INTEGRATED LAND USE SYSTEMS

Student authored course report

Albert-Ludwigs-Universität Freiburg

Content

Summary

A rapidly growing world population and changing consumption patterns are placing increasing pressure on agricultural and forestry production systems. However, classic intensification approaches to increase yields through genetic standardization, mechanization and application of agrochemicals triggers ambivalent results. In many places, negative environmental and social consequences have been observed such as soil degradation, eutrophication, decline in fresh water resources, loss of biodiversity, land-use conflicts, loss of employment, and rural-urban migration.

Against this background, Integrated Land Use Systems (ILUS), which combine different types of land uses and integrate several management goals, are gaining attention. It is assumed that ILUS, compared to classic production systems, provide a higher level of ecosystem goods and services, are less vulnerable to the risks of global change and market volatilities, and are better suited to the livelihood strategies of rural populations. Despite this potential, ILUS still only play a minor role in most agricultural landscapes.

Class of 2019 elaborating their case studies; Photo: S.Reinecke

Each summer term the Albert-Ludwigs-University Freiburg offers the Master’s Programme Module on Integrated Land Use Systems (ILUS) to its students of the elective track “International Forestry” and external professionals. The edited booklet at hand offers a compilation of summary reports that the students of 2019 have elaborated in small groups as to dive deeper into the barriers and options for implementing integrated land use in practice and at scale and reflecting about the social, environmental, and economic features of important ILUS and possibilities for a broader diffusion.

Student reports

The following summary reports compiled by 7 different students' groups explore the barriers and options for implementing integrated land use in practice and at scale.

1. Whether and to what extent does it make sense to combine the produce for local markets and of commodities for international markets?

Group 1
Aleksandra Blazeusz
Sandra Dalfiume Boner
Julius Willig
Jakob Albrecht

The commodification of agricultural systems can be introduced for a variety of reasons – for many farmers and businessmen it is a window of opportunity for improving their economic and social situation. When referring to the commodification of agriculture, we mean "cultivating commercial crops for markets rather than growing food crops primarily for household consumption" (Ambinakudige, 2006).

Commodification is often associated with monoculture production, which can result in replacing subsistence crops with cash crops, leading to food insecurity or malnutrition. In order to analyze the commodification of agriculture in terms of its multifunctionality, we used the four principles of multifunctional agriculture proposed by the OECD, namely; food safety, environmental, economic and social functions (OECD, 2001). We

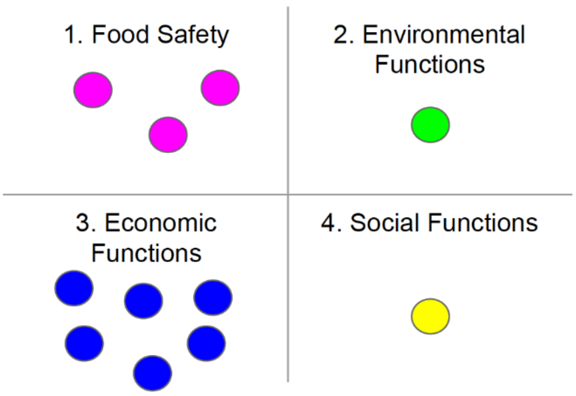

Figure 1: *Analysis of commodification of agriculture by means of multifunctional agriculture principles (OECD, 2001)*

found that the commodification of agriculture was mainly characterized by a focus on economic functions rather than on any other of the functions. An alternative to commodified agriculture could be Integrated Land Use Systems (ILUS).

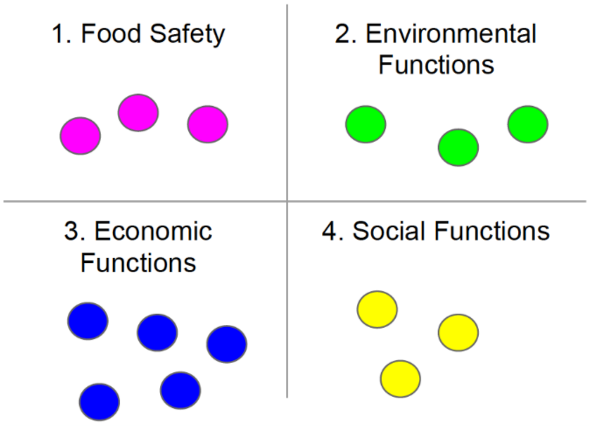

Figure 2: *Analysis of an Integrated Land Use System by means of multifunctional agriculture principles (OECD, 2001)*

