivation in large area, rich ancient tea plants and being naturally and artificially selected form abundant tea types resource will bring out many excellent species. If these resources lost, the threaten gene-diversity of tea will be happened, the heredity base and related cultivate technology will be narrowed, and traditional knowledge and ethnic culture related to tea will be disappeared. Therefore, the protection of the ancient tea garden and ancient tea plants is an importantly historical task.

Management measures and suggestions

As the results of this research, the protection of ancient tea garden and its biodiversity could be firstly summarized and spread suitable management methods. Lots of successful traditional management experiments, accumulated in the long history of local people's management, should be inherited, although some problems should still be solved. In recent years, some local farmers mowed ancient tea plants blindly for high productivity, but the serious destroying to the ancient tea garden was also occurred. Fortunately, this has been aroused the attention of government. They set up forest guards to forbid farmers mowing ancient tea plants branches. This rule stopped the destroying of ancient tea garden, but it impacted some necessary management, such as traditional training and eliminating disease branch. Therefore the government should enact suitable policies to interrupt local farmers' mismanagement on the ancient tea garden, seek for and promote the best mowing way. Besides the laws of forbidding livestock entering the tea garden, interdicting gene pollution by other tea trees and limiting the pick amount of tea are necessary. Government should establish technical project, science research institute, and local technology department and encourage farmers to participate for exploring and summarizing the traditional manage experiments and successful modes, as well as enhancing the farmers recognition of the importance of biodiversity protection and stimulating their enthusiasm through demonstration and training.

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