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STATE AND OUTLOOK OF AGROFORESTRY IN ASEAN:

Status, Trends and Outlook 2030 and beyond


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Forests, Trees and Agroforestry

State and Outlook of Agroforestry in ASEAN: Status, Trends and Outlook 2030 and beyond

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Foreword

This report is the first of its kind, and we are very pleased to endorse the implementation of its recommendations by the ASEAN Member States. The report stems from adopting the *ASEAN Guidelines for Agroforestry Development* at the 40th Meeting of ASEAN Ministers on Agriculture and Forestry in Ha Noi, Viet Nam, in October 2018. The *Guidelines* themselves were a world first. We would like to acknowledge the consistent support of the Food and Agriculture Organization of the United Nations in the process of bringing agroforestry into the mainstream of Member States, recognizing the critical role that agroforestry plays in food security, environmental and biodiversity conservation, improvement of livelihoods and mitigation of, and adaptation to, climate change. We would like to thank the coordinators of this report, especially World Agroforestry and the Southeast Asian Regional Center for Graduate Study and Research in Agriculture, and the many contributors, including the focal points of the ASEAN Working Group on Social Forestry, for their timely and insightful work that will help guide the Southeast Asian region through the coming decade and beyond. We acknowledge that this first report on the status, trends and outlook for agroforestry is neither complete nor comprehensive but will serve as a baseline for regular reporting by the Member States in the future. We urge all stakeholders to read the report closely and act on its recommendations.

ASEAN Senior Officials of Forestry

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Acronyms and abbreviations

AMAF	ASEAN Ministers of Agriculture and Forestry
AMS	ASEAN Member States
ASEAN	Association of South-East Asian Nations
ASFCC	ASEAN-Swiss Partnership on Social Forestry and Climate Change
AWG-SF	ASEAN Working Group on Social Forestry
CBFM	Community-Based Forest Management
CGIAR	Consultative Group on International Agricultural Research
COVID-19	Coronavirus Disease 2019
FAO	Food and Agriculture Organization of the United Nations
GAP	Good Agricultural Practices
GDP	Gross Domestic Product
GHG	Greenhouse gas(es)
ha	hectares(s)
ICRAF	World Agroforestry
IPBES	Intergovernmental Science–Policy Platform on Biodiversity and Ecosystem Services
m	metre(s)
NDCs	Nationally Determined Contributions
PES	Payment for Ecosystem Services
REDD+	Reducing Emissions from Deforestation and Forest Degradation Plus
SDGs	Sustainable Development Goals
SEANAFE	Southeast Asian Network for Agroforestry Education
SEARCA	Southeast Asian Regional Center for Graduate Study and Research in Agriculture
t CO2e	tonnes of CO_2 equivalent
TOF	trees outside forests
TCP	Technical Cooperation Programme
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States Dollar(s)

About this report

This report was commissioned by the Food and Agriculture Organization of the United Nations under a Technical Cooperation Programme with ASEAN: Scaling up Agroforestry for Livelihoods and Environmental Benefits in ASEAN. The study and publication of this report were coordinated by World Agroforestry and the Southeast Asian Regional Center for Graduate Study and Research in Agriculture. The report preparation benefited from additional funding and technical support from the CGIAR Research Program on Forests, Trees and Agroforestry. This report is neither complete nor comprehensive but provides an overview of the advances in and ongoing challenges to agroforestry development and research in ASEAN, primarily centring on initiatives over the last two decades (2000–2020). The report covers a range of thematic areas, from landscape restoration and climate change adaptation and mitigation through governance to knowledge hubs as a means to identify opportunities and gaps in creating pathways for agroforestry uptake.

Since agroforestry is not included in national reporting by either the forestry or agricultural sectors, this report has relied on primary analyses drawn from the literature, contributions from agroforestry researchers and expert practitioners, and survey data gathered from delegates the ASEAN Working Group on Social Forestry. By focusing on gaps and opportunities in agroforestry landscapes, the report presents recommendations pertinent to the needs and interests of ASEAN Member States. To this end, the report aims to motivate actions among ASEAN Ministers and Senior Officials of Agriculture and Forestry along with local resource users, the private sector, researchers and others in expanding the scale of sustainable natural resource management through agroforestry. The outcomes of these actions will contribute to the Sustainable Development Goals, Paris Agreement and other societal targets for environmental and human well-being.

Acknowledgements

We acknowledge the inspiration and funding support of the Food and Agriculture Organization of the United Nations, the CGIAR Research Program on Forests, Trees and Agroforestry and the Southeast Asian Regional Center for Graduate Study and Research in Agriculture. We also acknowledge the critical contributions of the Food, Agriculture and Forestry Division of the ASEAN Secretariat and the focal points of the ASEAN Working Group on Social Forestry. Special thanks are reserved for the contributors to this report and the writing and editing team.

Highlights

- Agroforestry is expanding in Southeast Asia. Over the last decade, trees outside forests have increased three times greater than trees inside forests across the Mekong Region, indicating a reversal in deforestation. These gains mostly occurred on croplands, grasslands and settlements. Despite this increase, agroforestry is missing in national accounting systems. A land-use classification and operational definition of agroforestry are necessary to monitor changes.

- Without an institutional home, agroforestry will remain at the periphery of the agri-food, forest and land-use sectors. National policies and programming for agroforestry will help clarify overlapping and conflicting land-use policies and provide social protection to smallholders and community forest users engaged in tree-based systems and related practices in and outside forests.

- A regional analysis of agroforestry practices shows similarities in approaches across Southeast Asia, highlighting the wider adaptability of these practices and the utility of establishing a regional knowledge management system to extract and build on lessons learned.

- The costs of environmental disasters in the region between 2000 and 2020 were more than USD 122 trillion, affecting over 324 million people. Growing trees can stabilize food supplies and incomes through diversification and provide physical protection against extreme weather events. Smallholders are increasingly adopting agroforestry to mitigate and adapt to climate change.

- Three ASEAN Member States have explicitly mentioned agroforestry in their Nationally Determined Contributions to the United Nations Framework Convention on Climate Change. With the exception of Singapore and Brunei Darussalam, Member States have included agroforestry in national forestry and agricultural development programmes. Of these programmes, Lao PDR, Myanmar, the Philippines and Viet Nam have explicit agroforestry-related targets. While agroforestry is greatly supported in Indonesia and Cambodia's social forestry programmes, no targets were set; This is the same case in Thailand, which have included agroforestry in sustainable agriculture. These developments indicate pathways for which ASEAN decision-makers can forge synergies between sustainable land use and climate-change mitigation and adaptation.

- Public-private partnerships can help capitalize on the opportunities of using agroforestry to achieve national and international targets for climate change and economic development. Agroforestry can serve as an entry point for most links between the Sustainable Development Goals and Nationally Determined Contributions.

- Increased recognition of agroforestry's role in addressing climate change, food insecurity and land degradation and the shift toward sustainable business models and community forestry schemes have increased demand for agroforestry experts. However, agroforestry education programmes in the region remain scarce. Building on the progress of regional and national agroforestry education networks can accelerate progress toward meeting this demand.

- Of the 17 Sustainable Development Goals, only five have been specifically targeted in agroforestry projects in ASEAN. Nearly all projects focused on Goal 2, no hunger (68%) and Goal 15, life on land (30%). Funding for agroforestry needs to be broadened to provide feasible pathways for achieving multiple societal goals at once.

- Excluding Brunei Darussalam and Singapore, AMS captured USD 27.48 million or 19.17% of the total global donor spending on agroforestry projects. Exploring ways to make carbon a viable commodity under market-based approaches can encourage ASEAN stakeholders to invest in agroforestry landscapes.

- Limited incentives and financing mechanisms currently exist for agroforestry. Technical and resource support is critical, given that benefits from agroforestry accrue progressively over time. Emphasis needs to be placed on commodity value-chains. Policymakers and practitioners should promote agroforestry in third-party certification programmes to increase smallholders' access to stable markets.

- As a research discipline, agroforestry has undergone progressive changes focusing on plot-level interactions to ecosystem and landscape interactions. Researchers should place more attention on policy, gender roles and geographic gaps in outputs. Indonesia has published the most agroforestry publications, followed by the Philippines and Thailand, while Cambodia, Lao PDR and Myanmar have produced the least.

- Agroforestry policy and programming are needed at national and regional levels to support ASEAN's vision and goals. Recent agri-food system shocks and the COVID-19 pandemic have revealed the fragility of regional supply and value chains.

- Under ASEAN bodies, decision-makers can pool available resources to support agroforestry development to directly contribute to the regional vision of making ASEAN a global agri-food competitor. A coordinated and targeted strategy on this front will help ensure the development and implementation of appropriate agroforestry models for various locations.

- The underlying framework for advancing agroforestry development already exists in most countries. The presence of an agroforestry agency, the development of agroforestry roadmaps, programmes and the availability of financing mechanisms can be used as indicators to measure the progress of agroforestry development in ASEAN.

SECTION I: Introduction

Chapter 1. Transforming challenges into agroforestry opportunities

Key messages

- Trees play a large role in building the resilience of the ASEAN agri-food systems. While Southeast Asia has about one-third of global agricultural land covered with at least 30% tree cover, national reporting of agroforestry and/or trees outside forests lack. To maximize the benefits of agroforestry, ASEAN policymakers should establish institutions and accurate baselines to make agroforestry visible as a step towards supporting and governing them.

- Certification of sustainable products and deforestation-free business models encourages agroforestry to preserve the natural environment and enhance local livelihoods. By building the technical capacity of smallholders, ASEAN leaders can revitalize degraded forestland while improving local livelihoods.

- Through the *ASEAN Guidelines for Agroforestry Development*, agroforestry contributes to the regional vision of economic and social prosperity and pathways to transform business-as-usual activities in the post-pandemic world.

Agroforestry can support opportunities for building multifunctional landscapes

Environmental and social concerns about the current state of natural resources in ASEAN call for an integrated agricultural and forestry management approach. Increasing trees in agricultural landscapes can help shift the focus from input-intensive monocultural agriculture to knowledge-intensive forms. Agroforestry builds on traditional and scientific knowledge to develop land-use models appropriate for local contexts. These models provide benefits that counter many of the adverse human health and environmental outcomes of input-intensive monoculture, including soil erosion, water contamination and climate disturbances. Agroforestry benefits range from biodiversity conservation through carbon sequestration and household food security to preserving socio-cultural values.

Smallholders in Southeast Asia have widely practised agroforestry for centuries. These practices have continued to evolve since the scientific acknowledgement of agroforestry in the late 1970s through World Agroforestry (ICRAF). ICRAF remains the only major institution devoted exclusively to agroforestry research. Issues raised by agroforestry researchers and practitioners in the past are similar to today. However, significant changes in the type and magnitude of factors affecting landscapes: less availability of arable land, livelihoods' concerns in sustainable forest management, and uncertainty of the weather, for example, has broadened the scope of agroforestry interventions.

With less than 8% of the global agricultural land base, Southeast Asia has 14.7% and 28.9% of such land with at least 10% and 30% tree cover, respectively (van Noordwijk et al. 2019). Agroforestry thus plays a significant role in achieving climate-change adaptation and mitigation targets and related objectives of the Sustainable Development Goals (SDGs). However, measuring the coverage of trees on agricultural land and agroforestry integration in community-managed forests is required as the basis for the proper management of agroforestry. Establishing accurate baselines can support investments in agroforestry as well as creating synergies between land-use activities.

Why an institutional bridge across the agriculture and forestry divide is needed

Despite various ministries and departments promoting agroforestry, no policy nor institution in any ASEAN Member State (AMS) exists to govern agroforestry. Separate agencies carry out Land-use policies on agriculture and forestry, and rarely collaboratively. Consequently, overlapping and sometimes contradictory rules and regulations increase, hindering tenure security and smallholders' roles in timber markets, for example. The lack of legal protection for tree-based farming is a deterrent to agroforestry adoption. Compared to monocultures of annual food crops, such as rice and maize, or tree crops, such as coffee, cocoa, rubber and oil palm, which have sophisticated market systems, financing options for agroforestry are limited. Without introducing policy reforms and establishing an institutional authority for mixed-land-use farming, business-as-usual activities will continue, and land degradation will likely go unaddressed, missing enormous opportunities for smallholders and society at large.

Providing land titles to smallholders so they can access credit and resources is critical to advancing agroforestry. Land degradation, which is one of the many symptoms of conventional farming, can be curbed by securing land tenure for agroforestry. Case studies across the region demonstrate the mutual benefits of agroforestry to land-use managers and local resource users in improving livelihoods and reducing deforestation. Within the purview of an institutional home for agroforestry, extension personnel can provide technical support to strengthen smallholders' adaptive capacity to unexpected agri-food system shocks such as the COVID-19 pandemic.

Tackling the COVID-19 pandemic and agri-food system shocks

There were over 3.4 million cases of COVID-19 in ASEAN as of 30 April 2021 (Johns Hopkins University 2021). Over the last six decades, Jones et al. (2008) found that most emerging infectious diseases were of wildlife origin. This outcome suggests the direct association between anthropogenic activities in formerly natural habitats and the frequency of emerging disease hotspots. The adverse impacts of COVID-19 strengthen the view that business-as-usual is no longer viable, as articulated in the ASEAN Comprehensive Recovery Framework and Implementation Plan. Establishing biodiversity corridors under agroforestry can create farm sanctuaries to conserve the rich wildlife diversity in Southeast Asia. The effect on the likelihood of the future emergence of zoonotic diseases is under discussion (Daguma et al., 2021).

Agroforestry can also reset ASEAN economies by shortening supply chains and creating durable assets to strengthen resilience against future shocks. In a recent study by Facebook and Bain & Company (2020), 73% of consumers in Southeast Asia reported being more health-conscious and 54% more environmentally conscious in the 'new normal' of COVID-19. Consumers in countries like the Philippines and Viet Nam also prioritized health and wellness even more than value for money (Facebook and Bain & Company 2020). Accordingly, ASEAN leaders have several promising avenues to address demand and supply gaps for sustainable production through agroforestry interventions.

Using agroforestry to achieve the ASEAN vision and goals for a more sustainable future

Social and environmental challenges may thwart the ambition of the ASEAN Ministers of Agriculture and Forestry (AMAF) in making ASEAN a global market competitor. These challenges include land degradation, climate change, population growth and outbreaks of pests and diseases. The resilience of the agri-food system lies at the heart of ensuring the

success of ASEAN as a global powerhouse. The endorsement of the *ASEAN Guidelines for Agroforestry Development* in 2018 was an important step toward realising this vision.

Sustainable production does not need to entail new and costly technologies but can instead involve expanding tested and scalable solutions, such as agroforestry. From its flexibility as a management approach, agroforestry allows resource users to target a range of specific and varied environmental and social issues. By investing in agroforestry through enabling factors — such as policy reforms, public-private partnerships and effective monitoring — decision-makers can maximize the use of limited resources and support results-driven interventions. Failing to exploit these opportunities may compromise commitments to enhance the welfare of people and the environment.

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Chapter 2. What to expect: the report's content and structure

Objectives and readership

This report is the first to provide an overview of agroforestry development in ASEAN. We analysed primary and secondary data to identify the pathways and bottlenecks facing agroforestry development in the region. The report encourages actions among ASEAN policymakers by leveraging opportunities to enhance the adoption of agroforestry. In addition to policymakers, this report aims at people in the private sector, extensionists and smallholders, researchers, and others interested in mainstreaming agroforestry. By presenting situation analyses of agroforestry in AMS, we hope to encourage discussion about bridging gaps to meet policy targets for human and environmental well-being.

Structure

The report is divided into three sections, as shown in Figure 2.1. Section I sets the stage by placing agroforestry in its contemporary context. This section presents the opportunities of agroforestry in ASEAN and explores the challenges in the agri-food sector. Section II covers the status and trends of agroforestry by delving into its conceptual understanding and application in Southeast Asia. This section examines the contribution of agroforestry to landscape restoration and climate change adaptation and mitigation. Public-private partnerships, governance and knowledge management, are also discussed to identify entry points for resolving obstacles to the adoption of agroforestry. By recognizing the links between the topics, we can view agroforestry as a system. Section III explores the way forward for using agroforestry to mitigate land-use challenges in the region. This section provides recommended actions for regional and national policymakers and practitioners.

The report aims to motivate readers to recognize the importance of multifunctional tree-based landscapes for meeting societal goals by highlighting the evidence of their economic and environmental co-benefits. To this end, communication and data-sharing between the agricultural and forestry sectors are highly encouraged. The responsibility of safeguarding the region's limited natural resources while improving local livelihoods rests with all of us. Long-term partnerships are required to realize the *Vision and Strategic Plan for ASEAN Cooperation in Food, Agriculture and Forestry 2016–2025*. Various instruments already exist to support AMS in this process, including the *ASEAN Guidelines for Agroforestry Development*. Policy and technological advances in ASEAN demonstrate the need for increasing trees on agricultural land to support millions of smallholders. However, this outcome will only be possible through concerted, coordinated action.

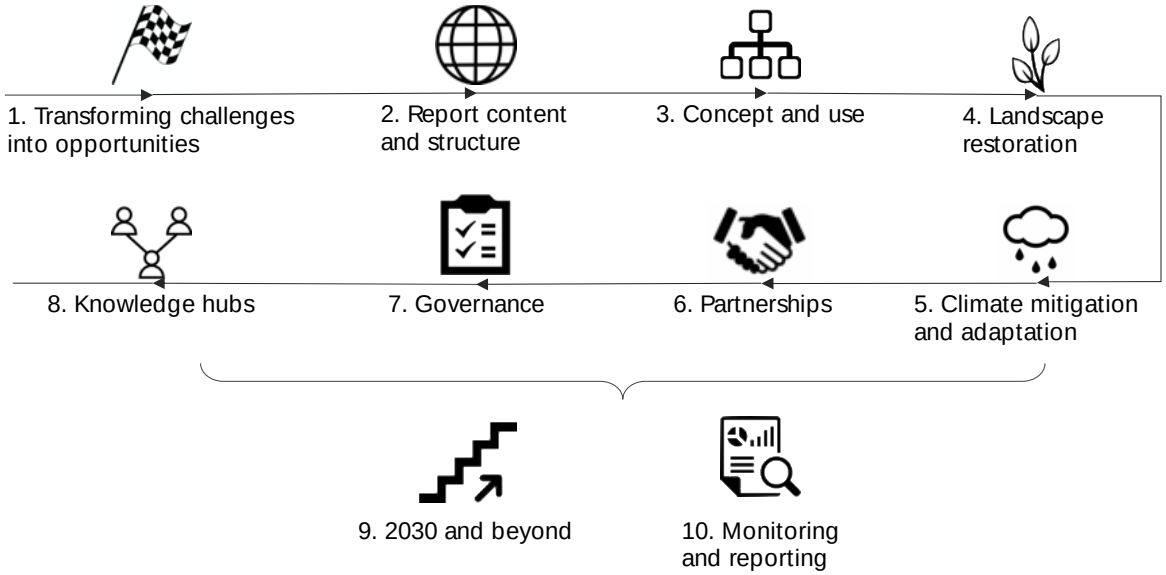

Figure 2.1. The report's structure

SECTION II: Status and trends

Chapter 3. What's in a name? The evolving concept and use of agroforestry

Key messages

- Agroforestry has a long history in Southeast Asia. As a formal concept, it can be encapsulated in three paradigms. These paradigms outline the changes of focus from plot-level interactions to landscape-level systems. The current paradigm encourages boundary-spanning work at the landscape scale and participatory monitoring of trees on agricultural land.

- Agroforestry is expanding. In the Mekong Region, the net gain of trees outside forests has been three times greater than trees inside forests over the last decade, indicating a reversal in deforestation drivers. National policies in AMS should explore this for enhancing landscapes.

- Establishing a clear definition and classification of agroforestry will support knowledge management, monitoring and evaluation.

What are the defining agroforestry paradigms?

Agroforestry takes an ecological approach to technologies and innovations suitable for local agricultural environments. Agroforestry can be broadly defined as 'agriculture with trees' or, more comprehensively, as

'land-use systems and technologies where woody perennials (trees, shrubs, palms, bamboos, etc.) are deliberately used on the same land-management units as agricultural crops and/or animals and fishery, in some form of spatial arrangement or temporal sequence. In agroforestry systems, there are both ecological and economic interactions between the different components. Agroforestry can also be defined as a dynamic, ecologically based, natural resource management system that, through the integration of trees on farms and in the agricultural landscape, diversifies and sustains production for increased social, economic and environmental benefits land users at all levels (FAO 2015). Agroforestry is practised in agricultural landscapes, in and along forest margins. Farming in forests and farm forestry are common trends. Interactions between trees and other components of agriculture may be important at a range of scales: in fields, on farms and landscapes (ICRAF 2021).

Since there is no one-size-fits-all formula, socio-ecological relationships in context are vital considerations in scaling up agroforestry innovations.

Agroforestry has a long tradition in Southeast Asia that reaches back centuries through practices such as swidden agriculture, 'taungya' (Box 3.1) and home gardens. Swidden agriculture and taungya involve clearing patches in forests to grow staple crops and then abandoning the land for fallow periods. The term taungya became primarily associated with a forestry practice where forestry-owned trees could be intercropped (and kept weed-free) by farmers (Box 3.1). Although cash-crop plantations and permanent farms replace swidden fields and rotational fallows, this practice remains a dominant land-use type in upland Southeast Asia. In the lowland humid tropics, multi-species home garden systems have also

historically been used by farming households (Box 3.2). Agroforestry research and projects since the 1960s have introduced new practices and revitalized older ones.

Van Noordwijk et al. (2016) summarized agroforestry concepts and practices into three paradigms (Figure 3.1). The first paradigm focuses on documenting and improving plot-level interactions. These interactions include taungya in Myanmar and 'tumpang sari' in Indonesia. In tropical ecosystems, insights were gained on belowground interactions, such as soil fertility, carbon storage and nutrient and water balances. These insights provided alternative systems to the trajectory of farm expansion in Africa and farm intensification in Asia. The first paradigm prioritized species' selection and integration to help spur the promotion, research and capacity development of agroforestry.

The second agroforestry paradigm embraced the landscape approach to resource management. This approach assessed the system impacts of incentives on technology and policy adoption. By contextualizing the benefits and costs to all users across different scales, researchers strengthened the understanding of trade-offs and synergies between social, economic and environmental aspects. Smallholders' knowledge and choices and the market demand for agroforestry products were seen as determinants to the uptake and longevity of agroforestry. The second paradigm focused on using agroforestry to enhance livelihoods, land rights and land-use governance.

The third and current agroforestry paradigm articulates the full gradient of trees–farms–forests interactions. The roles and rights of communities are considered central to land-use management and policies. While agroforestry research shows the numerous benefits of adoption, policy actions on removing ambiguities and institutional divides in the agriculture–forestry interface remain slow. With most gains in tree cover occurring outside forests in the last few decades, systematic studies of this phenomenon are needed to enable successful landscape restoration and climate-change interventions. Boundary-spanning work and landscape-wide partnerships are key features of this paradigm.

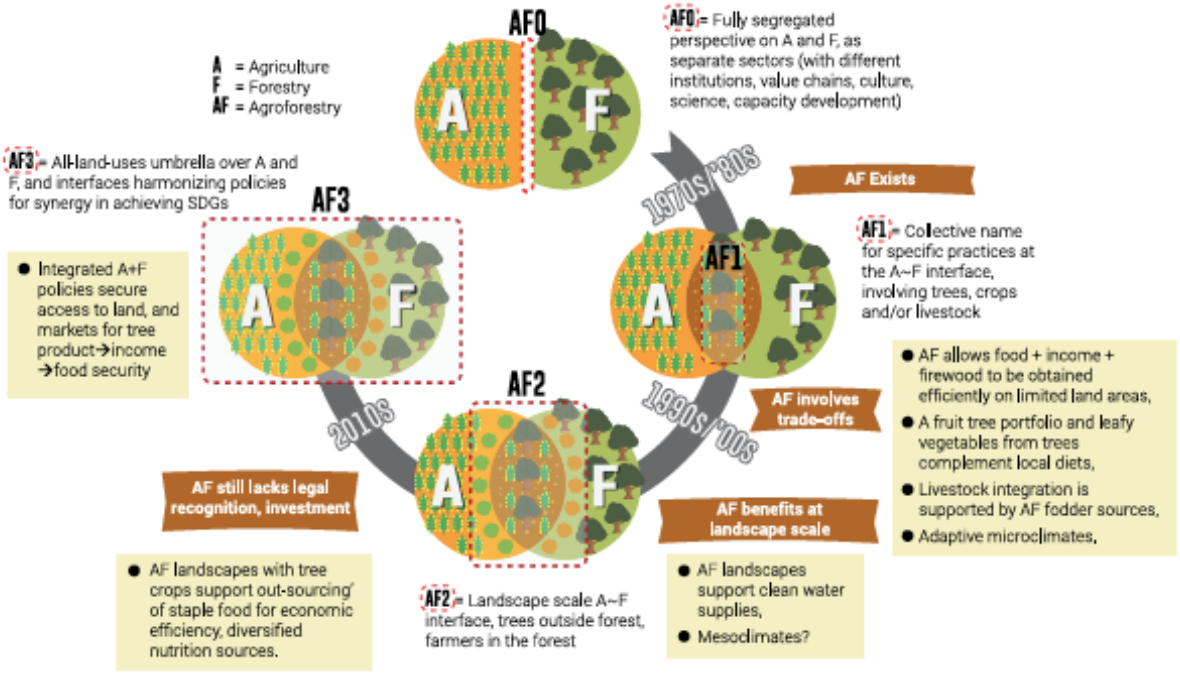

Figure 3.1. Graphical timeline of the three agroforestry paradigms
Source: Catacutan et al 2017, van Noordwijk et al 2016.

