Cultivated lands with mostly native trees

Cultivated lands with mostly native trees in boundaries and coutours - Pacobamba, Apurimac-Peru.

Photo: University of Bern/Sarah-Lan Mathez-Stiefel

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CHAPTER TWENTY

Methods in agroforestry research across its three paradigms

Meine van Noordwijk and Ric Coe

Highlights

- Methods in agroforestry research have evolved along with the paradigms and scales of interest
- For the field-level AF1 paradigm (What?, Where?, How?, Who?) methods have been derived from soils, microclimatology, forestry, agronomy and agricultural economics research, along with social science and geographical methods to describe typologies and spatial patterns
- Methods for the landscape-level AF2 paradigm (So what?, Who cares?, Why?) have been derived from those used in hydrology, ecology and social-ecological system analysis
- The policy-oriented AF3 paradigm requires additional methods for interaction with public attention issue cycles and boundary work

20.1 Introduction

Methods, subject to scrutiny of underlying assumptions and sources of bias, define the scientific approach to knowledge more than any other aspect, but they are driven by questions and judged by the results (data) they generate and the implications these are considered to have. Agroforestry research methods are 'horses for courses'; there is no single method that stands out across all purposes of research. Similarly, there are no research methods that are unique to agroforestry, and few that are completely new rather than modifications of something used earlier. Agroforestry research, like all applied research, has borrowed, used and sometimes improved methods from other fields – with all the hidden assumptions and potential biases these methods may have. The borrowing has not always been easy. For examples, methods from agronomic research may not be feasible with trees that take 30 years to mature. The value of method in advancing the field of agroforestry research is judged not only on credibility of results – judged, for example, by those assumptions and biases – but also their feasibility determined by cost, practicality in field conditions or ease of learning them. In this chapter we will give examples of how research methods have evolved alongside the articulation of the second (landscape) and third (policy) agroforestry paradigm (see Chapter 1), while enriching those that are used within the first (field/farm level) paradigm.

Research questions at the AF1 scale are primarily those about ***what?*** (agroforestry typology, tree diversity), ***where?*** (spatial context, including climate, topography, soils, accessibility), ***how?*** (understanding of growth, yield and plot-level interactions between trees and crops in relation to inputs and management) and ***who?*** (farmer typology). At AF2 level three additional questions are asked: ***So what?*** (Ecosystem service consequences), ***Who cares?*** (Stakeholders and their involvement) and ***Why?*** (Drivers of change, points of leverage and intervention). At AF3 level the last two questions are further enriched with a 'public attention issue cycle' concept with its own dynamic and points of intervention and learning.

20.2 Methods for research of field and farm level paradigm AF1

20.2.1 Typologies of agroforestry practices (what?, where?)

Agroforestry practices, where trees are intimately associated with agricultural components at a field scale, are often part of farming systems that include other components as well. The purpose of a general classification of agroforestry practices is to have logical labels for different types and to group those that are similar, thereby facilitating communication and the organized storage of information[1]. A generic scheme uses a primary classification based on relative dominance of (and priority amongst) naturally established or planted trees, tree crops, annual crops and livestock, and a secondary classification based on dispersed versus zoned tree distribution. Temporal dimensions of practices (length of rotations, sequential or simultaneous interactions) provide another classification. The specific agroforestry experience in Asia and Latin America, with high tree diversity agroforests, provides additional insights and lessons for an Africa-focussed typology[2]. In North America agroforestry developed a partially separate terminology and typology[3]. In European countries administrative structures that consider only agriculture or forestry as legitimate have resulted in the loss of agroforestry practices (and systems?) and an impoverishment of the benefits that they provide. Typology and nomenclature may need to be adjusted to make agroforestry possible within the existing land use concepts[4].

In the analysis of tree diversity in various agroforestry practices, the concepts of 'planned' and 'tolerated' diversity can help[5], as does the insight that agroforestry farm components may represent past + present + future value-determining elements (see Chapter 2).

20.2.2 Allometry and characterization of trees, soils, crops, livestock (what?, how?)

Research methods for characterizing biomass, carbon and nutrient cycling in agroforestry systems have been developed in parallel with those for other complex agro-ecosystems[6,7]. Tree biomass is generally derived from allometric relations with stem diameter established for trees growing in close stands[8,9], but may need to be adjusted for solitary trees[10] and shrubs[11]. A specific interest in agroforestry is in the belowground part of tree biomass, using common root research methods[12], as well as methods based on (fractal) woody root architecture derived from 'proximal root' diameters and angles[13]. Gains in prediction efficiencies of belowground biomasss allometry over 2000 measurements of belowground biomass using species-specific models were negligible[14]. However wood density, though not constant within a species, does vary by species and global data bases can be used in widescale assessments (compare Chapter 2).

20.2.3 Complementarity and competition in tree-soil-crop interactions (where?, how?)

Early research on agroforestry tried to understand under what conditions complementarity between tree and crops (or more rarely trees and pasture) could exceed competition for a net positive effect on usable biomass production[15] (see Chapter 5). Process-level studies led to models that linked tree and crop architecture and physiology to soil and climatic conditions, as well as management[16]. Experiments used a 'replacement series' concept of earlier intercropping analysis, with adjustments for the different sizes of trees and crops. However, a number of adjustments were needed to make the agronomic tradition of replicated small-plot trials with randomized treatment allocation feasible. Plot sizes had to be considerably enlarged, and the interference above- (e.g. microclimatic effects) and below-ground (horizontally scavenging roots) called for wide buffer zones between plots (linked to tree height) and/or root trenching to reduce the scavenging[17].

Agronomic field experiments have been used for more and 150 years based on the hypothesis that there is a 'treatment effect' to be estimated by rejecting a 'No-effect' null-hypothesis, in the face of spatial and temporal variation in yield. Statistical techniques (pioneered by Fisher in the analysis of the long-term fertilizer trials at Rothamsted, UK) were targeting a precise and unbiased estimate of the effect size, while variation around the effect was seen as 'error'. Factors that could possibly increase variation were controlled as much as possible, while replication and averaging reduced the impact of the variation. A major assumption thus was that spatial variability of fields makes it harder to assess 'treatment effects' but would not influence the treatment effect as such. This assumption has been rejected where the 'safe operating space' between adequately fertilized crops and nutrient leaching beyond water quality standards is involved[18]. Spatial variability within fields that are managed as a single unit can increase the likelihood of positive 'agroforestry effects' by meeting a risk reduction criterion based on correlation between component yields[19].

