



Managing for Resilience

Framing an integrated landscape approach
for overcoming chronic food insecurity

*Louise E. Buck
Ian D. Bailey*

Authors

Louise E. Buck, EcoAgriculture Partners and Cornell University
Ian D. Bailey, Cornell University

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Cover Photo

A woman seeks water in a dry riverbed near Kataboi village in remote Turkana in northern Kenya.
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Correspondence

Please contact Landscape Strengthening Working Group co-leader Louise Buck with inquiries at lbuck@ecoagriculture.org.

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Louise E. Buck and Ian D. Bailey

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The Cornell Ecoagriculture Working Group engages faculty, staff and students in exploring socio-ecological approaches to landscape management. The cross-disciplinary group has roots in the Department of Natural Resources and collaborates closely with Ecoagriculture Partners to advance understanding and improve capacities for integrating production, conservation and livelihood goals at landscape scale. Find out more at www.ecoag.cals.cornell.edu.



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Acronyms

ASAL	Arid and semi-arid land
FAO	Food and Agriculture Organization of the United Nations
FFA	Food for Assets
FMNR	Farmer-managed natural regeneration
GHARP	Greater Horn of Africa Rainwater Partnership
IAASTD	International Assessment of Agricultural Knowledge, Science and Technology for Development
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
IGA	Income generating activities
ILM	Integrated landscape management
IUCN	International Union for Conservation of Nature
LLS	Livelihoods and Landscapes Strategy
LPFN	Landscapes for People, Food and Nature initiative
MERET	Managing Environmental Resources to Enable Transitions to more sustainable livelihoods (Ethiopia)
NGO	Non-governmental organization
PRRO	Protracted Relief and Recovery Operation
RWH	Rainwater harvesting
SWC	Soil and water conservation
SSA	Sub-Saharan Africa
UNDP	United Nations Development Programme
WFP	World Food Programme
WRI	World Resources Institute
WWF	World Wildlife Fund

Preface

The challenges of climate change, land degradation and other threats to the natural resource base of our food systems have led the international development community to expand its focus beyond conventional priorities. Efforts to increase aggregate food production have widened to include making livelihoods and food supplies resilient to diverse shocks and supportive of long-term sustainable development.

Resilience is crucial for communities and individuals struggling with chronic and acute food insecurity. They are often more resource-dependent than others, more exposed to resource risks and crises, and have fewer alternatives to fall back on. For these groups, both rural and urban, achieving resilience requires action not only at household, community, and food system scales, but also at landscape scale.

In this paper, Louise Buck and Ian Bailey conclude that landscape resilience encompasses four dimensions: livelihood resilience, agroecosystem resilience, ecosystem resilience and institutional resilience. The social and ecological interface is critical, and must be reflected explicitly in initiatives designed to transition highly vulnerable populations from emergency food aid to sustainable development. The authors have pulled together evidence from innovative programs in chronic food insecurity hotspots to understand strategies for strengthening socio-ecological resilience through integrated management at landscape scale.

Full participation in the stakeholder process for integrated landscape planning and action is especially challenging for food-insecure people, who are defined by their marginality, lack of organization, and weak 'voice'. The examples in this paper describe some mechanisms that are being developed to tackle that challenge. The lessons drawn are relevant to enhancing inclusion in integrated landscape management more broadly.

Integrated landscape management (ILM) can be used in countless ecosystems to address a variety of needs. But there is a special challenge and imperative to build socio-ecologically resilient landscapes in areas where chronic food insecurity is deeply connected with resource risk and degradation. I encourage ILM leaders to consider more explicitly elements of ILM that can enhance food security for the most vulnerable in their landscapes.



October 27, 2014

“...achieving resilience requires action not only at household, community, and food system scales, but also at landscape scale.”



Sara J. Scherr
President, EcoAgriculture Partners
Chair, Secretariat of the
Landscapes for People, Food and
Nature Initiative



1. Introduction

Agriculture and agrarian-based livelihoods are becoming increasingly precarious. As weather patterns become more uncertain due to climate change and global markets fluctuate under increased demands for agricultural products, agrarian communities are facing considerable economic and environmental risks (Fraser 2007; McMichael 2009). “Shocks and crises,” according to the UNDP, “appear to have become the norm, rather than the exception” (UNDP 2011). In response to recent spikes in hunger and food insecurity, culminating in the severe food crisis of 2008 and 2009, there has been a renewed focus on farming and pastoralist communities amongst development agencies, researchers, and national governments. However, while development agencies and NGOs have implemented successful food security programs over the last several decades, the need is urgent to revamp these efforts and ‘scale up’ programs to meet new climatic, economic, and political challenges of the 21st century. Despite the efforts of food security and food relief programs, many communities continue to be at risk of hunger and food insecurity, as witnessed by the food crisis of 2008 and 2009 and the current drought, hunger, and malnutrition in the Horn of Africa.

How can agrarian livelihoods meet the food, fiber, and economic needs of communities while simultaneously mitigating the effects of climate change? Addressing this question requires action on multiple scales, from farm and ecosystem management to policy and institutional change. Chronically poor communities are often socially and politically marginalized, typically surviving on degraded lands where they construct precarious livelihoods on a limited natural resource base. Considerable programmatic effort must be geared towards strengthening livelihoods in these marginalized communities in order to enhance food security. Additionally, livelihood and food security initiatives must promote social and ecological resilience in the face of increasing climatic and economic stresses.

The costs of inaction are high. Without a sustained, large-scale, and coordinated effort by development agencies, national governments, NGOs, and local communities, risks increase for future famines, chronic malnutrition, hunger, and food insecurity amongst marginalized communities. Hunger and malnutrition have socially devastating effects, as generations struggle not just to survive, but to flourish. In addition to these severe social costs, economic, political, and environmental costs are substantial. Food insecurity undermines national efforts to sustain economic growth and reduce poverty. At the same time, efforts to maximize short term yields on marginal lands often lead to devastating resource degradation and exacerbate social, economic, and ecological vulnerabilities.

In light of these pressing issues, this paper seeks to help guide the development of livelihood and food security initiatives that build resilience in livelihoods

“Despite the efforts of food security and food relief programs, many communities continue to be at risk of hunger and food insecurity”

Opposite: A woman tends to her zai pits in the district of Zandoma, in Burkina Faso. September 2012. Photo by Minielle Tall/CAAFS West Africa.

and ecosystems through integrated landscape management (ILM). ILM refers to long term collaboration among different groups of land managers and stakeholders to achieve multiple objectives required from socio-ecological landscapes (Scherr, Shames, and Friedman 2013). Landscape approaches are gaining prominence as the limits of narrowly sectoral approaches to addressing complex global and local issues become more apparent. The paper draws on academic literature, field observation, insight from development practitioners and researchers, and agency reports to build a framework for guiding investments in landscape approaches to designing and scaling up food and livelihood security initiatives that aim to build resilience to the twin pressures of climate change and land degradation in communities of agriculturalists, agro-pastoralists, and pastoralists who are vulnerable to chronic and acute food and livelihood insecurity. We suggest that the organization of a landscape management framework around an emerging resilience paradigm offers a promising pathway for helping bring about the technical innovation and institutional capacity, as well as the political will that Frankenberger et al. emphasize will be necessary to move beyond conventional humanitarian and development assistance models (2012).

Our analysis begins in Section 2 with a review of salient literatures on resilience, livelihoods and food security to further establish the conceptual and practical context for advancing a landscape resilience approach to overcoming vulnerability to chronic and acute food security in the context of climate change and land degradation. In Section 3 we specify characteristics of integrated landscape management and suggest how the landscape scale and approach are conducive to building dynamic linkages between ecosystem resilience and social resilience in agrarian-based livelihoods. From these discussions we propose a four-dimensional framework for assessing resilience potentials in integrated landscapes and designing interventions to help realize these potentials. Section 4 presents brief case studies of initiatives that aim to improve livelihood outcomes through investment in natural and social capital to illustrate diverse contexts and strategies for building landscape scale resilience in the context of food and livelihood insecurity. In section 5 we summarize insights from development practitioners and researchers regarding key ingredients for building socio-ecological resilience at landscape scale. Section 6 discusses opportunities and strategies for mainstreaming landscape level resilience-building and recommends some ways forward.

2. Socio-Ecological Resilience, Livelihoods, and Food Security

Within the last decade, scholars and development practitioners have increasingly incorporated the concept of resilience into development programs, reflecting what the UNDP has described as a paradigm shift in development policy and practice. Focusing on resilience requires a broadening of the understanding and practice of adaption to deal with complex and changing systems, especially in the context of climate change (Nelson, Adger, and Brown 2007) and requires a shift from short-term emergency response to long-term planning and preparedness amongst development agencies.

The Stockholm Resilience Center defines resilience as “the long-term capacity of a system to deal with change and continue to develop...[and to] remain within critical thresholds” (Stockholm Resilience Centre 2007). Coined by C.S. Holling, the idea of resilience challenged the equilibrium-centered view of ecological systems. In doing so, focus was redirected from “the ability of a system to return to an equilibrium state after a temporary disturbance” (stability), to a notion of resilience as “a measure of the persistence of systems and of their ability to absorb change and disturbance and still maintain the same relationships between populations or state variables” (Holling 1973).

Two conceptions of resilience have emerged in the ecological and social sciences. On the one hand, ecosystem resilience is defined as “a measure of how much disturbance (like storms, fire, or pollutants) an ecosystem can handle without shifting into a qualitatively different state. It is the capacity of a system to both withstand shocks and surprises and to rebuild itself if damaged” (Stockholm Resilience Centre 2007). Social resilience, on the other hand, is conceptualized as “the ability of groups or communities to cope with external stresses and disturbances as a result of social, political and environmental change” (W.N. Adger 2000).

