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Regenerative Agriculture for Climate Resilience and Food Security in Southeast Asia

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A farmer uses a walk-behind tractor plough to prepare land for planting, instead of the traditional slash-and-burn method, during sunrise in Nakhon Sawan province, north of Bangkok, on 19 June 2026. (Photo by Chaiwat Subprasom/NurPhoto)

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EXECUTIVE SUMMARY

- Southeast Asia's agrifood systems are under increasing pressure from soil degradation, biodiversity loss, water pollution, greenhouse gas emissions, and climate change, all of which threaten long-term food security.
- Regenerative agriculture offers a pathway to address these by restoring soil health, biodiversity, ecosystem functions, and climate resilience. Regenerative agriculture seeks to reverse environmental degradation while supporting long-term food production.
- Regenerative practices already exist in Southeast Asia, including crop diversification, intercropping, cover crops, conservation tillage, biofertilisers, agroforestry, biochar, residue incorporation, and precision agriculture. These can improve soil fertility, enhance carbon sequestration, reduce chemical dependency, and strengthen resilience to climate shocks.
- Adoption remains constrained by economic, technical, and policy barriers. Farmers face transition costs, uncertain short-term returns, limited access to advisory services, weak market incentives, unclear performance metrics, insecure land tenure, and policies that continue to favour conventional input-intensive agriculture.
- ASEAN Member States (AMS), using the Food, Agriculture and Forestry Sectoral Plan (FAF SP) 2026-2030, can accelerate adoption through regional cooperation in research, farmer training, demonstration farms, soil-health measurement, digital agriculture, climate finance, and harmonised frameworks for regenerative agriculture.
- The Association of Southeast Asian Nations (ASEAN) has an important enabling role as coordinator, knowledge hub, and facilitator of financing, standards, and policy alignment. It can position Southeast Asia as a global leader in regenerative and sustainable agrifood systems.

BACKGROUND[1]

Current practices in agrifood systems have led to a decline in soil health, loss of biodiversity, and water contamination while contributing to Greenhouse Gases (GHG) responsible for climate change. In response, regenerative agriculture has been proposed as a solution in both scientific and policy circles. However, enthusiasm has outpaced evidence in some quarters, and confusion remains about what separates 'regenerative' from 'sustainable' agriculture.[2]

This paper seeks to explain the key challenges facing modern agricultural practices that underscore the need for regenerative approaches. It explores the core principles of "regenerative agriculture", reviews proven practices with a particular focus on Southeast Asia, discusses the barriers to adoption, and provides recommendations to accelerate its implementation in ASEAN. Finally, it proposes strategic actions that may be undertaken at the ASEAN level to promote and scale up regenerative agricultural practices.

ISSUES IN AGRICULTURE THAT NEED REGENERATION

Southeast Asia's agrifood system, which contributes 10 per cent of the region's GDP,[3] is under severe stress. Foremost of the problems being faced is the decline in soil health. Alarmingly, a growing proportion of Southeast Asia's agricultural land is being degraded, with the degradation rate in Indonesia and Malaysia almost doubling between 2015 and 2019 (Table 1). Land degradation is characterised by nutrient-poor soils, erosion, loss of soil structure and organic matter, and declining yields over time. These are the results of intensive monocropping, heavy use of chemical fertilisers and pesticides, as well as repeated tillage, crop residue removal and burning. The degradation has contributed to large yield gaps of up to 48% in the region's rice production and declining yield growth rate of 1-2% per year.[4] Underscoring this is the reduced income affecting the livelihood of smallholder farmers who till these lands. However, concerns about soil health need to be balanced with the role that monocultures like rice continue to play in assuring food security, especially for those living in cities.

Smallholders make up four of five farms in Southeast Asia.[5] Most have formed dependencies on practices which include synthetic fertilisers, pesticides and bought seed. While these practices have led to production increases of 2.6-5.9% across all crops[6], they have also led to high debt, low profit margins, and vulnerability to supply chain disruptions and price shocks in many farming communities.

