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RESEARCH ARTICLE

Smallholder Agroforestry for Sustainable Development Goals: Ecosystem Services and Food Security

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Abstract

The potential of agroforestry and tree-based systems to contribute to achieving the Sustainable Development Goals (SDG) is promising. At the macro level, sustainably managed agriculture, trees and forests, including their production systems, are key sectors for greening economies and efficiently transitioning to a service-based economy. Smallholder tree-farming systems could be one component of a general poverty alleviation strategy for agrarian-based, poor rural communities. The multi-functionality of tree-based agriculture or agroforestry practices provide a significant contribution to smallholders' livelihoods in many ways, both financially and non-financially, through increased food security, access to land security and ecosystem services provision for public goods. Findings indicate the importance of including tree-based systems as a reference point in national and international policies, both for public and private sectors, in achieving SDGs.

Key findings	Relevance for policy discussions
Agroforests provide food security, bioenergy and income through commodity market sales and, more importantly, serve as a living savings account for poor people, buffering them from market price fluctuations and, in general, reducing exposure to natural hazards.	National forestry and agricultural sectors should recognize the contribution and importance of smallholder forest and agroforestry systems to achieving sustainable landscape management, stable flows of bioenergy and income for poor farmers. Urgent action is needed, particularly on improving farmers' access to quality germplasm, support for local institutions and capacity-strengthening, and links to the market and its information.
Agroforests contribute to sociocultural value and provide non-financial benefits to local communities. Ecologically, tree-based farming systems also provide ecosystem services that potentially result in financial and non-financial benefits for smallholders as land managers, as well as public goods.	Governments, private sectors and other relevant stakeholders should acknowledge the values of forests and trees that belong to the ethical, spiritual and affective realm of human beings. Such acknowledgement will better account for the real welfare impacts, including social capital, cultural values and non-material aspects of managing forests and trees.
Strengthening communities' rights, tenure and governance of forests and trees improves local social capital as a component of poverty alleviation.	Governments at all levels should recognize local people's authority to manage their local environments; engendering social networks and local institutions in managing forests and trees; and supporting tree-dependent groups to become participants in policy process advocating for their own rights and capabilities. Governments, civil society organizations and the private sector should support this process through capacity-building in institutional and resources management for relevant communities.

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Introduction

The Sustainable Development Goals (SDGs) were a main outcome of the Rio+20 conference. They build upon the Millennium Development Goals and converge with the post-2015 development agenda[1]. As a set of universal and integrated principles, the SDGs include a significant number of interconnected objectives related to agriculture and food. SDG 2 focuses explicitly on food by seeking to "end hunger, achieve food security and improved nutrition and promote sustainable agriculture", but multiple other goals relate to challenges in the food system. SDG 1 focuses on poverty reduction, where agriculture and food has a key role to play. Sustainable agriculture plays a central role in achieving SDG 6 on water, SDG 12 on sustainable consumption and production, SDG 13 on climate change adaptation and mitigation, and SDG 15 on land use and ecosystems. These goals provide strong support for shifting to a greener, more inclusive economy as part of eradicating poverty and mainstreaming sustainable development through land-based resources by optimizing the role of tree-based farming systems in achieving the goals.

The value of trees to rural communities, at least, can be divided into three production categories: timber and non-timber products harvested from trees in natural and managed forests and woodlands; the various products and services obtained from a wide range of trees planted and/or retained in smallholders' agroforestry systems; and the commercial products harvested from cultivated tree commodity crops. Products and services provided by trees on agricultural lands support the needs and promote the well-being of hundreds of millions of people in developing countries; forestry and agricultural value added contributed to more than 32 per cent of the gross domestic product of low income countries in 2014.

How to develop multifunctional tree covers to meet the dual goals of poverty reduction, particularly food security and conservation, are challenges of the SDGs. Full integration of the benefits of trees and agroforestry within broader landscape management to achieve the SDGs is both desirable and feasible. Aspirations for agroforestry and forests can be both universal and differentiated to local circumstances. This article looks at developing countries and identifies smallholder farmers, supported by national and local governments and the private sector, who are jointly producing and investing in ecosystem services, enhancing food security and overall poverty alleviation to achieve the SDGs.