Increasingly, scholars and development practitioners have sought to bring these two concepts together through the notion of socio-ecological resilience, recognizing the complex interactions – and interdependencies – of social and ecological systems. The notion of socio-ecological resilience views human systems as part of natural systems, which combine to form an interrelated whole. Socio-ecological resilience thus focuses on multiple and inter-connected scales and the adaptive mechanisms that enable systems to not merely withstand shocks, but to recover to a stronger state, thus, improving their capacity to cope and manage future shocks (Frankenberger et al. 2012). In the context of climate change the emphasis is on reducing risks from droughts, floods, and severe weather patterns while increasing community and household capacities to overcome these events (W.N. Adger 2000; Berkes and Folke 1998; Lebel et al. 2006).

“...bring these two concepts together through the notion of socio-ecological resilience, recognizing the complex interactions and interdependencies of social and ecological systems.”

“...enhancing ecosystem functions and services not only improves livelihoods, but is also a critical strategy in achieving long-term and broad scale socio-ecological resilience.”

The interface between social and ecological systems is especially apparent in the context of rural livelihoods. Households and communities meet their material needs through direct or in-direct relations with ecosystems, altering ecological processes and in turn social relations (W.N. Adger 2000; Bessant 2006; Zimmerer 2007). To promote resilient livelihoods, management strategies are needed that enable communities (and the ecosystems they depend on) to withstand economic and climatic disturbances and strengthen adaptive capacities for future disturbances. Evidence is growing that landscape scale management of socio-ecological systems can promote the foundation for sustainable livelihoods by maintaining essential ecosystem services (van Walsum 2012). As such, enhancing ecosystem functions and services not only improves livelihoods, but is also a critical strategy in achieving long-term and broad scale socio-ecological resilience. Building on these insights, our framework focuses on promoting resilient livelihoods as a means of improving the health and functioning of socio-ecological systems, as well as a mechanism for achieving food security.

In the following section, we explore the relationships between livelihoods, food security, and socio-ecological resilience. We first discuss the meaning and effects of vulnerability, and identify populations most vulnerable to food and livelihood insecurity in the context of climate change. Next, we examine the linkages between food and livelihood security by exploring their common underlying vulnerabilities and their reliance on a healthy natural resource base, ecosystems functions and services. We highlight land degradation as a critical component in these processes, and demonstrate that a socio-ecological resilience perspective reveals possibilities for mitigating food and livelihood insecurity while restoring degraded land through landscape management practices.

Understanding vulnerability and global food insecurity: who, what, and where

Vulnerability is a household, community, or region’s susceptibility to harm from exposure to stresses, disturbances, or shocks associated with environmental and social change (W. N. Adger 2006)—the antithesis of resilience. Importantly, both vulnerability and resilience are “processes rather than static states” (Frankenberger et al. 2012). In the case of climatic shocks, vulnerability is shaped by both ecological and social factors. Ecologically, communities living in areas expected to have severe weather events and climatic change will be the most vulnerable to the biophysical effects of climate change. These areas include low lying coastal regions, tropical islands, delta regions, arid and semi-arid regions (at risk of desertification), and monsoonal areas. Communities that live on ‘marginal lands’ (i.e. where water is scarce, soils are poor, etc.) will

also be more vulnerable to climatic stressors. Changing monsoon patterns and timing in areas such as South Asia will increase biophysical vulnerabilities in those communities. Likewise, communities that depend on rain-fed agriculture for their livelihoods (including most of Sub-Saharan Africa and South and Southeast Asia) will be vulnerable to changing precipitation patterns.

Social factors affecting vulnerability include political, social, and economic marginalization, as well as land degradation and resource depletion. For example, impoverished communities that lack the financial resources to cope with and/or adapt to biophysical or economic shocks have higher levels of vulnerability. Minority communities and/or ethnic groups that are politically marginalized are often denied access to government resources and safety net programs, making them more vulnerable to disasters. Social vulnerability can also stem from poor management of natural resources. Communities that exhaust their natural resource base through maladaptive management strategies increase their social vulnerability to disasters.

Examining ecological and social factors together, vulnerability can be understood as a combination of the severity of a stressor or event and the amount of exposure and sensitivity a community has to it (Turner, Matson, et al. 2003). For instance, low shocks can have grave consequences in areas of high social vulnerability, whereas medium to high shocks can be mitigated in areas where social vulnerability is minimal. The most socially devastating effects of climate change will occur in communities with high social vulnerability that are exposed to severe climatic shocks.

While the effects of climate change are geographically uneven, climate risks are greatly exacerbated by social inequalities. Populations that lack access to land, credit, and other productive resources are socially vulnerable to the effects of climate change. Likewise, populations are also vulnerable in countries lacking social safety nets such as food assistance and healthcare. Areas of conflict and social unrest increase the vulnerability of populations. Internally displaced people, refugees, and migrants often live in precarious conditions and are particularly sensitive to environmental stressors. Migration and displacement may also increase competition and conflict over scarce resources in local and regional contexts, especially access to land and water. Interactions between biophysical 'shocks' and social vulnerabilities often lead to devastating cumulative vulnerabilities.

Current levels of hunger and food insecurity also exacerbate ecological and social vulnerability. In 2009, the number of undernourished people in the world exceeded one billion. Although this number has declined in recent years, it still remains very high at 925 million malnourished people in the world (Food and Agriculture Organization 2010). Asia has the largest number of food insecure people at 578 million, but sub-Saharan Africa has the highest proportion of malnourished people at 30% of the total population (239 million people). There are 53 million malnourished people in Latin America and the Caribbean, 37

“The most socially devastating effects of climate change will occur in communities with high social vulnerability that are exposed to severe climatic shocks.”



million in the Near East and North Africa, and 19 million in developed countries (Ibid.). It is estimated that by 2050, the number of people at risk of hunger will increase by 10 to 20 percent, while the number of malnourished children is expected to increase by 24 million (World Food Program 2010). Sub-Saharan Africa is expected to have the largest increase of food insecure people and malnourished children, especially in the Horn of Africa including Ethiopia, Eritrea, Djibouti, Sudan, Kenya and Somalia where social and biophysical vulnerabilities to climate change are high (Flintan, Behnke, and Neely 2013). Women and children are often the most socially vulnerable in this region, and thus, the effects of climate change will likely impact them the most. While there is great need to combat malnutrition and food insecurity in all parts of the world, NGOs and development agencies recognize the need amongst these most vulnerable populations in the world is particularly urgent.

Food and livelihood security are intricately related. A household's ability to meet their nutritional needs depends on their ability to access food, either by producing for household consumption, bartering, or purchasing food, or through food aid and relief services. Whether livelihoods are largely subsistence- or market-oriented, household livelihood strategies significantly influence household food in/security (Sen 2000; Food and Agriculture Organization 2011). Similarly, household food insecurity impacts households' abilities to sustain livelihood strategies. For instance, insufficient caloric and nutritional sustenance affects farmers' and pastoralist's ability to improve and/or create alternative livelihoods (Coates et al. 2010). First, low caloric intake reduces the amount of energy people are able to expend for work. Second, when food intake is insufficient, peoples' priorities tend to be structured around short-term solutions as opposed to asset generation for the future (Barrett and Swallow 2006).

In the last couple of decades, the recognition of this coupled relationship between livelihood strategies and food security has prompted development agencies and NGOs to focus on integrating efforts that address livelihood and food security (World Food Programme 2005). Likewise, there has been a corresponding emphasis on sustainable livelihoods within academic and practice-based literatures (Farrington et al. 1999). In a context of climate change, attention is turning to developing climate-resilient livelihoods as a way to achieve food security and sustain the natural resource base upon which livelihoods are constructed (CARE 2010).

A number of social, environmental, and political events and conditions can threaten national, community, and household food and livelihood security. Threats include natural disasters, climate change, land degradation, food price volatility, economic shocks (unemployment), political turmoil, violence, or any other events or conditions that limit access to natural, economic, human, and social capital and/or also reduce or limit human capabilities (Scoones 1998; Bebbington 1999; Carney 1998). Such 'shocks' prevent communities and

households from accessing food and productive resources, or in some cases, degrade the natural resource base upon which they produce food (UNDP 2009). Additionally, events or conditions that reduce self-sufficiency and create excessive dependencies, exclude people and communities from the political process, create excessive debt, and/or displace or dispossess people of land create the conditions of livelihood vulnerability (Farrington et al. 1999; Ellis and Biggs 2001).

Severe hunger, food insecurity, and famines often are a culmination of confounding factors. These conjunctural events, such as the 2009 food crisis, are not always simply a matter of food shortages. Hunger and famine are also a matter of inequality in the distribution of food (Sen 2009). Changes in wages—whether drastic or subtle—unemployment, and increased food prices in tandem with poor food distribution systems results in food crises (Ibid.). While food crises are triggered by precipitating events (i.e. social, economic, political, or environmental), the effects of these events are exacerbated by underlying socio-economic and ecological vulnerabilities. When livelihoods are vulnerable to environmental, economic, and political stressors, the risk and likelihood that ‘shocks’ will result in food insecurity or famine are greatly increased.

