

Developing and promoting agroecological innovations within country program strategies to address agroecosystem resilience in production landscapes: a guide



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The Small Grants Programme

The Small Grants Programme (SGP) is a corporate programme of the Global Environment Facility (GEF) implemented by the United Nations Development Programme (UNDP) since 1992. SGP grantmaking in over 125 countries promotes community-based innovation, capacity development, and empowerment through sustainable development projects of local civil society organizations with special consideration for indigenous peoples, women, and youth. In particular, SGP supports biodiversity conservation, climate change mitigation and adaptation, prevention of land degradation, protection of international waters, and reduction of the impact of chemicals, while generating sustainable livelihoods.

One of the strategic initiatives of the Sixth Operational Phase of the Small Grants Programme is Climate-Smart Innovative Agro-ecology. This initiative will target geographical areas that show declining productivity as a result of human induced land degrading practices and the impact of climate change by working in buffer zones of identified critical ecosystems, as well as in forest corridors.

COMDEKS

The “Community Development and Knowledge Management for the Satoyama Initiative (COMDEKS)” supports local community activities to maintain and, where necessary, rebuild socio-ecological production landscapes and seascapes (SEPLS), and to collect and disseminate knowledge and experiences from successful on-the-ground actions for dissemination and adaptation to other smallholder organizations in other landscapes and regions of the world. Landscape strategies are developed with four outcomes, one of which addresses agroecosystem resilience, while aiming at improving food security and stabilizing and improving ecosystem services. COMDEKS is delivered through and based on the lessons learned of SGP, which has over two decades of experience with community level projects and activities.

About this guide

This guide is intended to serve as the basis for the implementation of the Innovative Agro-ecology component of the GEF Small Grants Programme in its 6th Operational phase, and to provide guidance for the agro-ecosystem outcome of the COMDEKS landscape approach. In particular, this guidance aims to enable communities to make meaningful contributions to agroecosystem resilience in selected production landscapes, by providing guidance on tools and methods that can be used to engage smallholder organizations in the participatory analysis of agroecosystem vulnerability to impacts of climate change, and other social and economic factors as well as the identification of resilience outcomes, as well as to help communities to identify agroecosystem vulnerability and resilience enhancing innovations, how to test and implement these innovations, monitor progress and analyze and evaluate results.

Presentation

This guidance note provides conceptual and methodological elements for developing and promoting agroecological innovations within country strategies to address agroecosystem resilience in specific production landscapes. The guide explains basic agroecological concepts, principles and its application in the design and management of biodiverse and resilient farming systems. The guide builds on the COMDEKS landscape approach but strengthens its agroecosystem component so that it is more effective in building the social, economic and ecological resilience of production landscapes. Described landscape management strategies aim at building social and ecological resilience of rural communities while enhancing biodiversity and ecosystem services; smallholder agroecosystem productivity and sustainability.

The guide which complements a farmers manual on agroecology and resiliency, provides tools and methods that can be used by practitioners to engage smallholder organizations in the participatory analysis of how well agroecological principles are being applied in their farming systems, and assessment of agroecosystem vulnerability to impacts of climate change, as well as the identification of ways to improve resilience outcomes. The goal is to use this guidance note to improve how an integrated portfolio of projects should be developed to maximize impacts on agroecosystem resilience, landscape restoration, community capacity development and agroecological knowledge generation and dissemination.

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1. Baseline vulnerability assessment

A baseline sustainability assessment is necessary in selected regions in order to identify systems that have withstood climatic events recently or in the past, to assess the level of vulnerability of a range of farming systems to such events, but more importantly to understand the agroecological features that allowed some of these farms to resist and/or recover from droughts, storms, floods or hurricanes. The derived resilience principles can then be disseminated to family farmers in neighboring communities and others in the region via field days, cross-visits, and other farmer to farmer mechanisms. The main goal of these activities is to explain farmers how to assess the level of vulnerability of each farm and then explore ways to enhance via agroecological practices the resiliency of farms to both drought and strong storms.

Resilience can be understood as the propensity of a system to retain its structure and productivity following a perturbation. Thus, a “resilient” agroecosystem would be capable of providing food production, when

challenged by severe drought or by excess rainfall.

When exposed to climate change, the resulting risk endured by a farm is the product between threat, vulnerability and response capacity as described in:

$$\text{Risk} = \frac{\text{Vulnerability} * \text{Threat}}{\text{Response Capacity}}$$

- *Threat* is the climatic event’s intensity, frequency, duration and level of impact (i.e. yield losses due to storm or drought)

The resulting risk is the product between threat, vulnerability, and response capacity. For an event to be considered a risk depends on whether in a particular region there is a community that is vulnerable to it (Figure 1).

- *Vulnerability* can be defined as the possibility of loss of biodiversity, soil and water resources, or productivity by an agroecosystem when confronted with an external perturbation or shock. Vulnerability

refers to the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate variability and denotes an incapacity to adapt.

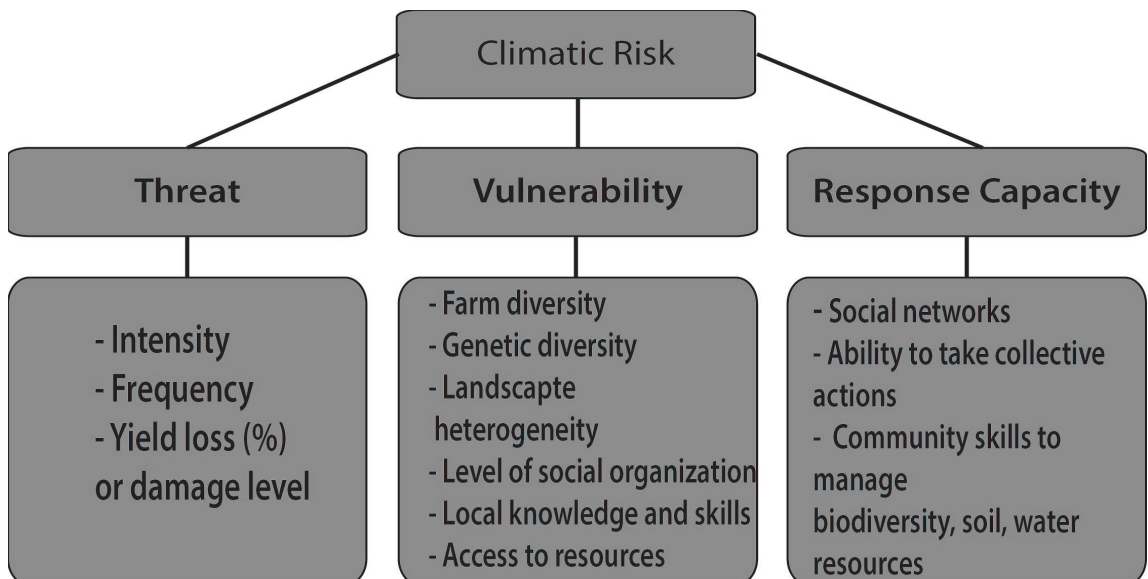
The level of vulnerability of a farm is determined by its type of agroecological infrastructure (level of landscape, crop and genetic diversity, soil quality and cover, etc.) and social traits of the family or community (levels of organization and networking, food self-sufficiency, etc.). A community's vulnerability is higher if the levels of landscape and farm diversity are low and the community's social organization is weak and lacks

the necessary knowledge or skills to respond.

Vulnerability can be reduced by the "response capacity" of the community which is defined as the agroecological features of the farms and the management strategies used by farmers to reduce climatic risks and to resist and recover from such events. Adaptation refers to the adjustments made by farmers to reduce risks (Figure 2).

The capacity of farmers to adapt is based on the individual or collective reserves of human and social capital that include attributes such as traditional knowledge

Figure 1. Socioecological features that determine the vulnerability and reactive capacity of farmers to enhance the resiliency of their farms and communities to climatic threats.

