2.4. Flagship 4. Landscape dynamics, productivity and resilience

2.4.1 Flagship Project Narrative

2.4.1.1 Rationale and scope

Closing the multi-functionality gap

Day-to-day choices and decisions in tropical landscapes reflect the grand challenges to humanity, meeting the Sustainable Development Goals (SDGs) within the constraints of planetary boundaries. Use of land for production of tradable or locally consumed goods is traded off against the imperatives of environmental integrity of water, nutrient and carbon cycles and biodiversity conservation. Issues on human rights, tenure, poverty, migration and lack of options for young people add to the complexity. Actual landscapes tend to operate substantially below their potential ('production possibility frontier'). It is this '***multi-functionality gap'*** that FTA Flagship 4 addresses[1]. The Flagship project supports negotiations of multi-functionality at landscape scale within a SDG framework. It does so by combining: 1) observations of changes in forest cover, land use and the presence of trees on farms, with 2) consequent changes in the provision of ecosystem services (provisioning, regulatory, cultural, supportive/regenerative), and 3) the search for alternatives, design of policy instruments to nudge decision-makers towards reduced externalities, scenario evaluation and multi-stakeholder platforms for agreeing on changes to close the multi-functionality gap. Exploration of the concepts and principles goes hand-in-hand with action research to achieve change in complex contexts.

Vision

Multifunctional landscapes with trees, agroforestry and forests are managed on the interface of public and private sector actors to meet the SDGs of their inhabitants and external stakeholders.

Approach

Landscapes are socio-ecological systems that influence and constrain the way actors convert, retain and/or manage forests and trees on farms and the way this in turns contributes to or reduces human well-being and resilience. It is at the landscape scale that: (i) households seek ways to improve their on-farm and off-farm livelihoods (interacting with out-of-landscape revenue); (ii) governance mechanisms aggregate up to the currently insufficient attempts at managing the 'commons' that shape future earth; and (iii) the private sector interacts with dynamic, globalizing value chains. The wide range of socio-ecological conditions represented in the global network of FTA Sentinel Landscapes, for example, provides a framework for understanding what optimizing the design and management of multifunctional landscapes may entail.

The research targets a deeper understanding of the **forest or tree cover transition** framework of historical pathways, spatial gradients and shared global drivers, and an **ecosystem services** and **multiple capitals** perspective on trade-offs between provisioning services (goods) and the regulating, cultural and supportive services that tend to be externalities of decision-making. A central tenet for this FP is that adaptive management of landscapes, negotiated in a complex socio-ecological system context, can be effectively supported by:

1. Estimation of current stocks, observations of actual change (incl. forest/tree cover, demography) and inference on drivers of change, ***[more evidence]***
2. Estimation of consequences of tree cover change and more inclusive interpretation of functions, ecosystem services and tradeoffs, ***[holistic interpretation]***
3. Innovation in search for technical and institutional (governance) solutions, ***[innovative]***
4. Comprehensive analysis of scenarios of proposed solutions in the context of external trends and expected global change, ***[prospective]*** and
5. Explicit, early involvement of stakeholders that can shape political platforms of change in polycentric governance systems aimed at SDG attainment ***[change negotiation]***.

The two **Flagship hypotheses** in this context are:

1. a) Landscapes and their ecosystems provide goods, regulatory, cultural and supportive ecosystem services essential to sustainably support the livelihoods of their inhabitants.
   b) Most tropical landscapes today have sub-optimal design and management resulting in a big gap between the potential and actual multifunctional output of the landscapes.
   c) It is possible to significantly improve the design and management of the landscapes to close the multi-functionality gap.
2. Any generic theory of desirable change needs localization, given the global diversity in landscape patterns, path dependency of historical changes within the broad spectrum of governance options, wider economic linkages, and current gender equity and youth ambitions.

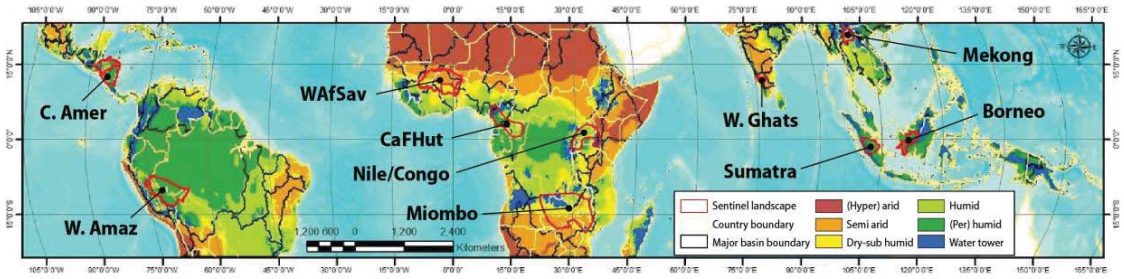
Scope and geography

Our main **research questions** and clusters of activity derive from this perspective on the body of scientific evidence on multi-functionality in practice. Our theory of change is built on a sequencing of four major research questions that can jointly lead to more informed decisions and negotiations at the landscape level, interacting with household and national or global-scale decisions, policies and discourses. These are:

1. What are the **current patterns and intensities of change** in tree cover?
2. What are the **consequences of such changes** for ecosystem function and services?
3. How does landscape diversity **contribute to human well-being and healthy diets**?
4. How can efficient and fair landscape governance emerge that influences **the generic drivers** and/or **community and household level incentives** to increase multi-functionality

To answer these questions in their local context, a network of landscapes selected to represent broad agroecological zones (Figure 1) is used for four clusters of activities: 1. Landscape observatories[2], 2. Landscape mosaics, biodiversity and ecosystem services, 3. Healthy diets from diverse landscapes and 4, Adaptive landscape institutions: “learning landscapes”.

[2] Previously termed Sentinel Landscapes by FTA.



Agroecological zone (indicative mean annual rain-fall range)	Target geography (Sentinel landscapes: most have multiple zones)	Human population density: (min)–mean–(max) km^{-2}; forest%[B]	ES issues related to dominant land uses[A]; **degradation** (loss of ecosystem services due to loss of ecosystem function)	Recovery, restoration, agro-forestation
Drylands: 17.6% of tropical area; 2.2% of tropical population (6.9 km^{-2}) 0% of SL area	No specific research landscapes, methodo-logical support for work in the Livestock and DCL CRPs where trees support drylands	No sentinel landscapes	Few high-value tree crops; overharvesting of trees for fuelwood; annual fires; overgrazing by livestock; wind erosion; irrigation agriculture islands of functioning subhumid with risk of salinization	Specific attention to migratory circuits and routes for wildlife and pastoralists
Semiarid: 16.9% of tropics; 15.2% of people (49.8 km^{-2}) 21% of SL area	**W. Africa Savanna** (Ghana/ Togo/ Burkina Faso/ Mali)	(6)–49–(1758) 0% forest (at >50% cover)	Location-specific opportunities for tree-based participation in global markets; overharvesting of com-mercial timber and within urban reach for charcoal; land clearing for crop production; annual fires; local climate effects of tree cover change.	Controlled use of remaining forests, legalization of woodfuel trade as basis for investment; recognition of mesoclimatic effects of tree cover in 'parklands' context.
Dry-Subhumid: 9.8% of area; 12.0% of people (67.68 km^{-2}) 20% of SL area	**E. African Miombo** (Zambia, Malawi, Mozambique)	(0)–23–(4727) 14% forest		
Water towers: 10.8% of area; 15.8% of people (80.8 km^{-2}) 15% of SL area	**Nile-Congo Water-towers** (Uganda /Kenya)	(0)–172–(17,025) 14%	Expansion of highland crops and vegetables; coffee, tea, cacao; overharvesting of commercial timber; highly vulnerable biodiversity (endemics); changes in local climate; modified water flows; erosion/ sedimentation; loss of soil C and nutrients	Recognition of specific hydrological functions, including attention for riparian zones as key to buffering, and ecological connectivity; incentives need to match downstream (incl. urban) interests
	S. Asia Water towers (W. Ghats in India)	(118)–240–(1360) 43%		
Humid forest: 19.7.2% of tropics; 22.0% of people (61.9 km^{-2}) 19% of SL area	**Mekong** (China, Laos, Vietnam, Thailand)	(7)–43–(301) 67%	Convertible to coffee, tea, cacao, rubber, bananas, oil palm, pasture. Overharvesting of commercial timber; connectivity loss ecological corridors; changes in local climate; soil compaction; erosion/ sedimentation; loss of soil C and nutrients	Shift from monoculture tree crops to diversified agro-forestry options; restoration of degraded pastures; spatially explicit forest restoration for biological corridor; changes in land tenure may be needed
	C. America (Nicaragua/ Honduras)	(0)–56 –(70) 63%		
(Per)Humid lowland forest zone: 25.2% of tropics; 32.9% of people (72.3 km^{-2}) 25% of SL area	**W. Amazon** (Peru/ Paraguay/ Brazil)	(0)–3–(228) 92%	Convertible to oil palm, rubber, pulp & paper plantations. Logging along rivers, and major roads; overharvesting of commercial timber; high biodiversity loss; erosion/ sedimentation; loss of soil C and nutrients; peatland issues	Opportunities for domestication and increased use of local resources may require change of rules for market access; changes in land tenure may precede ecological recovery
	CAFHUT (Came-roon/Congo/**DRC**)	(1)–33–(5622) 82%		
	Insular SE Asia (Sumatra/**Borneo**)	(0)–45–(8705) 58%, 73%		

