

The Economics of Ecosystems and Biodiversity (TEEB)

**Promoting a Sustainable Agriculture
and Food Sector**

CHINA

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I. INTRODUCTION

Agriculture heavily relies on nature, particularly well-functioning ecosystems. Activities related to agri-food systems, such as biological resource utilization, land use change, and pollution, significantly contribute to biodiversity loss. Moreover, agriculture serves as a vital source of employment, livelihoods, social well-being, and cultural development, impacting human health and nutrition.

The transformation towards sustainable agri-food systems involves various objectives. These encompass reducing agrochemical usage, curbing agricultural encroachment on forest land, and optimizing resource utilization per unit of land. Simultaneously, global conflicts periodically threaten food security, while the challenge of limiting global temperature rise to 1.5°C emphasizes the crucial role of agriculture in reducing greenhouse gas (GHG) emissions. How can this transformation address these challenges effectively?

The Economics of Ecosystems and Biodiversity (TEEB) stands as a vital international program, aiming to underscore nature's significance by incorporating biodiversity and ecosystem values into decision-making processes globally. Its extension, TEEBAgriFood, specifically

applies TEEB's principles and methodologies to the agricultural sector. Employing a systemic approach, TEEBAgriFood conducts economic evaluations within the 'ecosystem-agricultural-food' nexus, shedding light on both positive and negative externalities. This enhances policymakers' understanding of the intricate relationship between agriculture, the environment, and society.

In China, the concept of 'ecological civilization' has emerged as a paramount political ideology, guiding environmental policies, laws, and national development strategies. Its iconic view, 'lucid waters and lush mountains are invaluable assets' or 'Green is Gold', signifies a value system centered on respecting, adapting to, and protecting nature (Liu and Hou 2018). It mirrors the ecological economy's perspective on natural capital and fosters strategies for synchronized environmental protection and development nationwide.

The concept of TEEB aligns with China's pursuit of effective Green-to-Gold transformations. Among the national innovation bases practicing 'Green is Gold,' Tengchong City in Yunnan Province was chosen as the focal area for TEEBAgriFood due to



its full-scale landscape ecosystem, abundant biological and cultural resources, potential influence on policy and management decisions, level of government support, and international comparative relevance. The goal is to offer policy backing for ecological and green development, facilitating the effective Green to Gold transformation in this specific area. Additionally, it aims to serve as a model for other regions, providing insights into promoting the establishment of an ecological civilization across China.



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Tea is one of Tengchong's traditional industries

II. BACKGROUND

Tengchong, situated in southwestern Yunnan Province in China, serves as a pivotal ecological region, nestled on the southeastern edge of the Tibetan Plateau. The topography, carved by rivers running from north to south, manifest as a mosaic of mountains and valley basins. Boasting a remarkable 77% forest coverage (Tengchong Municipal Bureau of Statistics 2022), the region stands as a repository of diverse and abundant species, ranking among China's and the world's biodiversity hotspots. Additionally, the area is rich in cultural diversity, home to several ethnic minority groups.

The unique natural resources in Tengchong sustain a local population of 700,000 residents and foster a burgeoning agriculture and food sector (Tengchong Municipal Bureau of Statistics 2022). Leveraging its diverse agricultural system, Tengchong actively explores eco-friendly agricultural practices and endeavours to merge agriculture with tourism to convert the 'Green' into tangible economic gains (Figure 1).

The TEEBAgriFood study in Tengchong considers various agricultural policies, such as reducing chemical usage, implementing under-canopy plantation methods, adopting combined planting-breeding approaches, and controlling greenhouse gas emissions. It meticulously weighs both visible and invisible costs and benefits, considering the interests of present and future generations. Multiple development scenarios, ranging from Business as Usual to Optimistic and Pessimistic outlooks, are scrutinized (Figure 2). The study assesses the costs and benefits across four capital types: natural, produced, human, and social.

By unravelling the interdependencies within agri-food systems and navigating the trade-offs, the study aims to illuminate pathways for effective 'Green to Gold' transformations. Its outcomes are poised to inform sustainable agriculture policies, aligning with the objectives of the China Biodiversity Conservation Strategy and Action Plan (2011-2030) (China, Ministry of Environmental Protection 2010). The overarching goal remains reducing agriculture's impact on biodiversity and rejuvenating degraded landscapes.