Food and livelihood security and the role of land degradation

Land degradation serves as one of the most significant threats to food and livelihood security. The largest percentages of food insecure people rely on natural resources for their livelihoods. According to McIntyre, more than “70% of the world’s poor live in rural areas. These 2.1 billion people live on less than US\$2 a day” (IAASTD 2009). The world’s poorest farmers, pastoralists, and agro-pastoralists disproportionately depend on marginal and degraded lands to meet their livelihood needs. Thus, it is imperative that efforts to improve food security focus on improving landscape management (natural resources/ecosystem services) upon which rural communities often create their livelihoods. As the Montpellier Panel report argues, “continued growth in agricultural production depends on agro-ecology-based programs that deliver improved sustainability and resilience of production. These include maintaining soil fertility levels, conserving soil and water, resisting pests, diseases and weeds, and adapting to climate change where the solutions rest heavily on ecological principles and practices” (The Montpellier Panel 2012).

Since the greatest proportion of vulnerable communities depends on natural resources, it is imperative that livelihood and food security programs focus on curtailing and reversing land degradation, a critical factor leading to and exacerbating conditions of vulnerability. Land degradation decreases yields, increases sensitivity to minor and major climatic shocks, and reduces the ability of people to maintain household food security and livelihoods. Land degradation is the consequence of a complex set of historical, natural, political-economic, and social interactions. While severe weather events

can cause land degradation (landslides, floods, etc.), the extent of the damages is often influenced by land management practices, socio-economic conditions, and government policies (van Walsum 2012). There is a direct link between poverty and land degradation, in part because impoverished farmers, pastoralists, and agro-pastoralists have been politically or socially excluded from fertile, productive lands. These populations often have to create livelihoods on degraded lands, and in some cases, further degrade lands either from maladaptive management techniques or out of short-term necessity.

Some of the more immediate factors leading to land degradation include intensive resource extraction, population growth, inappropriate management, and agricultural expansion into marginal lands. For instance, agricultural expansion is clearing forests and other natural ecosystems of high value biodiversity; by 2050 up to 25% of the world's food production is threatened by and may be lost due to environmental breakdowns (Nellemann et al. 2009).

In addition, as Scherr and Wallace argue,

Growing populations, high levels of economic growth, accelerating globalization and large-scale extraction, often driven by demands and investments from outside, are placing unprecedented demands on natural resources and putting new pressures on the livelihoods that depend on these resources. Farmlands must not only increase the supply of food, but also provide bioenergy and products traditionally supplied from now-depleted forests, wetlands, grasslands, and fisheries (Scherr and Wallace, 2010).

While a number of immediate management practices exacerbate land degradation, it is also imperative to understand the historical contexts in which land degradation occurs. Attention to histories of local livelihood strategies, histories of land use change (colonial and postcolonial), and patterns of land tenure can shed light on contemporary socio-ecological conditions. As Batterbury and Bebbington argue, "it is difficult to understand the dynamics of land-use change at a point in time if these are not analyzed within the context of longer histories of society-environment interactions. These contextualized histories may help debunk policy orthodoxies" (Batterbury and Bebbington 1999). Understanding the 'lay of the land', or how particular environmental conditions were created is a critical first step in developing management alternatives. With these critical factors in mind, we turn next to an analysis of integrated landscape-scale management as a tool for achieving socio-ecological resilience.

3. Integrated Landscape-Scale Management: Strategies for Food Security and Rural Livelihood Resilience

The previous section of this paper highlights links between food security, sustainable livelihoods, and socio-ecological resilience. In this section, we describe how to strengthen and sustain linkages between these aspects of rural development through effective landscape management. Implementing a landscape-scale perspective, we suggest, contributes to food security and sustainable livelihoods by improving agroecological practices at the farm level as well as broader ecological processes (watershed protection, erosion protection, forest cover, biodiversity, etc) to enhance ecosystem services. We present a framework composed of four interrelated dimensions, including livelihoods, agroecosystems, ecosystems, and institutions. While these are treated as conceptually distinct components of management, this separation is strictly for analytical purposes, as frameworks must necessarily simplify complex socio-ecological relationships in order to conduct effective programming. This does not mean, however, that these dimensions should be treated as autonomous or independent of one another. In practice, all four components are implemented concurrently and with an effort to emphasize their overlapping relationships. Indeed, the realization of socio-ecologically resilient management systems for livelihoods, food security, and ecosystems is achieved through synergies created amongst the four dimensions through adaptive collaborative management processes.

Landscape management approach

As a unit of management, the landscape scale includes a combination of local ecosystems connected across space encompassing agricultural and pastoral lands, human settlements, and natural and degraded habitats (Milder et al. 2012). Landscapes are defined by and within local contexts, including cultural and historical land patterns as well as natural features and ecological processes.

Conceptually, a landscape is a socio-ecological system that consists of a mosaic of natural and/or human-modified ecosystems, with a characteristic configuration of topography, vegetation, land use, and settlements that is influenced by the ecological, historical, economic and cultural processes and activities of the area. Both the mix of land cover and use types that make up the larger mosaic, including agricultural lands, native vegetation, and urban areas (landscape composition); and the spatial arrangement of different land uses and cover types (landscape structure) contribute to the character of a landscape.



Box 1. Integrated landscape management

Scherr, Shames and Friedman synthesize five defining characteristics of landscape approaches to integrating rural development and environmental sustainability.

1. *Shared or agreed management objectives that encompass multiple benefits (the full range of goods and services needed) from the landscape;*
2. *Field, farm and forest practices are designed to contribute to multiple objectives, including human well-being, food and fiber production, climate change mitigation, and conservation of biodiversity and ecosystem services;*
3. *Ecological, social, and economic interactions among different parts of the landscape are managed to realize positive synergies among interests and actors or to mitigate negative trade-offs;*
4. *Collaborative, community-engaged processes for dialogue, planning, negotiating and monitoring decisions are in place; and*
5. *Markets and public policies are shaped to achieve the diverse set of landscape objectives and institutional requirements (2013).*

Source:

Scherr, Sara J., Seth A. Shames and Rachel Friedman. 2013. Defining Integrated Landscape Management for Policy Makers. Ecoagriculture Policy Focus No. 10. Washington, DC: EcoAgriculture Partners.

Depending on the management objectives of the stakeholders, landscape boundaries may be discrete or fuzzy, and may correspond to watershed boundaries, distinct land features, and/or jurisdictional boundaries, or cross-cut such demarcations. Because of the broad range of factors a landscape may encompass areas of 100s to 10,000s square kilometers (Ibid.).

The central emphasis underlying a landscape approach to land and resource management is on socio-ecological connections and interdependencies (Scherr, Buck, and Milder 2014). Box 1 explains the five defining characteristics of integrated landscape management.

In tightly coupled systems, human activity and ecological functioning are harmonized to limit vulnerability to prospective stressors, and foster resilience through adaptive capacity, ecosystem flexibility, and the ability to learn in response to disturbances (Turner, Kasperson, et al. 2003). In practical terms, livelihood practices do not degrade soils, water, or nutrient cycles, but rather contribute to the continued health of ecosystems, resulting in a mutually enhancing relationship between human and ecological well-being. Coffee agro-ecosystems serve as an illustrative example. Shade managed coffee systems maximize on-farm and ecosystem synergies by improving bird migration within the tree canopy, increasing soil organic matter and water retention, and decreasing soil erosion. As a result of nurturing ecosystem health, coffee farmers ensure the

long-term resilience of their livelihoods. By contrast, in communities that rely on degraded or marginal lands, rural livelihoods are built upon vulnerable socio-ecological conditions, and are more sensitive to ecological and economic shocks. In some pastoral systems, for example, excessive grazing can further compromise the regeneration of soils leading to increased risk of erosion and fertility depletion.

Landscape approaches to achieving food production, natural resource conservation, and livelihood security goals seek to better understand and recognize interconnections between different land uses and the stakeholders that derive benefits from them (Sayer et al. 2013). While livelihood approaches have been useful in identifying household level decision-making and local production practices, they often have neglected the larger ecosystem processes that support or hinder livelihood strategies. Both livelihood strategies and ecological functions operate at a landscape scale. For instance, ecological flows and functions, such as water, nutrients, sediments, plants, animals, and diseases operate beyond farm or community boundaries. As such, management of these flows as ecosystem services – drinking water, irrigation water, pest control as well as diseases and interactions with wildlife – should also operate beyond the farm or community boundaries, at the landscape level. A landscape approach aims to increase the synergies and beneficial relationships between ecosystem functioning and livelihood strategies. Management strategies that focus too narrowly at the farm or household level tend to miss the broader dynamics between ecosystem functioning, food production, and livelihoods (Milder et al. 2012). Further, action at the household level alone is not enough to pull households out of “poverty traps;” effective action at the landscape or sub-regional level is also necessary (Barrett and Swallow 2006; Milder et al. 2012).

Three trends in many developing countries favor the landscape approach:

1. the decentralization of authority, or devolving administration of development programs to smaller units of government;
2. the formation of partnerships between villages, communities, and NGOs; and
3. an emphasis on market-based solutions to rural development.

Together, these institutional tendencies further emphasize the key role of landscape-scale action. Small farmers and villages are increasingly becoming tied together in regional networks based on market access and rural enterprise, supported by development and aid agencies, and therefore influenced by broader market forces (World Resources Institute 2008). Thus, as Milder et al attest, it “becomes necessary to widen the lens through which rural livelihoods are understood and advanced” (Milder et al. 2012). In the same line of thinking, such market opportunities that compensate farmers for being stewards of their

“...livelihood approaches...often have neglected the larger ecosystem processes that support or hinder livelihood strategies.”

land and its ecosystem services (e.g. eco-certification, eco-labeling) require attention to landscape flows that operate beyond farm boundaries.