A recent surge of interest in heterogeneity effects 'beyond averages' has focussed on risks of technology success and failure[20]. The definition of the population of contexts to be used in assessing risks proved to be controversial and open to multiple ways of data interpretation[21,22,23].

Development of measurement methods were important for understanding of processes plot-level interactions: sap flow, root activity, litter and root decomposition, easy logging of light and water, as reviewed in chapters 4 and 5. During the first two decades of ICRAF many of the contentions in research methods, particularly experimental design, centred on trying to use agronomic experimentation paradigms when they could not be adapted to agroforestry. When looking at a specific process-based hypothesis then it was (still is) feasible, with enough ingenuity, to come up with a viable experiment. But much agronomic practice is based on empirical experimentation to derive 'recommendations' for farmers. AF research was dominated by agronomists who tried to use the same methods and often failed. They failed not only because of plot size and land heterogeneity problems, but also because of system interactions, challenges to defining sensible 'controls' or baselines, the genetic variably of the trees, the edges that should and should not be included. More fundamentally, the issue probably was failure to identify useful questions.

20.2.4 Production ecological perspective on yield gaps (where?, how?)

Where the focus is on annual (or tree) crops, the concept of a 'yield gap' between actual and potentially achievable yields has become popular[24]. It commonly partitions the yield gap in three parts, attributed to water, nutrient and pest & disease limitations, respectively, suggesting that yield gap closure depends on pest & disease control, fertilization and irrigation & drainage (Fig. 20.1.A). As the distinction between these three limitations may reflect the skill of crop simulation models in predicting effects of interventions, rather than a real hierarchy and independence of the three types of cause, two alternative interpretation of yield gaps split them i) in the gap between potential and attainable under economically justifiable use of inputs (of any type), and a management-defined gap between actual and attainable yields, and ii) in a gap due to environmental rules that prevent Y_{pot} being achieved, and a sustainable intensification gap that indicates progress possible beyond Y_{act}.

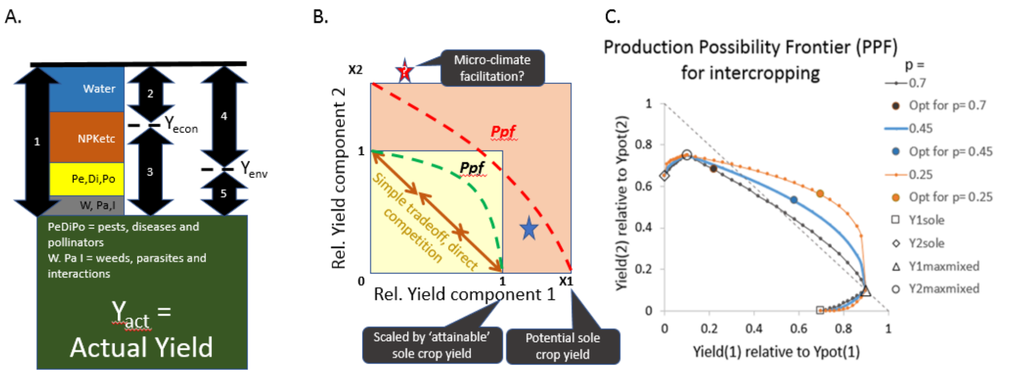

Figure 20.1 A. Five ways of interpreting 'yield gaps', between four yield concepts[a]; ; B. Attainable and potential sole crop yields as two possible reference points for production possibility frontier (ppf) derivation and calculation of Land Equivalent Ratio (LER); C. Possible ppf shapes where attainable yields of sole crops are exceeded by complementarity effects

These concepts of actual, attainable and potential production levels are also relevant for the way intercropping experiments are analysed. In the tradition of Land Equivalent Ratios, where the combined yield of two (or more) crops in combination is compared with that of the respective sole crops, it is common practice to use actual (or attainable) sole crop yields. LER values of around 1.2 are feasible, especially where a longer effective cropping season is achieved[25]. In the combination of timber and food crops, in settings where the trees can benefit from fertilizer inputs to the crop while sole-tree fertilization is not economically

[a] $\mathbf{Y_{pot}}$ = Potential Yield for specific **G**enotype in radiation, temperature&[CO_2] **E**nvironment and ***maximized*** **M**anagement ; $\mathbf{Y_{econ}}$ = Yield level of Econ farmers, economically ***optimized*** M ; $\mathbf{Y_{env}}$ = Yield meeting all Environmental regulations

feasible, LER values up to 1.8 have been suggested[26]. Microclimatic effects can also lead to high LER values in suboptimal climates[27]. The overall conclusions about farm-level benefits of specific forms of agroforestry thus depend as much on the choice of controls (or comparators), as they do on the yields achieved in experiments.

20.2.5 Participation by researchers in farmer experiments (how?, who?)

The experiments and analysis discussed so far have not explicitly included the farmer and her management choices as part of the system and within the boundary of analysis. Keeping the farmers out is a way to 'control' variation (and increase the specificity of definition of treatments applied) but contributes to 'yield gaps' between experiments and farm practice on often more heterogenous plots. Keeping the farmer and management choices explicitly involved in the experiments makes the data obtained more realistic, even though they will likely be harder to interpret[28].

Recommendations for research methods for multistrata agroforestry systems with coffee and cacao[29] included (but all may need to be re-evaluated with current understanding):

- Research focused on characterization and production studies (of crop and timber including border areas) of traditional systems should assess the whole plot, including the border areas, and not some subjectively selected central area which supposedly represents unit area productivity.
- Uncontrolled crop, tree, and management heterogeneity limited extrapolation of early on-farm research results to other farmers' fields.
- On-station research included the use of systematic spacing designs to test extreme shade tree density treatments of coffee. Most nutrient cycling studies were also carried out on-station, using service and timber shade species over coffee and cacao to evaluate the ability of these agroforestry systems to maintain nutrient reserves and diversify production.
- Plot size (even 36 × 36 m) was limiting for long term research because of inter-plot interference, both below- and above ground, when using fast growing, tall timber trees as shade. These experiences suggest a minimum plot size of 2,500 m^2 . Individual tree designs and tree-crop interface studies (e.g. regression analysis of data taken along transects) are promising experimental/sampling approaches that need further development.