A. Mining causes local ES loss in all zones; tree-based restoration options are differentiated by climate zone; while private-sector restoration is mandated in mining contracts, large areas of past damage require public restoration sources

B. Forest percentage, with threshold at >50% tree cover

Figure 1. Five ecological zones in relation to forest transition, with four prioritized for FTA Phase II Sentinel Landscapes

2.4.1.2 Objectives and targets

Objectives

The objectives of the Flagship project are to contribute to the knowledge base and operational modalities needed to achieve four elements of the intermediate development outcome targeted in the CGIAR Strategy and Results Framework (SRF):

- Land, water and forest degradation (incl. deforestation) minimized and reversed (35%)
- Increased access to productive assets, including natural resources (20%)
- Increased access to diverse nutrient-rich foods (20%)
- Increased resilience of agroecosystems and communities, especially those including smallholders (15%)
- Improved capacity of women & young people to participate in decision-making (10%)

Table 1. Investments by sub-IDOs

Sub-IDOs	Amount needed (million USD)	W1/W2 (%)	W3 (%)	Bilateral (%)
3.2 Increased livelihood opportunities (Sub-IDO 1.3.2).	13	21.5	0	78.5
4.5 Increased access to productive assets, including natural resources	11	21.5	0	78.5
B.1 Gender---equitable control of productive assets and resources	6	21.5	0	78.5
5.2 Increased access to diverse nutrient-rich foods	11	21.5	0	78.5
D.1 Enhanced institutional capacity of partner research organizations	10	21.5	0	78.5
8.1 Land, water & forest degradation (incl. deforestation) minimized and reversed	27	21.5	0	78.5
B.3 Improved capacity of women & young people to participate in decision-making (Sub IDO B.3)	12	21.5	0	78.5
10.1 Increased resilience of agroecosystems and communities, especially those including smallholders	14	21.5	0	78.5
7.1 Improved water quality	3	21.5	0	78.5

The specific contribution FTA Landscapes will make to these CGIAR portfolio level development outcomes and synthetic international public goods (IPG's)[1,2,3] are expected to occur at four interconnected scales:

IPG's: Global theories of place-change interaction across SDGs ("change of theory"), connectivity across global value chains

National capacity in key countries/regions: Technical and professional capacity to work in the interdisciplinary and multi-sectoral contexts needed to support multifunctional landscapes is enhanced as universities adopt and adapt modern forestry/ agroforestry/ landscape curricula ("theory of change of theory")

Subnational scale implementation: Better informed and equitable planning and governance mechanisms for landscapes, land use plans, rights and ES-incentives ("theory of change" tested; theory of place articulated as part of options in context concepts)

Local scale (Tier 3, see below): Landscape stakeholders, incl. farmers, and (private/public) beneficiaries co-invest in adaptive management ("theory of change within theory of place" translated into action)

Research efforts will be managed to achieve targeted development outcomes across scales, with cluster of activity organized around one major outcome each.

Table 2. Outcomes by windows of funding

Outcomes	Amount needed (million USD)	W1/W2 (%)	W3 (%)	Bilateral (%)
4.1 (Sub)national governance systems in at least 10 countries use contextualized theories of change to guide transitions to integral achievement of sustainable development goals through restoration, conservation and management of landscape multi-functionality, using similarity domains based on patterns and intensities of forest and tree cover change in space and time in Sentinel Landscapes understood on the basis of 'drivers' that operate at larger scales.	21	21.5	0	78.5
4.2 (Sub)national governance systems in landscapes covering 100 M ha and inhabited by 70 M people use quantified and valued functions of FT&A for biodiversity, full hydrological cycle and ecosystem services analyzed across knowledge domains and available for policy-level synthesis and planning.	32	21.5	0	78.5
4.3 Diverse diets from tree cover in mosaic landscapes recognized and enhanced as contributions to balanced diets through Increase of availability, and access to, nutrient---rich wild and cultivated food products from these landscapes (10 Sentinel Landscapes; 10 M people)	21	21.5	0	78.5
4.4 Adaptive landscape institutions empowered and supported on 6 M ha inhabited by 4 M people to manage changing landscape mosaics towards more balanced and adaptive multi-functionality and successful 'forest landscape restoration' through 'action research' and inclusive, participatory learning. This is aligned with efforts in PIM.5.2 "6 million hectares of shared landscapes under more productive and equitable management".	32	21.5	0	78.5
Total	**107**	**21.5**	**0**	**78.5**

Targeted outcome 1 (20% of resources)

(Sub)national governance systems in at least 10 countries use contextualized theories of change to guide transitions to integral achievement of SDGs through restoration, conservation and management of landscape multi-functionality, using similarity domains based on patterns and intensities of forest and tree cover change in space and time in landscape observatories understood on the basis of 'drivers' that operate at larger scales.

Targeted outcome 2 (30% of resources)

(Sub)national governance systems in landscapes covering 100 M ha and inhabited by 70 M people use quantified and valued functions of FT&A for biodiversity, full hydrological cycle and ecosystem services analyzed across knowledge domains and available for policy-level synthesis and planning

Targeted outcome 3 (20% of resources)

Diverse diets from tree cover in mosaic landscapes recognized and enhanced as contributions to balanced diets through Increase of availability, and access to, nutrient-rich wild and cultivated food products from these landscapes (10 landscapes; 10 M people)

Targeted outcome 4 (30% of resources)

Adaptive landscape institutions empowered and supported on 6 M ha inhabited by 4 M people to manage changing landscape mosaics towards more balanced and adaptive multi-functionality and successful 'forest landscape restoration' through 'action research' and inclusive, participatory learning. This is aligned with efforts in PIM.5.2 "**6 million hectares of shared landscapes under more productive and equitable management**".

2.4.1.3 Impact pathway and theory of change

Our theory of 'how change happens' is that knowledge generated on the four research questions described above can be used (as active 'theory of how we help the world to change') to support specific impact pathways according to tiers of research applicability:

Tier 1: agro-ecological zones and the recognized domains of socio-ecological system similarity (**theories of place**), overlain by national boundaries and differentiated systems of governance; impact at this level generally depends on policy change, informed by ideas and experience at tier 2, plus long term changes in human capacity supported by change in curricula

Tier 2: 'learning landscape' action research efforts that benefit local actors (incl. farmers) and contribute to international public goods by tested paradigms, concepts and generic **theories of change**

Tier 3: landscape observatory sites with intensive data collection for monitoring and unraveling the **complexity of change** as it happens without specific project interventions.