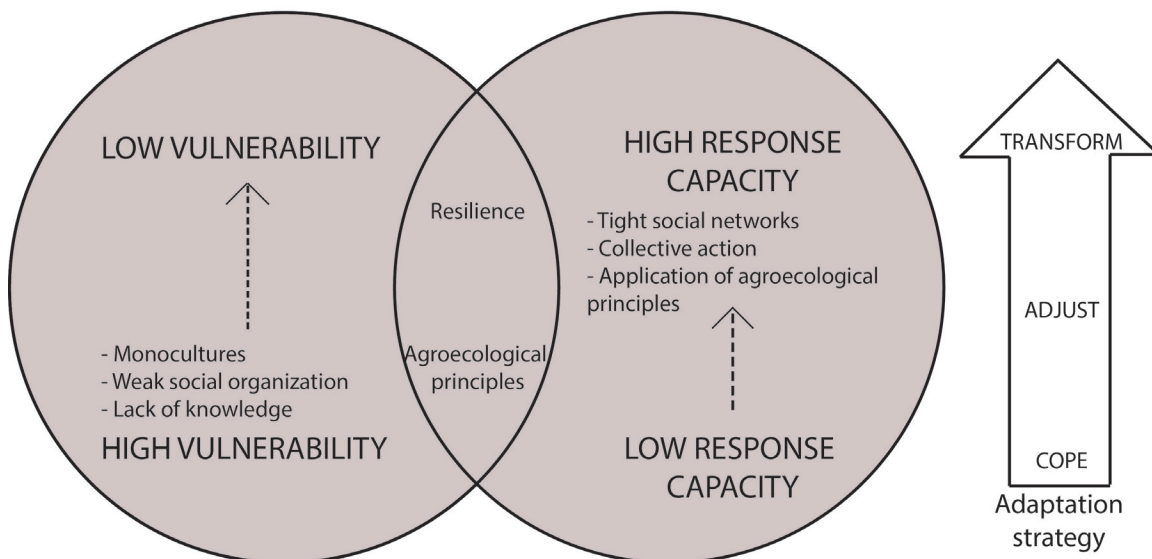


and skills, levels of social organization, and safety networks, etc.

A community with a high level of response capacity will feature highly cohesive social networks capable of taking collective action to mobilize local skills and agroecological knowledge to enhance the overall resilience of affected farms.

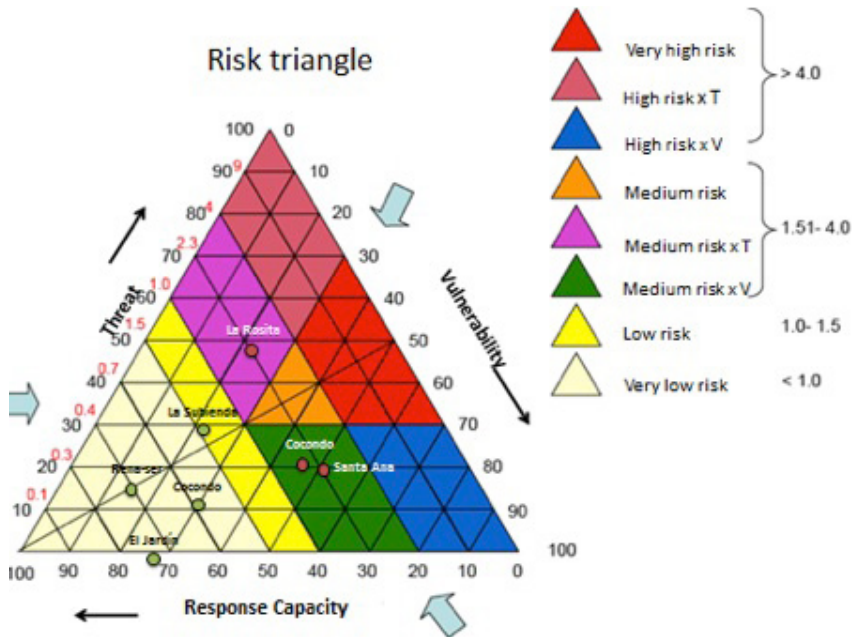
By applying simple indicators with values from 1-10 (1= high vulnerability and low response capacity), vulnerability, response capacity and the impact of the threat (i.e. % yield loss) can be estimated for each farm in a landscape. The measured values can be plotted in a triangle diagram which will indicate according to the position in the triangle, which farms are at high, medium or low risk (Figure 3)

Figure 2. Resilience as the result of how effectively the enhanced reactive capacity of a community is able to reduce vulnerability and therefore climatic risk. An effective adaptation strategy evolves from coping to adjusting to climatic variability, although the ultimate goal is the transformation of the vulnerable system.

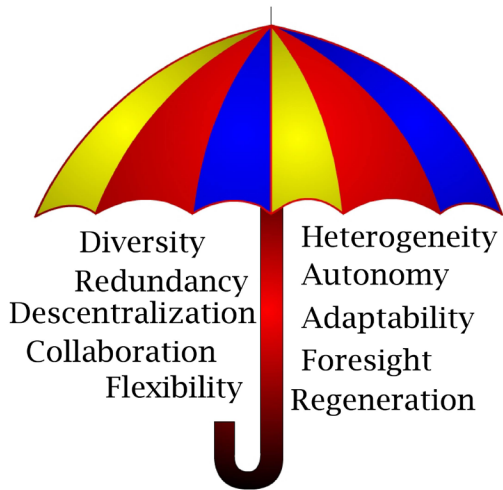


- ✓ The primary purpose of assessing resilience is to identify vulnerabilities in social-ecological systems so that action can be taken to create a more sustainable future for people and the land. The ability of rural communities to adapt in the face of external social, political, or environmental stresses must go hand in hand with ecological resiliency.
- ✓ To be resilient, rural societies must generally demonstrate the ability to buffer disturbance with agroecological methods adopted and disseminated through self-organization and collective action.
- ✓ The vulnerability will be reduced in communities where the natural and social capital is well developed.
- ✓ Reducing social vulnerability through the extension and consolidation of social networks, both locally and at regional scales, can contribute to increases in agroecosystem resilience.

Figure 3. A risk triangle showing the location of farms (agroecological –green dots and conventional–orange dots in Antioquia, Colombia) along a gradient of vulnerability and capacity of response values. The graph allows mapping of farms that are at high, medium or low risk from extreme climatic events. The goal is to define the agroecological strategies that will move farms in the medium-high risks areas of the triangle to the low risk areas in the lower left of the triangle.



Principles of Resiliency



Ten key principles to consider when implementing resiliency strategies in rural communities

Monocultures tend to be more vulnerable to drought than polycultures in Mixteca Alta, Mexico

2. Methods to assess resiliency in a community

The farmer's manual that complements this guidance note provides an assessment method, which can be applied across many farms in the community and the results collated for discussion. After the diagnosis conducted by farmers, different agroecological measures would be expected to be applied to enhance resiliency for each individual farm, depending on each one's situation.

Participating farmers conduct observations of the landscape in which their farms are inserted to determine their level of vulnerability considering variables such as slope, exposure, presence of windbreaks or distance to protective forests. Similarly farmers carry out observations of features or their farms (level of crop diversity, soil cover, soil structure and organic matter content, etc.). Each of these observed features of characteristics is considered an indicator, which reflects an aspect,

condition or change of the landscape or farm (Table 1)

The "semaforo" (traffic lights) method allows farmers to rank each indicator in colors: red signifies high (risk-values 1-2 in a scale of 1-5), yellow (medium risk-values 3-4) and green (little or no risk, value of 5). For example, a farm located in a landscape void of natural vegetation would receive a red score for the indicator landscape diversity.

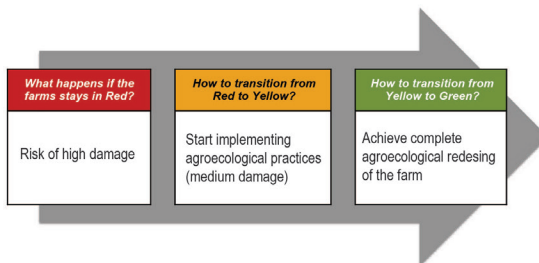
On the contrary a farm totally surrounded by forests would receive a green score for the same indicator. Colors prompt farmers to think about what it means that a set indicators exhibit the color red or yellow and the consequences for the farmer if the indicators remain yellow or red. Such reflections lead farmers to think about what to do to transition their systems towards a state of higher resilience, towards green (Figure 4).

Table 1. Farm and landscape features to be observed when assessing the readiness of agroforestry systems to the impact of a storm or hurricane.

