Agroforestry into its fifth decade

Palembang, South Sumatra Province, Indonesia's first Master Plan for Renewable Resources-Driven Green Growth. This photo was taken on Mt Dempo (3159 metres above sea level) in Pagar Alam District, South Sumatra Province, Indonesia. Tea gardens at varying stages of growth bordering coffee agroforestry make for a delicately patterned, sustainable landscape.

Photo: World Agroforestry/Arga Pandiwijaya

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CHAPTER TWENTY ONE

Agroforestry into its fifth decade: local responses to global challenges and goals in the Anthropocene[a]

Meine van Noordwijk, Lalisa A Duguma, Sonya Dewi, Beria Leimona, Delia C Catacutan, Betha Lusiana, Ingrid Öborn, Kurniatun Hairiah, Peter A Minang, Andree Ekadinata, Endri Martini, Ann Degrande, Ravi Prabhu

Highlights

- In its fifth decade agroforestry is a drive to greater policy synergy between technologies, landscapes, rights and markets to achieve restoration of multifunctionality in a Sustainable Development Goals (SDG) context
- Bottom-up interest in sustainable and profitable land use interacts with concerns at livelihood and landscapes scale (rights, migration, livelihoods and ecosystem services) and nation al and international policy agendas with their top-down goal-setting and instruments
- Three broad groups of SDG coexist: A) articulating demand for further human resource appropriation, B) sustaining the resource base, and C) redistributing power and benefits
- The FEWI (food, energy, water, income) agenda can be reflected in a broadened LER (land equivalence ratio) concept of land-sparing through -sharing in multifunctional landscapes
- A new 'Anthropocene equation' relates planetary boundaries to population, affluence, life style, waste and land use technology, with multiple resilience concepts as connections with a new agroforestry agenda
- Synergy between agriculture and forestry can evolve from recognizing coexistence and agreed boundaries towards joint land use programs and innovation in a circular economy

[a] Expanded and updated from reference 1

21.1 Introduction

Chapter 1 outlined the evolution of agroforestry as a concept at plot/farm, landscape and policy scales, with all three coexisting in the current links between praxis, knowledge and policy. Chapter 19 ended with the need for policies that seek and support SDG synergy in pursuit of landscapes that not only produce goods for existing markets, but also provide the services that 'downstream' stakeholders have in the past taken for granted but do miss when they are affected. We will here focus on the third agroforestry paradigm and the need for reinventing the interfaces between agriculture and forestry in the food, energy, water and income nexus[1] as part of addressing the challenges of the Anthropocene, the geological era dominated by a single (our own) species.

The formulation of Millennium Development Goals, precursor to current Sustainable Development Goals (SDGs) brought the ending of poverty and the need for environmental sustainability on the same 'goal' level in high-level discourse[2]. It allowed multifunctional land uses, such as agroforestry, to gain wider support[3]. With the SDG agenda[b] of the United Nations, agreed upon by 193 countries in September 2015, the debate has shifted from 'willingness' to 'ability to act'. Because the human brain is challenged when a list contains more than 3-5 items, there have been many attempts to group the 17 SDGs[4,5]. One way (Figure 19.2) is to recognize five groups: 1) SDG 1-5 deal with multiple dimensions of poverty (food, income, health, education, gender), 2) SDG 6-9 with development infrastructure (water, energy), 3) SDG 10-12 with the fairness-efficiency balance, 4) SDG 13-15 with ecological infrastructure, and 5) SDG 16 and 17 with institutions. A further grouping sees a group of goals that articulate increased demand for resources (including food, energy, water)[6], a group that tries to maintain the resource base and a group modifying access to resources, power and benefit distribution (including gender and youth-based distinctions beyond homogeneous household perspectives)[7]. Despite critique on the goals ("By attempting to cover all that is good and desirable in society, these targets have ended up as vague, weak, or meaningless")[8] and comments from the science community[9] that were only very partially taken to heart, they are still the most legitimate attempt at global governance so far, deserving efforts to try and make it work[10].

Progress within each of these SDG groups probably requires efforts that are at least compatible with goals in the other groups (being neutral to or with modest trade-offs), while providing the focus and clarity needed to address a specific target. Having 17 single-goal implementing policies is not efficient; the Tinbergen rule about the need for the number of policy instruments to match the number of goals[11] can be softened where goals in practice (at least in a given local context) align. Central to all groups of SDGs is 'land use' as a meeting point for material and immaterial needs. Sustainable land use as target has been debated since long ago[12,13], but could still be the key to progress. It connects the need for further human appropriation of resources, the efficiency with which existing land is used for achieving agricultural and forest production of goods and services, and the rights and governance agenda of who decides, controls and benefits.

[b]http://www.un.org/sustainabledevelopment/development-agenda/

As described in chapter 1, the concept of agroforestry was from its very beginning aligned with 'restoration' and linking farmers' knowledge, objectives and expectations to desirable environmental change. Four decades of agroforestry research and development, as reviewed in the chapters of this book, have deepened the need for reconciling local interests and opportunities at farm level, with the global agenda for nature, forests, agriculture and urban land use as agreed on in the 17 Sustainable Development Goals (SDGs) (Figure 21.1, Figure 21.2).