While mono-cropping systems have a focus on economic profit, ILUS serve a greater variety of functions. Characteristics of ILUS such as diversification of land use and sustainable use of resources, especially soil and water, strongly support the environmental function. With respect to social aspects, ILUS provide more opportunities for the cultivation of crops with non-economic, e.g. spiritual values or of crops which are part of traditional land use. Furthermore, the complexity of some integrated systems requires more labor which can lead to better employment opportunities, especially for young adults. Lastly, ILUS can create synergies between subsistence and cash crops, such as the quality added to coffee, growing under the shade of banana.

Two case studies from Peru were selected to highlight the differences between a) a fully commodified system (cash crop production in monoculture by the Shampuyacu community) and b) an integrated approach (commodity and subsistence farming through ILUS by the Yanesah community). For a) the main consequences where a loss of their nutritional basis (manioc) and exposure to local and global price fluctuations. For b) the community was able to maintain a higher level of self-reliance due to the inclusion of subsistence crops. The establishment of a cooperative also played an important role to get access to the global markets and thus achieve higher added values. In order to get an idea about the required preconditions for the implementation of ILUS we also took a look at the initial situation of each community. In case of a) there was a low level of education and bad market access for b) this was the opposite. The combination of bad market access and a fully commodified system is a paradox when compared to findings by Thanichanon et al. (2018), who observed a transformation from subsistence to commercial agriculture (agrarian change) when market accessibility increased.

Photo by Margaret MacDonald/CIFOR

Based on our research we came up with some general prerequisites for the successful implementation of ILUS: i) security of land tenure rights, ii) financial and technical support to overcome the high initial cost and iii) market accessibility.

Balancing subsistence crops with cash crops is of paramount importance because it allows communities and farmers to generate an income without affecting their food security. Also, it provides a buffer against market fluctuations which can negatively affect the ability of communities to purchase food. It is our opinion that it depends on each case whether and to what extent the two types of crops should be combined. Communities with a larger amount of available land, for instance, will be in a better position to achieve such combinations than farmers with small farming plots (Current et.al., 1995).

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2. Is it realistic to expect that the agro-industry will start to work with Integrated Land Use Systems?

Group 2
Irene Sirotti
Lukas Kuhn
Maxime Rushemuka
Tommaso Antinori

Agro-industry refers to actors involved in the intensive production, processing and trade of agro-products at a large scale and in large quantities grounded in the application of standardized input-intensive agro-technology packages of seeds, fertilizers and pesticides, and effectively organized global value chains. Being a commercial actor the agro-industry's main goal is to generate maximal profit with low level of risk.

Cabbage seedling planting in a nursery area. Vegetables as agro industry commodities reduce prices even with high costs for fertilizer and transportation. Photo by Ricky Martin/CIFOR

The agro-industry significantly contributes to affordable food and agro-commodities, but is criticised because of its negative social and environmental consequences, especially in the rural tropics. Integrated Land Use Systems adopt a comprehensive approach to the management of land by integrating multiple management goals and actors on one unit of land, and thus have the potential merit of meeting at the same time environmental sustainability, economic stability and social integrity.

Adopting ILUS might help to overcome some of the drawbacks blamed on agro-industrial production schemes. But, is it realistic to expect that the agro-industry adopts ILUS. We analysed this question by assessing whether and to what degree ILUS might become attractive for the agro-industry from an economic, environmental, social and political perspective.

From an economic perspective, adopting ILUS involves high investments for the companies, since commodity chains for the additional new products have to be developed and implemented. ILUS makes management more complex, and the lack of ILUS technology package increases uncertainties and risks. Moreover, it may happen that the demand for additional products is insufficient to achieve prices that allow for comparable profit margins of the main crop. All this makes an adoption of ILUS principles unattractive for the agro-industry. However, it might happen that the situation changes in the future due to a growing demand for products from sustainable agriculture, as observed for the rapidly increasing markets for organic food.

