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AGROFORESTRY | ORIGINAL ARTICLE

Evaluation of Ecosystem Services of Golden Camellia–Cinnamon Agroforestry System in Western Nghe An, North–Central Vietnam

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ABSTRACT

The private and public sectors of Nghe An Province have been actively working on *Acacia mangium* afforestation, which has contributed to the recovery of woody vegetation on slash-and-burn agricultural slopes. However, it also has negative effects on the region, such as the homogenization of vegetation with non-native species and increasing erosion risks after harvest. Western Nghe An was nominated as a biosphere reserve in 2007; thus, revegetation planning must have considered the surrounding vegetation after the designation; however, the non-native species *A. mangium* remain a dominant species for planting, even though several economically high-valued native species grow in this region. In the northwestern area of Western Nghe An, a local Cinnamomum species called Saigon cinnamon has been traditionally grown by ethnic minorities. Recently, some households started cultivating the highly economically valued native shrub tree *Camellia quephongensis* (golden camellia) under cinnamon tree canopies, that is, the golden camellia–cinnamon (GCC) agroforestry system was adopted in this region. However, the cinnamon afforestation area has not been widely increased because of the long period required for harvest compared with *A. mangium*. Thus, we clarified advantages in ecosystem services of GCC agroforestry system compared with golden camellia–acacia (GCA) agroforestry system to expand the cinnamon forest. The GCC agroforestry system has superior supporting services; more than 2-fold greater standing crop stem volume and functioning feeding places for small birds supplying berries. For regulation services, carbon sequestration in the GCC agroforestry system is 3.3–3.7-fold higher than that in the GCA agroforestry system. These findings could encourage stakeholders such as forestry managers, golden camellia tea processors, scientists, and policymakers to introduce the GCC agroforestry system in this region.

1. Introduction

Western Nghe An is a mountainous and remote area located in North-Central Vietnam covered with tropical rainforests. This area is diverse and rich in fauna and flora; thus, it was designated as the Western Nghe An Biosphere Reserve in 2007 (UNESCO 2007). However, the forests were degraded because of slash-and-burn agriculture in this region before designation of the reserve, e.g., the study site of Co Muong, Chau Kim Commune, Nghe An Province had 30% of logged area. According to the land owner of this area, slash-and-burn agriculture started in 1988 and continued until 1992. Subsequently, logging was banned in 1996 by the local government (Takahashi et al. 2023). The logged area was recovered by ecological succession and formed secondary forests (Takahashi et al. 2023), and afforestation of *Acacia mangium* (hereafter referred to as acacia) was conducted in the private and public sectors (MARD 2016; Cochard 2021). Nghe An Province participated in the Emission Reductions Program and had been actively proceeding with this program; consequently, the acacia plantation area in this province was the largest in the north central coastal region of Vietnam from 2001 to 2014, except for in 2008 (MARD 2016). Acacia afforestation has restored green resources in the region; however, it faces some environmental problems in its management in Vietnam, including 5–10-year logging rotation cycles and burning after harvest, causing soil surface erosion and occasionally gully erosion (Nambiar 2014). In addition, fog negatively affects the productivity of acacia (Phan et al. 2024). Although this region frequently experiences foggy days (Tran et al. 2023), acacia trees are actively planted as important forest resources.

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Although acacia afforestation is being conducted in this region, the non-timber forest product, which is local *Cinnamomum* (known as Saigon cinnamon, hereafter referred to as cinnamon), has also received attention, particularly from the ethnic minorities in this region. Traditionally, cinnamon has been an important source of livelihood for ethnic minority households in remote areas of Vietnam, and cinnamon plantations yield a four-fold greater income than acacia plantations (Doan and Nguyen 2024). However, because it takes at least 10 years (Derks et al. 2020), and in some cases, up to 30 years to be harvested according to the cinnamon plantation owner, it has not expanded widely in this region.

Recently, the shrub of yellow-flowered camellia (*Camellia quephongensis*), known as golden camellia, has become popular in this region to grow under acacia or cinnamon canopies because of its processing factory into golden camellia tea being developed in Kim Son, which is the center of this region (Takahashi et al. 2023). *C. quephongensis* is a short shrub tree, 4–5 m in height, native to the forests in this area (Le et al. 2021), whose yellow flowers have been used as a health-tea, named golden camellia tea, and sold at hundreds of USD per kilogram in retail markets (Tran et al. 2019).