Participatory research that combines the knowledge of farmers and researchers promotes the development of a variety of agroforestry options that may meet the various needs of different farmers, and thus exploits one of the greatest strengths of agroforestry - its plasticity[30]. On-farm research has been a main driver of agroforestry research over its four decades[31,32,33] , as it was realized early on that to study existing agroforestry systems and their complexity, to learn from farmers' knowledge and experience, to access representative site conditions, or to elicit farmer evaluation of new technology all required such direct farmer-researcher interaction. Methods were used and adapted based on concepts and experience from other areas of research. New elements added by agroforestry included participatory tree species selection and improvement (see Chapters 2 and 3) and linking community seedling production to on-farm research.

Figure 20.2 Clarity of terms and definitions is easily assumed, but higher-level categories are often interpreted to include different specific entities

20.2.6 Farm economics

Interest in the economic side of agroforestry as integral element of many studies emerged in the first agroforestry decade[34]. After a phase of literature reviews, qualitative, and purely descriptive quantitative research based on small sample sizes, and often struggling with the categorization of goods and services (Figure 20.2), more rigorous statistical analyses of better and larger data sets started to emerge twenty years ago[35]. Methods for valuing agroforestry systems[36] require a good understanding of farmer decision making, rather than being objectively measurable quantities that guide decision making and scaling up of agroforestry practices[37]. There often is a two-way adjustment between 'rationality' concepts (which can well go beyond profitability) and 'decision making' (Fig. 3). Financial analysis of agroforestry practices needs to be adapted to farmers' objectives such as feeding livestock, providing firewood, or improving soil fertility[38,39]. Agroforestry practices provide by-products and services which are difficult to value, such as border markings, improved animal health and calving rates, firewood and curbed soil erosion in the case of fodder shrubs, or improved soil structure and moisture retention in the case of improved fallows. Rotational woodlots may reduce deforestation, as home-produced firewood is substituted for firewood cleared from the forest and trucked to the farm. As part of the rotational woodlot experiments in Shinyanga (Tanzania; compare chapter 7), researchers were in for a surprise. After 4 or 5 years of fast growth, researchers plan was to cut down the trees for firewood and crop the area assumed to have improved soil fertility. But farmers saw multiple other options, such as coppicing for regrowth, use as a grazing reserve, letting the trees grow on to produce timber or simply leaving them because they look nice.

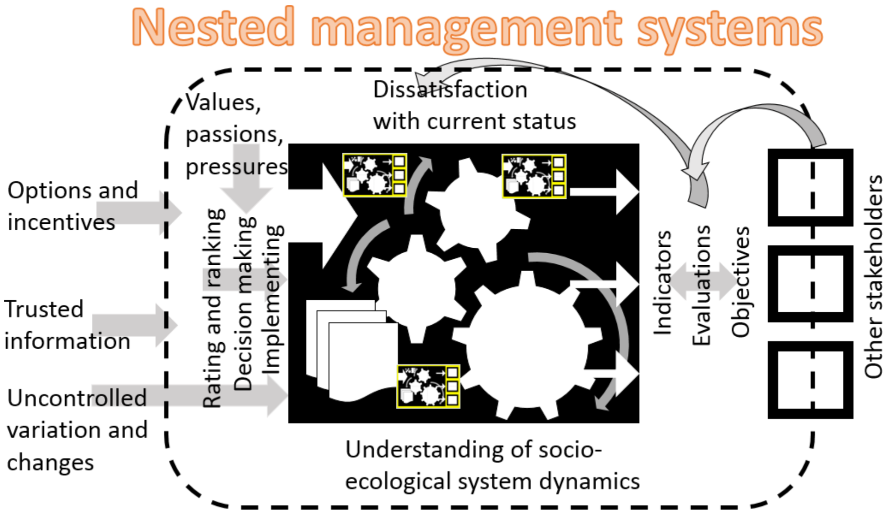

Figure 20.3 Understanding of decision making as a management concept, driven by a contrast between actual performance and objectives, within the range of options known, rated and ranked

For many AF systems the low requirements for financial investment and likely reduction of risk in the face of climatic variability form additional considerations. Accounting for all direct costs and benefits in existing practices, together with sensitivity analysis to variation in the woody component, can, after choosing an appropriate discount rate for future benefits relative to current costs, lead to Net Present Value (NPV) comparisons, as well as 'returns to labour'. On-farm trials are useful for measuring benefits, because agroforestry practices can be readily compared with alternative ones[40]. Researcher-designed, farmer-managed trials appear most appropriate for financial analysis. Because these trials are designed by researchers (in consultation with farmers), non-experimental practices (such as weeding) are relatively uniform across treatments. This uniformity ensures that differences among treatments are caused by the practices being tested and not by extraneous variables. The standardization of plot size and purchased inputs in such trials also helps facilitate the collection of data on the use of labour. However, labour (e.g. person days of work) remains one of the most complex inputs to measure, as the number of hours of actual work per day varies and there are issues on how to account for weather or other conditions that prevented a planned labour input to happen, but also prevented alternative use of the time allocated. The problems in measuring and valuing labour in small farm contexts are not restricted to agroforestry research[41].

In contrast, farmer-designed trials vary greatly among farms in size, types of inputs, and management and thus contain several feedbacks from farmers' perceptions of profitability. In farmer-managed trials measurement of inputs and outputs more realistically reflects farmers' experiences with the practices, interacting with 'objective' profitability[42]. Tenure is not only a precondition for planting trees but can also be obtained by doing so[43], further complicating the assessment of 'profitability'. One more complication results from the time lag between input and benefits, with little evidence that economists' use of discount rates is connected to farmers' ways of making decisions. Focus group discussions can be used to check the rational and estimate the key elements of cost benefit comparisons in a participatory way (see LUPA method described below), but doesn't circumvent the need for replication and statistical rigour in subsequent analysis.

20.2.7 Adoption through adaptation: research in development (what?, where?, how?, who?)

Local and indigenous knowledge, beyond its role in economic decision analysis, has been a long-term interest in agroforestry research, with early articulation of the need to combine qualitative and quantitative, participatory but researcher-led, and formal data and informal collection methods as they provide complementary and supplementary perspectives on a complex reality[44].