An integrated landscape and resilience management framework

Promoting food security and sustainable livelihoods that are resilient in the face of climate change entails reducing vulnerabilities (i.e. sensitivities and risk) and increasing adaptive capacity of marginalized communities. In the context of climate change and economic globalization, reducing vulnerabilities includes lessening the exposure and sensitivity of communities to climatic and economic disturbances and stressors. Meanwhile, adaptive capacity refers to “the preconditions necessary to enable adaptation, including social and physical elements, and the ability to mobilize these elements” (Nelson, Adger, and Brown 2007). Adaptive capacity highlights the need for flexible management models in the face of unpredictable change, especially with the current and projected climatic and economic variability (Ibid.). This approach is commonly referred to as adaptive management. As described above, bringing a landscape perspective to adaptive management strategies – or harnessing and enhancing the synergistic relationships between ecosystem services and community/household livelihood strategies – is critical for realizing food security and sustainable livelihoods at a large scale.

Both diversity and learning are central to adaptive capacity and resilience. The importance of fostering and maintaining diversity is emphasized by Chapin et al. in their ‘resilience-based stewardship’ framework. As they describe, “the central goal of ecosystem stewardship is to sustain the capacity of ecosystems to provide services that benefit society by sustaining or enhancing the integrity and diversity of ecosystems as well as the adaptive capacity and well-being of society” (Chapin et al. 2009). Similarly, we stress the interdependency of livelihood security with resilient ecosystem management. Regional management of climate change is necessary to accommodate shifting patterns of people and resources (e.g. agricultural suitability, water quality and availability, habitat), and is a step towards ensuring resilience at the household level (Milder et al. 2012; Lal et al. 2011). For instance, to address water scarcity, a landscape scale approach implements a number of management strategies ranging from water harvesting systems on farm; protecting watersheds; maintaining forest cover/vegetative cover; reforestation/restoration; and increasing water retaining capacity of soils through minimum tillage, intercropping, crop rotation and other methods that improve soil structure and organic matter.

Diversity is an especially important ingredient in socio-ecological resiliency. As Kofinas and Chapin state, “diversity provides the raw material or building blocks on which adaptation can act. It increases the range of options, at least



some of which are likely to be successful under whatever new conditions arise, thereby reducing the likelihood of radical degradation of the system” (Kofinas and Chapin 2009). For instance, crop and livestock diversity helps to minimize vulnerability to both ecological disturbances and economic fluctuations. In contrast, practices that reduce diversity, rely on external inputs, and/or degrade ecosystem services tend to reduce ecological resilience and the adaptive capacity of communities.

In addition to crop diversity, practitioners are familiar with the need for diversity of cultural knowledges and practices. As ecological resilience is also dependent upon social stability and cohesion, a landscape scale approach attends to knowledge, social learning, and democratic participation in policy and management decision-making and implementation. A critical component of developing adaptive capacity and reducing vulnerability entails institutionalizing ecological learning. This could include, for example, farmer-to-farmer training programs that disseminate ‘best practices’ amongst farmers. Community-based learning programs can help develop a knowledge base around landscape processes that informs management practices. At higher levels developing adaptive capacity entails attention to principles of institutional diversity that characterize robust, self-organized resource governance institutions (Ostrom 2005).

The proposed resilience framework emphasizes the relationships and dynamism between four landscape dimensions and scales: agroecosystems, ecosystems, livelihoods, and institutions. Management strategies within each component of the landscape system are directed towards reducing vulnerabilities and promoting adaptive capacities through the production and maintenance of agricultural, livelihood, ecological and institutional diversity while promoting fairness and equity in accessing the resources generated. The dimensions of the framework are brought together through multi-stakeholder adaptive management processes as depicted in Figure 1.

The framework is used to identify successes and building blocks, as well as opportunities for adding, expanding, and/or linking activities that will lead to better socio-ecological resilience, and therefore reduced vulnerability of project beneficiaries to the effects of climate change. Below we briefly define and describe each component of the framework. It is important to note that the four dimensions are separated in this framework for applied purposes, i.e. to inform policy and practice. In reality, these four dimensions are intricately connected. Therefore, we stress that this framework should be employed with attention to the interactions among these four dimensions, and to the importance of investing in adaptive collaborative landscape management platforms and processes to help realize the potential synergies.



Figure 1. Components of resilient landscapes. Photos (clockwise from top right) by Seth Shames, Bas Leenders, Martin Noponen, and Jeff Holt.



Agroecosystem resilience

Management of agroecosystems predominantly focuses on the farm level scale, while the ability to manage agroecosystems is greatly dependent on interactions beyond the farm level, including dynamic relationships with the three other levels detailed in this framework. Resilience rooted in agroecosystem management will arise from the application of ecological concepts and principles to the design and management of sustainable farming systems through the expanding field of agroecology (Silici 2014). Central to developing agroecosystem resilience is soil management, diversification, sustainable intensification, reducing external inputs (i.e. seeds, fertilizers, machinery), and recycling of farm resources. As water is predicted to become increasingly scarce and unpredictable with climatic variations it is important to

manage farms for water efficiency, including improved water retention in soils, intercropping and agroforestry techniques to protect against soil erosion and to provide shade/ground cover, store and use irrigation water efficiently, etc. Agroecosystem resilience entails the following components:

- Enriched soil
 - » Reduced erosion
 - » Increased fertility (e.g., compost, fertilizer trees)
 - » Carbon sequestration (e.g., minimal tillage, organic agriculture, agroforestry)
- Sustainable intensification (e.g., increased production per unit area)
- Diversification of crops and animals over space and time (agrobiodiversity)
 - » Using drought-tolerant varieties
 - » Rotating crops
 - » Crop and livestock genetic diversity
- Intensive livestock management, (e.g., rotational grazing, stall feeding)
- Improved water management
 - » Improved water retention in soils (such as through mulching and other organic input strategies)
 - » Intercropping and agroforestry techniques to protect against soil erosion
 - » Efficient storage and use of water
 - » Efficient irrigation management
 - » Water/moisture harvesting
- Energy use efficiency (e.g., transportation, animal traction)
- Reducing external inputs (e.g., seeds, fertilizers, machinery)
- Recycling farm resources
- Carbon sequestration
 - » High-carbon cropping systems, (e.g., perennial grains, agroforestry)
 - » Protection of existing carbon stores, (e.g., in grasslands, woodlands, adjacent forests)
- Rehabilitation and sustainable management of degraded lands, (e.g., re-vegetation of watersheds, rangelands, and woodlands)



Livelihood resilience

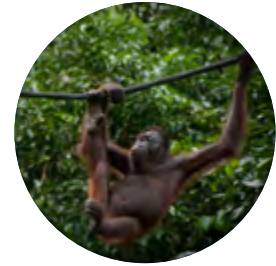
The livelihood dimension encompasses a range of social and economic activities that include agricultural producers and their communities. A primary goal of a resilience-focused management framework includes the diversification of income sources, including crop diversification and off-farm income-generating strategies as well as the establishment of cooperatives and community-based organizations to coordinate the production and sale of household and community products. Such diversification provides added security in meeting household and community needs, and protecting against vulnerabilities associated with climate change and market fluctuations. In addition, livelihood resilience requires the promotion of women and children's social and economic status such that, with regard to gender, women receive an equitable share of the benefits of economic activity (including access to productive resources), and children are afforded opportunities for education, including the dissemination of local knowledges around cultural and agricultural traditions and practices. Additionally, access to adequate health and sanitation resources and services is critical to livelihood resilience. Livelihood resilience incorporates the following:

- Nutritional improvements, (e.g., from increased crop diversity)
- Improved access to material assets, (e.g., land, regular and clean drinking water, food, firewood, charcoal, building materials)
- Diversification of income sources
 - » Crop diversification
 - » Off-farm income-generating strategies
- Establishment of cooperatives and community-based organizations to coordinate the production and sale of household and community products
- Improved capacity of households to turn assets into income through access to viable markets
- Improved social and economic status for women
 - » Women receive equal access to productive resources
 - » Women receive an equitable share of the benefits of economic activity
- Children have access to education, including the dissemination of local knowledges around cultural and agricultural traditions and practices
- Access to adequate health and sanitation resources

Ecosystem resilience

The management of ecosystems (in tandem with agro-ecosystems) encompasses multiple scales, from watersheds and migratory pathways to soil ecology and microhabitats. Ecosystem management is critical for protecting biodiversity as well as for maintaining ecosystem services, such as clean and abundant water. Ecosystem resilience interconnects with agroecosystem and livelihood resilience by focusing on the broader landscapes in which agroecosystems and livelihood strategies are embedded. Healthy ecosystem functioning provides essential services that help sustain agroecological process and support or complement livelihoods. Such 'environmental flows' within and between ecosystems and agroecosystems can be measured in quantity, extent, and quality, and include water, forests, woodland, rangeland, and grassland, as well as population integrity, threatened species protection, and habitat of wild biodiversity. Activities that build ecosystem resilience include:

- Planting, protecting, and restoring trees and woodlands, especially around waterways and on hillsides;
- Hillside rainwater harvesting
- Managing access to and use of water resources on a seasonal basis;
- Grassland management through rotational grazing;
- Designation and protection of wildlife corridors.



In Carchi, Ecuador, Water User Groups build fences and plant trees to protect a spring that runs between ranch lands and potato fields and is threatened by agrochemical and manure contamination, (illegal) deforestation and soil erosion. Photo by Robin Marsh.