The golden camellia–cinnamon agroforestry system (hereafter referred to as cinnamon forest) is economically superior to the golden camellia–acacia agroforestry system (hereafter referred to as acacia forest); however, the ecological aspects of cinnamon plantations with golden camellia remain poorly understood. Therefore, this study aimed to evaluate the ecosystem services provided by the golden camellia–cinnamon agroforestry system.

2. Materials and Methods

2.1. Study area and sites

The study area is located in the westernmost part of the Nghe An Province, adjacent to the boundary of Laos (Fig. 1a, b). Topographically, it is surrounded by high mountain ranges, comprising granite, tonalite, and mafic rocks (Inoue et al. 2020; Trinh et al. 2021), from which multiple streams flow to the center of this region, forming the Hieu River (Fig. 1c). *C. quephongensis*, which is planted in cinnamon and acacia forests, was originally scattered along these streams and rivers. Because western Nghe An is rich in forests, it has been designated as a biosphere reserve by UNESCO (Fig. 1b).

In terms of climate, it is influenced by monsoons, with April–October representing the summer due to monsoons from the southwest (or Laos wind), with the heaviest rainfall occurring during August–October. Winter is relatively cold and dry due to the northeast monsoon. The annual average temperature and air humidity are 23 °C–24 °C and 84%, respectively. The mean annual rainfall is 1800 mm (Nguyen et al. 2019; JICA et al. 2019).

We selected cinnamon forests in Co Muong, Chau Kim Commune (hereafter referred to as Chau Kim), and Thong Thu Commune (hereafter referred to as Thong Thu) and acacia forests as counterparts in Kim Khe, Chau Kim, and Muong Noc Commune (hereafter referred to as Muong Noc) (Fig. 1c).

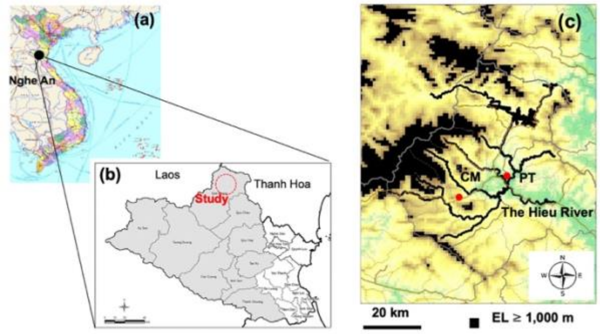

Figure 1. Study area and sites. (a), (b), and (c) indicate the location of Nghe An Province, Western Nghe An, and the study sites, respectively. The grey-shaded area and red circle in the map (b) indicate the biosphere reserve (UNESCO) and study area, respectively. MN, CK, and TT in the map (c) are the Moung Noc, Chau Kim, and Thong Thu study sites, respectively. Black lines display the river network

2.2. Evaluations of ecosystem services

Ecosystem services are defined as the goods and services provided by ecosystems to humans (Troy and Bagstad 2009), and can be classified into four functions: provisioning, supporting, regulatory, and cultural (Millennium Ecosystem Assessment Board. 2005). In the present study, the supporting and regulatory functions of cinnamon forests were evaluated and compared with those of acacia forests.

2.3. Supporting functions

To evaluate the primary products in cinnamon forests and their acacia forest counterparts, stand structure and litter fall supply were surveyed.

2.3.1. Stand structure

In terms of the stand structure survey, three quadrats of 10 m × 10 m or 20 m × 20 m (quadrats for stand structure, hereafter referred to as the main quadrat: MQ), depending on the stand height measured by the laser distance meter (Zamo, BOSCH Corporation, Yokohama), were set up in each forest, and slope gradients and directions were recorded as quadrat characteristics. Subsequently, the diameter at breast height (DBH: 130 cm from the ground) of all trees in the canopy layer was measured by counting the seedlings of canopy-layered species in a 1 m × 1 m quadrat set up at the edge of each MQ, which was located on the boundary between the stand and open space, on January 12, 13, and 18, 2024. Using these data, the diameter distribution and basal area (BA) of cinnamon forests and their acacia forest counterparts were clarified, and the stem volumes of both forests were estimated by multiplying the total BA by the stand height. In cases of some useful plants, such as golden camellia, contained in the stand, the individual number of trees and plant coverage of herbs on the ground were recorded with the species name and the layer grown.

For golden camellia, tree height was measured, and the year after planting was asked to the forest owner to evaluate the growth rate in the cinnamon forest compared with that in the acacia forest.