In research we zoom in from Tier 1 to Tier 3, with site selection for Tier 3 geared towards explicitly known 'representativeness' and 'salience', to facilitate the learning of lessons, by zooming out, for Tier 1 application elsewhere. The forest transition theory of FTA phase I will still form a first step to theories of place[4,5]. Water flows are a major functional connector of landscape elements, and a dominant argument for protecting and restoring parts of it[6,7] Landscape level effects on nutrition and dietary diversity provide a new entry point for policy[8].

In line with the impact pathway and theory of change, the Flagship project was designed (**Figure 2)** with four clusters of activity (CoA) that differ in research approach and focus, but interact on an enriched understanding of context ('theory of place') and system dynamics ('theory of change'). The geographic domains selected as landscape observatories or learning landscapes (beyond the sites characterized in Phase 1) are the primary focus of FP 4. Existing efforts on forest landscape restoration, enhancement of nutritional diversity, use of economic instruments in enhancing ecosystem services and integrated conservation efforts in learning landscapes are testing the relevance of the similarity domains at tier 2 level, beyond the mapped boundaries of the Sentinel Landscapes.

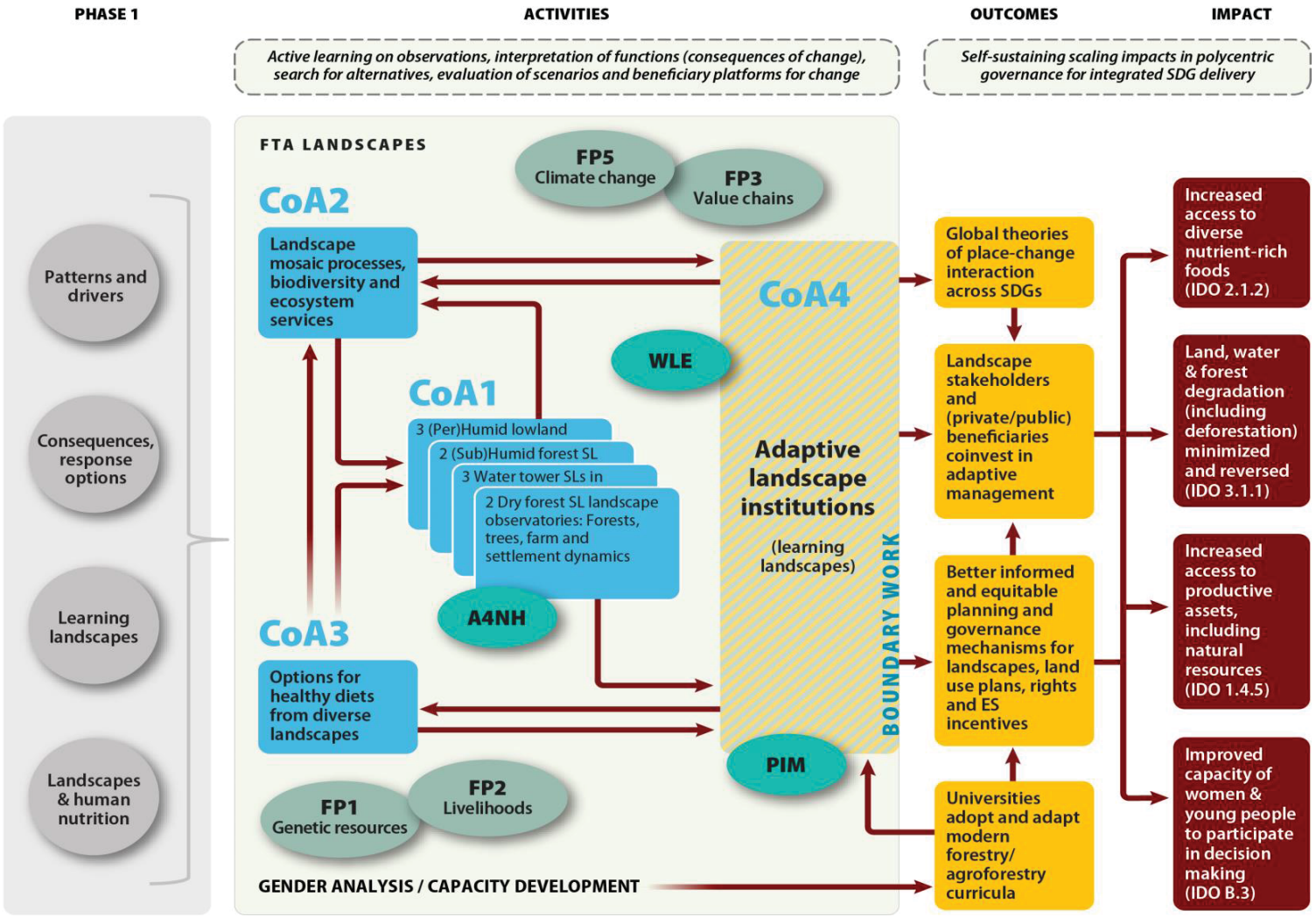


Figure 2. Schematic relationship between structure in Phase 1, CoA's in Phase II, the generic types of outcomes targeted in boundary work, and the CGIAR Intermediate Development Outcomes (IDO). These are related to; interactions with other FPs in FTA and three integrative CRPs (PIM, WLE and A4NH) are indicated

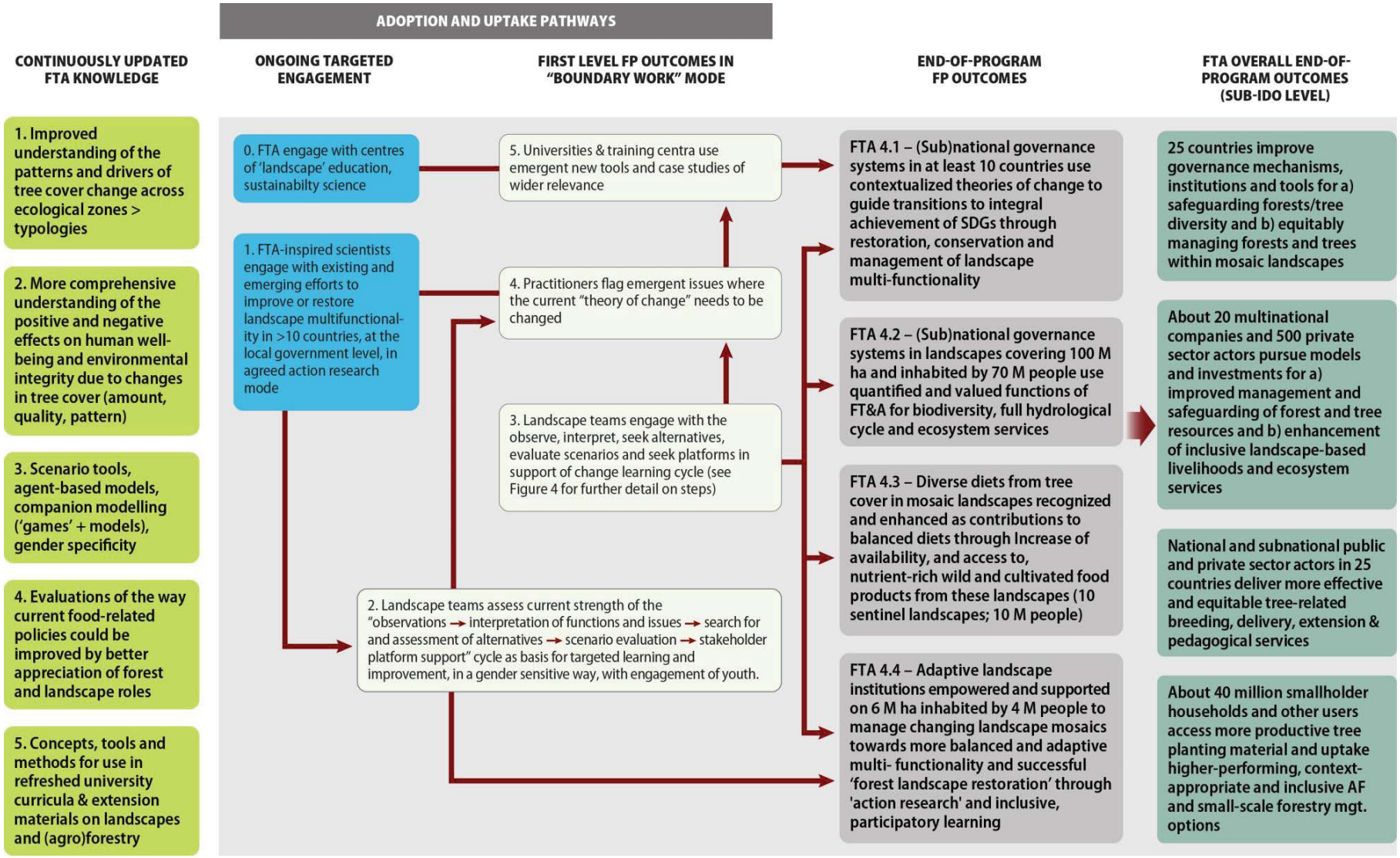


Figure 3A. Theory of change for the landscapes Flagship project.