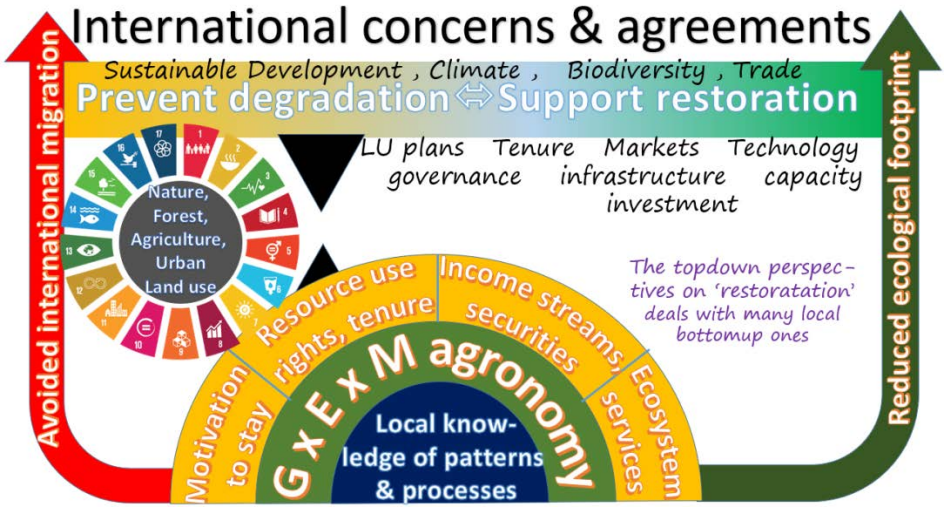

Figure 21.1 Bottom-up interest in sustainable and profitable land use (based on Genotype x Environment x Management or GxExM interactions involving trees) interacts with concerns at livelihood and landscapes scale (rights, migration, livelihoods and ecosystem services) and nation al and international policy agendas with their top-down goal-setting and instruments

Throughout the chapters we have seen that the interest in what agroforestry has to offer has evolved along with 'issue cycles'[11]: the entry point for public debate and policy responses has varied within the multifunctional landscape, but 'solutions' become 'next-generation problems' unless the totality of functions is understood and considered. The tendency of academic researchers to tackle problems one-at-a-time and defend the territorial boundaries of disciplines is not particularly helpful in this context. Present-day agroforestry science takes its clues from integrative fields such as 'agro-ecology'[14] and 'boundary work'[15]. It participates in and builds on integrative science-policy assessments such as those on agricultural science and technology[16], forests, food and nutritional security[17] and forests and water[18]. It also benefits from integrative concepts such as the co-adaptation of people and trees to climate change[19] and treesilience[20].

The debate on planetary boundaries[21,22] as next step beyond limits to growth[23] has connected current human resource appropriation to a 'carrying capacity' perspective on what the energy, water, nutrient, pollutant and further cycles can afford. Similar to earlier carrying capacity debates[24], the agility of humankind to adapt and modify technology can shift the hard limits proposed. There are, however limits to adaptation[19,25] and current progress may be hindered by a fall back to earlier 'denial' phases by important stakeholders in the debate. The planetary boundaries concept, just as the earlier limits to growth may be most useful if it

is a self-unfulfilling prophecy that triggers a just-in-time human adaptive response. Smarter technologies, however, need to go hand in hand with efforts to contain current global environmental change by enhanced and sustained agility[26,27], once goals have been set.

The various SDGs have from their start and political platform in the discussion, been associated with existing sectoral perspectives. SDG2 for example is seen as the domain of 'agriculture' and SDG15 of 'forestry'. It seems logical to relate SDG2 on 'Zero hunger' primarily to agriculture. However, current understanding of the multiple dimensions of food security (adequacy of supply, economic and physical access by all, absence of factors restricting utilization, stability and sovereignty[28]), has opened up to wider perspectives[29]. The concept of 'outsourcing' of staple foods (but not of other elements of healthy diets) in tropical forest margins[30], has pointed at rural income security as basis of food security. A wide range of forest and tree crop products can be a basis for income and thus food security. In many countries, food insecurity and under-nutrition are not the result of a lack of availability of food but are related to unequal distribution of resources and unequal access to healthy natural resources, productive inputs, credit, social protection and information. Lack of clean water (SDG6) or energy to cook (SDG7) link forests and trees to underachievement of SDG2. Efforts to achieve food security and nutrition thus require dealing with challenges in production, distribution, pricing and information, access to healthy land and water. However, it also deals with problems of insufficient health care and education, inadequate sanitary systems, or factors such as economic decline and climate change impacts on production and distribution[31]. Rural societies need to deal with all SDGs, rather than SDG2 alone, just as they deal with agriculture, forestry and everything in between.

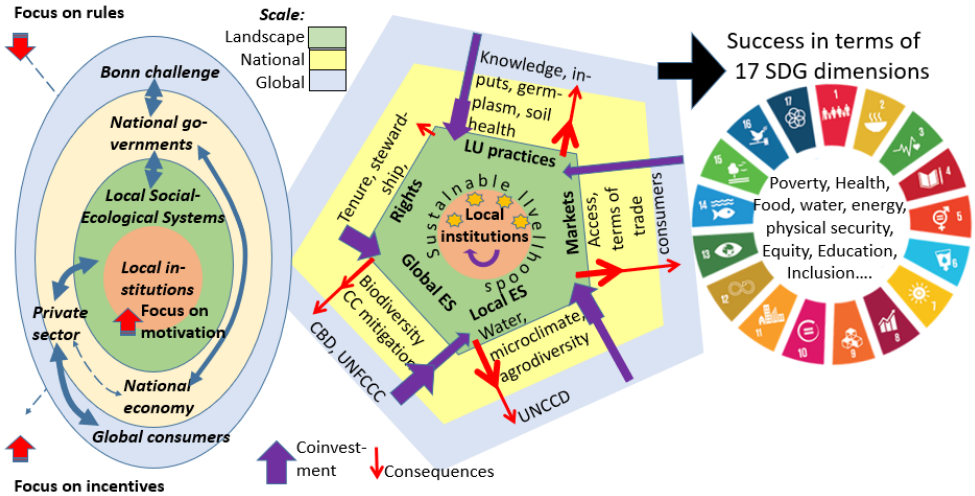

Figure 21.2 Linkage of global concerns to local change in land use can start from rules, incentives or motivation (left panel), but to be effective it will need to address all sides of the pentagon (middle panel) and be directed towards the totality of 17 SDGs