2.3.2. Litter fall supply

Litter fall traps and square pyramid-shaped nets (1 m × 1 m × 1.3 m were prepared (Fig. 2), and the traps were allocated to each quadrat at 20 m × 20 m in the cinnamon forest at Co Muong and 10 m × 10 m in the acacia forest at Kim Khe. Five litter fall traps were placed in each forest. The traps were set up on December 10 and 25, 2023 in the cinnamon and acacia forests, respectively, and samples from both traps were collected in January, April, May, September, and December, 2024. Except for the sampling of acacia traps in September and December, clearing was conducted by the forest owner in September, 2024.

Figure 2. Litter fall trap set up in the cinnamon forest located in Co Muong, Chau Kim

The litter fall samples from the traps installed in the cinnamon forest were sorted into organs by plant species, and as a result, the samples were categorized into five categories: 1) cinnamon leaves, 2) cinnamon fruits, 3) leaves of *Peltophorum dasyrhachis*, 4) all stems, and 5) others, whereas the samples from the traps in the acacia forest counterpart were not sorted into subcategories. Subsequently, the litter samples were brought to the laboratory, and dried at 80 ℃ using convection oven until no further weight change was detected.

2.3.3. Berry supply and natural regeneration potential

Snow and Snow (1988) reported interactions between birds and berries based on observations of berry-eating birds. Using data obtained from the litterfall traps installed in the cinnamon forest in Co Muong Chau Kim, the phenology of berry supply from cinnamon trees was revealed, and the natural regeneration potential was analyzed based on the dispersal of the seedlings on the forest floor.

2.4. Regulatory functions

Regarding regulatory functions, the potential carbon sequestration of the cinnamon forests located in Co Muong, Chau Kim, and Thong Thu was evaluated and compared with that of their acacia forest counterparts in Kim Khe and Chau Kim.

2.4.1. Carbon sequestration

Aboveground biomass and the carbon content of the cinnamon forests in Co Muong, Chau Kim, and Thong Thu, and the acacia forest counterpart in Kim Khe, Chau Kim were estimated using the data on stand structure by the allometric equations reported in previous studies.

2.5. Statistical analysis

To understand the phenology of leaf fall and berry supply from cinnamon trees, we used ANOVA to test differences between seasons, and in the case of significant differences ($p < 0.05$), Tukey's test was performed to compare samples collected in different seasons. The differences in the amount of total litter fall between the cinnamon and acacia forests in each season was tested using the Welch's t-test.

3. Results

3.1. Stand structure

3.1.1. BA and stem volume

Fig. 3 shows the DBH distribution of cinnamon forests (Fig. 3a) and their acacia forest counterparts (Fig. 3b). The cinnamon forest in Co Muong, Chau Kim is 20 years old, and the DBH mode value is 20 cm ≤ DBH < 30 cm, whereas that in Thong Thu is 7–8 years old, with a DBH mode value of 10 cm ≤ DBH < 20 cm. The forest in Co Muong was more widely varied in DBH, containing the useful plant of *Peltophorum dasyrhachis* as a canopy layer component, of which the DBH mode value was 5 cm ≤ DBH < 10 cm. In contrast, the acacia forest counterpart in Kim Khe, Chau Kim is 5 years old, whereas the age of the acacia forest in Muong Noc is unknown. Their DBH distribution patterns were similar, with mode values of 5 cm ≤ DBH < 10 cm, followed by 10 cm ≤ DBH < 20 cm.

The BA of the canopy-layered trees was calculated using DBH data, and the results are shown in Fig. 4. Those of the cinnamon forests in Co Muong, Chau Kim, and Thong Thu, and those of their acacia forest counterparts in Kim Khe, Chau Kim, and Muong Noc were 2,958 ± 1,180 $cm^2/100\ m^2$, 1,410 ± 461 $cm^2/100\ m^2$, 3,128 ± 406 $cm^2/100\ m^2$, and 2,913 ± 327 $cm^2/100\ m^2$, respectively.

The 20-year-old cinnamon forest in Co Muong, Chau Kim supported 5.9 $m^3/100\ m^2$ of stem volume, which was approximately two times greater than the 5-year-old acacia forest counterpart in Kim Khe, Chau Kim (2.7 $m^3/100\ m^2$).