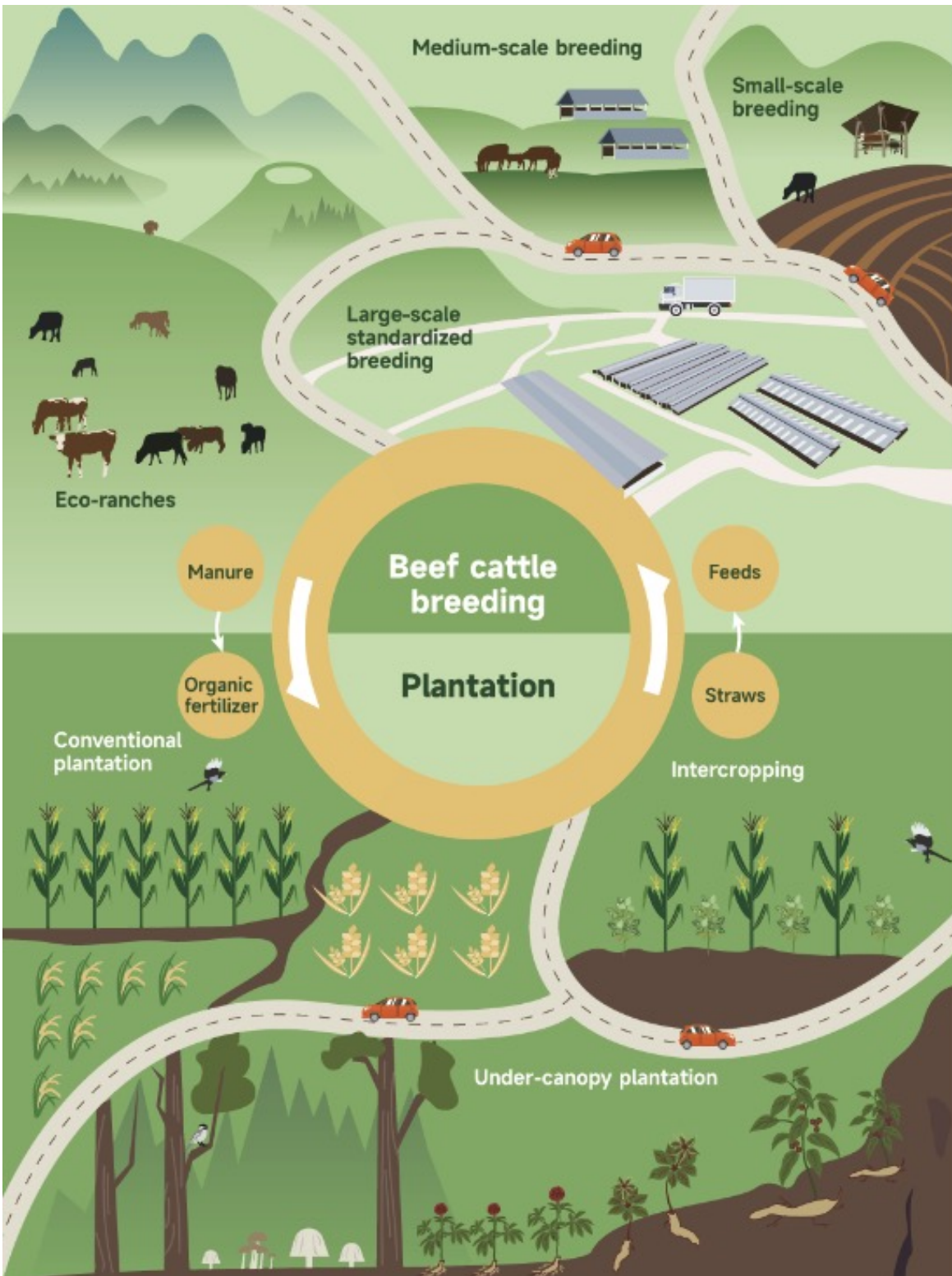


Figure 1 Tengchong's multifunctional agricultural system. Source: Authors

