Policy Brief

Integrating traditional and modern bioproduction systems for resilient futures in Asia

Introduction

Amidst the unprecedented challenges of climate change, ecosystem decline, and diminishing biodiversity, the need to develop sustainable and resilient approaches to agricultural production has become increasingly vital (Muluneh, 2021). Bioproduction systems (BPS) encompass diverse traditional and modern farming practices and offer pathways to safeguard food security, uphold biodiversity, and foster socio-economic prosperity (Stokes et al., 2023). However, as environmental complexities escalate, there is a need to harmonize traditional wisdom with modern innovation, navigating the intricate interplay between human activities and natural ecosystems (Plieninger et al., 2023).

BPS in Asia are at the nexus of ecological resilience, sustainable livelihoods, and food security (Lahoti et al., 2023). These systems face significant challenges, such as climate change, habitat loss, and unsustainable practices. Climate change disrupts weather patterns, intensifies natural disasters, and threatens agricultural productivity, thereby endangering food security (Saleem et al., 2024). Additionally, ecosystem destruction driven by deforestation, urban expansion, and unsustainable agricultural methods leads to biodiversity loss and the degradation of crucial ecosystem services essential for human well-being and environmental stability (Wassie, 2020). Reduced biodiversity further weakens ecosystems' ability to endure and recover from environmental pressures, intensifying the difficulties facing bioproduction systems (Shin et al., 2022).

In this context, traditional agricultural practices, rooted in indigenous knowledge and local ecosystem understanding, provide crucial perspectives on sustainability and biodiversity conservation that are often overlooked (Ba et al., 2018). Meanwhile, modern innovations harness advanced technologies and scientific research to boost productivity and resilience (Gebresenbet et al., 2023). Integrating these traditional and modern approaches effectively enables bioproduction systems to foster ecological health, ensure economic stability, and promote social equity, addressing multifaceted challenges while advancing long-term sustainability (Ogar et al., 2020).

The Integration of Traditional and Modern Bioproduction Systems for a Sustainable and Resilient Future (ITMoB) project begins as an inspiration of hope amidst these challenges, embarking on a collaborative three-year research endeavor to navigate a path toward a sustainable and resilient future within the challenges of climate change and ecosystem perturbations. Grounded in cooperative research activities across Japan, the Philippines, and Indonesia, the ITMOB project seeks to find pathways toward sustainability by unraveling the complex network of bioproduction systems across a variety of socio-ecological landscapes. Through this combined effort, ITMoB endeavors to bridge critical knowledge gaps and unearth transformative insights that transcend geographical boundaries.

This policy brief offers insights assembled from project-related studies and presents actionable recommendations aimed at nurturing sustainability and resilience within bioproduction systems across Asia. The findings and directives outlined are shaped to guide policymakers, practitioners, and stakeholders in implementing sustainable land practices, fortifying biodiversity conservation efforts, and strengthening strategies for climate change adaptation.

Location map for three study sites

The following four policy recommendations were developed based on the project's diverse research outputs. They are intended for national and regional environmental policymakers, agricultural development agencies, urban planners, financial institutions, and local government officials.

1. Eco-integrated bioproduction systems for biodiversity conservation and agricultural sustainability

Key message: Integrating eco-integrated bioproduction systems (EIBS) harmonizes biodiversity conservation with agricultural production, offering substantial societal and environmental benefits.

Background and key findings

EIBS are increasingly recognized for their role in addressing environmental challenges while supporting sustainable development (Natori and Hino, 2021). These systems promote biodiversity, enhance ecosystem services, and improve agricultural productivity. Successful examples, such as stingless bee cultivation in Indonesia, tiger grass cultivation and agri-ecotourism in the Philippines, and crested ibis rice certification in Japan, illustrate the potential of EIBS to enhance ecosystem health, agricultural resilience, and sustainable livelihoods. Stingless bee cultivation in Indonesia enhances biodiversity by supporting pollinator populations, provides economic benefits through honey production, and promotes social sustainability through community involvement (Noorahya et al., 2023; Withaningsih et al., 2023a; Withaningsih et al., 2023b). Tiger grass cultivation and agri-ecotourism in the Philippines combine agricultural production with tourism to diversify income sources, support local biodiversity by maintaining native plant species, and increase awareness and education about sustainable practices (Landicho et al., 2020). Crested ibis rice certification in Japan encourages environmentally friendly farming practices, preserves habitats for the endangered crested ibis, and demonstrates the value of integrating traditional knowledge with modern certification schemes (Takahashi et al., 2023).