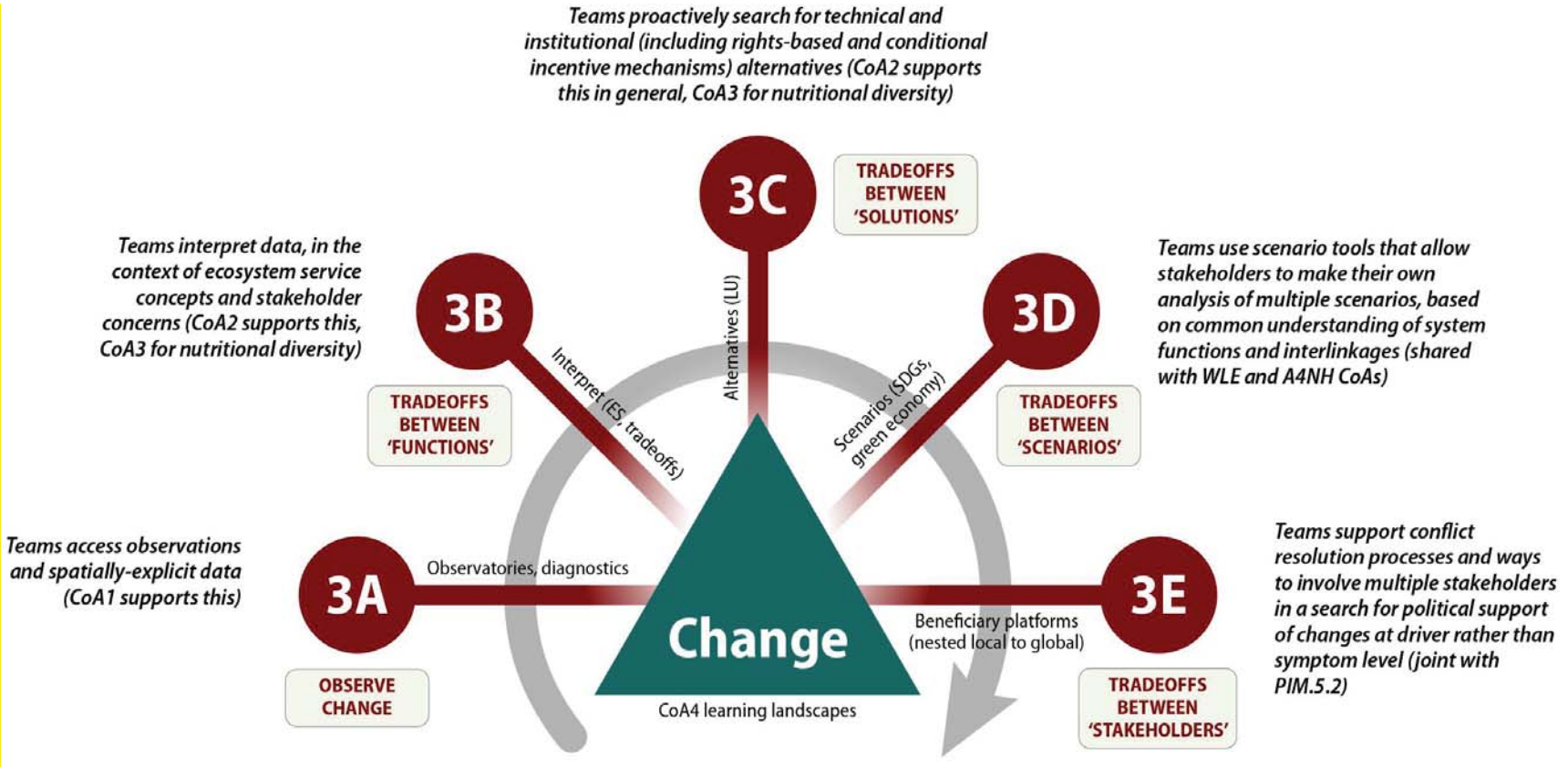


Figure 3B. The learning loop in 'learning landscapes' as part of overall theory of change.

Table 3. Example of how a landscape systems approach can lead to location-specific project ToCs

Question	Topic	Theory of change	Project articulation
Why?	Drivers of current/recent/past degradation? Leverage or nudge?	Change of rules, incentives, motivation?	Approach
Who?	Who are actors and stakeholders of what led to current (degraded?) state	Free and Prior Informed Consent?	Actors
What?	What land uses and ecosystem components support on-farm and off-farm livelihoods; what are options for change?	land use change, livelihood options, value chains?	Means, interventions
Where?	Landscape configuration, lateral flows, buffers, filter effects?	Spatial zoning?	Targets (spatially explicit)
So what?	Ecosystem service change?	Restoration potential, urgency of protection	Objectives (rationale)
Who cares?	Common but differentiated responsibility across scales	Which combination of carrots, sticks and sermons can be used?	Co-investment (rights-based, financing)

Boundary work: the 'learning landscapes' cluster of activity on adaptive landscape governance (CoA 4.4) provides the primary interface with local stakeholders (incl. government agents, private sector, local communities) to ensure that science can move from 'enlightenment' to 'decision support' and 'negotiation support' modes.

Youth considerations: employment and business opportunities in dynamic multifunctional landscapes are an explicit consideration for the integrative planning tools; engagement of young people in the process can energize the search for innovative solutions, the sense of urgency and legitimacy of what is proposed.

Gender aspects: process-level inclusive engagement across gender and social strata is key to the theory of change; explicit attention to resource access and land tenure has a strong gender dimension in terms of targeted outcomes[9,10,11].

2.4.1.4 Science quality

The interdisciplinary science of landscapes is still relatively young. Policy-driven discourse – such as 'land sparing versus sharing versus caring' or attractiveness of Payment for Ecosystem Services (PES) schemes as basis for REDD+ – are not sufficiently recognizing earlier progress. That includes the segregating versus integrating comparisons; scale-dependent conclusions on tests of the Borlaug intensification hypothesis; political and social context of instruments perceived to be primarily economic in nature; rich lessons on human decision-making of behavioral economics beyond 'rationality'. The CIFOR-led exercise to have target groups of practitioners identify their top questions, T20Q, framed two questions on greening business models, but 18 others on restoration, integration of local knowledge, environmental services, landscape approaches and rights and benefits. Generic answers on all these exist, supported by the outputs of related FTA research in Phase I (395 journal articles, 129 book chapters, 26 books per 1 March 2016). However, specific support for localizing the generic principles in project-level theories of change remains in demand. It characterizes most of the bilateral/W3 funding for FTA's landscapes agenda, ensuring that it is aligned with real needs on the ground.

FTA Landscapes science consists of three parts, balanced within funding realities:

1. Uses current methods and concepts ("Theory of change") in practical applications, often in bilaterally funded projects that align with donor priorities for location and context specific problem solving, with sufficient predictability to convince an application-oriented investor,
2. Closes in on 'paradigm shifts' ("Change of theory") where existing, dominant ideas and common assumptions don't seem to align with the observations and emerging facts ('changing the theory of change'), and
3. Tests new ideas, concepts and methods that have the potential to be game-changers, but that so far lack 'proof of principle'.