Box 3.1. The rise and decline of taungya in Myanmar

Taungya is a traditional shifting cultivation system in Myanmar wherein people clear forest land to grow food and cash crops for 3 to 4 years before the tree canopy closes. Taungya is a Burmese word derived from *taung* (hill) and *ya* (cultivation). The German forester, Dr Dietrich Brandis, is credited with the popularization of taungya after observing the practice among the Karen people in the mid-1800s. Under the auspices of the Forest Department, Brandis established valuable teak (*Tectona grandis*) plantations using taungya in current-day Tanintharyi. Labour for these plantations was outsourced to the Karen people, who were encouraged to grow rice and cotton crops, which were beneficial for the young teak trees. The success of taungya and later intensification of teak production activities led to the export of this system to other colonies.

While socioeconomic factors, such as competing wages, led to the decline of taungya for Government teak production, taungya continues to be used and adapted by smallholders across Myanmar. For example, farming households in Kayin State have established taungya systems to help supplement their yields from monsoon rice and other forms of monoculture. The rise in the demand for cardamom and turmeric has also turned taungya into cash-cropping systems, although local preferences and climate change remain underlying threads to these changes. While there is some space to serve the interests of both the farmers and the forest owner in these systems, the longer-term interests of the two parties to the contract do not necessarily match. Despite moves to give farmers a bigger stake in future timber production, it remains a challenge to evolve into true co-management of forested landscapes (Cahyono et al. 2020).

Box 3.2. The multiple functions and benefits of 'pekarangan' in Indonesia

Home gardens are typically fenced-in gardens surrounding individual homes, containing timber and fruit trees, vegetables, herbs, annual crops and small livestock. The first studies

on tropical home gardens in Southeast Asia were conducted in Java, Indonesia (Wiersum 2006). One of the words in Indonesia used for a home garden is 'pekarangan'. Pekarangan is one of several systems of multi-storey agroforestry. Studies of home gardens in the late 1970s demonstrated the importance of these systems for nutritional security. Common fruit trees grown in home gardens include banana (for example, 'ambon' and 'susu'), coconut, rambutan (*Nepheleum lappaceum*) and durian (*Durio zibethinus*). Home gardens in West Java gradually replaced other types of tree-gardening, such as 'talun' (forest gardens) practised by the Sundanese people, through the extension of the separate and more populous Javanese culture.

Home gardens in Indonesia usually have a vertical stratification of starchy food plants, vegetables and spaces at ground level followed by fruit trees and cash crops in the next layer and tall trees — such as coconut and timber — in the highest layer (Mohri et al. 2013, Figure 3.2). In West Java, Abdoellah et al. (2006) found high diversity of plant species in home gardens; sampled plots had an average of 15 species. This was also the case in other regions, including Central Sulawesi (Kehlenbeck and Maass 2006). The shift towards commercialization has reduced these systems' diversity in recent years. Households with home gardens nevertheless value the importance of access to fresh and nutritious foods. Pekarangan is considered a prototype for home gardens worldwide.

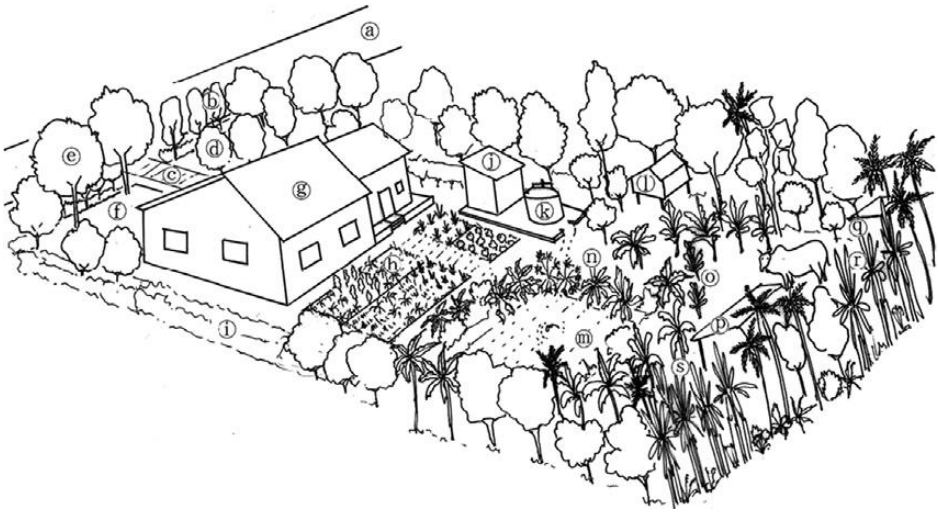

Figure 3.2. Schematic diagram of a Javanese agroforestry home garden
Source: Mohri et al. 2013.

Agroforestry in ASEAN

Unlike other land-uses, agroforestry lacks a clear class definition and is often left out of land-cover maps. The rigid boundaries between major land-use types reinforce the dichotomy of agriculture and forestry. In turn, mixed land-use policies are harder to develop and enforce. In their global assessment of tree cover on agricultural land, Zomer and others (2014) indicated that 43% of all agricultural land had at least 10% tree cover in 2010.[1]

[1] In Zomer et al (2014), agricultural land encompasses three agricultural land-use types from the Global Land Cover Class scheme used for the Global Land Cover 2000 database including: Cultivated and managed areas (Agriculture — intensive), Cropland/Other natural vegetation (non-trees) (Mosaic agriculture/degraded vegetation) and Cropland/Tree Cover Mosaic (agriculture/degraded forest).

About 77% of agricultural land in Southeast Asia had at least 10% tree cover, representing more than 130 million hectares inhabited by 170.1 million people (Zomer et al. 2014).

Based on Zomer et al.'s analysis (2014), Malaysia, Indonesia, the Philippines and the Lao People's Democratic Republic (PDR) had the highest proportion of agricultural land with tree cover in 2010. Nearly all agricultural land in Malaysia (98.86%), Indonesia (97.79%), Philippines (97.53%), and Lao PDR (90.64%) had at least 10% tree cover (Table 3.1). Tree coverage on agricultural land was also high in Viet Nam, representing 77.32% of the country's total agricultural area. To a lesser extent, 10% tree cover on agricultural land was also found in Thailand (51.96%), Cambodia (42.96%) and Myanmar (41.92%).

Except for Brunei Darussalam and Singapore, where no data is available, seven out of eight AMS experienced increases in tree cover on agricultural land from 2000 to 2010. Many of these increases were for agricultural land with 30% tree cover. However, Myanmar, which witnessed a loss in total agricultural land with tree cover, saw a decline of farmland with 30% tree cover. Nonetheless, these overall trends signal opportunities in leveraging trees outside forests (TOF) through agroforestry.

Table 3.1. Area and percent change of agricultural land with tree cover in ASEAN

Country	**Agricultural area with at least 10% tree cover (ha) in 2010**	**The areal extent of land with at least 10% tree cover as a percent of total agricultural area (%) in 2010**	**Percent change in agricultural land with at least 10% tree cover from 2000 to 2010**
Brunei Darussalam	Not available	Not available	Not available
Cambodia	2,397,600	42.96	0.43
Indonesia	60,811,400	97.79	2.54
Lao PDR	4,166,000	90.64	0.86
Malaysia	10,556,500	98.86	0.11
Myanmar	8,089,500	41.92	-0.52
Philippines	18,418,700	97.53	1.32
Singapore	Not available	Not available	Not available
Thailand	14,297,000	51.96	9
Viet Nam	11,670,400	77.32	1.02

Source: Zomer et al. 2019; the scale of basic spatial unit 300 x 300 m

More recently, an assessment in the Mekong Region revealed that most of the tree cover gains between 2010 and 2018 occurred outside forests (Figure 3.3). These gains were three times greater than inside forests. The net gains of TOF were 4.7 million hectares, whereas the net loss of trees inside forests was 0.3 million hectares. All countries except Lao PDR experienced an increase in the gross area of TOF. Myanmar saw the highest area increase of TOF. Regional gains in TOF were highest in shrublands, followed by grasslands and croplands. The results indicate the importance of integrating agroforestry systems and TOF into land-use maps for devising better national policies for landscape restoration.

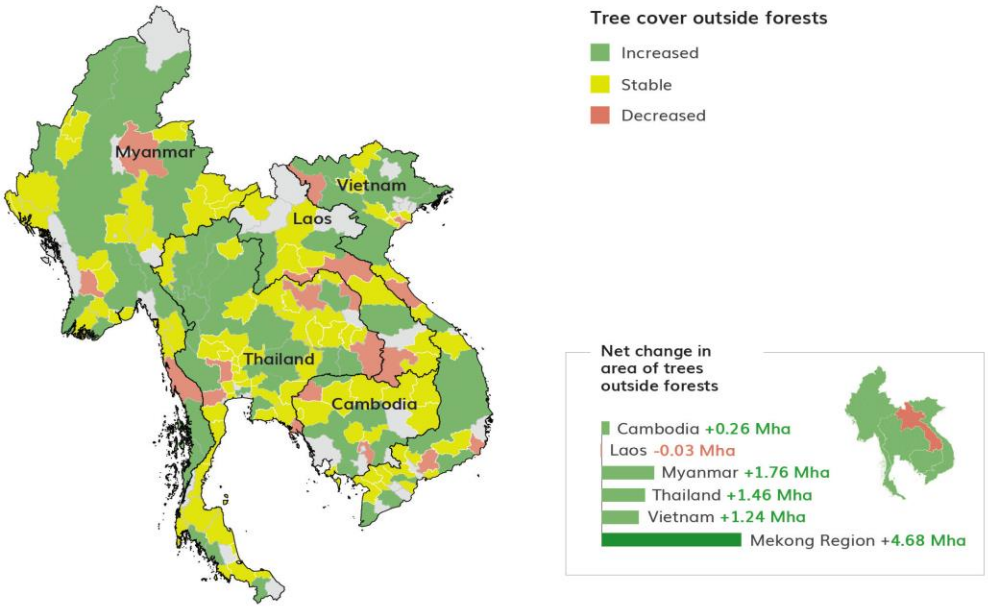

Figure 3.3. Changes in tree cover outside forests in the Mekong Region, 2010 to 2018
Source: Data collected via Collect Earth mapathon by JD 4Consulting interpreted by World Resources Institute 2019, published by NYDF Assessment Partners 2019.

On the development of agroforestry systems in forest areas, Tenneson et al. (2021) found that agroforestry using herbaceous crops was generally the most expansive. Agroforestry involving shrub crops, such as coffee and tea, was most common in Indonesia and Viet Nam, having a total area that reached 719,000 ha and 137,000 ha, respectively. The main palm crops were oil palm in Indonesia and coconut in the Philippines and Thailand. Tree crops included agroforestry with fruit or nut tree species or tree species commonly used in forest plantations, such as rubber, or pulpwood species, such as acacia or eucalyptus. Across the sampled countries, large areas of tree crops were found in Cambodia and Indonesia. Mulia and Nguyen (2021) recently published a book on the diversity, distribution and area of agroforestry practices in Viet Nam. However, such compilation for other Southeast Asian countries is scarce.

Drivers of agroforestry expansion

The main drivers of the positive trend of agroforestry are not systematically reported. However, case-study evidence suggests the following: 1) increasing demand for deforestation-free and sustainable supply chains of global commodities, such as coffee, rubber, tea, nuts and fruits; 2) promotion of, and support for, agroforestry in social forestry or community-based forest management programmes (CBFM); 3) climate change and demographic shifts; 4) urban and peri-urban agriculture; 5) promotion and support from donor-funded projects; 6) favourable domestic policies; and 7) public-private partnerships (Box 3.3).

In the Philippines, domestic policies on agroforestry have been central in encouraging sustainable farming and forestry to curb land degradation and rural poverty. Agroforestry was instrumental in earlier forms of CBFM and continues to be championed as a restoration mechanism by various groups in the country. In Viet Nam, adherence to sustainable supply chains has accelerated agroforestry adoption among smallholders. For example, farmers are

increasingly converting their monocultural coffee systems into coffee agroforestry to gain product certification and greater market value for their products. This change has a large-scale impact on the socio-ecological landscape, given that Viet Nam is the world's second-largest coffee producer after Brazil (FAOSTAT 2021).

Likewise, the demand for sustainable and deforestation-free supply chains affects Indonesia, Malaysia, and Thailand's rubber and oil-palm production activities. In 2019, these three countries together made up 87.87% and 57.78% of the global production of palm oil and rubber, respectively (FAOSTAT 2021). In recognizing commodity agriculture as the leading cause of deforestation in Southeast Asia, research and development organizations such as ICRAF and WWF have partnered with farmers to explore eco-certification through agroforestry. Commodity agroforests have been shown to deliver higher yields and co-benefits of biodiversity conservation, with greater profits. Further successes from agroforestry expansion require supportive policies for rewarding environmental services.

Box 3.3. A tree-based farming partnership in Isabela, Philippines
Once covered by virgin forest in the eastern coastal zone of Sierra Madre mountain range, the upland village of Bukal Del Norte, Dinapigue, Isabela saw its peak of commercial logging from 1970 through to the early 1980s. Residents worked as forest guards, scalers, haulers and labourers for logging companies. However, the closure of three logging companies in 1993 brought a major economic setback. Two remaining companies — LUZMATIM and PATECO — had scaled down their activities due to declining natural forests harvests.

To meet the company's future demand for raw materials, PATECO initiated a community-based tree-growing project in partnership with the Government's Community Environment and Natural Resources Office (CENRO). PATECO offered incentives to participating households, such as funding, seedlings and training. CENRO released abandoned fallow land for tree farming with corresponding users' rights over the planted trees, and PATECO agreed to buy the trees at fair prices. To safeguard each party's interest, a tripartite agreement was entered into by PATECO, farmers and CENRO. With an initial 105 participants in the first three years, it became so attractive that almost all households were growing trees associated with crops. The farms planted with trees ranged from 1 to 5 hectares. With market security, start-up capital and tree ownership, the farmers successfully converted idle land into a vibrant agroforestry landscape.

Source: Paulo Pasicolan

Finding a common agroforestry classification system for knowledge management

Agroforestry typically includes trees and crops, trees and animals, or a combination of all three, with trees being the main feature. A common way of grouping agroforestry is based on its structural components. In this classification, agroforestry practices are labelled as agrosilviculture, silvopastoral or agrosilvopastoral (Table 3.2). Agrosilviculture refers to tree-based farming, silvopastoral refers to tree-based pastures, and agrosilvipastoral refers to integrated, tree-based livestock systems. Since these groupings do not distinguish the system's composition from its purpose, multiple labels may be applied to the same practice. While this classification may also be restrictive because not all agroforestry practices with livestock have a pastoral element, practitioners use this schema to show similarities in the practices while highlighting the specific resource components.

Table 3.2. Classification of agroforestry by structural components

System	Description	Examples of practices
Agrosilviculture	Intercropping of timber and fuelwood species and annual/seasonal crops	Alley cropping, multistorey agroforestry, home gardens, shelterbelts and windbreaks
Silvopastoral	Combining tree species and domesticated animals in managed grazing lots	Browsing banks, trees in rangelands, plantation crops with pastures and animals
Agrosilvopastoral	Integration of trees and/or shrubs, crops and animals in managed farming units	Multipurpose woody hedgerows, home gardens with animals, apiculture with trees, silvofishery

Agroforestry systems and practices can also be organized by function or purpose. Under this criterion, Torquebiau (2000) presents six categories for classifying agroforestry. These categories include crops under tree cover, agroforests, agroforestry in a linear arrangement, animal agroforestry, sequential agroforestry, and minor agroforestry techniques. This nomenclature is a continuum for agroforestry practices similar to the structural grouping because some practices can fall under multiple categories. Other classification systems have also used ecological and economic interactions and geographic locations as the criteria (Atangana et al. 2014, Raj et al. 2019). While no consensus exists on agroforestry classification in any of the AMS, policymakers should consider time-stable and geographically representative categories to avoid the overhaul of classification schemes.

Common practices and distribution of agroforestry across ASEAN

Little is known of the geographic distribution of agroforestry across ASEAN because information about agroforestry is neither systematically collected nor reported. For example, in FAO's Corporate Statistical Database, agroforestry practices can be listed under four separate categories[2], leading to difficulties in the approximation of the total agroforestry area. Monitoring systems for agroforestry are needed to assess the tree–farms–forests interactions and reduce reporting burdens, especially with the growing urgency for integrated landscape restoration and biodiversity conservation.

In the absence of national reports on agroforestry, data from surveys with representatives of the ASEAN Working Group on Social Forestry (AWG-SF)[3] and case studies are summarized here to highlight the role of trees in agri-food systems. These descriptions do not capture all agroforestry practices in the AMS but, instead, present a representative picture of the diversity in the models commonly used and promoted. Many practices span more than one country, with similarities in the structures across sites. Thus, regional collaboration can strengthen the opportunities for sustainable agricultural and forestry management.

Brunei Darussalam

[2] The four categories are 1) forest land, which covers, for example, taungya during the first years of forest rotation; 2) land under permanent meadows and pastures; 3) land under permanent crops; and 4) naturally regenerating forest.

[3] ICRAF conducted two surveys on agroforestry in AMS' strategies and programming. The first survey focused on a situation analysis of agroforestry and policy directions for implementing the *ASEAN Guidelines for Agroforestry Development*. The second survey captured the distribution of agroforestry and the barriers and benefits of these systems. Responses were received from AWG-SF representatives in July and December 2020 for the first and second set, respectively.

Located on the island of Borneo, Brunei Darussalam is characterized by flat coastal plains that rise to mountains in the east and hilly lowlands in the west. Bryan and others (2013) found that 54% of the country's forests remain intact, which is about three times greater than in the Malaysian Borneo states of Sabah and Sarawak. By favouring the preservation of forest ecosystems and excluding industrial logging from within its borders, the Government of Brunei Darussalam has maintained much of its primary forests. However, the Government's current initiative to increase agricultural production and industrial and resettlement areas have reduced total forest area (FAO 2020).

Although agroforestry is not a household term in Brunei Darussalam, it will likely play a central role in the national agenda as the Government balances achieving food security and mitigating climate change under areal constraints.

Population	437,000
Forest area (in ha, % of total land)	380,000 ha; 72.11%
Agricultural land (in ha, % of total land)	14,400 ha; 2.73%
Arable land (in ha, % of total agricultural land)	5,000 ha; 0.95%
Agriculture and forestry valued added (constant 2010 USD, % of GDP)	USD 107,313,898; 0.99%
Common agroforestry practices	Forest farming, mixed-species plantation

Source: 2020 population from UN DESA 2019, 2016 forest, agricultural and arable land from World Bank database 2020, 2019 GDP contribution from World Bank database 2020.

Cambodia

Cambodia is mostly composed of flat plains with a few mountains in the southwestern and northern parts of the country. Many shifting cultivators exist in northeastern Cambodia due to the terrain, where they clear land for rice fields. This practice has declined in recent years as more land is devoted to rubber and oil-palm plantations. Since 2019, the Government of Cambodia has implemented agroforestry through forest farming in community-managed forestlands and taungya and alley cropping in degraded areas.

The Forestry Administration has piloted agroforestry on 2–10-hectare plots with 18 communities. At these sites, tree species such as 'kranhong' (*Dalbergia cochinchinensis*), 'thanong' (*Pterocarpus macrocarpus*) and 'beng' (*Afzelia xylocarpa*) are planted about 5–10 metres apart, allowing for the cultivation of crops in between the rows. Under small canopy gaps, farmers grow shade-tolerant species such as cacao, coffee, mushrooms, rattan and herbs. Other non-timber forest products — including honey, wild fruits and ornamental plants — are also cultivated for household and commercial use. Fishing in the seasonal streams of inundated forests also provides critical sources of food and income to farmers. With the expansion of rice fields and cash cropping, households commonly establish homesteads to supplement their production during the dry season. Some donor-funded projects in Cambodia include agroforestry components; however, statistics on agroforestry-focused or -related projects in the country are not available.

With support from the Forestry Administration, community forestry groups in Cambodia have established agroforestry sub-groups to experiment with tree-based farming and benefit from these practices. In Kampot Province, agroforestry farmers of a community forestry group generated a total profit of USD 500 in 2019 and USD 1500 in 2020 by selling red maize grown between rows of trees. Profits from selling agroforestry products were re-invested into the management activities of the group.

Population	16,719,000
Forest area (in ha, % of total land)	9,329,600 ha; 52.85%
Agricultural land (in ha, % of total land)	5,455,000 ha; 30.90%
Arable land (in ha, % of total agricultural land)	3,800,000 ha; 21.53%
Agriculture and forestry valued added (constant 2010 USD, % of GDP)	USD 4,332,222,471; 20.71%
Common agroforestry practices	Taungya, alley cropping, forest farming, home garden

Source: 2020 population from UN DESA 2019, 2016 forest, agricultural, and arable land from World Bank database 2020, 2019 GDP contribution from World Bank database 2020.

Indonesia

Indonesia is an archipelago with four main agro-ecological zones ranging from wetlands through drylands and highlands to irrigated lowlands. Many Indonesian agroforestry systems closely resemble primary forests. In complex agroforestry, households integrate many species into their farming systems to protect the soil, water and biological diversity and secure year-round provision of horticultural products. Households also establish simple agroforestry in densely populated areas. Simple agroforestry involves a lower number of species, simple crop associations, and one or two strata. Popular forms of simple agroforestry include alley cropping, intercropping, and hedgerows, where farmers establish coffee gardens with legumes and vegetables.

Throughout Java, Sumatra and Kalimantan, agroforestry systems are widespread. Farm-based agroforestry systems include pekarangan and 'kebun' or talun and 'pelak' (tree gardens). Multiple vertical layers are used in these systems, with tall trees enclosing the plot and a mixture of annual and seasonal crops at the centre. Protein banks are provided for livestock through fodder supply (for example, *Gliricidia* and *Leucaena* shrubs). In silvofishery systems, aquaculture is fundamental to livelihoods and the conservation of mangroves for coastal communities. These systems have provided local people living on the coastlines with physical protection and safety-net strategies during extreme weather events.

While monocultural farming has increased through the cultivation of commodity crops such as rubber and oil palm, agroforestry plays an integral role in the production of coffee and cocoa and much of the local fruits. The role of domestic circular migration (such as 'merantau') between areas of different population density and land-use intensity has probably played a positive role in the spreading of agroforestry knowledge and practices between areas of origin and target areas for temporary migrants (Mulyoutami et al. 2020). In Lampung, the adoption of sustainable agroforestry has successfully maintained the diversity of 56 species, including 24 types for food production. Alongside supporting food diversification and sovereignty for communities living around the forests, agroforestry has contributed to 50 to 80% of total family income in this example.

Current national agroforestry initiatives are couched in the social forestry programme, which receives governmental, private, and development funding. These include agroforestry in the Economic Recovery Programme (Program Pemulihan Ekonomi/PEN) and technical arrangements on governmental support for agroforestry for food security in Central Kalimantan.

Population	273,524,000
Forest area (in ha, % of total land)	120,475,732.96 ha; 64%
Agricultural land (in ha, % of total land)	57,000,000 ha; 31.46%
Arable land (in ha, % of total agricultural land)	23,500,000 ha; 12.97%

Agriculture and forestry valued added (constant 2010 USD, % of GDP)	USD 149,053,103,992; 12.72%
Common agroforestry practices	Tumpangsari, multi strata cocoa, mixed fruit tree agroforestry, home garden, forest garden, jungle rubber, agrosilvofishery

Source: 2020 population from UN DESA 2019, 2020 forest data from MOEFRI, 2016 agricultural and arable land from World Bank database 2020, 2019 GDP contribution from World Bank database 2020.

Lao PDR

Lao PDR is characterized by flat and sloping plateaux and mountainous areas. Most of the country is mountainous, with the mean elevation being 710 metres above sea level. Steep sloping terrain and limited fertile land have made shifting cultivation the dominant agricultural strategy in these areas. Plantations of non-timber forest products (bitter bamboo, red cardamom and pineapple) and animal husbandry (cattle) coupled with shifting cultivation are widely established in the mountainous regions. Like other countries in Southeast Asia, the Government of Lao PDR has promoted tree plantations to curtail shifting cultivation. In recent years, the Government has recognized the benefits of rotational agriculture in overcoming the challenges of monoculture.