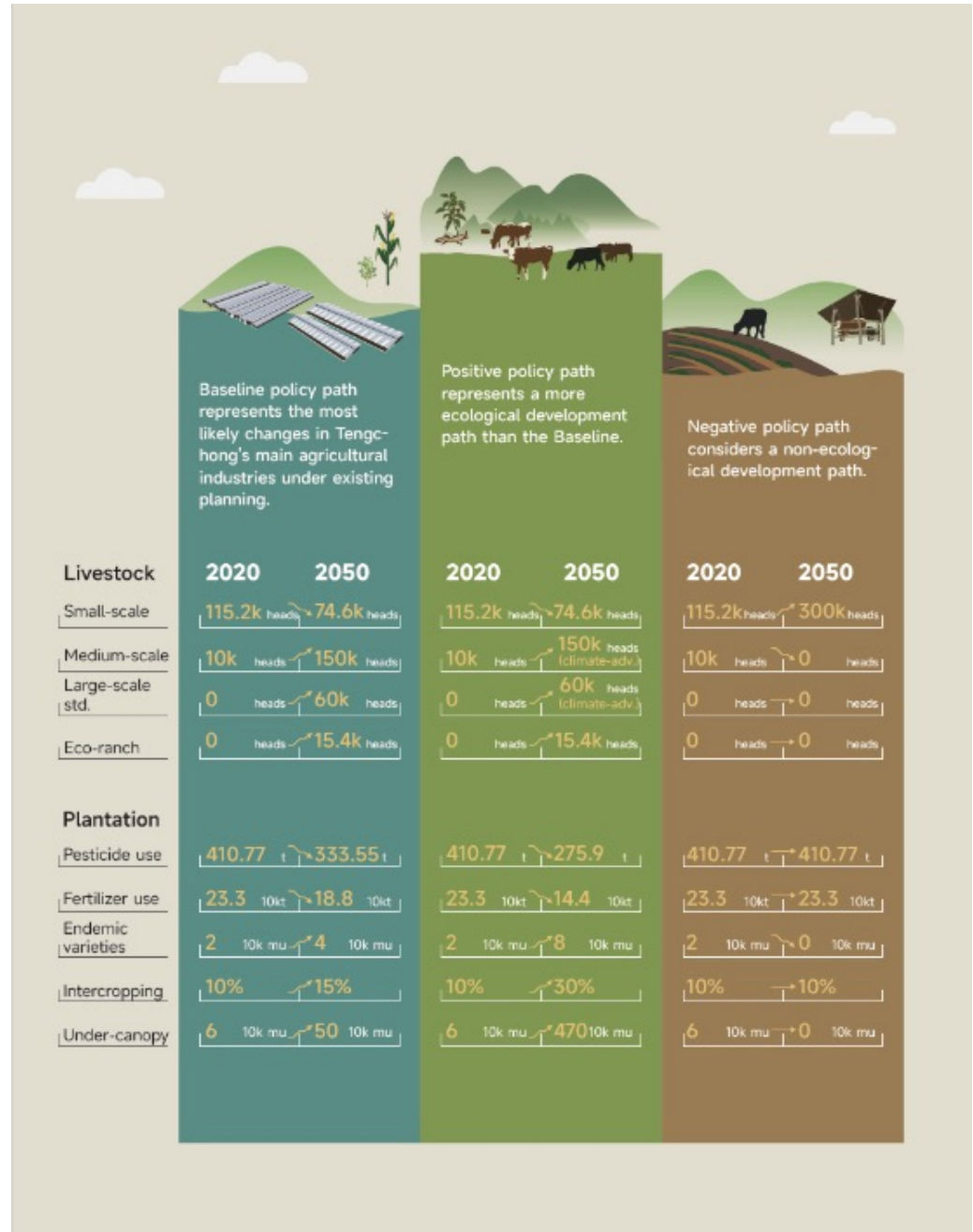


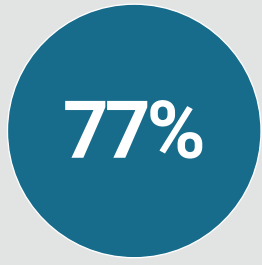
Figure 2: The study scenario setting. Source: Authors