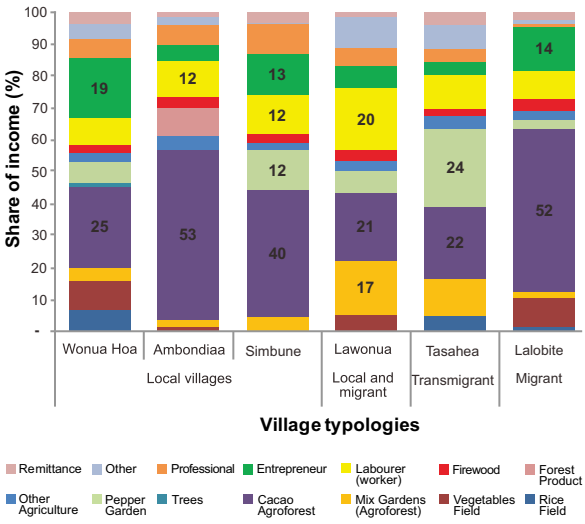
Findings

Trees for food security, bioenergy and financial buffering

Trees serve as livelihood safety nets for poor people (Chambers and Leach, 1989). They are the last reserve when these people face emergencies and periodic large expenses, such as school fees and weddings (Roshetko and Westley, 1994; Roshetko *et al.*, 2013). Particularly for agroforestry systems, maintaining tree diversity is a sound strategy to cope with price and crop yield fluctuations, thus increasing farm income stability and lowering financial risk contributes to the first SDG, which aims to eradicate extreme poverty for all people everywhere.

Trees and tree products from forests and cultivated areas contribute to employment and income for downstream processing and trade activities (Ferris *et al.*, 2014). Their income contribution to household budgets of rural people is significant, though varies widely from 15 to 80 per cent depending on context (Khususiyah *et al.*, 2012; Angelsen *et al.*, 2014; Jamnadass *et al.*, 2015) as shown in Figure 1. For example,

Figure 1. Agroforestry practices contribute to more than 50 per cent of income share in Sulawesi, Indonesia



Source: Khususiyah *et al.* (2012)

[1] https://sustainabledevelopment.un.org/topics/index.php?menu=1561

FROM CAPSA

Dear Palawija Readers,

Welcome to the April 2017 edition of *Palawija Forum*. This edition will highlight the issue of agricultural ecosystem services. The area has gained increasing attention from policymakers, international organizations, academics and NGOs since the 1990s as a promising concept to address the links among and integration of the environmental, social and economic implications of agricultural development. Ecosystem services contribute to sustaining agricultural productivity and nutrition value by supporting the pollination of crops and soil formation; regulating water, disease and climate; and providing recreational, cultural and spiritual benefits. In the agriculture landscape, famers are both stewards and beneficiaries of ecosystem services and have the potential to manage their farmland to enhance ecosystem services and ensure maximum benefits for themselves and others.

UNESCAP (2009) noted that payments for ecosystem services (PES) is an innovative socioeconomic policy to improve environmental performance. Ecosystem services support human economies and societies, as well as playing an important role in climate change mitigation and adaptation. Incentives for the sustainable management of ecosystems through PES can boost action on sound ecosystem management. CAPSA's mandate is in line with the idea that rewards to farmers who implement sustainable agriculture, such as agroecological farming systems, should be promoted.

The first article in this edition discusses the potential of smallholder tree-farming systems to provision ecosystem services and food security. The research findings indicate that tree-based systems are an important reference point in national and international policies, both for public and private sectors, in achieving the SDGs.

A short article about the social, cultural and ecological values of ecosystem services provided through farming systems in the Pacific Islands illustrates the local wisdom on ecosystem services provision, which is an ancient concept in Palau and throughout the Pacific. This edition also shares an impact story on the case of financial incentives provided through a bee farms programme to coffee farmers in the Kodagu district of Karnataka, India that helps them to conserve the landscape they have inherited.

We hope you find the information provided in this forum is worthwhile, and welcome any feedback and contributions to future issues.