In flat and sloping areas, smallholders have adopted home gardens, intercropping systems, and mixed-species plantations. Homegardens involve the strategic combination of fruit trees (papaya, banana and jackfruit), vegetables (cabbages, eggplant and chilli) and small livestock (chicken and pig). Fruit trees contour the home garden, serving as living fences and windbreaks. Intercropping or alley-cropping systems encompass the simple integration of trees and annual crops — such as eucalyptus and rice, paper mulberry and maize — and a more complex mixture of trees and crops, such as banana, rubber, pineapple and orange. The latter practice can also be categorized as multi-storey systems or mixed-species plantations. Along with smallholders, private corporations, including Stora Enso and Burapha Agroforestry, have established tree plantations.

Population	7,276,000
Forest area (in ha, % of total land)	18,950,580 ha; 82.11%
Agricultural land (in ha, % of total land)	2,369,000 ha; 10.26%
Arable land (in ha, % of total agricultural land)	1,525,000 ha; 6.61%
Agriculture and forestry valued added (constant 2010 USD, % of GDP)	USD 1,956,126,167; 15.29%
Common agroforestry practices	Shifting cultivation, intercropping, mixed-species plantation, home garden

Source: 2020 population from UN DESA 2019, 2016 forest, agricultural, and arable land from World Bank database 2020, 2019 GDP contribution from World Bank database 2020.

Malaysia

Malaysia features steep, forest-covered mountain ranges in Peninsular Malaysia and coastal plains covered by dense rainforests in East Malaysia. Most agroforestry practices in Malaysia involve the combination of trees and crops, with animal rearing and aquaculture taking place to a smaller degree. On a small scale, the Forestry Department of Peninsular Malaysia promoted taungya for forest rehabilitation in forest reserves during the 1950s. For example, in the Mata Ayer Forest Reserve, farmers grew cash crops such as upland rice and tobacco in between rows of teak seedlings. This practice was adopted in northern Perak, with the interplanting of 'yemane' (*Gmelina arborea*) and tobacco. Agroforestry gained more traction between the 1960s and 1970s when the Forestry Department introduced a varied selection

of trees and crops in larger areas of forest reserves. The implementation of agroforestry has enhanced relations between forest users and managers (Box 3.4).

Along with the Forestry Department, the Malaysian Rubber Board has been active in agroforestry development and implementation. The Board was established in the early 1970s with the primary objective of finding optimal land-use strategies for smallholders during unproductive rubber periods. The taungya system was initially adopted in some areas. Farmers intercropped maize, banana, vegetables and soybeans within the first three years of their rubber plantations. Interplanting rattan with mature rubber trees was also considered through a joint trial with the Forest Research Institute Malaysia. The success of this and subsequent trials drew support from other government agencies and the private sector and led to greater uptake of rubber agroforestry systems.

Population	32,366,000
Forest area (in ha, % of total land)	18,273,487 ha; 55.31%
Agricultural land (in ha, % of total land)	8,627,000 ha; 26.26%
Agriculture and forestry valued added (constant 2010 USD, % of GDP)	USD 30,510,237,004; 7.26%
Common agroforestry practices	Taungya, intercropping, fruit tree and mixed-species plantation, tree-based pasture, apiculture with trees

Source: 2020 population from UN DESA 2019, 2020 forest area from Ministry of Energy and Natural Resources, 2016 agricultural land from World Bank database 2020, 2019 GDP contribution from World Bank database 2020.

Myanmar

Myanmar contains three distinct agro-ecological regions: hills, dry and delta. In the hilly region, the Forest Department has introduced tree plantations, home gardens and community forests to reduce shifting cultivation. Farmers intercrop upland rice (*Oryza sativa*), sesame (*Sesamum indicum*), maize (*Zea mays*) and vegetables with teak (Maung and Yamamoto 2008). Households also have established home gardens, which consist of fruit trees such as coconut palm (*Cocos nucifera*), banana (*Musa* spp*)*, mango (*Mangifera indica*) and vegetables (Maung and Yamamoto 2008). In the dry zone, the Land-Use Division of the Department of Agriculture has used contour hedgerows and windbreaks for soil and water conservation. Across Myanmar, the total area under experimental agroforestry is about 194,244 hectares, involving 97,884 farmers.

For dry-zone farmers, tree-based pastures are also popular forms of agroforestry that provide cheap fodder to feed their cattle and fuelwood, food, and other income-generating products. Fodder species include 'zi' (*Zizyphus jujube*), 'magyi' (*Tamarindus indica), Terminalia bellerica, and* 'shaw phyu' (*Sterculia versicolors*). In the delta, fishery components are often integrated into tree-based farming systems, such as mud crab (*Scylla serrata*), clam, shrimp and tilapia. In degraded mangrove forests, households have established multi-storey and mud-crab-based agroforestry systems as rehabilitation and livelihoods' strategies. Home gardens that consist of annual crops (betel leaves and vegetables) and perennials (coconut, betel nut and other fruit trees) are also commonly adopted by farmers to provide year-round food and income security (Feurer et al. 2018, Rammohan et al., 2019). Climatic changes in the delta region and elsewhere have led smallholders to implement more multi-use, low-emission, agroforestry technologies.

Population	54,410,000
Forest area (in ha, % of total land)	28,544,000 ha; 43.73%
Agricultural land (in ha, % of total land)	12,760,000 ha; 19.54%

Arable land (in ha, % of total agricultural land)	10,908,000 ha; 16.70%
Agriculture and forestry valued added (constant 2010 USD, % of GDP)	USD 20,340,811,978; 21.35%
Common agroforestry practices	Taungya, mixed-species plantation, alley cropping, tree-based aquaculture

Source: 2020 population from UN DESA 2019, 2020 FRA data, 2016 agricultural, and arable land from World Bank database 2020, 2019 GDP contribution from World Bank database 2020.

Philippines

The Philippines is an archipelago marked by mostly mountains and narrow coastal lowlands. Most upland farmers are agroforestry by growing fruit trees, such as durian, mango, mangosteen and jackfruit, alongside cacao and coffee and other timber trees, such as mahogany. The intercropping of upland rice and nitrogen-fixing trees have also been extensively practised by smallholders, which evolved from shifting cultivation. Other traditional agroforestry practices include rice terraces in Ifugao, coconut pineapple multi-storey systems in Cavite, and coffee–multi-storey cocoa systems in Mindanao. Along with combinations of trees and crops, animal components, such as poultry, cattle and fish, are commonly integrated into tree-based farming practices.

Agroforestry mango plantation under National Greening Program in Ifugao, Philippines. Photo courtesy of DENR (2013).

The Department of Environment and Natural Resources uses forest-based agroforestry, such as taungya, to promote reforestation and reduce upland shifting cultivation. The Department of Agriculture also encourages agroforestry by piloting rice terraces in Cordillera to enhance food security and resilience among upland communities. In response to severe soil erosion in the uplands, Mindanao Baptist Rural Life Center introduced the Sloping Agricultural Land Technology (SALT) in the 1980s. This technology was adapted from alley cropping methods to include 3–5 metre bands of permanent crops between double-

contoured rows of nitrogen-fixing trees and shrubs. Farmers in Claveria in Mindanao also adopted natural vegetative strips, which are less labour-intensive than SALT, to control soil erosion and surface run-off fertilizers. Adopting these technologies enabled more profitable cropping systems and larger areas of arable land.

Population	109,581,000
Forest area (in ha, % of total land)	7,014,154 ha; 23.38%
Agricultural land (in ha, % of total land)	12,691,940 ha; 42.93%
Arable land (in ha, % of total agricultural land)	5,590,000 ha; 18.75%
Agriculture and forestry valued added (constant 2010 USD, % of GDP)	USD 34,074,206,111; 8.82%
Common agroforestry practices	Alley cropping, taungya, multi-storey system, tree–crop grazing system, SALT, natural vegetative strips

Source: 2020 population from UN DESA 2019, 2015 forest and agricultural data from Land Cover Data of the Philippines, 2016 arable land from World Bank database 2020, 2019 GDP contribution from World Bank database 2020.

Singapore

Singapore is a city-state that features a series of low ridges on generally flat land. Although Singapore does not have an agroforestry sector, the small agricultural sector focuses mainly on produce such as eggs, fish and vegetables for local consumption to supplement imports. The Ministry of National Development has previously used public land to develop agrotechnology parks and leased land to businesses for livestock raising, horticulture, aquaculture and fruit production.

Population	5,690,000
Forest area (in ha, % of total land)	16,390 ha; 22.77%
Agricultural land (in ha, % of total land)	660 ha; 0.93%
Arable land (in ha, % of total agricultural land)	560 ha; 0.79%
Agriculture and forestry valued added (constant 2010 USD, % of GDP)	USD 106,058,577; 0.03%
Common agroforestry practices	Home garden, fruit tree, and mixed-species plantation

Source: 2020 population and 2016 forest area from the Singapore Department of Statistics, 2016 agricultural and arable land from World Bank database 2020, 2019 GDP contribution from World Bank database 2020.

Thailand

Thailand encompasses high mountains in the north, a central lowland plain and an upland plateau in the northeast. Traditionally, upland farmers used shifting cultivation to expand their agricultural land. Homegardens enabled Karen and Lua ethnic groups to supplement their income from rice farming. Adopters of home gardens established 3–5 strata and grew multipurpose trees, such as *Moringa oleifera* and *Sesbania grandiflora*, in the north and wild durian (*Durio* spp.) 'yang' (*Dipterocarp* spp.) in the south. In the mid-1950s, the Royal Forest Department introduced improved taungya to northern farmers, which involved the interplanting of crops and fruit and rubber trees with various timber-tree combinations. This programme supported food self-sufficiency and the protection of critical watershed areas.

Broadly, agroforestry in Thailand can be classified into four groups: integration of tree species with farmland, pastures, forests, and aquaculture. Although the combination of these four groups in a single agroforestry system yields the highest income, tree planting on marginal agricultural farmland remains the most popular form of agroforestry owing to limited available land.

Farmers engaged in rubber production (*Hevea brasiliensis*) in southern Thailand have also incorporated other species into their plantations to increase on-farm diversification. Some of these species include timber trees — such as 'neem' (*Azadirachta excelsa*) and rattan (*Calamus caesius*) — fruit trees — such as 'salak' (*Sallaca* spp) and durian (*Durio zibethinus*) — and shrubs, such as 'pak liang' (*Gnetum* spp.). Other popular agroforestry models in Thailand are 'miang' (forest tea gardens), tree-based pastures, apiculture with trees, and pond culture integrated with trees, crops and animal husbandry.

Population	69,800,000
Forest area (in ha, % of total land)	16,429,000 ha; 32.16%
Agricultural land (in ha, % of total land)	22,110,000 ha; 43.28%
Arable land (in ha, % of total agricultural land)	16,810,000 ha; 32.90%
Agriculture and forestry valued added (constant 2010 USD, % of GDP)	USD 40,112,026,414; 7.98%
Common agroforestry practices	Shifting cultivation, home garden, taungya, mixed-species plantation, forest farming

Source: 2020 population from UN DESA 2019, 2016 forest, agricultural, and arable land from World Bank database 2020, 2019 GDP contribution from World Bank database 2020.

Viet Nam

Viet Nam comprises densely forested highlands with wetlands and long coastlines in the east of the country. About 900,000 hectares of agroforestry are estimated to exist (ICRAF 2021). In upland and midland areas, the interplanting of seasonal crops with industrial trees (for example, coffee, cashew and tea) is widely practised by farmers. The Government of Viet Nam has supported these practices through subsidies and technical assistance to encourage environmental conservation. These practices have expanded through research and development since the 1960s, which popularized traditional agroforestry, including home gardens, 'vuon–ao–chuong' (garden–pond–livestock) and 'vuon–ao–chuong–rung' (garden–pond–livestock–forest). Households have carried out various tree–crop–animal combinations to meet household production and income needs.

In wetland and delta regions, aquaculture and mangrove species are featured in many rice-farming systems. Systems of melaleuca trees with seasonal crops and aquaculture can be found in provinces in the Mekong Delta, including Ca Mau, Dong Thap Muoi and Kieng Giang. These systems typically include canals for fish- or shrimp-raising, rice plots, mixed plots of rice and melaleuca trees, and melaleuca forests. The integration of aquaculture and mangrove species has allowed farmers on the coastlines to optimize the saline-flooded areas for material and food production. Through payment for forest environmental services and community-based forest management, agroforestry has preserved these landscapes' ecological productivity and biodiversity.

Population	97,339,000
Forest area (in ha, % of total land)	14,677,215 ha; 42.01%
Agricultural land (in ha, % of total land)	12,178,000 ha; 39.28%

Arable land (in ha, % of total agricultural land)	6,998,000 ha; 22.57%
Agriculture and forestry valued added (constant 2010 USD, % of GDP)	USD 27,434,281,700; 13.96%
Common agroforestry practices	Shifting cultivation, taungya, tree-based aquaculture and pasture, home garden

Source: 2020 population from UN DESA 2019, 2020 forest area from MARD, 2016 agricultural and arable land from World Bank database 2020, 2019 GDP contribution from World Bank database 2020.

Box 3.4. Benefits of apiculture with trees in the Merchang Forest Reserve, Malaysia

Through agroforestry initiatives by the Forestry Department of Peninsular Malaysia, tree-based bee breeding was introduced in forest reserves to enhance communities' livelihoods. In Merchang Forest Reserve, Terengganu, farmers breed stingless bees — 'lebah kelulut' (*Meliponini* sp) — for honey production, creating sustainable products such as soap, syrup and honey juice. Since stingless bees build nests in cavities of acacia trees, farmers could optimize their land use. At least 400 beehives can be found on half a hectare of acacia plantation in the forest reserve. Owing to the proximity of natural forests, bees have sufficient year-round access to food, enabling local businesses to thrive.

Located in the Merchang Forest Reserve, Big Bee Honey Sdn Bhd is a local company that specializes in producing and selling agroforestry-based honey products. Since 2014, the company has collaborated with various private and government agencies and universities to raise awareness and knowledge of apiculture with trees. Along with their commercial activities, Big Bee Honey has provided training on bee cultivation. While bee breeding is done inside the forest reserve, this agroforestry practice supports forest conservation as beekeepers can survey the area for potentially illegal forest activities. By encouraging agroforestry in forest reserves, the Forestry Department has increased the revenue streams of forest communities while reducing the costs for forest protection.

Source: AWG-SF survey.

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Chapter 4. Bring it back! Agroforestry: the tool for landscape restoration

Key messages

- The annual cost of land degradation in Southeast Asia is equal to USD 5.97 billion or 2.5% of regional GDP. Compared to other land-use systems, agroforestry supports the agriculture–forestry continuum, which lessens the potential 'leakage' effect of conservation.

- There needs to be a stronger emphasis on extension services and financial resources to strengthen agroforestry as a tool for landscape restoration. Alongside technical support and land tenure reforms, policies that connect agroforestry farmers to markets are needed to enhance local livelihoods and mitigate forest conflicts.

- The role of agroforestry in payment for ecosystem services (PES) is an underexplored opportunity. Investing in agroforestry–PES initiatives, particularly on agricultural land, can contribute to the development of agri-biodiversity, water-use efficiency, land productivity and improved livelihoods.

- CBFM across ASEAN places greater attention on agroforestry to address the livelihoods' needs of forest-dependent communities.

- Agroforestry's positive contribution to farm biodiversity is evident, yet, it remains on the periphery of ASEAN's agenda to conserve biological diversity.

Harnessing the restorative ecological and economic benefits of agroforestry

About 25% of the planet's land area is already degraded, with more than 70% of arable land in some parts of Southeast Asia experiencing severe erosion (>11 t ha^{-1} yr^{-1}; Sartori et al. 2019). Nkonya and others (2016) estimated that land degradation from land-use and land-cover change in Southeast Asia cost USD 5.97 billion per year or 2.5% of regional GDP in 2007. Agroforestry helps reduce the 'leakage' effects of conservation because human well-being and ecological integrity are simultaneously targeted. This interaction is a necessary consideration in Southeast Asia, where socio-ecological challenges, such as urbanization, have shrunken the total area available for large-scale restoration.

Owing to its versatility, agroforestry is often employed to resolve underlying and proximate causes of land degradation (van Noordwijk et al. 2020a). For example, in the Philippines, where over 60% of the total land area is comprised of uplands, farmers have established contour hedgerows on sloping land to control soil erosion (Magcale-Macandog et al., 2010). Likewise, tree–crop arrangements on volcanic foot slopes on Java Island, Indonesia, have been shown to mitigate the risks of landslide reactivation (Purwaningsih et al. 2020). In these landscapes, the restorative benefits of agroforestry were realized over the long term.

The presence of trees on agricultural land has also been shown to result in productivity comparable to monocultural crops and, in some cases, to higher yields while at the same time supporting biodiversity and ecological functions (Table 4.1). Comparing monocultural and agroforestry rubber plots in southern Thailand, Warren-Thomas et al. (2020) found higher yields and more tree species' richness in rubber agroforests. In Lao PDR, intercropping eucalyptus trees with rice generated higher financial returns than eucalyptus monoculture (Phimmavong et al., 2019). Likewise, cocoa-coconut agroforestry systems had the highest economic and environmental advantage than cocoa monoculture and were preferable to cocoa-rubber agroforestry in Banyuwangi Regency, Indonesia (Utomo et al. 2016). These results indicate the importance of local conditions for species integration.

Through on-farm diversification, agroforestry also carries fewer economic risks than monoculture. Santos Martin and van Noordwijk (2011) observed that maize monoculture resulted in negative profitability values for 27% of cases simulated in the Philippines whereas all tree intercrop systems maintained positive values. These systems included native and exotic trees, suggesting that policies should widely promote native trees in agriculture. The results were also confirmed by Bertomeu (2012), who found intercropping systems of maize and timber delivered the highest profitability compared to monocultures of either species. More groups are expressing interest in tree-based farming for ecosystem services (Do et al. 2020). Yet, poor access to extension services and financial resources are limiting factors in adopting agroforestry.

Table 4.1. Agroforestry studies on production yield in Southeast Asia

Agroforestry system	Study design and yield	Location	Source*
Intercropping trees with maize	Data on the impact of two timber tree species were collected from experimental plots with three treatments: maize monocropping; trees in block arrangements intercropped with maize; and trees in hedgerows intercropped with maize. Overall profitability was highest in intercropping systems than either maize monoculture or woodlots.	Mindanao, Philippines	Bertomeu 2012
Eucalyptus agroforestry	Financial analyses were conducted on sample plots of three plantation models: eucalyptus intercropping with rice; eucalyptus intercropping with cassava; and eucalyptus monoculture. The eucalyptus–rice model (USD 1459) generated the highest returns, followed by eucalyptus monoculture (USD 1190) and intercropping with cassava (USD 1156).	Four provinces in Lao PDR	Phimmavong et al. 2019
Intercropping native and exotic trees with maize	Production data on maize monoculture and intercropping of maize with native and exotic trees were compared using the Water, Nutrient and Light Capture in Agroforestry Systems (WaNuLCAS) computer model. For all tree densities and species tested, intercropping was as profitable as monocropping scenarios. Economic risks were higher in the latter scenarios, as negative profitability values were simulated in 27% of cases.	Leyte, Philippines	Santos Martin and van Noordwijk 2011
Cocoa agroforestry	Land productivity of five rain-fed cocoa farms was analyzed using land equity ratio, which compares yields between intercropping and monoculture. Higher yield and better	Banyuwangi Regency, Indonesia	Utomo et al. 2016

	environmental performance were found in cocoa-coconut agroforestry systems than cocoa monoculture and cocoa-rubber agroforestry.		
Rubber agroforests	Rubber yield estimates were collected in 47 agroforests and 34 monocultural rubber plots with spatial overlap to biodiversity data. The average annual rubber yield was similar: 1.34 t ha^{-1} ± 0.61 in agroforestry plots and 1.51 t ha^{-1} ± 0.54 in monoculture plots.	Two provinces in southern Thailand	Warren-Thomas et al. 2020

*Listed alphabetically

The role of agroforestry in community-based forest management

In ASEAN, agroforestry has mostly been mainstreamed through CBFM programmes, which, broadly, involve local communities and indigenous peoples in forest management (Table 4.2). Different names for CBFM include 'community forestry', 'social forestry' and 'village forestry'. While much of the earlier focus of CBFM was placed on reforestation and provision of wood, the current focus has broadened to include benefit-sharing, income-generation, and mixed land-use, such as agroforestry.

Despite limited data on the extent of agroforestry in community forestry, case studies of mixed land-use highlight the prevalence of agroforestry in forest areas. In Indonesia, communities have carried out conservation activities under CBFM in exchange for permission to cultivate multi-strata coffee systems in protected forests (Box 4.1). The authorization of agroforestry has forged mutual relationships between local people and the Ministry of Environment and Forestry and reduced forest protection. By allowing farmers to plant and use multipurpose trees on land near forests, governments can offset local dependence on natural forests and support local biodiversity and conservation of water and soil, as seen in the Philippines (Box 4.2).

Table 4.2. Community forestry management policies for agroforestry in ASEAN

Country	Legal or policy document and regulation
Cambodia	In the 2003 Sub-Decree on Community Forestry Management (No. 79), community forestry user groups may practise traditional swidden agriculture for the time specified in their community forestry management plan (article 11). They can also plant, manage, harvest and sell non-timber forest products and tree species approved in their management plan (article 12).
Indonesia	Under Ministerial Regulation No.P37/2007 on Community Forestry, agroforestry can be applied in Community forestry areas. Subsequent regulations have extended agroforestry to production, protection and conservation forests (Government Regulation No. 23/2021 Forest Administration). Agroforestry is promoted in landscapes where timber cutting is prohibited. The 2019 Ministerial Regulation No P.62 on plantation forests (HTI) removed the time restriction of practising agroforestry.
Lao PDR	In the 2019 Forestry Law, individuals and households can convert land from one category to another to contribute to the people's livelihood inconsistency with other existing laws, strategies and sectoral and local land use plans (articles 169-179). Proposals for conversion will be examined based on their impacts on the social and natural environment. Through the land allocation programme, households may grow trees and claim ownership after receiving their land title. Restoration activities through community-based plantations are further articulated in the Forest Strategy 2030.

Malaysia	The Sabah Forestry Department and Forest Department Sarawak promote agroforestry in their social forestry programmes, focusing on the rehabilitation of degraded forests with local participation. In Peninsular Malaysia, social forestry programmes allow forest users and households to plant traditional fruit trees along forest fringes.
Myanmar	In the 2019 Community Forestry Instructions, members of community forestry user groups have the right to adopt agroforestry systems suitable for the conditions of the community forestry area (article 23. f).
Philippines	According to their approved management plan under Executive Order No. 263 S. 1995, organized communities and indigenous peoples can employ agroecological approaches and customary practices in community forestry. The Department of Environment and Natural Resources is tasked with providing financing options and technical assistance for agroforestry development and other livelihoods' strategies for CBFM.
Thailand	In the 2019 Community Forestry Act, communities can use community forest areas for conservation and utilization purposes. Forest products and services can be used for subsistence. Non-timber forest products-based enterprises and ecotourism can be developed according to authorized management guidelines. Communities receive all income generated by activities from forest products and services. Although agroforestry practices are not mentioned in the Act, the objectives of establishing community forestry include rehabilitation, biodiversity conservation and sustainable use of natural resources.
Viet Nam	In the 2017 Forestry Law, mixed land-use activities — such as growing seasonal crops with trees and aquaculture — are allowed in protection forests (article 57) and production forests (Article 60). Forest owners, including communities and individual households, of planted protection and production forests, can engage in these activities as long as their management plan adheres to existing forest regulations.

Note: Brunei Darussalam and Singapore do not have official CBFM programmes and are not included.
Source: AWG-SF focal points, RECOFTC and AWG-SF 2017.

Box 4.1. Rewarding community-based forest-fire management in Indonesia

After the economic crisis in 1998, the Government of Indonesia encouraged farmers to use uncultivated land for growing food, indirectly strengthening their tenure rights. For the upland farmers of the Trimulyo community, uncultivated land included parts of the protected forest area that had been previously cleared and were subsequently under unproductive grassland (*Imperata cylindrica*). In the protection forests under the social forestry scheme, nearly 89% of coffee was grown in multi strata systems, in which other fruit trees and vegetables featured as income-diversification strategies. Cultivation of coffee and other commodities around and inside the forests coincided with visible reductions in forest fires (Figure 4.1).