Furthermore, agriculture, especially plantation agriculture for industrial crops like palm oil,[7] has driven deforestation and habitat loss, resulting in biodiversity loss in a region considered to be a global biodiversity hotspot.[8] Overuse and misuse of chemicals have polluted rivers and groundwater. Additionally, Southeast Asian agriculture is a major source of greenhouse gas emissions, especially of methane.[9]

Southeast Asia feeds over 600 million people. Food security depends not just on high yields, but on sustaining them through increasingly volatile climate conditions.[10] Soils have been degrading with each cropping cycle, forcing farmers to abandon their land on 25% of badly degraded land.[11] One report estimates that global soil degradation costs US$6.3 trillion to US$ 10.6 trillion annually, with Asia and Africa bearing the highest costs.[12] Projections suggest that

ASEAN's GDP will be reduced by 6% due to climate change impacts on agriculture by the end of the century[13], and that the region could lose 35% of its total GDP by 2050.[14]
Regenerative agriculture has been advocated as having the potential to restore some of these degraded lands,[15] reverse the yield decline, and reduce emissions through practices that lower soil tillage and conserve soil health.

Table 1. Degraded* and damaged land in Southeast Asia

Degraded land	% of land area degraded		Area degraded (million ha)
	2015	2019	2019
Brunei Darussalam	n.a.	n.a.	n.a.
Cambodia	17.37	19.57	3.47
Indonesia	9.93	17.57	32.68
Lao PDR	n.a.	n.a.	n.a.
Malaysia	8.06	15.22	4.94
Myanmar	n.a.	n.a.	n.a.
Philippines	38.28	49.44	14.26
Singapore	n.a.	n.a.	n.a.
Thailand	n.a.	n.a.	n.a.
Timor-Leste	n.a.	n.a.	n.a.
Vietnam	28.2	23.41	7.76

*Land degradation is the reduction or loss, in arid, semi-arid and dry sub-humid areas, of the biological or economic productivity and complexity of rainfed cropland, irrigated cropland or range, pasture, forest and woodlands resulting from land uses or from a process or combination of processes, including processes arising from human activities and habitation patterns such as soil erosion caused by wind and/or water; deterioration of the physical, chemical and biological or economic properties of soil; and long-term loss of natural vegetation

Source: UNCCD[16]

CORE PRINCIPLES AND PRACTICES OF REGENERATIVE AGRICULTURE

Regenerative agriculture does not have a single universally accepted definition, but it is generally understood as a system of farming principles and practices that regenerate and enhance the health of ecosystems, particularly soil.[17] The focus on soil is by no means at the exclusion of other important parts of agricultural ecosystems, such as water and biodiversity. The term "regenerative" implies renewal, restoration, and improvement rather than mere maintenance. While sustainable agriculture aims to reduce harm and leave the land in a state that supports future farming.[18,19] regenerative agriculture seeks to reverse damage already done.

Fundamentally, regenerative agriculture focuses on rebuilding soil organic matter and restoring soil biodiversity.[20] Healthy soil acts as the foundation for productive farming systems, supporting plant growth, water retention, nutrient cycling, and carbon sequestration. Healthy soil is also increasingly recognised as one of the most important carbon sequesters.[21] Regenerative agriculture views farms as living systems in which plants, animals, microorganisms, and humans are interconnected.

The core principles of regenerative agriculture include maintaining soil health and soil biology, minimising soil disturbance, maintaining continuous soil cover, increasing plant diversity, integrating livestock, adapting practices to local ecological conditions, and supporting climate resilience.[22,23,24] Ending the use of synthetic fertilisers as a regenerative agriculture practice has also been advocated.[25] These core principles are flexible rather than prescriptive; this is to allow farmers to apply them in ways that suit their specific environments and crops. Regenerative agriculture is demonstrated through the use of one or more of the practices shown in Table 2. These practices aim to create farming systems that are environmentally sustainable, economically viable, and socially responsible.[26] The global market for regenerative agriculture has been estimated by one source to grow from US$9.2 billion in 2025 to US$20.69 billion by 2031 at a compound annual growth rate (CAGR) of 14.46 per cent.[27]