From an environmental perspective, the effects of climate change such as more extreme weather events such as floods and droughts, and unpredictability of rainfall, as well as ongoing degradation of soils, result in uncertainty regarding production conditions. This might sensitize the agro-industry for the limits of technological production approaches. In the same vain, the increase of land scarcity may raise agro-industry's interest in ILUS. However, experience show that the companies instead even stronger invest into technological innovation such as the search for drought resistant crop varieties and large-scale irrigation.

From a social perspective, the last two decades have seen an increase of societal mobilization against conventional agriculture and agro-industry. Movements like "Fairtrade", "Organic Farming", and, more recently, "Fridays for Future", are putting pressure on the agro-industry both by coercion and by spreading values that lead to the demand for sustainable products. However, at the same time, countries with fast growing economies like China and India strongly foster the use of intensive agriculture to satisfy the demand for cheap agricultural products, of proofed quality, to be sold in supermarkets.

Prevailing agriculture policies favour agro-industrial production schemes. Moreover, the agro-industry is a powerful actor with strong influence on policy-makers. Against this backdrop, it would be unrealistic to expect drastic changes in the current policy design. Nonetheless, recent dynamics, such as the increasing presence of the Green party in the European Parliament, and the high frequency of sustainable agriculture on the political agenda, may indicate the possibility for a policy shift in the future.

Overall, we think it is unrealistic to expect that ILUS will be adopted by the agro-industry, at least in the near future. Nevertheless, increasing social awareness and the dramatic effects of climate change may stimulate adoption of ILUS in the long run.

Libo County, Guizhou Province. Rice fields and forest plantations integrated in the landscape provide food and timber resources while regulating water provision to an ancient agricultural irrigation system. Photo by Louis Putzel/CIFOR

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3. Why do small-scale farmers hesitate to adopt agroforestry systems? What are possibilities to stimulate adoption rates?

Group 3
Philippe Schmitz
Christian Scriba
Elliot Freshwater
Zachary Bernard
Pedro Bremberger Pássaro

Agroforestry systems (AFS) are "Integrated Land Use Systems" that combine the use of woody perennials (trees, shrubs, palms, bamboos, etc.), agricultural crops and/or animals, and their interaction with each other. The conscious integration or maintenance of trees on agricultural land enhances social, economic, and environmental benefits. The application of AFS can potentially improve habitat structure, increase biodiversity, reduce erosion and evaporation, diversify production, reduce fertilizer application and increase the land use efficiency, just to name a few of the advantages.

However, for small-scale farmers it seems that this kind of land use is difficult to apply, either because management is too complex or not adapted to the specific needs and ecological, social and economic characteristics of the region, where it is to be implemented. Often the risks related to the implementation are perceived as too high and the lack of coordination between sectors (agriculture, forestry, rural development, environment) creates more adoption obstacles. Some reasons for the reluctance to adopt agroforestry are listed below:

- Loss of potential harvestable crop land, through tree plantations.
- Expected competition between trees and plants for nutrients, water, light and space.
- Trained manpower shortage: In some rural regions the introduction of AFS consists of a new land use approach, which no one ever used before.
- Longer time horizons: Trees only become valuable after a longer time period, unlike the yearly income conventional agricultural crops can produce.

In theory, there are some possibilities to stimulate the adoption rates of agroforestry. Financial subsidies in various forms could be seen as an important stimulus approach. Subsidies for switching from conventional land use to agroforestry and financial relief to reduce risk of upcoming failures would be the main examples. By minimizing the financial risk, hesitant farmers may be more likely to adopt new cultivation techniques and early-adopters may show more rapid innovation. Therefore, providing extension services by the state or NGO´s could help farmers to understand the new processes and assess their potential in relation to the farmer´s land. Though farmers can be trained to cultivate trees or new crops, there may be a problem selling the produce because markets are non-existent or far away. Consequently, new and accessible markets for timber and non-timber forest products should be established as part of a program to promote agroforestry. Furthermore, community-based cooperatives such as “Regionalwert AG” could be helpful to support the adoption rate by enabling the sharing of tools and machines between landowners. Agroforestry-newcomers do not have to accept as much risk, and they can support each other in implementing agroforestry.