Encyclopedia-style enumerations of ethnobotany (and ethnozoology) of all the plants (and animals) involved in forest/agroforestry/agriculture transitions showed a rich diversity, and helped in understanding how generic 'local' knowledge can be (restricting 'property rights' claims to such knowledge in many cases). A different set of methods was developed for describing and analysing explanatory knowledge, seeking to understand the 'logic' became a separate line of research[45,46,47,48]. A combination of enumerative and explanatory knowledge was used, for example, in assessing shade composition of multistrata coffee systems in Mexico[49]. For selection of candidate species of the local forest flora suitable for dry-season fodder banks a recent analysis used three types of knowledge: farmers, bromatological science and cows (in their actual feeding behaviour)[50].

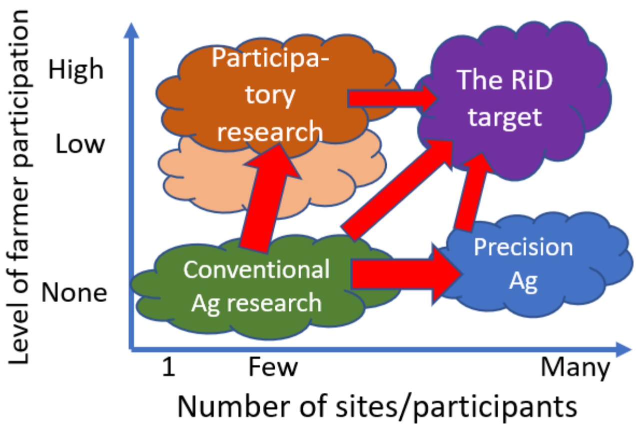

Figure 20.4 Trends in agronomic experiments towards more inclusion of site variability and farmers, with 'research in development' (RiD) as target to reduce 'implementation gaps'[51]

Overall, current trends in field-level experimentation (Fig. 20.4) is towards 'Large N, participatory' trials that include as much of the variation in context as is feasible within the likely 'extrapolation domain' of a candidate technology to be assessed[52]. The challenges of working with many farmers who may all give a different interpretation to the treatments to be tested are managed in part by explicitly describing and analysing farmer ratings and rankings, alongside measurements as part of experiments[53].

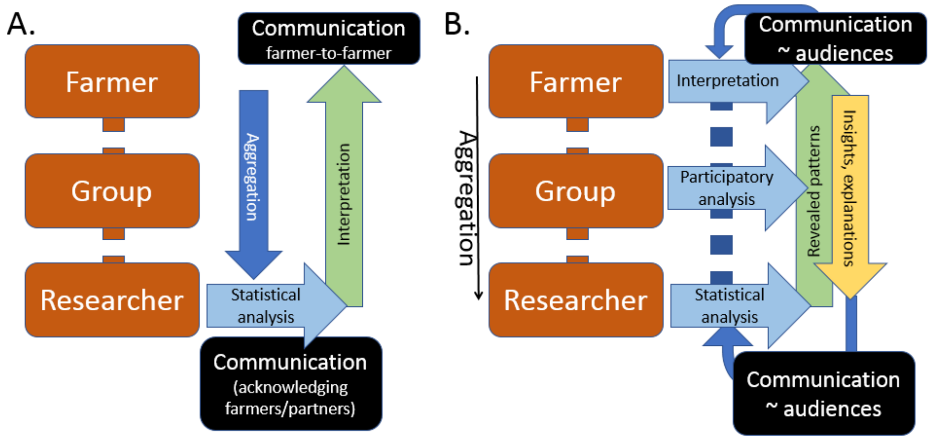

Figure 20.5 A. Conventional approach to data from on-farm experimentation with researchers aggregating data, doing a statistical analysis and communication results back to farmers. B. Alternative iterative approach that incorporates farmers' individual and group-level perspectives and explanations.

A decade ago, a method review for multistrata system research found[54] little evidence of research on complexity at several scales, but limitations were not only methodological. There has been at least some progress since that time. For example, the diversification trajectories in the cocoa belt of West Africa were found[55] to differ between men and women with the most profitable trajectory controlled by men, and gender-based inequalities negatively impacting agricultural productivity.

20.3 Methods for research of landscape-level paradigm AF2

In the first agroforestry decade, the implementation of newly developed agroforestry techniques in various places all over the world, led some researchers already to the realization that[56]:

- Problem solving cannot be limited to the individual farmstead or plot level from a social and ecological point of view,
- Existing landscapes present both constraints and opportunities for further land development,
- More appropriate agroforestry techniques can be applied by classifying landscape units and existing land-use systems,
- Planning is necessary because agroforestry requires a holistic perspective to be sustained during the long time necessary for implementation.

Yet, a 'landscape approach' took some time to become formally articulated[57],[58] and embraced[59]. The choice of research methods has been directly linked to the conceptualization of system components, interactions and boundaries. Three concepts that found wide application are the ecosystem structure/function/services cascade (Fig. 20.6A), the drivers, pressures, states, impacts, response (DPSIR) framing of causal chains (Fig. 20.6B, 20.7) and the options, context, issues, goals cycle across scales (Fig. 20.6C, 20.6).

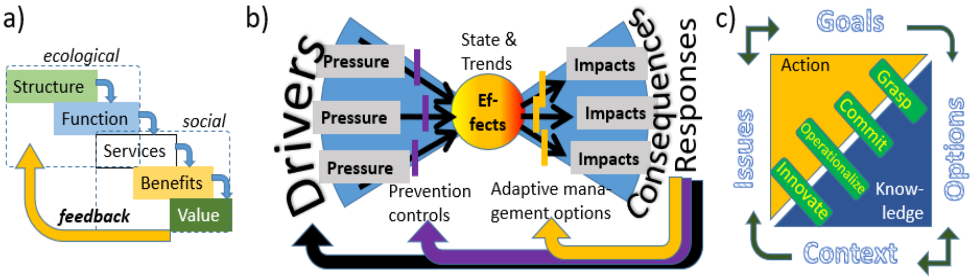

Figure 20.6 Analytical frameworks for landscape level understanding of agroforestry (AF2)

Various typologies for ecosystem services have been used in agroforestry research[60,61]. Quantification of lateral flows became the basis for understanding non-area-based scaling rules for processes such as net sediment movement by erosion[62,63]. New metrics provided ways of analysing evidence in the longstanding debate on flooding risk and tree cover[64].