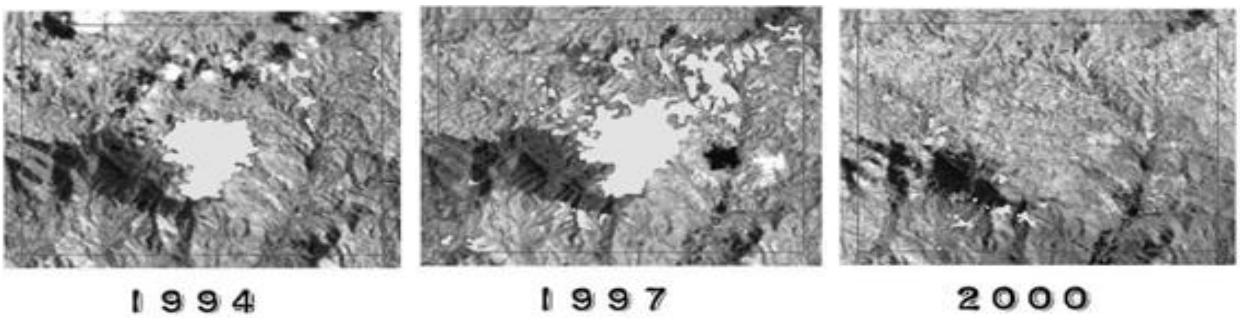

Figure 4.1. Change in burn scar from 1994 to 2000 in Trimulyo, Sumatra, Indonesia
Note: Burn scar indicated by the white areas.

The communities reduced the incidence of large-scale forest fires and stabilized the soil for cultivation by carrying out controlled burning. These outcomes prompted a series of negotiations between farmers and forestry officials on forest co-management, increasing farmers' land-tenure security in the protected forests. Through agroforestry, livelihoods' development and land tenure in the forest areas provided the incentives for the people to engage in forest-fire management. The costs of forest protection were reduced along with social conflicts between forest users and managers.

Increasingly, forest communities are given statutory land tenure rights in exchange for sustainable forest management through the social forestry programme. Since December 2020, there are 7513 social forestry enterprise groups (Kelompok Usaha Perhutanan Sosial/ KUPS) in Indonesia. Of these groups, nearly 30% manage their land through agroforestry practices. For example, the social forestry enterprise of Wono Lestari in Lumajang, East Java, has adopted silvopasture, allowing its members to produce livestock feed (`rumput gajah'), cow's milk, taro, banana and 'sengon' (*Albizia chinensis*). Promoting agroforestry in social forestry areas has led to the production of key commodities such as coffee, honey, rattan, bamboo, and timber for meeting national and international demand. Further agroforestry extension is needed to improve the business management and governance of local cooperatives.

Source: AWG-SF survey, Suyanto et al 2005.

Box 4.2. Less reliance on natural forests through agroforestry in the Philippines
In 1995, the Government of the Philippines issued an executive decree to promote CBFM. The Integrated Social Forestry Program (ISFP), which started in 1982, was subsequently included in this national programme. Through the ISFP, occupants were given 25-year tenure over public forestland for agricultural cultivation. Participants in this programme were discouraged from intensive agriculture and burning and instead were required to grow trees, including five fruit-tree species per hectare, on their farms. In a socio-economic assessment of the programme, participants were less dependent on natural forests than non-participants. Participating households gathered most of their fuelwood from their farms, which reduced competition for scarce harvestable timber in the nearby forests.

Under the broader CBFM programme, the Government completed over 1500 projects, of which 80% involved agroforestry. Between 2007 and 2020, a total of 66,258.15 hectares of upland and coastal areas were restored, benefitting 1,688 community forestry organizations and 148,496 households in their CBFM-CARP projects alone. The National Greening Program, which also includes agroforestry as a strategy, rehabilitated 2,078,903 hectares

and provided 5 million jobs from 2011 to 2020. By placing sustainable forestry and farming as national priorities, the Government has also ushered in investment from international donors, including the Japan International Cooperation Agency (JICA), Asian Development Bank (ADB) and the International Fund for Agricultural Development (IFAD).

Through JICA funding, the Department of Environment and Natural Resources established 32,593 hectares of agroforestry to strengthen three critical river basins with forestland. Likewise, they also established 14,374 hectares of agroforestry to conserve four priority upper river basins with ADB and IFAD funding. These outcomes demonstrate the importance of national policies in realizing opportunities for agroforestry development.

10 hectares agroforestry coffee plantation in Bukidnon, Philippines. Photo courtesy of DENR.

Source: AWG-SF survey, Bugayong 2003.

Agroforestry in payment for ecosystem services' schemes remains underexplored

While agroforestry-based PES schemes have emerged in other places, including Costa Rica and Mexico (Corbera et al. 2009, Cole 2010), these schemes remain an underexplored area in Southeast Asia. This is the case even though, in practice, in many pilot PES landscapes, agroforestry plays a large role (Leimona et al., 2015).

The majority of PES schemes in Southeast Asia are at the prototype stage, except in Viet Nam where a legal foundation exists for forest-based payments for watershed services (Duong and de Groot 2020). Establishing PES programmes and metrics for agroforestry-specific activities is critical to leverage resources to engage poor households in sustainable development. Farmers are often not compensated for growing trees on their farms but only on degraded land for reforestation. Institutional arrangements between service users and providers in PES schemes should include dialogues to create equitable benefit-sharing mechanisms and deploy a landscape approach to ensure that land uses and benefits for both the environment and humans are optimized (Figure 4.2).

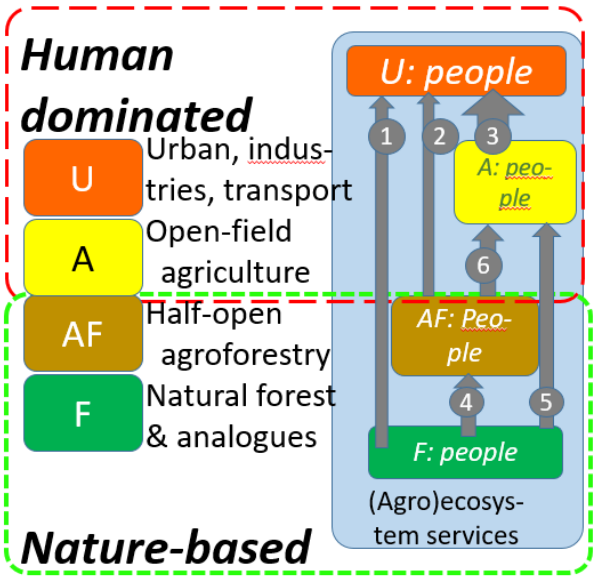

Figure 4.2. Ecosystem services as benefits people derive from functioning (agro-) ecosystems
Note: These can be direct and indirect (in arrows 1–6), based on forests, half-open agroforestry and open-field agriculture, depending on where people live.
Source: Duguma et al. 2021.

The inclusion of agroforestry as a component in PES schemes has created a range of partnerships to bridge stakeholders' interests and needs. For example, in Bac Kan Province, Northeast Viet Nam, the provincial government compensated forest users in a national park for their forest management, which enhanced carbon sequestration and related ecosystem services (Table 4.3). Private companies have also worked with service providers through PES schemes related to forest and water conservation. Rewards for conservation efforts have supported local infrastructural development and led to tenure security, as seen in cases in Indonesia and the Philippines (Table 4.3). With agroforestry known to improve environmental and human welfare, investment in agroforestry-specific PES schemes can support the livelihoods of millions of smallholders in ASEAN.

Table 4.3. Case studies of payment for ecosystem services schemes in Southeast Asia

	Sumberjaya, Indonesia	**Ba Be National Park, Viet Nam**	**Bakun, Philippines**
Ecosystem services	Watershed rehabilitation for the District Forestry Service and water quality for hydropower	Water quality and carbon sequestration	Water quality for hydropower
Conservation activities	Soil conservation, agroforestry, growing grasses and trees to reduce sedimentation	Water and soil conservation on slopes and growing trees	Sustainable horticultural practices
Environmental service providers	Migrants and long-term residents in the watershed	Communities of Ta Leng River Basin in the core and buffer zones	Upland indigenous Kankanaey-Bago tribe in Bakun
Environmental service buyers	Hydropower plants, District Forestry Service	Two hydropower plants, ecotourism businesses and a voluntary carbon market	Four hydropower plants

Rewards	Conditional tenure rights (HKm) to farmers' groups, cash rewards and electrification for the Rivercare group	In-kind and cash payments	Cash from the power company to the municipal government for infrastructural development

Source: modified from Vardhan and Catacutan 2017.

Further, compared to the other types of ecosystem services, cultural services are typically not evaluated. The trend in agroforestry research over past decades also shows this bias. Shin et al. (2020) found that only 2% of 771 articles between 1980 and 2018 on agroforestry and ecosystem services in the Asia-Pacific examined cultural services. This outcome is not surprising given the focus on plot-level biophysical interactions and socio-economic incentives in the first two agroforestry paradigms. In this third paradigm, a more holistic approach to agroforestry opens opportunities for considering the role of cultural services (Box 4.3). Taking a socio-cultural perspective to agroforestry can encourage cross-scale links to achieve the SDGs. In current documents of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES), discussion of cultural values has mostly shifted to one on 'relational values' of nature to people (van Noordwijk et al. 2020b).

Box 4.3. How do farmers feel about agroforestry in the Ayeyarwady Delta of Myanmar?

In a first-ever study, Lin (2020) examined the impact of knowledge ties on well-being among agroforestry farmers. Those farmers who had more connections to share with and more advice to give were more likely to report higher socio-cultural well-being, happiness, quality of life, and other subjective dimensions related to cultural ecosystem services. The indicators used for the study covered therapeutic value, connection to nature, place identity, spiritual value, social ties and aesthetics (Table 4.4). Study respondents were agroforestry farmers who resided in the Ayeyarwady Delta of Myanmar, which has undergone significant land-use changes since Cyclone Nargis in 2008.

Table 4.4. Socio-cultural well-being indicator statements and dimensions

No.	Indicator statement	Dimension
1	Visiting my agroforestry site helps me reduce my stress.	Therapeutic value
2	Visiting my agroforestry site leaves me feeling healthier.	
3	Visiting my agroforestry site gives me a sense of freedom.	
4	Visiting my agroforestry site makes me feel more connected with nature.	Connection to nature
5	Visiting my agroforestry site has made me learn more about nature.	
6	My agroforestry site feels almost like a part of me.	Place identity
7	I miss my agroforestry site when I have been away from it for a long time.	
8	At my agroforestry site, I feel part of something greater than myself.	Spiritual value
9	I have strengthened my social ties with others by taking them to my agroforestry site.	Social ties
10	I have felt touched by the beauty of my agroforestry site.	Aesthetics

Despite the high traffic of development projects in the area, it was the first time for respondents to be asked about non-material aspects of their farming practices, which aligns

with the limited assessments of cultural ecosystem services found in the agroforestry literature. In addition to the role of advice ties, site location also affected well-being outcomes, with respondents at two sites strongly agreeing with at least half of the statements and respondents at the other two sites strongly agreeing with only one-third of the indicator statements. Further analysis of socio-cultural values can provide a more comprehensive understanding of human well-being and trade-offs in management practices.

Source: Lin 2020.

Agroforestry and water-use efficiency and productivity

There is scant documentation of trees concerning water-use efficiency in ASEAN. We do have evidence that in South Sulawesi, Indonesia, agroforests in the Bialo Watershed reduced evapotranspiration by 2.6% between 1989 and 2009 and stabilized surface soil flows (Tanika et al. 2013). By increasing water-use efficiency and productivity, agroforestry builds farmers' resilience to shocks and stressors. In Northwest Viet Nam, tea plantations and tree-based farming systems experienced less erosion and had more water holding capacity than monocultures (Hoang et al., 2017).

While integrating trees on farmland can support water conservation, investment in agroforestry research is also needed to avoid the harm of implementing maladapted models. An inappropriate mix of species, for example, can lead to undesirable resource competition. Land-use and tree cover alone do not capture the full state of water services. Through long-term assessments of ecosystem services, resource users can be better informed about optimal agroforestry models for implementation.

Agroforestry as a biodiversity conservation tool

Agroforestry promotes ecological corridors between fragmented habitats, acting as an intermediary between natural forests and intensive agriculture. Numerous studies have shown a direct association between enhanced biodiversity and agroforestry. For example, in southern Thailand, Warren-Thomas et al. (2020) found that rubber agroforests supported greater butterfly species' richness than monocultures. Researchers from the Community Land Allocation Project in Chiang Mai, Thailand, recorded 243 plant species at one agroforestry site, indicating the value of agroforestry in biodiversity conservation. In recognizing this, the Convention on Biological Diversity included agricultural biodiversity, sustainable aquaculture and forestry management in its various targets. The ASEAN Center for Biodiversity supports these targets through leading dialogues with regional stakeholders.

Local knowledge of the role of trees in farming systems influences land-use decisions about integrating different species, which affects ecosystem functions and biodiversity outcomes. In Northwest Viet Nam, Nguyen et al. (2019) found that shaded coffee agroforestry plots had on average 10 more tree species than full-sun coffee monoculture. Most farmers were aware of the ecosystem benefits provided by coffee agroforestry systems, such as improving soil moisture, enhancing biodiversity and protecting against the wind (Nguyen et al. 2020). However, they were directed by the market in their selection of species for intercropping (Nguyen et al. 2020). With significant overlaps in biodiversity hotspots and coffee farms (Jha et al. 2014), agroforestry can maintain the gene flow for plants and serve as a biological corridor to increase connectivity between protected areas and farms.

In Sulawesi, Indonesia, Clough et al. (2020) reported an increase in bird species' richness when cacao agroforests were close to forests. In the Philippines, Fidelino et al. (2020) found no significant difference in fruit bat species' richness, overall abundance and diversity

between secondary forests and reforestation sites using agroforestry. The concentration of endemic species in reforestation sites was lower than in secondary forests, which may be due to exotic tree species in these initiatives. Emerging outbreaks of pests and diseases from loss of biodiversity and human-wildlife conflict signal the value of agroforestry in regional land-use planning and landscape-based management.

Capitalizing on agroforestry for landscape restoration

Agroforestry strengthens the relationship of humans with nature in creating multifunctional landscapes. These landscapes integrate production activities into the ecological fabric, supporting critical ecosystem services and livelihoods development. Bastin et al. (2019) revealed that the Earth could accommodate an additional 0.9 billion hectares of continuous forest, storing up to 205 Gt CO_2. Much of this potential lies outside forests, signifying the need to leverage agroforestry to enable a 25% increase in global forest cover (Bastin et al. 2019). However, follow-up studies with higher spatial resolution will be needed to clarify where this potential exists (Friedlingstein et al., 2019). Along with spatial assessments of TOF, policies that promote agroforestry, including community forestry and watershed restoration, can boost opportunities to support ecosystems and livelihoods' well-being.

Multifunctional agroforestry landscapes help balance the social and ecological demands of the surrounding environment. Trees on farmland can ignite a positive feedback loop between environmental sustainability and economic growth (van Noordwijk et al. 2020a). Specifically, these systems improve agri-food production through enhanced ecosystem services and attract tourists to local enterprises. The latter outcome reflects the desire among urban residents in megacities, such as Bangkok, Ho Chi Minh City, Jakarta and Manila, to reconnect with nature (Box 4.4). The shrinking distinctions between rural and urban areas present conditions for agroforestry to thrive as ecological corridors that support resilient, environmentally sustainable and economically diverse economies.

Box 4.4. Delivering agroforestry co-benefits in Bang Kachao, Thailand
Bang Kachao, also known as the 'lungs of Bangkok', is an artificial island located on the city's peri-urban southern fringe, in the Chao Phraya River (Figure 4.3). Bang Kachao covers 1920 hectares and is an oasis for urban residents to recuperate from the city's congestion. Much of the island is under traditional agriculture, comprising orchards and crops, coconut and mango monocultures, and farms with multipurpose trees. The last system stems from HM King Bhumibol Adulyadej's advice of 'three forests, four benefits'. Through three kinds of trees in farming, HM the King promoted agroforestry to produce positive environmental externalities from on-farm diversification.

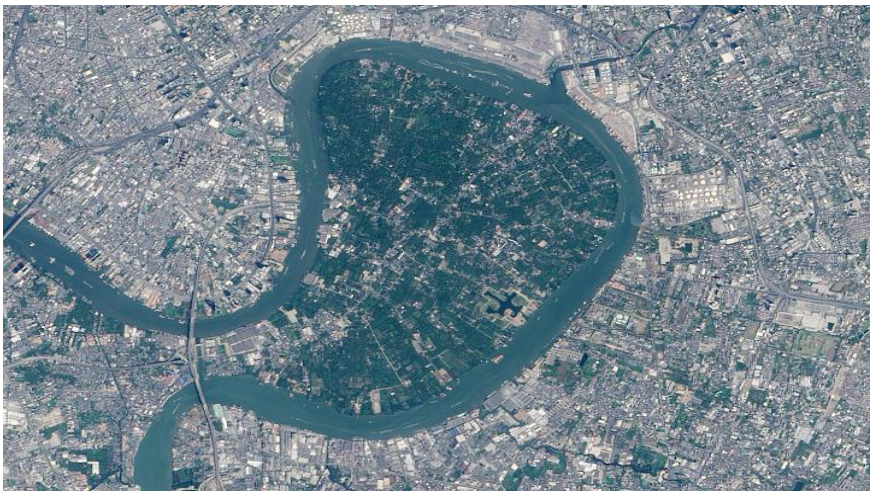

Figure 4.3. Map of Bang Kachao, Bangkok, Thailand
Source: Google Earth (2020).

Through agroforestry practices, the urban greenery and locally produced, sustainable products have enabled Bang Kachao to benefit from agritourism, increasing their socio-economic status through income from the accommodation, health services and agricultural educational activities. Under the One Tambon One Product programme, which stimulates Thai entrepreneurship, agroforestry has enabled local businesses to stay competitive by selling sustainable agri-food products. The mutually beneficial relationship between 'rural' and urban residents indicates the importance of urban green spaces in integrated land-use management.

Sources: Petcharat et al. 2020, Sommeechai et al. 2018.

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Chapter 5. Adaptive and resilient communities through agroforestry

Key messages

- Agroforestry is low-cost insurance for smallholders against environmental disasters, yet there is limited technical support, restricting widespread adoption. Multi-sectoral partnerships are needed to bridge knowledge and resource gaps.

- Agroforestry can link the SDGs and Nationally Determined Contributions (NDCs) to the United Nations Framework Convention on Climate Change (UNFCCC). ASEAN decision-makers should explore ways to make carbon an economically viable commodity to scale up suitable agroforestry models. This will enhance agroforestry as a proactive adaptation tool in the stable supply of food and material goods and physical protection against environmental disasters.

Agroforestry is low-cost insurance against environmental disasters

For rural communities at the frontlines of climate change, agroforestry is low-cost insurance against extreme weather events and environmental disasters. On-farm diversification by integrating multiple agricultural and forestry components helps build better management of risks from external shocks, including market failures and unanticipated weather changes, as witnessed in Viet Nam and the Philippines (Landicho et al. 2016, Nguyen et al. 2013). In contrast to monocultures, agroforestry presents smallholders with the ability to modify their farming practices according to their local conditions. Smallholders can claim ownership over agroforestry technologies through this bottom-up approach and have a greater incentive to maintain adoption, supporting land-use sustainability.

The growing prevalence and magnitude of environmental disasters and hazards make nature-based solutions such as agroforestry critical for reducing climate-change risks and costs. All AMS are vulnerable to the effects of climate change, with four AMS (Myanmar, Philippines, Viet Nam and Thailand) in the global top-ten countries most at risk of extreme weather events (Eckstein et al. 2020). In 2017, the financial costs of environmental disasters in Southeast Asia were at least USD 4.7 billion, with 90% of these disasters being floods, storms and landslides (EM-DAT 2021). This figure adds to the total costs from environmental disasters in the region of more than USD 121.12 trillion, with 324 million people affected between 2000 and 2020 (EM-DAT 2021).

Given that food systems account for about a third of global anthropogenic greenhouse gas (GHG) emissions (Crippa et al. 2021), adopting agroforestry can mitigate costs associated with climate change while enhancing local adaptation. Over half of the top solutions for reversing global warming consist of changes in land use, food production, and consumption (Project Drawdown 2020). These solutions include reduced food waste, plant-rich diets, and tropical forest restoration, which can sequestrate an estimated total CO_2 eq of 348 Gt between 2020 and 2050. Contributions of sustainable agriculture, such as agroforestry, are critical in Southeast Asia, where the food system was responsible for 74% of GHG emissions in 2015 (Crippa et al., 2021). This figure represented a 13% drop from 1990, indicating the sustained importance of developing and implementing effective policies to address food-related emissions.

How growing trees on farmland can reduce greenhouse gas emissions

Most AMS have ratified international climate-change initiatives, although progress remains uncertain because many national policies are missing explicit targets. In the submissions to

the Koronivia Joint Work on Agriculture under the UNFCCC, countries recognized agroforestry as a key approach to achieving societal objectives for food security, biodiversity conservation and climate resilience (Chiriaco et al. 2018). Agroforestry is also embedded into restoration-focused initiatives, such as Reducing Emissions from Deforestation and Forest Degradation Plus (REDD+), the Bonn Challenge, United Nations' conventions to Combat Desertification — through Land Degradation Neutrality — and on Biological Diversity.

Sustainable conversion of forest ecosystems is critical to mitigating climate change because natural forests in Southeast Asia store high amounts of carbon — up to 500 Mg C ha^{-1} — and absorb up to 3 Gt C per year (IPCC 2014). Throughout Southeast Asia, commodity crop plantations have opened pathways to accelerate economic growth yet at a hefty price to environmental and social landscapes (Tenneson et al., 2021). In Sabah, Malaysia, Besar et al. (2020) found that oil-palm agroforestry systems had higher total ecosystem carbon stock than monocultures. Carbon stock ranged 78.28–85.40 Mg C ha^{-1} for agroforestry systems and 60.30–76.44 Mg C ha^{-1} for monocultures (Besar et al. 2020). Adopting agroforestry can, thus, deliver social and environmental co-benefits and avoid agricultural expansion into and wood extraction from intact natural forests (Box 5.1).

Although comparisons of GHG emissions between monocultures and agroforestry systems are rare in Southeast Asia, studies of Asian agroforestry systems show that they can sequester 2–10 t CO_2e ha^{-1} $year^{-1}$ (Table 5.1). The total carbon stock of agroforestry ranges 4–23 t CO_2e ha^{-1} $year^{-1}$ for aboveground biomass, 1–4 t CO_2e ha^{-1} $year^{-1}$ for belowground biomass, and 1–14 t CO_2e ha^{-1} $year^{-1}$ in soils. All three components of carbon stocks are relevant in measuring the potential for carbon sequestration. Focusing on only one may lead to misguided assumptions. For example, Bruun et al. (2018) show that conversion from swidden agriculture with fallows to rubber plantations incurred a loss in soil carbon stock in northern Lao PDR. However, depending on the rotation intensity of the swidden cultivation, this loss may be compensated by an increase in the aboveground carbon stock of the perennial rubber. A recent synthesis quantified some of the challenges in soil carbon measurements where soil compaction after forest-to-agriculture conversion can partly mask real changes in soil carbon stock (Hairiah et al. 2020).

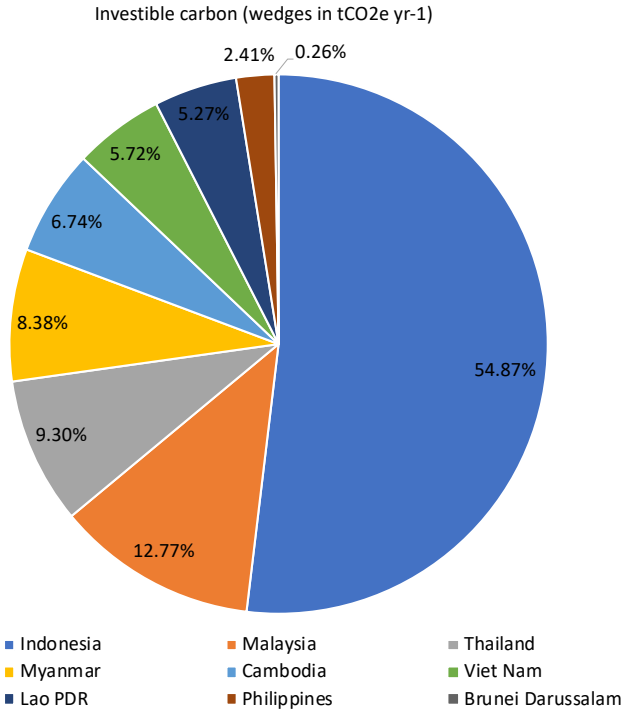
Table 5.1. Annual sequestration rates of above-, belowground and soil-organic carbon (AGC, BGC and SOC) for agroforestry systems in Asia

System	AGC[1]	BGC[1]	SOC[1]
Rotational woodlot	23.0 ± 5.9	n.d.	n.d.
Multi-strata	11.1 ± 7.7	2.7 ± 1.8	n.d.
Improved fallow	10.6 ± 6.7	n.d.	n.d.
Homegarden	10.2 ± 1.7	n.d.	14.1 ± 1.3
Agroforestry (all types)	9.9 ± 2.6	4.0 ± 2.2	n.d.
Silvopastoral	9.7 ± 2.9	n.d.	n.d.
Shaded perennial	7.6 ± 1.9	1.8 ± 0.5	n.d.
Silvo-arable	5.5 ± 4.1	1.3 ± 0.9	4.8 ± 4.6[2]
Agrosilvicultural	4.1 ± 2.9	n.d.	0.9
Alley cropping	n.d.	n.d.	7.0 ± 2.7[2]
Hedgerow	n.d.	n.d.	2.2 ± 1.2[2]

Note: [1] Rate measured in t CO_2e per ha per year.
[2] Stock value calculated for agroforestry converted from cropland.
Source: Data for woodlots, improved fallow, home garden, silvopastoral and agrosilviculture (synonymous to silvo-arable) from Feliciano et al. (2018). Data for multi-strata shaded perennial, silvo-arable, alley cropping and hedgerow from Cardinael et al. (2018). Data for agroforestry (all types) from Bernal et al. (2018).