Institutional resilience

Institutional resilience requires social learning, i.e. the ability for institutions to facilitate flexibility and adaptive capacity in response to economic and ecological change. It depends also on transparency and inclusiveness in decision processes, and policy-making that is attentive to the needs of marginalized populations. Institutional resilience is built also upon diversity; that is, ensuring that organizations representing diverse sectors and interests are able to interact constructively and collaborate. The following strategies and capacities will help to build institutional resilience:

- Improved collaboration between women and men (e.g., equal access to information and resources)
- Improved capacity to learn and innovate (e.g., learning through experimentation and monitoring)
- Effective learning models (e.g., farmer field schools, knowledge exchange networks, and collaboration between multiple stakeholders)
- Effective information channels (e.g., reliable local access to climate and market information, government technical support)
- Strengthened links with local and/or regional markets and capacities for marketing (e.g., processing, storage, and transportation infrastructure, reliable market information)
- Improved capacities for adaptive management, e.g. forums for coordinated planning and decision-making about ecological and livelihood asset management at household, community, and landscape scales
- Application of collaborative adaptive management cycle in planning, implementing, and evaluating project activities
- Capacity to develop land and resource use agreements that are locally respected, monitored, enforced
- Capacity to form and strengthen cooperatives and community-based organizations
- Capacity to align projects with national programs and policies
- Capacity for democratic political participation

Implementing resilience management

Together, the four dimensions of the landscape approach offer significant potential for promoting social and ecological resilience – including food and livelihood security – and adaptive capacities. To help focus attention on the interconnections among the four dimensions of the framework a variety of



Stakeholders from Udakumbura, Sri Lanka at a landscape planning dialogue. Forums for coordinated decision-making can improve capacities for adaptive management of ecological and livelihood assets. Photo by Raffaella Kozar.

tools are available to help design optimal interventions, as well as monitoring systems that capture their multiple intended impacts. The multi-stakeholder adaptive management process that is featured at the center of the socio-ecological resilience framework can be usefully guided by attention to the phases of the adaptive management cycle depicted in Figure 2.

A diagnostic assessment of opportunities for integrated management, for example, might involve preparing and overlaying maps of the four dimensions of resilience to help locate current and potential interactions. Negotiating



Figure 2. *Phases in a collaborative stakeholder management process for building resilient integrated landscapes.*

strategies for landscape governance can give attention to interactive learning processes and inclusive decision-making rules to help ensure that innovations and representation are drawn from multiple sources. Designing multi-objective interventions will help prevent a proliferation of single-sector sub-projects known as 'siloes'. Monitoring systems that account for multiple landscape performance criteria, and use of integrative indicators and means of measure will further help to address synergies and tradeoffs among multiple desired outcomes from landscape management. Buck et al (2007) describe a cross-sectoral 'landscape measures approach' for guiding landscape management. A corresponding 'landscape measures resource center' can be useful in operationalizing the approach (<http://landscapemeasures.info>). Ground based photo-monitoring can be an especially useful tool for engaging local communities and other stakeholders in assessing landscape potentials and performance on the basis of readily visible indicators of conditions and interventions likely to affect socio-ecological resilience (Lassoie, Myron, and Buck 2014).

Managing landscapes collaboratively over the long term requires the development of landscape governance systems that work. Landscape

governance is concerned with the institutional arrangements, decision making processes, policy instruments and underlying values by which multiple actors pursue their interests in sustainable food production, biodiversity and ecosystem service conservation and livelihood security in multifunctional landscapes (Kozar et al. 2014). The use of stakeholder-engaged planning, design and evaluation methods, combined with the vision and the political will necessary to invest in landscape approaches to building socio-ecological resilience at scale are key ingredients in the building of viable landscape governance systems.

The design and implementation of resilience management programs must translate the general principles and desired outcomes conveyed in the framework into 'on-the-ground' strategies and realities. The use of the resilience management framework can help practitioners and communities develop adaptive capacities and improve livelihood and food security measures, programs and policies. In addition, users must be attentive to context specific features of communities during their development and implementation. To aid in these processes we turn in the following two sections to a review of food security, livelihood, and ecosystem management initiatives to analyze the key characteristics, or 'best practices', of successful projects.



4. Resilient Landscape Management in Practice

This section presents a selection of case studies to highlight examples of integrated initiatives that have linked sustainable production with the management of other landscape components to improve food and livelihood security of vulnerable populations of farmers, pastoralists and their communities. The cases illustrate a diversity of ecosystems, production systems, primary concerns, land uses, stakeholder relationships, and other characteristics of integrated management and of strategies for capturing synergies across multiple dimensions of resilience.

United Nations World Food Programme initiatives

The three case studies presented first focus on initiatives supported by the United Nations World Food Programme (UN WFP) in Ethiopia, Kenya and Ecuador respectively. To develop these cases field visits were conducted by EcoAgriculture staff in November 2011 (Kenya and Ethiopia) and May 2012 (Ecuador) where they consulted with country-based staff and project participants. Ethiopia was re-visited in October 2012. WFP is working to build long-term community assets in some of the most difficult parts of the world. In these regions, climate change is increasing the frequency and intensity of water stress and food insecurity events, with the potential of heightened vulnerability and degraded natural resources. WFP with its partners have demonstrated emergent capacities to link each of the pillars of socio-ecological resilience, including livelihood, institutional, and ecological resilience in relation to core investments in agroecological resilience for sustainable production and food security. While the programs in each location have many differences, similar aims and issues tie them together.

Watershed and agricultural restoration in Tigray, Ethiopia

The MERET (Managing Environmental Resources to Enable Transitions to more sustainable livelihoods) project utilizes a community-based participatory watershed approach aimed at improving the long-term livelihood and food security of chronically food insecure and drought-prone communities. Many regions of Ethiopia are characterized by severe land degradation that undermines food security and rural livelihood. Related issues include increased and recurrent drought, unpredictable and variable rainfall, population growth and in-migration, unsustainable agricultural practices and management, and low and declining soil fertility and land productivity. Climate change has compounded these risks.

MERET uses two main methods of programming. The first engages in Food for Assets (FFA), using food and cash assistance as incentives for chosen

“Virtually all of the interventions require cooperation including collaborative learning and management. A special focus on gender equity is central...”

Opposite: Tigray escarpment, Ethiopia. Landscape management is restoring degraded land to productivity. Photo by Rod Waddington.

communities to invest in sustainable land management practices, homestead development, and income generating activities (IGAs). The second method uses technical assistance to build climate resilience at community and sub-watershed levels. It emphasizes strengthening technical, organizational and management capacity of communities and project partners. Efforts include disseminating best practices and lessons learned and expanding the technical capacity of extension agents to include climate change knowledge and planning tools.

Notable practices introduced by MERET include:

1. environmental rehabilitation and ecological restoration achieved by rehabilitating degraded lands through area closure, moisture harvesting, and biomass enhancement;
2. rendering non-productive lands productive through measures such as re-vegetation of gullies; and,
3. rehabilitating productive farm lands with soil and moisture conservation structures. Climate change mitigation measures include increasing carbon sequestration through area closures and afforestation, as well as improvement of soil organic matter through best practices in farm production.

The MERET program has successfully increased resilience across agrobiodiversity, livelihood, and institutional dimensions. For example, there has been a notable increase in production per unit area and in agrobiodiversity, on both communal lands and homesteads. Major improvements in product diversification are being made through the establishment of income generating associations (e.g. livestock fattening, beekeeping, and vegetable and fruit planting), and this is just one of several ways households have improved capacity to turn their assets into income. Farmers are enterprising, experimenting on their homesteads and on communal lands. They engage in informal knowledge exchange as well as regularly receiving technical advice from WFP, the government, and project partners.

Agroecosystem Resilience in Turkana, Kenya

Turkana County is an arid and semi-arid land (ASAL) in northwest Kenya. The Turkana peoples, traditional pastoralists who base migratory patterns on annual periods of long and short rains, populate the region. The region increasingly is affected by climate change, with effects including prolonged droughts, destruction of crops, loss of topsoil, and uncertainty as to when to plant crops. Water is the major limiting factor in the development and livelihood security of Turkana. WFP in Turkana County uses food as an incentive for communities to build long-term livelihood assets, that is, FFA. FFA expands the effectiveness of WFP activities by embedding longer-term recovery and

transitional development strategies in its emergency response interventions. WFP activities are built on partnerships with the national government and non-governmental implementing partners.

Water is the major limiting factor in Turkana; therefore, many of the technologies and practices promoted by FFA are oriented towards increasing water supplies or making more efficient use of water. The team observed several rainwater harvesting and management technologies implemented through FFA, including:

1. trapezoidal bunds and soil structures for farming/pasture use;
2. water pans and shallow wells for domestic and livestock use;
3. rock catchment water harvesting;
4. water tank with tap;
5. livestock troughs;
6. small-scale irrigation schemes for agriculture; and
7. planting pits.

Virtually all of the interventions require cooperation including collaborative learning and management. A special focus on gender equity is central to the management of these interventions.

FFA program sites in Turkana already are showing early improvements in agroecosystem resilience. Turkana County has intensified its production appreciably through small-scale irrigation and moisture harvesting. Farmers



Women maintain a water pan in Turkana County, Kenya. Photo by Courtney Wallace-Stokes.

“The final critical lesson from the PRRO project is the necessity of harmonizing institutional roles and functions in promoting food security and watershed management.”

have increased agrobiodiversity by planting drought-tolerant varieties of sorghum as well as traditional sorghum, and incorporating wild fruit trees into farms. Increased crop diversity combined with effective water management strategies has helped to improve livelihood resilience. Water-saving measures are particularly beneficial to the overall health of the family; because mothers do not have to travel as far to obtain water and are better able to breastfeed, they can more effectively promote the health and nutrition of their children (EcoAgriculture Partners and World Food Programme, 2011).