Policy recommendations

The following actions need to be undertaken to enhance EIBS for biodiversity conservation and agricultural sustainability.

1. Participatory planning and capacity building
    - Policymakers should enhance the integration of successful EIBS approaches through participatory and science-based methods.
    - Engage local communities in planning and execution.
    - Build local capacity through comprehensive educational programs on sustainable practices, workshops, seminars, and online training sessions.
2. Financial support and incentives
    - Address knowledge and financial barriers by providing financial incentives such as subsidies, grants, and low-interest loans.
    - Establish funding mechanisms for research and development in sustainable agriculture.
3. Monitoring and adaptive management
    - Establish monitoring and evaluation frameworks with indicators, benchmarks, and reporting mechanisms to assess the impact of EIBS approaches on biodiversity conservation and agricultural productivity.
    - Use these frameworks to track progress and inform adaptive management strategies for continuous improvement in sustainable bioproduction systems.

2. Enhancing synergies between ecosystem services in bioproduction systems

Key message: Significant changes in ecosystem services due to land use changes indicate the need for localized, participatory management strategies that enhance ecosystem services and ensure long-term sustainable development.

Agroforestry systems, conservation areas, food production

Background and key findings

Ecosystem services are vital for human well-being, encompassing benefits like food production, climate regulation, and recreational opportunities (Tallis et al., 2012). Managing land strategically can optimize these services, ensuring sustainable resource use while maximizing societal benefits (Gu et al., 2021; García-Martín et al., 2022). Effective land use supports resilience and fosters a balanced relationship between development and ecosystem preservation for future generations (Ibrahim et al., 2024). Recent studies in the Pagsanjan-Lumban Watershed (PLW) and Baroro Watershed (BW) in the Philippines (Almarines et al., 2024) and the Rancakalong region in Indonesia highlight significant changes in ecosystem services (ES) and carbon stocks due to land use changes (Withaningsih et al., 2021; Nasrudin et al., 2022).

From 2000 to 2020, significant declines were observed in water yield, baseflow, sediment retention, phosphorus retention, and runoff regulation in the PLW and BW, while nitrogen retention and carbon storage increased (Almarines et al., under review). Forestation positively influenced several ecosystem services, whereas transitions to shrubland or built-up areas generally led to declines. In contrast, the BW experienced increases in most ecosystem services, except for sediment retention and carbon storage, where deforestation resulted in decreases.

Sahle et al. (under review) reported that in the PLW and BW, land use and land cover changes revealed shifts in annual crops, urban areas, forests, and mixed agroforestry systems, reflecting the impact of human-induced land use changes on ecosystem vitality. Habitat quality assessments showed fluctuations over time, with improvements in the PLW and relative stability in the BW. Food production analysis showed varying yields, emphasizing the importance of sustainable farming practices. Correlation analysis between food provision and habitat quality revealed that while the PLW exhibited trade-offs, the BW demonstrated a statistically significant positive correlation, indicating a potential synergy. These findings highlight the complexity of balancing agricultural production with biodiversity conservation and underscore the importance of integrated land management approaches.

In Indonesia, a strong correlation was found between NDVI values (from Landsat 8 imagery) and carbon stocks, with polynomial regression models showing high determination coefficients and linear regression offering high accuracy (Malik et al., 2023). The northern Rancakalong District had concentrated carbon content. A life cycle analysis of tali bamboo products revealed varying carbon footprints and storage capacities across different products, with significant carbon storage observed during the products' lifespan (Ibrahim et al., 2023). From 2009 to 2021, vegetated areas increased from 51% to 57%, despite a reduction in mixed gardens and drylands, resulting in an 11,096-ton decrease in aboveground carbon stocks due to reduced mixed gardens (Withaningsih et al., 2024).