Investment in agroforestry research can inform policy recommendations for climate-change strategies, including NDCs. In Mindanao, the Philippines, Tolentino et al. (2010) found that complex agroforestry systems had a carbon stock of 192 t C ha^{-1}, three times more than the carbon stock of tree plantations (59 t C ha^{-1}). Multi-strata cacao-agroforestry systems in Indonesia and the Philippines have shown to hold stock above 100 t C ha^{-1} for aboveground carbon (Lasco et al. 2001, Santhyami et al. 2018). If agroforestry systems in Viet Nam were expanded to their potential of an additional 10 million hectares, at least 260 Mt C could be sequestered annually (Mulia et al. 2018, 2020).

Focusing on investible forest carbon,[4] Koh et al. (2021) found the Asia-Pacific region yields the highest regional financial returns at USD 24.62 billion per year. Of this amount, ASEAN countries captured 79.69% or USD 19.62 billion per year. The high profitability of forest carbon in the Asia-Pacific is likely owed to the high deforestation rates and high carbon density of tropical forests (Koh et al. 2020). Overall, the ASEAN region has 420.01 million t CO_2e yr^{-1} in investible carbon, with much of the carbon investment potential concentrated in Indonesia (Figure 5.1). Despite this opportunity to obtain financial returns for forest protection, investment in carbon projects, especially related to agroforestry, is not widespread in Southeast Asia. They are exploring ways to make carbon a viable commodity can encourage various stakeholders to balance carbon storage and production requirements, as demonstrated among teak agroforestry smallholders in northeast Thailand (Box 5.2).



Country	Investible carbon (t CO^2e yr^{-1})
Indonesia	230,478,000
Malaysia	53,632,000
Thailand	39,054,000
Myanmar	35,182,000
Cambodia	28,307,000
Viet Nam	24,031,000
Lao PDR	22,123,000
Philippines	10,133,000
Brunei Darussalam	1,101,000
Singapore	1,000
Total	420,011,000

Figure 5.1. Investible forest carbon in ASEAN
Note: Singapore excluded from the pie graph as national estimates were less than 0.00% of the regional total.
Source: Data for pie graph and table from Koh et al. 2021.

[4] In Koh et al (2021), investible forest carbon refers to certifiable carbon from forest protection projects. This was estimated by combining total volume of CO_2 from three carbon pools in tropical forests: aboveground carbon, belowground carbon, and soil organic carbon. Key criteria of Voluntary Carbon Standard was then applied to model and map investible forest carbon.

Box 5.1. Co-benefits of oil-palm and rubber agroforestry systems against price shocks

Given that most commodity crops are produced by smallholders (Lowder et al. 2016), agroforestry can empower smallholders to improve their livelihoods. In Indonesia, smallholders' rubber and oil palm constitute 85% and 40% of total production volumes, respectively, with similar figures elsewhere in the region (Giessen et al. 2016, Naylor et al. 2019). Although commodity crops such as oil palm and rubber have increased smallholders' economic welfare, these markets are sensitive to price shocks (Figure 5.2), indicating the importance of safeguards, such as on-farm diversification. The irreversible effects of converting natural ecosystems to agricultural land use also require strategic consideration for environmental and human well-being.

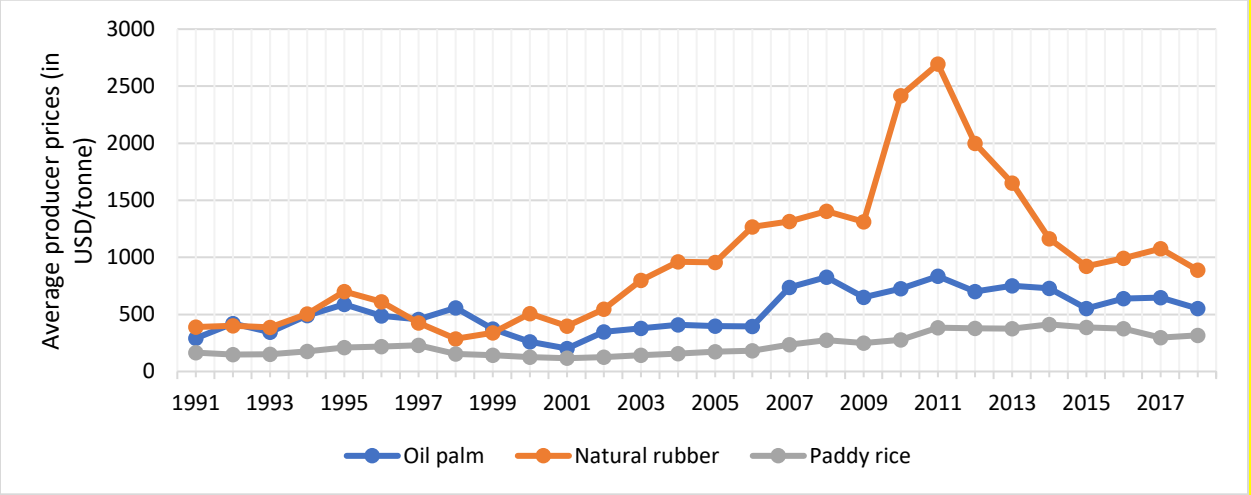


Figure 5.2. Producer prices for oil palm, natural rubber and rice, 1991–2017
Note: Paddy rice added as a marker to compare with oil palm and rubber.
Source: Data of average producer prices for oil palm, natural rubber and paddy rice calculated based on the available dataset of AMS from FAOSTAT 2020.

Both rubber and oil palm thrive in moisture-rich environments with deep soil and stable high temperatures, making peatlands prone to land-use conversion. Guillaume et al. (2018) estimated that for each hectare of tropical rainforest lost to rubber and oil-palm monoculture, 159 and 174 t CO_2 is released into the atmosphere, respectively. After oil palm is harvested, the underground biomass can be 90% lower, contributing to cumulative declines in soil fertility (Guillaume et al., 2018). By comparison, the conversion of tropical rainforest to rubber agroforests or jungle rubber with no fertilizer or herbicide applications reduces the release of CO_2 by 27% (116 t CO_2 ha^{-1}) (Guillaume et al. 2018). Based on these estimates, about 534 million t CO2 would not be released into the atmosphere if all monocultural rubber plantations in Southeast Asia were under agroforestry systems.

Box 5.2. Making agroforestry carbon offsets economically viable in Northeast Thailand

After initial success in agroforestry systems, a group of former cash-crop farmers established the Inpang network in 1987 to promote sustainable agroforestry techniques throughout Northeast Thailand. Since then, the network has grown to over 4000 members

in five provinces. By recognising agroforestry farmers' role in carbon sequestration, national and international stakeholders involved the Inpang network in a series of capacity-building workshops about using carbon stored in trees as offsets. Following approval from the Thailand Greenhouse Gas Management Organization, 98 agroforestry teak smallholders enrolled in the Carbon Bank project. Under favourable policy conditions, the Inpang Carbon Bank highlights the ability of agroforestry carbon offsets as an intervention to tackle both rural poverty and climate change.

Source: Samek et al. 2011.

Agroforestry as a proactive adaptation tool for farmers at the frontline

Studies of climate-change variability show the benefits of multipurpose agroforestry for income and food security. In Viet Nam, Nguyen et al. (2013) found that rice and rain-fed crop systems suffered over 40% losses of yields in years of extreme drought or flood compared to tree-based systems. Households with home gardens had a higher adaptive capacity to climate change due to diverse tree species' resilience. Likewise, upland smallholders in the Philippines who adopted agroforestry were reportedly experiencing less severe impact from extreme weather events (Landicho et al., 2016). Under changing climate conditions, agroforestry supports smallholders by providing a more stable supply of food and material goods necessary for building local adaptation abilities.

In addition to improving the resource base, agroforestry also strengthens existing farming practices and systems by replenishing soil health and enhancing related ecosystem services to maintain yields under changing biophysical conditions (Table 5.2). Through the Conservation Agriculture Network for Southeast Asia, institutional partners from six Southeast Asian countries promoted low-cost agroecological technologies — such as intercropping and cover-cropping systems — as adaptation strategies against climate change (Legoupil et al. 2015). Natural physical barriers, including windbreaks and shelter breaks, also serve as vital adaptation tools by reducing crop damage caused by wind, as observed among farming households in Viet Nam by Simelton et al. (2015).

Table 5.2. Adaptation benefits of agroforestry practices in Southeast Asia

Practice	Adaptation benefits	Case study
On-farm diversification with trees (home gardens and multi-storey systems)	Reduces impact and sensitivity to climate change of agricultural production systems, ensuring better incomes and food security	- Rice farmers in Viet Nam (Nguyen et al. 2013) - Upland farmers in the Philippines (Landicho et al. 2016) - Coastal and mountainous farming households in Viet Nam (Simelton et al. 2015)
Conservation agriculture and agroforestry (crop rotation, live fences and shade trees)	Regeneration of soil fertility for degraded land, control of soil erosion and weeds, and production of high-quality forage	- Farmers in southern Lao PDR (Slaats and Lestrelin 2009) - Conservation Agriculture Network for Southeast Asia (Legoupil et al. 2015)
Windbreaks/shelterbelts	Physical protection against climatic elements to reduce soil erosion, conserve water and enhance crop and livestock productivity	Farming communities in the north-central coast of Viet Nam (Van Thuyet et al. 2014)

Fire management	Reduce risks of forest fires through controlled burns and participatory forest management	Upland farmers in Indonesia (Suyanto et al. 2005)
Mangrove conservation and restoration	Buffer storm surges and coastal erosion to protect communities and habitats while providing food and material goods from forests	- Communities in the Ayeyarwady Delta, Myanmar (Thant et al. 2010) - Communities in West Aceh, Indonesia (Bayas et al. 2011) - Communities in Leyte and Eastern Samar, Philippines (Delfino et al. 2015)
Wetland restoration	Rewetting of wetlands to support water management and infiltration and reduce fire risks from the land clearing in degraded areas	National park and smallholders' plantations in Central Kalimantan, Indonesia (Tata 2019)

Source: adapted from Matocha et al. 2012.

Agroforestry has also contributed to human security as a climate-change adaptation tool. In the Ayeyarwady Delta, Myanmar, mangrove forests near farmland were a refuge for local people during Cyclone Nargis in 2008. The presence of forest reduced human mortality from the cyclone stands around communities (Thant et al., 2010). Similarly, in the Philippines, communities with high mangrove forests suffered less damage from Typhoon Haiyan in 2013 than communities without mangroves (Delfino et al., 2015). In the absence of mangrove forests, Bayas et al. (2011) found that coastal vegetation in the front of settlements reduced causalities by an average of 5% from the 2004 tsunami in West Aceh, Indonesia. However, the spatial arrangement of coastal vegetation relative to the location of agricultural sites and settlements is an important determinant for the protection value of agroforestry (Bayas et al., 2011).

Agroforestry at the heart of climate-change strategies

With much of the original forests lost in Southeast Asia (Estoque et al. 2019), ASEAN leaders should explore agroforestry as a natural climate solution. Although sustainable agriculture and forestry are promoted to improve local adaptive capacities, very few countries have streamlined policies to deliver this outcome. Lessons and experiences of the role of agroforestry in local adaptation highlight the weak policy instruments that are hindering farmers' ability to diversify their farming systems. The unequal distribution of climate-change impacts on people's lives and livelihoods also requires strategic responses to support individuals most affected by climate change yet least adapt to it. Several platforms already exist to develop synergies between mitigation and adaptation through agroforestry, but a multi-sectoral approach is needed to put ideas into action (Figure 5.3).

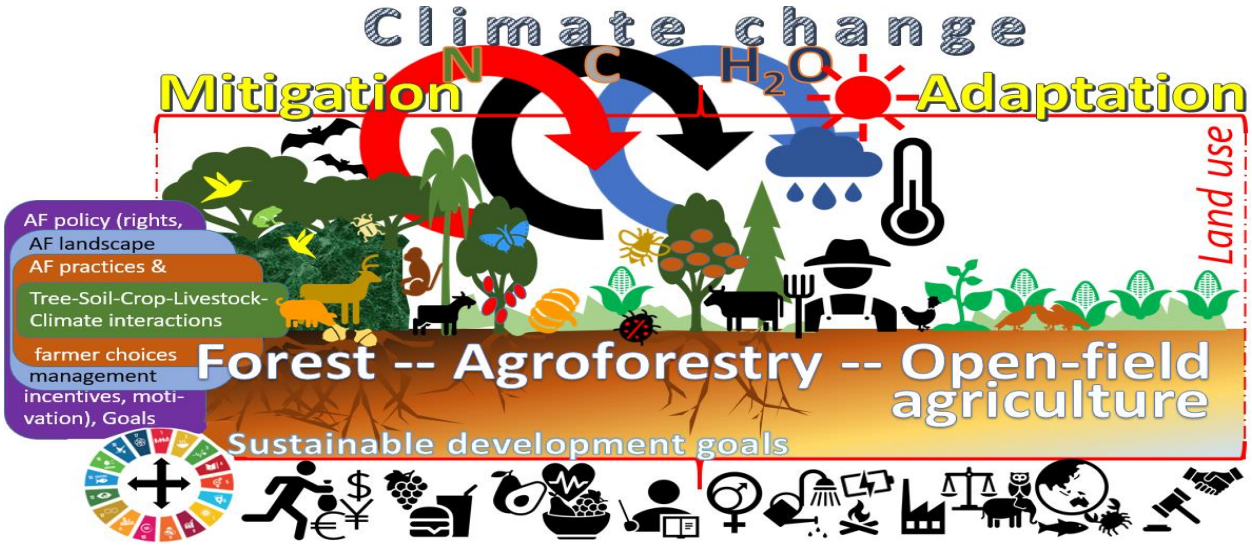


Figure 5.3. The forest–agroforestry–agriculture gradient in land use

Note: The gradient forms a buffer between climate change and attainment of the SDGs, with mitigation primarily linked to the carbon and nitrogen cycles and adaptation (reduced vulnerability) to the water cycle, showing the strong links between the two distinct policy issues (Cardinael et al. 2021).

Facilitating pathways for agroforestry strengthens interactions to achieve multiple goals at once. Within the AMS' NDCs, there are 690 potential links to the SDGs, according to World Resources Institute's Climate Watch (Table 5.3). Through a qualitative content analysis, agroforestry can be used as an entry point for 77% of these links to align policy measures on climate change and sustainable development. This is particularly important because nearly all countries reported a lack of finance as a barrier to achieving their mitigation and adaptation goals (Figure 5.3).

Table 5.3. Role of agroforestry in links between NDCs and SDGs in AMS

Country	NDC–SDG linkages	Agroforestry as an entry point[1]
Brunei Darussalam	58	29 (50%)
Cambodia	102	78 (76%)
Indonesia	35	33 (94%)
Lao PDR	171	129 (75%)
Malaysia	24	18 (75%)
Myanmar	48	46 (96%)
Philippines	22	22 (100%)
Singapore	28	13 (46%)
Thailand	43	32 (76%)
Viet Nam	143	116 (81%)
Total	**673**	**516 (77%)**

Note: [1] We conducted a qualitative content analysis of the linkages in column 2 to obtain the values for using agroforestry as a potential entry point to achieve the SDGs and NDCs. Through a textual reading of the NDC articles in the Climate Watch dataset, wherein for each country, we counted the sectors in which agroforestry might be an entry point for the interventions. Column 3 represent the proportion of agroforestry as an entry point from the number of SDC-NDC linkages established in column 2. Hence, the values in column 3 provide the scope of NDC interventions where agroforestry can be embedded to address actions, needs and gaps.

Dataset source: Northrop et al. 2016, dataset last retrieved from Climate Watch on 23 March 2021.

Three countries (Lao PDR, Myanmar and Viet Nam) explicitly mention agroforestry in their NDCs as a forestry and land-use approach to cope with climate change. Lao PDR (2015) aims to use agroforestry for mitigation and poverty reduction under its 2020 National Forestry Strategy. Similarly, the Government of Myanmar (2015) promotes agroforestry practices to implement soil conservation and sustainable forest management techniques and climate-smart agriculture. The Government of Viet Nam (2020) seeks to develop agroforestry models to enhance carbon stocks and conserve natural habitats and biodiversity. While agroforestry is not a panacea for all developmental and environmental ailments, the multisectoral nature of agroforestry allows for a joint and systematic approach to address climate change in complementarity with other strategies (Box 5.3).

Box 5.3. Participatory tools for agroforestry and land-use planning in Viet Nam

In Northern Viet Nam, smallholders viewed the environmental value of multi-strata tree canopies, such as natural forests and home gardens, as the highest and paddy rice as the lowest (Simelton and Dam 2014). The suitability of individual smallholders' trees against extreme weather conditions also differed by location (Simelton and Dam 2014). Providing a comprehensive overview of landscape changes to smallholders and extension staff has helped them estimate the risks of practices and develop alternative strategies to adapt to the challenges (Table 5.4). By recording response strategies before, during and after hazards, smallholders and planners can better evaluate decisions and incorporate insights to achieve long-term mitigation and adaptation goals (Le et al. 2018).

Climate risk and insurance models for adaptation and mitigation are shifting the mindset of decision-makers from reactive to proactive land-use planning, driven largely by donors and investors. Through agroforestry, resource investment in participatory, technical and financial tools for system design, tree selection and monitoring can improve disaster preparedness and reduce damage incurred from extreme weather and climatic events. For example, remote sensing and mapping technologies have helped fish farmers in the Lower Mekong Delta implement appropriate agroforestry systems to avoid the negative impacts of drought on farm production (Truong and Do 2018). Although several countries are in the process of developing early-warning and climate information dissemination systems, on-the-ground interventions such as agroforestry must also be included to buffer the adverse impacts of climate-induced disasters.

Table 5.4. Example of tree-suitability ranking chart for Ha Tinh Province, Viet Nam

	Tree/crop	Cold spell	Hot spell	Drought	Flooding	Storm	Flash flood	Early rain	Late rain	Salinity	Number of villages
Staple crops	Rice										9
	Sweet potato										7
	Maize										6
	Cassava										5
Forestry	Eucalyptus										8
	Melia										5
	Casuarina										7
	Acacia										8
	Bamboo										2
	Mango-pine										2
	Mangrove										2
	Agarwood										1
Fruit trees	Lemon										8
	Orange										8
	Banana										6
	Star fruit										6
	Guava										5
	Jackfruit										5
	Longan										5
	Mango										5
	Pomelo										2
	Mandarine										1
	Star apple										1
Cash crop and intercropping	Peanut										8
	Soybean										4
	Mungbean										3
	Black pepper										3
	Sesame										3
	Tea										3
	Pineapple										2
	Acacia (*)										1
	Manglietia conifera(*)										1

(*): Intercropping with cassava in the first year

Colour codes: very suitable; suitable; not affected; unsuitable; badly affected

Source: Le et al 2018; data from Simelton et al 2012.

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Chapter 6. Advancing the Sustainable Development Goals through agroforestry-based partnerships and financing

Key messages

- Despite the positive contributions of agroforestry to multiple SDGs, donors' investments in agroforestry projects are scarce. Funding for agroforestry needs to be broadened and re-designed to provide feasible pathways to achieve various societal goals.

- Of the 17 SDGs, only five have been largely targeted in agroforestry projects in ASEAN. Nearly all projects focused on Goal 2, no hunger (68%) and Goal 15, life on land (30%). By exploring synergies between goals for agroforestry, governments can meet multiple targets while optimizing costs.

- Connecting agroforestry farmers to consumers remains an underdeveloped area. Smallholders can better manage the trade-offs and synergies of agroforestry through peer-to-peer farmers' networks and public-private partnerships.

- Agroforestry farmers can reap the benefits of sustainable agriculture and forestry products through third-party certification programmes. However, certification programmes need to pay attention to smallholders' opportunity costs and land-use patterns to alleviate adoption risks and high entry barriers.

Funding for agroforestry needs to broaden to provide various societal benefits

Official donors spent more than USD 5 trillion on development aid to low- and middle-income countries between 1990 and 2013 (AidData 2020). Of this amount, USD 2.79 billion went to 323 agroforestry-inclusive projects and USD 130.59 million to 138 agroforestry-specific projects (AidData 2020, activity code: 31220.07). During this period, AMS received USD 259.11 million and 5.56 million or 9.28% and 4.26% of the global total on agroforestry-inclusive and agroforestry-specific projects, respectively (AidData 2020, activity code: 31220.07). The largest regional donor was the World Bank, which has described agroforestry as a climate-smart investment (World Bank 2016).

Despite the multiple entry points for using agroforestry to support national development outcomes (Table 5.3), donor investment in this arena has been relatively small. Sethi et al.'s dataset (2017) on the official development assistance committed to the SDGs shows that international donors invested USD 143.3 million in agroforestry projects in low- and middle-income countries from 2000 to 2013. These projects targeted 12 out of the 17 Goals, amounting to 0.01% of the total global aid commitment (USD 1.23 trillion) to the SDGs (Table 6.1). Excluding Brunei Darussalam and Singapore, AMS captured USD 27.48 million or 19.17% of total global donor spending on agroforestry projects.

Table 6.1. Role of agroforestry projects in official donor commitments to the SDGs, 2000–2013

Sustainable Development Goal	Global agroforestry projects (amount in USD, % of total)	ASEAN agroforestry projects (amount in USD (% of total))
1. No poverty	45,713 (0.03%)	-
2. No hunger	50,654,931 (35.35%)	18,739,222 (68.20%)
3. Good health	-	-

4. Quality education	5,943,929 (4.15%)	551,895 (2.01%)
5. Gender equality	207,772 (0.14%)	-
6. Clean water and sanitation	2,828,716 (1.97%)	-
7. Renewable energy	353,328 (0.25%)	-
8. Good jobs and economic growth	230,765 (0.16%)	-
9. Innovation and infrastructure	185,383 (0.13%)	-
10. Reduced inequalities	-	-
11.Sustainable cities and communities	-	-
12. Responsible consumption	-	-
13. Climate action	-	-
14. Life below water	10,680 (0.01%)	916 (0.003%)
15. Life on land	66,500,719 (46.40%)	8,181,441 (29.78%)
16. Peace and justice	13,518,348 (9.43%)	3,662 (0.01%)
17. Partnership for the goals	2,828,716 (1.97%)	-
Total	**143,309,003 (100%)**	**27,477,135 (100%)**

Source: a dataset from Sethi et al. (2017).

Only five out of the 17 Goals were covered by these projects in ASEAN (Table 6.1), indicating the need to broaden funding schemes and the design of agroforestry initiatives. Among the agroforestry projects included in the Sethi et al. dataset (2017), the largest aid recipient was Viet Nam (USD 23.02 million), followed by Indonesia (USD 3.57 million) and the Philippines (USD 0.58 million). The bulk of agroforestry projects through official development assistance focused on alleviating hunger and improving life on land. At the same time, Sethi et al. (2017) noted the methodological difficulties of mapping cross-cutting activities. The funding gaps between agroforestry and development goals, such as climate action, present opportunities to better integrate national agroforestry agendas.

Importance of partnerships and peer networks in agroforestry value-chains

Owing to the smaller-scale operations of agroforestry, agroforestry farmers are often left out of formal agricultural networks and the modern financial system in Southeast Asia. For example, the Myanmar Agricultural Development Bank, which is the largest financial institution serving rural people in the country, often only provides financial services for rice production. Farmers engaged in activities other than this commodity are not targeted by the Bank, reducing farmers' ability to invest in biodiverse farming systems and increasing the Bank's exposure to the harvest failures and price fluctuations of a single crop (World Bank Group 2014). Public-private partnerships are essential for strengthening agri-food value chains for sustainable and resilient land-use production.

Unlike monocultural crop systems with sophisticated supply chains, agroforestry systems contain various goods and services that target different market segments (Langenberger et al. 2009, Leakey et al., 2012). Without technical and trade support, farmers who lack specific marketing knowledge and skills will miss out on opportunities for maximizing their return on investment. Creating information exchange networks and farmers' groups for agroforestry can serve as hubs of trusted information sources that may be otherwise unavailable from extension agencies. To close this capacity gap, the Government of the Philippines included a set of provisions on the participation of the private sector and financial institutions in CBFM and the National Greening Program. The success of nine

agroforestry cooperatives in the Philippines, as reported by SEARCA (2019), demonstrates the viability of benefit-sharing in agroforestry models.