Women harvesting candle nuts in an agroforestry system. Photo by Aulia Erlangga/CIFOR

As previously mentioned, agroforestry provides many social, economic and environmental benefits. Unfortunately, current conditions like high transport costs, uneducated labour force, low market demand, contradictory incentives and regulations, as well as poorly designed and adapted AFS may limit practical implementation of these systems. National and international resources such as financial or material support may stimulate adoption. Once these solutions work properly, more small farmers may turn to agroforestry and contribute to integrated land-use management.

4. Silvopastoral Systems in semi-arid areas: Ecological and social functions, challenges and potentials

Group 4
Nina Effelsberg
Sorin Ploscaru
Anton Begma
Ricardo Serra
Silvia Schrötter

In the face of climate change, it is essential to find alternatives to monocultures in agriculture, especially in semi-arid areas, where drought and therefore erosion is a common problem.

Silvopastoral systems intentionally combine livestock and forage with managed trees or other woody components, mimic natural landscapes, whilst supplying natural resources to humans. Applying this integrated system has the potential to restore degraded land and mitigate desertification. It ensures the production and livelihood in drought regions, wherefore it could function as an approach that withstands and decreases environmental changes and hazardous consequences.

Three types of silvopasture are distinguished: (1) livestock farmers adding forest plantations to their farms, (2) forestry companies with own livestock in their forests, and (3) forestry companies with agreements with livestock farmers for grazing in their forests (Bussoni et al. 2019).

A cattle herd returning to the pasture just outside Zorro village, Burkina Faso. Photo by Ollivier Girard/CIFOR

The vegetation coverage of silvopastoral systems creates a microclimate, which protects soil from wind and water erosion, as well as from sun radiation (and heat) providing shade for livestock and understory vegetation. These systems are some of the most conservative of sound soil conditions as they are less depleting. Starting from degraded land, they contribute with nitrogen fixing vegetation, livestock manure (soil organic carbon improvement) and improvement of water holding capacity (Mistra et al. 2014) through a build-up of soil biota. The structure of these systems translates into good carbon sinks and an increased number of niches is realized by the vegetation, habitats, biodiversity, and provision services (like firewood, timber, fodder, livestock, fruit, water).

This way of using natural resources ensures food security and brings additional income, if sold at markets. It is a sustainable way to address climate change, therefore supports livelihoods in the regions, as they also promote improved regulating, habitat and cultural services. Enhancement of scenery and value of property can also be associated.

Still there are challenges to face when applying silvopasture approaches. For example, competition can arise between different plants for water, light, and nutrients. Accordingly, there is a need to properly set the composition of the plants. Damage from browsing and grazing, as well as from drought needs to be prevented, which adds to the challenge of finding suitable species that are also resilient to these risks. Depending on the density of the canopy, shrubs and grasses have to be shade tolerant. Identifying multi-purpose trees is another challenge but also a chance to make the system more efficient. Wildlife interactions and wildfire have to be taken into account, too.

Silvopastoral systems have a long tradition and, if applied in new regions, they should be adapted to the local conditions, needs, and culture of local people to make this approach more applicable. Silvopastoral systems require specific knowledge of management strategies and a good understanding of interactions as to successfully achieve all inherent functions. Labor intensity may be high in some cases, which might lead to high costs especially during the inception phase. Trees grow slowly, translating into a late break-even point. Uncertainty on tenure rights, lack of (up front) investments and limited market access, as well as legal restrictions, can make this system not feasible in all semi-arid regions.

Despite these drawbacks silvopastoral systems have a high potential to work as resilient land use systems towards climate change and following risk to the environment and societies.

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5. The Potential of Agriculture-Aquaculture Systems on Producers, Consumers, and Society

Group 5
Ashley Miller
Michelle Thompson

The agriculture-aquaculture system is a form of integrated land-use that allows for potential increase in benefits to local producers, consumers, and society when compared to a solely agricultural system. Here, we explore the potential of the agri-aquaculture system across these three tiers, and discuss the potential to combat climate change, increase food security, and maintain environmental services.

By diversifying the output of producers to include aquatic species in addition to crops and/or livestock, there is an increased security against pests and diseases, drought, fire, and other unknown risks (FAO, 2001). For example, if a pest devastates a field of rice, the farmer can still rely on their fish for food or as a source of income. This will become increasingly important in the face of climate change, which will exacerbate these occurrences, and can help to increase resilience for both subsistence farmers and those who sell their products on the market.