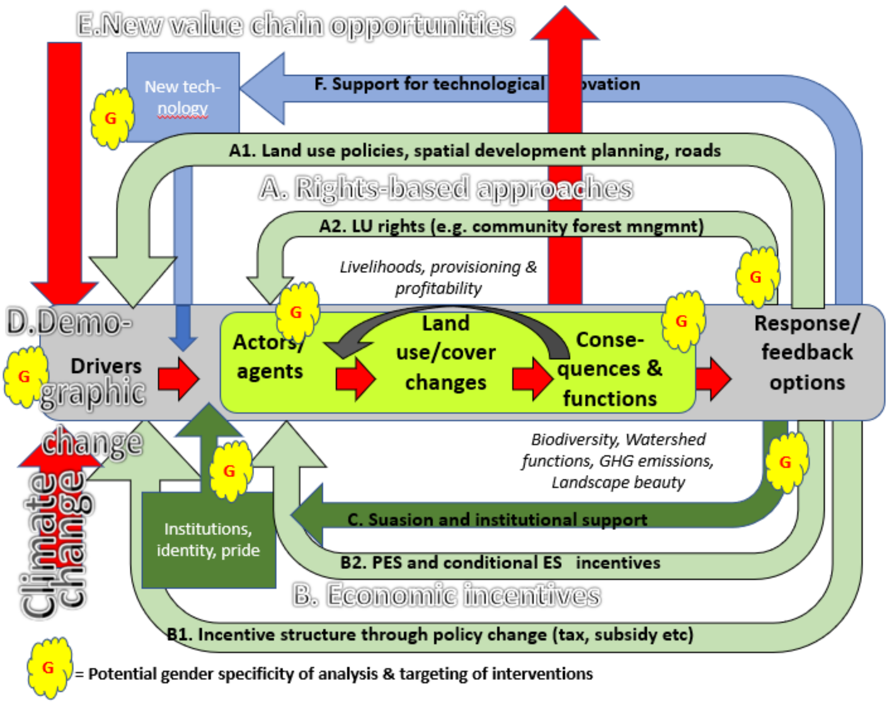

Figure 20.7 Embellishment of the Drivers-Pressures-State-Impacts-Responses (DPSIR) framework with multiple feedback loops and external influences[65]

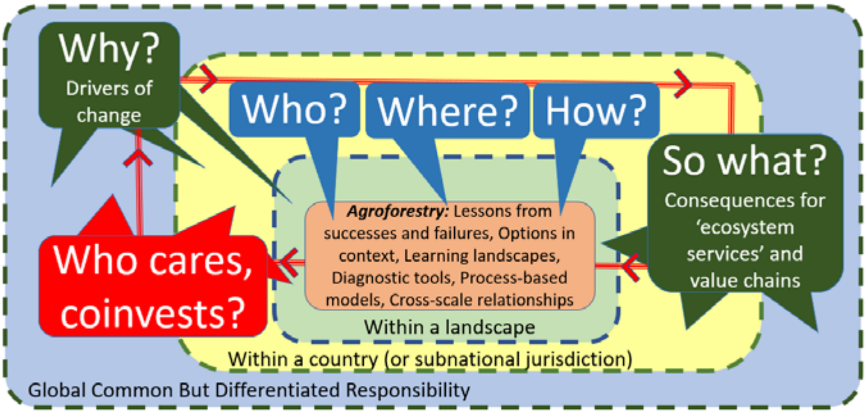

Figure 20.8 Cross-scale relations in the determinants and consequences of agroforestry land use choices

The landscape scale of Social-Ecological Systems is a meeting point for bottom-up local initiatives to secure and improve livelihoods from agriculture, agroforestry and forest management, and top-down concerns and incentives related to respecting planetary boundaries to human resource use[66]. Sustainable development goals require a substantial change of direction from the past when economic growth was usually accompanied by environmental degradation, with the increase of atmospheric greenhouse gasses as a symptom, but also as an issue that needs to be managed as such. In landscapes around the world, active learning takes place with experiments that involve changes in technology, farming systems, value chains, livelihoods' strategies and institutions.

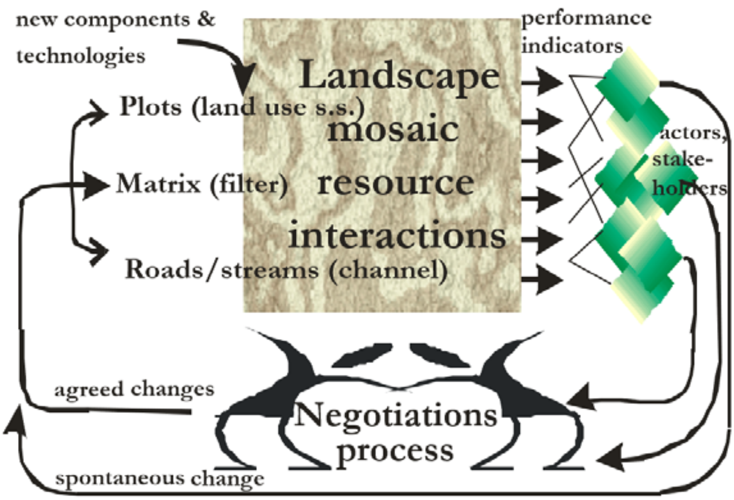

Figure 20.9 Early portrayal of Negotiation Support Systems (compare Chapter 9) as dependent on shared understanding of landscape mosaic-resource interactions as perceived by multiple stakeholders, and a negotiation process for planned change (in the face of spontaneous change)

An overarching hypothesis that is being tested is: Investment in institutionalising rewards for the environmental services that are provided by multifunctional landscapes with trees is a cost-effective and fair way to reduce vulnerability of rural livelihoods to climate change and to avoid larger costs of specific 'adaptation' while enhancing carbon stocks in the landscape.

Such changes can't come overnight. A complex process of negotiations among stakeholders is usually needed. The divergence of knowledge and claims to knowledge is a major hurdle in the negotiation process.

