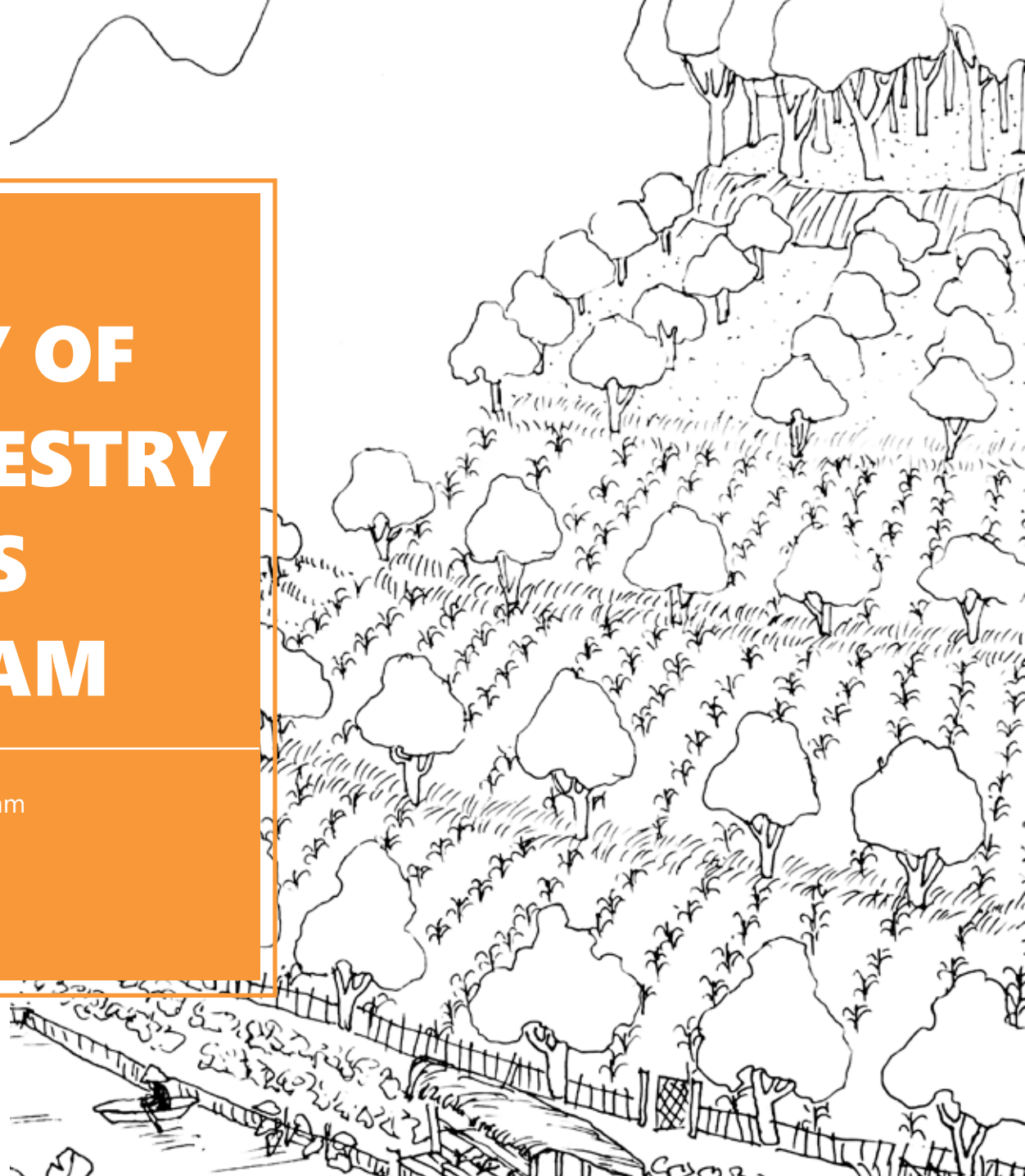
DIVERSITY OF AGROFORESTRY PRACTICES IN VIET NAM

World Agroforestry (ICRAF) Viet Nam



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Contents

Figures

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We also thank all dedicated staffs, partners, farmers, and agricultural extension services involved in the Agroforestry for Livelihoods of Smallholder Farmers in North West Viet Nam (AFLI) project, the study on main fruit-tree agroforestry practices in North West Viet Nam, the study on agroforestry's contribution to Viet Nam's Nationally Determined Contribution (NDC), and the climate-smart agriculture project in the North Central Coast who contributed in the data collection, that unfortunately we cannot list all their names and detailed contribution here.

Finally, we also sincerely thank Delia C. Catacutan, Tran Ha My, Robert F. Finlayson, Tikah Atikah and Melinda Firds for their valuable feedback on the content and publication of this book.

Preface

Agroforestry is one of traditional farming practices in Viet Nam. It varies in forms, plant components and species to fit into diverse topographical and climatic conditions as well as preferences of local people across the country. In the past decades, driven particularly by expansion of intensive monocropping practices, the area of agroforestry in the country has been shrinking. However, rural people still maintain agroforestry for different purposes, including as subsistence and income-generating farming system in home gardens, as part of their livelihood strategies.

To respond to global challenge of food insecurity and climate change, research and development communities worldwide have put significant attention to agroforestry as potential solution to reconcile economic and ecological pressure, and to achieve sustainable development. Furthermore, the recent Covid-19 pandemic has called a strong need to strengthen local food systems, to include farming systems around homestead that can provide diverse products for different purposes. An increasing awareness on benefits that can be derived from agroforestry also takes place in Viet Nam, and recently, the country has included agroforestry in its 2020 Nationally Determined Contributions as a measure for land conservation to maintain food production, and for carbon sequestration to combat climate change.

This book describes a high diversity of agroforestry practices in Viet Nam and can help (re-)introduce and support wider development of agroforestry in the country. ICRAF Viet Nam team has conducted a literature review and compiled information on agroforestry practices from different ICRAF projects and studies in Viet Nam. The book provides key information of all agroforestry practices presented, including plant components, distribution across the country, and actual or potential benefits. It also provides relevant photos for most of the systems to better illustrate them.

As the country representative for ICRAF Viet Nam, I am very pleased that the long efforts and all hard work from the team have manifested into this nicely designed and important book. I believe that this book will become one of most important publications by ICRAF Viet Nam, which can generate long and wider positive impacts for the country in particular, and for research and development of agroforestry worldwide in general. We purposely select March 21st,

2021 as the day to launch this book, namely the International Day of Forests and Trees, to signify that agroforestry, through its capacity of generating various products, can also contribute to forest conservation. Furthermore, we also plan to publish a Vietnamese version of this book to better target Vietnamese audience including smallholder farmers in the country. I would like to take this opportunity to sincerely thank all ICRAF and colleagues from partner organizations who have contributed to the publication of this book. This book will never be possible without their contribution.

Enjoy reading!

Nguyen Quang Tan (PhD)

Country Representative for ICRAF Viet Nam

March 14th, 2021

Ha Noi, Viet Nam

Lime fruits in 50 ha agroforestry with peach, plum and coffee in Dien Bien province, North West region.
Photo: World Agroforestry/Nguyen Mai Phuong

Introduction

Growing trees together with annual crops and with or without livestock on the same unit of land has been part of farmers' practices in Asia and around the world for centuries, mainly as subsistence farming. This practice, called agroforestry, has lately received attention from the global community, particularly since the latter half of the twentieth century when tropical deforestation led to serious environmental issues and biodiversity degradation. Rapid population growth, increasing food demand and commercialisation of agriculture have been the main drivers of massive deforestation.

Agroforestry was first deemed a promising approach for 'land sparing', soil conservation and resource-use efficiency. Thanks to collective efforts from various institutions and countless practitioners, nowadays agroforestry has been widely recognized as a sustainable land use that can help farmers mitigate risks from market uncertainties and climate change, and for local food production to reduce the impact of food insecurity, including during the recent Covid-19 pandemic.

Agroforestry has been practiced in Viet Nam for decades in the form of traditional models such as forest–garden–fishpond–livestock systems in the lowlands[1] and fruit or timber tree-based models in the uplands.

According to the Spatial Characterized Agroforestry (SCAF) online database[2], the total area of agroforestry in the country had reached about 900,000 hectares during 2013–2014.

Owing to its potential, enhanced knowledge on the scope, diversity and potential benefits of agroforestry are necessary, both for the authorities and for agricultural practitioners. In addition, knowledge of, and effort in, removing barriers to agroforestry adoption at national and sub-national levels will help accelerate agroforestry development.

Agroforestry development can also support Viet Nam in implementing and achieving targets of several national policies. For example, the National Action Plan of the 2030 Sustainable Development Agenda clearly emphasizes the need for developing a more sustainable agriculture in upland areas. The country's Nationally Determined Contribution to 2030 targets greenhouse-gas removal and land conservation using agroforestry. Recently, the

[1] Known as the VAC (*vườn-ao-chuồng*) or VACR (*vườn-ao-chuồng-rừng*) systems.
[2] *http://scafs.worldagroforestry.org/*

significance of agriculture in adapting and mitigating climate change has been officially acknowledged through the Koronivia Joint Work on Agriculture decided at the 23rd Conference of Parties of the United Nations Framework Convention on Climate Change. Agroforestry can generate many benefits relevant to the Joint Work.

In this book, we aim to describe the high diversity of agroforestry practices in Viet Nam. The book uses the SCAF database and data from ICRAF's projects and studies and a literature review as the main sources of information. The diverse systems were first grouped based on the type of main product that can be derived from the systems, namely timber tree-, fruit tree-, or commercial tree crop-based agroforestry. Each group is further detailed into sub-groups based on the main tree species of the systems. For example, the timber tree-based group is divided into sub-groups of acacia-based systems. For most of the systems presented, we provide relevant photos for better illustrations. Otherwise, only a summary table of the system's properties such as plant components, design, main products, and benefits were provided. The contents of the book are organized as follows.

Part I: Diversity of agroforestry practices in the SCAF database

The SCAF provides information on geographical location, biophysical and socio-economic characteristics of 48 agroforestry systems spread across 42 provinces in Viet Nam during 2013–2014. The documented agroforestry systems include those in mangrove areas. We made another group for these agroforestry systems — Mangrove agroforestry systems — to highlight their existence among other groups of agroforestry systems cultivated in dry lands. For each agroforestry system presented, we describe the plant components, system design, productivity and total cultivation area in the provinces where the system exists. We excluded information on income that could be derived from the systems because further studies are needed to validate the reported figures. Moreover, the figures relate to monetary value in 2013–2014.

Part II: Diversity of agroforestry practices reported in ICRAF projects and studies

This part describes agroforestry systems documented through different projects implemented by ICRAF Viet Nam, among others, the Agroforestry for Livelihoods of Smallholder Farmers in North West Viet Nam (AFLI) project[3] (2011–2021) funded by the Australian Centre for International Agricultural Research, a study on the main fruit-tree agroforestry practices in North West Viet Nam (2020) self-funded by ICRAF, a study on agroforestry's contribution to Viet Nam's Nationally Determined Contribution (NDC) (2017–2020) jointly funded by the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) and ICRAF, and a project on climate-smart agricultural

[3] See: *https://www.worldagroforestry.org/project/agroforestry-livelihoods-smallholder-famers-northwest-vietnam* (phase I) and h*ttps://www.worldagroforestry.org/project/developing-and-promoting-market-based-agroforestry-and-forest-rehabilitation-options* (phase II)

practices in the North Central Coast[4] (2015–2018) funded by CCAFS.

The AFLI project introduced several agroforestry models in the North West, both simpler agroforestry models that integrate 2–3 plant components and more complex models that integrate more than three components. The study on fruit-tree agroforestry in the North West recorded nine agroforestry practices, including the annual incomes and the estimated sequestered carbon to demonstrate potential mitigation of climate change. The NDC study compiled information on agroforestry practices in several provinces, reported by the provincial authorities. The climate-smart agriculture project promoted three agroforestry practices considered worthy of upscaling in suitable regions.

Part III: Diversity of agroforestry practices reported in the literature

This part describes other agroforestry systems in Viet Nam documented in the literature published between 2003 and 2017[5]. The documented systems include mixed planting in home gardens. We present the result of the review in a summary table that provides information on the location and plant components of the agroforestry systems and sources to find further information on the systems.

We hope this book will be informative to all decision makers and practitioners in the agriculture and forestry sectors in Viet Nam and provides concrete examples of sustainable farming practices that can generate and balance multiple benefits. In addition, we hope that it can stimulate both national and international research institutions and donors, including the private sector, to further investigate and assess the actual and potential contribution from agroforestry to combat poverty, food insecurity and the climate crisis.

Today, some practices described in this book might no longer exist in the same form or scale owing to continuous adaptation by farmers to prevailing socio-economic and environmental conditions, including climate change. However, such a possibility will not reduce the value of this book, which sets out the diversity of agroforestry systems that have been practised or are still being practised in the country.