III. Sample Facts and Figures



Number of 'Green is Gold' innovation hubs established as of 2022 (Liu and Liu 2023)



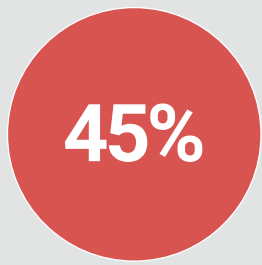
Forest cover in Tengchong (Tengchong Municipal Bureau of Statistics 2022)



Estimated annual value of water, soil and carbon related ecosystem services in 2020



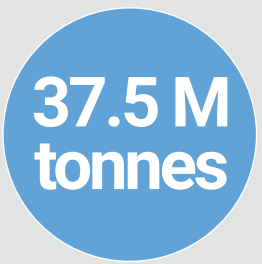
The invisible benefits of ecological development are 2.4 times the measurable benefits in the optimistic scenario



Saving in environmental protection cost of agricultural non-point source pollution in optimistic scenario compared to the pessimistic



Saving in agricultural non-point source pollution-related health costs in the optimistic scenario compared to the pessimistic scenario



CO₂e sequestered annually, and emissions from agriculture are 2.67% of this amount in 2020



In the optimistic scenario, women make up 55% of the agricultural workforce



15th Five-Year Plans at national, provincial and local levels into which results will feed

IV. TEEBAgriFood China – Heilongjiang application for soybean expansion

Additionally, alongside the Tengchong application, the Project Steering Committee in China has endorsed the development of a second application funded by the European Union in Heilongjiang Province, situated in Northeast China. This Heilongjiang-based application aims to focus on the national soybean expansion policy and assesses its natural, economic, and social impacts resulting from changes in land use.

Against the backdrop of uncertainties stemming from global soybean production challenges due to climate change and geopolitical tensions, the Chinese government is keen on expanding soybean cultivation in suitable regions (Chinese Communist Party Central Committee and State Council 2023). This expansion aims to address the escalating domestic soybean demand and fortify the food system's resilience. Heilongjiang's climatic and environmental suitability for soybean cultivation is exceptional by virtue of its situation in the heart of a black soil region in China, as well as relatively cool and temperate climate, coupled with ample rainfall during the growing season. Heilongjiang has consistently ranked at the forefront of China's grain production, notably maize, rice, and soybeans. (China National Bureau of Statistics 2022).

The Heilongjiang application encompasses three scenarios – business-as-usual, soybean priority and grain priority – overlaid with two climate change scenarios: RCP 4.5 and RCP 8.5. The soybean priority scenario emphasizes extensive expansion of soybean cultivation, primarily through transitions from paddy fields and maize to soy. Conversely, the grain priority scenario focuses on conservative soybean expansion, prioritizing maize and paddy rice productions.

The assessment of natural capital predominantly encompasses ecosystem services such as water provisioning, water purification, soil retention, carbon sequestration, and pollination, alongside evaluating the costs associated with air and water pollutants, solid waste, and greenhouse gas emissions. Produced capital evaluation includes crop production and agricultural inputs. The social and human capital assessment will cover labor and health impacts, as well as aspects like women's empowerment and social cooperation.

Key findings

- The soybean priority scenario indicates the lowest total value (302 billion Yuan by 2050) compared to both the grain priority scenario (403 billion Yuan by 2050) and the business-as-usual scenario (383 billion Yuan by 2050).
- The soybean priority scenario forecasts an 83% reduction in environmental costs and a 23% decrease in health cost by 2050 compared to grain priority scenario. Notable reductions are expected in fertilizer and pesticide use, emissions, and human health-related exposures. However, this scenario faces significant financial losses due to reduced grain output and employment.
- The high subsidy costs associated with soybean expansion impose a financial burden, requiring an additional 19 billion Yuan annually in the soybean priority scenario. Despite this, soybean expansion enhances China's resilience to international soybean market fluctuations, although accurately quantifying this benefit presents challenges.