21.2 Agroforestry concepts, impact pathways and theories of change

As described in Chapter 1 and formalized in a set of hypotheses[32], agriculture and forestry have a long history as separate and often antagonistic sectors[33], but reality in the landscapes

shows a much smoother continuum. In the four decades of its existence[1], agroforestry as a concept has been understood and defined by reference to various system scales of interest: trees (Chapters 2 and 3), soils[34] (Chapter 4) plot-level interactions (Chapter 5) and management practices[35], development goals[36] or climate change[19]. Where earlier definitions of agroforestry focused on the technology of plot-level integration of trees[37] (AF1) (see Chapter 6 for the regional variation in tree cover in agricultural lands). Subsequent interpretations of agroforestry as an element of multifunctional landscapes, have embraced a much larger share of the natural resource management and rights agenda[38,39] (AF2), as described for different parts of the tropics in Chapters 7 – 12. Finally, it led to current perspectives on how the land-based sectors using the principle of agroforestry knowledge and practice (AF1 and AF2) can contribute to the achievements of SDGs by removing the conceptual and institutional barriers between agriculture and forestry (AF3)[40]. Chapters 13-19 have discussed various policy lenses through which agroforestry may appear to be part of solutions to be pursued.

The relationship between the agriculture and forestry sectors has in the past largely been analysed as competition for space in a zero-sum (land-sparing) game[41] and power, but the existence of wider 'planetary boundaries' than space as such, including the causation of climate change, may urge for a reanalysis[42,43] of the underlying discourses. Discourses are shared, structured ways of speaking, thinking, interpreting, and representing things in the world[44], and represent one of the highest level 'leverage points' identified by systems analysis[45]: from parameter settings to the dynamic structure of feedback loops, their strengths and time-lags, to differential information access, goal setting, paradigms and self-organization. Publicly held paradigms and existing segregated institutions are key bottlenecks to SDG attainment.

The SDGs call for new alignments across sectors that don't have a history of smooth cooperation in many countries[46,47], including agriculture and forestry as part of natural resource management. The opportunities for a coherent SDG approach to 'all land uses' across the full spectrum of human use intensity and measurable tree cover, will be bounded by the degree of success in overcoming institutional divides. A seven-point scale has been proposed to describe interactions between goals[48], ranging from 'Cancelling' (-3) through 'Neutral' (0) to 'Indivisible' (+3). This interaction scaling can be applied on how agroforestry at the agriculture/forestry interface on the various contexts contributes to climate change adaptation with co-benefits for mitigation within SDG 13, while addresses food, energy and water issues of SDGs 2, 7, 6 along with human health (SDG3) and healthy terrestrial ecosystems (SDG15), while never loses economic progress (SDG1) out of sight. An earlier analysis described how the way adaptation and mitigation dimensions of the global climate change debate can move from competing silo's towards complementarity and further to synergy[49] and took stock of current practice in developing countries in this regards[50].

Following earlier agroforestry reviews of food security and climate change in Africa[51,52], water and climate change adaptation in Indonesia[53], nitrogen fixation as SDG friend or foe[54], and multifunctional agriculture[55], the rest of this review focuses on the need for a comprehensive 'land use' SDG agenda, transcending existing sectoral views on agriculture and forestry. Four steps in such a process of enhancing synergy can be coupled to the four knowledge-to-action

chains[11,56] that relate understanding of 'public concern' issues to willingness to act, ability to act and capacity to innovate:

Progress in resolving issues of public concern can be constrained by any of these four chains[5].

21.3 Science-based understanding of prioritized issues and their trade-offs

Increased demand for food and healthier diets, renewable energy and reliable clean water, as part of the SDG portfolio, all imply claims on land. Increased functionality per unit land is needed to reconcile footprints and available space. Intensification (greater use of inputs and energy per unit land to obtain more output) has been the main strategy in agriculture and production forestry to reduce competition for land with other societal functions. In trying to close 'yield gaps', however, a common pathway to intensification has widened other 'efficiency gaps'[57]. In a major review of the diversity of impact pathways by which (international) agricultural research can increase rural prosperity[58,18] pathways were identified. The first five describe the traditional core area of such research in the Genotype x Environment x Management interactions of high-yielding germplasm and associated input markets (Figure 21.3A). The next eight broader issues of natural resource management, property rights, gender, skills and value chains, and the last five policies relating to health, safety nets, food waste and international trade (Figure 21.3B). The three interpretations of agroforestry (Chapter 1) relate to the first five (AF1), the first nine (AF2) and the full set (AF3).

Current understanding of the complexity of the forest-rural and rural-urban interfaces of land use thus gives space for new discourses on how land use as an integral concept can be managed, in line with societal priorities. This is especially relevant in developing countries before and around their demographic and economic transition where more than half of the population and economy is urban. With current projections Africa is the only continent where rural populations are expected to still show absolute increases[c], elsewhere rural population densities are expected to be stable or on the decline[59]. This transition has consequences for an increasing space for forests, but tree densities in densely populated (peri- or sub- urban) sub-catchments of the tropics, are higher than those for purely agricultural ones[60]. Evidence for a global increase in trees outside forest[61] can be seen in this light.

Recent debate[62,63] has focussed on the relevance of a diversity of conceptual frameworks[64], beyond what the Millennium Ecosystems Assessment[65] promoted, especially in connection

[c]https://data.worldbank.org/indicator/SP.RUR.TOTL.ZG

with the 'payments' concept[66,67]. The new language promoted by the IPBES assessment[68] of 'nature's contributions to people' expresses the same degree of anthropocentricity as the 'ecosystem services' it tries to replace, assuming a 'free and prior informed consent' on the other side of human resource appropriation[d]. While the terminology debate may have relevance for part of the audience, a more empirical approach may see that many of the functions, services or contributions of 'wild' nature are taken over by more 'domesticated' land uses and/or non-land-based technology (Figure 21.4). A further quantification of these relations will undoubtedly lead to a refinement of the options and context-specificity of the various substitution processes, but a first mental step is to see land uses as a continuum open to empirical exploration, rather than as forest-agriculture dichotomy.