Research of Type B is a primary target for W1/W2 funding, with increased investment in the more risky Type C if more funds become available.

Table 4. Examples of research topics in the three parts of the FTA Landscapes portfolio

C. New ideas, seeking 'proof of principle', extending theory	B. Closing in on paradigm shifts	A. Utilizing current paradigms in practical applications
'Ecological rainfall infrastructure' and 'biological rainfall generation': vegetation effect on hydroclimate	Co-investment, compensation and commodification as PES paradigms	Negotiation Support process reconciling local, public/policy and science-based knowledge
Typology of landscape configurations beyond 'forest transition curve' stages	Land equivalent ratios as indicator of potentially negative yield gaps at landscape scale	Land use for multiple environmental services (LUMENS) as spatial planning tool for local governments
Agent-based models of (gendered) land use decisions interacting with rule-based governance options	Tree diversity transition curves as underpinning of proactive management	Forest landscape restoration based on contextualized understanding of driver+ actor+ pattern+ consequences
Tree functional/life-history traits[12] as basis for biodiversity and ecosystem service management	Quantified buffer functions used in climate downscaling	Tenure reform as basis for increased landscape multi-functionality
Reconciling 'five capitals' concept, investment and ES-dividends[13]	Gendered understanding of land use change preferences	Explicit recognition of forest-based scenarios for inclusive food security[14,15]
Trees on farms: single-tree ecosystems and their goods and other ecosystem services	Scattered trees on farms as source of ES, likely to be high per unit biomass	Assessment of the contribution of trees on farms to provision of ecosystem services at the landscape level

FTA operates, across these three types of science in four out of five broad agroecological zones (Figure 1), each represented by two to three landscape observatories characterized in FTA Phase I as Sentinel Landscapes. We expect the FTA effort to be allocated across the six ecological zones at approximately <5 (drylands), 15, 15, 15, 20 and 30%, respectively. Within each of the five prioritized zones, FTA Phase II will work across the range of landscape configurations that represent forest and tree cover transitions and have implications for the balance between livelihoods and ecosystem services (Figure 4).

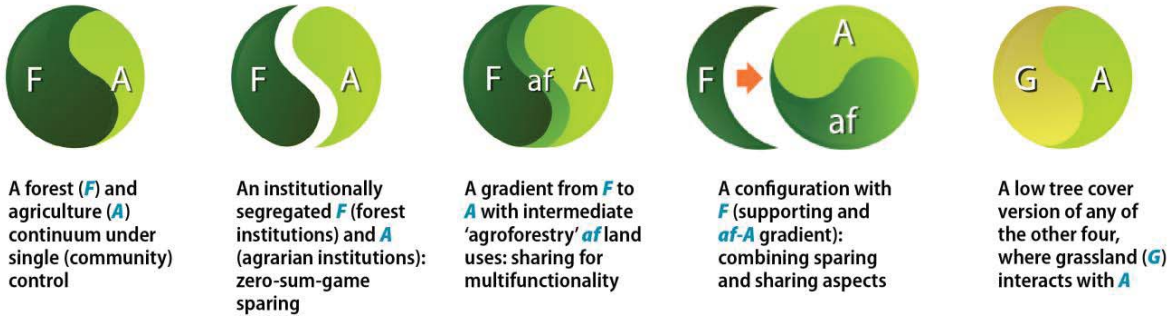


Figure 4. Five-step classification of landscape configurations derived in Phase I[16,17]

Research team niche and qualifications

The forest transition focus of Flagship 4 provides a broad vision of the integrated institutional change needed to achieve the CGIAR System Level Outcomes. The team includes: Ecologists, Economists, Geographers, Geoscientists, Social scientists, Anthropologists, (Agro)foresters, Nutritionists and Statisticians. 31 scientists with Scholar.Google h-factor of at least 10. Two of the top-ten CGIAR scientists based on total citation scores in Scholar.Google, ten of the top-hundred. Five out of 11 scientists in the core team of the Flagship, and 17 out of top 40 scientists are female.

Table 5. Key scientists involved (CVs in Annex 3.8)

Name, institution	Original discipline	H	Total cited	Rank in CGIAR	FP4 role
Meine van Noordwijk, ICRAF[#1]	Ecologist, modeler	63	18156	3	FP4 leader, WLE
Terry Sunderland, CIFOR[#2]	Ecologist	28	3518	61	FP4.1 leader, A4NH
Peter Minang, ICRAF[#3]	Social ecologist	18	1108	176	FP4.2 leader
Eduardo Somarriba, CATIE[#4]	Agroforester	30	3765	58*	FP4.3 leader
Beria Leimona, ICRAF[#5]	Env. economist	16	924	191	FP4.4 leader
Delia Catacutan, ICRAF[#6]	Social scientist	15	779	234	FP4.4,PIM liaison
Bryan Finegan, CATIE[#7]	Forest ecologist	32	5030	45*	FP4.2 focal
Laura Snook, Bioversity[#8]	Forest ecologist	16	1106	155	FP4.3 focal
Rene Boot, TBI	Ecologist	22	2056	102*	FP4.4 focal
Sonya Dewi, ICRAF[#9]	Spatial ecologist	18	1311	151	FP4.2 focal
Stepha McMullin, ICRAF	Social scientist	1	1		FP4.4 focal
Douglas Sheil, CIFOR assoc	Ecologist	49	8681	18*	FP4.2 scientist
Christine Padoch, CIFOR	Anthropologist	43	5160	35	FP4.1 scientist
Sven Wunder, CIFOR[#10]	Economist	44	13369	9	FP4.2 scientist
Manuel Guariguata, CIFOR	Forester	35	5589	30	FP4.1 scientist
Jianchu Xu, ICRAF	Ethnoecologist	33	8290	19	FP4.2 scientist
Robert Nasi, CIFOR	Forester	33	4180	44	FP4.3 scientist
Ingrid Oborn, ICRAF	Soil scientist	26	2217	91	FP4.2 scientist
Ravi Prabhu, ICRAF	Forester	23	2696	73	FP4.4 scientist
Rhett Harrison, ICRAF	Ecologist	22	2014	103	FP4.1 scientist
Barbara Vinceti, Bioversity	Forest ecologist	20	1637	122	FP4.3 scientist
Cheikh Mbow, ICRAF	Geographer	20	1889	112	FP4.2 scientist
Suyanto, ICRAF	Economist	18	938	185	FP4.2 scientist
Glen Hyman, CIAT	Geographer	17	1103	165	FP4.1 scientist
Robert Zomer, ICRAF	Geographer	17	1281	145	FP4.1 scientist
Betha Lusiana, ICRAF	Statistician	15	2460	82	FP4.2 scientist
Evert Thomas, Bioversity	Ethnobotanist	14	527		FP4.4 scientist
Grace Villamor, ZEF, ICRAF assoc	Modeler	13	423		FP4.2 scientist
Tor Vaagen, ICRAF	Geo-scientist	12	764	225	FP4.1 scientist
Rachmat Mulia, ICRAF	Statistician	11	381		FP4.2 scientist
Amy Ickowitz, CIFOR	Economist	10	939	175	FP4.3 scientist
Katja Kehlenbeck, ICRAF assoc	Agroforester	10	352		FP4.3 scientist
Ujjwal Pradhan, ICRAF	Social scientist	10	367		FP4.4 scientist

Diversity analysis
Male: 21, Female: 12

Continent of origin
Asia: 10, Africa: 2, Latin America: 2, Europe: 14, North America: 5, Pacific: 0

2.4.1.5 Lessons learned and unintended consequences

Beyond location-specific lessons learned from characterization of the Phase I Sentinel Landscapes, and guidance from FTA evaluation, five lessons in particular were used to prioritize the new Flagship project:

1. The initial forest transition hypothesis was expanded as a theory of change interacting with 'theories of place', defining domains of similarity and the degrees of freedom in deviating from 'destiny' in the way forests and human population density interact. We will use these insights in communicating landscape perspectives across FTA and the CRP portfolio of CGIAR.
2. Conceptual development progressed on how payments for environmental services (PES) can be more effective, and how commodification, compensation and co-investment concepts relate to each other and to application domains[18,19] We aim to take further steps in CoA 4.4.
3. New insights were derived on the way forests, trees and water interact at the landscape and (sub)continental scales. New activities on the full hydrological cycle in CoA 4.2 will follow this lead.
4. Guidance was derived on how a landscape approach can be implemented and a toolbox on (gender-sensitive) negotiation support was launched[1]. This will serve as an example for our theory of change on how a synthesis of locally derived lessons can inform global debate and set new standards.
5. New perspectives emerged on the roles of forests, trees and agroforestry for dietary diversity and food security. As a specific interest within the wider ecosystem services discourse, global prioritization of this issue shaped our CoA 4.3 and guided global forestry policy processes[20].