CAPSA Palawija Team

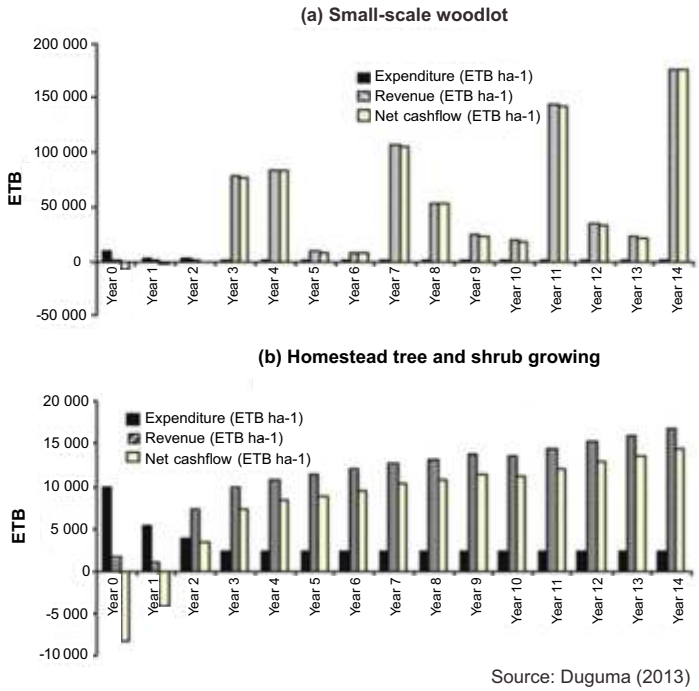
smallholder teak systems, besides supplying food for households, provide 40 per cent of household income from agricultural and timber crops (25 per cent from agricultural production, 12 per cent from teak and 3 per cent from other timber) (Roshetko *et al.*, 2013). Teak and other tree crops allow households to re-allocate labour to off-farm employment when those opportunities are lucrative. Farmers generally restrict plantings to the number of trees that can be maintained and integrate tree growing with their crop and animal production activities. Thus, knowledge of management practices to assure good food crop yields, cultivation, weed control and fertilization that benefit the overall system, exist at the local level.

Tree seed collection and processing provide an excellent economic opportunity for women (Roshetko and Dianarto, 2008). Women provide 75 per cent of the seed collection and processing labour. The case in Indonesia shows that tree seed collection occurs during the dry season from July through September, when agricultural activities and other economic options are limited. Farmers are available and

eager to collect tree seed to enhance their incomes and provide a means of facilitating off-farm employment for young people. Tree-seed collection is a major income earner for them, providing 33 to 66 per cent of their dry-season income (USD 20-60). Processing seed is equally lucrative for farmers living near seed companies, providing USD 30-70 per employee per dry season (Roshetko and Dianarto, 2008). An example from Tanzania shows that the highest income effect for the poorest households was derived from agroforestry, which households used as a source of firewood and fruits for sale or home consumption, followed by *Jatropha curcas*, sugarcane and finally cassava (Faße *et al.*, 2014). Agroforestry in general has also been found to substantially release the pressure on public forest reserves.

A study in the central highlands of Ethiopia showed that small-scale agroforestry practices were very attractive financially to the famers with a positive net present value (NPV) and greater benefit-cost ratio (BCR) than annual commodity farming, such as cereal crops (Duguma, 2013). An ex-ante analysis of different agroforestry practices providing information for time horizons of up to 15 years promised positive financial attributes and cash flow (Figure 2).

Figure 2. The annual expenditure, revenue, and cash flow structures of agroforestry practices over 15 years in Ethiopia



Source: Duguma (2013)

Trees provide sociocultural value and nonfinancial benefits for local communities and contribute to ecosystem services provisions

Beyond income and financial benefits, trees and natural features can fulfil social needs, such as health (physical and mental), education and research, recreation, social identity, or artistic and spiritual development (Boffa, 1999). Forests and products derived from trees have meanings that reflect cultural perception and roles for community integration and social relationships (Chiesura and De Groot, 2003). Symbolic relationships between indigenous people living in or on the margin of forests form the basis for their way of managing and conserving this ecosystem (Seeland, 1997). For example, in the Gambia, typical parkland products, such as *Parkia biglobosa soumbala* and *Vittelaria paradoxa* or Shea butter, are kept for social needs to be given as gifts for births and weddings, or dowries (Crélerot, 1995; Ouédraogo, 1995). In Nepal, forest conservation is influenced by beliefs and practices centred on sacred forests and tree worship (Ingles, 1997). The exclusion of these important social and psychological benefits underestimates the value of the forest and results in management failure.