While regenerative agriculture is often presented as a modern innovation, many of its principles are rooted in traditional and indigenous practices, as well as in the scientific field of "agroecology," which is strongly promoted by the Food and Agriculture Organization (FAO).[28] Indigenous communities around the world have long practised forms of land stewardship that emphasise harmony with nature, soil fertility, and long-term productivity. Techniques such as crop rotation, intercropping, agroforestry, and the use of organic matter to enrich soils have been used for centuries. However, meeting the challenges of climate change and the need for more food necessitate integrating modern technological innovations with these traditional practices. The conundrum lies in the relatively low production from traditional systems at a time when human population growth and urban migration demand high production.[29]

Therein lies the dilemma of balancing between the short-term needs of society to produce more food and the longer-term need to protect production environments.

Supportive Practices

The core principles of regenerative agriculture have been supported by a plethora of farming practices in Southeast Asia as listed below (Table 2):

Table 2: List of regenerative practices in Southeast Asia, their benefits, and impacts

Regenerative practice	Definition/ Example	Main Benefits	Impact on regeneration
Polycultures & crop rotations	Growing more than one crop species together at the same time, complementing each other through plant architecture or functions (like Nitrogen (N)-fixation), e.g., corn, beans, and squash	The corn provides support for the beans; the beans fix nitrogen; the squash provides ground cover. This reduces reliance on chemical fertilisers; improves soil fertility.	Increases on-farm biodiversity, nitrogen cycling, and soil resilience.
Intercropping	involves growing two or more crop species simultaneously in the same field during a single growing season and	Lowers fertiliser and pesticide needs; improves space use.	Promotes root and soil diversity, microbial activity, and balanced nutrient cycling.

	harvesting the crops at the same time		
Contour farming	Tilling along lines of equal elevation on slopes.	Conserves rainwater, prevents erosion and runoff.	Protects topsoil and soil organic matter and stabilises ecosystems on slopes.
Conservation tillage/ Low or No-till farming	Minimises soil disturbance during cultivation.	Maintains soil ecology, reduces fuel/input costs.	Boosts soil carbon storage, structure, and microbial life.
Cover crops	Crops grown to protect and enrich soil (e.g., legumes, clover).	Reduces erosion, improves water retention, suppresses weeds, breaks up pest and disease cycles, increases biodiversity, provides late pollinator food sources, and brings other benefits to the farm; especially valuable in plantation row crops like palm oil and rubber	Builds organic matter, root diversity, nutrients, and soil biodiversity.
Bio-fertilisers	Inputs containing beneficial microorganisms (bacteria, fungi, cyanobacteria).	Improves plant nutrition efficiency and soil health, reduces or replaces chemical fertiliser needs	Increases nutrient bioavailability to improve plant growth and health and promotes living soil systems.
Green manure	Leguminous crops are ploughed under while still green.	Adds organic matter and nitrogen naturally.	Enriches soil fertility and supports carbon regeneration.
Biochar	A carbon-rich material produced from biomass through pyrolysis. (heating in the absence of oxygen)	Improves soil structure, water, and nutrient retention; can reduce fertiliser losses.	Sequesters carbon long-term and supports stable soil habitats.
Straw Residue Incorporation	Returning crop residues to the soil instead of burning or removing	Increases soil organic content, fertility, and biological activity.	Replenishes the soil carbon pool and supports nutrient cycling and aggregation.
Precision agriculture or "Smart farming"	Using Internet-of-Things (IoT), data, and sensors to apply the right input, at the right rate, time, and place.	Increases efficiency, reduces fertiliser and pesticide use, waste and runoff.	Limits pollution and resource overuse, helping keep surrounding ecosystems intact.
Agroforestry	A land use management system that integrates trees with crops or pasture.	Reduces deforestation pressure, increases resilience.	Restores habitat diversity, enhances carbon sequestration.