Policy implications

- Balancing short-term financial impacts with long-term environmental sustainability remains crucial. Providing suitable subsidies and support for soybean expansion is imperative to mitigate these impacts.
- Encouraging sustainable farming practices through incentivization and technological advancements is vital to enhance resource efficiency and reduce environmental impact.
- Developing accompanying industries, such as processing and marketing, is essential to balance employment changes.
- Continuous monitoring and assessment of the food system's resilience are essential for adaptive management of the soybean expansion policy.
- China's soybean expansion may impact international soybean trade, but growing demands in emerging markets might offset this effect. Comprehensive modelling and analysis are necessary to draw conclusive insights.

V. Public Policy Options

a. Embracing Systems Thinking for Sustainable Agriculture and China's 'Green to Gold' Transformation

TEEBAgriFood emphasizes the importance of adopting a holistic systems-thinking approach in pursuing sustainable agriculture and China's 'Green-to-Gold' transformation. This approach goes beyond individual farm boundaries, considering their intricate interactions with supporting ecosystems and the broader impacts along the entire value chain, thereby influencing the well-being of people. Tengchong presents a compelling case study in this regard.

Tengchong demonstrates significant natural capital, notably reflected in the high quantitative values of ecosystem regulating services, particularly soil and water-related services. The net benefits, which are not directly observable in the market, are 2.4 times the amount of the market-visible net benefits. Moreover, these unobserved benefits prove resilient across various scenarios, emphasizing the commendable efforts of both national and local policies aimed at conserving natural ecosystems, efforts that merit ongoing support and sustainability.

The adoption of a systems-thinking approach also provides insights from an individual decision-making perspective, where financial costs and returns play pivotal roles. Findings from Tengchong illustrate that embracing eco-friendly farming practices does not necessarily escalate operational costs. On the contrary, these practices can yield long-term economic advantages, providing an incentive for stakeholder engagement in sustainable transformations.

To extend the adoption of systems-thinking into broader geographic or thematic contexts, capacity-building initiatives become imperative, particularly in developing countries with significant agricultural sectors and rich biodiverse ecosystems. Strengthening scenario analysis and fostering multi-disciplinary cooperation involving agriculture, economics, and environmental and social sciences will equip these countries to navigate the complexities of agri-food systems, fostering a sense of ownership.

b. Balancing Conservation and Development through a Multistakeholder Approach



In the case of Tengchong, eco-tourism emerges as a critical contributor to both conservation and development. The optimistic scenario projected for 2050 indicates that eco-tourism generates approximately 1.92 billion CHN Yuan in income, almost on a par with the income generated from crop and beef cattle production, underscoring its economic significance.

Maintaining the integrity of forest and grassland ecosystems while promoting eco-tourism can result in significant benefits, especially for regions rich in ecological diversity. Policies need to consider specific regional conditions and plan accordingly to ensure that disturbances from eco-tourism do not exceed the ecosystems' functional thresholds. Additionally, educating tourists on environmental ethics and minimizing the environmental impact of the tourism process become imperative.

Implementing this balanced approach necessitates ensuring equitable distribution of benefits among various stakeholders. At the national level, it preserves the original ecosystem functions and prevents degradation. For local governments, it translates into increased fiscal revenues as eco-tourism flourishes. Simultaneously, local enterprises and communities witness growth in size and income, thereby creating job opportunities, particularly for women within the community.

To support natural resources constrained from tourism or other development, the national government should adopt a holistic view and mobilize financial support to safeguard local development, such as through the fiscal transfer payment system.

c. Employing Multi-pronged Measures to Control Agriculture Non-Point Source Pollution

Reducing chemical fertilizer and pesticides usage stands as a significant policy in China (China, Ministry of Agriculture and Rural Affairs 2022). In the case of Tengchong, substantial reductions in pollution-related environmental costs and health costs can be achieved by enhancing the efficiency of chemical usage. By 2050, the optimistic scenario predicts a 27.0% and 45.5% decrease in pollution-related environmental costs compared to the business-as-usual and pessimistic scenarios, respectively. Similarly, the optimistic scenario projects a 17.4% and 29.8% decrease in pollution-related health costs compared to the business-as-usual and pessimistic scenarios, respectively.

However, non-point source pollution remains a limiting factor in Tengchong's agricultural development. By 2050, the purification capacities of natural ecosystems are estimated to absorb less than 7% of total nitrogen emissions and less than 25% of total phosphorus emissions from agricultural systems in the optimistic scenario.