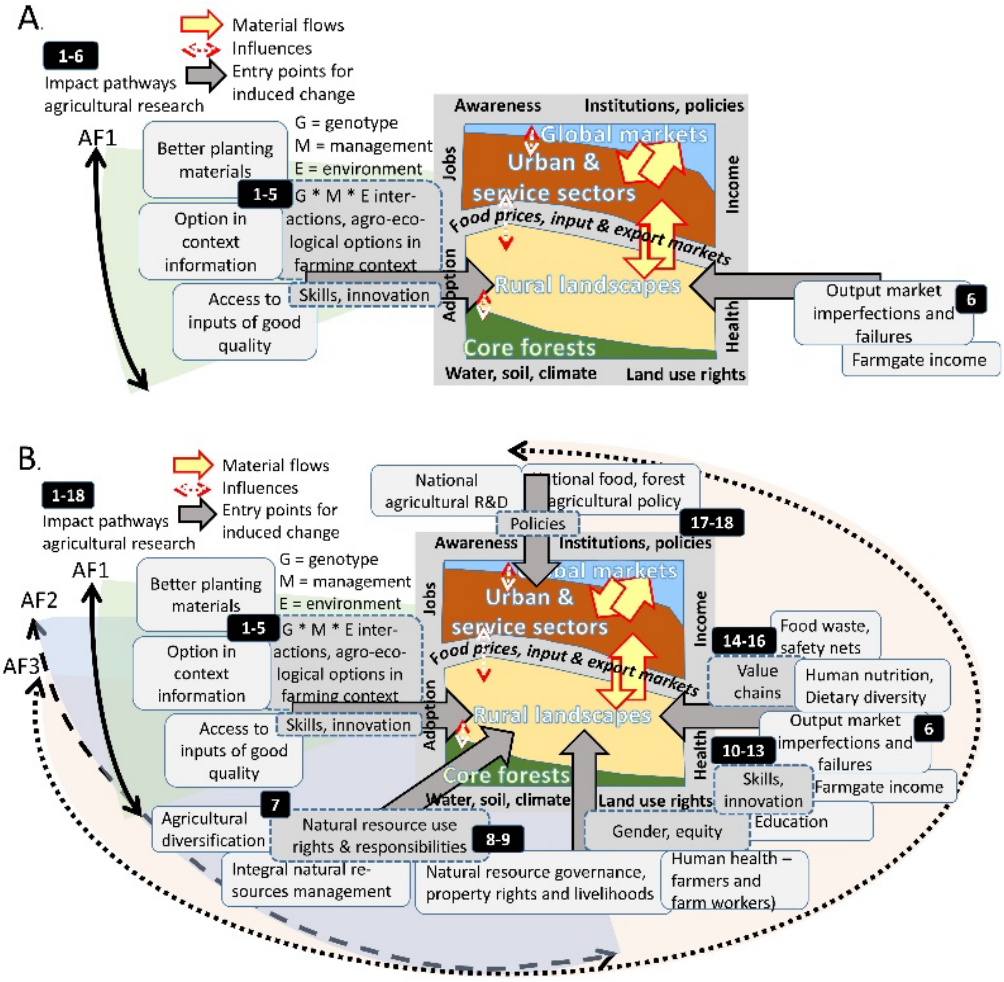

Figure 21.3 Systems perspective on aspects of agriculture, rural development and national economies, with multiple impact pathways for agricultural research; A. Focused on the initial strength of international agricultural research; B. With the current agenda[59]; three interpretations of agroforestry are indicated as AF1, AF2 and AF3

[d]http://science.sciencemag.org/content/359/6373/270/tab-e-letters

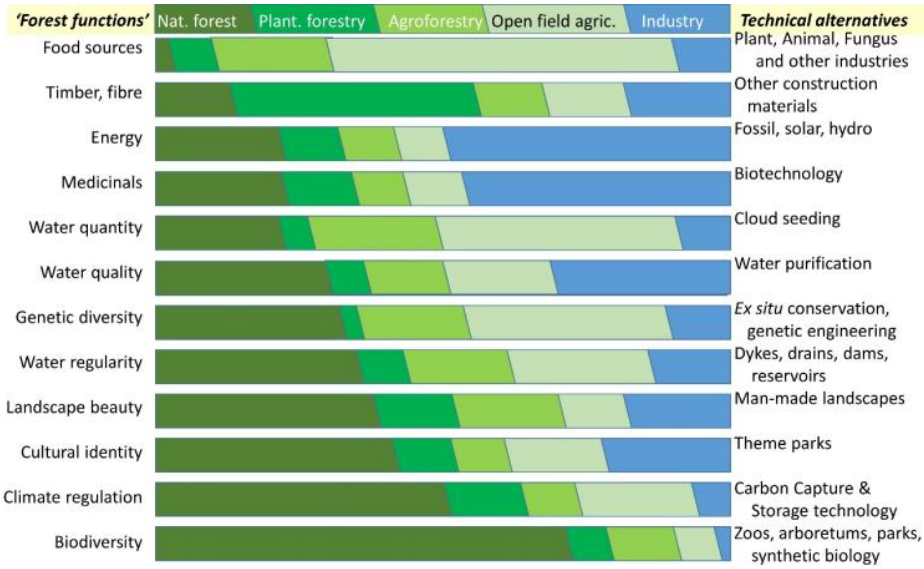

Figure 21.4 Conceptualization of the degree to which a range of 'forest functions' are provided by natural forests, plantation forestry, agroforestry, open-field agriculture or industry, with an indication of the technical alternatives that can substitute for 'contributions from nature' to match human agendas

Agroforestry landscape including a tea plantation, Vietnam. Photo: World Agroforestry/Ingrid Öborn