Inter-sectoral collaboration in Carchi and Sucumbios provinces, Ecuador

The WFP Food Security and Dietary Diversity program in Ecuador aims for long-term solutions to food insecurity by linking small producer associations of organic farmers and gardeners with vulnerable consumers in local schools, district markets, and farmers' markets. In addition, WFP has promoted community-based water protection activities, including fencing, reforestation and water conservation.

One of the pilot projects under this thematic is the Protracted Relief and Recovery Operation (PRRO) in Carchi and Sucumbios Provinces. The PRRO project aims to meet the short-term emergency food needs of Colombian refugees and school children, and to reduce tensions between refugees and host communities to promote long-term assimilation. The project is implemented by WFP staff in collaboration with local government officials and NGOs and entails the promotion of agroecological production methods of diverse and nutritious foods; improved market access for local farmers; capacity-building; training and education in health, sanitation, deworming, and nutrition; and improved access to clean water through community-based protection of water sources.

The PRRO project provides redeemable vouchers to schools to purchase nutritious, fresh food from local producer associations for lunch programs, and to refugee families for purchase of nutritious foods at specific local markets. The project also provides food rations to members of Water User Groups during traditional work 'mingas' as an incentive to participate both in water protection activities (e.g. fencing, tree planting) and short nutrition education workshops. The voucher system is a non-cash incentive for improving food security, household nutrition, and watershed management. The vouchers have a multiplier effect in that they not only support households and school children, but also local food producers. Thus, they serve as an economic stimulus in the community. The food rations for water user groups function as a payment for ecological services scheme; ecological stewardship is incentivized through food provisioning. Management of water resources is a central feature of this project, as it is widely recognized that access to clean water is necessary for



The PRRO project increases sales for the Siembras de Futuro women's association of organic vegetable producers by providing access to new markets. Photo by Courtney Wallace-Stokes.

strengthening community resilience to environmental risks as well as food and nutrition security.

A final, and critical, lesson from the PRRO project is the necessity of harmonizing institutional roles and functions in promoting food security and watershed management. Coordinating multiple institutions to promote synergistic relationships is essential to achieving a landscape approach to resilience. This entails coordinating national and local government agencies with international and local NGOs and community groups.

Other Integrated Initiatives

Our second set of three cases highlights a spectrum of initiatives in Africa that have been supported and/or documented by TerrAfrica, the Lake Victoria Basin Commission with the International Union for Conservation of Nature (IUCN) and the Climate Development and Knowledge Network (CDKN), respectively. The cases have been prepared from program and project documents, and some interviews, to shed light on technical and institutional innovations that have led to livelihood security, sustainable productivity and ecological conservation outcomes. The diverse strategies used to stimulate coordinated

action sufficient to demonstrate landscape scale benefits for populations who are vulnerable to food and livelihood insecurity suggest some practical, cost-effective ways of building socio-ecological resilience through integrated management.

Farmer-led regeneration in the Sahel

The regeneration of woodlands and productive drylands in the West African Sahel began three decades ago, with improved soil and water conservation practices in Burkina Faso and tree planting in Niger. Tales of the early agricultural and economic success of a few pioneers lead to the “spontaneous” expansion of tree planting and other relatively easy-to-implement practices across these countries and into Chad, Mali and Ethiopia. This farmer-managed natural regeneration (FMNR) continues to reverse the historic trend of widespread land degradation, even in a region with severe climatic conditions and population pressures. Today over 4.5 million people on five million hectares of land reap the benefits (Cameron 2011).

Strategies

FMNR hinges on taking advantage of local wisdom and traditional methods. For example, in a centuries-old practice, FMNR manages native



Farmer managed natural regeneration is helping to regenerate woodlands and productive drylands in the West African Sahel. Photo (cropped) by Daniel Tiveau/Center for International Forestry Research (CIFOR).

tree species that re-sprout extensively after being cut, resulting in continuous harvests of timber, food and fodder without requiring replanting (Ibid.). FMNR thus does not require tree nurseries or high-level training, improved seeds or transportation of seedlings. A farmer simply selects sprouts from tree stumps and decides how many will be allowed to grow on each stump. Pruning excess stems and branches every 2-6 months stimulates growth and produces straighter, more valuable stems. Through this system, large areas can be rapidly restored, as tree stump stems have a much deeper root system than do other seedlings. Project implementation costs are estimated at \$10/ha, substantially less than an estimated \$200 +/-ha for tree planting schemes (Ibid.). Notably, FMNR has a 100% survival rate (Ibid.).

Production, livelihood, and conservation outcomes

Successful FMNR generates increased crop yields, farm profits, restored woodlands and rehabilitated farmlands, and potential for climate change mitigation. The core FMNR activity of tree planting on farms enhances the environment for crop production through, for example, increased water retention, provision of windbreaks, shading, and soil organic matter from fallen leaves. Tree products provide diversified food sources for people and livestock, improving local food security. The planting of *Faidherbia albida* trees in some places has enriched soil nitrogen, resulting in increased cereal yields of 400-500 kg/ha, in addition to providing fodder in the form of leave and pods. Such an increase in fodder means that farmers can keep livestock closer to their fields, allowing for more intensive livestock production as well as easier usability of manure as crop fertilizer (Reij, Tappan, and Melinda 2009).

An immediate benefit of FMNR is the availability of fuelwood from tree branches, which can be sold in local markets as early as the second year after planting (Cameron 2011). In addition to significantly reducing the burden on women to collect fuelwood, this increased availability may reduce pressure on existing woodlands. With similar effect, new income opportunities reduce incentives for communities to migrate (Reij, Tappan, and Melinda 2009). Trees provide windbreak, reducing soil erosion. On-farm agrobiodiversity and diversity of local vegetation increased, and evidence points to land rehabilitation as the primary cause of improved local water levels (Ibid.). Increases in wild biodiversity often come in the form of pests, a reported disincentive to farmers to adopt FMNR (Ibid.). Farmers are reported to have earned up to an additional 50% of income each year, and an early study indicated that from 1985 to 1997 100 villages sold between them USD\$600,000 worth of wood (Cameron 2011). Emerging evidence from remote sensing analysis suggests FMNR has significant climate mitigation benefits. For example, experts estimate that Niger could store 60 million tons of carbon in its restored, regenerated lands (Ibid.).

FMNR in the Sahel demonstrates the ability of farmers to generate positive landscape-scale effects, starting from the grassroots. Consistent support from diverse external actors at several levels institutionalized the FMNR approach and its knowledge management; this “fluid coalition of actors” also helped keep the movement alive through regulatory and political difficulties (Reij, Tappan, and Melinda 2009; Cameron 2011). This case drives home that successful development at-scale can happen without costly investments in infrastructure with applicable local wisdom and rich information and support networks.

Forest landscape restoration in Mt. Elgon, Uganda

The slopes of Mt. Elgon, a 4-km high extinct volcano that straddles the Kenya-Uganda border, are home to a growing human population, a rich variety of altitudinal vegetation zones and wild fauna, and a 1,145 square kilometer national park with proven tourism value. The mountain is important for watershed protection, as a major source for the Kenya, Uganda and wider Nile Basin ecosystems and at least 12 rivers and streams (Nordic Development



A man tends to his newly planted tree seedlings in a nursery on Mount Elgon in Arokwo Village, Kapchorwa, Uganda. Photo: Kate Holt/Africa Practice

Fund 2010). This complex landscape illustrates how multi-stakeholder dialogue and sound agroecological management of productive areas, with institutional support, can realize multi-functionality where protection of biodiversity and natural areas is paramount.

Strategies

The International Union for Conservation of Nature (IUCN) has been operating in Mt. Elgon since the late 1980s when rapid population growth led to rampant deforestation. Particularly affected was the Benet community of original forest dwellers, who were resettled when the forest was closed off. Growing scarcity of food and livelihood resources, heavily silted water sources, and deterioration of other ecosystem services compelled the Benet and other residents to turn to the protected areas. The IUCN, through its Livelihoods and Landscapes Strategy (LLS), initiated landscape restoration activities with the goal of reducing pressure on the protected areas (IUCN 2012).

LLS first helped communities to form their own by-laws to prevent overgrazing and undermining of soil and water conservation (SWC) measures. Early positive impacts from such by-laws prompted neighboring communities to create and adopt their own rules (Ibid.). With such protection in place, communities, with the guidance of LLS technical staff and funding from several external donors, undertook early land restoration activities selected through multi-stakeholder participatory visioning, goal setting and planning (IUCN 2009). Activities included building contours for soil and water conservation planted with grasses and small shrubs, tree planting for shade and fuelwood, and rehabilitative closing of areas along rivers (Ibid.).

As an incentive to adopt SWC, LLS donated improved livestock breeds to communities, allowing them to keep a smaller number of animals while maintaining the availability of adequate supplies of milk for consumption and sale. Apiculture helped diversify livelihoods, and given their benign ecological impact, hives were established in closed-off buffer zones. Many communities established tree nurseries and fodder banks (Ibid.). As with the by-laws, efforts spread organically as communities witnessed the positive outcomes their neighbors were experiencing. In a new model of park boundary management, some communities are allowing the poorest households to grow crops in a boundary planted with tree seedlings in return for weeding and pruning seedlings. When the boundary matures, wood is harvested for communal projects or given to the poorer households (IUCN 2009). LLS is also helping communities to engage in ecotourism.