<p>Landscape level</p> <p><u>Landscape diversity</u>: it refers to the mix of mosaics of natural areas and production systems in the surveyed region, including forest patches, hedgerows, cropping systems and their slope and exposure, water courses, etc. The higher the landscape diversity, the lower are the chances of a disaster to cause damage, as surrounding forests can protect against winds and regulate local water cycles, and when crops are grown at various altitudes, slopes and exposures damage levels can be reduced.</p> <p><u>Slope</u>: The steeper the slope the highest the expected damage by rains if no conservation practices are in place.</p> <p><u>Exposure of the hillside</u>: crops grown on hill sides directly exposed to dominant and strong winds will suffer more damage and are potentially subjected to mudslides</p> <p><u>Proximity to forests or protective hills</u>: farms adjacent to forests or hills that intercept dominant winds and rains are generally less exposed to the effects of hurricanes</p> <p><u>Windbreaks and/or hedgerows</u>: depending on its vegetational structure (species composition, density and stratification), location, etc, these structures can intercept dominant winds and exert a protective role.</p> <p><u>Proximity to rivers</u>: farms located in lower zones close to rivers can suffer flooding when excess rain occurs</p> <p>Farm level</p> <p><u>Plant diversity</u>: the higher the plant diversity and complexity (vertical stratification) of the farm, AFS will be more resistant to impacts of hurricanes.</p> <p><u>Root depth</u>: trees with deep roots tend to hold the soil and are more resistant to being uprooted by strong winds.</p> <p><u>DAP (diameter at chest level)</u>: the higher the DAP value and the more the vigorous is the tree, the lower the possibility of branch breaking and for the trees to fall down.</p> <p><u>Soil structure</u>: soils with good aggregation exhibit high infiltration rates thus avoiding saturation and runoff</p> <p><u>Soil organic matter</u>: Soils rich in organic matter exhibit better structure and higher infiltration rates.</p> <p><u>Soil cover</u>: Soils with a thick mulch or a living cover crop exhibit lower erosion rates</p> <p><u>Soil conservation practices</u>: the use of practices such as mulching, living or dead barriers, terraces, contour planting protect soils from the erosive effect of runoff</p> <p><u>Drainage</u>: the presence of infiltration trenches, drainage canals and other works are key to deviate excess water and diminish water velocity and landslides.</p> <p><u>Food self-sufficiency (% of family food produced in the farm)</u>: the higher the degree of self sufficiency of a family, the less a family depends on external sources of food many times interrupted by heavy storms or hurricanes.</p> <p><u>Level of farmer knowledge and skills on adaptive practices</u>: Farms managed by farmers with higher skills and knowledge about adaptive practices will better resist hurricanes and will recover its productive capacity faster after the event.</p>

Figure 4. A semaforo (traffic light) system assigning colors to the degree of vulnerability or resilience of a particular farm, depicting the consequences of staying in red or yellow and the actions needed to be taken in order to transition the system to a state of higher resilience (green).

Color	Situation	Action	Numerical Value
Green	Low Vulnerability or High Resilience	Maintain the level of management / conservation (Vigilance)	5
Yellow	Medium vulnerability	Must do something to improve (caution)	3 – 4
Red	High vulnerability	Must do much to improve (Risk)	1 – 2



Farms inserted in a complex landscape matrix exhibit higher resilience.



3. Outcomes reflecting agroecological improvements of overall resilience

When applying agroecological principles farmers and their farming systems can respond creatively and adaptively to environmental change (Figure 5). Depending on the socio-economic, cultural and environmental realities of each community, these principles take different technological forms and are applied as a set of practices.

For example, a key agroecological

principle is diversity. Diversification at the field level occurs through practices such as variety mixtures, rotations, polycultures, agroforestry, crop-livestock integration, etc.

Emergent ecological properties develop in diversified farms allowing the system to sponsor its own soil quality and fertility, pest regulation and total farm production (Figure 6)

A set of combined agroecological

Figure 5. Six key agroecological principles that when applied through site specific practices lead to an agroecosystem design that allows the farming system to sponsor its own function (nutrient cycling, pest regulation, productivity) without need of external inputs.

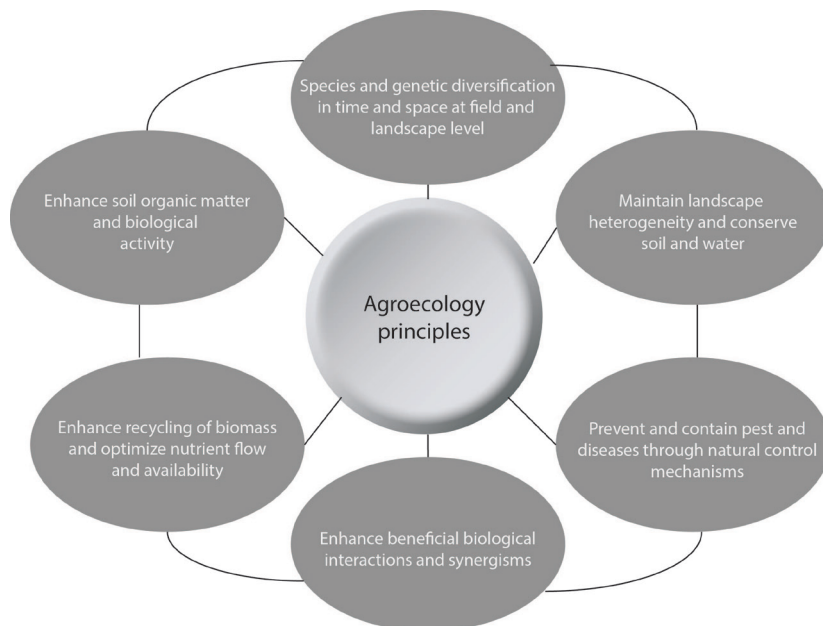
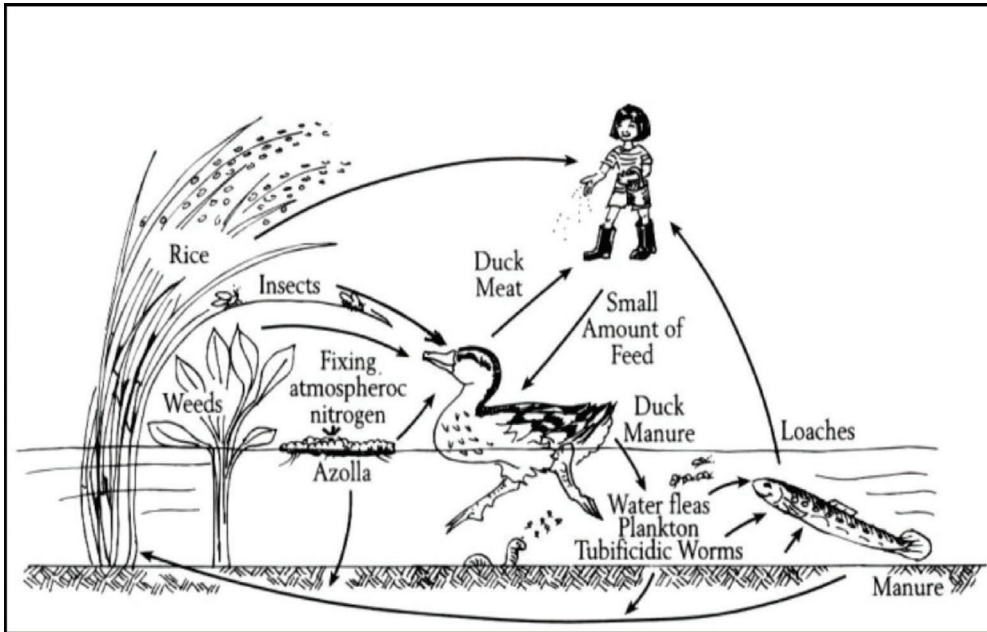
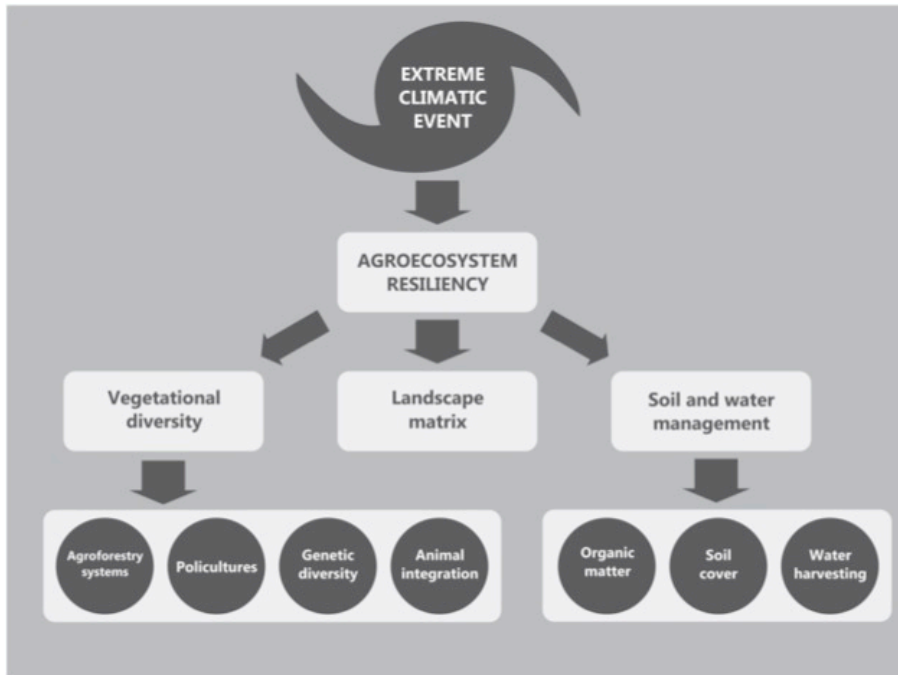


Figure 6. A traditional rice paddy system in Asia where interactions between rice, azolla, fish, ducks, weeds and organic matter sponsor nutrient cycling, pest regulation and other processes necessary to achieve stable yields. The function of the farm is the result of the correct assemblage of biodiversity which through interactions set in motion ecological processes in the agroecosystem.