Box 21.1 Land equivalent ratio for multifunctionality

The continuum can be described by a single metric: the degree to which land use in its current form achieves the goals set, relative to other ways of achieving these. The Land Equivalence Ratio concept, so far focussed on productivity, can be expanded to do so. The conventional Land equivalence ratio (LER) concept (Eq. 1) that is central to AF1, can for AF2 be expanded to a multi-functionality land equivalence ratio (LERM, Eq.2).

$$LER = \sum_i P_i / P_{i,ref} \quad (1)$$

$$LERM = \gamma_{P,S} \sum_i P_i / P_{i,ref} + \gamma_{R,S} \sum_j R_j / R_{j,ref} + \gamma_{C,S} \sum_k C_k / C_{k,ref} \quad (2)$$

Where Pi , Rj and Ck represent the attainment (in any metric of choice, per unit area) of a range of provisioning (P), regulating (R) and Cultural (C) services provided by a landscape, Pi,ref ,Rj,ref and Ck,ref the attainment (in the same metric) of such services in a landscape optimized for that specific service (often a 'monoculture') and $\gamma_{P,S}$, $\gamma_{R,S}$ and $\gamma_{C,S}$ the weighting functions for the importance of the three groups of ecosystem services from perspective S. Full representation of all weighting factors γ_S may in fact represent the AF3 concept (Figure 21.3). A comprehensive analysis of properties of alternative cropping systems was recently completed for cacao, quantifying various trade-offs.

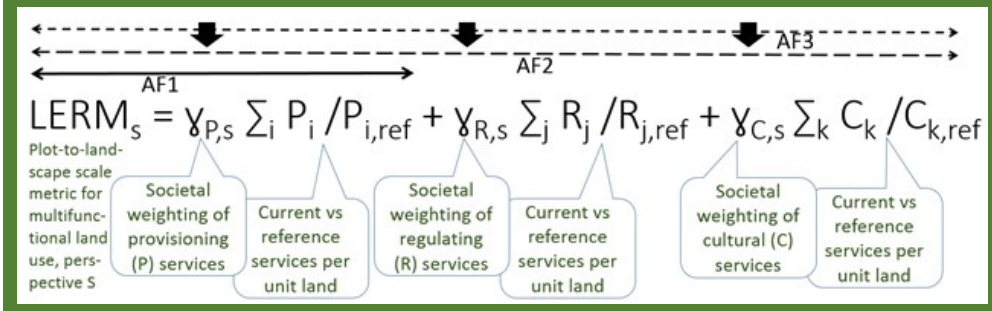

Figure 21.5 Land Equivalent Ratio for Multifunctionality (LERM) as landscape (AF2) extension of the plot-level (AF1) productivity LER; if LERMs > 1 the mixed system, from perspective s and its weighting parameters γ, spares land relative to a segregated mosaic of monofunctional reference land uses

The big questions of the Anthropocene about the ecological footprint of humanity, already transgressing the planetary boundaries of 'safe operating space', require that the full spectrum of SDGs is taken seriously (Box 21.2). 'Land use' (with or without 'agroforestry') is the starting point for supply chains (and their current waste that can be recycled), life-style consumption choices (with greater awareness of consequences for personal and planetary health) and continued efforts to ensure that '*nobody is left behind*'.

Box 21.2 Anthropocene equation

Human impact on the planet has since the 1970's been summarized in the IPAT equation[69], stating that impact (I) is the product of population (P), affluence (A), and technology (T). In current discussions, the affluence is replaced by 'well-being' (in a SDG sense) and the life-style choices that support is, while the technology needs to at least distinguish between the efficiency of value chains between production and consumption, and the land-based 'primary' production that is at its base. In impact the concept of resilience and human adaptive capacity to support it need to be part of the analysis. A more elaborate and up-to-date form is presented in Figure 21.6 as '***Anthropocene equation***'. Agroforestry has conventionally been conceived as a form of land use, to be evaluated primarily on the basis of its productivity. In the fifth decade of agroforestry a wider perspective is needed on balancing human ambitions with the various planetary boundaries that have already been crossed.

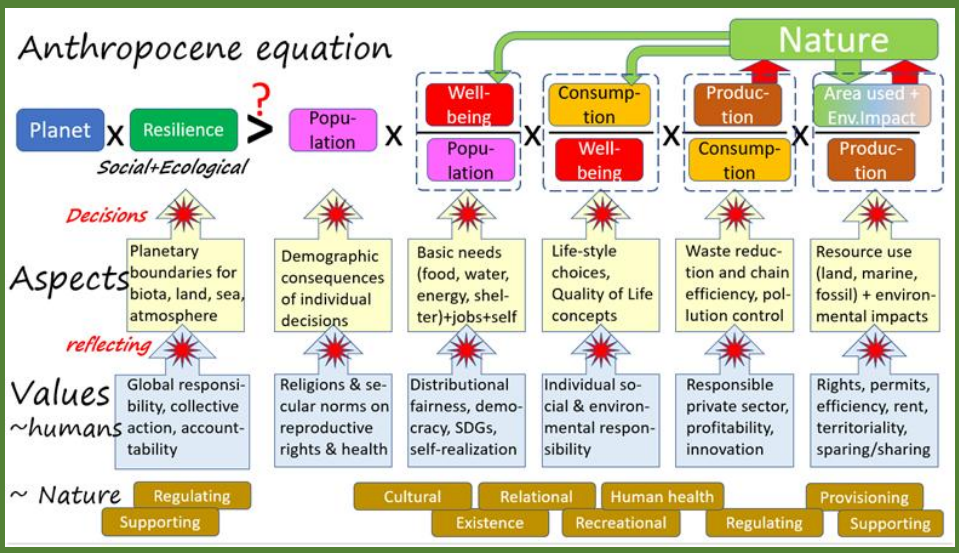

Figure 21.6 Updated version of the IPAT (Impact = Population * Affluence * Technology) equation incorporating life-style choices, waste reduction and contributions of Nature to quality of human life based on a range of ecosystem services; agroforestry discussions can no longer be restricted to the land use box without connecting to the chains of value (or waste), consumption and wellbeing that link 'Nature' to 'People'