Many different land types are combined in this landscape at Mount Halimun Salak National Park, West Java, including use for crops, forestry, pasture, fisheries and energy production. Photo by Aulia Erlangga/CIFOR

Further, the inclusion of aquaculture provides an additional source of protein for the farmer and consumers of his products. Diets can be diversified and food security increased through the addition of multiple aquatic animals, such as fish, crustaceans, and molluscs. It is important to note that the use of non-native species poses risk of invasion, and should only be introduced on a case-by-case basis.

Additionally, society can benefit from this system which produces food as well as maintains environmental services in the long-term. While other agricultural systems may purchase mineral fertilizers and livestock feed from afar, an agri-aquaculture farm produces them on-site. For example, farmers use the sediment in the bottom of a fishpond to fertilize their fields, and livestock excrement to both feed coprophagic fish, and fertilize aquatic plants. This creates a closed system independent of external inputs, which allows for a reduction of carbon emissions that the system produces. Societal benefits will ultimately depend on the farmer's management and willingness to perform such tasks, where increased labor and time may be necessary.

Many transitional barriers exist, such as high start-up costs, lack of knowledge, access to fertile soil and water, and finding buyers for new outputs (Tipraqsa et al., 2007). However, once these barriers are crossed, it is clear that this system shows great potential to produce security in the face of climate change, food availability, and long-term environmental health, and ultimately benefit producers, consumers and society as a whole.

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6. What are the challenges to consider ILUS principles in contemporary efforts to restore landscapes at multiple (especially large) scales?

Group 6
Timothy Nairn
John Brickley
Hao Chen
Muhammad Sharif
Poonam Ghimire

The challenges associated with applying ILUS principles to achieve landscape restoration at multiple scales, i.e. small, medium and large, can be discussed across five categories: ecological, economic, technical, political and social challenges.

The major ecological challenges for land restoration using ILUS are the choice of species, climate uncertainties and finding long-term functional diversity (Chazdon, 2016). In some cases, especially with high levels of degradation, species or approaches not normally associated with ILUS principles may be used to begin the restoration process (Newton, 2015).

Pursuing landscape restoration can result in economic challenges due to alteration by means of afforestation, grass planting and ILUS, meanwhile the traditional agricultural products from the previous landscape are either lost or replaced (De Groot et al, 2013) which brings risks and uncertainty to smallholders, as well as pressure on the local agricultural market (Weinstein 2008). Additionally, large-scale land restoration requires enormous investments while the expected economic return is comparably limited and thus making an appeal to appeal to investors is another challenge to be considered (Crouzeilles et al., 2016).

Technical challenges to incorporating ILUS principles in landscape restoration in small-scale include land preparation, limitations of rudimentary tools, and, according to Vieira (2009), intensive work. Across medium and large scales, many actors face challenges that include lack of institutional support, coordinating disparate disciplines (Sabogal, 2009), and disregard of local techniques (Sawadogo, 2001). For all scales, procuring plant or seed material can pose challenges (Vieira, 2009), and, as many of the integrative systems lack scientific study, technical knowledge gaps can also create challenges.

Woman holding a sapling planted in a reforestation area in Tigray, Ethiopia. Photo by Mokhamad Edliadi/CIFOR

Politics at all scales can have a major influence on what land-use is practiced (Ajayi & Place, 2012). Therefore, politicians must first be in favor of landscape restoration and then in favor of using ILUS principles to achieve this. The design of policies/incentives that suit cultural and economic environments is vital to success (Ruff, 2011). At small scales, implementation of and adherence to policies is a challenge for politicians (Vaast & Somarriba, 2014). At larger scales, corporate influence and national policy play major roles.

> *"We abuse land because we regard it as a commodity belonging to us. When we see land as a community to which we belong, we may begin to use it with love and respect."-*
>
> *Aldo Leopold*

Human societies and landscapes are proponents to each other and that's the reason why landscape restoration are often challenged by the social systems. Cultural resistance to change, multiple stakeholders, unclear land boundaries and tenure, loss of traditional land use, complexity in information dissemination and/or non-implementation of inclusive policies (for women and marginalized groups) on the ground are some of the socio-cultural challenges to landscape restoration. Landscapes are multi-functional (Oliver et al., 2012; Van Oosten 2013) and thus are affected by external factors like migration, global trade, consumer preferences, international agreements, investors, and climate change (Martín-López et al., 2017).