- ✓ Biodiversity enhances ecosystem function because components that appears redundant at one point in time become important when some environmental change occurs. The redundancies allow for continued ecosystem functioning in the midst of climatic or other changes.
- ✓ On the other hand, a diversity of species acts as a buffer against failure due to environmental fluctuations, by enhancing the compensation capacity of the agroecosystem, because if one species fails, others can play their role, thus leading to more predictable aggregate community responses and enhanced ecological resiliency.
- ✓ Agroecosystems tend to be more resilient when inserted in a complex landscape matrix, featuring genetically heterogeneous and diversified cropping systems managed with organic matter rich soils and water conservation-harvesting techniques (Figure 7).

Figure 7. Landscape heterogeneity, on farm diversity and soil and water conservation features that enhance the ecological resiliency of farms to climate change



strategies confer farming systems resilience to climate change as greater agroecosystem diversity may buffer against shifting rainfall and temperature patterns and possibly reverse downward trends in yields over the long term as a variety of crops and varieties respond differently to such shocks (Figure 8)

Farming systems managed with agroecological principles exhibit a number of socio-ecological features that when identified in an agroecosystem,

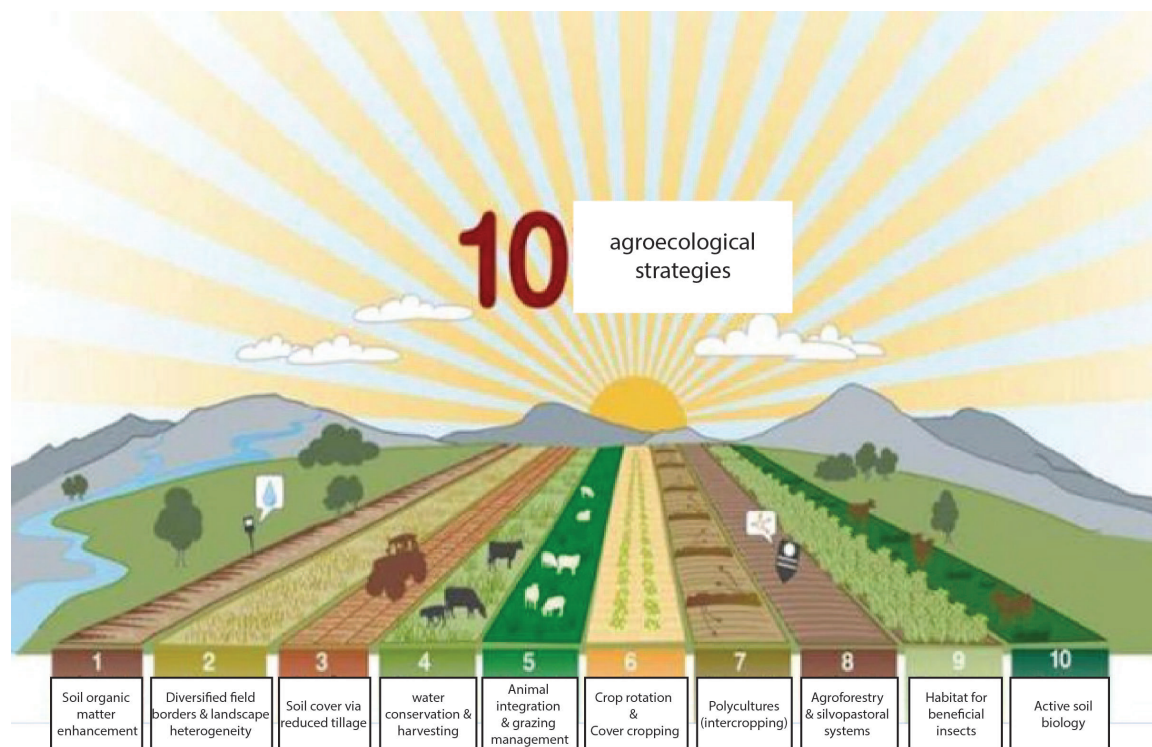
suggest that it is resilient and endowed with a capacity for adaptation and transformation. The presence of these features identifies resilience in the system; their absence or disappearance suggests vulnerability and movement away from a state of resilience (Table 2)

Another way of exploring whether a particular agroecological project is addressing pressing community concerns is to establish a set of questions (Table 3) that examine whether or not current management practices

Table 2. Socio-ecological features of Resilient Farming Systems and Communities

- ✓ High levels of biodiversity and species redundancy
- ✓ High connectivity and complementarity between farm components
- ✓ High spatial and temporal heterogeneity at the farm and landscape level
- ✓ High levels of autonomy and independence from exogenous controls
- ✓ Socially self organized conforming configurations based on needs and aspirations
- ✓ Reflective people that anticipate and plan for change
- ✓ High levels of cooperation and exchange
- ✓ Community honors legacy and use traditional knowledge and practices as well as local germplasm
- ✓ Human capital developed and able of mobilizing resources through social networks

Figure 8. Ten key agroecological strategies that confer diversity, efficiency, resiliency and sustainability to agroecosystems.



Polycultures are an example of biodiverse systems that confer farmers higher production stability



Table 3. A set of guiding questions to assess if proposed agroecological interventions are contributing to resiliency and sustainable livelihoods

1. Are they reducing poverty?
2. Are they based on rights and social equity?
3. Do they reduce social exclusion, particularly for women, minorities and indigenous people?
4. Do they protect access and rights to land, water and other natural resources?
5. Do they favor the redistribution (rather than the concentration) of productive resources?
6. Do they substantially increase food production and contribute to household food security and improved nutrition?
7. Do they enhance families' water access and availability?
8. Do they regenerate and conserve soil, and other landscape elements such as vegetation cover?
9. Do they reduce soil loss/degradation and enhance soil regeneration and fertility ?
10. Do practices maintain or enhance organic matter and the biological life of the soil?
11. Do they prevent pest and disease outbreaks?
12. Do they conserve and encourage agrobiodiversity?
13. Do they reduce greenhouse gas emissions?
14. Do they increase income opportunities and employment?
15. Do they reduce variation in agricultural production under climatic stress conditions?
16. Do they enhance farm diversification and resilience?
17. Do they reduce investment costs and farmers dependence on external inputs?
18. Do they increase the degree and effectiveness of farmer organizations?
19. Do they increase human capital formation?
20. Do they contribute to local/regional food sovereignty?

are contributing to resiliency and sustainable livelihoods by improving natural, human, social, physical and financial capital.

Additionally it is important to check whether the project is meeting certain goals and supporting the following principles for a sustainable and resilient agriculture:

- ✓ Promotes durable total farm productivity with crops exhibiting stable yields and nutritional quality to meet existing and projected future needs in the community.
- ✓ Minimizes adverse effects of agricultural practices on soil fertility, water quality, biodiversity and human health.
- ✓ Reduces risks and enhances resiliency to external shocks including climate variability.
- ✓ Enhances biodiversity and associated ecosystem services at the landscape and farm level.
- ✓ Prevents land degradation and water contamination and loss.
- ✓ Optimizes protection, use and recycling of renewable resources while minimizing use of non-renewable resources and external inputs.
- ✓ Promotes economic viability by reducing technological and input dependency, reducing production costs and creating local solidarity markets.
- ✓ Contributes to social justice and cultural cohesion.