Separate studies from Central America, covering Honduras, Costa Rica and Nicaragua (Kosoy *et al.*, 2007), and Asia, in particular Indonesia (Leimona *et al.*, 2010), have revealed that the amount received from the payment for ecosystem services (PES) scheme constitutes less than 2 per cent in Central America and up to 3 per cent in Indonesia of gross annual income for most participating farmers. Voluntary and continuous participation in such schemes indicate that landholders obtain economic benefits from forests' environmental goods and services, such as provision of firewood, non-timber products, shade or scenery. Furthermore, in-kind benefit, such as technical training, (socially acknowledging) good environmental stewardship and social networking may also play an important role in motivating providers to adopt the PES scheme. Local social and cultural features, such as religious or social habits, environmental awareness and education programmes, may prompt forest conservation, even though it may be economically inefficient from an individual point of view.

Box 1. Payment and co-investment in ecosystem services from production landscapes

Global initiatives have recently recognized the importance of the agricultural landscape and agroecosystems beyond their production functions. The Millennium Ecosystem Assessment (MEA, 2005) identified that as a system directly managed by humans, agriculture can and should be managed to provide ecosystem services beyond the production of food, fibre and fuel.

Managing this trade-off and shifting the decisions of land managers towards conservation are expected to be helped by policy instruments, such as public investment and market-based instruments (Tomich *et al.*, 2004; Smith *et al.*, 2006; Asquith and Wunder, 2009). Public investment in restoration efforts seems unavoidable and, as prevention is better than cure, a direct public role in preventing degradation is logical. Market-based instruments for watershed services to internalize the negative externalities of watershed problems are expressed in monetary units and speak the same language as the direct economic benefits of land use.

In the 1990s, "Payment for Ecosystem Services" (PES) was introduced from forest subsidies in Costa Rica (Chomitz *et al.*, 1999). Over the last decade, these voluntary mechanisms have inspired wider experimentation with payments to hybrid markets for watershed services as policy and institutional options in managing watersheds and (involuntarily) charging the "captive audience" of water users.

In Asia, a decade of action and learning in the PES sites (2002-2012) has formed part of the Rewarding Upland Poor for Environmental Services (RUPES) project of the World Agroforestry Centre (ICRAF), Southeast Asia Region. There are ten sites in three countries, i.e. Indonesia (Kapuas Hulu-West Kalimantan, Singkarak-West Sumatra, Bungo-Jambi, Sumberjaya-Lampung, Cidanau-Banten), the Philippines (Kalahan-Nueva Vizcayas, Bakun-Benquet, Lantapan-Bukidnon) and Nepal (Kulekhani-Makwanpur).

Van Noordwijk and Leimona (2010) suggested four criteria for PES, with three related to the efficiency of the measures (realistic, conditional, voluntary), and one to the "fairness" of the measures (pro-poor). Approaches that support collective action at the local community level and address issues of conflict over land-use rights are now seen as essential to achieve success. This shift suggests a need to co-produce perspectives and knowledge of various relevant actors during the planning and implementation of any PES schemes in enhancing watershed services (Leimona *et al.*, 2015a). Further, based on empirical experiences in developing countries, PES is envisioned as "a joint and voluntary investment between ES providers and beneficiaries in a binding agreement under different degrees of conditionality for the provision of ES" (Leimona *et al.*, 2015b).

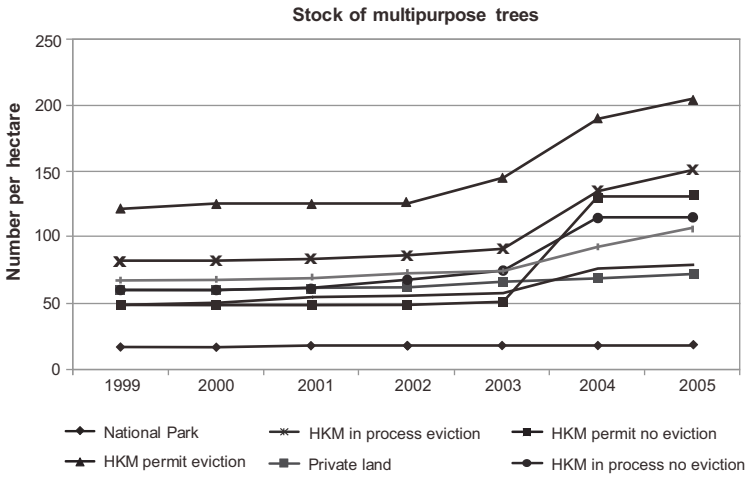
Payment and co-investment in ecosystem services provide incentives to preserve the agroforestry systems from other more profitable but environmentally vulnerable farming systems, such as monoculture, oil palm in lowlands and horticulture in dry uplands (Van Noordwijk *et al.*, 2014).