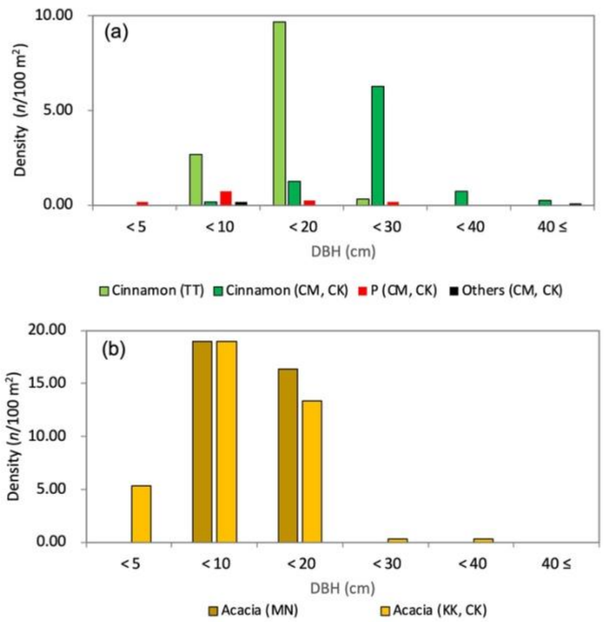

Figure 3. DBH distribution of the cinnamon (a) and acacia forests (b). TT and CM, CK in (a) denote Thong Thu and Co Muong, Chau Kim, respectively. MN and KK, CK in (b) denote Muong Noc and Kim Khe, Chau Kim, respectively

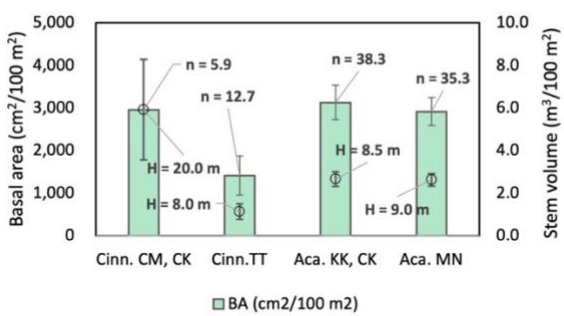

Figure 4. BA and stem volume of the cinnamon and acacia forests. Green columns and error bars, and circles and error bars indicate BA and standard errors (SE), and stem volume (SV) and SE, respectively. H and n stand for height (m) and density (n/100 m^2), respectively. Cinn. and Aca. are cinnamon and acacia, respectively. CM, CK; TT; KK, CK; and MN denote Co Muong, Chau Kim; Thong Thu; Kim Khe; and Muong Noc, respectively

3.1.2. Useful plants

The cinnamon forest in Co Muong, Chau Kim contains two useful plants in the canopy and herb layers, namely *P. dasyrhachis* and *Amomum schmidtii*, respectively, in addition to *C. quephongensis* transplanted (Table 1). These two species are natively grown in stands, and forest owner selectively cultivates them. *P. dasyrhachis*, belonging to the family Fabaceae, is a large deciduous tree that grows up to 30 m, planted as a source of materials and for ornamental purposes, and its bark is used for medicines (Sam et al. 2004). *A. schmidtii* is an herbaceous plant belonging to the family Zingiberaceae. Members of the genus *Amomum* are widely used in cooking and medicine (Lamxay and Newman 2012).

In terms of *C. quephongensis* (golden camellia), it was transplanted with wide densities, ranging from 0.01 trees/100 m^2 to 6.30 trees/100 m^2 on average (Table 1); however, the growth rate did not differ between the cinnamon and acacia forests; the tree heights of the 8-year-old golden camellia in the cinnamon forest in Co Muong, Chau Kim and in the acacia forest in Kim Khe, Chau Kim were 166.5 ± 11.6 cm and 153.2 ± 2.2 cm, respectively (Fig. 5).

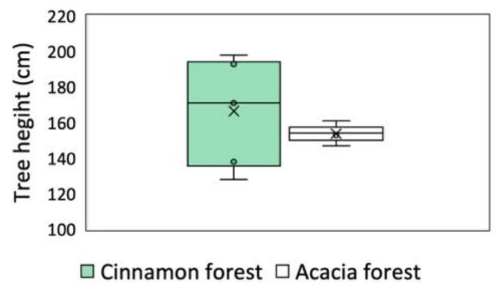

Figure 5. Tree height distribution of 8-year-old golden camellia in the cinnamon and acacia forests