Maintaining local genetic diversity is a major goal of agroecological initiatives

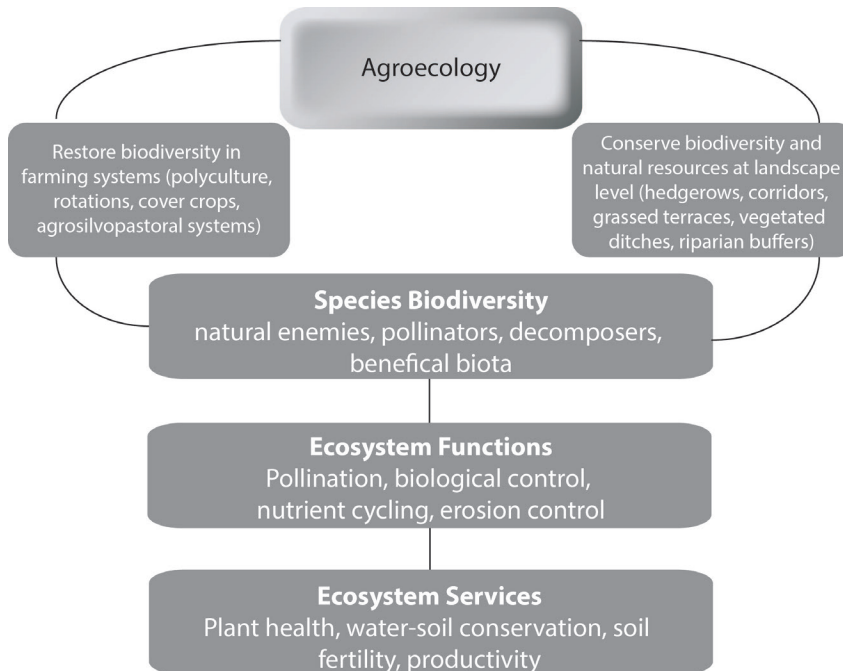


4. Actions required to achieve or work toward resiliency outcomes

The ultimate goal of an agroecological strategy is to knit together agroecosystems within a landscape unit, with each system mimicking, in the best way possible, the structure and function of natural ecosystems. Restoring ecological services in farms involves using various plant diversification

schemes at the farm level (polycultures, rotations, cover crops, agroforestry, etc.) and at the landscape level (hedgerows, corridors, etc.), which bring back the components of a functional biodiversity necessary for maintaining ecological functions (Figure 9)

Figure 9. Agroecology provides the theory and principles to restore biodiversity in farming systems embedded in production landscapes. Restoration and conservation of biodiversity through diversification strategies enhance functional biodiversity which in turn provide ecosystem services key for landscape integrity and agroecosystem productivity.



4.1 Actions at the landscape level

Agricultural landscapes are important as they provide multiple functions, and therefore they need to be protected and diversified in order to restore, harness, and conserve natural resources and associated ecosystem services.

Diversification at the landscape scale may occur by integrating multiple production systems such as mixing agroforestry management with cropping, livestock, and fallow with patches of natural vegetation to create a highly diverse mosaic type agricultural landscape. Agroecological practices confer resiliency to the landscape and embedded farms (Table 4).

Farms are nested within larger landscapes and thus interact with other land uses. The overall performance of

such farms depends on how effectively they take advantage of the suite of ecosystem services provided by surrounding natural or unmanaged ecosystems.

Small crop fields inserted in a complex landscape tend to exhibit higher resiliency than larger fields surrounded by cleared land or simplified agricultural landscapes containing only small fragments of natural habitats.

The expansion of large monoculture agriculture at the expense of natural habitats, in combination with high agrochemical inputs in crop fields, are the primary causes for the rapid decrease of biodiversity in many landscapes with the consequent deterioration of ecosystem functions.

Table 4. Appropriate agroecological management can restore landscape functions by promoting key practices that confer adaptation features at the landscape level.

- ✓ Maintenance of landscape diversity-including a mosaic of agricultural and natural habitat.
- ✓ Maintaining a complex matrix of field margins, riparian buffers and forest edges around farms yields several ecological services for farmers.
- ✓ Keeping forest fragments adjacent to agricultural systems increase pollination and pest control services by harboring beneficial insects.
- ✓ Natural ecosystems may also purify water and regulate its flow into agricultural systems.
- ✓ Establishment of agroforestry and silvopastoral systems.
- ✓ Increase the duration of fallow periods in selected fields.
- ✓ Restoration of degraded lands.
- ✓ Restoration and conservation of wetlands.
- ✓ Reduced expansion of cropland into remaining natural habitats.
- ✓ Maintenance of habitat connectivity for faunal movement across the landscape.



Practices that should be avoided as they reduce biodiversity and resiliency at the landscape level.

- ✓ Specializing on one or two crops instead of mixed farming.
- ✓ Converting perennial habitat (i.e. grassland) to arable fields.
- ✓ Destroying edge habitats (hedges, field boundaries, buffer zones along creeks).
- ✓ Reallocating land to increase field size and make farms more compact.
- ✓ Simplifying landscapes with a spatially and temporally limited number of land-use types increasing landscape homogeneity.
- ✓ Giving up traditional, low-intensity land-use management.
- ✓ Avoiding set-aside fallows and cultivating formerly abandoned areas (old fields, fallows).
- ✓ Fragmenting natural habitat.

4.2 Actions at the farm level

Agroecology provides the basic ecological principles (Table 5) for the design and management of agroecosystems that are biodiverse, productive, resilient and natural resource conserving. Such systems are also culturally sensitive, socially just and economically viable.

The application of agroecology leads to the development of agroecosystems with a minimum dependency on agrochemical inputs and energy, emphasizing interactions and synergisms among the many biological components of diversified farms, which lead to enhanced nutrient and biomass recycling, biological pest control and stabilized yields, while improving overall resilience, ecological efficiency and environmental protection.

The main goal of designing a diversified farming system is the enhancement and maintenance of agrobiodiversity as a strategy for provisioning ecological services which emerge from beneficial ecological interactions among crops, animals and soils deployed in the farms.

By strengthening the weak ecological functions in the agro-ecosystem, farmers first reduce and substitute external with internal inputs. Farmers gradually eliminate inputs altogether by redesigning the farm system to rely primarily on ecosystem functions.

There are many agroecological management practices that increase agroecosystem diversity and complexity as the foundation for soil quality, plant health, and crop productivity.

Table 5. Agroecological principles for the design of biodiverse, energy efficient, resource-conserving and resilient farming systems

- ✓ Enhance the recycling of biomass, with a view to optimizing organic matter decomposition and nutrient cycling over time.
- ✓ Strengthen the “immune system” of agricultural systems through enhancement of functional biodiversity – natural enemies, antagonists, etc. by creating appropriate habitats.
- ✓ Provide the most favorable soil conditions for plant growth, particularly by managing organic matter and by enhancing soil biological activity.
- ✓ Minimize losses of energy, water, nutrients and genetic resources by enhancing conservation and regeneration of soil and water resources and agrobiodiversity.
- ✓ Diversify species and genetic resources in the agroecosystem over time and space at the field and landscape level.
- ✓ Enhance beneficial biological interactions and synergies among the components of agrobiodiversity, thereby promoting key ecological processes and services.

In agroecology the emphasis is on diversifying and strengthening the agro-ecosystem by adding regenerative components such as combining crops in intercrops, animals and trees in agrosilvopastoral systems, using legumes as cover crops or in rotations or raising fish in rice paddies. (Table 6)

- ✓ Agroecology does not promote technical recipes but rather principles, which when applied in a particular region take different technological forms depending on the local socio-economic needs of farmers and their biophysical circumstances.
- ✓ The applied practices set in motion ecological interactions that drive key processes for agroecosystem function (nutrient cycling, pest regulation, productivity, etc.)
- ✓ Agroecology is not about promoting a few magic bullet solutions that are divorced from local contexts and can be disseminated following top-down approaches. It relies on the quality of complex interactions that result from the adequate combination of various practices whose operationalization in particular circumstances will necessarily have to change depending on each context, since each environment has its own characteristics.
- ✓ Depending on how it is concretely applied and complemented or not by other practices, one particular practice can sometimes function as an “ecological turntable” by activating key processes such as recycling, biological control, antagonisms, allelopathy, etc., essential for the sustainability and productivity of a particular farming system (Figure 10).

Figure 10. Cover crops as an example of a key practice that acts as an “ecological turntable” which affects many agronomic factors simultaneously thus activating several key processes in the farming system.

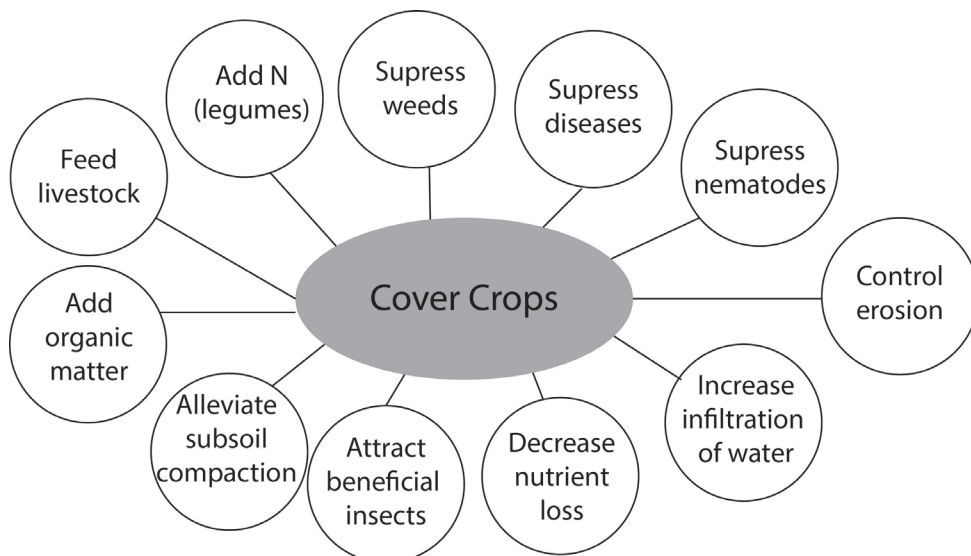


Table 6. Temporal and Spatial Designs of Diversified Farming Systems and Their Main Agroecological Effects.