[4] *https://www.worldagroforestry.org/project/my-loi-climate-smart-village-ky-son-commune-ky-anh-district-ha-tinh-province-csv*

[5] A more recent publication by Do et al (2020) describes agroforestry models introduced by the AFLI project. We cite it as a reference in part II.1

Mango, longan, plum, pomelo and lemon - Forage grass in exemplar agroforestry landscape in Son La province, North West region.
Photo: World Agroforestry/Tran Ha My

What is agroforestry?

As this compilation suggests, a large variant of agroforestry practices often led to definitional challenges or misunderstanding of the key features of agroforestry. However, in general, agroforestry can be simply defined as 'agriculture with trees', or an agricultural use of trees in farms or landscapes, farming in forests or along forest margins, either in dry- or wet-lands[6]. Trees are protected, regenerated, planted, or managed and interact with annual crops, humans and/or livestock and wildlife. The integration of different components should be intentional, with management to deal with interactions among the components. The four 'I's — intentional, intensive, interactive and integrated — are considered the key features of agroforestry compared to non-agroforestry practices[7].

Intentional

Trees and annual crops with or without livestock are intentionally combined and managed together to generate benefits that cannot be obtained if each component is cultivated separately.

Intensive

All components are managed intensively to enhance the productive and protective functions of the system. For example, in a coffee agroforestry system, shade trees are pruned regularly to maintain appropriate levels of shading for the coffee.

Interactive

Interaction among a system's components is managed and/or manipulated and used for optimizing production and ecosystem functions.

Integrated

All components are combined in one integrated plot management unit. Agroforestry is not a system in which different components within a system are managed separately without any consideration of mutual effect among components.

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[6] *https://www.worldagroforestry.org/about/agroforestry*

[7] See Nair PKR. 2013. Agroforestry: trees in support of sustainable agriculture. Reference module in earth systems and environmental sciences. *https://www.sciencedirect.com/science/article/pii/B9780124095489050880* or Centre for Agroforestry. 2015. Chapter 1: Defining agroforestry. *http://www.centerforagroforestry.org/academy/2015/chp1-DefiningAgroforestry_2015.pdf*

Classification of agroforestry systems

Agroforestry exists in various forms and can be classified according to the variety and arrangement of a system's components or functions of the system. Each classification has its merits and limitations. No single classification can be used for universal application. The most common classification is by the nature of a system's component, namely into 'agrosilvicultural' (trees, annual crops), 'silvopastoral' (trees, livestock) and 'agrosilvopastoral' (trees, annual crops, livestock). A classification proposed by Xu et al (2013)[8] is described in the figure below.

As mentioned earlier, in this book we first grouped agroforestry systems in Viet Nam based on the type of main product that can be derived from the systems (timber tree-, fruit-tree- or commercial-tree-crop-based systems). We considered this grouping more helpful to planning authorities. We assumed they can relate more easily to types of products than to types of systems. Notwithstanding, we also used classification based on arrangements or functions of a system's components — for example, intercropping, mixed planting or perennial shade systems — when describing the plot design of each system[9].

In addition to the classification by Xu et al (2013), agroforestry can also be classified into 'simple' and 'complex' systems based on the diversity of components and functions that can be generated by the system. Complex agroforestry includes 'multi-story systems', which refers to an intimate association of various kinds of annual and perennial crops with or without livestock, with different plant heights, canopy patterns and rooting systems to optimize resource capture and use[10]. This complex agroforestry can often be found in home gardens, that is, on land located nearby a house as part of the homestead. In Viet Nam, agroforestry practices in home gardens can generally be classified into three types[11].

[8] Xu J, Mercado A, He J, Dawson I. 2013. *An agroforestry guide for field practitioners*. Kunming, China: World Agroforestry (ICRAF) East Asia

[9] See also a grouping of agroforestry systems in Viet Nam into 13 categories in Pham TS. 2015. *A review of the status of agroforestry in Vietnam*. Report written for the Regional Consultation on Agroforestry: the Way Forward, 8–10 October 2015, New Delhi, India. Phu Tho: Viet Nam: Northern Mountainous Agriculture and Forestry Science Institute.

[10] See Nair PKR. 2000. Overstory #64 – Home gardens. *https://agroforestry.org/the-overstory/199-overstory-64-homegardens*

[11] See Mohri H, Lahoti S, Saito O, Mahalingam A, Gunatilleke N, Irham Van TH, Hitinayake G, Takeuchi K, Herath S. 2013. Assessment of ecosystem services in homegarden systems in Indonesia, Sri Lanka, and Viet Nam. *Ecosystem Services* e124–e136; Pham TS. 2015. *A review of the status of agroforestry in Viet Nam*. Phu Tho, Viet Nam: Northern Mountainous Agriculture and Forestry Science Institute.

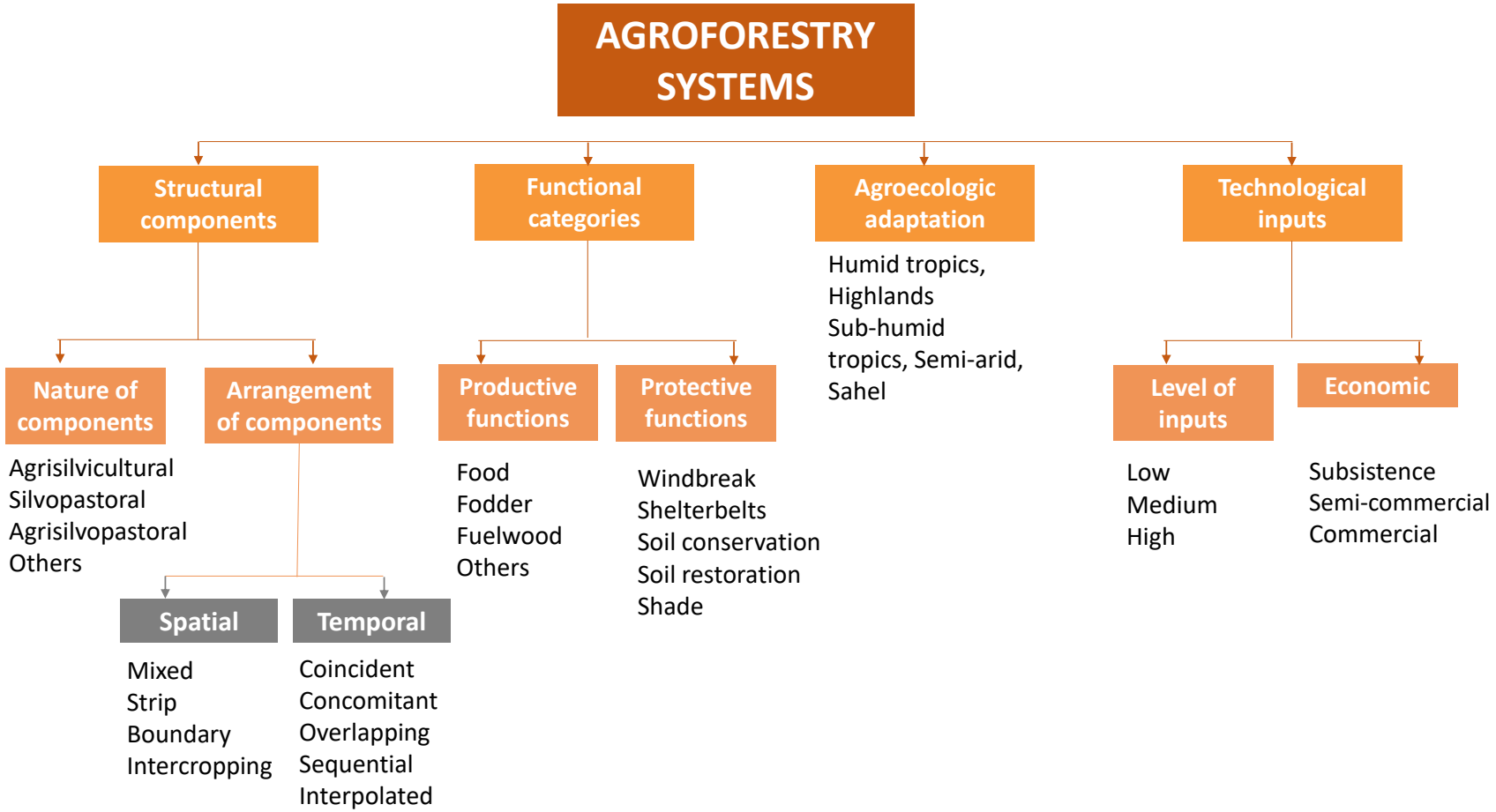


Figure 1. Classification of agroforestry systems. *Source: Xu et al 2013*

I) ‘Mixed’ home gardens with fruit and timber trees, woody shrubs such as tea or coffee, annual crops, and medicinal plants as components.

II) VAC (*Vườn–Ao–Chuồng* or garden–pond–cage) systems with fruit and timber trees, annual crops, aquaculture, and livestock. Therefore, these systems have three production components: gardening (agricultural and forest plants), aquaculture and animal husbandry.

III) VACR (*Vườn–Ao–Chuồng–Rừng* or garden–pond–cage–forest) systems with mixed fruit and timber trees, annual crops, aquaculture and animal husbandry and, in addition, forest trees that are usually cultivated in the upper part of the home garden, separated from the other components. In terms of land size, VACR is often larger than VAC.

Apart from the three types, the term ‘improved VAC’ is sometimes used to refer to a more commercialized VAC[12], and VACB for VAC with biogas[13].

[12] Edwards P. 2010. Rapidly changing aquaculture scene in the Red River delta, Viet Nam. *Aquaculture Asia Magazine* 15:3–10.

[13] Zhu T. 2006. *Assessment of small-scale biogas systems and their widespread dissemination in Can Tho City, Viet Nam*. Independent Study Project Collection. 303. h*ttps://digitalcollections.sit.edu/isp_collection/303.*

Potential benefits

The economic, ecological and social benefits of agroforestry include, but are not limited to, the following.

Economic benefits: A more stable income thanks to diverse products and lower production costs because of lesser inputs and higher resource-use efficiency. Although resource competition could affect productivity of each plant component, several studies show that agroforestry can potentially generate higher total income at the system level compared to sole crop plantations, owing crop diversification[14]. It is not common but possible that resource facilitation rather than competition occurs among plant component, which results in higher productivity of each plant component compared to their production in sole crop plantations[15]. Agroforestry can generate faster investment returns and break-event points than sole tree plantations[16].

Ecological benefits: In addition to reduced water and chemical inputs through higher resource-use efficiency, agroforestry can potentially sequester large amounts of carbon in soil and plant biomass, which altogether contributes to emission mitigation and greenhouse-gas removal[17]. On sloping land, agroforestry can reduce soil erosion and sedimentation through crop strips and contour planting[18]. Trees in general, and especially those with deep rooting systems, improve soil pores, infiltration and water retention[19]. They also modify micro-climates within a system, including through shading, which provides a conducive environment for shade-tolerant species[20]. In addition, trees can increase biodiversity of a system, including through providing a temporary or permanent habitat for wildlife[21]. Agroforestry can reduce the risk of forest encroachment and degradation through providing 'forest products', such as timber and fuelwood, and thus help conserve forests and their ecosystem services[22].

[14] See Do VH, La N, Mulia R, Bergkvist G, Dahlin AS, Nguyen VT, Pham HT, Öborn I. 2020. Fruit tree-based agroforestry systems for smallholder farmers in North West Vietnam: a quantitative and qualitative assessment. *Land* 9:451.

[15] See Mwalwanda AB, Ajayi OC, Akinnifesi FK, Beedy T, Sileshi G, Chiundu G. 2011. *Impact of fertilizer trees on maize production and food security in six districts of Malawi.* Lilongwe, Malawi: World Agroforestry (ICRAF). *https://www.worldagroforestry.org/publication/impact-fertilizer-trees-maize-production-and-food-security-six-districts-malawi.*

[16] See La N. 2019. Outcomes of agroforestry and monocropping: comparison and assessment. *Proceedings* 36:163. *https://www.mdpi.com/2504-3900/36/1/163.*

[17] See Mulia R, Nguyen DD, Nguyen MP, Steward P, Pham VT, Le HA, Rosenstock T, Simelton E. 2020. Enhancing Vietnam's Nationally Determined Contribution with mitigation targets for agroforestry: a technical and economic estimate. *Land* 9:528.

[18] See Tacio HD. 2013. Sloping Agricultural Land Technology (SALT): a sustainable agroforestry scheme for the uplands. *Agroforestry Systems* 22(2):145–152.

[19] See Van Noordwijk M, Bayala J, Hairiah K, Lusiana B, Muthuri C, Khasanah N, Mulia R. 2014. Agroforestry solutions for buffering climate variability and adapting to change. Chapter 14 in: Fuhrer J, Gregory PJ, eds. *Climate change Impact and adaptation in agricultural systems.* Wallingford, UK: CAB International. pp 216–232.