Production, livelihood, and conservation outcomes

The establishment and regular maintenance of soil and water conservation structures such as contours planted with grasses and small shrubs has significantly reduced soil erosion, as evidenced by clearer water. The

maintained soil has improved land productivity, and the system of contours has prevented the destructive flash floods that historically followed heavy rains (Ibid.). The lessened impact of smaller herds was augmented by the closure of lands buffering river banks and steep cliffs, preventing further degradation and allowing land to revegetate. Livelihood options have improved through diversification of income and nutrition; success with improved dairy and honey production has prompted efforts to improve markets linkages (Ibid.). With awareness, strategies, and incentives to keep protected areas and ecosystem services—including ecotourism potential—intact, communities also adhere to forest commodities guidelines and are actively involved in monitoring protected areas (Ibid.).

The multistakeholder collaboration fostered from the outset has led to the adoption of locally-appropriate and naturally-expanding restoration activities; the establishment of effective by-laws, and the improvement of local livelihoods. With these activities and benefits in place it is easier to foster the vision among diverse stakeholders in the complex Mt. Elgon landscape as a healthy mosaic of productive smallholdings, managed grazing areas, clear waters, regulated-use buffer zones, and biodiversity-rich protected areas that stakeholders can strive to fully realize over time.

Large-scale rainwater harvesting in West and East Africa

Widespread land degradation and devegetation in sub-Saharan Africa (SSA) have had major deleterious effects on watershed functions, including the provision of reliable water from surface sources and groundwater, water quality, flood control, sediment and salinity control. Watershed deterioration, in turn, has depreciated agriculture through increasing topsoil erosion and the vulnerability of crop and livestock production to floods and droughts, ultimately leading to lower yields (Rockstrom et al. 2004). Integrated watershed management must be a coordinated effort among agricultural, domestic, industrial and urban water users, to avoid fighting over water “at the end of the pipe”. Innovators are now seeking ways to increase the total supply of water through better water and watershed management. New approaches to watershed management aim to restore degraded watersheds through a triple-win strategy for addressing water scarcity, food security, and climate change. This section describes rainwater harvesting, an approach supported by TerrAfrica (Liniger, Hauert, and Gutner 2011).

Strategies

Large-scale rainwater harvesting (RWH) is the scaling up of field-level RWH innovations that have dramatically increased crop yields in many parts of SSA (Reij, Tappan, and Melinda 2009). RWH involves the collection and concentration of runoff for productive purposes: a catchment area produces runoff, a conveyance system of bunds, ditches or channels redirect water, and

a storage system accumulates and holds water. At a larger scale, farmers can utilize various methods to catch and redirect surface runoff to croplands, and store water in small dams, ponds and earthen tanks (EcoAgriculture Partners 2013). This is especially crucial given that nearly 70% of rainfall in Sub-Saharan Africa is lost to surface runoff. Proper water storage helps farmers through the dry season and hedges risk of unpredictable rainfall.

Coordination among farmer networks, community-based groups and technical assistance support organizations is necessary to bring RWH practices to scale. High initial investment costs in building conveyance and storage systems may require financing mechanisms or other incentives. Secure land and water use rights are also crucial for farmer to invest time and money, as are links to markets (Liniger, Hauert, and Gutner 2011).

The Greater Horn of Africa Rainwater Partnership (GHARP), established in 2001 and comprised of national rainwater associations in Kenya, Uganda, Ethiopia, Tanzania, and Somalia, is promoting RWH throughout the region. The GHARP is learning from lessons generated through RWH experience in Burkina Faso, Ghana, Niger, Senegal, South Africa and Sudan.

Production, livelihood, and conservation outcomes

RWH has been shown to increase water availability, crop productivity, drought resistance, and farm profitability and reduction of risk of production failure, soil erosion, and flooding damage. The practice recharges groundwater, enhances soil health and has helped reduce upstream-downstream conflict over water resources (EcoAgriculture Partners 2013). Other benefits include reducing women's burden of collecting water, perhaps allowing girls to attend school, and providing a safe and clean source of drinking water. RWH is a decentralized water supply system that encourages community self-reliance.

Implemented together with conservation agriculture, RWH can triple maize production, while simultaneously reducing the risk of crop failure during droughts (Mati, Malesu, and Oduor 2006). In the Eastern Tigray watershed of Ethiopia the adoption of integrated watershed management practices has enriched the soil, increasing yields for teff, wheat, and barley by an average 0.3 t/ha, while reducing sedimentation and improving the reliability of water supply (Alemayehu et al. 2009). A study of RWH in Tanzania reported returns between USD\$10 and \$200 per person day of labour through the use of storage ponds (Liniger, Hauert, and Gutner 2011).

“Nearly 70% of rainfall in Sub-Saharan Africa is lost to surface runoff. Proper water storage helps farmers through the dry season and hedges risk of unpredictable rainfall.”



5. Highlights and Lessons from Practitioner Experience

Practitioners who are engaged in on-the-ground efforts to improve rural livelihoods and food security amongst vulnerable populations offer essential insights into effective strategies for building socio-ecological resilience within the respective components of the proposed landscape resilience framework and across the four dimensions. From interviews with such practitioners and from reviewing program and project reports that they recommended, we are able to highlight some notable innovations and synthesize key lessons from their experience.

Especially notable is that interdependencies among ecosystem services, sustainable livelihoods, and food security increasingly are recognized and appreciated as well as the need for integrated management. While historically little interaction between livelihood and food security projects and ecosystem conservation has been apparent, recent integration efforts stem from the realization that the majority of food insecure people in the world meet their economic and subsistence needs through agriculture, and that ecosystem services generated on agricultural lands are critical to the security of rural livelihoods. This growing understanding that the ability of agrarian communities to meet their food needs depends on healthy ecosystem functioning is at the root of socio-ecological resilience building through landscape management.

Integrating socio-ecological management

Although unique in scale, scope, and location, projects described in the practitioner reports and in interviews with practitioners reflect some common characteristics that can contribute to a resilience-building landscape approach. First, the reports and interviews recognize the importance of integrating social and ecological systems through practices that promote agricultural, ecological, and livelihood diversification. This approach has several components, including improving farm level diversity (or increasing the genetic diversity of crops and livestock), enhancing production techniques, improving product marketing and market channels, and restoring degraded lands.

Farm level diversity is promoted as a way to improve livelihoods, food security, and on-farm ecological functioning. By increasing crop or livestock diversity, farmers and pastoralists can diversify incomes and marketing channels. Likewise, diversifying production systems can improve household provisioning and function as a food buffer when market prices decline. Ecologically, farm- or pasture-level diversity often enhances both on and off-farm ecological functioning by creating habitat, harnessing mutually beneficial relationships, and maintaining soil fertility. Farm diversity is also a form of risk management. Managing farms and pastures for diversity promotes resilient systems by increasing the likelihood for adaptation to short- and long-term

Opposite: Cattle market in Ambalavao, Madagascar. Photo by Michael Sale.

effects of climate change. As each crop or livestock species has a range of genetic capacity to deal with climatic variability (e.g., drought, flood, hot or cold temperatures, etc.), the diversification of crops and livestock serves as a way to manage for unpredictable weather events and climate change, as there is a greater likelihood that some crops and/or livestock will survive weather events/shocks better than others. This is a marked contrast with monoculture agriculture, in which the large-scale planting of a single crop can have disastrous social and ecological consequences.

Enhancements of production techniques are usually geared towards increasing yields or improving pest resistance. These innovations include improved seed varieties, irrigation techniques, fertilizer use, and farm equipment. Additionally, the reports describe soil management techniques through agroforestry and conservation agriculture practices—including crop rotations, cover crops, hedgerows, composting, and intercropping—as essential to sustainable production. Improving yields has a direct effect on household and community food security and livelihoods. As discussed above, many marginalized farmers and pastoralists observe low productivity in their fields because of poor soil. Improving yields through technological innovation can increase a farmer’s income and/or the ability to meet household food needs. Likewise, these technical innovations often promote the efficient and sustainable use of renewable resources. For example, smallholder irrigation management employs methods of efficient water collection, storage, distribution, and application to achieve higher water use efficiency.

Value added marketing helps retain more value at the household and community levels to enable farmers and pastoralists to earn more income from their crops and livestock. Supplemental income from crops and livestock improves livelihood security by enabling reinvestment in production in addition to purchasing power for food and other needs. A fundamental way to add value is by improving the quality of production at a local scale to make products more marketable. Additionally, project reports focus on improving the vitality of local markets, so that farmers and pastoralists have more opportunities to sell their produce and livestock locally or regionally. Improving local markets also helps assure better food access by communities and households.

Restoration and rehabilitation of degraded lands is another area of innovation frequently mentioned in reports and interviews. The restoration of degraded lands is promoted in order to improve ecosystem services such as nutrient and water retention and recycling. By providing clean water, reducing erosion, increasing water storage, and increasing forest foods and forage, these projects improved the natural resource base upon which household and community livelihoods are established.

Combining technical and institutional innovations

Coupling technical and institutional innovations to pursue synergistic relationships between improvements in production practices, natural resource management systems, and the institutional capacities needed to support them is another common feature across the reports and interviews. While most projects in this review incorporate multiple technical innovations, they recognize that technical innovation alone does not guarantee successful outcomes. Particularly important institutional innovations include prioritizing the needs of the poor, improving community and regional infrastructure, blending local and scientific knowledge in development practice, and investing in leadership. Practitioners also highlighted the need to understand the broader landscape in which technical and institutional innovations in integrated management for resilience are being pursued, and stress the importance of recognizing and addressing the prospective difficulties of engaging highly food insecure populations in multi-stakeholder management processes.