<p><u>Crop Rotations:</u> Temporal diversity in the form of cereal-legume sequences. Nutrients are conserved and provided from one season to the next, and the life cycles of insect pests, diseases, and weeds are interrupted.</p> <p><u>Polycultures:</u> Cropping systems in which two or more crop species are planted within certain spatial proximity result in biological complementarities that improve nutrient use efficiency and pest regulation thus enhancing crop yield stability.</p> <p><u>Variety Mixtures:</u> Incorporating landraces and local varieties mixed with improved ones enhances adaptability to changing soil and climatic conditions and enhances resistance to diseases.</p> <p><u>Agroforestry Systems:</u> Trees grown together with annual crops in addition to modifying the microclimate, maintain and improve soil fertility as some trees contribute to nitrogen fixation and nutrient uptake from deep soil horizons while their litter helps replenish soil nutrients, maintain organic matter, and support complex soil food webs.</p> <p><u>Cover Crops and Mulching:</u> The use of pure or mixed stands of grasslegumes e.g., under fruit trees can reduce erosion and provide nutrients to the soil and enhance biological control of pests. Flattening cover crop mixtures on the soil surface in conservation farming is a strategy to reduce soil erosion and lower fluctuations in soil moisture and temperature, improve soil quality, and enhance weed suppression resulting in better crop performance.</p> <p><u>Green Manures:</u> Those are fast-growing plants sown to cover bare soil. Their foliage smothers weeds and their roots prevent soil erosion. When dug into the ground while still green, they return valuable nutrients to the soil and improve soil structure.</p> <p><u>Crop- livestock mixtures:</u> High biomass output and optimal nutrient recycling can be achieved through crop-animal integration. Animal production that integrates fodder shrubs planted at high densities, intercropped with improved, highly-productive pastures and timber trees all combined in a system that can be directly grazed by livestock enhances total productivity without need of external inputs.</p>
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A complex and biodiverse cacao based agroforestry does not require external inputs to function and produce.



5. Identification of appropriate indicators and monitoring activities

Once a farm or group of farms has been intervened with agroecological practices an important task is to identify indicators that allow assessment of whether farmers are correctly applying the agroecological principles to achieve resilience.

The methodology offers a set of indicators (Table 7) consisting of observations or measurements that are done at the farm and landscape level to assess agroecological features of the farms which signal the performance of the farming systems. Indicators allow to determine if changes in species biodiversity, soil quality, plant health, crop productivity, etc.

are positively evolving and if not, practitioners need to prioritize the agroecological interventions necessary to correct observed soil, crop or system deficiencies.

Since all the measurements made are based on the same indicators, the results are comparable and it is possible to follow the evolution of the same agroecosystem along a timeline, or make comparisons between farms in various transitional stages.

Each indicator is valued separately and assigned with a value between 1 and 10, according to the landscape and farm attributes observed (1 being

Table 7. Indicators used to assess if farms are utilizing agroecological principles in their design and management.

- | |
|---|
| <ul style="list-style-type: none">✓ Landscape diversity (amount and type of vegetation surrounding farm)✓ On-farm crop and animal diversity (number of species)✓ Genetic diversity (number of local crop varieties and/or animal races)✓ Soil quality (organic matter content, structure, soil cover, infiltration, etc.)✓ Signs of degradation or resource losses (soil erosion signs, deforestation, fragmentation, state of water courses, efficiency in use of water, nutrient levels, etc.)✓ Plant health (presence of pests, diseases and weeds, crop damage)✓ Dependence of external inputs (% of inputs originating from outside of farm)✓ Levels of food self-sufficiency (% of food originating on farm)✓ Interactions and bio-resources flows between farm components (recycling of crop residues and manure; effective use of biomass, complementarities between plants; level of natural pest control, etc.)✓ Resilience to external disturbances (capacity to resist and recover from pests, droughts, storms, etc.)✓ Use of renewable energy (windmills, biogas etc) and level of energy self-sufficiency. |
|---|

the least desirable value, 5 a moderate or threshold value and 10 the most preferred value).

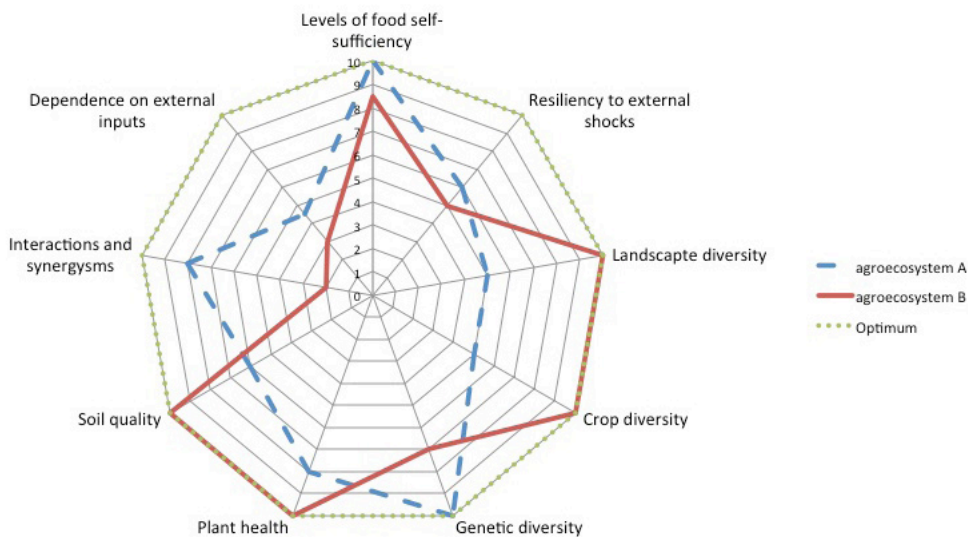
Once the indicators are ranked, each farmer can visualize the conditions of his or her farm, noticing which of the landscape, soil or plant attributes are sufficient or deficient compared to the threshold value of 5.

The indicators are more easily observed by using an amoeba-type graph as it allows one to visualize the general status of soil quality and crop health, considering that the closer the amoeba approaches the full diameter length

of the circle the more sustainable the system is (a 10 value). Farms with an overall value lower than 5 in soil quality and/or crop health are considered below the sustainability threshold, and rectifying measures should be taken to improve the indicators exhibiting low values on the targeted farms (Figure 11).

The amoeba shows which indicators are weak (below 5) allowing farmers to prioritize the agroecological interventions necessary to correct soil, crop or system deficiencies. At times it may be possible to correct a set of deficiencies just by intervening on one specific attribute. For instance,

Figure 11. Amoeba type diagram exhibiting indicator values for key agroecological indicators in two agroecosystems, indicating that both systems still have some indicator values below 5, suggesting that agroecological principles are not being correctly applied and thus corrections in design and practices need to be implemented.





increasing the species diversity or the soil organic matter will in turn affect other system attributes. By adding organic matter several simultaneous positive effects can be achieved: increased soil's water carrying capacity, enhanced soil biological activity, and improved soil structure.

The average values of all measured indicators for each farm can be obtained

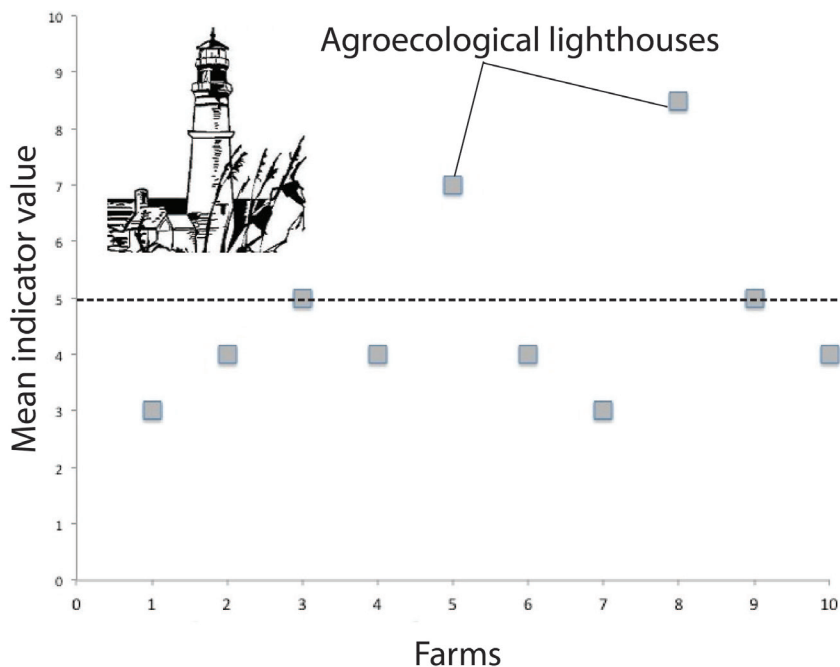
and then plotted as shown in Figure 12 allowing researchers and farmers to visualize how each farm fares in relation to the threshold level (5). This graph clearly depicts the "above-average" farms with total indicators means above 5, which are considered to be undergoing agroecological transition.