In Indonesia, farmers' groups have disseminated information on consumer demand and empowered smallholders to establish grading systems for their agroforestry products (Roshetko et al., 2007). This process has allowed smallholders to be rewarded with higher prices for high-quality products (Roshetko et al., 2007). Raising market awareness to meet consumers' demand has also led to mutual benefits between agroforestry producers and buyers in the Philippines (Catacutan et al. 2008a) and Lao PDR (Barney and van der Meer Simo 2019), among others. However, the task of equipping smallholders with the necessary market skills requires institutional support. Public-private partnerships can boost incentives for agroforestry adoption by supplying smallholders with targeted extension services and an integrated market into which they can sell their products.

Third-party product certification for agroforestry: a forgone opportunity

By espousing principles of agro-ecological farming and decent employment, farmers engaged in agroforestry are well-positioned to reap the benefits of certification programmes for sustainable farm production. The third-party validation of environmental and social standards creates exclusive markets for agroforestry to attract more customers and generate a higher income. Numerous programmes are available for the certification of agroforestry products based on the agroforestry model and commodity type (Table 6.2).

For wood and non-wood forest products, smallholders can apply for certification under the Programme for the Endorsement of Forest Certification (PEFC) and Forest Stewardship Council (FSC), which together are responsible for certifying 430 million hectares of the world's forests. With the expansion of TOF, PEFC (2018) revised its sustainable forest management framework to include tree products from agroforestry systems. This amendment signals an entry point for using product certifications to advance agroforestry.

While agroforestry complements the certification requirements for the sustainable use and management of natural resources, most certification programmes miss prescriptive agroforestry-specific criteria (Elevitch et al., 2018). Of the certification programmes examined, only the Smithsonian Migratory Bird Center, which administers the certification of coffee, requires farmers to implement agroforestry systems according to their criteria. Rainforest Alliance (2020) provides guidelines on trees on farmland but are less stringent about the system design. The guidelines are stated as recommendations and differ according to crop type and geographic location. For example, cacao farmers in Southeast Asia are encouraged to plant a minimum of five native tree species per hectare to meet the 40% canopy cover threshold. Other related certification programmes include the GLOBALG.A.P. and Organic Guarantee System, focusing on good agricultural practices (Table 6.2).

Table 6.2. Description of agroforestry's position in selected certification programmes

Certification programme[1]	**Provision related to agroforestry**
Forest Steward Council Forest Management Certification (FSC)	Among the international and national standards (Indonesia, Viet Nam, and Malaysia), FSC seems to be neutral on TOF as long as it complies with the requirements of natural forests, plantations and small, low-intensity managed forests. The latter system excludes plantations of non-timber forest products such as oil palm and cacao plantations. Starting in 2018, forest managers who demonstrate their contribution

	to ecosystem services can claim additional benefits for their forest products.
Programme for the Endorsement of Forest Certification (PEFC)	In their sustainable forest management framework, PEFC has broadened the scope of management activities to include TOF in 2018. According to scientific and traditional knowledge, the maintenance and enhancement of tree cover and ecosystem services are at the core of the guidelines. Agricultural components are advised to adhere to good agricultural practices. Agriculture- and settlement-extensive systems are excluded from the land-use management categories.
Rainforest Alliance Sustainable Agriculture Standard (Rainforest Alliance)	In the 2020 Rainforest Alliance Sustainable Agriculture Standard, farmers are recommended to adopt agroforestry using native trees to achieve 10–15% canopy cover on farms with shade-tolerant crops. Rainforest Alliance establishes minimum requirements of the number of native tree species per hectare based on the region for these systems. Planting trees favourable to the natural ecosystem is noted under the mandatory requirements related to ecosystem services. This standard also applies to UTZ Certified products, following the merger between the two organizations in 2018.
GLOBALG.A.P. (GLOBALG.A.P.)	The GLOBALG.A.P. is a farm assurance programme that focuses on sustainable farm management to promote environmental sustainability, food safety and product traceability. Although agroforestry is not mentioned in the general requirements and rules, farmers carrying out GAP are eligible to apply for this programme to certify their crop, livestock and aquacultural products. This programme initially targeted the European market and has now expanded globally.
Bird-Friendly Coffee (Smithsonian Migratory Bird Center)	In their farm criteria, Smithsonian Migratory Bird Center (2020) requires coffee farmers to adopt agroforestry systems to be certified. Minimum requirements are set for height of the canopy, foliage cover, species and structural diversity. Suggestions are provided on the presence of leaf litter, weeds/herbs/forbs, and living fences and buffer zones along waterways. The coffee system should at least qualify as traditional polyculture and is required to obtain organic certification by a USDA-accredited agency.
Organic Guarantee System (IFOAM)	Under the IFOAM standards (2014), farmers must implement measures to maintain and improve the ecological health of the landscape through on-farm wildlife corridors. Agroforestry is not mentioned in the standards but may be used to address many of the socio-ecological requirements of the organic production of farm products.

Note: [1] Organization responsible for the certification programme is placed in parentheses.

In addition to international certification programmes, agroforestry farmers in Southeast Asia can also access national certification schemes for agricultural and forestry products. Using the IFOAM standard, the Government of Lao PDR approved the Lao Organic Standards in 2005 to certify organic agricultural products. With support from international partners, the Government of Myanmar introduced the GAP protocol in 2017 to boost farm productivity and profitability through sustainable agricultural practices, which align with the ASEAN GAP (ECOCERT 2019). Since many of the certification programmes in ASEAN are managed by governmental or quasi-governmental bodies, the lack of communication and coordination between agriculture and forestry ministries may adversely impact the certification process. The lack of emphasis on TOF in many certifications complicates the process for agroforestry farmers to assess their farm's eligibility.

In their analysis of vegetable-agroforestry, Catacutan and others (2008b) noted the difficulties faced by smallholders in complying with GAP certification standards in the Philippines owing to high entry barriers and literacy requirements for documentation.

Likewise, Flanagan and others (2019) outlined a range of direct and direct costs for smallholders growing trees, deterring farmers from adopting certification standards. Direct costs included establishing proof of ownership and monitoring commitments, and indirect costs included time spent on establishing management practices and loss of income from other activities. While certification schemes promote longer rotations to secure economic returns, they often do not consider the volatile environmental and policy conditions in which smallholders operate. Lenders also perceive high risks in growing trees. Farmers are often trapped in a cycle of debt from years of monocultural farming, contributing to the challenge of financing agroforestry, as seen in Thailand and elsewhere in Southeast Asia.

Embedding production risks in product certification are important because governments are shifting toward mandatory state certification. Through the European Union's initiative to combat illegal logging, governments that have signed the Voluntary Partnership Agreement on Forest Law Enforcement, Governance and Trade must enforce chain-of-custody procedures for tracing timber. Forest product certification from third parties closely aligns with the national laws and regulations in countries that have established this partnership, including Indonesia, Lao PDR, Malaysia, Thailand and Viet Nam. The verification and validation procedures are often lengthy and sometimes overlapping, allowing companies to secure market share by outsourcing the steps. Historical land-use patterns are also not considered in certification schemes, disadvantaging agroforestry farmers who often face legality issues outside their control (Box 6.1).

Box 6.1. How global and local markets are shaping coffee agroforestry in Viet Nam
In recent years, coffee production in Viet Nam has become less stable owing to the climate crisis, land degradation, pests and diseases, and competition from commodity crops. In 2017, late heavy rainfall through October to December led to 600,000 fewer bags of coffee — 36,000 tonnes — than projected (Tran 2018). To stabilize the income of coffee growers, the Ministry of Agriculture and Rural Development introduced intercropping methods to supplement coffee production with crops such as avocado, durian and macadamia. Allocating more area for shade-tree species is intended to promote on-farm diversification and high-quality production of premium coffee beans. Also, by integrating nitrogen-fixing plants and trees — such as *Cassia siamea* and *Leucaena* sp — farmers can enhance the health of their soil while reducing the application of synthetic fertilizer.

Sustainable and biodiverse coffee production under agroforestry systems can make farmers eligible for product certification programmes such as GLOBAL.G.A.P. and VietGAP, which the Government promotes. However, despite efforts to transform coffee monoculture into agroforestry and to increase the area of certified coffee plantations, underdeveloped value chains impede opportunities for sustainable farming practices. Further, the legacy of converting natural forests to establish new settlements and cultivation sites among highland communities also excludes many coffee farms from the most sustainable coffee certification schemes. Establishing public-private partnerships and providing forums for the development of agribusinesses are essential to encourage sustainable coffee production in lieu of strong market links between producers, traders and consumers.

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Chapter 7. Agroforestry governance in ASEAN

Key messages

- Without an institutional home, agroforestry falls between agriculture and forestry. The lack of communication and coordination between government agencies often leads to the duplication or absence of agroforestry programming, increasing public expenditure and reducing the overall effectiveness of interventions. A cross-sectoral mandate for agroforestry is needed to guide collaboration between research and extension personnel working in the same field.

- Similarities and differences in agroforestry governance across the AMS require a targeted and coordinated approach to build on lessons learned and explore techniques suitable for local contexts. Through the *ASEAN Guidelines for Agroforestry Development*, governments should develop a regional knowledge and resource hub to consolidate and disseminate information on agroforestry. Private-sector, research and civil-society organizations can support this hub.

- Assessing agroforestry-based partnerships is critical to provide transparent and accountable reporting for results-based outcomes. This will help the effective deployment of resources in modifying interventions and expanding the scale of best practices.

Breaking barriers through an agroforestry policy framework

To date, no country in Southeast Asia has adopted a national policy on agroforestry despite repeated claims of the benefits of agroforestry by AMS. However, the endorsement of the *ASEAN Guidelines for Agroforestry Development* by the ASEAN Ministers of Agriculture and Forestry in October 2018 reduced the rigid segregation of agriculture and forestry as distinct land-use types. Under the ASEAN–Swiss Partnership on Social Forestry and Climate Change (ASFCC), ICRAF and FAO developed this high-level policy document in collaboration with the AWG-SF and technical partners. The *Guidelines* were an outcome of the *Vision and Strategic Plan for ASEAN Cooperation in Food Agriculture and Forestry 2016–2025* (AMAF 2015). The objectives of the *ASEAN Guidelines for Agroforestry Development* are also closely interlinked with the SDGs and other international and national targets for sustainable economic growth.

The *Guidelines* present 14 guiding principles covering institutional, economic, environmental, socio-cultural, technical design, communication, and scaling dimensions (Catacutan et al. 2018, Table 7.1). These principles support AMS in formulating agroforestry policies, the private sector in their investment decisions, and research and training institutions in their agroforestry programming and curricula. Clarifying institutional roles and arrangements, developing a national programme to spearhead agroforestry planning and financing, and establishing monitoring, reporting, and verification schemes are some of the key considerations articulated in the *Guidelines*. Knowledge management is also noted as a critical aspect to ensure the effective sharing of information between stakeholders.

Table 7.1. Guiding principles of ASEAN agroforestry development

Dimensions	No.	Nested principles
Institutional	1	Create an enabling environment
	2	Ensure effective organizational capacity
	3	Support effective cooperation and participatory decision-making
Economic	4	Recognise the value of ecosystem goods and services

	5	Enable environments for agroforestry investments and markets
Environmental	6	Maintain and enhance ecosystem services at farm and landscape scales
	7	Understand and manage trade-offs
Socio-cultural	8	Recognise and respect local knowledge, traditions and choices
	9	Support gender equity and social inclusion
	10	Ensure safeguards and tenure rights
Technical design	11	Design agroforestry options based on context
	12	Select agroforestry components in a participatory manner
Communication and scaling	13	Effectively communicate agroforestry knowledge
	14	Plan for effective scaling up and sustainability

Source: Catacutan et al. 2018.

Institutional home for agroforestry

Agroforestry straddles agriculture and forestry in the absence of an institutional home. Overlapping and often conflicting land-use policies are prominent barriers to the implementation of agroforestry. Agriculture and forestry departments in AMS often conduct research and development related to agroforestry, yet little cross-sectoral coordination exists. Double expenditure on the same or similar agroforestry-related projects concerns dwindling public budgets for the extension. Extension support through government, private sector and non-profit actors are critical for providing smallholders with the knowledge and capacity to adapt their land-use management and agribusinesses under changing social and environmental conditions.

Cambodia
Cambodia has created an Agroforestry Office under the Department of Plantation Development and Private Forest of the Forestry Administration (FA), the Ministry of Agriculture, Forestry and Fisheries (MAFF). This office is responsible for promoting agroforestry in degraded forest areas. Also, the Community Forestry Office of FA is responsible for promoting agroforestry in CBFM areas. However, it lacks human and financial resources to deliver on its mandate. Under MAFF, the Royal University of Agriculture is also involved in formulating recommendations to expand tree-based farming to tackle food insecurity.

Owing to the lack of supportive policies, promotion, and limited capacity, most Government officers, development partners and community groups have little understanding of agroforestry. With initial support from ICRAF under the ASFCC and follow-up activities under the FAO-ASEAN TCP, the Forestry Administration became involved in creating a national roadmap for agroforestry development. Accordingly, developing the capacity of the agroforestry unit is especially important as the Forestry Administration is piloting several agroforestry models in CBFM areas. Partnerships are also needed to finance agroforestry initiatives and programmes, as only a small fund is currently available for agroforestry implementation from the Government.

Indonesia
Under the Ministry of Environment and Forestry (MOEF), the Directorate of Social Forestry and Customary Forest Business Development and the Forest Research and Development Agency are engaged in agroforestry research and development. Balai Penelitian dan Pengembangan Teknologi Agroforestry (Agroforestry Research and Development Institute) of FORDA is responsible for the research and development of agroforestry. Both MOEF and the Research Center on Agroforestry Development publish on agroforestry progress throughout the year. The Center also conducts research through demonstration plots under

different conditions to improve agroforestry practices, which can be advanced in future policies. In particular, agroforestry has been mainstreamed through regulations on social forestry.

Lao People's Democratic Republic
No Government agency is mandated to promote agroforestry, although the practice is permissible in certain areas classified as Village Forestry. Under the Ministry of Agriculture and Forestry, the National Agricultural and Forestry Research Institute conducts agroforestry research and development. Private companies, such as Stora Enso and Burapha Agroforestry, are taking the lead in establishing agroforestry models in the country through mixed-species tree plantations, with the Government granting medium-to-large-scale land concessions. The private sector provides technical capacity is provided to farmers by the private sector to ensure high-quality timber and forestry production for industrial use.

Malaysia
There are no national Government agencies leading efforts to coordinate resources and efforts for agroforestry development. However, several Ministries and agencies are conducting agroforestry research and supporting the implementation of agroforestry projects. These Ministries and agencies include the Ministry of Energy and Natural Resources, Ministry of Agriculture and Food Industries, Ministry of Plantation Industries and Commodities, Forestry Department of Peninsular Malaysia, Sabah Forestry Department, Forest Department Sarawak and Forest Research Institute Malaysia. Through the Forestry Department of Peninsular Malaysia, Department of Agriculture and other Government and private-sector actors, some funds have been made available to farmers for agroforestry, although mostly on a small scale. The Government of Malaysia has previously promoted agroforestry in the National Agriculture Policy (1998–2010). However, in the 10th Malaysian Plan (2011-2015), agroforestry was deemed no longer viable and has since been discontinued. Malaysia is taking an alternative approach more suitable to its conditions.

Despite the roles and interests of various agencies for exploring agroforestry options to boost farmers' incomes, agroforestry initiatives are not well coordinated. Agencies in both the forestry and agriculture sectors focus on specific crop and tree species, resulting in poor communication across ministries. Land governance also follows along the same lines, with the Ministry of Agriculture and Food Industries responsible for activities on agricultural land and the Ministry of Energy and Natural Resources responsible for activities on forest land. Joint experiments between the Malaysian Rubber Board and the Forest Research Institute Malaysia on rubber agroforestry systems have presented promising avenues to enhance agroforestry collaboration and governance.

Myanmar
No Government agency is mandated to oversee agroforestry development. However, under the Ministry of Natural Resources and Environmental Conservation, the Forest Research Institute and the Forestry Department are involved in agroforestry research and development. While the Department of Agriculture under the Ministry of Agriculture, Livestock and Irrigation does not have an agroforestry agenda, they recognize agroforestry as a climate-smart technology. They have promoted numerous perennial crops on agricultural land. Within the national CBFM programme, the Forest Department raises awareness of agroforestry through training and extension support. The University of Forestry and Environmental Science (UFES) and Yezin Agricultural University (YAU) also provide some agroforestry training.

Minimal agroforestry-based partnerships currently exist in the country, with scarce funding opportunities for agroforestry implementation. Adding to this, the distinct responsibilities between the Forest Department and Agricultural Department in managing and monitoring forest land and agricultural land, respectively, increase fragmentation of agroforestry. The involvement of both departments in developing the national agroforestry roadmap presents encouraging signs of clarifying land-use policies to enable agroforestry adoption. Financing options for agroforestry, such as loans for growing trees, should be explored to create incentives for monocultural farmers to adopt tree-based farming. Paying attention to biophysical and socioeconomic challenges to agroforestry adoption — such as rainfall variability, market fluctuations, and poor market access — is also needed to resolve barriers to creating sustainable multifunctional landscapes in the agroforestry roadmap Myanmar.

Philippines
The provision of agroforestry support services is intended to be a joint effort by the Department of Environment and Natural Resources and the Department of Agriculture. In practice, this relationship has not been effective. Some personnel from the two agencies have been trained in agroforestry through regional and site-level projects. Under the Department of Environment and Natural Resources, the Ecosystem Research and Development Bureau researches non-timber forest products near forest-agriculture transition landscapes. The Department of Agriculture has high technical capacity in soil conservation and perennial crop culture, which are the building blocks of agroforestry; however, it is not clear to what extent agroforestry is considered a core competency forestry or agriculture agencies.

Most upland areas in the country are declared as 'forest land', belonging to the State under the Department of Environment and Natural Resources management. However, large swathes of these areas have already been converted to agriculture. Since the Philippines has a decentralized governmental system, local governments play major roles and exercise devolved forest, land-use, and environmental governance functions. In addition to national government agencies and local governments, numerous stakeholders — including the Institute of Agroforestry and the Institute of Plant Breeding at the University of the Philippines Los Baños, Philippine Agroforestry Education and Research Network, and ICRAF — are involved in agroforestry development. A clear mandate and legal definition of agroforestry are needed to enhance resource coordination and avoid confusion between land uses.

Thailand
Under the Ministry of Agriculture and Cooperatives and the Ministry of Natural Resources and Environment, the Department of Agriculture and the Royal Forest Department participate in agroforestry development. Agroforestry is viewed as part of sustainable agriculture, although no policy document formally guides this outlook. Public universities, including Kasetsart University in Bangkok and Maejo University in Chiang Mai, are taking the lead in agroforestry research and development. Various community-based and non-profit organizations have also supported agroforestry interventions in farming communities throughout Thailand. However, lessons learned are scattered due to the absence of a national database and lead agency in agroforestry development.

Viet Nam
The Ministry of Agriculture and Rural Development (MARD) oversees forest land and cultivated land, with separate sub-departments responsible for agriculture and forestry. Departments of Agriculture and Rural Development at the provincial level and people's committees at the local level are instructed to carry out national land-use management programmes that may include agroforestry. Yet, technical training on agroforestry is limited

among agency personnel, and little coordination exists, quickly depleting intervention resources. The National Agricultural Extension Center is an agency under MARD, which delivers agricultural extension in the areas of agriculture, forestry, salt production, fishery, and irrigation across Viet Nam. At the provincial level, the Provincial Agricultural Extension Center has been established under the Department of Agriculture and Rural Development.

Stakeholders in the agroforestry arena

A range of stakeholders is involved in developing and financing agroforestry interventions across Southeast Asia, from international development donors through private companies to grassroots community organizations. Typically, development donors finance a fair share of agroforestry projects in lower-income countries, with the private sector having a bigger role in more developed economies. The political context also shapes the allocation of resources for agroforestry projects through national priority settings. Grassroots organizations are particularly important drivers of agroforestry in remote regions where business transactions may be costly. Research institutions within and outside governments are often at the core of delivering policy recommendations.

Bilateral and multilateral donors

International aid donors have been pivotal players in supporting agroforestry projects in Southeast Asia to address tropical deforestation and rural poverty since the 1970s. The incorporation of trees in agricultural landscapes to develop resource-dependent communities is essential to resolve the false dichotomy between the two systems. debt-for-nature swaps with agroforestry components in the buffer zones of national parks were established to promote biodiversity protection in countries, including Indonesia, the Philippines and Viet Nam. After the 1992 Rio Summit, agroforestry was absorbed into the sustainable-development movement and market-based strategies on climate change to increase global tree cover. However, within the global funding scheme of the Kyoto Protocol, van Noordwijk et al. (2008) noted the bottlenecks created from the confusion over 'forest' definitions and the eligibility of state land for growing trees and agroforestation.

Government agencies

Government land-use management policies are the foundations for the necessary frameworks for agroforestry development. Progressive, albeit slow, changes to land-use allocations across Southeast Asia have enhanced people's rights to land while also enhancing sustainable farming (Box 4.1). Through reforestation programmes in Indonesia, the Philippines and Viet Nam, national governments' investment in agroforestry extension has helped increase the adoption of TOF and remove barriers to success. Partnerships between governments and the private sector have filled market gaps in several countries, such as Lao PDR, Myanmar and Viet Nam. From this, technical expertise has been more readily available to agroforestry farmers on the expectation of them adequately managing timber for sale (van der Meer Simo 2020). Evaluation of these relations is required to determine the opportunity costs and concession claims across different subgroups.

Private companies

The surge in corporate social responsibility coupled with the emphasis on efficient and reliable value-chain development has increased the role of the private sector in financing agroforestry. This outcome is part of a larger trend in the development sector, which focuses more on returns on investment through business-oriented models (OECD and UNCDF 2019). In market-based agroforestry engagements, non-governmental organizations have served as mediators between private companies and local producers to ensure compliance with due diligence standards. For example, along with WWF and the United

Nations Environment Programme, ICRAF negotiated the first Indonesian sustainability bond on supplying smallholders' rubber to Michelin in 2018 (Box 7.1). While the private-sector approach is aimed at project accountability on each dollar spent on aid, it may also increase incentives for confirmation bias and selective reporting (van Noordwijk et al., 2016).

Smallholders
While some large agricultural and forestry companies have introduced multipurpose trees in their monocultural plantations, smallholders remain the primary drivers of agroforestry uptake in Southeast Asia. The Federal Land Development Authority, Austral Plantations, Golden Hope Plantations, and IOI Plantation have integrated timber trees with oil palm in Malaysia. Still, much of the tree planting is confined to the boundaries of the plantations. Public-private partnerships can help increase the uptake of sustainable agroforestry practices at greater scales in the agricultural and forestry sectors and ensure compliance to standards so that agroforestry is not used solely as a marketing strategy. The participation of smallholders in these partnerships is vital to environmental and human well-being as their livelihoods and land-use decisions are directly affected by land degradation, climate change, biodiversity loss, and other related agri-food system shocks.

Local civil-society organizations
In the background of international funding schemes, such as the Global Environment Facility and Green Climate Fund, local financial incentives for sustainable agriculture and agroforestry remain important. In Bukidnon, the Philippines, the provision of agroforestry incentives — such as input subsidies for crop production, extension services and subsidized crop insurance — through a decentralized system garnered national support with the Government aiming to replicate the model (Catacutan et al. 2012). The acknowledgment of positive externalities from sustainable land use highlights how locally designed mechanisms can advance agroforestry by integrating the diverse needs and voices of smallholders and local resource users in participatory decision-making.

Research and conservation organizations
International and national research institutions operating in Southeast Asia have also been at the forefront of advancing agroforestry for regional uptake. Most of these institutions are funded by development donors, with some receiving government support as a research branch under the forestry or agriculture ministries. However, the lack of national frameworks for agroforestry leads to poor coordination. For example, despite the departments of agriculture and forestry integrating agroforestry in policy documents in some countries, no unified body exists, which increases overall costs of research and development. Nonetheless, with the adoption of the *ASEAN Guidelines for Agroforestry Development*, pathways to remove barriers are within sight.

Box 7.1. Corporate sustainability bond for natural rubber in Indonesia
In 2018, the first corporate sustainability bond in Asia was completed by the Tropical Landscapes Finance Facility. This facility is a multi-stakeholder partnership between the United Nations Environment Programme, ICRAF, BNP Paribas and ADM Capital. The bond was worth USD 95 million, supporting sustainable rubber production in Indonesia from Jambi and East Kalimantan provinces to supply to Michelin via PT Royal Lestari Utama. The partnership engaged smallholders living on degraded land as the primary rubber producers to promote sustainable commodity production and environmental conservation. Since the launch of the bond, the number of private–community partnerships has increased to buffer the challenges of agri-food system shocks such as COVID-19, with the Government of Indonesia authorizing conflict-resolution measures between parties.