[20] See Gomes LC, Bianchi FJJA, Cardoso IM, Fernandes RBA, Filho EIF, Schulte RPO. 2020. Agroforestry systems can mitigate the impacts of climate change on coffee production: a spatially explicit assessment in Brazil. *Agriculture, Ecosystems and Environment* 294:106858.

[21] See Udawatta RP, Rankoth LM, Jose S. 2019. Agroforestry and biodiversity. Sustainability 11:2879; Mulia R, Hoang SV, Dinh VM, Duong NBT, Nguyen AD, Lam DH, Thi Hoang DT, van Noordwijk M. 2021. Earthworm diversity, forest conversion and agroforestry in Quang Nam province, Viet Nam. *Land* 10(36). *https://doi.org/10.3390/land10010036.*

[22] See Murniati, Garrity DP, Gintings AN. 2001. The contribution of agroforestry systems to reducing farmers' dependence on the resources of adjacent national parks: a case study from Sumatra, Indonesia. *Agroforestry Systems* 52:171–184.

Social benefits: Agroforestry can contribute to enhancement of food and nutritional security, especially those of poor communities, through providing a more varied diet that provides nutrients, fibre and protein[23]. In addition, agroforestry allows more time with the family by providing products such as fuelwood, which otherwise would need to be extracted from distant forests[24]. This also increases personal safety, especially for women, and reduces the risk of violating laws of forest protection and conservation even if driven by subsistence needs. Furthermore, the time saving also provides opportunities for women, who often spend considerable time in daily household works, to play a bigger role in production and market value-chains, decision making, and other income-generating activities.

[23] See Dawson IK, Place F, Torquebiau E, Malézieux E, Iiyama M, Sileshi GW, Kehlenbeck K, Masters E, McMullin S, Jamnadass R. 2013. *Agroforestry, food and nutritional security.* Background paper for the International Conference on Forests for Food Security and Nutrition, Rome, 13–15 May 2013. Rome, Italy: Food and Agriculture Organization of the United Nations. http://www.fao.org/3/a-mg491e.pdf.

[24] See Kiptot E, Franzel S. 2011. Gender and agroforestry in Africa: a review of women's participation. *Agroforestry Systems* 84:35–58.

Regions of Viet Nam

For each of agroforestry systems presented, we provide the region and province where the system was located. Viet Nam can be divided into several regions that each consists of several provinces. In this book, we use a division into eight regions differentiated by geographical characteristics, topographical features, ecosystem types and climate. These eight regions are North West, North East, Red River Delta, North Central Coast, South Central Coast, Central Highlands, South East, and Mekong River Delta. The detailed characteristics of each region, including soil conditions and dominant land uses, are given in Vu et al 2011[25].

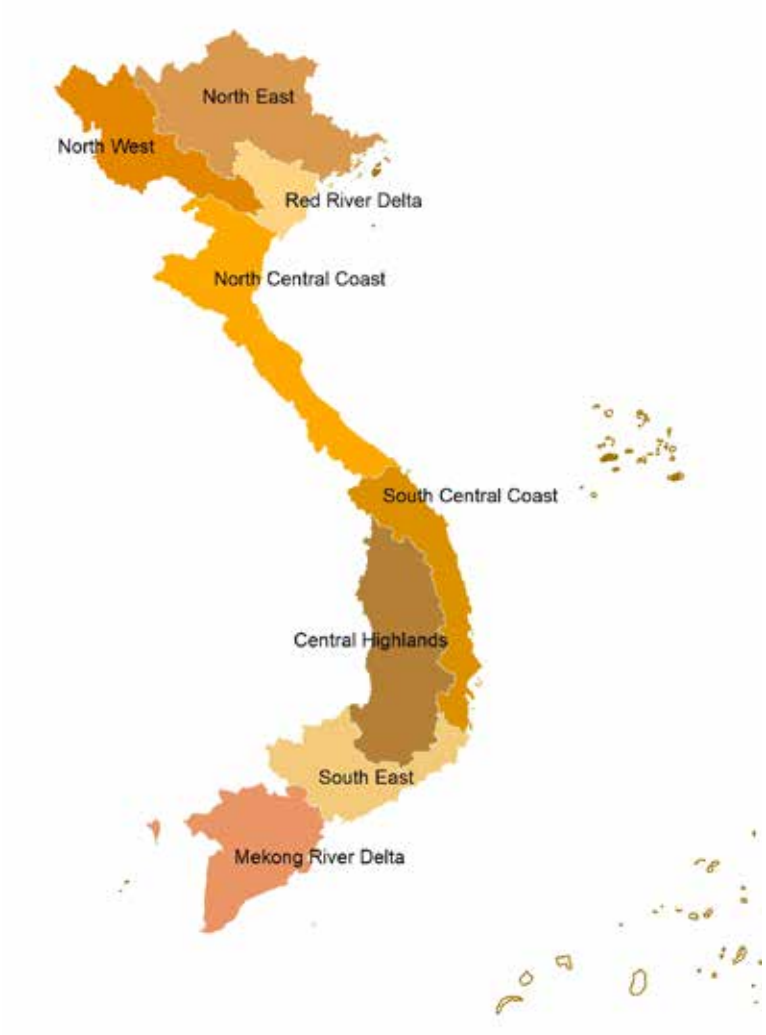


Figure 2. Regions of Viet Nam

[25] Vu TP, Nguyen TML, Nguyen NL, Do DS, Nguyen XQ, Tran VL, Ngo DQ, Tran VC, Nguyen DK, Lai VC, Do HT, Ngo TG, Hoang VA, Dinh TG, Pham NT. 2011. *Final report on forest ecological stratification in Viet Nam*. Ha Noi, Viet Nam: United Nations REDD Program Viet Nam.

Arabica coffee and *Leucaena leucocephala* in Dien Bien province, North West region. World Agroforestry/Tran Ha My

PART I

Diversity of agroforestry practices in the SCAF database

I.1. Timber-tree-based systems

I.1.1 Acacia – Cassava

I.1.2 Acacia – Medicinal plants

I.1.3 Eucalyptus – Cassava

I.1.4 *Melia azedarach* – Mixed crops

I.1.5 *Litsea glutinosa* – Cassava

I.1.6 *Sterculia foetida* – Annual crops

I.1.7 Acacia – Annual crops

I.1.8 *Illicium verum* – Mixed crops

I.1.9 *Manglietia conifer* – Maize

I.1.1 ACACIA – CASSAVA

Components	*Acacia mangium* or Acacia hybrid (*Acacia mangium x auriculiformis*), cassava
Common design	Temporal intercropping: Between rows of acacia trees, cassava is planted usually in the first two years after acacia planting
Products	Timber, food, fodder
Ecological benefits	Carbon sequestration, soil restoration (acacia is an N-fixing species) and other ecosystem services thanks to increased tree cover[26]
Tree density (trees ha^{-1})	Acacia: 1600–2500
Distribution	North East region (Phu Tho province), South Central Coast (Quang Nam, Quang Ngai)
Productivity	Acacia timber: 90–100 m^3 ha^{-1}; cassava: 5.5 ton ha^{-1}
Estimated area in 2013–2014 (ha)	Phu Tho: 2615; Quang Nam: 44,106; Quang Ngai: 13,879
Reference	World Agroforestry (2016)[27]

[26] As compared to sole annual crop cultivation. Other ecosystem services include reduced soil erosion on sloping land, improved soil porosity and water infiltration thanks to tree roots, increased biodiversity both above- and below-ground. Please see the section on potential ecological benefits of agroforestry, p 12.

[27] World Agroforestry. 2016. *The Spatially Characterized Agroforestry (SCAF) database*. Ha Noi, Viet Nam: World Agroforestry (ICRAF). *http://scafs.worldagroforestry.org/*

Young acacia hybrid trees with cassava in Quang Ngai province, South Central Coast region.
Photo: World Agroforestry/Vietnam Academy of Forest Science

I.1.2 ACACIA – MEDICINAL PLANTS

Components	*Acacia mangium* or Acacia hybrid, *Morinda officinalis, Kaempferiae galanga*
Common design	Acacia with medicinal plants as understorey
Products	Timber, fruits and roots for medicine. Acacia timbers are usually harvested at 5–6 years after planting
Ecological benefits	Carbon sequestration, soil restoration (acacia is an N-fixing species) and other ecosystem services thanks to increased tree cover
Tree density (trees ha^{-1})	Acacia density in: Acacia – Morinda: 2000 Acacia – Kaempferiae: 400
Distribution	Red River Delta (Quang Ninh)
Production	Acacia timber: 40–50 m^3 ha^{-1}, Morinda root: 4–5 ton ha^{-1}, Kaempferiae root: 3–3.5 ton ha^{-1}
Estimated area in 2013–2014 (ha)	718[28]
Reference	World Agroforestry (2016)

[28] This includes *Acacia mangium* – cassava systems common in Quang Ninh province. No information specific to acacia – medicinal plants.

Acacia trees - Medicinal plants in Quang Ninh province, Red River Delta region.
Photo: World Agroforestry/Vietnam Academy of Forest Sciences

I.1.3 EUCALYPTUS – CASSAVA

Components	*Eucalyptus urophylla*, cassava
Common design	Temporal intercropping: Between rows of eucalyptus trees, cassava is planted usually in the first two years after tree planting
Products	Timber, food, fodder
Ecological benefits	Carbon sequestration and other ecosystem services thanks to increased tree cover
Distribution	North East (Bac Giang)[29]
Tree density (trees ha^{-1})	Eucalyptus: 1660
Production	Eucalyptus: 119 m^3 ha^{-1}; cassava: 20 ton ha^{-1}
Estimated area in 2013–2014 (ha)	3653[30]
Reference	World Agroforestry (2016)

[29]Eucalyptus – cassava also exists in South Central Coast (e.g. Binh Dinh province) but no information is available on tree density nor productivity of the system.
[30]This includes acacia – cassava systems that are also common in Bac Giang province. No information specific to eucalyptus – cassava.

Eucalyptus urophylla trees after cassava harvest in Bac Giang province, North East region.
Photo: World Agroforestry/Vietnam Academy of Forest Sciences

I.1.4 MELIA AZEDARACH – MIXED CROPS

Components	*Melia azedarach*, banana, vegetables, maize, cassava or tea
Common design	Strip or border planting: Melia is usually planted as border tree or in rows with intercrops
Products	Timber, food, fodder, tea leaves. Melia timbers are usually harvested at 6–7 years after tree planting
Ecological benefits	Carbon sequestration, melia provides shade and windbreak for tea, other ecosystem services thanks to increased tree cover
Tree density (trees ha^{-1})	Melia density in: Melia – tea: 1000–1100 Melia – cassava: 400 Melia – maize: 900
Distribution	North East (Tuyen Quang)
Production	Melia: 190 m^3 ha^{-1}; maize: 3.2 ton ha^{-1}; cassava: 16.4 ton ha^{-1}; tea leaves: 0.6–1.3 ton ha^{-1}
Estimated area in 2013–2014 (ha)	759
Reference	World Agroforestry (2016)

Melia azedarach - Tea in Tuyen Quang province, North East region.
Photo: World Agroforestry/Vietnam Academy of Forest Sciences

I.1.5 LITSEA GLUTINOSA – CASSAVA

Components	*Litsea glutinosa*, cassava
Common design	Temporal intercropping: Between rows of litsea trees, cassava is planted in the first few years after litsea planting
Products	Timber, bark, food, fodder
Ecological benefits	Carbon sequestration and other ecosystem services thanks to increased tree cover
Tree density (trees ha^{-1})	Litsea: 1000
Distribution	Central Highlands (Gia Lai)
Production	Litsea (dried bark): 14–19 ton ha^{-1}; cassava: 2 ton ha^{-1}
Estimated area in 2013–2014 (ha)	1037
Reference	World Agroforestry (2016)

Litsea glutinosa - Cassava in Gia Lai province, Central Highlands region.
Photo: World Agroforestry/Nong Lam University, Ho Chi Minh City

I.1.6 STERCULIA FOETIDA – ANNUAL CROPS

Components	*Sterculia foetida* L, watermelon, pumpkin or purple onion
Common design	Temporal intercropping: Between rows of sterculia trees, watermelon or purple onion is planted in the first four years after sterculia planting
Products	Timber, medicine (from sterculia), fruit, food. Sterculia timbers are usually harvested at 20 years after planting
Ecological benefits	Carbon sequestration and other ecosystem services thanks to increased tree cover
Tree density (trees ha^{-1})	Sterculia: 1000
Distribution	South Central Coast (Binh Thuan)
Production	N/A[31]
Estimated area in 2013–2014 (ha)	673
Reference	World Agroforestry (2016)

[31]Information is not available.