Farms with values above 7- 8 are considered agroecological lighthouses

(farms where agroecological processes operate optimally) that can be featured in field days or other farmers exchange activities. The idea here is not for farmers to copy the techniques that lighthouse farmers use, but rather to emulate the processes, synergisms and interactions that emerge from the

way biodiversity is deployed in each lighthouse farm conditioning a specific ecological infrastructure, which in turns determines the successful performance of the lighthouse farms.

Figure 12. Hypothetical comparison of combined averages of agroecological indicators of each farm, featuring averages for all farms assessed and allowing identification of farms with values higher than 7 which are considered agroecological lighthouses, from which farmers exhibiting low values can learn.



Desirable threshold levels of various indicators (values used herein are hypothetical; threshold levels should be determined by community members through a participatory process.) Thresholds are minimal values above which the community is progressing towards resiliency and sustainability.

At farm level

- ✓ Crop diversity (at least 3 species including at least one legume.)
- ✓ Genetic diversity (at least 2 varieties per crop species of which one is a local variety or landrace.)
- ✓ LER (land equivalent ratio) > 1,5. LER= Yield of crop 1 in polyculture/ Yield of crop 1 in monoculture+ Yield of crop 2 in polyculture/Yield of crop 2 in monoculture. When the LER value is higher than 1, it means the polyculture overyields. LER of 1,5 means that one hectare of polyculture produces 50% more than one hectare of monoculture.
- ✓ More than 80% of food consumed by family produced on farm. More than 9 months of household food provisions available.
- ✓ More than 70% of inputs (biomass, nutrients, water, etc.) originating on farm.
- ✓ More than 70% of the energy to run the farm originated internally (biogas, windmills, animal or human labor, etc.)
- ✓ Income (at least 30% income surplus after covering production costs). Net farm income rising.

At landscape level:

- ✓ More than 70% of land covered by vegetation.
- ✓ No more than 25% of land area showing signs of degradation (erosion rills, deforestation, fragmentation, overgrazing, etc.)
- ✓ At least 50% of the land area using improved agroecological practices.
- ✓ Noticeable presence of hedgerows, corridors, riparian forests, no less than 50% of such features protected.
- ✓ At least 50% of forest fragments protected excluding cattle access.
- ✓ No less than 50% water courses protected from contamination and conserving springs.

6. Considerations in the implementation of agroecological projects to enhance resiliency

6.1. Criteria for identifying landscapes to implement agroecological projects and landscape.)

✓ Landscapes with farming systems that may substantially contribute to food and livelihood security of local communities representing the majority of their livelihood provisions.

✓ Landscapes endowed with agricultural biodiversity and genetic resources (species, varieties & breeds), as well as other biodiversity such as wild relatives, pollinators and wildlife associated with the agricultural system

✓ Landscapes nurtured by farmers and /or indigenous peoples which still maintain invaluable knowledge, ingenious technology and management systems of natural resources, including seeds, biota, land, water.

✓ Landscapes with groups organized in social organizations and/or networks, including customary institutions for agro-ecological management, normative arrangements for resource access and benefit sharing, etc.

A rice landscape endowed with agricultural biodiversity nurtured by farmers with deep traditional knowledge.



✓ Landscape features resulting from human management, that provide particularly ingenious or practical solutions to environmental challenges (i.e. water management, soil conservation) and create opportunities for enhancement of biodiversity conservation, and collective recreational, aesthetic, artistic, educational, spiritual, and/or scientific uses.

6.2. Restoring degraded landscapes.

Many rural landscapes face great challenges in adapting to rapid environmental and socio-economic changes including climate variability and economic pressures which lead

to environmental degradation, thus limiting the capabilities of local populations to meet their food security needs and livelihood requirements.

Agroecology provides the basis for a holistic approach to landscape design in which farming systems are optimized considering the ecological potential and the physical limits of the landscape.

In the case of highly degraded landscapes it is essential to conduct restoration strategies aimed at assisting the recovery of an ecosystem that has been degraded, damaged or destroyed.

By implementing agroecological strategies aimed at managing landscapes

Principles of ecological landscape restoration

- ✓ Identify the threats and causes of degradation.
- ✓ Stop degrading forces (keep cattle out, prevent fires, etc.)
- ✓ Reintroduce plant species as needed.
- ✓ Restoration techniques include practical techniques, such as agroforestry, enrichment planting, and natural regeneration at a landscape scale.
- ✓ Strategically locate vegetation necessary to achieve a set of functions such as habitat for wildlife, soil stabilization, provision of fuel or building materials for local communities.
- ✓ Protect area from further degradation (soil conservation practices, water harvesting, etc.) and use adaptive management practices.
- ✓ Monitor progress of restoration using performance indicators or reference ecosystems

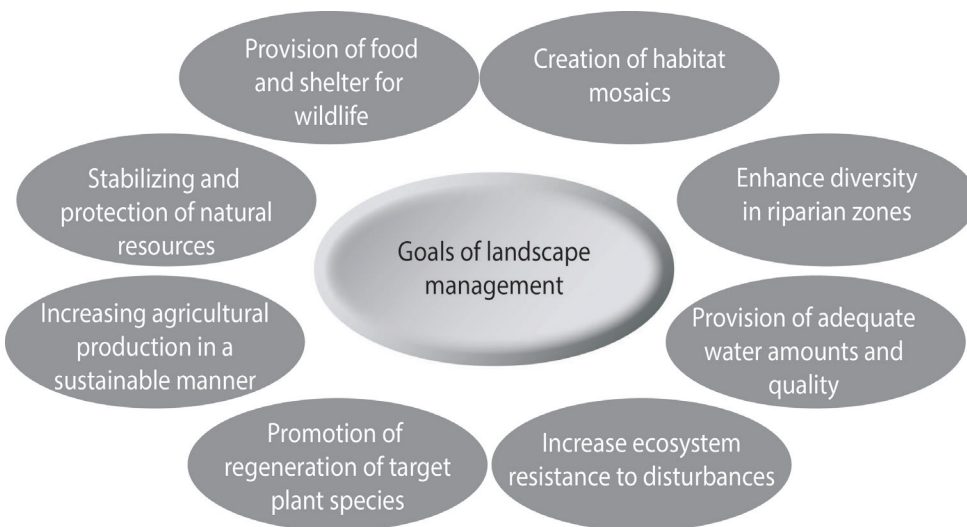
original biodiversity may be recovered and the protective function and many of the original ecological services may be re-established.

Reclamation: recovery of productivity at a degraded site using mostly fast growing rustic exotic tree species avoiding monocultures.

Rehabilitation: re-establishing the productivity and some of the plant and animal species originally present, thus the new forest cover may include species not originally present.

Ecological restoration: re-establishing the structure, productivity and species diversity of the forest originally present.

The goals of landscape management based on agroecological principles.



6.3 On farm implementation of an agroecological strategy

An adaptation is considered a key factor that will shape the future severity of climate change impacts on food production. Changes that will not radically modify the monoculture nature of dominant farming systems

may moderate negative impacts temporarily. The biggest and most durable benefits will likely result from more radical agroecological measures that will strengthen the resilience of farmers and rural communities, such as diversification of agroecosystems in the form of polycultures, agroforestry systems and crop-livestock mixed

systems accompanied by organic soil management, water conservation and harvesting and general enhancement of agrobiodiversity. Multi-country studies exploring resilience of smallholder farming systems to climate variability and change conducted in Latin America and Africa, revealed the following farmers priorities for strategies to adapt to climate change: (a) improving soil fertility with green manures and organic residues (b) conserving water and soil (c) developing mechanisms for establishment and sustenance of local strategic food reserves, (d) supporting traditional social safety nets to safeguard vulnerable social groups, (e) conservation of indigenous

fruit trees and other locally adapted crop varieties,(f) use alternative fallow and tillage practices to address climate change-related moisture and nutrient deficiencies and (g) change land topography to address the moisture deficiencies associated with climate change and reduce the risk of farm land degradation.

Understanding the agroecological features that underlie the resilience of traditional agroecosystems that exhibit resiliency properties is an urgent matter, as they can serve as the foundation for the design of adapted agricultural systems.