Rights, tenure and governance of forests and trees for local social capital

Through the lens of development theory, social capital offers a way to bridge sociological and economic perspectives, thus providing potentially richer and better explanations of economic development (Woolcock and Narayan, 2000). Social interactions between communities and institutions shape economic development. As a result, attention to the degree to which economic development is constrained by non-economic institutions (i.e. social and political environment) needs special attention. In the context of developing countries, land reform by improving the poor's access to land is one of the policies that promote economic growth by applying the welfare redistributive concept (Besley and Burgess, 2000). A study in eastern and southern Africa showed that farm sizes were declining over time and roughly a quarter of the agricultural households were virtually landless controlling less than 0.10 hectares per capita (Jayne *et al.*, 2003).

A case study of impacts of a social forestry programme in Indonesia, Hutan Kemasyarakatan (HKM) in the Sumberjaya watershed in Sumatra, showed that in general the farmer groups and household members joining the HKM believed that participation in the programme would substantially increase their land tenure security, land values, land investment and incomes. The estimated mean stocks per hectare of timber trees and multipurpose trees have increased throughout the various strata of the Sumberjaya watershed since 1999 (Figure 3). The study also showed that land tenure and HKM status had direct impacts on profitability (Table 1). This

Figure 3. Estimated stock of multipurpose trees (bottom) on various strata, 1999-2005



Source: Kerr *et al. (2006)* Note: HKM = community forestry

Table 1. Profits on plots of varying tenures and HKM status in 2005 (thousands of Rupiah/ha)

Land Tenure/ HKM Category	Mean	Standard Error
National park	1 019.6	114.7
Private	1 968.8	201.4
HKM permit	767.6	145.0
HKM application pending	991.9	110.7
PF land without HKM	405.0	89.3

Source: Kerr *et al. (2006)*

mostly resulted from the high stock of multipurpose trees that had a positive impact on profits. The programme is seen to be pro-poor and to provide some environmental services, suggesting the possibility of both reducing poverty and providing environmental services. This provides empirical support for continuing and expanding programmes that strengthen community's land security.

Ways forward

Farmers indeed have rich local and traditional agronomic knowledge. However, financial constraints (buying seedlings and paying daily labourers for households with labour shortage), lack of tree and shrub seedlings and labour force scarcity are listed among the constraints on the expansion of agroforestry practices in the community. As there is lack of support from the government for removing obstacles to ensure the smallholders use their assets productively, farmers become more vulnerable. With their limited financial capital, any decision made on a land use is irreversible. Policy disincentives regarding procedures for farm-grown timber sales and movement need to be removed (the application of forest-management regulation to farm-forestry situations). Smallholders with diverse, risk-averse farms that include a significant tree component could be efficient producers of other tree commodities in the future. Their tree-farming systems have high potential to yield both wood and non-wood products and play an important role in the reforestation of degraded lands.

The resolution of social issues in rural areas depends critically on correctly identifying the range of stakeholders and their interrelations. How their power and political interests will be affected by proposed policy interventions is a vital consideration. Landscape with tree diversity can be a way to negotiate policy intervention for rural land reform. Once rights are strengthened, government agencies and other stakeholders have an important role to play in providing communities with capacity-building in leadership, agroforestry and marketing skills; and developing access to quality germplasm, other agricultural inputs, extension services and trader networks as inseparable parts of increasing the competitiveness of small and poor farmers.

At the national and subnational level, lack of proper land-use planning, particularly on land-based systems (forests, tree-based agriculture systems) and other natural resources delays the application of green growth. Application of scientifically based information specifically providing alternative scenarios for subnational government to assess development and conservation trade-offs can help formulate forest and agriculture policy and regulation.

When it comes to achieving a global agenda, such as the SDGs, national, subnational and rural households are managers of complex asset portfolios. As most of the rural poor in developing countries depend on land-based economic systems, particularly forest and agriculture sectors, how to optimize these systems to reduce poverty and vulnerability, and how to remove barriers at all levels, become vitally important. Recognition of international and national authorities on agroforestry practices by smallholders is a major constraint to claiming its role in achieving global agendas for poverty eradication.

(List of references can be made available upon request)