3.2. Litter fall supply

Fig. 6 shows the change in litter falls supplied by the cinnamon forest in Co Muong, Chau Kim. The leaf falls of the cinnamon trees peaked in April–May (3.01 ± 0.58 g/m^2 day), as did those of the *P. dasyrhachis* trees (2.07 ± 1.14 g/m^2 day), whose quantity was significantly greater than that of the other seasons (p < 0.01). However, although leaf falls were supplied most in quantity from April to May in the cinnamon forest, litter falls in total (6.09 ± 1.42 g/m^2 day) did not significantly differ in quantity from those in the acacia forest (4.78 ± 0.93 g/m^2 day) (p = 0.10), and no significant differences in December, 23–January (p = 0.64) and January–April (p = 0.07) were observed (Fig. 7).

3.3. Berry supply and natural regeneration potential

Berries of cinnamon trees were trapped throughout the year in a cinnamon forest located in Co Muong, Chau Kim, and no significant seasonal differences were detected (Fig. 6). However, in-situ observations revealed that the cinnamon trees at the study site flowered from November to December (Fig. 8a), and ripened berries were mainly trapped from December to April (Fig.8b). No fruits (seeds or pods), but only flowering branches, were found in the samples collected from acacia forests in Kim Khe, Chau Kim.

Table 1. Useful plants in the forests. A, B, and C indicate different MQs. CM, CK; TT; KK, CK; and MN denote Co Muong, Chau Kim; Thong Thu; Kim Khe, Chau Kim; and Muong Noc, respectively

Agroforestry type		Cinnamon forest		Acacia forest	
Location		**CM, CK**	**TT**	**KK, CK**	**MN**
Canopy layer					
	A	3.25	0.00	0.00	0.00
P. dasyrhachis (*n*/100 m^2)	B	0.25	0.00	0.00	0.00
	C	0.50	0.00	0.00	0.00
	Mean	1.33	0.00	0.00	0.00
Shrub layer					
	A	0.01	7.00	8.00	2.00
C. quephongensis (*n*/100 m^2)	B	0.00	5.00	0.00	0.00
	C	0.01	7.00	0.00	0.00
	Mean	0.01	6.30	2.67	0.67
Herb layer					
	A	6	0	0	0
A. schmidtii, cover rate (%)	B	0	0	0	0
	C	40	0	0	0
	Mean	15	0	0	0

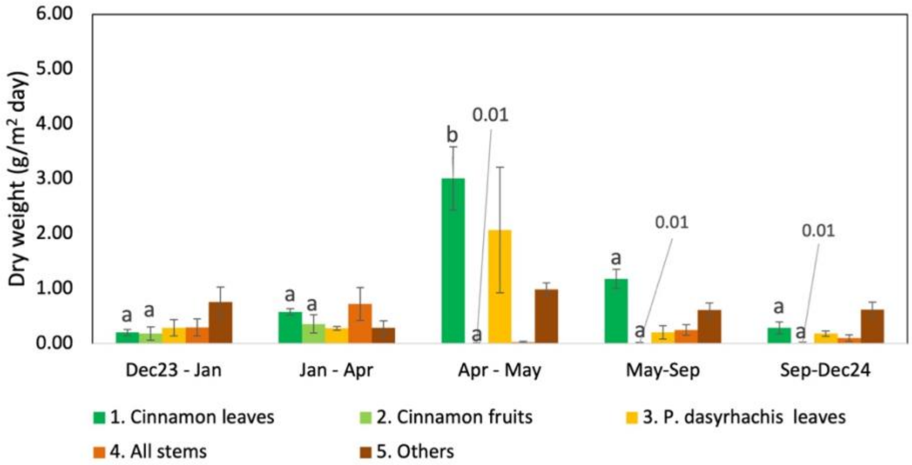

Figure 6. Seasonal change in litter falls in the cinnamon forest. Error bars indicate standard error, different alphabets denoted on the error bars of cinnamon leaves indicate significant differences ($p < 0.01$). Cinnamon fruits do not differ among seasons