Only four AMS have explicit agroforestry-related targets

The forestry sector is often targeted for agroforestry interventions, as revealed through the AWG-SF survey responses (Table 7.2). However, only four AMS have explicit targets related to agroforestry in their national policies and programmes. These targets involve an increase in forest cover, land rehabilitation, and climate-smart agriculture. For example, Lao PDR and Viet Nam's governments aim to increase to 70% and 41.45% of forest cover, respectively, by adopting mixed tree-farming systems and agroforestry-related practices. On the other hand, Myanmar and the Philippines have area-based targets on expanding agroforestry for reforestation and land-rehabilitation goals. Indonesia and Cambodia have agroforestry embedded in their CBFM programmes but without explicit targets on use and application. This is also the case in Thailand and Malaysia, where agroforestry is included in climate-smart agriculture.

Table 7.2. Agroforestry in national programmes and targets in AMS

Country	**Explicit agroforestry-related targets**	**National policy targets related to agroforestry development**	**National agroforestry roadmap**
Brunei Darussalam	x	None	x
Cambodia	x	No targets related to the use of agroforestry, but it is embedded in the community forestry programme	In progress
Indonesia	x	No targets related to the use of agroforestry, but it is embedded in the social forestry programme	x
Lao PDR	√	Increase forest cover to 70% by 2020 through sustainable forest management, including permanent agroforestry under the Forest Strategy, which is expected to be extended up to 2025	In progress
Malaysia	x	- No current strategy that mentions agroforestry in interventions - Agroforestry was mentioned throughout the third National Agriculture Policy (1998–2010) as a means to increase productivity, competitiveness and food security - Since then, the Government has excluded agroforestry from the 10th Malaysian Plan (2011–2015) because agroforestry was not found to be viable in Peninsular Malaysia	x
Myanmar	√	- Establish 6764 ha of agroforestry plantations by 2027 under the National Reforestation and Rehabilitation Programme, with agroforestry also embedded in 311,742 ha of community forests during this period - Agroforestry mentioned in the Agriculture Development and Investment Plan, which seeks to enhance governance and productivity - 275,000 ha of agricultural land to be under agroforestry in the revised NDC (provisional at the time of writing)	In progress
Philippines	√	- Plant 1.5 billion trees on 1.5 million ha of public land and rehabilitate 7.1 million ha of degraded	x

		land under the National Greening Program using agroforestry as one of the strategies - Agroforestry is one of the main strategies to achieve goals of prioritizing high-value crops such as coffee, cocoa and bamboo in the Forestry Investment Roadmap - Establish agroforestry on 429,792 ha over 10 years (e.g., rubber-, bamboo-, and mixed crops-based systems) under the Master Plan for Climate-Resilient Forestry Development - Agroforestry is also embedded in the CBFM programme, although no targets exist	
Singapore	x	None	x
Thailand	x	- Agroforestry is identified in the National Strategy Plan (2017–2036), 12th National Economic and Social Development Plan (2017–2021), and the National Master Plan on Climate Change (2015–2050), although no targets exist on agroforestry	x
Viet Nam	√	- Increase forest cover to 41.45% by 2020 using agroforestry and other reforestation techniques under the strategy for sustainable forestry development - Agroforestry is mainstreamed in the agriculture and forestry restructuring policies. - In the 2021-2030 National Forestry Strategy, agroforestry measures forest protection and management, forest development, and conservation of biodiversity. Agroforestry will be promoted in Northern upland, North Central, South Central, Central Highlands, and Southeast regions of Viet Nam. - Planting 690 million trees outside forest lands, including farmlands and home gardens under Decision 524/QD-TTg on the planting of one billion trees for the period 2021-2025	x

Source: AWG-SF survey responses from focal points.

Without an overarching institutional structure for agroforestry development at the national level, projects' efforts at local to subnational levels deliver benefits to only a small population segment. In Viet Nam, Simelton et al. (2017) presented smallholders' challenges in receiving agroforestry extension support owing to limited coordination between agriculture and forestry personnel. Training provided to smallholders is usually general in scope and not relevant to promoting agroforestry products. Subsidized government and donor support for input-intensive agriculture are some of the greatest challenges to scaling up agroforestry across Southeast Asia, including in Indonesia, Myanmar and Viet Nam. Despite these obstacles, the growing interest in agroforestry among smallholders suggests the need to develop national policies that set clear pathways for integrated farming systems.

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Chapter 8. Agroforestry knowledge hubs

Key messages

- The global trend in agroforestry research shows the progression from the plot-through to landscape-scale analyses of development and conservation issues. While agroforestry research has broadened the understanding of land-use sustainability, more emphasis should be placed on bridging thematic and geographic disparities in outputs. This includes attention to policies, gender roles and cultural ecosystem services.

- ICRAF Indonesia ranked as the top-most productive publisher of agroforestry knowledge. As a consequence, Indonesia had the most agroforestry publications, followed by the Philippines and Thailand. Among countries with research outputs, Cambodia, Lao PDR, and Myanmar had the least agroforestry publications.

- Demand for individuals with expertise in agroforestry has increased, with growing investments in sustainable business models and value chains; however, supply remains low. Agroforestry education networks can help spur public-private partnerships and activities to fill the gap in the supply of agroforestry graduates.

- Farmers' field schools and peer-to-peer networks are important in building smallholders' capacity for agroforestry adoption. Incorporating these programmes into the regular extension activities of agriculture and forestry departments can maximize resources to secure long-term positive outcomes in land-use sustainability.

Trends in agroforestry research

Since the establishment of ICRAF in 1977, agroforestry researchers focused on experiential studies, deriving knowledge from direct observation of traditional systems and practices (Nair and Garrity 2012). This focus gradually evolved into more experimental research designs, which involved testing hypotheses and simulation tools in generating inferences (Nair and Garrity 2012, Sanchez 1995). The topics in earlier studies centred around soil fertility, tree and crop interactions, and resource competition. Socio-economic and policy issues were later embraced to address the underlying challenges of low agroforestry adoption rates (Alavalapati et al. 2004, Nair and Garrity, 2012). Research became more application-oriented to target regional and global issues. The trajectory of agroforestry research is in parallel with the three key agroforestry paradigms (Figure 3.1).

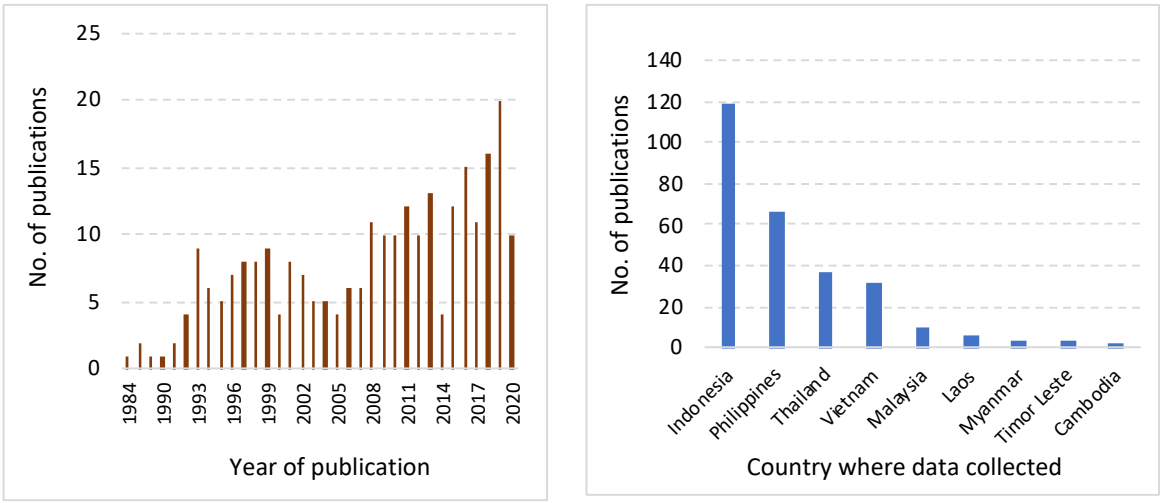
Bibliometric analysis of agroforestry research in Southeast Asia

Through a bibliometric analysis of agroforestry research in Southeast Asia using the ICRAF database[5] and Google Scholar, 266 peer-reviewed publications were found over the last four decades (1980–mid-2020) (Figure 8.1(a)). No publication was found before 1984. Most of the publications contained Indonesia, the Philippines, Thailand and Viet Nam (Figure 8.1b). Agroforestry publications were scarce in Cambodia, Lao PDR, Myanmar and Timor-Leste, with no record for Brunei. The number of publications per year has increased in the last

[5] Bibliometric analysis was carried out by ICRAF scientist Rachmat Mulia. The World Agroforestry database covered publications from Indonesia, Thailand, the Philippines and Viet Nam while Google Scholar explored publications in all Southeast Asian countries. Five different key terms were used to search publications in Google Scholar: agroforestry, intercropping, alley cropping, hedgerows and home garden. Only publications in international journals were considered. Assessment of publications' relevance was based on the title, abstract and keywords.

decade. On average, three publications were published annually from 1980 to 2000, seven from 2001 to 2010, and 13 from 2011 to mid-2020 (Figure 8.1(b)).

Agroforestry publications fell into 12 main research themes, with the possibility of publications appearing in multiple themes. Research themes ranged from ecosystem services through food security to gender. Between 1980 and 2000, agroforestry studies focused on describing agroforestry models, the attributes of agroforestry species, and the benefits of agroforestry for the environment and local livelihoods (Figure 8.2(a)). In the next decade (2001–2010), more studies emerged on linking agroforestry with agro-biodiversity, climate-change mitigation and adaptation, and ecosystem services (Figure 8.2(b)). From 2011 to mid-2020, agroforestry studies were mostly focused on themes of regional and global concern such as food security and mitigation and adaptation (Figure 8.2(c)). Although still limited, studies of policy support for agroforestry development were found since 2009 and gender roles in agroforestry production and market value-chains since 2015.



(a) (b)

Figure 8.1. Agroforestry publications, Southeast Asia
Note: (a) year of publication; (b) country where data collected

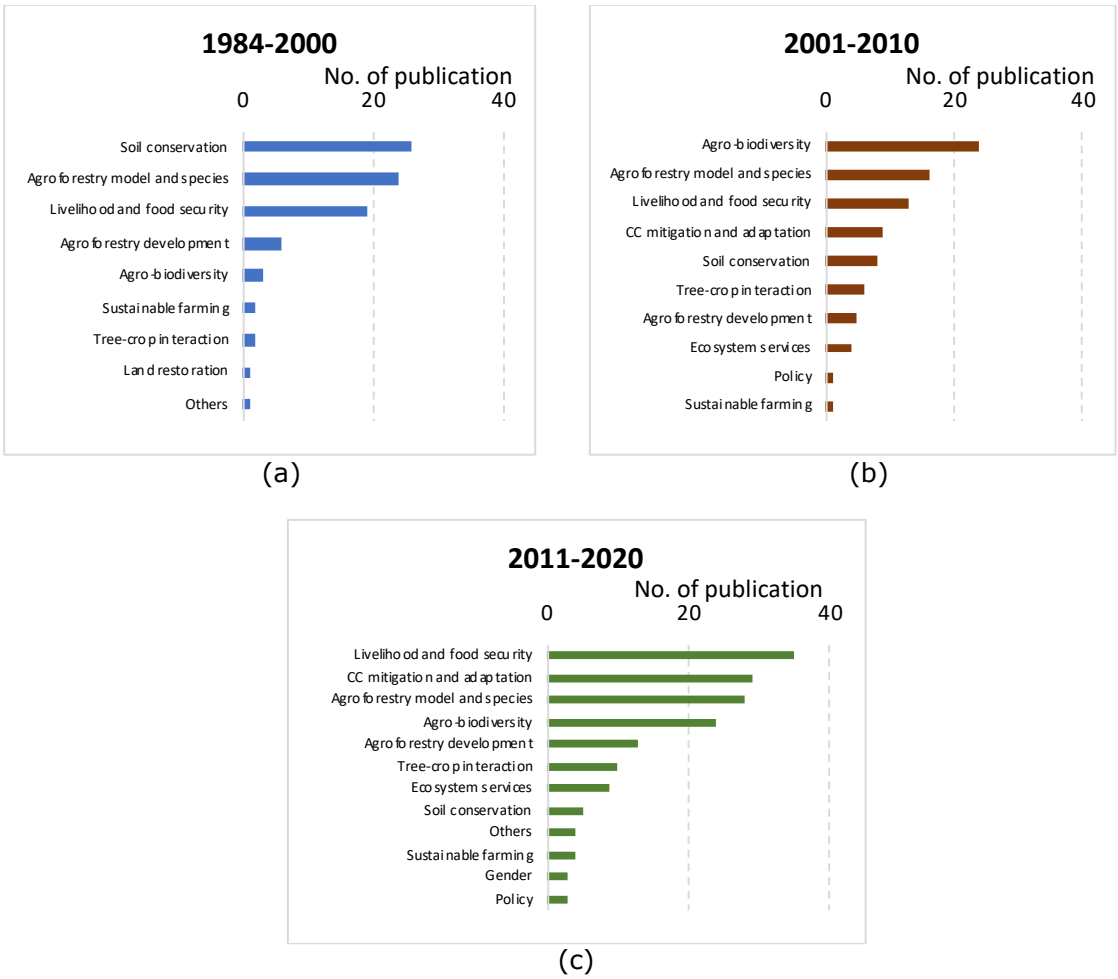


Figure 8.2. Agroforestry publications by research theme since 1984

Note: (a) 1984–2000; (b) 2001–2010; (c) 2011–2020. Publications were catalogued into 12 research themes: 1) climate change and adaptation: carbon sequestration, reduced emissions from management practices, agroforestry as climate-smart agriculture; 2) agro-biodiversity: above- or belowground diversity in agroforestry; 3) ecosystem services: regulating, supporting or cultural services at plot or landscape levels for landscape multifunctionality; 4) soil conservation: maintenance or restoration of soil fertility at plot or farm scales; 5) tree and crop interactions: interactions above- and belowground including resource competition and facilitation; 6) livelihoods and food security: for subsistence, economic benefits or nutrient security; 7) agroforestry model and species: descriptions of specific agroforestry models, attributes of specific agroforestry tree species; 8) agroforestry development: constraints or enabling conditions for agroforestry adoption and development; 9) sustainable farming: agroforestry for reconciling economic and ecological benefits at plot or landscape scales; 10) land restoration: contribution of agroforestry for land restoration at ecosystem or landscape scales; 11) gender: role of gender in agroforestry production and market value-chains; 12) policy: supporting policies for agroforestry development; and others: aspects other than the 12 above, e.g. education system for agroforestry, monitoring tools for agroforestry, bibliometric analysis of agroforestry research.

Findings from this analysis are similar to other studies in the agroforestry literature. In their bibliometric analysis of global agroforestry research, Liu et al. (2019) also reported that livelihoods and food security had been the focus of agroforestry research in Southeast Asia to address the challenges of rapid population growth. In another study on ecosystem services from agroforestry, Shin et al. (2020) found 54 peer-reviewed articles from

Indonesia, 19 from the Philippines, 15 from Thailand, 9 from Malaysia, and 7 from Viet Nam published between 1980 and 2018. These five countries also produced the greatest number of scientific articles on various agroforestry research themes, as shown in Figure 8.1(b).

278 different institutions produced the 266 identified publications. Among the most productive was ICRAF Indonesia, followed by local and foreign universities (Table 8.1). Leading local universities were Brawijaya University in Indonesia, the University of Los Baños in the Philippines, and Bogor Agricultural University in Indonesia. Leading foreign universities were the University of Gottingen, Wageningen Agricultural University, and the University of Hohenheim. Local universities undertook agroforestry research in Indonesia, Malaysia, the Philippines and Thailand. In Cambodia, Lao PDR, Myanmar and Timor Leste, where agroforestry research was limited, most authors came from institutions outside the country.

Table 8.1. Productivity ranking of institutions publishing agroforestry research

Rank	Institutions[1]	No. of publication[2]	% of total (n=266)
1	World Agroforestry (ICRAF) Indonesia	78	29.3
2	University of Gottingen, Germany	26	9.8
3	Brawijaya University, Indonesia	21	7.9
4	University of Los Baños, the Philippines	19	7.1
5	World Agroforestry (ICRAF), Philippines	17	6.4
6	Bogor Agricultural University, Indonesia	16	6.0
7	Tadulako University, Indonesia	13	4.9
8	World Agroforestry (ICRAF), Viet Nam	12	4.5
	International Rice Research Institute, Philippines	12	4.5
	Wageningen Agricultural University, Netherlands	12	4.5
9	University of Hohenheim, Germany	11	4.1
10	Kasetsart University, Thailand	10	3.8

Note:[1] The same organization located in different countries is listed as different institutions
[2] Institutional ownership is not exclusive because a publication can have authors from different institutions.

Mainstreaming agroforestry knowledge through education networks

The Southeast Asian Network for Agroforestry Education (SEANAFE) was established in 1999 to recommend a needs' assessment by ICRAF (Tengas et al. 2008). The assessment revealed the low quality of agroforestry education in Southeast Asia due to limited collaboration opportunities, inadequate and outdated curricula, and gaps in lecturers' expertise, among others. Through support from the Swedish International Development Cooperation Agency, ICRAF initiated the regional network, involving 80 member institutions in five countries: Indonesia, Lao PDR, Philippines, Thailand and Viet Nam, each with their national network.

As the largest national network and the only one to gain legal status as a non-profit organization, the Philippine agroforestry network has been pivotal in driving educational reform (Box 8.1). Likewise, the national network in Viet Nam has standardized the agroforestry curriculum at the BSc level. The national networks in Lao PDR and Thailand have organized a series of workshops to mainstream agroforestry, but few milestones have been achieved owing to logistical and resource constraints. In Indonesia, little activity has taken place through the national network. While budget constraints, limited interaction with national policymakers and insufficient attention on gender are common issues in the various

countries, specific strategies for agroforestry education should be developed to accommodate local contexts and policy environments.

High demand for agroforestry expertise yet low supply of agroforestry graduates

The demand for agroforestry graduates is projected to increase from growing initiatives on landscape restoration, sustainable farming and community development. Providing full-fledged programmes and integrated courses on agroforestry through higher learning institutions is at the heart of achieving progress in sustainable development. Insufficient agroforestry knowledge among extension workers and professionals largely reflects the limited incentives and capacity of institutions to build agroforestry curricula and attract students. Investing in agroforestry education can help address the projected demand for agroforestry graduates and minimize the costs of providing piece-meal training.

In several ASEAN countries, the 'nomenclature' that lists the topics in which professional education can be provided, which is used in recruitment processes, is very difficult to change. Existing agroforestry training remains 'hidden' under either an agriculture or forestry certification, with little recognition for specific skills acquired.

Through assessing the priority programmes of 82 institutions in the conservation sector in the Philippines, Tolentino et al. (2010) found agroforestry development and promotion to be the most common activity. Yet, only 3% of staff were formally trained in agroforestry (Tolentino et al. 2010). The mismatch between expertise and expectations creates additional burdens for extension personnel and results in ineffective interventions because the support is not what beneficiaries want, as seen in Viet Nam (Simelton et al., 2017). In Malaysia, Mohamed et al. (2013) found that most Government officers in agroforestry-related jobs did not have an agroforestry education, and only one-third had taken an agroforestry course. In contrast to dedicated agroforestry programmes, many agroforestry courses are theory-based, with limited practical elements.

Since extension officers and practitioners are in the frontlines of implementing agroforestry, equipping them with the resources to support local resource users can ensure continued adoption of technologies. In 2013, the Forestry Research and Development Agency of the Ministry of Environment and Forestry in Indonesia established the first National Strategy for Research on Agroforestry, which ICRAF supported. This national strategy aims to mobilize and coordinate resources for targeted agroforestry research among Government researchers so that findings are directly incorporated into the National Forestry Plan. By assessing the state of agroforestry education and developing an agreed-upon schedule to target priority areas, decision-makers can advance regional efforts to create agroforestry knowledge hubs.

Box 8.1. Pushing for agroforestry education reform in the Philippines

Knowledge of agroforestry in the Philippines is rooted in issues of environmental degradation faced by upland farmers. The first CBFM programme was established in 1979 by the Department of Environment and Natural Resources. In that same year, Don Mariano Marcos Memorial State University in Northern Philippines launched their 4-year BSc agroforestry programme. There are 34 state colleges and universities that offer agroforestry education programmes as of 2009. Various agroforestry programmes were anchored in the belief that practitioners should play a central role in natural resource management. Thus institutions that offer these programmes remain strategically located near upland areas.

By raising awareness of agroforestry education, the Philippines Agroforestry Education and Research Network and other civil society and research organizations standardized the

national agroforestry curriculum. After lobbying policymakers in the Senate and House of Representatives, the Philippines Agroforestry Education and Research Network had the curriculum approved through the Government's issuance of Commission on Higher Education Memorandum Order No.6. Coinciding with this achievement, the agroforestry network also advocated for the professionalization of agroforestry to make it a distinct discipline from agriculture and forestry. These and many other related achievements of the agroforestry network in the Philippines demonstrate the proactive stance needed by ASEAN stakeholders to push for legislative reforms in the education system.

Source: Tolentino et al 2010, Tolentino and Landicho 2011.

Agroforestry teaching and training material is scarce and outdated

The bibliometric analysis of agroforestry research revealed a skewed distribution of agroforestry knowledge sources across Southeast Asia. ICRAF in Indonesia is a major source of agroforestry knowledge in the form of journal articles. This coincides with high research outputs by national universities in Indonesia and the Philippines, contributing to the scientific progress on agroforestry in the region. However, despite advances in agroforestry research and development, agroforestry teaching is scarce. Courses on natural resource management often mimic the ministerial division between agriculture and forestry, leading to information silos. As a result, graduates are not well-positioned to take advantage of the shift toward agroforestry expansion and integrated land-use management from their limited exposure to these topics.

In January 2021, SEANAFE, ICRAF, SEARCA and the University of the Philippines' Institute of Agroforestry organized a webinar workshop on the status of agroforestry in Southeast Asia. The workshop was attended by members of SEANAFE in Indonesia, Malaysia, the Philippines, Thailand and Viet Nam. Workshop discussants highlighted the urgent need to update agroforestry teaching and reference material: some material currently being used spans several decades and articulates agroforestry modalities that might not be applicable in the contemporary context.

This outcome reflects lengthy and cumbersome curriculum-approval processes and difficulties with doing scientific translations. It is two of the major blocks in providing students with the most up-to-date agroforestry knowledge. Owing to the multi-disciplinary nature of agroforestry, cross-sectoral platforms of different groups are needed to promote agroforestry education and create pathways for curriculum reform.

Further, agroforestry training material itself is often outdated and not readily accessible. Most of these outputs were produced through donor-funded projects, including those implemented by ICRAF, FAO and RECOFTC. The Department of Environment and Natural Resources of the Philippines has produced guidelines for agroforestry, and Cambodia's Forestry Administration has published a manual for agroforestry with support from the Danish International Development Agency. RECOFTC and ICRAF have produced recent agroforestry training material for regional application under the auspices of ASFCC in 2020, and by FAO under two Global Environment Facility projects: Sustainable Cropland and Forest Management in Priority Agro-ecosystems of Myanmar (2019); and the Life and Nature Project in Cambodia (2020). A regional repository of training material would help AMS efficiently map the next stages for training development to build extension staff, practitioners and smallholders. In a period where the 'training of trainers' model is central to land-use sustainability, investment in training material can reduce agency costs and ensure the diverse needs of stakeholders are met for the uptake of agroforestry.

Using experiential agroforestry learning to fill the gap in formal education

In the absence of extension support, farmers' field schools and peer-to-peer learning have encouraged the uptake of agroforestry. FAO in Southeast Asia pioneered farmers' field schools as a practical way to diffuse knowledge-intensive integrated pest management (Feder et al., 2003). Since then, various development organizations have integrated them and related participatory methods into their interventions to promote agroforestry. Smallholders are more willing to experiment with new farming techniques through peer-to-peer networks, as shown by Indonesian smallholders' preference for agroforestry knowledge from other smallholders (Martini et al. 2017, Prawiti and Suzuki 2017). Interpersonal relations reduce uncertainties and risks of failures from adoption, which are among the largest impediments to the scaling-up of agroforestry.

Despite the success of experiential learning programmes, they remain largely outside the regular agriculture and forestry extension services in Southeast Asia. Coordinating and allocating resources to these programmes can reduce overall costs and enable mutual benefits for farmers and extension agencies.