Unintended consequences of our type of engagement at landscape scale have been noticed where latent vertical and horizontal conflicts (hidden from view by existing power structures, between local communities, government and private sector, or between communities) change to open conflict stage. Challenging *status quo* on tenure and access of forest can increase perceived conflict before situations improve. In such situations the legitimacy *dimension* of science quality is as important as the *credibility* and *salience* dimensions: it is important who the messenger is and how it is brought, beyond what the message is. The shared experience in the negotiation support toolbox provides some guidance on how to avoid unintended consequences of this type to spiral out of control.

Recognition of the complexity of landscape-scale change can slow down the implementation of policies, such as REDD+, that were designed with a simplified scheme of land cover (e.g. forest vs. non-forest) as basis[21]. Mitigating this type of risk is possible where understanding of the complexity is shared in an early stage of an "issue cycle", where a different perspective on definitions and framing can avoid the false coalitions that fuzzy concepts can induce otherwise, but that don't lead to implementable policy.

The use of economic instruments to internalize ES externalities in land use decisions has led to a discussion of motivational crowding out: payments can undermine existing social cohesion and motivation for environmental management. Part of the FTA.Landscapes research has tried to ascertain the risks involved, with a perspective on longer-term sustainability, rather than metrics at the time scale of typical projects. The downsides of existing PES experiments are shared with wide audiences alongside the positive experiences, to reduce the risk of naïve upscaling with unintended consequences remaining unmanaged.

2.4.1.6 Clusters of activity (CoA)

CoA 4.1 Landscape observatories: Forests, trees, farm and settlement dynamics

Problem statement and rationale.

This CoA is designed to maximize its interactions with all other parts of the FTA CRP that require data on actual tree cover change and countries that have commitments to the Aichi targets of the CBD, Bonn Challenge and associated reporting obligations. The observatory function of monitoring actual change in 10 landscapes selected to represent 5 major agroecological zones will continue the ***'Sentinel Landscapes'*** of Phase I, and plan for a second characterization around 5 years after the initial one. It links between wider

agroecological zone concepts and the observatories, supporting analysis of representativeness and extrapolation domains of site-based studies across FTA.

Targeted outcome FTA.4.1 (see above)

Hypothesis: Forest and tree cover transition as process interacts with social, political, economic and ecological factors in ways that allow the recognition of similarity domains, supporting out- and up- scaling of theories of change where an integrated landscape approach is used.

Key research questions:

1. ***Who*** are the actors and stakeholders of the landscape, in a historical-political perspective on (claimed) rights, an economic perspective on livelihoods and value chains and a cultural-social perspective on identity and aspirations?
2. ***What*** land use systems are present ***where*** in the landscape and what are **current patterns and intensities of change** (tree cover, objectively observable aspects of forests, farms, other land uses) in space and time
3. Can observed changes be understood (***'why?'***) on the basis of drivers that operate at larger scales, demography and economic policies?

Question 1 implies differentiation by gender and age as sub-questions in the fact-finding stage.

Key deliverables

2017 Identified similarities (tier 1 & 2) connected to 10 Sentinel Landscape data sets, used as basis for planned impact studies of interventions across all FTA FP's, and linked with SDG performance planning and monitoring in 10 countries. Decision support tools for approaches (natural regeneration or planting), species (seed sources) for landscape restoration adopted within three countries with Bonn Challenge pledges.

2018 Adjustments to portfolio of Sentinel Landscapes for round-2 characterization based on explicit account of representativeness for wider domains, track record of connecting results to local development planning (local governments and external supporting agencies) and interventions balancing livelihood opportunities and reversal of land degradation and deforestation. Decision support tools for sites and objectives for restoration of forests, at the landscape and local scale, tested and adopted in three priority countries.

2019 Second round surveys of conditions and trends in at least 10 Sentinel Landscapes, tailoring surveys to the integral SDG portfolio and its internal tradeoffs, with strong roles for local partners

2020 Second round surveys of conditions and trends in Sentinel Landscapes completed, changes documented, interpreted, and linked to national SDG reporting systems.

2021 Scenario studies and participatory development planning results for at least 10 Sentinel Landscapes that make use of rounds 1 + 2 results, aligned with national goals and international commitments (incl. Aichi targets of CBD, UNCCD and UNFCCC modalities)

2022 Use of FTA research results in evaluation of SDG performance and adjustments to the goals and means of implementation. Countries in Africa, Latin America and Asia, guided by FTA-informed practices and policies, successfully establish on degraded land millions of ha of self-sustaining forest that benefit local communities.

CoA FTA.4.2 Landscape mosaics, biodiversity and ecosystem services

Problem statement and rationale.

This CoA is coordinated with the **Ecosystem Services Flagship in WLE**, the Ecosystem Services Partnership and FutureEarth groups in the academic world. It will use a variety of methods to unravel the complex relations between human well-being and ecosystem services as affected by (bidirectional) tree cover change and its effects on biodiversity, water quantity, quality and regularity of flow. What degree of 'restoration' is feasible and how can climate change adaptation be built into traditional "steady-state" restoration concepts? Location-specific studies of ecosystem service issues will be used to test and further develop classifications,

such as a recent '10 prototypes' list of tree-related watershed services in specified 'theories of place'. New efforts will be made to understand the role of terrestrial evapotranspiration and associated plant functional traits. This will especially examine the roles of trees and forests in rainfall elsewhere on the same continent based on prevailing winds, and more specific hypotheses about 'bioprecipitation' and 'biotic pump' that suggest further agency for vegetation. A combination of methods will use coupled soil-vegetation–atmosphere models, dendrochronological reconstructions of past water sources (land versus ocean derived), and reconstructions of specific 'teleconnections'.

Targeted outcome FTA.4.2 (see above)

Hypothesis: Spatial and temporal configurations of forests and trees on farms in landscape mosaics at various scales (landscape, watershed, farm, plot) matter for the way ecosystem services change with scale; understanding of the scaling rules can be used in planning land use for multiple ecosystem services.

Key research questions:

1. What are the **consequences of changes** ('so what?' and 'who cares?') in quality, quantity and spatio-temporal configuration of forest and tree cover in landscapes for ecosystem functions that underpin the provision of usable goods and other ecosystem services (with specific attention to biodiversity and the full hydrological cycle e.g. effects on terrestrial recycling of rainfall, safe drinking water, water-sustainable agricultural intensification, and regulated water flows)
2. How are perceptions and preferences of ecosystem functions differentiated by gender, ambitions of young people and intergenerational aspects?
3. How can stakeholders of the (unintended) consequences of landscape change achieve **leverage on the drivers** of change, through a combination of rights-based approaches (incl. land use planning, tenurial reform), economic instruments (generic tax/subsidy, specific performance-based contracts) and motivational factors (addressing perceived 'fairness', 'environmental justice')?
4. How can existing 'green economy' planning tools for land use for multiple ecosystem services be improved, adapted and adopted more widely?

Questions 1 and 2 imply differentiation by gender and age as sub-questions.