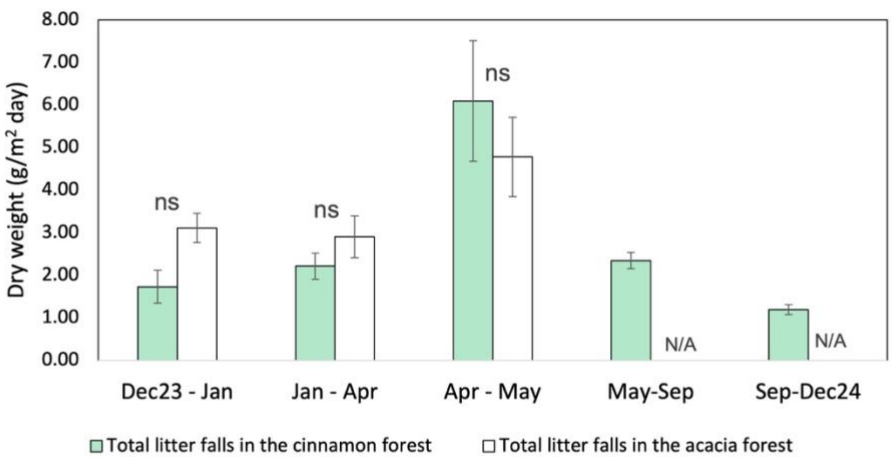

Figure 7. Comparison of litter falls in the cinnamon forest with those in the acacia forest. Error bars indicate standard errors. ns and N/A denote not significant and not available, respectively

Table 2 indicates the seedlings of the canopy layer consisting of trees grown on the forest floor, which contained the next generations in Co Muong, Chau Kim and Thong Thu, whose average densities were 20.7/m^2 and 0.3/m^2 in January 2024, respectively, whereas no seedlings were observed on the acacia forest floor in Kim Khe, Chau Kim and Muong Noc from December 2023 to May 2024. Young cinnamon trees were growing under the canopies of another deciduous tree, such as *Vernicia montana*; however, no trees were observed under the canopies of cinnamon trees based on on-site observations.

3.4. Carbon sequestration

The allometric equations for the aboveground biomass of cinnamon and *A. mangium* have been previously reported. In terms of allometric equation for cinnamon, that from Lakprasadi and Navaratne (2012) (equation (1) in Table 3) is function of DBH and tree height, whereas that from Ginoga et al. (2014) (equation (2) in Table 3) is function of age. The above ground biomass of the 20-year-old cinnamon forest in Co Muong, Chau Kim was calculated using these allometric equations, and estimated from 201.0 ton/ha to 374.6 ton/ha. Carbon stock varied from 100.5 ton/ha to 183.7 ton/ha if the carbon content of the biomass was 50% (Brown 1995). The 7–8-year-old cinnamon forest in Thong Thu was 73.2 ton/ha to 138.1 ton/ha in biomass, and carbon stock varied from 36.6 ton/ha to 69.0 ton/ha. Conversely, the biomass of the 2–7-year-old *A. mangium* forests in Vietnam was reported, ranging from 29.0 ton/ha to 70.0 ton/ha, equivalent to 13.9 ton/ha–37.9 ton/ha of carbon contained (Nguyen 2022) if the carbon content was 47.97% (Cuong 2020). The data obtained from the 5-year-old acacia forest counterpart in Kim Khe, Chau Kim were calculated using the allometric equations with variable DBH (Ilyas 2013; Cuong, 2020), and the biomass and carbon stock varied from 62.2 ton/ha to 104.9 ton/ha and 29.9 ton/ha to 50.3 ton/ha, respectively.

4. Discussion

4.1. Supporting functions

4.1.1. Primary products

The 20-year-old cinnamon forest in Co Muong, Chau Kim produced a stem volume of 5.9 m^3/100 m^2, whereas that of the 5-year-old acacia forest counterpart in Kim Khe, Chau Kim was 2.7 m^3/100 m^2. This is due to the difference in harvest rotation terms between them: the acacia forest counterpart was harvested once in 5 years, whereas the cinnamon forest surveyed was not logged over 20 years. Consequently, the cinnamon forest provided more than 2-fold greater standing crops in stem volume in this region. However, in terms of litter fall supply in dry weight, no significant differences were noted.