21.4 Willingness to act on ambitious goals

Research on land use, especially that on tropical forest margins, has quantified trade-offs between production (local income) and conservation (global wellbeing) goals[11,70,71] and clarified the need for policy instruments to align land use choices across scales by internalizing externalities. Such trade-offs have in the past been portrayed as 'development' versus 'environment', or short- versus medium- and longer-term goals. The 'future we want' agenda of 17 SDGs has stressed the coherence between these goals and has refrained from a hierarchy among the 17 goals to ensure that national policy can adopt them according to each country's contexts and needs. Yet, domestic policy platforms for the various goals have not

(yet) converged as much as the international agreements suggest. Within countries and governments, a strong preference for 'development' over 'sustainability' dimensions can still be observed. The same may be true where international organizations, and parts thereof, that have so far focussed on single goals, now face new challenges to achieve a higher level of coordination and integration[72,73]. Although accepted as goal by all countries, the effective integration of the gender agenda on land use and natural resource management remains a challenge[74,75]. Complementarity between international, national and local policies needs to be met in raising the 'ability to act'.

Box 21.3 Global trade and consumer responsibility: shifting blame or resolving issues?

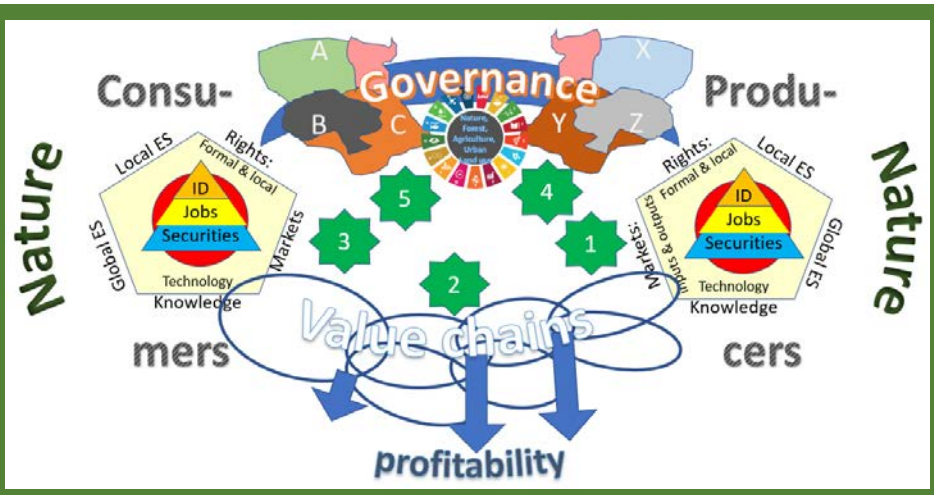

Figure 21.7 Four-component system view (governance, private sector value chains, producers and consumers) on global trade, with 5 emerging issues discussed in the text

Public-private partnerships connect consumers, producers, value chains and governance as four subsystems in the global Social-Ecological System (Figure 21.7). Nature plays a role in both the producer and consumer side, but in different ways, and partly in a trade-off. Outsourcing the production of commodities such as timber, animal feed or staple crops has facilitated local nature conservation and reforestation[76], but at unaccounted costs for global nature. Despite all social differentiation in both consumer and producer settings (indicated by the red circles in Fig. 21.7), the complexity of human can for the current analysis be reduced to three layers of the Maslow pyramid: securities or basic needs of shelter, water, food and energy, a middle layer of jobs and income, and an upper part of identity and self-realization. The governance connection needs to reconcile a democratic streak, in which consensus among 192 UN countries counts, and a power-reality one, in which three economic blocks (China, EU and USA) control 50% of the global economy[e] and 3 countries dominate two-thirds of globally traded commodities in the case of tropical timber, palm oil, coffee, cacao, coffee and tea (Chapter 6). Global trade developed as the margin between willingness of consumers to pay for (low-cost in their view) products still left an entrepreneurial profit margin after farmgate commodity prices were paid, and costs

[e] https://en.wikipedia.org/wiki/World_economy

of transport, processing and taxes covered. Gaps between living standards of producers and consumers increased opportunity for the private sector controlling value chains, with 'intellectual property rights' on intermediate steps in the value chains delaying a race to the bottom. Globalization, however, also brought increased flows of information about the social and environmental consequences of commodity production, and an increasing sense of guilt. Boycotts (or threats thereof) sparked a response that started with 'denial' and moved to 'shifting blame', when 'worst case' examples were confirmed in public scrutiny. Shifting blame requires the articulation and acceptance of 'standards', and forms of 'certification' of compliance to such standards by trusted third parties. As a range of social and environmental issues, each initially triggering separate standards, coalesce, overarching standards and labels emerge. Globally established companies try to gain trust in their brands, but to do so have to be seen as front-runners in 'voluntary standards' and declarations on 'deforestation-free', 'fair-trade', 'organic' or whatever is the term with most traction in public discourse. As a response of last resort, the social responsibility for poor primary producers and the 'sovereignty' of producer countries faced with demands of ill-informed affluent consumers is brought into the debate, polarizing and politicizing the issues. Analysis of such 'issue cycle' responses for a number of tropical commodities[77,78] (from heavily contested palm oil[79] and tropical timber[80], via fair-trade focussed coffee[81] and cacao[82], to agnostic rubber[83]) has focussed on the 'shifting blame' and 'resolving issues' aspects. Five trends have been noted for further analysis:

1. Optimal intensification: where the land-sparing benefits of intensification and the local-impacts minimizing aspects of land sharing have been contrasted as an a priori choice, the analysis of footprints per unit product show[84] that there is a middle-ground of 'socially optimal intensification' from an environmental perspective, that may or may not coincide with 'privately optimal intensification'.
2. Chain responsibility drives towards the monopsonies of vertical integration and exclusion of smallholder producers, unless the gap between end-consumers and primary producers is so wide that the chain functions better if links are partially independent.
3. The concept of indirect land use change (ILUC) has come on top of the responsibility on the producer side to meet emerging standards; ILUC is arbitrary in its level of aggregation (e.g. 'palm oil' versus 'vegetable oils') and in its current application feeds conspiracy theories in exporting countries.
4. There may well be a trend from a product-based to a territorial 'jurisdictional' approach, looking for integrated solutions. Products can be protected by 'geographic indication' with local compliance checking and joint responsibility for brands. Transfer of accountability for net greenhouse gas emissions along the value chain may require a globally coordinated 'carbon tax' (e.g. similar to the 'value added tax' concept)
5. Limits to public responsibility and government involvement support a 'consenting adults' perspective, where Free and Prior Informed Consent (FPIC) on the producer side is accompanied by absence of child labour and compliance with producer-country regulations (e.g. ISPO), with fully informed customers who are free to express their preferences, responsibility and choices. The norms, values and procedures of the World Trade Organization (WTO) that aim to protect 'free trade', need to be reconciled with the 'responsible production and consumption' intent of Sustainable Development Goals 12.

21.5 Ability to act across goals with common programs, funding and institutions

The historical institutional divides between 'mitigation' and adaptation', as well as between 'forestry' and 'agriculture' remain a barrier for effective SDG attainment, as project proposals have to target one of the two as goal, as basis for eligibility for international or national funding[85]. An analysis of 201 project design documents from adaptation funds, mitigation instruments, and project standards found that 37% of the documents explicitly mentioned a contribution to the other objective[86], though often as unsubstantiated co-benefit. The drive to integrate climate change mitigation and adaptation includes urban areas[87] and 'climate smart' landscapes[88].

Despite challenges in its operationalization, an integrated landscape approach[89,90,91] still appears to be the best way of coherently targeting the Sustainable Development Goals (SDGs) through new forms of collaboration between stakeholders (which can include scientists) based on long-term commitments[92]. It requires a perspective on land use that integrates beyond what has currently been mainstreamed in 'green economy' policies, both at the national and sub-national level. Local governance systems, linked with existing jurisdictions, have to reconcile compliance with national rules, especially where forests are concerned, and local interests that more directly align with agriculture. Beyond land use planning, clear performance metrics for landscape functions and systems for monitoring and evaluation of achievements are essential to a culture of innovation.

David Kenduywo at his farm in Kembu, Bomet County in Kenya. He grows fodder trees, shrubs and grass for his dairy cattle. Photo: World Agroforestry/ Sherry Odeyo

Box 21.4 Rural Resource Centres

While the essential role played by rural advisory systems in reducing poverty and hungeris increasingly recognised, agricultural extension in many developing countries continues to offer single size interventions that do not consider the increasingly complex nature of farming systems in the face of global challenges, such as poverty, food insecurity, climate change and degradation of natural resources. A shift to more user-driven research and co-production of solutions is needed[93, 94].

The participatory tree domestication efforts (Chapter 3) started filling such a gap in Cameroon about 15 years ago[95,96, 97]and since then found following in diverse socio-economic and cultural settings, e.g. in Chad, Burkina Faso, Democratic Republic of Congo, Ethiopia, Indonesia, Kenya, Mali, and Rwanda. In a bid to tackle land degradation and social deprivation, farmers are being enabled to implement agroforestry techniques using a novel community-based extension approach, providing a multitude of services and products tailored to farmers' livelihood needs and capacities. Rural Resource Centres (RRC) are training, experimentation and demonstration hubs that are managed by grassroots organisations[98]. Emphasis is put on access to knowledge, interactive learning, and networking among farmers, and between farmers and other actors. In Cameroon, 10 RRCs were opened, hosting 150 nurseries and serving over 10,000 households, planting over 1.6 million trees. The average income of participating communities rose to over USD 26,000. More recently in Mali, 14 RRCs were established, 4 million trees of 25 species planted and 80,000 farmers in 183 villages engaged. The Regreening Africa project, led by ICRAF, supports the Governments of Kenya, Rwanda and Ethiopia for land restoration through the establishment of rural resource centres and community nurseries to improve access to high-quality tree germplasm.

In Indonesia the number of extension agents is far short of the regulation that states each village should have one. Thus, ICRAF and partners are testing the effectiveness of Rural learning centres in scaling up the adoption of improved production practices of forestry and agroforestry commodities such as teak, coffee, candlenut, bamboo, honeyand fruits[99].

Rural Resource Centres can develop new, and mobilise existing, competencies to cultivate farmer-centred innovation suitable to rapidly changing biophysical and socio-economic conditions, including climate variability and change. The 'capacity to innovate' nurtured by the RRC approach is demonstrated in terms of their capacity to identify and prioritise problems and opportunities; their aptitude to test, evaluate and adapt different social and technical options; and their ability to network and enable learning and knowledge sharing[100].

21.6 Action, shared monitoring, evaluation, innovation

Once institutional constraints to synergy have been addressed, innovation and co-learning can take place. Non-state actors have played essential roles in moving forward debates where national governments are entrenched, such as in the debate on oil palm[101].

Multi-sectoral platforms are processes which often become institutionalized bodies drawing together multiple stakeholder representatives from different sectors to make decisions. They are convened to harness the benefits of collaboration in tackling planning problems that span more than one sectoral jurisdiction and therefore require a co-ordinated response in policy formulation and implementation. Examples include platforms to address planning issues

around climate change, food security, biodiversity conservation, timber legality and so on – many of which have nested processes from international level right down to local level. A key question, however, is whether 'certification' can avoid prescribing 'solutions' and create space for goal-oriented innovation (Box 21.5).