Key deliverables

2017 Assessment of effects of tree cover change on rainfall patterns and variability at continental scales, combining global circulation models with qualified tree cover data, quantified water balance data, dendrochronological evidence of past change and vulnerability of livelihoods

2018 Synthesis of options for achieving Aichi targets of biodiversity conservation through managed transition zones around protected areas, landscape connectivity and ecological corridors and development zoning utilizing full spectrum of FT&A land use systems

2019 Valuation studies that relate human and social capital benefits across scales to changes in forest and tree cover as indicators of ecosystem services in local context, as contributions to national and international debate (incl. IPBES)

2020 Reevaluation of co-benefit relations among global conventions (CBD, UNCCD, UNFCCC) at landscape scale, utilized in international discourse

2021 Impact study of shifts in gender-equitable control of productive FT&A assets and resources. Policy options to favor sustainable restoration of tree-based ecosystems adopted by at least 3 countries that have made pledges to meet international agreements

2022 Re-assessment of new evidence of effects of tree cover change on rainfall patterns and variability at continental scales, combining global circulation models with qualified tree cover data, quantified water balance data and dendrochronological evidence

CoA FTA.4.3 Healthy diets from diverse landscapes.

This CoA will be further developed to match the Food Systems for Healthier Diets Flagship through specific attention to the way landscape diversity can contribute to healthier food systems and diets across forests and tree based systems/agroforestry[22]. It combines analysis of landscape-level patterns, with a focus on the various components of healthy diets and the way these can be derived in complementary ways from shifting cultivation, home gardens, landscape mosaics, and forests of a range of management intensities. Its theory of change is based on the lack of visibility in the current policy arena of the way food security and diverse diets depend on trees and forests (e.g. along the five landscape configurations used for characterizing the landscape observatories; see above). Identifying the opportunities and issues recognized is a first step, but requires well-chosen and adequately quantified case studies, as well as analysis of global datasets. The CoA will take a Research in Development approach with participatory action research to explore year-round portfolio solutions and options within local economic and social contexts. This includes management and improving available diversity of tree foods particularly nutrient rich fruits, vegetables, nuts and oils, and early steps will be taken towards domestication of wild edible mushrooms, fish dependent on forest streams, edible insects, bushmeat and tree products as part of diverse diets with sustainable harvest intensities. The CoA will provide information to land planners, decision-makers, development agencies and communities on the contribution of forests and trees on farms to local food security and strengthening rural-urban food system linkages. The evidence will be used for developing interventions, implementing them and evaluating failures and success as basis of further learning (as in CoA4).

Targeted outcome FTA.4.3 (see above)

Hypothesis: Landscape mosaics with partial forest cover and agroforestry support nutritional diversity and human health beyond their current weak recognition in policies aimed at increasing food security

Key research questions:

How does landscape multi-functionality **contribute to human well being and healthy and diverse diets** through the (local) availability of and access to improved tree food sources as well as wild foods (i.e. provisioning services part of the wider ecosystem services concept)?

The question implies differentiation by gender and age as sub-questions.

Key deliverables

2017 Stock taking of statistical data sets that link dietary diversity to species-level and genetic diversity of agricultural and associated landscapes and process-level models that interpret this in terms of availability, access and behavioral patterns, setting priorities for further work by FTA and partners

2018 Analysis of priorities and options for developing capacities of value chain actors (including input suppliers, producers, processors, retailers and traders) on production, post-harvest handling, processing, marketing and consumption of nutrient-rich foods derived at landscape scale

2019 In at least 5 landscapes: Increased on-farm production of a diversity of fruits, nuts, vegetables and legumes, and increased amount of collected wild resources including wild fruits, vegetables, bush meat, mushrooms, insects and fish from forests

2020 In at least 5 countries: Increased value capture by producers/collectors of nutrient-rich food; reduced post-harvest losses of wild and cultivated nutrient-rich food; increased incomes and employment

2021 In at least 5 countries: Increased dietary diversity of low-income rural and urban consumers using a variety of nutrient-rich wild and cultivated nutrient-rich food available during economic, social and/or environmental shocks

2022 Impact study of the effectiveness of interventions by development partners aimed at supporting dietary diversity through diverse landscapes

CoA FTA.4.4 Adaptive landscape institutions

This CoA in Tier 2 landscapes interacts with **PIM 5.1 (property rights) and PIM 5.2 (NRM governance)**. It combines the development of local governance instruments (land-use plans, green economy plans), increased

understanding how PES instruments can be effectively used to shift incentives on the ground, and an action-research perspective on the way changing mosaics can be geared towards more balanced multi-functionality. It pays specific attention to gender, youth and innovations in institutional capacity to increase ownership and voice in natural resource management. Specific attention to environmental justice concepts and their application in local institutions will lead to critical reflection on current generic theories of change and the diverse roles of agency for change. The CoA will operate as a network of networks, building on the RUPES and PRESA networks in Asia and Africa, the Model Forest Network in Latin America, new initiatives on large scale forest landscape restoration, the ASB Partnership for Tropical Forest Margins, and the Poverty and Environment Network (PEN) set of data and landscape observatories. The CoA will interface with national-level forest negotiation platforms, including those managed by Tropenbos International (TBI) in 10 countries. It interacts with capacity development partners in the emerging "Landscape Academy"

Targeted outcome FTA.4.4 (see above)

Hypothesis: Contextualized generic theories of change at the landscape scale provide an "efficiently fair" middle ground in progress towards sustainable development goals

Key research questions:

How can local and external stakeholders concerned about consequences of 'business as usual' trajectories **affect the generic drivers and/or community and household level incentives** (including economic and socially constructed ones) and rights (including tenure) to nudge land-use decisions into a more desirable direction (including land-use plans for enhanced multi-functionality, economic incentives)? How can ecosystem services be restored most effectively within landscapes in terms of both defining the desired changes (restoration to forest or agroforest, use of ecosystem services-friendly agroforestry practices) and types of intervention (regulation, incentives, markets for ecosystem services)? Key sub-questions are the ways in which gender and intergenerational empowerment can be achieved.

Key deliverables

2017 Exchange of lessons learned across the various learning landscapes associated with FTA, including a further review of existing typologies of 'payment for watershed services' settings and as basis for new action research efforts.

2018 Reflection on the multi-scale character of the 'common but differentiated responsibility' phrase that so far is primarily used at international negotiation tables but that may increase space for local adaptive landscape management.

2019 Compilation of lessons learned at landscape scale across the learning landscape networks for reporting on Aichi targets to CBD.

2020 Impact study of the further development and use of the LUMENS tool for participatory planning of land uses providing multiple environmental services. Cost-effective, multi-scale and participatory protocols for monitoring viability of restored forests developed and adopted by key countries and other stakeholders.

2021 Documented investment action of development support partners on the basis of the shared learning that links issues to places and action perspectives

2022 Next-level stock taking of how the 'payment for environmental services' debate has progressed conceptually (combining behavioral economics, applied ecology and institutional political ecology) and in evolving practice.

2.4.1.7 Partnerships

The primary partners for Flagship 5 are ICRAF, CIFOR, CATIE, Bioversity and TBI, with active participation expected from CIAT and CIRAD. Under an existing MoU, the FTA Centers are supporting the Convention on Biological Diversity (CBD) and its national parties in their implementation of the Aichi targets. The political commitment in the Bonn challenge for forest landscape restoration has led to government initiatives, such as the 20x20 initiative for Latin America of which FTA partners were among the founders.

Four strategic external partnerships are:

- Ecosystem Services Partnership (ESP), an umbrella for the academic community interested in valuation at global and local scales, implementation of payment schemes and scenario modeling at landscape and global scales. Together with WLE, FTA connects ESP to developing countries.
- The Landscapes for People, Food and Nature (FPFN) network of key development partners. FTA provides conceptual and empirical support to the evolving community of practice. Jointly with LPFN, Cornell University and CDI (Wageningen), FTA partners are among the founders of the emerging "Landscape Academy".
- The Ibero-American Model Forest Network. Model Forests are social, inclusive and participatory processes that seek the sustainable development of a territory and thus contribute to global targets related to poverty, climate change, desertification and sustainable development. 29 model forests in 14 Latin American countries cover more than 31 million hectares. Three of these countries are CGIAR tier 1 (Brazil, Perú and Guatemala) and three are tier 2 (Bolivia, Colombia and Honduras).
- The national networks of Tropenbos International (TBI), operating at the government–society interface in 10 tropical forest countries that are also mostly FTA priorities, provides national interfaces for FTA research.