Sterculia foetida L - Pumpkin in Binh Thuan province, South Central Coast region.
Photo: World Agroforestry/Vietnam National University of Agriculture

I.1.7 ACACIA – ANNUAL CROPS

Components	*Acacia mangium* or Acacia hybrid, cassava or maize
Common design	Temporal intercropping: Between rows of acacia trees, cassava or maize is cultivated usually in the first two years after acacia planting
Products	Timber, food, fodder
Ecological benefits	Carbon sequestration, soil restoration (acacia is an N-fixing species) and other ecosystem services thanks to increased tree cover
Tree density (trees ha^{-1})	Acacia: 400–3000
Distribution	North East (Hoa Binh), North West (Yen Bai), North Central Coast (Thanh Hoa), South Central Coast (Binh Dinh)
Production	Acacia: 25–130 m^3 ha^{-1}; cassava: 12–20 ton ha^{-1}; maize: 4 ton ha^{-1}
Estimated area in 2013–2014 (ha)	Hoa Binh: 36,079; Yen Bai: 9320; Thanh Hoa: 3921; Binh Dinh: 13,594
Reference	World Agroforestry (2016)

Acacia - Maize in Thanh Hoa province, North Central Coast region.
Photo: World Agroforestry/Vietnam Academy of Forest Science

I.1.8 ILLICIUM VERUM – MIXED CROPS

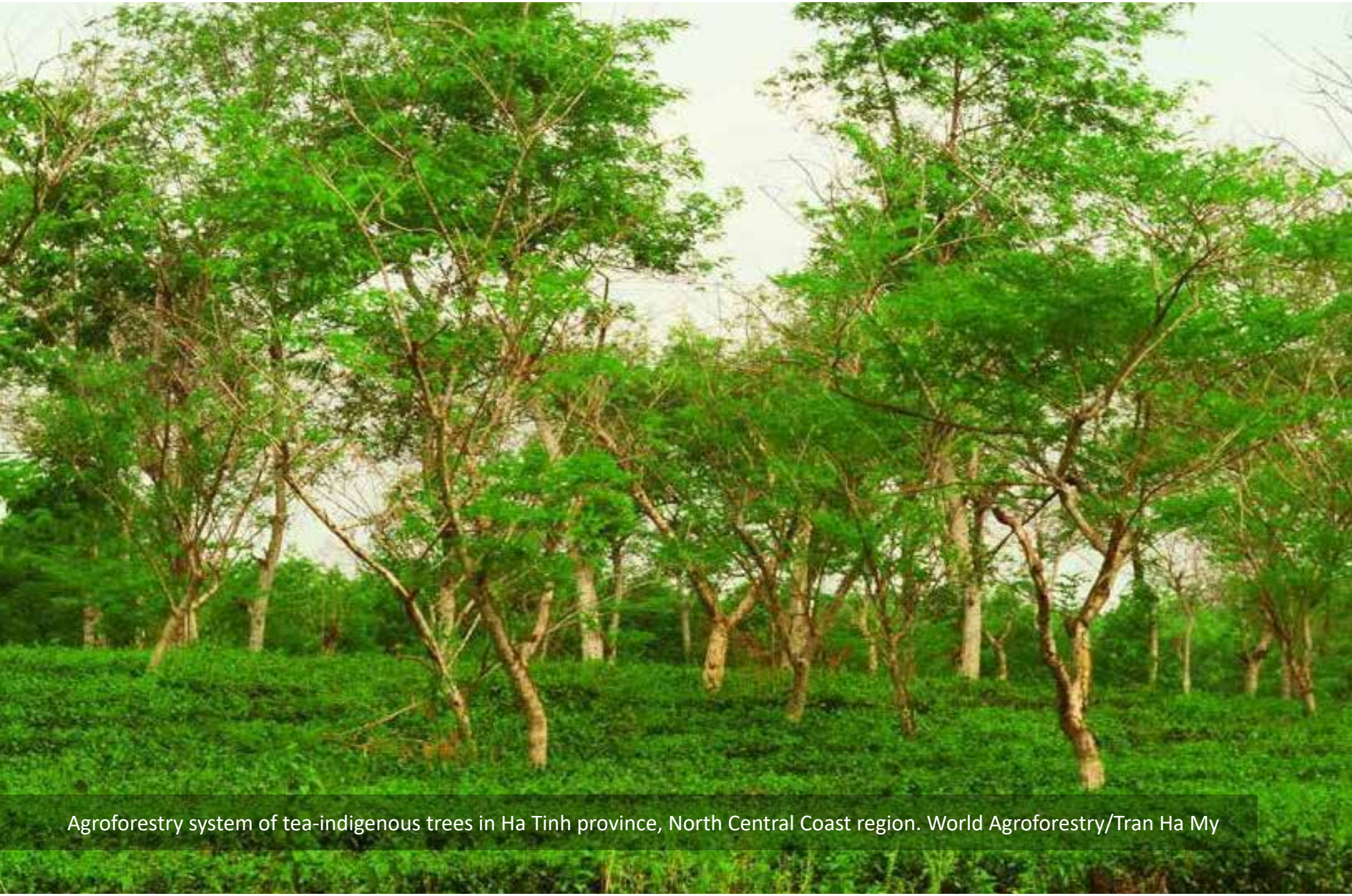
Components	Star anise (*Illicium verum*), rice, cassava or tea
Common design	Strip or border planting: Illicium is planted as border tree (with paddy) or in rows with cassava or tea usually in the first few years after tree planting
Products	Timber, spice, food, fodder
Ecological benefits	Carbon sequestration, illicium provides shade for tea, other ecosystem services thanks to increased tree cover
Tree density (trees ha^{-1})	Illicium: 400–500
Distribution	North East (Lang Son)
Production	Dried star anise: 247 kg ha^{-1}; tea leaves (dry): 2.7 ton ha^{-1}; cassava: 1.2 ton ha^{-1}; rice: 8.2 ton ha^{-1}
Estimated area in 2013–2014 (ha)	1736
Reference	World Agroforestry (2016)

Illicium verum - Tea in Lang Son province, North East region.
Photo: World Agroforestry/Vietnam Academy of Forest Science

I.1.9 MANGLIETIA CONIFER – MAIZE

Components	*Manglietia conifer,* maize
Common design	Temporal intercropping: Between rows of manglietia trees, maize is intercropped twice per year in the first 3 years after manglietia planting
Products	Timber, food, fodder
Ecological benefits	Carbon sequestration and other ecosystem services thanks to increased tree cover
Tree density (trees ha^{-1})	Manglietia: 1500–1700
Distribution	North East (Bac Kan)
Production	Manglietia: 170 m^3 ha^{-1}; maize: 3.5 ton ha^{-1}
Estimated area in 2013–2014 (ha)	10,893
Reference	World Agroforestry (2016)

Tea – *Cassia siamea* in Phu Tho province, North East region. World Agroforestry/Tran Ha My



Agroforestry system of tea-indigenous trees in Ha Tinh province, North Central Coast region. World Agroforestry/Tran Ha My

I.2. Industrial-tree-crop-based systems

I.2.1 Rubber – Cassava

I.2.2 Rubber – Mixed crops

I.2.3 Arabica coffee – *Leucaena leucocephala*

I.2.4 Robusta coffee – Macadamia

I.2.5 Robusta coffee – Cashew – Fruit trees

I.2.6 Robusta coffee – Cashew – Pepper

I.2.7 Tea – *Acacia mangium*

I.2.8 Rubber – Upland rice

I.2.9 Cashew – Mixed crops

I.2.10 Tea – *Cassia siamea*

I.2.11 Arabica coffee – Fruit trees – Annual crops

I.2.12 Robusta coffee – *Litsea glutinosa*

I.2.13 Robusta coffee – Macadamia – Black pepper – Fruit trees

I.2.14 Cocoa – Coconut

I.2.1 RUBBER – CASSAVA

Components	Rubber *(Hevea brasiliensis),* cassava
Common design	Temporal intercropping: Between rows of rubber trees, cassava is planted in the first 2–6 years after tree planting
Products	Latex, food
Ecological benefits	Carbon sequestration and other ecosystem services thanks to increased tree cover
Tree density (trees ha^{-1})	Rubber: 500–560
Distribution	North East (Lao Cai)[32], North Central Coast (Thua Thien Hue), Central Highlands (Kon Tum)
Production	Latex: 1.1–1.7 ton ha^{-1}; cassava: 12–18 ton ha^{-1}
Estimated area in 2013–2014 (ha)	Lao Cai: 9000; Thua Thien Hue: N/A; Kon Tum: 1268
Reference	World Agroforestry (2016)

[32]In Lao Cai, some systems have strips of forage grass and chickens raised under trees.

Rubber - Cassava in North Central Coast region. Photo: World Agroforestry/Vietnam Academy of Forest Sciences

I.2.2 RUBBER – MIXED CROPS

Components	Rubber (*Hevea brasiliensis*), cassava, maize, banana
Common design	Temporal intercropping In the lower slopes: Between rows of rubber trees, cassava, maize or banana is planted in the first 6–7 years after tree planting In upper slopes: Cassava, maize or banana is intercropped in the first 4–5 years after tree planting
Products	Latex, food, fruit, fodder
Ecological benefits	Carbon sequestration and other ecosystem services thanks to increased tree cover
Tree density (trees ha^{-1})	Rubber: 550–600
Distribution	North Central Coast (Quang Tri)
Production	Latex: 1.4 ton ha^{-1}; maize: 2.3 ton ha^{-1}; cassava: 15.7 ton ha^{-1}; banana: 13.6 ton ha^{-1}
Estimated area in 2013–2014 (ha)	5052
Reference	World Agroforestry (2016)

Rubber - Taro - Maize in Quang Tri province, North Central Coast region.
Photo: World Agroforestry/Vietnam Academy of Forest Sciences

I.2.3 ARABICA COFFEE – LEUCAENA LEUCOCEPHALA

Components	Arabica coffee*, Leucaena leucocephala*
Common design	Intercropping: Scattered planting of *L. leucocephala* amid rows of coffee
Products	Coffee cherries, fodder (*L. leucocephala* leaves)
Ecological benefits	*L. leucocephala* provides shade for coffee, improves soil fertility (*L. leucocephala* is an N-fixing species) and enhances carbon sequestration
Tree density (trees ha^{-1})	Coffee: 2500–2800; *L. leucocephala*: 150–170
Distribution	North West (Dien Bien)
Production	Fresh coffee cherries: 16–25 ton ha^{-1} (from the 3rd year)
Estimated area in 2013–2014 (ha)	780
Reference	World Agroforestry (2016)

Arabica - *Leucaena leucocephala* in Dien Bien province, North West region.
Photo: World Agroforestry/Thai Nguyen University of Agriculture and Forestry

I.2.4 ROBUSTA COFFEE – MACADAMIA

Components	*Coffee canephora, Macadamia integrifolia*
Common design	Intercropping: Scattered planting of macadamia amid rows of coffee
Products	Coffee, nuts
Ecological benefits	Macadamia provides shade for coffee and enhances carbon sequestration. Other ecosystem services thanks to increased tree cover
Tree density (trees ha^{-1})	Coffee: 780; macadamia: 70
Distribution	Central Highlands (Lam Dong)
Production	Coffee: 3 ton ha^{-1}; macadamia nuts: 3–5 ton ha^{-1}
Estimated area in 2013–2014 (ha)	19,976
Reference	World Agroforestry (2016)

Robusta coffee – Macadamia system in Lam Dong province, Central Highlands region.
Photo: World Agroforestry/Pham Thanh Van

I.2.5 ROBUSTA COFFEE – CASHEW – FRUIT TREES

Components	*Coffee canephora,* cashew *(Anacardium occidentale),* fruit trees, such as durian
Common design	Mixed planting: Cashew and fruit trees are amid rows of coffee shrubs
Products	Coffee beans, nuts, fruits
Ecological benefits	Cashew and fruit trees provide shade for coffee and enhance carbon sequestration. Other ecosystem services thanks to increased tree cover
Tree density (trees ha^{-1})	Coffee: 1100; cashew: 50–60; durian: 50–100
Distribution	Central Highlands (Dak Nong)
Production	Cashew: 2.5 ton ha^{-1}; coffee: 5 ton ha^{-1}; durian: 11 ton ha^{-1}
Estimated area in 2013–2014 (ha)	9295
Reference	World Agroforestry (2016)

Robusta - Cashew - Fruit trees in Dak Nong province, Central Highlands region.
Photo: World Agroforestry/Nong Lam University, Ho Chi Minh City