These findings underscore the profound impacts of urbanization, deforestation, and agricultural practices on ecosystem sustainability, providing actionable insights for environmental policy and management (Almarines et al., 2024; Pulhin et al., press).

Policy recommendations

The following actions need to be undertaken to enhance synergies between ecosystem services in bioproduction systems.

1. **Localized and participatory management plans:**
    - Co-develop and implement localized, science-based management plans that prioritize sustainable practices and are tailored to specific landscape conditions.
    - Integrating key ecosystem services such as water yield, sediment retention, nutrient retention, and climate regulation in management plans.
    - Involve stakeholders in decision-making processes to ensure inclusive and effective planning.
2. **Promote sustainable land use**
    - Encourage the adoption of agroforestry systems and sustainable agricultural practices to balance food production with carbon sequestration and other ecosystem services.
    - Provide incentives and technical support for integrating tree crops with agricultural production.
    - Use integrated land use planning frameworks that consider spatial and temporal dynamics of different land uses.
    - Utilize modeling tools for predictive and trade-off analysis to prioritize conservation efforts.
3. **Enhance conservation and restoration efforts**
    - Focus on preserving high-quality habitats and critical ecosystems to maximize ecosystem services and biodiversity conservation.
    - Invest in restoration initiatives that improve habitat quality and support sustainable land management practices.
    - Develop flexible management strategies that can adjust to changing environmental conditions and incorporate stakeholder feedback.
    - Facilitate multi-stakeholder partnerships to enhance knowledge sharing, resource mobilization, and collective action.

3. Enhancing bioproduction systems through a nature-based desirable future

Key Message: Integrating nature-based desirable futures into bioproduction systems through a participatory approach enhances resilience, equity, and sustainability by aligning ecological and socio-economic goals to preserve ecosystems and support development.

NFF related figure

Background and key findings

A nature-based desirable future approach, such as the Nature Future Framework (NFF), has emerged as a pivotal tool for envisioning and achieving sustainable futures in bioproduction systems (Kim et al., 2023). With the growing recognition of the need to integrate ecological and socio-economic dimensions in landscape management, three distinct studies were conducted in this project to explore the application of NFF across various regions and contexts. These studies collectively aim to address the challenges faced by bioproduction systems and identify viable pathways for their revitalization. The first study investigates the challenges and solutions for revitalizing bioproduction systems in Japan, the Philippines,

and Indonesia, utilizing the Millennium Ecosystem Assessment response typology and NFF to categorize policy responses, emphasizing stakeholder engagement and solution pathways (Lahoti et al., 2023). The second study employs NFF and multi-objective optimization to systematically analyze scenarios, identifying nature-positive strategies and key response options, demonstrated through a practical case study in Japan (Haga et al., 2023). The third study applies NFF to the BW in the Philippines, envisioning sustainable futures for bioproduction systems and addressing key challenges such as deforestation and water contamination while emphasizing stakeholder engagement and policy alignment (Lahoti et al., under review). Together, these studies illustrate the versatility and effectiveness of a nature-based desirable future like NFF in promoting socio-ecological resilience and guiding transformative change in bioproduction systems.

Policy recommendations

The following actions need to be undertaken to enhance bioproduction systems through a nature-based desirable future.