A collection of tools (Box 20.1) - methods, approaches and computer models - was shaped by over a decade of involvement in supporting such negotiations in landscapes where a lot is at stake. The tools are meant to support further learning and effectively sharing experience towards smarter landscape management. The terminology of Negotiation Support Systems (NSS)[67,68] emerged as complement to Decision Support systems that target a single decision maker.

The Land Degradation Surveillance Framework (LDSF)[69] is primarily based on 'objective' 'ground-truthing, remote sensing and advanced processing of large data sets[70]. In doing so it deliberately (and makes a bias-reducing virtue of) sampling land as if people are not involved. While this is fine for some questions (e.g. overall extent of land with specified biophysical properties), it may not be the most effective and efficient way to unpack social x biophysical interactions. Field tests suggest that land users may not share the same priorities, in terms of where, when and how to address degradation, with other actors involved in restoration initiatives, which implies a need for negotiation, and suggests that impacts of restoration activities are likely to be socially differentiated[71].

Games[72] and Agent-Based Models (ABM's) have become important tools for understanding the social interactions that shape landscape-level land use decisions (Fig. 20.8).

Auctions for economic incentives for enhancement of ecosystem services[73,74] have become a next step, beyond 'games', to explore the way land use decisions involving agroforestry can be 'nudged'.

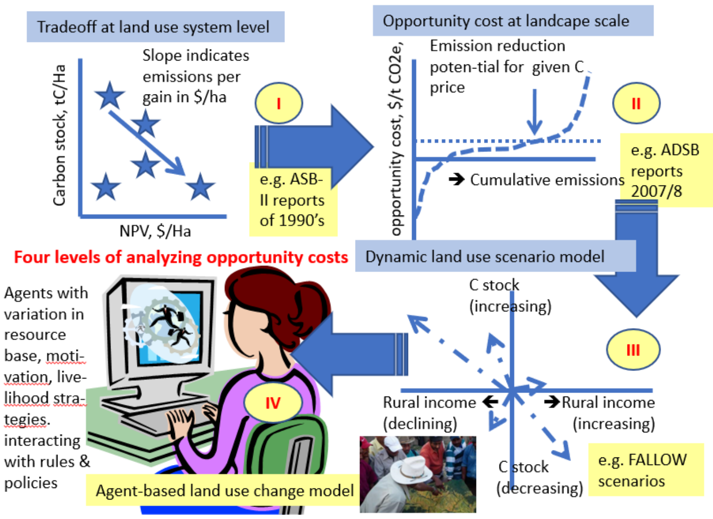

Figure 20.10 Four ways of analysing opportunity costs of retaining landscape-level carbon stocks: I. trade-off between NPV and time-averaged C stock of land use systems (RACSA plus LUPA method in Box 20.1), II opportunity cost curves based on actually observed land cover change (adding ALUCT data, using ABACUS), III. Using dynamic land use change models such as FALLOW, IV. Using agent-based land use change models that include actor variation.

Box 20.1 Negotiation Support Systems toolkit[75]

I. Understanding context: multifunctional landscape mosaics

- Participatory landscape appraisal (PaLA)
- Participatory analysis of poverty, livelihoods and environment dynamics (PAPoLD)
- Rapid appraisal of drivers of land-use change (DriLUC)

II. Lives, land use and livelihoods: trees, agroforestry technology and markets

- Rapid appraisal of agroforestry practices, systems and technology (RAFT)
- Local ecological knowledge: agroecological knowledge toolkit (AKT5)
- Land-use profitability analysis (LUPA)
- Rapid market appraisal (RMA)
- Gender roles in land use and value chains (GRoLUV)
- Tree diversity and tree–site matching (WhichTreeWhere?)
- Gender perspectives in selecting tree species (G-TreeFarm)
- Access to trees of choice (NotJustAnyTree)
- Climate-change opportunities offered by local trees (CoolTree)
- Tree and farming system resilience to climate change and market fluctuations (Treesilience)
- Functional branch analysis (FBA): tree architecture and allometric scaling
- Simple light interception model (SLIM)
- Water, nutrient and light capture in agroforestry systems (WaNuLCAS): at the plot level
- Spatially explicit individual-based forest simulator (SExI-FS): for management of agroforests
- Adopt and learn: modelling decision making and information flow

III. Landscape: ecosystem services, trade-offs

- Analysis of land-use and -cover trajectory (ALUCT)
- Trade-off matrix between private and public benefits of land-use systems (ASB Matrix)
- Rapid hydrological appraisal (RHA): watershed functions and management options
- Rapid landslide mitigation appraisal (RaLMA): managing trees for improved slope stability
- Participatory water monitoring (PaWaMo)
- Rapid agro-biodiversity appraisal (RABA)
- Quick biodiversity survey (QBSur)
- Rapid carbon stock appraisal (RaCSA)
- Reducing emissions from peatlands (REPEAT)
- Re-assessing oxygen supply and air quality (ROSAQ)
- Biofuel emission reduction estimator scheme (BERES): land-use history, production systems and technical emission factors
- Generic river flow at landscape level (GenRiver)
- Flow persistence (FlowPer)
- Rainfall Simulator (RainyDay) and Spatial Rainfall (SpatRain)
- Land-use Change impact assessment (LUCIA)
- Polyscape
- Forest, agroforest, low-value landscape or wasteland (FALLOW)
- Ecological corridors (ECor): a distributed population model with gender specificity
- REDD Abacus SP

IV. Transformations: governance, rights

- Rapid land tenure assessment (RaTA): understanding land tenure conflicts
- Why No Tree? (WNoTree) analysis of agroforestry constraints
- Fair and efficient REDD value chains allocation (FERVA)
- Rapid assessment of institutional strengths, networks and actors (RISNA)
- REDD/REALU site-level feasibility appraisal (RESFA)
- Trade-off analysis for land-use scenarios (TALaS)
- Scenario tools: land-use planning for low-emissions development strategies (LUWES)
- Capacity-strengthening approach to vulnerability assessment (CaSAVA)

V. Negotiation support as process

- Assessing and adopting social safeguards in all planned programs (AASSAPP)
- RUPES role-play game (RPG)
- Conservation auction and environmental services' enhancement (Con$erv)
- Multi-scale payments-for-environmental services' paradigms (MuScaPES)

20.4 Methods for research of policy-level paradigm AF3

Policy-oriented agroforestry research starts with listening to current discourses in policy debates, and trying to present existing knowledge in the 'flavour of the day'[76,77]. Rather than assuming either 'science' or 'policy' has a monopoly on 'truth', the tradition of boundary work[78] (Fig. 20.8) has emerged as a specific way of analysing the interactions. Research methods on 'discourses' that combine qualitative and quantitative aspects, such as the Q-method[79,80] have become part of the agroforestry research toolbox. To further describe and understand changes in public attention issue cycles, scales for four parallel changes (grasp, commit, operationalize, innovate) have been proposed, awaiting further testing (Fig. 20.9).