I.2.6 ROBUSTA COFFEE – CASHEW – PEPPER

Components	*Coffee canephora,* cashew *(Anacardium occidentale),* black pepper
Common design	Mixed planting: Cashew trees amid rows of coffee and black pepper. Black pepper grows along dead woody pillars or *Cassia siamea* trees
Products	Coffee beans, nuts, black pepper
Ecological benefits	Cashew provides shade for coffee and enhances carbon sequestration. Other ecosystem services thanks to increased tree cover
Tree density (trees ha^{-1})	Coffee: 300–600; cashew: 100–120
Distribution	South East (Binh Phuoc)
Production	Coffee: 2 ton ha^{-1}; cashew: 1.3 ton ha^{-1}; pepper: 2.5 ton ha^{-1}
Estimated area in 2013–2014 (ha)	9780
Reference	World Agroforestry (2016)

Robusta - Cashew - Black pepper in Binh Phuoc province, South East region.
Photo: World Agroforestry/Nong Lam University, Ho Chi Minh City

I.2.7 TEA – ACACIA MANGIUM

Components	Tea *(Camellia sinensis), Acacia mangium*
Common design	Border planting: Acacias are usually planted as border trees for windbreak or scattered amidst tea for shade
Products	Tea leaves, timber
Ecological benefits	Acacia provides shade and windbreak for tea, improves soil fertility (acacia is an N-fixing species) and enhances carbon sequestration. Other ecosystem services thanks to increased tree cover
Tree density (trees ha^{-1})	Acacia: 200; tea: 20,000–27,000
Distribution	North East (Thai Nguyen)
Production	Tea: 3.2 ton ha^{-1}; acacia timber: N/A
Estimated area in 2013–2014 (ha)	3721
Reference	World Agroforestry (2016)

Acacia mangium - Tea in Thai Nguyen province, North East region.
Photo: World Agroforestry/Thai Nguyen University Of Agriculture and Forestry

I.2.8 RUBBER – UPLAND RICE

Components	Rubber (*Hevea brasiliensis*), upland rice
Common design	Temporal intercropping: Rice amidst rows of rubber trees in the first 3 years after tree planting
Products	Latex, food
Ecological benefits	Carbon sequestration and other ecosystem services thanks to increased tree cover
Tree density (trees ha^{-1})	Rubber: 500
Distribution	North West (Dien Bien, Lai Chau)
Production	Rice: 1.7 ton ha^{-1}; latex: N/A
Estimated area in 2013–2014 (ha)	Dien Bien: 266; Lai Chau: 507
Reference	World Agroforestry (2016)

I.2.9 CASHEW – MIXED CROPS

Components	Cashew (*Anacardium occidentale*), rice, maize, cassava or sugar cane
Common design	Temporal intercropping: Between rows of cashew trees, rice, maize, cassava or sugar cane is intercropped before canopy closure of trees.
Products	Nut, food, fodder
Ecological benefits	Carbon sequestration and other ecosystem services thanks to increased tree cover
Tree density	N/A
Distribution	South East (Ninh Thuan)
Production	Cashew: 4.5 ton ha^{-1}
Estimated area in 2013–2014 (ha)	635
Reference	World Agroforestry (2016)

I.2.10 TEA – CASSIA SIAMEA

Components	Tea *(Camellia sinensis), Cassia siamea*
Common design	Scattered planting of cassia amid rows of tea
Products	Tea leaves
Ecological benefits	Cassia provides shade for tea, improves soil fertility (cassia is an N-fixing species) and enhances carbon sequestration and other ecosystem services thanks to increased tree cover
Tree density (trees ha^{-1})	Tea: 16,000
Distribution	North Central Coast (Nghe An)
Production	Tea: 15–18 ton ha^{-1}
Estimated area in 2013–2014 (ha)	4070
Reference	World Agroforestry (2016)

I.2.11 ARABICA COFFEE – FRUIT TREES – ANNUAL CROPS

Components	Arabica coffee, fruit trees such as longan *(Dimocarpus longan),* maize, banana
Common design	Mixed planting: Coffee in rows, fruit trees are scattered amid rows of coffee, maize is planted in the first two years after planting fruit trees
Products	Coffee, fruit, food, fodder
Ecological benefits	Fruit trees provide shade for coffee and enhances carbon sequestration and other ecosystem services thanks to increased tree cover
Tree density (trees ha^{-1})	Coffee: 2500–2800; fruit trees: 150–170
Distribution	North West (Son La)
Production	Fresh coffee cherries: 19 ton ha^{-1}; longan: 1 ton ha^{-1}; maize: 10 ton ha^{-1}; banana: 30 bunches ha^{-1}
Estimated area in 2013–2014 (ha)	6717
Reference	World Agroforestry (2016)

I.2.12 ROBUSTA COFFEE – LITSEA GLUTINOSA

Components	*Coffee canephora, Litsea glutinosa*
Common design	Intercropping: Scattered planting of litsea amid rows of coffee
Products	Coffee beans, bark of litsea
Ecological benefits	Litsea provides shade for coffee and enhances carbon sequestration and other ecosystem services thanks to increased tree cover
Tree density (trees ha^{-1})	Coffee: 600–900; Litsea: 100–300
Distribution	Central Highlands (Kon Tum)
Production	Coffee: 1.7 ton ha^{-1}
Estimated area in 2013–2014 (ha)	5206
Reference	World Agroforestry (2016)

I.2.13 ROBUSTA COFFEE – MACADAMIA – BLACK PEPPER – FRUIT TREES

Components	*Coffea canephora, Macadamia integrifolia,* black pepper, *Cassia siamea* and fruit trees, such as durian and avocado
Common design	Mixed planting: Macadamia, pepper and fruit trees amid coffee shrubs
Products	Coffee beans, nuts, black pepper, fruits
Ecological benefits	Macadamia provides shade for coffee, cassia improves soil fertility (cassia is an N-fixing species), trees enhance carbon sequestration. Other ecosystem services thanks to increased tree cover
Tree density (trees ha^{-1})	Coffee: 700–900; total of macadamia and fruit trees: 100–300
Distribution	Central Highlands (Lam Dong)
Production (ton ha^{-1})	Coffee: 4.1; black pepper: 1.4; durian: 4; avocado: 5.2; macadamia: 0.5–0.8
Estimated area in 2013–2014 (ha)	202,022
Reference	World Agroforestry (2016)

I.2.14 COCOA – COCONUT

Components	Cocoa *(Theobroma cacao),* coconut
Common design	Intercropping: Cocoa and coconut in rows
Products	Fruit, cocoa beans
Ecological benefits	Coconut provides shade for cocoa, other ecosystem services thanks to increased tree cover
Tree density (trees ha^{-1})	Cocoa: 3000–4000; coconut: 48–70
Distribution	Mekong River Delta (Ben Tre)
Production	Cocoa: 5 ton ha^{-1}; coconut: 10,000 fruits ha^{-1}
Estimated area in 2013–2014 (ha)	8344
Reference	World Agroforestry (2016)

Robusta coffee – Black pepper in Lam Dong province, Central Highlands region.
Photo: World Agroforestry/Nong Lam University, Ho Chi Minh City

Acacia – Mango – Maize – Forage grass photo in Yen Bai province, North West region. Photo: World Agroforestry/Do Van Hung

I.3. Fruit-tree-based systems

I.3.1 Mango – Maize/banana/papaya

I.3.2 Custard – Mango – Banana

I.3.3 Lime – Acacia – Papaya

I.3.1 MANGO – MAIZE/BANANA/PAPAYA

Components	Mango, maize, banana or papaya
Common design	Intercropping: Between rows of mango trees, maize, banana, or papaya is intercropped in the first 5–6 years after tree planting
Products	Fruits, food, fodder
Ecological benefits	Carbon sequestration and other ecosystem services thanks to increased tree cover
Tree density (trees ha^{-1})	Density of mango in: Mango – maize: 400; mango – banana: 400; mango – papaya: 333
Distribution	South Central Coast (Khanh Hoa)
Production	N/A
Estimated area in 2013–2014 (ha)	1260
Reference	World Agroforestry (2016)

Mango - Maize in Khanh Hoa province, South Central Coast region.
Photo: World Agroforestr/Vietnam Academy of Forest Sciences

I.3.2 CUSTARD – MANGO – BANANA

Components	Custard apple *(Annona squamosa),* mango, banana
Common design	Intercropping: Custard apple and mango in rows, with banana as intercrop
Products	Fruits, fodder (banana leaves)
Ecological benefits	Carbon sequestration and other ecosystem services thanks to increased tree cover
Tree density (trees ha^{-1})	Custard apple: 400–625; mango: 120–150; banana: 1000–1300
Distribution	South East (Tay Ninh)
Production	Custard apple: 10–16 ton ha^{-1}; mango and banana: N/A
Estimated area in 2013–2014 (ha)	872
Reference	World Agroforestry (2016)

I.3.3 LIME – ACACIA – PAPAYA

Components	Lime (*Citrus aurantifolia*), Acacia hybrid, papaya (*Carica papaya*)
Common design	Intercropping and boundary planting: Lime trees in rows with papaya as intercrop in the first two years after planting, with acacia as border trees
Products	Fruits
Ecological benefits	Acacia acts as a windbreak and enhances carbon sequestration; acacia mulch improves soil fertility (acacia is an N-fixing species) and other ecosystem services are provided thanks to increased tree cover
Tree density (trees ha^{-1})	Lime: 1350–1600; acacia and papaya: N/A
Distribution	Mekong River Delta (Long An)
Production	N/A
Estimated area in 2013–2014 (ha)	943
Reference	World Agroforestry (2016)

Rhizophora apiculata – Shrimp in Mekong River Delta region. Photo: World Agroforestry/Nguyen Tien Hai

I.4. Mangrove agroforestry systems

I.4.1 *Rhizophora apiculata* – Shrimp

I.4.2 *Melaleuca cajuputi* – Rice

I.4.1 RHIZOPHORA APICULATA – SHRIMP

Components	*Rhizophora apiculata*, shrimp
Common design	Rhizophora trees with shrimp farming in the canals
Products	Timber, shrimp
Ecological benefits	Mangrove restoration to reduce impact of sea-water intrusion, enhance biodiversity and carbon sequestration, and provide clean water
Tree density (trees ha^{-1})	Around 10,000
Distribution	Mekong River Delta (Ca Mau, Soc Trang)
Production	Rhizophora: 3500 stems ha^{-1} (harvested at 10–15 years old); shrimp: 400–500 kg ha^{-1}
Estimated area in 2013–2014 (ha)	Ca Mau: 103,723; Soc Trang: 4890
Reference	World Agroforestry (2016)

Rhizophora apiculata – Shrimp in Mekong River Delta region. Photo: World Agroforestry/Nguyen Tien Hai

I.4.2 MELALEUCA CAJUPUTI – RICE

Components	*Melaleuca cajuputi,* rice
Common design	Rice is planted alongside large, deep, parallel canals. Melaleuca is next to the rice fields. Small, shallow canals irrigate melaleuca plantations
Products	Timber, leaves, oil, food
Ecological benefits	Coastal protection, fresh-water inland forest restoration for biodiversity and carbon sequestration and provision of clean water
Tree density (trees ha^{-1})	Melaleuca: 15,000–20,000
Distribution	Mekong River Delta (An Giang, Soc Trang, Ca Mau, Kien Giang)[33]
Production	Rice: 4.3–6.3 ton ha^{-1}
Estimated area in 2013–2014 (ha)	An Giang: 45,154; Soc Trang: 5381[34]
Reference	World Agroforestry (2016)

[33]In Ca Mau and Kien Giang, banana and fish farming are often integrated into melaleuca – rice systems.
[34]No information on Ca Mau and Kien Giang.