Acai nursery in Acre, Brazil - a state government initiative to assist forest restoration. Photo by Kate Evans/CIFOR

Critics also argue that restoration takes too long, costs too much, and produces too few benefits to justify public or private expenditures (Verdone & Seidl 2017). In a nutshell, ILUS can be a solution for landscape restoration, but it is not the case for every scenario (Crouzeilles et al., 2016) as restoration efforts depend upon the conditions found in a particular area (Lamb, 2002). Despite many challenges principles of landscape restoration are being applied for landscape restoration at multiple scales and should be continued using the right based approach with the involvement of all relevant stakeholders to solve the above challenges.

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7. Contribution of agroforestry systems to the well-being of local resource users in the buffer zones of protected areas

Group 7
Borwen L. Sayon
Charlotte Gengenbach
Eldrige Ampong
Rebecca C. Ogu

The establishment of Protected Areas (PA) has become a major policy for the protection of biodiversity. The principle approach to PA in the tropics implies the determination of a fully protected core zone surrounded by a buffer zone where local resource users are allowed to practice sustainable land uses. Buffer zones have two main functions: a) environmental buffering, thus to conserve the core habitat for plants and animals, and, b) socio-buffering, meaning the provision of local livelihood opportunities. Governments, development organizations and scholars promote the implementation of agroforestry systems (AF) in buffer zones as a "silver bullet" to address both functions.

To critically assess the relevance of this assumption, and to understand the conditions under which AF can contribute to a satisfactory well-being of local resource users, we analysed six scientific articles on experiences with AF in buffer zones that we found with keyword research in the internet. The papers cover seven PA located in Uganda (two cases), Tanzania, Cameroon, the Philippines, Indonesia and Mexico, and encompass different AF including perennial tree-crop systems, multi-strata tree planting, woodlots, agro-silvopastoral systems and coffee-based schemes. Our analysis considered seven categories of potential AF benefits: land tenure, health, income, food, seeds, environmental services, and social relations such as farmers' association and gender equality, and scanned information on eventually existing challenges and related strategies for action.

In six of the seven cases, strong empirical evidence for a massive positive contribution of AF to local well-being was found. Nevertheless, the papers also identified several challenges hampering the functionality of AF for local resource users. Among the institutional challenges, unclear land tenure was a predominant issue, but also conflicting interests and the effects of contradicting conservation policies. Socio-economic challenges comprised inadequate markets and logistics, as well as financial constraints. Inadequate access to information and technologies, lack of good-quality seeds, and limited extension support were major technical challenges reported.

The papers also suggested several strategies to address these challenges, most importantly to: a) secure land tenure, b) adapt AF to the local biophysical, economic and conservation contexts, c) provide information, training and extension services, d) make financial support available, e) form farmers' associations and cooperatives, f) establish market linkages for the diversity of AF products, g) enhance community-based germplasm strategies, and, finally, h) more intensively involve local knowledge. Little evidence was provided regarding the success of the proposed strategies.

A Lubuk Beringin villager walks home from the forest at Lubuk Beringin village, Bungo district, Jambi province, Indonesia. The villagers adhere to and implement numerous rules for forest management in support of preserving protected forests, rubber forest areas and water sources.

Due to the limited sample, it is not possible to draw general conclusions about the contribution of AF to local well-being, supporting conditions and the appropriateness of the proposed strategies. Nonetheless, it can be said that all publications tended to highlight the benefits and potential of AF whilst failing to address possible shortcomings and implications for local people. Accordingly, it is unclear whether and to what degree the analysed papers really reflect the farmers' perspective on the practical feasibility of AF. It remains also questionable if the proposed strategies sufficiently address the listed challenges.

AF is one of many possible options to contribute to the well-being of local resource users in buffer zones of PAs; however, it is not a "silver bullet". To comply with the high expectations, AF needs to overcome manifold barriers related to investment, organization, tenure, technology, and monitoring. It is deemed helpful to assess the relevance of AF in comparison to other options such as payment for ecosystem services, classical agriculture, and ecotourism.

Edited by:
Reinecke, S.; Pokorny, B.; Schmidt-Vogt, D.
Chair of Forestry and Rural Development
Albert-Ludwigs-University Freiburg

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