Further partnerships will be developed strategically to increase the likelihood that a relevant enabling environment will emerge, with organizations that include IIASA, SEI, WRI, IUCN, WWF, TNC and the Ibero-American Model Forest Network.

2.4.1.8 Climate change

Climate change has increased the awareness of landscapes as a relevant scale at which feedback loops operate. Forests and trees can dampen the variability in climatic parameters such as maximum temperatures, wind speed and humidity and as such contribute to 'buffering' of the climate as experienced by crops, livestock and people. Loss of tree cover will increase exposure to macroclimatic variability and a reduction or reversal of deforestation can be a relevant part of human adaptation strategies, as is studied in more detail in FP5. FP4 adds a deeper understanding of buffering of hydrological cycles, with recent interest in effects on rainfall as a potential 'game changer'. Analysis of flow persistence and flood risks, as influenced by the condition ('health') of upper watersheds, helps in teasing apart the interactions of land use change and climate change on blue water availability (as basis of WLE discussions on water-focused policy issues), exposure to 'hazards' (floods, landslides), and negative effects of lateral flows (erosion/deposition cycles). Multifunctional landscapes also contribute to human resilience in the face of climatic shocks via dietary diversity, with options to retain and restore diversity in integrated development pathways that form alternatives to the simplification that has often accompanied intensification for specific commodities.

FP 4 supports the use of land use and economic planning instruments that reconcile climate change adaptation, locally appropriate mitigation actions and development ambitions – with LUMENS as current work in progress. These tools help to understand the opportunities to reconcile climate change policies (SDG 13) with the imperatives of the other SDGs.

2.4.1.9 Gender

We expect to contribute to all three gender foci related to the sub-IDOs formulated in the SRF:

B.1: Gender-equitable control of productive assets and resources: In CoA 4.1 the legends used for describing and analyzing land use need to be gender inclusive; in CoA 4.4 increased security of tenure for women is potentially important for the maintenance of ecosystem services in sensitive landscapes, while empirical evidence for this assertion is scarce.

B.2: Technologies that reduce women's labor and energy expenditure developed and disseminated: in CoA 4.2 the specific methods that are used to manage the ecosystem service consequences of land use will be evaluated in a gender sensitive way; in CoA 4.3 mothers with young children are an especially important target group of nutritional education with potential impacts on children under five years of age; CoA 4.4 will assess the effectiveness of existing informal gender-specific networks on landscape management.

B.3: Improved capacity of women and young people to participate in decision-making: in CoA 4.2 the effects of landscape level land-use change on ecosystem services will be evaluated with an emphasis on explicitly understanding the consequences for women and young people. Visioning exercises with young people will be used to explore the way landscapes and livelihoods are expected to change and the desirability of changes. These will be documented and incorporated into wider discussion; in CoA 4.4 participatory land-use planning methods that support the negotiation of effective multi-functionality will ensure full representation of all social strata (including women and young people).

2.4.1.10 Capacity development

Landscape management has evolved from singular disciplines (such as planners, architects, foresters, civil engineers, development economists) designing and managing according to disciplinary principles into a broader transdisciplinary interaction, understanding and co-management. However, universities still deliver and agencies still employ disciplinary experts. Reflexive practitioners do not come out of universities automatically, rather through exchange of practice, coded, tacit and local knowledge. FTA.LAN supports efforts to innovate in and refresh university curricula, providing opportunities for direct engagement in learning landscapes. It recently joined an initiative for a "Landscape Academy" in which the knowledge, skills and attitudes are defined that can inform curricula, existing materials are made more accessible and new modules are developed and tested. Synergy with similar other efforts is sought[23].

Capacity development elements of this Flagship are focused on four sub-IDOs:

D.1: Enhanced institutional capacity of partner research organizations: in all four CoAs national partners are actively engaged in projects, within the specific modalities required for bilateral projects, and guided by institutional agreements with host countries.

D.2: Enhanced individual capacity in partner research organizations through training and exchange: in all four CoAs there are opportunities for graduate student involvement, with a preference for staff of partner organizations and universities in regional networks associated with FTA (CapDev Element 4), and under existing arrangements with international universities (including Bonn, Cornell, Davis, Goettingen, Harvard, Uppsala and Wageningen).

D.3 and D.4: Increased capacity for innovation in partner R&D organizations: the inter- and transdisciplinary nature of ecosystem service and landscape concepts is a specific challenge for most partner research organizations, because they are mostly organized under a forestry, agricultural, environmental or socioeconomic framework. CoA 4.4 addresses adaptive landscape institutions and provides an opportunity to support innovation at local levels.

2.4.1.11 Intellectual assets and open access management

The following CGIAR IA Principles are guiding IA management in FP 4:

- Research results and development activities are regarded as international public goods for the maximum possible access;
- Partnerships are critical to ensuring access to the best knowledge and innovation to achieve maximum impact;
- Sound management of IA and Intellectual Property Rights (IPR) with integrity, fairness, equity, responsibility and accountability.

FP 4 research involves the interface of local, public/policy and science-based ecological knowledge systems, and is aware of the sensitivities regarding protection of intellectual property rights of traditional knowledge and its recognition in the CBD as a potential source of future revenue on ethnobotanical (or related) knowledge of biological resources with potential wider use. In exploring local knowledge systems FP 4 tends to focus on more generic, explanatory knowledge, and associated preferences and concerns about land use systems and landscape configurations. In current negotiation support practice, a balance is sought between protecting vulnerable informants of sensitive information and the benefits that can be obtained by more inclusive and open-access knowledge systems. We respect the concept of "Free and Prior Informed Consent" that has emerged in ecocertification and REDD+ debates, and help to further operationalize these ideas.

Subject to fund availability, FP 4 outputs will be made available under the least restrictive licensing to describe the legal rights to information products and encourage their use and adaptation. It will be published in a format that can be downloaded, indexed and searched by commonly used web applications. The outputs will

be disseminated through open access repositories to ensure it is archived and shared systematically with other Centers and made accessible as International Public Goods. See also Sections 1.0.12 and 1.0.13 of the Full FTA Proposal, including a detailed strategy for IA management in Annex 3.10 and OA/OD implementation in Annex 3.9.

2.4.1.12 FP management

Flagship 4 is led by Meine van Noordwijk, Chief Science Adviser to the World Agroforestry Centre (ICRAF), who, together with the leaders of the four CoAs and the focal points (identified in Table 5) will form a core group that discusses progress, responds to new opportunities and adjusts the annual work plans.

The four clusters of activity (CoA) are organized to add focus and depth to the overall integrative effort:

CoA 4.1 – an 'observatory' function of monitoring actual change in 10 landscape observatories (also called Sentinel Landscapes) selected to represent four agroecological zones, providing a platform for cooperation between all Flagships; the CoA will be led by an ICRAF scientist (Dr. Peter Minang) and has active participation by all FTA.4 partners, and active interfaces with all FP's.

CoA 4.2 – unraveling of the complex relations between human well-being and ecosystem services as affected by tree cover change (degradation and deforestation, restoration) and its effects on biodiversity, water quantity, quality and regularity of flow, coordinated with WLE. The CoA is led by a CATIE scientist (Dr. Eduardo Somariba) with active participation by scientists from all partners.

CoA 4.3 – new and specific attention to the way that diverse and healthy diets relate to landscape multifunctionality across the forest transition curve, coordinated with A4NH (Healthy Food Systems); the CoA is led by a CIFOR scientist (Dr. Terry Sunderland), with active participation from ICRAF and evolving interest in CATIE.

CoA 4.4 – a local governance and action research perspective on the way changing mosaics in learning landscapes can be geared towards more balanced, integrated and adaptive multi-functionality, coordinated with PIM 5.2; the CoA is led by an ICRAF scientist (Dr. Beria Leimona), with leadership in the contributing networks by CATIE, CIFOR and TBI.