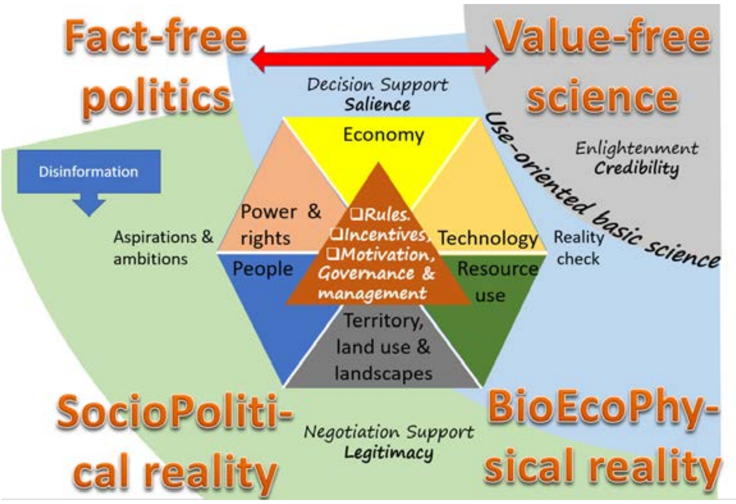

Figure 20.11 Three aspects of knowledge (credibility, salience and legitimacy) in relation to boundary work between Bio-Eco-Physical reality, value-free science, fact-free politics and socio-political reality

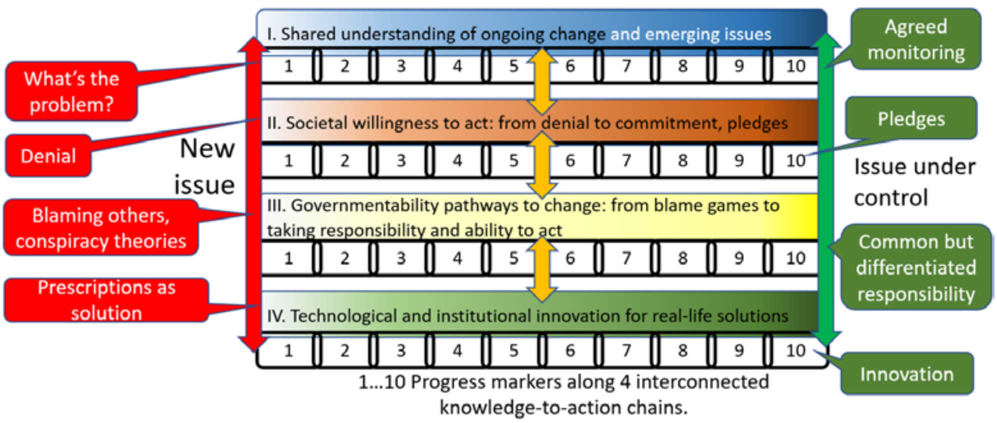

Figure 20.12 Four parallel processes that jointly determine progress on public attention issue cycles in terms of shared understanding, commitments, implementation and innovation[81]

There has been considerable effort and progress in 'true-cost accounting' in agrifood systems[82]. Apart from many issues at the operationalization level, such methods, however, stay within a narrowly financial concept of value that cannot be universally applied. As discussed by Mazzucato[83] (2018), in "The value of everything: making and taking in the global economy", the concept of value has been central to economic theory in the past, but became (in the transition from 'classical; to 'neoclassical' economic theory) replaced by market prices, losing the distinction between the creation of value and the appropriation of 'rent'. Her analysis tries to revive concepts that the grandfathers of economic science introduced, but that subsequently became lost by a 'monetary value only' framing. These include Adam Smith (who included moral judgements in the distinction between 'rent' obtained from control and 'value' obtained from production), Ricardo (who distinguished value concepts for reproducable from that for non-reproducable goods and services) and Pareto (who focussed on consumer satisfaction as driver of economic decisions). The new school of behavioural economics[84] has established a 'bottom-up' perspective on actual decisions made, often contrasting with the 'rationality' assumptions that dominated economic analysis in the past. Perceptions matter at least as much as 'facts', and 'communication strategies' are at the core of AF3 research, rather than an afterthought. Repetition of messages and attention to the persons voicing them (e.g. in public panels) is key to success. The ASB Partnership developed a specific format for its policy briefs (around four salient findings and their policy implications as a 1-pager, followed by the supporting evidence and references) that according to existing evaluations matched expectations of at least part of the target audience (Box 20.2). Attempts were made to stay as close to 'current debate' as feasible, often opportunistically defying the mandates of advance project planning.

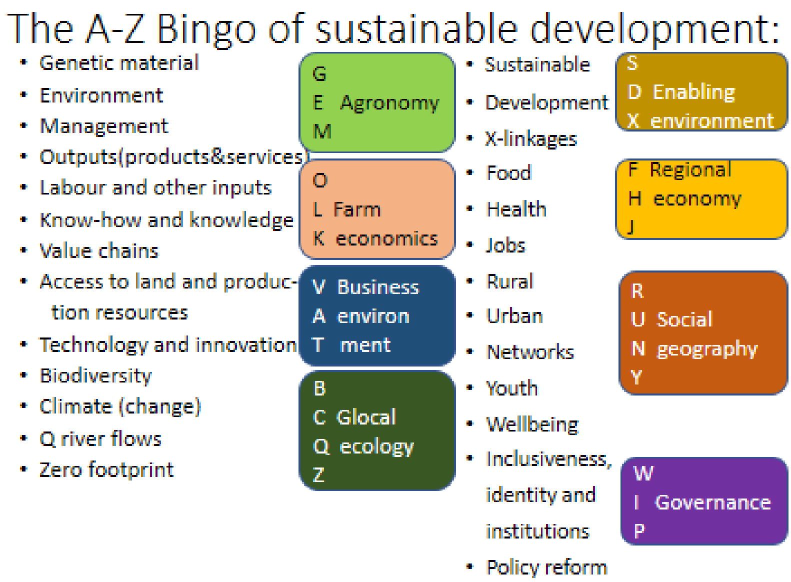

Figure 20.13 With the realization that the AF3 concept requires a basic understanding of a large number of subsystems and their interactions, an alphabet Bingo game can help to list and group 26 aspects that modern agroforestry research needs to be at least aware of