When bringing the classroom to the farm, trainers need to carefully design their courses to accommodate varying socio-cultural and geographic factors affecting engagement and attendance. Analysis of the local streams of agroforestry knowledge across Southeast Asia has been fruitful in unravelling the rationale of adoption behaviour. Trainers should recognize potential agroforestry adopters' short- and long-term aspirations, so that knowledge gaps are defined and addressed to affect positive behavioural changes and management outcomes.

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SECTION III: Outlook and monitoring

Chapter 9. Meeting the future: agroforestry in 2030 and beyond

Key messages

- Agroforestry can boost agricultural efficiency and CBFM. Promoting agroforestry can optimize resources and offset trade deficits in agri-forest-food commodities. These interventions also shorten supply and value chains to build the resilience of ASEAN economies against shocks.

- To overcome the bottlenecks faced by agroforestry, governments should provide technical and market support to farmers. Public-private partnerships can improve market access and financing opportunities for agroforestry farmers.

- The underlying framework for advancing agroforestry development already exists in most countries. AMS representatives suggested having an agency responsible for agroforestry, a national agroforestry roadmap, and agroforestry financing mechanisms as indicators to track agroforestry development in the region.

Agroforestry can be a solution for countering the scarcity of arable land and for improving the livelihoods of community forest users

A third of the world's arable land has disappeared over the past four decades (Grantham Centre for Sustainable Futures 2015). The total average arable land in ASEAN was reduced from 0.22 to 0.12 hectares per person between 1961 and 2016 (WB 2020). This loss occurred at a mean annual decline of 1.18%. In this period, labour productivity of the agri-food sector remained largely stagnant for the top four countries most dependent on agriculture — Cambodia, Lao PDR, Myanmar and Viet Nam — accounting for 15–22% of GDP and 34–62% of total employment in 2018 (WB 2020). The multiple challenges that these and other AMS will continue to face underline sustainable agri-food production as a regional priority issue.

Agroforestry can alleviate the devastating blows that low production may have on the regional economy by combining scientific and local knowledge to design and implement resilient and multifunctional farming systems. The loss of genetic diversity owing to modern production technologies, climate change and land-use change is a global concern for food sovereignty.[6] About half of the population in Southeast Asia cannot afford a diet that meets their nutritional requirements (FAO et al. 2020). The dietary benefits of agroforestry is an untapped depth through which policymakers can achieve food and nutritional security and environmental health.

Re-invigorating the agri-food-forestry sector through agroforestry

While agri-food commodities provided economic stability at the regional level, differences in net trade balances between AMS were also observed (Figure 9.1). Brunei Darussalam, Cambodia and the Philippines have consistently recorded negative balances in agri-food trade over the last five years, indicating the importance of locally embedded solutions, such as agroforestry, to nourish current and future populations. Compared to monocultures, agroforestry can tap opportunities of increasing demand for sustainable agri-food-forestry

[6] 'Food sovereignty' refers to the right of people to healthy and culturally appropriate food produced through socially and ecologically sound methods (Via Campesina 2007).

products to increase smallholders' incomes while supporting the ecological functions of the natural environment. Along with investing in extension support for agroforestry adoption, ASEAN leaders need to emphasise technical and trade promotion so that agroforestry can compete in domestic and global markets.

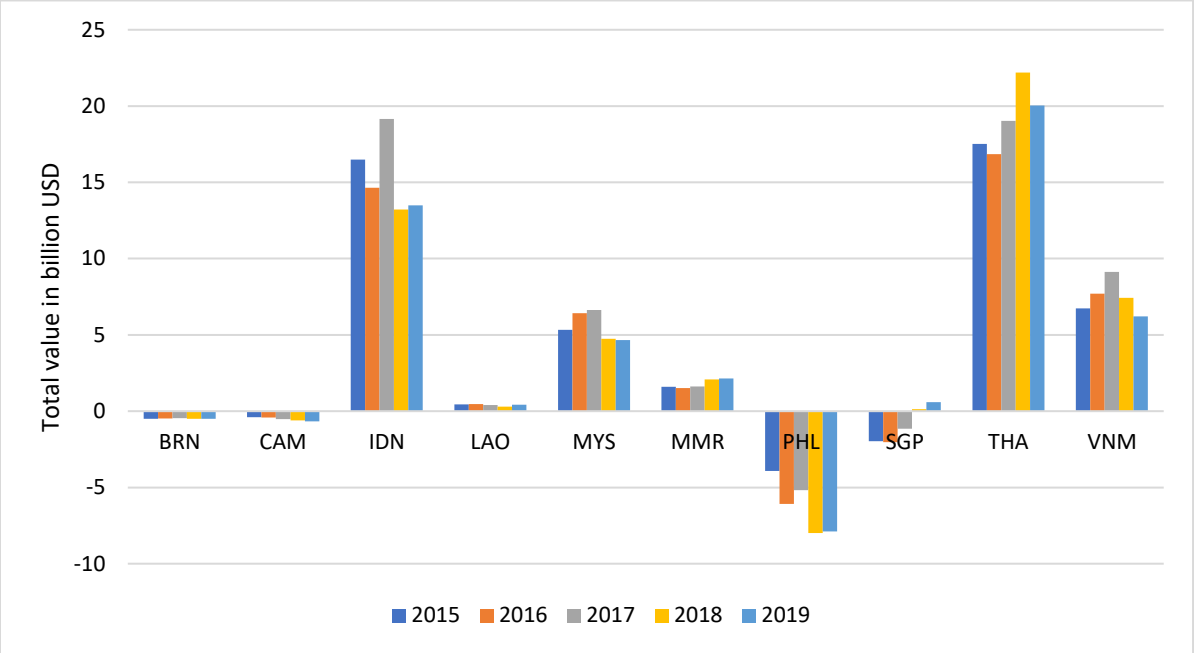

Figure 9.1. Net annual agri-food trade balance in ASEAN, 2015–2019
Note: Net calculated from exports minus imports. Country names abbreviated: BRN = Brunei Darussalam; CAM = Cambodia; IDN = Indonesia; LAO = Lao People's Democratic Republic; MYS = Malaysia; MMR = Myanmar; PHL = Philippines; SGP = Singapore; THA = Thailand; VNM = Viet Nam. Agri-food commodities values added from harmonized system codes (1–24).
Source: Data from ASEAN Secretariat 2020a.

Structural changes within the agri-food sector owing to export competition and off-farm opportunities indicate the importance of optimizing inputs to maintain production levels. Increasingly, major commodity cropping systems — such as rice, rubber, oil palm and coffee — have gained exposure in agroforestry research as more smallholders struggle to secure yields in the climate crisis. Studies of the production output of agroforestry systems show comparable yields and more plentiful outputs to those of monocultures when systems are designed and implemented for local socio-ecological conditions (Table 4.1). The combination of trees, crops and animals improves land-use efficiency because smallholders can generate multiple goods and services from a single unit of land.

Cross-sectoral partnerships are essential to identify gaps in knowledge and capacity and create market links for agroforestry products. The involvement of diverse stakeholders — such as companies, farmers and research institutions — in agroforestry partnerships relieves the burden of placing the onus for resolving large-scale issues — such as climate change, rural poverty and malnutrition — on a single entity. Rather, resources can be pooled to achieve common goals and objectives. Partnerships through the certification of agroforestry products, for example, increase farmers' market power, contribute to corporate social responsibility, and boost consumers' confidence in safe production standards. Shortening agri-food-forestry value chains can also be realized through these partnerships

because farmers become directly connected to consumers, reducing the market and trade disruptions from shocks such as the COVID-19 pandemic.

Averting the high emissions scenario of a 4.8 °C regional temperature increase

Southeast Asia has had the fastest relative increase in total GHG emissions globally between 1990 and 2016 (WRI 2020). Trees on agricultural land are central to mitigation goals in lieu of available areas for large-scale restoration. Globally, agroforestry has the potential to mitigate between 0.11 and 5.68 Gt CO_2e yr^{-1} (Roe et al. 2019). Low estimates represent conservative adoption of agroforestry in crop and livestock systems. In contrast, high estimates represent more diversified scenarios of silvopasture with intercropping and multi-strata agroforestry and tropical staple trees (Roe et al., 2019). In addition, agroforestry can help remove 1.57 Gt CO_2e yr^{-1} in ASEAN through afforestation and reforestation, forest management, and peatland restoration (Griscom et al., 2017).

In a recent study, Tenneson and others (2021) indicated that almost 1.5 billion t CO_2 were lost due to tree cover conversion to cropland in Southeast Asia between 2000 and 2015. Some agroforestry systems store as much carbon as secondary forests. Conversion to cropland without tree components results in the largest loss of landscape carbon, aside from complete forest clearance. Conducting trials of different types of agroforestry can improve understanding of suitable replacements for monocultures. With mounting evidence of agroforestry's environmental and social benefits, policymakers can embed agroforestry at the centre of agriculture and forestry production while additional trials are taking place. These actions can help AMS avert the 'business-as-usual scenario of a 4.8 °C mean annual temperature increase in ASEAN by 2100 (ASEAN Secretariat 2020b).

Directions for future agroforestry research

Agroforestry research into mitigation strategies for food insecurity, biodiversity loss and the climate crisis is needed in Southeast Asia. Researchers should expand and strengthen these aspects both at national and regional levels to support policymakers and practitioners in creating enabling conditions for agroforestry. Owing to the paucity of agroforestry research and support for capacity building in certain areas of Southeast Asia, priority should be assigned to countries such as Cambodia, Lao PDR and Myanmar. Based on the results of the bibliometric analysis (Figures 8.1 and 8.2), research into agroforestry in Southeast Asia should focus on the topics mentioned below.

Plot management and resource-use efficiency

In contrast to intensive monocropping systems, which rely on costly inputs such as chemical fertilizers and high-yielding seed varieties, a salient feature of agroforestry are lower input and higher resource-use efficiency. This outcome can be achieved through appropriate combinations and spacing of the tree, animal and crop components and plot-management design. Investigations into optimal design and management practices and water conservation technologies can support greater resource efficiency under different agroforestry systems.

Agroforestry options by context

Determinants of agroforestry adoption include labour, land and socio-economic assets. Other factors, such as institutional and policy support, are also influential. The limiting factors for agroforestry adoption vary by household and location. Continued emphasis on agroforestry options suitable for each locale and region will help scale up best practices

across different landscapes. These efforts can be complemented by geospatial tools and land-sustainability analyses to identify the most suitable areas for agroforestry expansion.

Socio-ecological trade-offs and synergies in agroforestry options
Landscape resilience mainly depends on ecological functions, whereas smallholders' resilience depends on economic, social and cultural factors. Therefore, a balance of socio-ecological aspects is key to developing a multifunctional and sustainable landscape. Analysis of the material and the immaterial outcomes of agroforestry adoption can provide insights into the incentives and deterrents to integrating trees with agriculture across space and time. The trade-offs and synergies of various agroforestry options can be accurately assessed to ensure sustained adoption by smallholders and other local resource users. The balance between goal-oriented (or 'instrumental') and socio-cultural (or 'relational') values needs to be further explored and guarded as they communicate with different segments of society.

Market access to agroforestry products
Input-intensive monocultures generally have stronger market links than agroforestry, which produces a diversity of products at smaller scales (USDA 2019). Third-party labelling and product certification in collaboration with the private sector have opened smallholders opportunities to increase their incomes through sustainable farming. Based on the bibliometric analysis of agroforestry research in Southeast Asia, no published research was found in the last four decades that focused on value chains. Thus, researchers should investigate innovative platforms for smallholders to enhance the quality of agroforestry products by examining enabling factors, such as access to stable markets.

Gender roles in production and value chains
The lack of attention to gender roles in production and value chains limits the effectiveness of agroforestry interventions. Agroforestry impacts cannot be thoroughly evaluated without clearly understanding the varying roles and benefits between men and women in natural resource management (Catacutan and Naz 2015). This area is important as ASEAN seeks to mainstream gender in the agricultural and forestry sectors throughout its strategic plans. Collecting gender-disaggregated data will help develop more suitable agroforestry models in the face of growing environmental and social inequalities.

Research outputs can be funnelled into a public repository accessible by all ASEAN members to enhance implementation plans and frameworks for agroforestry development. By collating agroforestry case studies in a single knowledge management system, ASEAN leaders can better identify research gaps and efficiently deploy resources to address them. Furthermore, linking research with policy through collaborative platforms and long-term projects will help ensure the effective uptake of evidence-based recommendations.

Directions for policy

The ASEAN community seeks to create a competitive, inclusive and sustainable agri-food sector integrated with the global economy by 2025 (AMAF 2015). Under this regional vision, the *ASEAN Guidelines for Agroforestry Development* suggest streamlining and developing national agroforestry programmes to accelerate this process (Catacutan et al., 2018).

Survey responses from focal points of the AWG-SF emphasise each relevant AMS was having an agency responsible for agroforestry, integrated into national programs, and agroforestry financing mechanisms as potential indicators to track progress toward agroforestry development in the region (Table 9.1). Assessing the local uptake of agroforestry on agricultural and forest lands through a national agroforestry roadmap, policy, and farmer adoption were also noted as potential indicators. Less emphasis was

placed on quantifying private-sector engagements in the adoption of the *Guidelines* as metrics for success.

Table 9.1. Potential indicators to track progress of the *ASEAN Guidelines for Agroforestry Development*

Country	Responsible agency for agroforestry	Agroforestry policy	Agroforestry roadmap / programme	Integrated into national programmes	Budget for agroforestry	Agroforestry area	Number of farmers adopting agroforestry	Number of businesses adopting the *Guidelines*	Agroforestry Research
Brunei Darussalam	√	√							
Cambodia	√		√	√	√	√	√		
Indonesia	√	√	√	√	√	√	√	√	√
Lao PDR				√	√	√		√	
Malaysia	√		√	√	√	√	√		
Myanmar	√		√	√	√	√	√		
Philippines	√	√		√	√	√	√		
Thailand	√	√	√	√	x	√	√	√	
Viet Nam	√	√	√						
Total	7	5	5	6	6	6	5	3	

Source: AWG-SF survey. No selection of indicators from Singapore.

Building on the ASFCC, and currently, with support from FAO, agroforestry roadmaps in Cambodia, Lao PDR, and Myanmar could inspire other countries to follow, in the spirit of ASEAN cooperation in Food, Agriculture and Forestry. This process entails a series of multi-stakeholder workshops with personnel from different agencies at various levels establishing action plans, milestones and deliverables to create an enabling institutional environment where joint coordination between agencies helps agroforestry thrive. Regionally, the underlying framework for agroforestry already exists in most countries within the agricultural and forestry sectors. Much of the remaining work lies in fostering a culture of coordination, information sharing and joint problem-solving between government agencies. Through cross-sectoral cooperation and coordination, diverse stakeholders can reduce barriers to scaling up agroforestry.

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Chapter 10. Monitoring and reporting of agroforestry in Southeast Asia

Key messages

- Governments should establish national-level monitoring systems for agroforestry. Investment in internet infrastructure, simulation models and geospatial tools and training across Southeast Asia will complement efforts to create a practical path to agroforestry development.

- At the national level, recommended actions include developing an institutional framework for agroforestry between government agencies, providing financing options for adopters, and encouraging agroforestry-based investment partnerships.

- At the regional level, recommended actions include incorporating agroforestry criteria into market initiatives, such as the ASEAN GAP, and managing and sharing lessons learned between AMS.

Tools for agroforestry evaluation

The deployment of computer-based simulation models, geospatial techniques and other research-support tools can augment existing information on the coverage of agroforestry. Results can feed into cost-benefit analyses between conservation and livelihoods' outcomes of different agroforestry models and minimize the risk of adopting unsuitable models.

Several tools have been developed to support simple hypothesis testing to more advanced econometric and remote-sensing techniques for agroforestry management. Models have remained limited owing to the complex parameter requirements, lack of updates, constraints on simulating different crops and types of agroforestry systems (Ellis et al. 2004, Luedeling et al. 2015). Nonetheless, they help capture the complexity of components and their interactions, estimate economic and ecological benefits and trade-offs and predict potential outcomes from shocks and stressors. Among the identified models in Table 10.1, the Water, Nutrient and Light Capture in Agroforestry Systems model is one of the few developed for tropical agroforestry. It thus is frequently employed in Southeast Asia (for example, Pansak et al. 2010 in Thailand and Khasanah et al. 2020 in Indonesia).

Table 10.1. Existing models for assessing tree and crop interactions in agroforestry

Acronym*	Title	Source
APSIM	Agricultural Production Systems Simulator	Keating et al. (2003)
Farm-sAFe	Financial and resource-use Model for Silvo-arable Agroforestry for Europe	Graves et al. (2011)
Hi-sAFe	Three-dimensional model for Silvo-arable Agroforestry for Europe	Dupraz et al. (2019)
HyCAS	Combination of Hybrid and GUMCAS model for cassava	Matthews and Lawson (1997)
HyPAR	Combination of Hybrid and Predicting Arable Resource Capture in Hostile Environments (PARCH)	Mobbs et al. (1999)
SCUAF	Soil Changes Under Agriculture, Agroforestry and Forestry	Young et al. (1998)
WaNuLCAS	Water, Nutrient and Light Capture in Agroforestry Systems	van Noordwijk et al (2011)

Yield-sAFe	A one-dimensional model for estimating the productivity of Silvo-arable Agroforestry for Europe	van der Werf et al. (2007)

*Alphabetically ordered

Having reliable information about the distribution of agroforestry allows for socio-economic impact assessments. Such information remains scarce owing to deficiencies in high-resolution satellite imageries, standard procedures for determining the boundaries of agroforestry plots, and ground reference for validation (Rivzi et al. 2020). Over time, researchers have developed geospatial techniques to enable more accurate image interpretation, supported by open-source image analysis and crowdsourcing platforms. For example, Tenneson et al. (2021) used the Collect Earth Online platform and the Digital Globe and Bing high-resolution imagery (< 5 m^2) as the primary inputs for characterizing commodity crops in forest-loss areas between 2000 and 2015 across Southeast Asia.

With the expansion of agroforestry initiatives, a compilation of the various frameworks and tools used by researchers can help advance decision-making processes and standards. Drawing on experience throughout Southeast Asia, van Noordwijk et al. (2013) developed the first toolkit to support negotiations between local stakeholders for agroforestry development. This tool kit contains 48 negotiation-support frameworks and tools to account for the diverse knowledge systems and interests and address local socio-ecological conditions of management practices. In addition to reviewing the toolkit, ASEAN policymakers and practitioners should conduct an inventory of country-specific tools that will further inform decisions on the interlinked aspects of agroforestry for sustainable development.

Recommended actions to monitor and report progress on agroforestry development in ASEAN

Recommended actions are proposed at national and regional levels to encourage ASEAN stakeholders to exploit opportunities for and overcome barriers to agroforestry development. Actions are presented in a staged manner, which can be taken simultaneously or in a different order based on the discretion and needs of stakeholders. Much of the recommended actions are drawn from the *ASEAN Guidelines for Agroforestry Development*, which AMAF endorsed in October 2018.

National level

Given the various indicators suggested by AWG-SF focal points to track agroforestry progress against the adoption of the *ASEAN Guidelines for Agroforestry Development* (Table 9.1), investment in monitoring and evaluation will be necessary to establish baseline conditions and track progress and outcomes. The scope of monitoring should cover institutional arrangements, policy and programming, financing, the extent of area coverage and farmer adoption, and larger private-sector engagement and development.

Setting up a national monitoring system for agroforestry as a cross-cutting approach to meeting multiple cross-sectoral targets and goals indicates the need for someone to be responsible for it. This can be purposely orchestrated through proper institutional arrangements with a policy mandate. Existing monitoring schemes can be used to optimize limited human resources and avert duplication of efforts. A home for agroforestry might be an essential step, responsible for reporting to the ASEAN Secretariat.

With most tree cover gains occurring outside of forests (Figure 3.3), establishing a national-level monitoring system for agroforestry will help capture the extent of existing agroforestry systems to guide policy development. Initiatives such as the OneMap projects in Indonesia and Myanmar show the possibilities of leveraging open-access spatial data to combine official government data and participatory maps for land-use planning (Wibowo and Gissen 2015, CDE 2020). The quantification of TOF through participatory multi-stakeholder approaches can enable more reliable food production and environmental conservation (Bahar et al. 2020).

Along with establishing a national-level monitoring system, implementing a system to track the survival of planted trees on farmland is needed to capture the outcomes of agroforestry interventions. This tracking mechanism could be integrated into the national-level monitoring to streamline research and reporting. Recalibration of existing management approaches to replace unsuitable agroforestry models can also be carried out based on available time-series data. This is important because local environmental and socio-economic contexts continue to evolve rapidly.

Regional level
At the regional level, the ASEAN Secretariat should be responsible for monitoring the progress of AMS in adopting the *ASEAN Guidelines for Agroforestry Development* using agreed indicators. An online reporting system should be developed and managed at the ASEAN Secretariat. Milestones and status of accomplishment should be reported annually to generate country-specific reports on agroforestry development across ASEAN.

Concluding remarks: the road ahead

This report is a first attempt to capture the overall situation, trends and outlook of agroforestry in Southeast Asia. The image of agroforestry captured in this report is neither complete nor comprehensive, reflecting the vast neglect of documenting agroforestry, despite its recognized potential. Since AMS does not practise agroforestry reporting, this report relied on published reports and scientific articles, AWG-SF surveys and contributions from agroforestry experts. Although partial in scope, this report is, thus, valid and truthful.

The explicit inclusion of agroforestry in high-level policy documents of ASEAN gestures the growing importance of tree-based systems to tackle some of the most pressing issues, such as the climate crisis, land degradation and food insecurity. Managing the silos of agriculture and forestry through dedicated institutions for agroforestry will help ensure effective communication for land-use planning and emergency response. This is necessary to support regional resource-use efficiency because the urban population across ASEAN is projected to surpass 500 million people by 2050. Constraints on land availability for farming and restoration enforced by urbanization and population growth require clear frameworks and procedures to enable mixed land-use mosaics.

The shift toward healthier diets and safer agri-food production and consumption behaviour, farm sanctuaries and ecosystem services has provided more opportunities to promote agroforestry. The COVID-19 pandemic has laid bare the fragility of the existing ASEAN food system, which often depends on costly imported inputs. Greater emphasis on agroforestry in the regional agri-food-forest sector can enhance economic integration while ensuring sustainable certification requirements. Within AMS, enabling agroecological approaches to local food and timber production requires reform of the subsidization of input-intensive agriculture and direct-income support to farming- and forest-dependent communities. By relaxing incentives to input-intensive production systems and incentivising sustainable practices, such as agroforestry, policymakers can present households with the flexibility to

make management choices that lower their environmental footprints and increase productivity.

Enhancing agroforestry governance will help the uptake of sustainable agricultural and forestry management through providing targeted guidance on optimal management options. The *ASEAN Guidelines for Agroforestry Development* is an important milestone in scaling up agroforestry. Nested within the *Vision and Strategic Plan for ASEAN Cooperation in Food, Agriculture and Forestry 2016–2025*, this high-level policy document is part of a larger movement towards sustainable development in the face of the climate crisis and the Earth's overshoot planetary boundaries. Policy recognition of the role of agroforestry in responsible investment is also highlighted in the ASEAN Comprehensive Recovery Framework for COVID-19, which includes training in agroforestry management as a key deliverable and inclusion of agroforestry in NDC targets by some AMS. These policy mechanisms provide the basis on which ASEAN decision-makers can take further action.

An alignment between political aspirations and policy conditions is required to make advances in agroforestry. While Cambodia, Lao PDR and Myanmar are moving on their roadmaps for agroforestry development, participation from other AMS is also needed to help boost the profile of ASEAN as a food-secure and climate-resilient region. Placing agroforestry at the forefront, policymakers and practitioners in Southeast Asia can adapt to external shocks and changes and build human and ecosystem resilience. An important aspect of this development is to increase the supply of agroforestry expertise by boosting agroforestry curricula programmes in ASEAN institutes of higher learning.

Agroforestry, as a practice, science and movement, has been shown to increase the benefits and aspirations of local resource users without comprising the social and environmental objectives of natural resources management. Ongoing and new challenges to livelihoods' development and conservation will continue to test the infrastructure and systems of ASEAN societies. By encouraging locally appropriate farming techniques through agroforestry, policymakers can empower smallholders to establish viable management practices over the long term to produce more diversified and higher quality food and forestry products. This can be accomplished by including agroforestry management criteria in regional product certification initiatives, such as the ASEAN GAP. Agroforestry can help lessen the negative impacts of societal challenges in ASEAN, yet it can only be realized if strong regional coordination and cooperation exist amongst AMS.

Finally, the scaffold for mainstreaming agroforestry already exists. However, discussion about the specific interior and exterior reinforcements is needed to set a path to achieving the goals. With increased cooperation among AMS to increase the momentum of agroforestry, the outlook for 2030 and beyond might just be brighter in just a decade since the ratification of the *ASEAN Guidelines for Agroforestry development* in 2018 by the ASEAN Ministers of Agriculture and Forestry and the ASEAN population may have more to expect.

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