Coffee - Pepper with *Cassia siamea* and *Ceiba pentandra* as living trunk in Gia Lai province, Central Highlands region.
Photo: World Agroforestry/Pham Thanh Van

Exemplar agroforestry landscape in Son La province, North West region. Photo: World Agroforestry/Tran Ha My

PART II

Diversity of agroforestry practices reported in ICRAF's projects and studies

II.1. Systems introduced in AFLI project

Commercial-tree-crop-based system

II.1.1 Macadamia – Arabica coffee – Soybean

Fruit tree-based systems

II.1.2 Longan – Maize – Forage grass

II.1.3 *Docynia indica* – Forage grass

II.1.4 *Docynia indica* – Maize

Complex agroforestry systems

II.1.5 Acacia – Longan – Coffee – Soybeans – Forage grass

II.1.6 Teak – Plum – Coffee – Soybean – Forage grass

II.1.7 Acacia – Mango – Maize – Forage grass

II.1.1 MACADAMIA – ARABICA COFFEE – SOYBEAN

Components	Macadamia *(Macadamia spp),* Arabica coffee*,* soybean
Common design	Strip and contour planting: three rows of coffee between two rows of macadamia. Soybean is planted seasonally in the remaining area amid tree rows
Products	Coffee cherries, nuts, food
Ecological benefits	Macadamia provides shade for coffee, carbon sequestration and other ecosystem services thanks to increased tree cover
Tree density (trees ha^{-1})	Macadamia: 154; coffee: 2160
Experimental sites	North West (Dien Bien, Son La)
Production	Macadamia (6 years old): 0.51 ± 0.13 ton ha^{-1}; coffee (6 years old): 6.3 ± 1.87 ton ha^{-1}; soybean: 0.135 ± 0.07 ton ha^{-1}
Estimated area in 2020 (ha)	0.7
Reference	La et al (2019a)[35]

[35]La N, Pham HT, Do VH, Do TH, Tran HM, Vu TH, Nguyen VT 2019. Agroforestry technical manual. Option: macadamia – coffee – soybeans. Leaflet. Ha Noi, Viet Nam: World Agroforestry (ICRAF). *http://apps.worldagroforestry.org/region/sea/publications/detail?pubID=4520*

Macadamia - Arabica coffee in Son La province, North West region. Photo: World Agroforestry/Nguyen Mai Phuong

II.1.2 LONGAN – MAIZE – FORAGE GRASS

Components	Longan (*Dimocarpus longan Lour*), maize, guinea grass (*Panicum maximum Jacq*)
Common design	Strip planting along contour line: longan in double-rows, with 15 m distance between two double-rows. Two rows of guinea grass with 0.5 m distance to rows of longan. Maize in remaining area close to rows of trees or grass
Products	Fruit, food, fodder
Ecological benefits	Reduced soil erosion compared to sole crop plantations, carbon sequestration and other ecosystem services thanks to increased tree cover
Tree density (trees ha^{-1})	Longan: 240
Experimental sites	North West (Son La, Dien Bien, Yen Bai)
Production (ton ha^{-1})	Longan (7 years old): 0.9; maize: 4.2; guinea grass: 14.6
Estimated area in 2020 (ha)	0.54
Reference	Do et al (2020)[36]

[36]Do VH, La N, Mulia R, Bergkvist G, Dahlin AS, Nguyen VT, Pham HT, Öborn I. 2020. Fruit tree-based agroforestry systems for smallholder farmers in North West Vietnam: a quantitative and qualitative assessment. Land 9:451.

Longan - Maize - Forage grass in Yen Bai province, North West region. Photo: World Agroforestry/Do Van Hung

II.1.3 DOCYNIA INDICA – FORAGE GRASS

Components	*Docynia indica* (vernacular name: 'son tra'), forage grass (guinea or mulato)
Common design	Strip and contour planting: three rows of forage grass between two rows of docynia
Products	Dried docynia fruits for medicinal use, fodder (grass)
Ecological benefits	Reduced soil erosion compared to sole crop plantation, natural terrace formation by grass strips, carbon sequestration and other ecosystem services thanks to increased tree cover
Tree density (trees ha^{-1})	Docynia: 2240
Experimental sites	North West (Dien Bien, Son La, Yen Bai)
Production	Docynia (6 years old): 1.8 ton ha^{-1} with docynia – guinea grass, 4.7 ton ha^{-1} with docynia – mulato grass; guinea grass: 40.8 ton ha^{-1}; mulato: 45.7 ton ha^{-1}
Estimated area in 2020 (ha)	0.25
Reference	Do et al (2020)[37]

[37]Do VH, La N, Mulia R, Bergkvist G, Dahlin AS, Nguyen VT, Pham HT, Öborn I. 2020. Fruit tree-based agroforestry systems for smallholder farmers in North West Vietnam: a quantitative and qualitative assessment. *Land* 9:451.

Docynia indica - Forage grass in Dien Bien province, North West region. Photo: World Agroforestry/Nguyen Mai Phuong

II.1.4 DOCYNIA INDICA – MAIZE

Components	*Docynia indica* (vernacular name: 'son tra'), maize
Design	Strip and contour planting: docynia in double-rows with 12 m distance between two double rows. Maize between double rows of docynia
Products	Dried docynia fruits for medicinal use, food, fodder
Ecological benefits	Reduced soil erosion compared to sole crop plantation, carbon sequestration and other ecosystem services thanks to increased tree cover
Tree density (trees ha^{-1})	Docynia: 300
Experimental sites	North West (Son La)
Production	Docynia (3 years old): 0.1 ± 0.02 ton ha^{-1}; maize: 2.6 ± 0.3 ton ha^{-1}
Estimated area in 2020 (ha)	0.15
Reference	La et al (2016)[38]

[38]La N, Do VH, Pham HT, Agustin M, Do TL, Hoang TL et al. 2016. Participatory Farmer Trials Results. Technical report no. 19. Agroforestry for Livelihood of Smallholder farmers in Northwest Viet Nam project. Ha Noi, Viet Nam: World Agroforestry (ICRAF)

Docynia indica – Maize in Tram Tau, Yen Bai province, North West region. Photo: World Agroforestry/Do Van Hung

II.1.5 ACACIA – LONGAN – COFFEE – SOYBEANS – FORAGE GRASS

Components	Acacia *(Acacia mangium),* late longan *(Dimocarpus longan* Lour*),* Arabica coffee*,* forage (guinea) grass, soybean
Design	Strip planting along contour line: acacia and longan trees in rows along contour lines. Rows of the two species alternate, with 10 m distance between rows. Three rows of coffee between rows of acacia and longan. Guinea grass in strips close to acacia and longan rows. Soybeans in the remaining area within the system
Products	Timber, fruit, coffee cherries, food, fodder
Ecological benefits	Reduced soil erosion compared to sole crop plantation, acacia and longan provide shade and windbreaks for coffee, acacia improves soil fertility (acacia is an N-fixing species), carbon sequestration and other ecosystem services thanks to increased tree cover
Tree density (trees ha^{-1})	Acacia: 300; longan: 125; coffee: 1680
Experimental sites	North West (Dien Bien)
Plot size	1200 m^2
Production	Coffee (5 years old): 3.67 ± 0.46 ton ha^{-1}; soybean: 0.03 ± 0.01 ton ha^{-1}; guinea grass: 13.2 ± 2.1 ton ha^{-1}; longan (5 years old): 0.13 ± 0.08 ton ha^{-1}
Reference	La et al (2019b)[39]

[39]La N, Pham HT, Do VH, Do TH, Tran HM, Vu TH, Nguyen VT. 2019. Agroforestry technical manual. Option: acacia – longan – coffee – soybeans – forage. Leaflet. Ha Noi, Viet Nam: World Agroforestry (ICRAF) *http://apps.worldagroforestry.org/region/sea/publications/detail?pubID=4519*

Acacia - Longan - Coffee - Forage grass in Dien Bien province, North West region. Photo: World Agroforestry/Tran Ha My

II.1.6 TEAK – PLUM – COFFEE – SOYBEAN – FORAGE GRASS

Components	Teak (*Tectona grandis*), plum (*Prunus salicina*), Arabica coffee, forage (guinea) grass, soybean
Design	Strip planting along contour lines: teak and plum trees in rows along contour lines. Rows of the two species alternate, with 10 m distance between rows. Three rows of coffee between rows of teak and plum. Guinea grass in strips close to teak and plum rows. Soybeans in the remaining area within the system
Products	Timber, fruit, coffee cherries, food, fodder
Ecological benefits	Reduced soil erosion compared to sole crop plantation, teak and plum provide shade and windbreak for coffee, carbon sequestration and other ecosystem services thanks to increased tree cover
Tree density (trees ha^{-1})	Teak: 204; plum: 125; coffee: 1680
Experimental sites	North West (Son La)
Plot size	1200 m^2
Production	Plum (5 years old): 1.1 ± 0.5 ton ha^{-1}; coffee (5 years old): 4.2 ± 1.2 ton ha^{-1}; soybean: 0.16 ton ha^{-1}; guinea grass: 14.2 ± 3 ton ha^{-1}
Reference	La et al (2019c)[40]

[40]La N, Pham HT, Do VH, Do TH, Tran HM, Vu TH, Nguyen VT. 2019. Agroforestry technical manual. Option: teak – plum – coffee – soybeans – forage grass. Leaflet. Ha Noi, Viet Nam: World Agroforestry (ICRAF).

Teak - Plum - Arabica coffee - Forage grass in Son La province, North West region. Photo: World Agroforestry/Tran Ha My

II.1.7 ACACIA – MANGO – MAIZE – FORAGE GRASS

Components	Acacia (*Acacia mangium*), mango, forage (mulato) grass, maize
Design	Strip planting along contour lines: acacia and mango trees in rows along contour lines. Rows of the two species alternate, with 10 m distance between rows. Mulato grass in strips close to acacia and mango rows. Maize in the remaining area within the system
Products	Timber, fruit, food, fodder
Ecological benefits	Reduced soil erosion compared to sole crop plantation, acacia improves soil fertility (acacia is an N-fixing species), carbon sequestration and other ecosystem services thanks to increased tree cover
Tree density (trees ha^{-1})	Acacia: 300; mango: 125
Experimental sites	North West (Yen Bai)
Plot size	1200 m^2
Production	Mango (5 years old): 0.15 ton ha^{-1}; maize: 3.4 ton ha^{-1}; mulato grass: 6.5 ton ha^{-1}
Reference	La et al (2019d)[41]

[41]La N, Pham HT, Do VH, Do TH, Tran HM, Vu TH, Nguyen VT. 2019. Agroforestry technical manual. Option: acacia – mango – maize – forage grass. Leaflet. World Agroforestry (ICRAF), Ha Noi, Viet Nam. *http://apps.worldagroforestry.org/region/sea/publications/detail?pubID=4518*

Acacia – Mango – Maize – Forage grass photo in Yen Bai province, North West region. Photo: World Agroforestry/Do Van Hung

Complex agroforestry system in Son La province, North West region. Photo: World Agroforestry/Pham Huu Thuong

II.2. Systems reported in a study of fruit-tree agroforestry in the North West region

Systems with single fruit-tree species

II.2.1 *Docynia indica* – Upland rice

II.2.2 Shan tea – Longan

Systems with multiple fruit-tree species

II.2.3 Fruit trees – Maize – Forage grass

II.2.4 Arabica Coffee – *Docynia indica* – Fruit trees

II.2.5 Plum – Arabica Coffee – Fruit trees – Annual crops

II.2.6 Arabica Coffee – Macadamia – Fruit trees

II.2.7 Arabica Coffee – Longan – Plum – Fruit trees – Honey

II.2.8 Arabica Coffee – *Docynia indica* – Fruit trees

II.2.9 Fruit trees – Arabica Coffee – Annual crops

II.2.1 DOCYNIA INDICA – UPLAND RICE

Components	*Docynia indica* (vernacular name: 'son tra'), upland rice
Design	Rice is planted among rows of docynia
Products	Dried fruits of docynia for medicinal use, food
Net income in 2019[42]	USD 1717 ha^{-1}
Ecological benefits	Carbon sequestration of about 35 ton CO_2e ha^{-1} and other ecosystem services thanks to increased tree cover
Tree density (trees ha^{-1})	Docynia: 350
Study site	North West (Son La)
Plot size	200 m^2
Production (ton ha^{-1})	Docynia (6 years old): 6.7; upland rice: N/A
Reference	Nguyen et al (2020)[43]

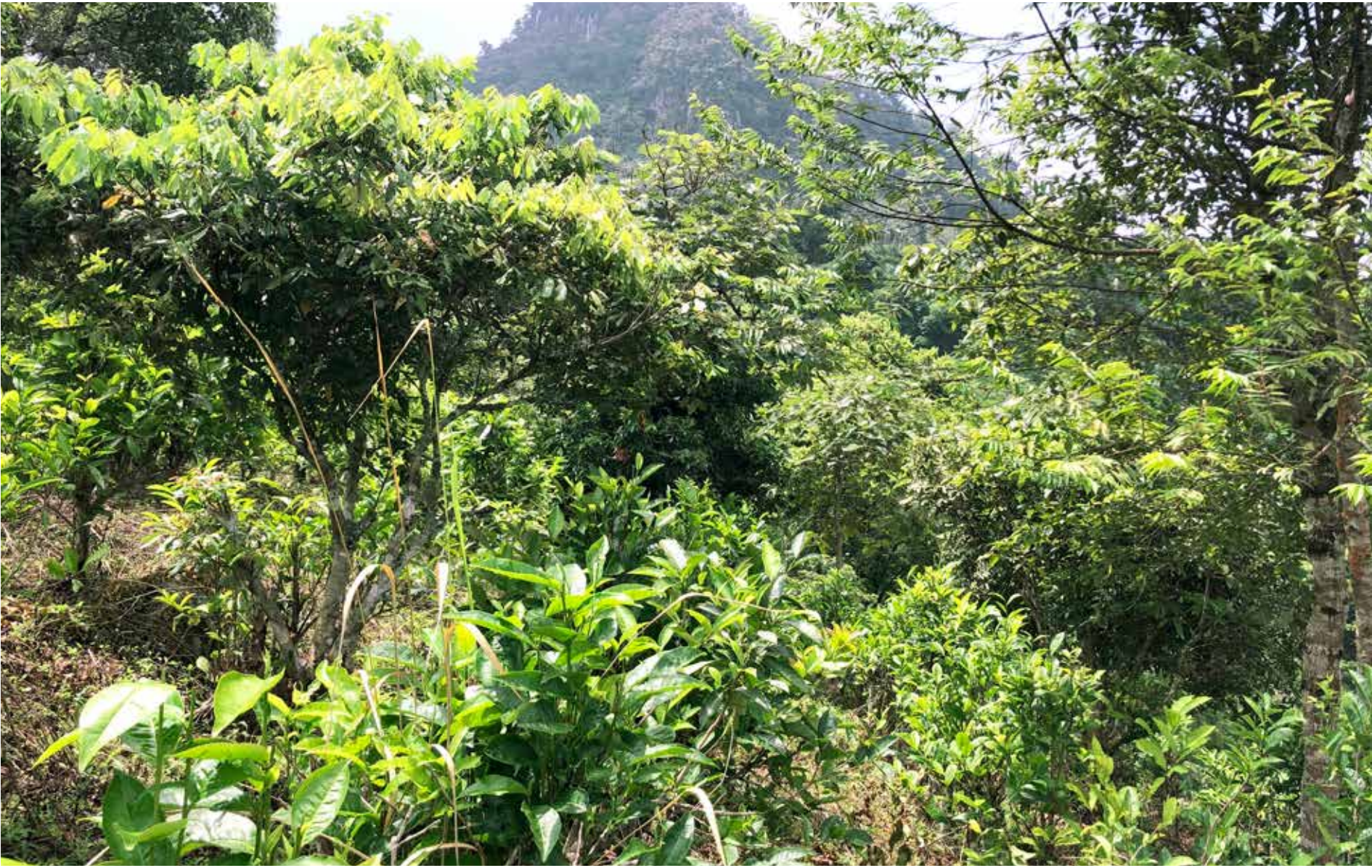
[42]All economic values in this section use the rate USD 1 = VND 23,000