Box 21.5 Green Growth and Restore+ planning

Green Growth as a concept fosters economic growth and development, while ensuring that natural assets continue to provide the resources and ecosystem services on which our well-being relies[102]. Mainstreaming Green Growth as a policy agenda comprises a menu of policy tools, strategies, principles and indicators that translate the concept into ways of solving trade-offs between economic growth and ecological problems. For green growth to matter in the world of policy and politics, two conditions have to be met[103]. First, strategies must exist for translating the framing concept into policy change. Second, those strategies must be adopted and implemented. For a number of provinces of Indonesia World Agroforestry (ICRAF)has used its experience in analysing land use and its trade-offs to gain commitments from the sub-national governments to apply the green growth concept at the practical level using evidence-based information. Development of a Green Growth Masterplan in South Sumatra led to its mainstreaming and a governor's decree in 2017. Similar efforts followed in Jambi, Papua, and Papua Barat provinces.

The South Sumatra plan for Green Growth is a homegrown initiative that emphasizes on distinct local characteristics. It is in line with the national initiative of the 'Nawa Cita' and partakes in the Nationally Determined Contribution (NDC) to the UNFCCC Paris Agreement, as well as Sustainable Development Goals (SDGs). South Sumatra is endowed with enormous capital to obtain green growth, namely: (i) leadership and commitment to global and national community; (ii) a favourable businessclimate – investment by and partnership withprivate sectors in palm industry and industrial plantation forest (HTI – Hutan Tanaman).

The Green Growth Plan of South Sumatra[104] resulted in 17 indicators at the provincial level comprising seven strategies. The strategies are: (1) Sustainable allocation and land-use planning that address the gap between land demand and supply; (2) Improve people's access to livelihood capital; (3) Increase productivity and diversification; (4) Improve value chain by ensuring fair distribution of benefits; (5) Improve connectivity and economic scale; (6) Restore degraded land and forests; and (7) Provide incentive for ecosystem services and innovative funding for sustainable commodities. Compared to the Business As Usual (BAU), the Masterplan of Green Growth South Sumatra will reduce greenhouse gas emissions by 22 percent. These calculations don't yet include likely reductions in the emission from forest and land fires as one of the pressing problems in this province. By applying the Green Growth scenario up to 2030, the emissions of the production forest, which is the largest land sector emitter, will be negative. Furthermore, the application of Masterplan of Green Growth will contribute to the protection and conservation of biodiversity at the landscape level by maintaining connectivity between dryland forest and mangrove through the landscape corridors. The LUMENS (Land Use Modelling for Environmental Services) projected that the regional GDP will increase by 6.4% by 2130 compared to BAU. The growth rate of regional GDP from land-based sectors will be 1.9% per annum.Follow-up activities have focussed on the way forest and peatland restoration can become part of such a wider Green growth scenario, under the heading Restore+.

With the history of forests as part of the landscape that were to be protected from local, innovative resource use, it is particularly challenging to frame space for further agroforestry innovation in its polycentric governance context, avoiding the temptation to over-define and over-regulate at the highest level. Jurisdictional certification might address the above problems. The approach taken by the Common Agricultural Policy of the European Union[105], leaving specifics on what agroforestry is or can be to be further defined at country level is a step in the right direction. Similarly, the Indian agroforestry policy focussed on removing institutional hurdles between agriculture and forestry, rather than on creating agroforestry as a segregated policy domain[106].

21.7 Discussion

From our review of science-based understanding (chain 1) we found strong support for a 'continuum' understanding of 'land use, rather than a dichotomy of forests and agriculture as sectors. Trade-offs between functions are important for the SDG portfolio as a whole; the multifunctionality version of the Land Equivalent Ratio can guide a search for synergy and complementarity. Where willingness to act on ambitious goals (chain 2) is secured for the SDG portfolio at a high level, the ability to act across goals (chain 3) with common programs, funding and institutions is in many cases still a bottleneck. Shared monitoring, evaluation and support for innovation (chain 4) will be essential to allow the synergy options to become reality. The innovation and boundary work literature[107] suggests concrete steps to move to a higher level of integration:

1. **Resources**: It is important that there is an allocation of financial and human resources to encourage the integration of forestry and agriculture, potentially to re-emerge as 'agroforestry' (AF3). Donors could also give integration more space in their resources allocation processes and calls for proposals.
2. **Time**: Policy formulation and implementation issues are often slow processes which require deliberation at multiple scales in the form of consultation and learning. The growing quest for evidence in the policy spaces will require clarity on what difference integration can bring to the wider goal of achieving the SDGs in an effective and efficient way.
3. **Institutional space**: creating a space or a unit within the existing frameworks without complicating the management hierarchy can promote efforts to integration.
4. **Performance indicators**: existing key indicators across the SDG spectrum will be the direct test of integrated land use perspectives, but only if institutional agendas can be contained.
5. **Integrating scenarios** in local development planning for SDGs need to build on existing land use systems, regardless of their current 'agriculture' or 'forestry' labels. At national and global levels bottom-up and top-down models need to be reconciled in view of planetary boundaries and limits to adaptation.

In conclusion, the SDG portfolio can indeed trigger a major step towards more holistic land use perspectives at the agriculture-forestry interface and can, if used well, trigger institutional

change to enhance dynamic sustainability. Agroforestry concepts, science and praxis can make major contributions to a comprehensive approach to land use.

In retrospect, agroforestry is the painful process of reinventing what was all part of agriculture previously, before the separation of crops and livestock from trees and forests. This segregation was artificial and driven more by the limits of imagination, the exigencies of mechanisation, power relations and the state of scientific knowledge than by any real needs to remove trees. It was both artificial and unnecessary in the extent to which it was practiced. It is the advance of knowledge and the (often forced - resilience, biodiversity, bioclimate, climate change, soil fertility, value for investment…) re-imagining of landscapes and land-use management along with a more nuanced development of mechanisation that is driving the changes we see and summarised in this book. While not seeing the forest for the trees is a well-known risk, agriculture for too long has not been able to see its future for the lack of trees.

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