Table 20.1 Achievable goals for researchers interracting with policy issue cycles

Stages of Policy Cycle	Researcher goals	Impact looks like...
Problem alert	Spotting new social and environmental problems or phenomena that (someone believes) limit progress to development goals such as SDGs	Raised interest and concern among researchers (and others? Activists?)
Problem scope and basis	Understanding: - Extent of the problem (areas, people affected) - Drivers and mechanisms - Connections to current or new theory	Either: Increasing numbers of people aware of and understanding nature of the problem and why it matters Or (if it turns out to be an unimportant problem): Efforts redirected to areas with more potential effect
Potential solutions and interventions	Show that there are actions that will alleviate the problem and policies that will promote those actions	Pilot projects that excite people, increase demands, generate more nuanced research
Political Agenda setting	Get relevant policy makers interested and pushing towards policy change	Convincing demonstration that problem impacts on things they care about and that policies proposed will help
Policy formulation	Systematic investigation of a problem and thoughtful assessment of options and alternatives	Convincing policy options formulated
Selection Process	(Decisions making) Prioritization of available options given, cost/benefits and compromise across diverse stakeholder interests	New policies adopted and followed
Implementing	Introduce actions based on policy aimed at changing the problem	Change in state of problem
Evaluation and monitoring	Confirm that the problem is under control (or tracking in the right direction) and remains so	Problem is solved – extent of 'fix' and role of the policy.

New insights in public/policy issue cycles lead to many ways of targeting stepwise progress towards a final impact of reducing the intensity of problems identified, but there often is the challenge that the time-line of research is such that an issue cycle has moved on by the time results have been obtained (let alone analysed and published). Without claiming the arrogance of foresight, research design will have to try to anticipate what might emerge, and convince its funding sources that investment is needed. As there seems to be no limit to the number of subsystems and associated knowledge with which AF3 research may have to interact (Fig. 20.13), the conventional concept of a 'generalist' needs to be expanded, with network abilities to quickly team up with a wide range of specialists.

Box 20.2 Samples of Policy Briefs produced by the ASB partnership in the tropical forest margins[85,86]

Generic sustainable development concepts

53. Minimizing the footprint of our food by reducing emissions from all land uses.

50. Trees as nexus for Sustainable Development Goals (SDG's): agroforestry for integrated options

47. Ecological rainfall infrastructure: investment in trees for sustainable development

46. Transforming REDD and achieving the SDGs through support for adaptation-mitigation synergy

42. The ASB Policy Brief Series: Reflections from Twenty Years of ASB Partnership

26. Agroforestry in REDD+: Opportunities and Challenges.

25. Drivers and consequences of tropical forest transitions: options to bypass land degradation?

23. On-farm timber production for emission reduction with sustainable benefits at the tropical forest margins.

19. Linking scientific knowledge with policy action in Natural Resource Management.

17. Emissions Embodied in Trade (EET) and Land use in Tropical Forest Margins.

16. Reducing emissions from deforestation inside and outside the 'forest'

15. If we cannot define it, we cannot save it.

14. Perceptions of Fairness and Efficiency of the REDD Value Chain

13. Reducing Emissions from All Land Uses (REALU): The Case for a whole landscape approach.

10. The Opportunity Costs of Avoiding Emissions from Deforestation.

8. Deforestation and the multiple functions of tropical watersheds.

7. Participatory development of methods

6. Deforestation has no single cause but is the outcome of a web of factors whose mix varies greatly in time and space.

5. Balancing development and global concerns over the environmental consequences of tropical deforestation

Country-specific land use issues in relation to climate change discourses

51 Peat and land clearing fires in Indonesia in 2015: Lessons for polycentric governance.

49 When can oil palm production qualify for a 'carbon neutral' claim?

45 Stopping haze when it rains: lessons learnt in 20 years of Alternatives-to-Slash-and-Burn research in Indonesia

41. Planning for low emissions developments efforts in Ucayali, Peru.

40. Climate smart landscapes: Integrating mitigation; adaptation and development in Shinyanga region Tanzania.

39. Linking development pathways and emission reduction at local levels: An analysis of feasibility in the Efoulan municipality, Cameroon

38. How feasible is a landscape approach to REDD+ in Vietnam?

36. Reassessing peat-based emissions from tropical land use.

35. Land-use planning for low-emission development strategies (LUWES).

34. Reducing emissions from all land uses in Indonesia: motivation; expected funding streams and multi-scale policy instruments.

33. Hot spots in Riau; haze in Singapore: the June 2013 event analyzed.

32. What drives reforestation in Viet Nam.

31. REDD+ readiness in Vietnam: a rapid assessment and its implications.

30. Incentives for Reducing Carbon Emission from Illegal Logging in Cameroon.

24. Why smallholders plant native timber trees: lessons from the Philippines.

22. Recognizing traditional tree tenure as part of conservation and REDD strategy: Feasibility study for a buffer zone between a wildlife reserve and the Lamandau river in Indonesia's REDD Pilot Province.

Box 20.2 Samples of Policy Briefs produced by the ASB partnership in the tropical forest margins[85,86]

4. Smoke pollution is a serious public health problem and disrupts livelihoods in large areas of the humid tropics.

3. Removing restrictions on the marketing of timber from agroforestry systems in the humid tropics: a rare 'win-win'

2. Creating fair and effective policies and institutions to govern land and tree tenure.

21. Hot spots of confusion: contested policies and competing carbon claims in the peatlands of Central Kalimantan; Indonesia.

20. Co-existence of people and orangutan in Sumatra. Stabilising gradients for landscape multifunctionality

18. Stewardship agreement to reduce emissions from deforestation and degradation (REDD) in Indonesia.

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