[43]Nguyen MP, Mulia R, Nguyen QT. 2020. *Báo cáo kỹ thuật: Hệ thống Nông lâm kết hợp với cây ăn quả ở Tây Bắc Việt Nam: Các hệ thống điển hình và lợi ích.* Technical report: agroforestry system with fruit trees in Northwest Viet Nam: typical systems and benefits. Ha Noi, Viet Nam: World Agroforestry (ICRAF).

Docynia indica - Upland rice in Son La province, North West region. Photo: World Agroforestry/Nguyen Mai Phuong

II.2.2 SHAN TEA – LONGAN

Components	Shan tea *(Camellia sinensis var. Shan),* longan
Design	Shan tea in rows with scattered longan trees
Products	Tea leaves, fruit
Net income in 2019	USD 674 ha^{-1}
Ecological benefits	Longan provides shade and windbreak for tea, carbon sequestration of about 140 ton CO_2e ha^{-1} and other ecosystem services thanks to increased tree cover
Tree density (trees ha^{-1})	Shan tea: 6850; longan: 260
Study site	North West (Yen Bai)
Plot size	300 m^2
Production (ton ha^{-1})	Fresh shan tea (20 years old, some over 100 years old): 1.1; Longan (12 years old): 0.8
Reference	Nguyen et al (2020)



Shan tea - Longan in Yen Bai province, North West region. Photo: World Agroforestry/Nguyen Mai Phuong

II.2.3 FRUIT TREES – MAIZE – FORAGE GRASS

Components	Plum, mango, longan, pomelo, maize, forage grass
Design	Plum and mango are planted in rows adjacent to grass strips, with maize in the remaining space within the plot from June to October. Longan and pomelo are scattered over the plot
Products	Fruit, food, fodder
Net income in 2019	USD 1518 ha^{-1}
Ecological benefits	Carbon sequestration of about 57 ton CO_2e ha^{-1} and other ecosystem services thanks to increased tree cover
Tree density (trees ha^{-1})	Plum: 40; mango: 80; longan: 25; pomelo: 2
Study site	North West (Son La)
Plot size	1 ha
Production (ton ha^{-1})	Plum (5 years old): 0.5; mango (5 years old): 0.7; maize: 7
Reference	Nguyen et al (2020)

Mango/Longan/Plum – Maize – Forage grass in Son La province, North West region. Photo: World Agroforestry/Tran Ha My

II.2.4 ARABICA COFFEE – DOCYNIA INDICA – FRUIT TREES

Components	Arabica coffee, *Docynia indica* (vernacular name: 'son tra'), fruit trees such as mango and peach
Design	Coffee planted in rows with scattered docynia and fruit trees
Products	Coffee cherries, fruits, dried fruits from docynia for medicinal use
Net income in 2019	USD 2700 ha^{-1}
Ecological benefits	Docynia and fruit trees provide shade and windbreak for coffee, carbon sequestration of about 62 ton CO_2e ha-1 and other ecosystem services from increased tree cover
Tree density (trees ha^{-1})	Coffee: 1460; docynia: 50; mango: 30; peach: 10
Study site	North West (Dien Bien)
Plot size	1 ha
Production (ton ha^{-1})	Docynia (9 years old): 10.5; other crops not yet productive
Reference	Nguyen et al (2020)

Coffee - *Docynia indica* - Fruit trees in Dien Bien province, North West region. Photo: World Agroforestry/Nguyen Mai Phuong

II.2.5 PLUM – ARABICA COFFEE – FRUIT TREES – ANNUAL CROPS

Components	Plum, Arabica coffee, other fruit trees such as mango and peach, annual crops such as taro
Design	Coffee planted in rows with scattered fruit trees and annual crops such as taro as understorey
Products	Coffee cherries, fruits, food
Net income in 2019	USD 2170 ha^{-1}
Ecological benefits	Fruit trees provide shade and windbreak for coffee, carbon sequestration of about 62 ton CO_2e ha^{-1} and other ecosystem services thanks to increased tree cover
Tree density (trees ha^{-1})	Coffee: 2000; plum: 75; mango: 50; peach: 40
Study site	North West (Son La)
Plot size	4000 m^2
Production (ton ha^{-1})	Coffee (7 years old): 1.5; plum (20 years old): 6.2; mango (4 years old): 1.8
Reference	Nguyen et al (2020)

Plum - Coffee - Fruit trees - Annual crops in Son La province, North West region. Photo: World Agroforestry/Nguyen Mai Phuong

II.2.6 ARABICA COFFEE – MACADAMIA – FRUIT TREES

Components	Arabica coffee, macadamia and fruit trees such as jackfruit, longan, mango and peach
Design	Coffee planted in rows with scattered macadamia and fruit trees
Products	Coffee cherries, nuts, fruits
Net income in 2019	USD 622 ha^{-1}
Ecological benefits	Macadamia and fruit trees provide shade and act as a windbreak for coffee, carbon sequestration of about 20 ton CO_2e ha^{-1} and other ecosystem services thanks to increased tree cover
Tree age (years)	Macadamia: 5; coffee: 7; jackfruit: 4; guava: 2; plum: 2; longan: 2; peach: 2
Tree density (trees ha^{-1})	Coffee: 750; macadamia: 110; longan: 80; jackfruit: 30; pomelo: 30; peach: 20; lime: 20; plum: 10; guava: 10
Study site	North West (Dien Bien)
Plot size	1000 m^2
Production (ton ha^{-1})	Coffee: 2.3; macadamia: 0.2 (not for sale); jackfruit: 3.6 (not for sale). Other fruit trees not yet productive
Reference	Nguyen et al (2020)

Coffee - Macadamia - Fruit trees in Dien Bien province, North West region. Photo: World Agroforestry/Nguyen Mai Phuong

II.2.7 ARABICA COFFEE – LONGAN – PLUM – FRUIT TREES – HONEY

Components	Arabica coffee, longan, plum and other fruit trees, such as mango and pomelo, and bee keeping
Design	Coffee planted in rows with scattered fruit trees, with bee keeping under fruit trees
Products	Coffee cherries, fruits, honey
Net income in 2019	USD 7826 ha^{-1}
Ecological benefits	Fruit trees provide shade and act as a windbreak for coffee, carbon sequestration of about 248 ton CO_2e ha^{-1} and other ecosystem services thanks to increased tree cover
Tree age (years)	Coffee: 13; longan: 26; plum: 22; pomelo: 10; other fruit trees, such as mango, jackfruit, guava and starfruit were generally 3 years old
Tree density (trees ha^{-1})	Coffee: 1110; longan: 170; plum: 135; mango: 80; pomelo: 50; other fruit trees, such as guava, jackfruit and starfruit: 5
Study site	North West (Son La)
Plot size	4000 m^2
Production (ton ha^{-1})	Coffee: 2.5; longan: 1.8; plum: 2.5; pomelo: 1.25 (not for sale)
Reference	Nguyen et al (2020)

Arabica coffee - Longan - Plum - Fruit trees - Honey in Son La province, North West region.
Photo: World Agroforestry/Nguyen Mai Phuong

II.2.8 ARABICA COFFEE – DOCYNIA INDICA – FRUIT TREES

Components	Arabica coffee*, Docynia indica* (vernacular name: 'son tra') and fruit trees such as mango, peach, pomelo, *Pyrus granulosa*
Design	Coffee planted in rows with scattered fruit trees
Products	Coffee cherries, fruits
Net income in 2019	USD 1987 ha^{-1}
Ecological benefits	Fruit trees provide shade and windbreak for coffee, carbon sequestration of about 51 ton CO_2e ha^{-1} and other ecosystem services thanks to increased tree cover
Tree age (years)	Coffee: 20; docynia: 20; peach: 10–20; pomelo: 20
Tree density (trees ha^{-1})	Coffee: 85; docynia: 20; peach: 115; pomelo: 25; pyrus: 10; mango: 10; guava: 5; mango: 5
Study site	North West (Dien Bien)
Plot size	3500 m^2
Production (ton ha^{-1})	Coffee: 4.5; docynia: 2.3
Reference	Nguyen et al (2020)

Coffee - *Docynia indica* - Fruit trees in Dien Bien province, North West region.
Photo: World Agroforestry/Nguyen Mai Phuong

II.2.9 FRUIT TREES – ARABICA COFFEE – ANNUAL CROPS

Components	Arabica coffee, fruit trees such as longan and plum, and vegetables
Design	Coffee planted in rows with scattered fruit trees and strips of vegetables in remaining areas within the plot
Products	Coffee cherries, fruits, food
Net income in 2019	USD 6361 ha^{-1}
Ecological benefits	Fruit trees provide shade and act as a windbreak for coffee, carbon sequestration of about 238 ton CO_2e ha^{-1} and other ecosystem services thanks to increased tree cover
Tree age (years)	Coffee: 10; longan: 30; plum: 19; pomelo: 4; mango: 4; apple: 3; lychee: 3; peach: 3; guava: 3
Tree density (trees ha^{-1})	Coffee: 3110; longan: 330; plum: 270; pomelo: 210; mango: 170; lychee: 30; guava: 20; peach: 10
Study site	North West (Son La)
Plot size	6000 m^2
Production (ton ha^{-1})	Coffee: 5; longan: 5; plum: 5; pomelo: 1.5 (not for sale)
Reference	Nguyen et al (2020)

Fruit trees - Arabica coffee - Annual crops in Son La province, North West region.
Photo: World Agroforestry/Nong Lam University, Ho Chi Minh City

II.3. Systems reported in a study of agroforestry's contribution to Viet Nam's NDC

System Region (province)*	Perennial crop components	Annual crop components	Total area in the province in 2018 (ha)
Timber tree-based systems			
Red River Delta (Ninh Binh)	*Acacia mangium*	Cassava, peanut, beans	973
North East (Ha Giang)	*Acacia mangium* or hybrid	Cassava, upland rice, and/ or turmeric	744
North Central Coast (Nghe An)	*Acacia mangium* or hybrid	Cassava, pineapple, peanut, Dianella ensifolia	700
South East (Ba Ria Vung Tau)	Big timber such as *Afzelia xylocarpa, Hopea odorata, Terminalia* sp, *Pterocarpus macrocarpus* or *Lagerstroemia* sp	Cassava or maize	700
Mekong River Delta (Ca Mau)	Acacia hybrid	Banana, bean, peanut etc	420
South Central Coast (Quang Nam)	*Acacia mangium*	Upland rice	400
North Central Coast (Ha Tinh)	Acacia hybrid	Cassava	150
North West (Lai Chau)	Forest trees	*Amomum auranticacum* under forest canopy	74