1. **Adopt and integrate the nature-based desirable future in policy and planning**
    - Advocate for incorporating the nature-based desirable future framework in policy and decision-making within the environment and natural resources sectors to promote sustainable bioproduction systems (examples: integrating biodiversity plan).
    - Balance conservation and development by protecting critical ecosystems and promoting sustainable agricultural landscapes.
    - Anticipate future challenges and opportunities to ensure resilience and sustainability in bioproduction systems.
2. **Capacity building, community engagement, and public awareness**
    - Provide comprehensive training and educational programs to enable stakeholders to utilize the nature-based desirable future framework in land use and local development planning (examples…NFF).
    - Engage communities in land use planning and decision-making processes, respecting traditional knowledge and promoting social equity.
    - Invest in public outreach campaigns and environmental education initiatives to build a culture of stewardship and sustainability within bioproduction landscapes.
3. **Research and promotion of nature-positive practices**
    - Support research initiatives focusing on sustainable land use dynamics and ecosystem functions to implement the nature-based desirable future framework effectively.
    - Encourage combining traditional and modern bioproduction systems, ensuring the conservation of natural habitats and sustainable development practices.

4. Accelerating environmental solutions through cross-country collaboration and capacity development

Key message: Cross-country studies, networking, and capacity development are vital strategies for rapidly generating knowledge and solutions to environmental challenges by leveraging diverse expertise and fostering collaborative efforts.

Workshops, events, conference, summer schools

Background and key findings

In our interconnected world, environmental issues such as climate change, biodiversity loss, and urbanization extend beyond national borders and require coordinated global action (Arnott & Lemos, 2021). Addressing these challenges effectively involves collaborative research, shared knowledge, and the development of robust networks (Pittaway et al., 2004). Cross-country studies and networking have proven to be powerful methods for pooling resources, expertise, and perspectives from various contexts, thus facilitating innovative solutions (Ozdemir et al., 2023). The ITMoB project, a three-year research initiative, has explored sustainable pathways for bioproduction systems under climate and ecosystem changes across Japan, the Philippines, and Indonesia. It highlights the importance of integrating traditional and modern practices for resilience and sustainability. The project established a platform for capacity development, enabling researchers from multiple countries, including early-career researchers, to engage in joint research activities and interact with international scientific communities.

Policy recommendations

The following actions are essential to enhance cross-country collaboration and capacity development, thereby accelerating environmental solutions:

1. **Establish a Community of Practice (CoP)**
    - Develop a network of professionals, researchers, and policymakers involved in environmental studies across countries.
    - Organize regular meetings, workshops, and online forums to exchange knowledge, experiences, and best practices.
    - Encourage collaboration within the CoP to tackle complex environmental problems from various perspectives.
2. **Continue supporting E-Asia to expand initiatives**
    - Ensure ongoing backing for E-Asia to broaden its environmental sustainability initiatives.
    - Align E-Asia projects with national and regional policies for coherent environmental action.
    - Assess the impact of E-Asia initiatives to enhance their effectiveness and scalability.
3. **Encourage cross-country research and support young researchers**
    - Create grants specifically for cross-country research collaborations.
    - Implement mentorship programs and fellowships to engage young researchers in international projects, especially from developing countries.
    - Provide opportunities for young researchers to present their work, network with senior scientists, and engage with policymakers.
    - Reduce barriers and streamline processes for international research collaborations to focus on scientific progress.

Conclusion

The policy recommendations underscore integrating traditional and modern bioproduction systems to enhance climate change adaptation and sustainability. They advocate for a holistic approach that marries

traditional wisdom with contemporary innovations to build resilience in agricultural practices and safeguard ecosystem health. By incorporating EIBS, enhancing ecosystem services, and employing nature-based frameworks like the NFF, these briefs provide a comprehensive strategy for addressing environmental challenges. Key recommendations emphasize participatory planning, capacity building, and financial support, all of which are essential for fostering adaptive and sustainable bioproduction systems. Cross-country collaboration further enriches these efforts by facilitating knowledge exchange and capacity development across diverse contexts.

While each policy recommendation offers significant advantages, it also carries risks. Addressing these risks will be crucial for successful implementation. Careful planning, balanced financial management, robust data systems, inclusive stakeholder engagement, and flexible approaches are essential to mitigating potential challenges and ensuring effective outcomes. Implementing recommendations requires further evaluating technical feasibility, economic feasibility, financial viability, political support, and administrative capacity to ensure they are practical, sustainable, and manageable.