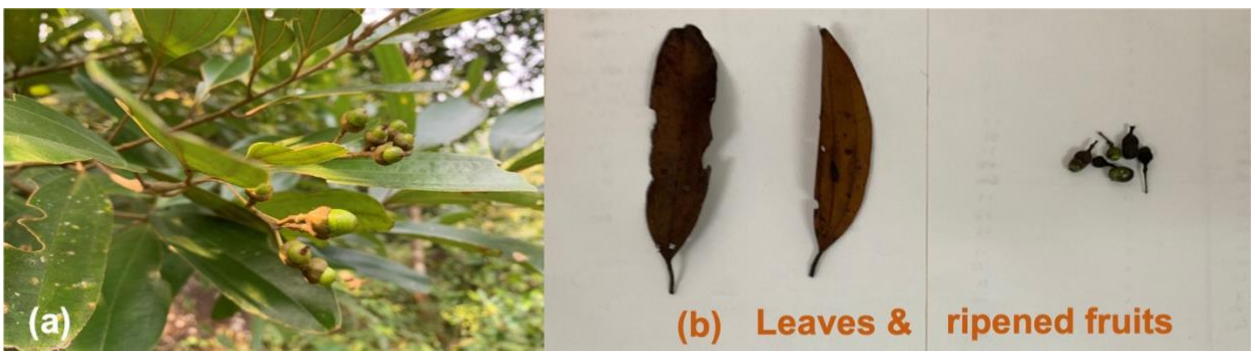

Figure 8. Cinnamon berries (a) and cinnamon leaves and their ripen berries trapped (b). (a) and (b) were photographed in December 22, 2024, and in January 29, 2024, respectively

Table 2. Seedlings grown in the forests. A, B, and C indicate different quadrats. CM, CK; TT; KK, CK; and MN denote Co Muong, Chau Kim; Thong Thu; Kim Khe, Chau Kim; and Muong Noc

Agroforestry type		Cinnamon forest		Acacia forest	
Location		CM, CK	TT	KK, CK	MN
Cinnamon (n/m^2)	A	38	1	-	-
	B	9	0	-	-
	C	15	0	-	-
	Mean	20.7	0.33	-	-
Acacia mangium (n/m^2)	A	-	-	0	0
	B	-	-	0	0
	C	-	-	0	0
	Mean	-	-	0	0

Table 3. Estimation of carbon sequestration by the cinnamon and acacia forests. W, D, and H in equation (1) [Eq. (1)] are above ground biomass (kg/tree), DBH, and tree height, respectively. C and t in Eq. (2) are carbon content (ton/ha) and time in years, respectively. Estimated parameters are α = 1.92, β = 120.91, and γ = 0.1554. W and D in Eq. (3) and Eq. (4) are the same as above

Forest type	Site/ Tree density	Age/ DBH(mean)/ Tree height (mean)	Above ground biomass (ton/ha)	Carbon sequestration (ton/ha)	Allometric equation	Reference
Cinnamon	Co Muong 400 trees/ha (only cinnamon trees)	20 years 24.5 cm 20.0 m	374.6	187.3	$W = 0.078\ D^2\ H$ Eq. (1)	Lakprasadi and Navaratne (2012)
			201.0	100.5	$C = \beta\left(\frac{\alpha}{\beta}\right)^{e^{-\gamma t}}$ Eq. (2)	Ginoga et al. (2014)
	Thong Thu 1,270 trees/ha	8 years* 13.2 cm 8.0 m	138.1	69.0	$W = 0.078\ D^2\ H$	Lakprasadi and Navaratne (2012)
			73.2	36.6	$C = \beta\left(\frac{\alpha}{\beta}\right)^{e^{-\gamma t}}$	Ginoga et al. (2014)
Acacia	Vietnam	2–7 years	29.0–70.0	13.9–37.9	N/A	Nguyen et al. (2022)
	Kim Khe, Chau Kim 3,833 trees/ha	5 years 9.3 cm 8.5 m	104.9	50.3	$W = 0.4668\ D^{1.8278}$ (stem) Eq. (3)	Ilyas (2013)
			62.2	29.9	$W = 0.010\ D^{3.321}$ Eq. (4)	Cuong et al. (2020)

*: Estimated stand age is 7–8 years old, thus, calculated as age of 8-year-old.

4.1.2. Berry supply as a feeding site

Cinnamon trees at the study site started flowering in November–December, and mature fruits were produced in three–four months. This flowering–fruiting phenology is similar to that of *C. sintoc*, requiring approximately 40 days to complete flowering and an additional 82 days to produce mature fruits (Ismail et al. 2022). The cinnamon's fruits are berries that feed small birds. Wheelwright et al. (1984) reported that berry-producing *Acnistus* and *Citharexylum* are food plants for tropical fruit-eating birds.