System Region (province)*	Perennial crop components	Annual crop components	Total area in the province in 2018 (ha)
Fruit tree-based systems			
Red River Delta (Ninh Binh)	Pomelo, sugar apple or lychee	Pineapple	1200
North Central Coast (Hoa Binh)	Citrus trees (orange, pomelo)	Fabaceae (e.g. peanut, soybean), small taro (*Colocasia esculenta*), Cucurbitaceae (e.g. pumpkin)	700
North Central Coast (Thanh Hoa)	Fruit trees (longan, lychee, pomelo, dragon fruit)	Mixed annual crops	211
North West (Lai Chau)	Orange	Soybean, peanut	51
Industrial tree crop-based systems			
North West (Yen Bai)	Cinnamon *(Cinnamomum verum)*	Cassava	932
North Central Coast (Quang Binh)	Rubber	Watermelon, cassava, peanut, lemongrass	220
North East (Lang Son)	Cinnamon	Cassava, upland rice	129

*ordered by total area in the province

Orange - *Arachis pintoi* system in Ha Tinh province, North Central Coast region. Photo: World Agroforestry/Tran Ha My

II.4. Systems reported in a climate-smart agriculture project

II.4.1 Orange – Annual crops – Forage grass

II.4.2 *Wrightia annamensis* – Black pepper – Forage grass

II.4.1 ORANGE – ANNUAL CROPS – FORAGE GRASS

Components	Grafted orange (Chanh, Bu or V2 varieties), *Arachis pintoi* and/or guinea grass, and seasonal annual crops for the first 2–3 years, such as peanut, bean, vegetables and ginger
Design	Contour plantation of orange with 4 x 5 m spacing and grass strips
Products	Fruits, food, fodder
Average annual income	USD 5285 ha^{-1}
Ecological benefits	Reduced soil erosion, increased recycled crop residue, reduced burning of crop residue, carbon sequestration, improved soil nutrient levels (*A. pintoi* is an N-fixing understorey plant) and other ecosystem services thanks to increased tree cover
Tree density (trees ha^{-1})	Orange: 500
Study site	North Central Coast (Ha Tinh)
Production	Orange: 10–20 ton ha^{-1} at peak production; grass: 40–60 ton ha^{-1}, *Arachis pintoi:* up to 150 ton ha^{-1}
Reference	Le and Simelton (2018)[44]

[44]Le TT, Simelton E. 2018. Portfolio of CSA practices for scaling. No. 1. Wageningen, Netherlands: CGIAR Research Program on Climate Change, Agriculture and Food Security. *https://ccafs.cgiar.org/resources/publications/portfolio-csa-practices-scaling*

Orange – Annual crops – Forage grass photo in Ha Tinh province, North Central Coast region.
Photo: World Agroforestry/Pham Duc Thanh

II.4.2 WRIGHTIA ANNAMENSIS – BLACK PEPPER – FORAGE GRASS

Components	*Wrightia annamensis* trees, black pepper cuttings, *Arachis pintoi* and vermiculture
Design	*W. annamensis* with 2.5 x 2.5 m spacing as shade and support trees for black pepper
Products	Pepper, fodder
Average annual income	USD 652 ha^{-1}
Ecological benefits	*W. annamensis* provides shade for pepper, carbon sequestration, improved soil nutrient levels (*A. pintoi* is an N-fixing understorey plant) and other ecosystem services thanks to increased tree cover
Tree density (trees ha^{-1})	Wrightia: 1600
Study site	North Central Coast (Ha Tinh)
Production	0.8 kg dried seed per seedling in Year 1 and 1–1.5 kg dried seed per seedling per year in years 6 to 11; *Arachis pintoi:* up to 150 ton ha^{-1}
Reference	Le and Simelton (2018)

Wrightia annamensis – Black pepper – Forage grass photo in Ha Tinh province, North Central Coast region.
Photo: World Agroforestry/Le Thi Tam

50 ha agroforestry in Dien Bien province, North West region. World Agroforestry/Tran Ha My

PART III

Other agroforestry practices in Viet Nam reported in the literature

The practices reported in the reviewed literature are all at plot scale. Therefore, no information on total expansion area in a province is available. Several studies reported the productivity of a system's components and potential income. This information can be obtained through the references provided in the table below. We included information on home gardens in the category of 'complex agroforestry systems' but could not list the system components owing to their great diversity. References to the home garden studies are also provided.

System Region (province)	Perennial crop components	Other (short-term crop/ livestock) components	Source
Fruit-tree-based systems			
North West (Yen Bai)	Longan	Maize	Hoang Thi Lua et al (2017)[45]
North West (Yen Bai)	Orange	Maize, ginger	Hoang Thi Lua et al (2017)
North West (Son La)	Pomelo or persimmon	Lemon, ginger	Hoang Thi Lua et al (2017)
North West (Son La)	Longan	Cassava, banana	Hoang Thi Lua et al (2017)
North West (Son La)	*Docynia indica*	Maize, upland rice, or amomum	Hoang Thi Lua et al (2017)
North West (Son La)	Persimmon, peach, longan, mango	Mustard, maize, or cassava	Hoang Thi Lua et al (2017)

[45] Hoang LT, Roshetko JM, Pham HT, Pagella T, Nguyen MP. 2017. Agroforestry: the most resilient farming system for the hilly Northwest of Viet Nam. *International Journal of Agricultural Systems* 5(1):1–23.

System Region (province)	Perennial crop components	Other (short-term crop/ livestock) components	Source
Commercial-tree-crop-based systems			
Central Highlands (Dak Lak)	Cashew	Squash, green bean, maize	VNAFE (2008)[46]
Central Highlands (Dak Lak)	Robusta coffee, pepper, durian, *Areca catechu*, fruit tree (e.g. durian)	Annual crops: maize, green bean Livestock: chicken	VNAFE (2008)[47]
North West (Yen Bai)	Tea, hybrid eucalyptus, *Acacia mangium*, longan, *Melia azedarach*	Maize, banana	Hoang Thi Lua et al (2017)
North West (Son La)	Arabica coffee with fruit trees (longan, mango, custard apple, plum etc)	With or without short-term crops (cassava, ginger)	Hoang Thi Lua et al (2017)
North West (Son La)	Arabica coffee with timber trees (e.g. hybrid eucalyptus, *Chukrasia tabularis*, Acacia sp, *Michelia mediocris Dandy, Zanthoxylum rhetsa* (Roxb) DC, *Leucaena glauca*	With or without short-term crops (cassava, ginger)	Hoang Thi Lua et al (2017)
North West (Lang Son)	Star anise (*Illicium verum*) and tea	-	Hoang Van Thanh et al (2015)[48]
North East (Tuyen Quang)	*Melia azedarach*	Cassava	Hoang Van Thanh et al (2015)

[46] [VNAFE] Vietnam Network for Agroforestry Education. 2008. *Agroforestry practical models in Viet Nam*. Vietnam Network for Agroforestry Education. Productivity (ton ha^{-1} $year^{-1}$) reported by the publication: cashew 0.2; squash 28; maize 8.5; green bean 2.3.

[47] Productivity (ton ha^{-1} $year^{-1}$) reported by the publication: coffee 5; pepper 1; durian 6.

[48] Hoang VT, Tran VD, Kozan O, Catacutan DC. 2015. Cost-benefit analysis for agroforestry systems in Viet Nam. *Asian Journal of Agricultural Extension, Economics and Sociology* 5(3):158–165.

System Region (province)	Perennial crop components	Other (short-term crop/ livestock) components	Source
Complex agroforestry systems			
North East (Thai Nguyen)	Acacia, eucalyptus, *Schima wallichii* Choisy, *Canarium album*, bamboo, palm, jackfruit, longan, litchi, pomelo, tea, coconut	Annual crops: banana, ginger, cassava, sweet potato, pineapple, rice, sweet potato, bean Livestock: chicken, pig, buffalo, fish	VNAFE (2008)[49]
North Central Coast (Thua Thien Hue)	Home garden with diverse tree species	Diverse annual crop species	Vu et al (2015)[50]
North Central Coast (Thua Thien Hue)	Home garden with diverse tree species	Diverse annual crop species	Vlkova et al (2010)[51]
Red River Delta (Ninh Binh), North Central Coast (Nghe An), South East (Binh Duong), Mekong River Delta (Can Tho)	Home garden with diverse tree species	Diverse annual crop species	Trinh et al (2003)[52]
North East (Tuyen Quang)	Home garden with diverse tree species	Diverse annual crop species	Timsuksai et al (2015)[53]

[49]Productivity (ton ha^{-1} $year^{-1}$) reported by the publication: tea 6.4; rice 1.4; maize 1.5; lychee 0.64; longan 0.36; ginger 0.31. Other components: timber 7 m^3 ha^{-1} $year^{-1}$; firewood 3 m^3 ha^{-1} $year^{-1}$; palm leaves 700 leaves ha^{-1} $year^{-1}$

[50]Vu TM, Mizuno K, Funakawa S, Shinjo H, Tanaka U, Le VA. 2015. Home garden practices and crop contribution to livelihood in mountainous villages in Central Viet Nam. *Tropical Agriculture and Development* 59(3):118–126.

[51]Vlkova M, Polesny Z, Verner V, Banout J, Dvorak M, Havlik J, Lojka B, Ehl P, Krausova J. 2010. Ethnobotanical knowledge and agrobiodiversity in subsistence farming: case study of home gardens in Phong My commune, central Viet Nam. *Genetic Resources and Crop Evolution* 58:629–644 (2011). DOI: 10.1007/s10722-010-9603-3.

[52]Trinh LN, Watson JW, Hue NN, De NN, Minh NV, Chuf P, Sthapit BR, Eyzaguirre PB. 2003. Agrobiodiversity conservation and development in Vietnamese home gardens. *Agriculture, Ecosystems and Environment* 97:317–344.

[53]Timsuksai P, Nguyen DT, Rambo AT. 2015. Home garden of the Cao Lan, a Tai-speaking ethnic minority in Vietnam's northern mountains. *Southeast Asian Studies* 4(2):365–383.

Nearly 300 farmers joined cross learning in agroforestry landscape in Son La province. Photo: Vietnam Academy of Forest Science/Le Thi Hanh

Constraints to agroforestry development

Despite its proven and potential benefits, the wide-scale adoption of agroforestry in Southeast Asia, including in Viet Nam, remains limited. Constraints include insecurity of land tenure, lack of market access for agroforestry products, lack of quality planting material, and absence of financial support for farmers to establish systems[54]. Notwithstanding, amongst the various constraints, the absence of specific and adequate policies on agroforestry is deemed as the prime barrier to wide-scale agroforestry development[55]. The existence of such policies can enhance co-investment and efforts in:

- eliminating legal and institutional constraints to agroforestry;
- disseminating positive outcomes of agroforestry to the whole country; and
- compensating farmers for the delay in investment returns.

The Ministry of Agriculture and Rural Development has established a national Technical Agroforestry Working Group. One of its first tasks was to review agroforestry-related support in existing agricultural and forestry policies of Viet Nam. Recently, development of specific policies for agroforestry has taken a further step through a knowledge exchange between Government representatives of Viet Nam, India, and Nepal. The exchange was facilitated by ICRAF South Asia and ICRAF Viet Nam and focused on the necessary steps for developing and promulgating agroforestry policies with lessons learned from India and Nepal, the first and second nations, respectively, to adopt national agroforestry policies. India promulgated its policy in 2014 and Nepal in 2019. Knowledge will be further strengthened through a planned return visit by representatives of the Government of Viet Nam to India to identify the necessary steps for developing and promulgating agroforestry policy in Viet Nam. Owing to the covid-19 pandemic, the visit has been delayed but is still on the Government's agenda, to be facilitated again by ICRAF Viet Nam and ICRAF South Asia.

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[54]See Catacutan DC, van Noordwijk M, Nguyen TH, Öborn I, Mercado AR. 2017. *Agroforestry: contribution to food security and climate-change adaptation and mitigation in Southeast Asia*. White Paper. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program; Jakarta, Indonesia: ASEAN-Swiss Partnership on Social Forestry and Climate Change. *https://apps.worldagroforestry.org/region/sea/publications/detail?pubID=4231.*

[55][FAO] Food and Agriculture Organization of the United Nations. 2013. *Advancing agroforestry on the policy agenda: a guide for decision-makers*. Buttoud G with Ajayi O, Detlefsen G, Place F, Torquebiau E. Agroforestry Working Paper no. 1. Rome, Italy: Food and Agriculture Organization of the United Nations.

For Southeast Asia, the *ASEAN Guidelines for Agroforestry Development* were published in 2018[56] to foster a greater collaboration among member states in sharing technical and policy development issues related to agroforestry. In addition, the *Guidelines* emphasize the need to establish other enabling conditions for agroforestry development at the regional level, such as increased trans-border trade in agroforestry products.

[56]Catacutan DC, Finlayson RF, Gassner A, Perdana A, Lusiana B, Leimona B, Simelton E, Öborn I, Galudra G, Roshetko JM, Vaast P, Mulia R, Lasco RL, Dewi S, Borelli S, Yasmi Y. 2018. *ASEAN Guidelines for Agroforestry Development*. Jakarta, Indonesia: ASEAN Secretariat.*http://www.worldagroforestry.org/publication/asean-guidelines-agroforestry-development*

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