Multi-pronged measures are necessary. For instance, measures in plantation settings include precise fertilization (such as soil testing and formula fertilization) and substituting organic fertilizer for chemical fertilizer. In livestock farming, infrastructure for sewage treatment represents a means to further reduce the discharge of pollutants into water bodies.

d. Strengthen Agricultural GHG Emissions Management for Biodiversity Conservation and Climate Change Mitigation

Tengchong's forest ecosystem serves as a significant carbon sink, estimated at 37.5 million tons CO₂e in 2020. In contrast, GHG emissions from the agricultural system are relatively small – in 2020, agricultural GHG emissions accounted for 2.67% of its annual carbon sequestration. By 2050, the proportion is estimated to be around 5% across all the three scenarios.

Despite the relatively small portion of agricultural GHG emissions to Tengchong's overall carbon sequestration capacity, the national strategy of 'carbon peaking and carbon neutrality' emphasizes the importance of overall emissions from the primary sector. In this context, methane will be a primary focus for GHG emissions reductions.

Measures to reduce GHG emissions from rice cultivation include constructing well-facilitated farmland, alternating wet and dry cultivation, utilizing organic fertilizers, selecting low-emission rice varieties, implementing mixed farming, optimizing pesticide application efficiency, and improving farmland landscapes. For beef cattle farming, reducing methane and nitrous oxide emissions involves fine-tuning feed management (e.g., low-protein feeds), employing enzyme preparations and probiotics, fecal anaerobic digestion, and composting.

The voluntary market for Chinese Certified Emission Reduction (CCER) has the potential to catalyze GHG reduction measures in agriculture. The recently adopted Measures for the Management of GHG Voluntary Emission Reduction Trading (Trial) marks the resumption of CCER trading (China, Ministry of Ecology and Environment and State Administration of Market Regulation 2023). While limitations exist regarding eligible GHG emission reductions, Tengchong should monitor CCER registration development and explore possibilities.

e. Unleashing and Nurturing the Potential of Women in Agri-Food Systems Transformation



While women encounter numerous challenges in Agri-Food Systems Transformation, such as limited access to resources, vulnerability to climate change, and gender-based discrimination, it is essential to recognize the crucial roles they play as primary household caretakers and potential drivers of sustainable agricultural practices. Leveraging their inclination toward traditional and biodiversity-friendly agricultural methods can align household management with sustainable farming practices. Empowering women in agriculture extends beyond social justice; it is fundamental for building resilient and sustainable food systems.

As we envision the future landscape of Tengchong's agriculture, women emerge as central figures in its transformation. The optimistic scenario forecasts more job opportunities, with approximately 1.2 times as many women as men employed. While many roles held by women may be temporary, they signify a significant step toward gender inclusivity in agriculture.

Policymakers and practitioners should prioritize gender-inclusive approaches to unlock and nurture women's potential fully. Initiatives such as capacity-building programs empowering women and encouraging employers to increase female labor in technical and managerial positions become crucial. Additionally, by adopting a comprehensive and gender-sensitive approach, and supportive policies that promote gender equality, it is possible to create an environment where women can fully contribute to and benefit from Agri-Food Systems Transformation.



Farms in Tengchong, Yunnan Province

Supporting SDGs

SDG 15 (Life on Land), SDG 3 (Good Health and Well-being), SDG 13 (Climate Action), SDG 2 (Zero Hunger), SDG 12 (Responsible Consumption and Production), SDG 8 (Decent Work and Economic Growth), SDG 10 (Reduced Inequalities), SDG 5 (Gender Equality), and SDG 17 (Partnerships).

Supporting Kunming-Montreal Global Biodiversity Framework

Target 14 (mainstreaming biodiversity in the public decision making), Target 10 (biodiversity friendly agriculture practice), Target 7 (reduce pollution), Target 19 (synergies of biodiversity and climate financing), Target 3 (other effective area-based conservation measures), Target 16 (sustainable consumption choices), Target 22 (participation of women) and Target 23 (gender-responsive approach).

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The beef cattle industry in Tengchong is expected to increase significantly by 2025 – hence the city promotes the development of eco-ranches