Source: Authors' compilation

Many of these practices are adopted on different scales in rice, coconut, coffee, palm oil, and other crops, in Thailand, Vietnam, Cambodia, Malaysia, and Indonesia. Some practices are still in the pilot stages and more efforts are needed to scale them upwards.

ISSUES IN IMPLEMENTING REGENERATIVE AGRICULTURE

The biggest challenge in transitioning from conventional agriculture to one that focuses on regenerative principles is changing farmers' established practices and asking them to relearn farming. Such a transition is also accompanied by its costs and risks.[30]

Regenerative practices, as listed in Table 2, often require increased effort and may not yield immediate results. Investments are needed for new equipment (such as with minimum tillage seeding), seeds, cover crops, or fencing.[31] A transition will require de-risking mechanisms or incentives, and mindset changes among farmers, given their legacy practices and the possibility of short-term yield declines during the transition period.[32] One successful example is a pilot in Northern Thailand where approximately 2,000 farmers switched to straw residue incorporation, rather than burning, through the use of biostimulants. Early trials report that the new practice has resulted in a 20 per cent increase in yield while reducing methane emissions by 20 per cent.[33]

Regenerative agriculture is knowledge-intensive and highly context-specific.[34] Many farmers lack access to extension services or farm advisory services from people trained in regenerative practices. Additionally, ensuring demand from the private sector for regenerative products must be factored in. Research-backed training materials for implementing regenerative agriculture on small farms in tropical situations are also scant.

The lack of a universally agreed-upon definition of regenerative agriculture makes measuring success difficult. Some work is being done on metrics to show improvements in soil health,[35] while others may define improvements based on outcomes.[36] Without clear metrics, policymakers and investors may struggle to design appropriate programmes.

The market premiums for regenerative products are currently underdeveloped. Nothing akin to the Sustainable Rice Platform—a global alliance that sets voluntary sustainability standards for rice production across the value chain[37]—has been developed for regenerative agriculture. There is anecdotal evidence that some consumers may be willing to pay more, but until supply chains for regenerative products are stable, this will remain an obstacle. Market rewards are needed to incentivise farmers to transition.

Existing agricultural policies often favour conventional practices, especially with the prevalence of fertiliser subsidies in ASEAN Member States (AMS).[38,39,40,41] Few incentives exist for soil restoration or ecosystem services, and regulations may discourage diversified or integrated farming systems. Mixing different crops in the same field, while beneficial, also creates practical headaches — not least the need for different harvesting equipment for each crop type, for example for corn and cassava.

Soil health is one of the main outcomes of regenerative agriculture, but achieving this requires secure land tenure for long-term soil rejuvenation.[42] Unclear land rights, such as those held by

tenant farmers, will likely discourage investment in regenerative practices. The percentage of smallholder farmers without legal tenure varies in Southeast Asia between 6 per cent (Thailand) and 64 per cent (Timor Leste), with other AMS sitting between 20 and 30 per cent.[43]

While regenerative agriculture improves resilience, climate variability still poses risks, especially extreme weather events. Farmers hesitate to invest in new practices under unpredictable conditions. Lack of crop insurance tailored to regenerative systems increases risk. Added to this is the fact that many financial institutions do not understand regenerative agriculture and may see the practice as risky or unproven. It is for these reasons that the Food, Agriculture & Forestry Sectoral Plan, 2026-2030[44] puts special focus on developing an ASEAN regenerative agriculture implementation plan backed by appropriate financiers and financing mechanisms.

ACCELERATING ADOPTION: AMS COLLABORATION AND ASEAN'S ROLE

Regenerative agriculture is already embedded in Thrust 1 of the ASEAN Food, Agriculture and Forestry Sectoral Plan (FAF SP) 2026-2030,[45] but a concerted, coordinated effort must be made to accelerate its adoption in the face of climate change and disruptions in fertiliser supply.