Prioritizing the needs of the poor is emphasized in reports and interviews, entailing several levels of action. Small-scale farmers, pastoralists, and vulnerable populations require social protection and safety nets. In the short-term, this entails humanitarian relief and recovery assistance. Long-term efforts include health care provisions as well as the promotion of gender equity in access to resources and participation, the promotion of economic parity, governmental support for social and economic transitions, governmental support to mitigate shocks associated with climate change, national and international resources for resilience planning and program implementation, and the reinforcement of the ability of national institutions to establish effective resource transfer programs. Food-for-work programs, for example, provide the short-term food needs of vulnerable communities that allow them to invest in resource management and land improvement. Additionally, disaster mitigation combines targeted preparedness (e.g., multilayered early warning systems, contingency planning, and rapid impact assessments) with prevention strategies (e.g., raising houses in flood areas, construction of water catchment, tree planting, terracing) to reduce future vulnerability. Resilience thus includes strengthening coping and adaptive capacity of food insecure people while targeting the root causes of vulnerability to climate change.

Improving community and regional infrastructure, such as roads, irrigation systems, and water and grain storage, improves the ability of farmers and pastoralists to obtain farm inputs and to get their products to market. Moreover, infrastructure enhances community members' access to critical services, such as health care and education. Infrastructure, in many ways, is the backbone of production systems. Without well-maintained roads, storage facilities, and irrigation, community and household livelihoods are jeopardized.





In Kenya, the Huruma Women's Group is receiving support to turn their maize and other staple crops into value-added baked goods for sale in local markets, generating additional income and increasing food security for the women and their families. Photo by Fintrac, Inc.

Integrating local, cultural, scientific, experiential, and experimental knowledge is widely considered an essential ingredient in integrated resilience-building strategies. It implies and entails a participatory approach to management that promotes collaborations between farmers, vulnerable community members, national and international governmental institutions, and development partners. For example, many projects promote the formation of community groups that include multiple stakeholders where questions of management goals, processes of implementation, and modes of inclusion are negotiated. And in turn, community groups must learn to communicate and negotiate with stakeholders at other levels to advance landscape level management. Designers and facilitators of these processes need to explicitly value multiple knowledges to promote innovation as well as equity in participation and decision-making.

Organizing and sustaining multi-stakeholder processes that are required in managing for socio-ecological resilience in the context of chronic and acute food insecurity requires special attention to integrating relief and development efforts as exhibited by WFP and CARE. Using food aid strategically to help foster participation in the collaborative learning and asset-building activities needed to help build ladders out of poverty requires institutional commitment and know-how. The social capital and local political support that are commonly derived from investment in multi-stakeholder management processes provides incentive to sustain these processes throughout cycles of relative vulnerability.

Investing in leadership is integral to successful management across the technical-institutional spectrum of objectives and issues. Characteristics of effective leadership for integrated management that practitioners and reports identified include:

- extensive on-the-ground experience;
- deep historical and geographical knowledge of the landscape;
- capacity to comprehend multiple time-scales, to think about resilience as a function of time and ways to leverage immediate food assistance for long-term food security and resilience;
- interest and capacity to advocate for the poor;
- ability to forge partnerships amongst multiple groups with diverse interests across public, private and civic sectors; and,
- good facilitation of team-work.

Often there is much for good leaders to learn about breaking into and communicating work in this arena (with chronically poor and vulnerable populations, and transitioning from a narrow relief to a broader development oriented mission), securing funding, and establishing relevant and strategic partnerships, as well as avoiding or resolving conflicting goals within organizations and between them.

Understanding the wider landscape involves paying attention to rapidly developing linkages of rural to urban and peri-urban areas. Important questions to pursue in exploring these linkages might include, in what ways are urban areas assets to rural areas (e.g. markets) and rural areas assets to urban centers (e.g. clean water)? How can targeted food assistance help prevent outmigration to cities? Consideration of multiple time scales is important as well. Short, medium, and long term conceptions of time must be considered and balanced in landscape management, recognizing that resilience is a highly dynamic process.

Facilitating stakeholder processes in the context of acute and chronic poverty involves the challenge of organizing, managing and sustaining multi-stakeholder processes with vulnerable populations. By prioritizing the

needs of the poor and working consistently to help give them voice in multi-stakeholder forums, challenges can be turned to opportunities to build their confidence and motivation to engage and benefit from the process. Programs that advocate effectively for the poor likely are equipped to understand strategies and benefits of investing in building the esteem and effectiveness of community leaders in market and policy forums. The often rapid and visible pay-back to the poor in building wealth and resilience through investments in natural capital, commonly through group action, can be inducements to their engagement. In addition to assisting vulnerable populations to participate effectively in multi-stakeholder platforms, it will be incumbent on pro-poor development initiatives to advocate on their behalf with other stakeholders in the forums. Helping ensure that landscape negotiation processes include representatives of public agencies and community organizations with poverty alleviation orientations, and allying with trustworthy leaders, will help to ensure the successful participation of the poor. Strategic early successes will pave the way toward sustaining their engagement over time.

6. Mainstreaming Landscape-Level Resilience Building

Accelerating the process

Mainstreaming integrated landscape-level management for resilience and the broader arena of rural development will require action on several levels. Different stakeholders (e.g., program leaders, government officials, farmers and beneficiaries, and local NGOs) with diverse goals over differing timescales such as immediate food relief, short-term economic boosts, and long-term sustainability must come together to develop a spatially explicit shared vision for managing large areas of land-resilient, rural development. We contend that the most effective way to coordinate and harmonize multiple stakeholders is through a shared commitment to a landscape-scale approach to management.

The landscape scale approach takes a broad view of social and ecological relationships that encompass multiple dimensions to fulfill multiple demands over the long-term. The challenge of doing so can seem daunting, yet the need for integrated approaches is increasingly clear as the intertwined issues of food insecurity, poverty traps, ecosystem degradation, and climate change must be addressed. Fortunately, farmers, governments, NGOs, and others are sparking innovations that satisfy these multiple outcomes in diverse biophysical and socio-economic contexts (Buck and Scherr 2011; German et al 2012). The case studies highlight successful landscape initiatives. Such innovations and successes point to the possibility that integrated landscape management can be mainstreamed to promote resilience at multiple scales. The following actions may help to accelerate the process.

- Stay abreast of technologies and institutional mechanisms that rural communities can use to adapt to changing climates and manage disaster risk, and to expand work on path-breaking interventions such as climate risk insurance.
- Strengthen your organization's role as a 'learning laboratory' and invest in documenting and disseminating valuable lessons generated from project experience to the wider agriculture, rural development and climate change communities.
- Look for innovations that are spreading spontaneously (e.g. FMNR). Spontaneous uptake is a sign that things are working. Farmer visits can encourage these processes.
- Explore ways that food assistance can be leveraged to promote adoption of integrated landscape management principles and practices.

“Different stakeholders...with diverse goals over differing timescales... must come together to develop a spatially explicit shared vision for managing large areas of land-resilient, rural development.”

- Invest in leaders. Ultimately it is leadership that gives vision, voice, momentum and direction in landscape initiatives that are complex and multidisciplinary.
- Explore opportunities for synergistic partnerships with other organizations to scale up and scale out successes.

Next steps: what gaps need filling in knowledge, policy, and practice?

This paper has drawn on scholarly literature and practitioner experience to highlight the linkages between ecosystem management and livelihood and food security outcomes. As discussed, the livelihoods and food security of marginalized communities are increasingly under threat as climate change jeopardizes the natural resources upon which they depend. Political, economic, and demographic pressures are straining rural communities simultaneously. It is therefore critical at this moment that development agencies, NGOs, and governmental organizations coordinate and harmonize their efforts to promote climate levels of management, including farm level, household, ecosystem, watershed, local/regional markets, etc. Starting from a broad premise, the landscape scale allows policy makers and practitioners to develop overarching objectives within which they can craft short-, medium-, and long-term programs and initiatives for addressing livelihood and food security. The ability to assess programmatic efforts in terms of its landscape effects becomes critical in maintaining the broader goal of socio-ecological resilience.

Our integrated landscape and resilience management framework is designed around four inter-connected landscape dimensions (agroecosystem, livelihood, ecosystem, and institutions) that are critical for achieving livelihood and food security, and ecological resilience. This framework is geared towards a broad audience of practitioners, including those working in rural development, food aid and relief, agriculture, policy, and conservation, amongst others. It is our hope that this framework will evolve as practitioners adopt, adapt, and modify it through implementation and experience in diverse settings. The particularities of lived experience are what give meaning and substance to such frameworks. Furthermore, approaches and tools for designing and facilitating effective adaptive collaborative management systems for integrated landscapes are rapidly developing through efforts of the [Landscapes for People, Food and Nature initiative](#) and its numerous partners. Engaging with the LPFN initiative will enable practitioners and organizations engaged in socio-ecological resilience programming to stay abreast of these developments and contribute to them.



Developing successful landscape resilience programs will entail a great deal of leadership and vision. While many development agencies and experts are often confined to narrow parameters, the goal of landscape management is to broaden and connect people and organizations across space, experience, and expertise. However, this is easier said than done. Strong leadership is a central ingredient for implementing successful landscape management projects.

Last but not least, investors, agency heads, policy makers, and government officials concerned with food and livelihood security will benefit from learning more about landscape approaches to managing for resilience, and in using the resilience management framework to help scale up successful pilot initiatives. Providing incentives for cross-agency, multi-sector coordination will be important to this learning process.

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