After hurricane Mitch in Centra America diversified farms managed with agroecological principles resisted more than monocultures



7. Requirements for successful implementation

Is the project

- ✓ Generating early success and creating enthusiasm in communities?
- ✓ Maximizing the use of local resources and knowledge, but integrating useful new practices as well?
- ✓ Using the knowledge of the community to understand problems and to design interventions to improve the farming systems?
- ✓ Focusing on principles rather than on technologies?
- ✓ Encouraging farmers to diversify their farming systems?
- ✓ Prompting farmers to experiment to improve soil and water management and in situ conservation of local seeds?
- ✓ Strengthening local organizations to manage the process?
- ✓ Making sure that agroecological interventions provide accessible and rapid benefits to the community?

Are projects promoting social and human capital?

- ✓ Supporting collaborations among farmers organizations and other actors (NGOs, research institutions, local governments, etc.) working on agroecological solutions and sustainable food systems.
- ✓ Strengthening marginalized actors such as women, children and elderly people as well as farmers organizations.
- ✓ Making productive use of people's collective capacities to work together to solve common agricultural and natural resource problems.
- ✓ Targeting specific solutions that require collective action, such as agroecological practices of soil conservation, agro-biodiverse seed houses and re-localized markets.
- ✓ Ensuring a farmer-led, bottom-up approach: putting farmers in the driver's seat of the process through the most adequate methodologies for promoting farmers' innovation and horizontal sharing and learning.

- ✓ Encouraging diversification designs that break monocultures.
- ✓ Integrating biological and ecological processes such as nutrient cycling, nitrogen fixation, soil regeneration, allelopathy, competition, predation and parasitism into food production processes.
- ✓ Minimizing the use of agrochemical inputs that cause harm to the environment or to the health of farmers and consumers.
- ✓ Making productive use of the knowledge and skills of farmers, thus improving their self-reliance and substituting human capital for costly external inputs.

It is important to be aware that in each region there may be several factors limiting the adoption and implementation of agroecological practices. These may include lack of farmer to land, seeds, water, appropriate information and extension services, local and regional markets and credit and absence of government policies conducive to upscaling agroecology. Labor requirements maybe higher in agroecological farms and many women are marginalized and lack decision making power, constraining the adoption of agroecology. It is crucial to establish targeted schemes, both

integrating women, men and youth, to ensure that farmer-led, bottom up participatory processes lead to the co-construction of agroecological knowledge and its dissemination.

Agroecological projects encourage collective actions and solidarity.



Community agroecological projects aim at sustaining localized, viable, diverse, and productive peasant and family farms and food systems that are integral to vibrant local and regional economies, and which link rural and urban small-scale producers and consumers in healthy and culturally enriching ways. As such, agroecological projects:

- ✓ Build on the existing skills and practices of food-producing communities.
- ✓ Incorporate local culture and knowledge (in particular the knowledge of indigenous people and women).
- ✓ Encourage local food sovereignty and economic resilience,
- ✓ Strengthen family and community health.
- ✓ Protect natural resources including agrobiodiversity.
- ✓ Mitigate the negative effects of climate change while implementing adaptation practices.

8. Why is it important to consider traditional knowledge?

Agroecological systems are deeply rooted in the ecological rationale of traditional small-scale farmers who for centuries have developed farming systems many of which offer promising sustainability models as these systems promote biodiversity, thrive without agrochemicals, and sustain year-round yields meeting local food needs.

The evolution of these systems has been nourished by complex forms of traditional knowledge about vegetation, animals, soils, etc., within a certain geographical and cultural radius. Rural

knowledge is based on observation and on experimental learning. Successful adaptations are passed from generation to generation and historically successful innovations have been widely shared with members of the community.

The ensemble of traditional crop management practices represent a rich resource for agroecologists seeking to create novel agroecosystems well adapted to the local agroecological and socioeconomic circumstances of smallholders.

Contributions emerging from the correct retrieval and use of traditional ecological knowledge results in the provision of:

- ✓ Detailed local knowledge on productive resources and environment (soils, plants, rainfall conditions, etc.).
- ✓ Time-tested, in-depth knowledge of the local area as an essential part of any agroecological intervention.
- ✓ Identification of best-farmer practices for dissemination to other farmers and areas; use of locally adapted crop varieties and animal species;
- ✓ Criteria for technology development considering local goals and priorities, gender preferences, etc.
- ✓ Identification of best-farmer practices for dissemination to other farmers and areas; use of locally adapted crop varieties and animal species;
- ✓ A basis for testing new technologies and their 'rightness-of-fit' to local systems and circumstances.

Waru-warus in the high Andes represent models of resiliency against frost.



Campesino a Campesino is a cultural movement of horizontal exchange of innovation among peasants.



9. Agroecology and farmer-led participatory research

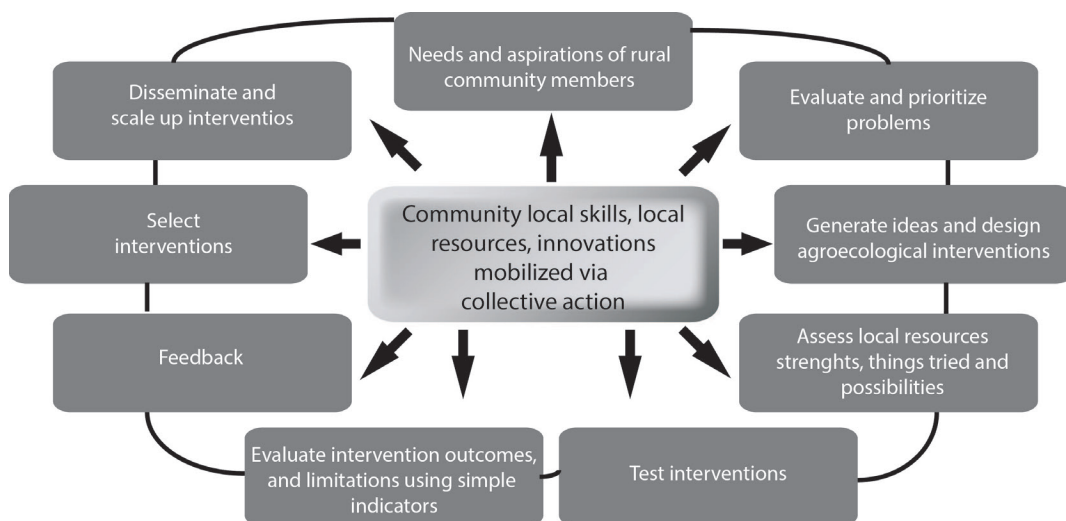
Agroecology is highly knowledge-intensive, and is based on techniques that are not delivered top-down but developed on the basis of farmers' knowledge and experimentation.

Agroecological innovations are born *in situ* with the participation of farmers in a horizontal (not vertical) manner and technologies are not standardized but rather flexible and respond and adapt to each particular situation.

Agroecology emphasizes the capability of local communities to experiment, evaluate, and scale-up innovations through farmer-to-farmer research and grassroots extension approaches.

During this participatory research process, farmers learn from each other by sharing wisdom, creativity and knowledge, not just techniques. Rather than simply transferring technologies, farmers primarily focus on principles and skills sharing, leading to collective action (Figure 13).

Figure 13. Steps in the process of agroecological participatory research, sharing of ideas, testing practices and dissemination among farmers.



Technological approaches emphasizing diversity, synergy, recycling and integration, and social processes that value community involvement, point to the fact that human resource development is the cornerstone of any strategy aimed at increasing options for rural people

In order for the technologies derived

from the application of principles to be relevant to the needs and circumstances of small farmers, the technological generation process must result from a participatory research process. This is why agroecology promotes community-oriented approaches emphasizing horizontal exchanges of ideas, self-reliance and community empowerment.

Basic principles used in farmer-to-farmer led agricultural experimentation and experience sharing

- ✓ Mobilize capacity for inquiry and foster novelty.
- ✓ Start small, grow slowly.
- ✓ Limit the introduction of technology emphasizing a limited number of practices so that farmers can manage the process of change.
- ✓ Small-scale experimentation to overcome limiting factors and stabilize ecological functions.
- ✓ Teach others, share innovations-Multiplier effect.
- ✓ To create a self-spreading effect, it is better to teach 100 farmers a few practices that work, rather than a few farmers 100 practices that work.
- ✓ Are there farmer-to-farmer sharing mechanisms of successful practices?
- ✓ Has a critical mass of adopters been reached, leading to a multiplier affect?
- ✓ Is the project strengthening local organizations to ultimately redesign and diversify their farms for autonomy, self sufficiency and resiliency?
- ✓ Is the project strengthening local organizations to manage the process?
- ✓ Are interventions providing accessible and rapid benefits to the community?



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