Collaboration among ASEAN Member States

AMS can collaborate by agreeing on the guiding principles for regenerative agriculture; shared frameworks can align regenerative agriculture with ASEAN food security and climate policies,[46] and facilitate consistency in strategies and incentives across countries. This encourages member states to move in the same direction while allowing flexibility for local adaptation.

There is still a lack of knowledge on the science behind current practices. Collaborative research is essential due to ASEAN's diverse agrifood ecosystems, which range from smallholder farms to large plantations. AMS collaboration could focus on key areas such as soil health and carbon sequestration, soil microbiomes, and climate-resilient regenerative practices. Sharing research findings and data across countries will reduce duplication and speed up innovation.

As most ASEAN farmers are smallholders, education and technical support are critical. AMS can collaborate by establishing regional training centres and demonstration farms, supporting farmer-to-farmer exchange programmes and developing shared training materials in local languages.

AMS share many common crops thus offering good opportunities for collaboration. Joint efforts allow countries to refine best practices and address common challenges such as pests, soil degradation, and water management.

Regenerative agriculture can contribute to climate mitigation and adaptation, which AMS can address collectively.[47] Collaboration could include soil health measurement and reporting, and use of carbon credits to finance climate action. However, transitioning to regenerative systems requires investment likely beyond what carbon credits generated by farmer action alone can provide. ASEAN can create regional financing platforms or blended finance mechanisms that integrate development banks and climate funds.

The FAF SP 2026-2030, and the ASEAN Ministers on Agriculture and Forestry (AMAF) have specially noted the importance of digitalisation to keep ASEAN agriculture competitive *and* supportive of food security goals.[48] Digital tools enable more precise decision-making so that fertilisers and pesticides can be applied at the right time and rate, based on the use of different sensors for weather, soil and environment. This not only saves costs for farmers but reduces pollution as well; up to 40 per cent of nitrogen fertilisers are presently inefficiently utilised.[49] AMS collaboration is also needed in assessment metrics to show progress in implementation.[50] Common metrics among AMS would help policymakers and donors evaluate progress and improve programmes. A Regenerative Agriculture Performance Checklist for smallholder farmers could consist of metrics that measure:

- Soil Health,
- Crop Diversity & Rotation,
- Tree & Habitat Integration,
- Water Management,
- Livestock Integration,
- Reduced Chemical Use & Inputs,
- Increased use of biological inputs,
- Farmer Wellbeing & Knowledge,
- Cropping System Adaptability & Resilience.

ASEAN's Role in Regenerative Agriculture

ASEAN can promote regenerative agriculture by acting as coordinator, facilitator, and enabler. Through shared frameworks, farmer support, education, research, market development, and climate integration, ASEAN can help regenerative agriculture scale up across Southeast Asia. However, as with ASEAN's usual modus operandi, it would be up to each AMS to make decisions on what the immediate, mid-term or long-term scaling goals will be. ASEAN is additionally an important link among individual AMS, Dialogue Partners and extra-regional ASEAN donors; this can help mobilise funding to help smallholders in transitioning to regenerative practices.

ASEAN can start by creating a shared regional framework or a set of guidelines which would:

- Define core regenerative principles (soil health, biodiversity, reduced chemical inputs, climate resilience),
- Allow flexibility for country-specific conditions and agrifood systems, and
- Align regenerative agriculture with existing ASEAN goals on food security, climate action, and sustainable development

ASEAN could draw ideas from existing frameworks such as the World Business Council for Sustainable Development's Global Framework for Regenerative Agriculture,[51] or Regen10's "Outcomes Framework".[52] The latter's framework includes 12 outcomes and associated indicators that span ecological, social, economic, and governance dimensions at the farm and landscape level. A common framework would limit confusion, encourage consistency, and give governments and investors a clear direction.