Conversely, acacia trees produce seeds 18–20 months after planting, and they ripen 5–7 months after flowering (the flowering season in Vietnam is December according to field observation), and during the maturity period of the fruits, they are dispersed by small birds (Sein and Mitlöhner 2011). However, no fruits (seeds or pods), but only flowering branches, were found in the litter fall samples collected in the flowering and ripening stages from the 5-year-old acacia forest in Kim Khe, Chau Kim. In contrast to the cinnamon forest, the acacia forest at the study site did not provide seeds to the small birds as food, but further studies are needed to determine if sterility is specific to the site, year, or none of them.

4.2. Regulatory services: carbon sequestration

At 7–8 years of age, the cinnamon trees accumulated carbon stocks of 36.6 ton/ha–69.0 ton/ha, and the carbon stocks increased drastically over an additional 12–13 years; the accumulated amount became 100.5 ton/ha–187.3 ton/ha, approximately 2.7-fold greater (lower limit /lower limit, upper limit/upper limit) than that until initial 7–8 years.

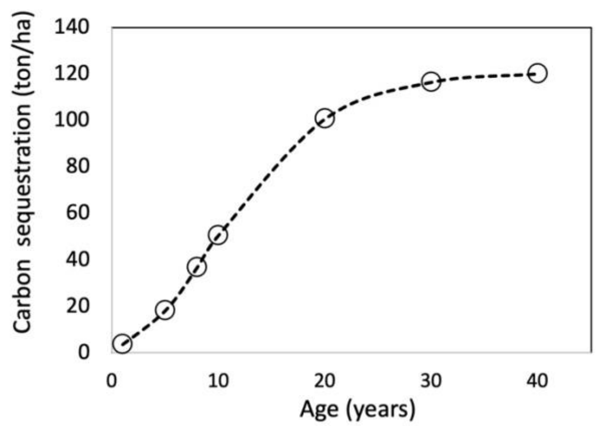

Figure 9. Estimation of change in carbon stock in the cinnamon forest with growth. Estimated using the allometric equations (Ginoga et al. 2014)

Fig. 9 displays a carbon stock curve with cinnamon forest growth estimated using the allometric equation with variable age (Ginoga et al. 2014). It indicates that carbons are stored sharply from 5 to 20 years, and their stock speed decreases from 30 years old. Thus, logging at ≥ 30 years of age can be the best practice considering carbon sequestration.

The retained carbons in the 5-year-old acacia forests in Kim Khe, Chau Kim were 29.9 ton/ha–50.3 ton/ha, 0.28–0.30-fold (lower limit /lower limit–upper limit/upper limit) greater than that retained by the 20-year-old cinnamon forest.

4.3. Recommendation of thinning and natural regeneration system

Generally, cinnamon trees are clear-cut in a 10–30-year-cycle. During the wood growth period, only branches are collected to peel the bark (Derks et al. 2020), implying that the primary products of the cinnamon forest finally fade into nothingness. Instead of clear-cutting, thinning and natural regeneration systems are recommended for use in the golden camellia–cinnamon agroforestry system, which can be economical. Compared with their acacia forest counterparts, cinnamon forests take 2–6 times longer to harvest; however, if the golden camellia saplings (generally 3-year-old saplings) are transplanted to the forest floor, they produce flowers in 5 years (Takahashi et al. 2023), yielding 160,000 VND/kg, which is the price of the golden camellia tea set by the processing company in this region. The golden camellia flower is one thousand times more commercially valued than acacia wood. In the case of the golden camellia–acacia agroforestry system, clear-cutting for harvest and burning affect golden camellia growth, and flower production must be decreased (Takahashi et al. 2023); therefore, the golden camellia–acacia agroforestry system does not fully yield golden camellia flowers.

In terms of the regeneration system, cinnamon tree seedlings grew under the canopy gaps, implying that the next generations will be recruited under the canopy gaps formed after thinning. Tabata et al. (2015) also reported that the emergence and establishment of *C. camphora* were promoted if large canopy gaps were created. Cinnamon trees can be reproduced by selecting seedlings for growth.

5. Conclusion

This study revealed that the GCC agroforestry system has superior ecosystem services than the GCA agroforestry system does. For supproting services, the former has more than 2-fold greater standing crop stem volume and functioning feeding places for small birds. For regulatory services, carbon sequestration in the GCC agroforestry system is 3.3–3.7-fold higher than that in the GCA agroforestry system. Golden camellia planted in the GCC agroforestry system provides high economic value at the early stage of cinnamon forests and the next generations will be recruited under the canopy gaps formed. Therefore, the GCC agroforestry system enables to adopt thinning and natural regeneration systems, even though cinnamon forests are generally clear-cut in a 10–30-year-cycle.

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Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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