Since ASEAN already has regional strategies on food security, climate resilience and sustainable agriculture,[53] regenerative agriculture can be formally embedded into ASEAN climate adaptation and mitigation plans, linking it to Nationally Determined Contributions (NDCs) under the Paris Agreement, as well as AMS' individual National Agriculture Plans

(NAPs). Ideally, it would encapsulate soil carbon, biodiversity restoration, and resilient farming. The intention is to showcase regenerative agriculture as a strategic priority and not a niche practice at the ASEAN level.

More research is needed to strengthen confidence in tropical regenerative agriculture, especially on aspects of soil microbiology. ASEAN can seek funding for regional research on soil health, carbon storage, yields, and resilience through its many mechanisms, such as the ASEAN Technical Working Group on Agricultural Research and Development (ATWGARD), and endorse shared indicators for measuring regenerative outcomes.

ASEAN can also influence policy by encouraging AMS to re-examine their fertiliser subsidy policies which skew farmers towards conventional practices. Instead, support should be strengthened for the development of "agri-biologicals" and incentives to scale them. Additionally, ASEAN can encourage the exploration of financial support for ecosystem services, such as soil carbon sequestration.

Regenerative agriculture will scale faster if farmers can earn better incomes. ASEAN has much credibility as a regional influencer to stimulate new demand markets for regenerative produce such as through procurement for public programmes like schools or hospitals. It can also improve regional trade opportunities for regeneratively produced crops.

ASEAN has a longstanding ambition to create an integrated market. Under the umbrella of the ASEAN Economic Community (AEC) Vision,[54] it could set up derisking strategies that promote a smooth transition to regenerative agriculture by facilitating market-driven opportunities and promoting preferred certification standards. This would lead to trading environments that promote regional and international trade.

Scaling regenerative agriculture within Southeast Asia will require "buy-in" from multiple stakeholders. ASEAN can guide private-sector involvement by endorsing partnerships that effectively improve soil health, farmer livelihoods and the overall agrifood ecosystem.

CONCLUSION

Southeast Asia needs to improve its agriculture resilience. Examining what the region has potential for—carbon farming, waste recovery, biologicals production, indigenous knowledge and others—is key to developing this resilience. Regenerative agriculture is a key component in this. It is a transformative approach to farming that goes beyond sustainability, to actively restore and enhance natural systems.

As global concerns about climate change, food security, and environmental degradation intensify, regenerative agriculture deserves increased attention from farmers, scientists, policymakers, and consumers alike.

While regenerative agriculture is not a single solution to all agricultural problems, it offers a compelling framework for addressing many of the most pressing issues facing modern agriculture. As awareness of environmental and climate challenges grows, advances in soil science, technology, and data collection will improve our ability to measure and optimise regenerative outcomes; meanwhile, growing consumer demand for environmentally responsible food will drive broader adoption of these practices. By restoring soil health,

enhancing biodiversity, and building resilient ecosystems, regenerative agriculture represents a hopeful path forward. In doing so, ASEAN would strengthen food security, climate resilience, environmental health, and rural livelihoods, positioning the region as a global leader in sustainable and regenerative food systems.

ENDNOTES

[1] Professor Paul Teng is also Senior Fellow at SEARCA, Philippines, and Executive Director of The IRRI FUND, Singapore. He also advises several agtech startups, and previously held leadership positions in the Worldfish Centre, the International Rice Research Institute, Monsanto Company, and U.S. universities. He is internationally recognised for his expertise in tropical agrifood systems and food security, with a focus on smallholder crops like rice. He has researched and taught in North America, Africa and Asia, and has published over ten books and over two hundred technical papers. He has been recognised for his work through multiple awards and conferred an Honorary D.Sc. from Murdoch University, Australia.
Ms Ludher previously owned a circular insect farm in Cambodia, and has contributed to food policy research at the World Bank, Centre for Liveable Cities Singapore, and the Singapore Food Agency. Her publications include "Rice Production and Food Security in SEA under Threat from El Niño", "RICH Food Smart City", "Food and the City: Overcoming Challenges for Food Security", and "Preparing for a Climate Resilient Singapore". She has a double Master's in Urban and Regional Planning and Bioresource Engineering.

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