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SUSTAINABLE LAND MANAGEMENT AND ITS RELATIONSHIP TO GLOBAL ENVIRONMENTAL BENEFITS AND FOOD SECURITY – A SYNTHESIS REPORT FOR THE GEF

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Introduction

Sustainable land management (SLM) represents the critical merger of agriculture, environment and human socioeconomic well-being. It has the dual objectives to maintain long-term productivity of ecosystem functions for land, water and biodiversity and, at the same time, to increase productivity of goods and services, and particularly safe and healthy food. Well-structured and resourced SLM programs have the potential to provide global environmental benefits through their contribution to combating land degradation and to arresting and reversing decline in biodiversity and other ecosystem services. Effective implementation of SLM programs will also deliver social and economic benefits through productivity gains and enhanced resilience of agroecosystems, which are essential to addressing the major challenges facing the world today – food security and climate change.

Programs for SLM and for combating land degradation have complementary goals as demonstrated in the objective of the land degradation theme of the Global Environment Facility (GEF) forward program strategic plan (GEF-6) to “maintain or improve flow of agroecosystem services to sustain food production and livelihoods”. According to the GEF strategic plan, a comprehensive landscape approach to SLM is needed to address the broad multi-faceted nature of land degradation across the range of agroecological and climatic zones in arid, semi-arid, sub-humid and humid areas of the world. The land degradation theme focuses on regions where agricultural and rangeland management practices underpin the livelihoods of poor rural farmers and pastoralists. It prioritizes programs for intensifying production of food crops and livestock through efficient use of land, soil, water and vegetation in agroecosystems. Thus, the GEF is well-placed to facilitate coordinated investment in SLM for global environmental benefits and to add significant value to programs addressing food security and climate change challenges.

Scope and structure of this paper

This review paper seeks to provide a synthesis of current knowledge on SLM and its relationship to combating land degradation, enhancing food security and addressing climate change adaptation and mitigation. The approach taken was to:

1. define key terms used in the paper to avoid some of the confusion that has arisen from inconsistent usage in this evolving area of research and application to management
2. examine sustainable management in the context of anthropogenic and natural pressures on the land resource
3. examine the role of SLM in addressing the critical challenge of global food security
4. provide an overview of the processes of land degradation as a basis for development of good practice for SLM that is scientifically sound and robust
5. review published literature on principles and practices for SLM that promote soil health, productivity and ecosystem services and the barriers to adoption of good practice for SLM

6. explore the potential to develop indicators and metrics needed to benchmark land condition and monitor the effectiveness of SLM programs
7. provide recommendations for an approach to developing and implementing SLM programs to support discussion of investment for global environmental benefits.

This review is intended to be relevant to a wide range of stakeholders involved in agriculture, environment and sustainability issues. It specifically targets, however, the need for a strong evidence base for GEF programs, including those supported through the Facility's role as the financial mechanism for the United Nations Convention to Combat Desertification (UNCCD).

Definitions and terms

This paper uses the World Bank definition of sustainable land management as a knowledge-based procedure that helps integrate land, water, biodiversity and environmental management to meet rising food and fibre demands, while sustaining ecosystem services and livelihoods. SLM encompasses the management of land resources (soils, water, plants and animals) for food and fibre production and ecosystem services, while protecting the long-term productive potential and ecological value of these resources. This broad definition assumes the relevance of all three pillars of sustainability – environmental, economic and social – and highlights the complexities of implementing SLM across biogeographical and governance boundaries. While targeting productive lands, good practice for SLM is assumed to have inter-dependencies with activities in "natural" landscapes through major linkages in hydrology, biodiversity and other ecosystem services that affect productivity in agroecosystems. Terms relating to land condition, including degradation, desertification, rehabilitation and restoration, are also defined; they are relevant to assessing priorities for SLM programs and monitoring the effectiveness of those interventions. While land degradation is considered more broadly, soil health is a key concept in process understanding and for evaluating SLM.

The land resource – pressures and degradation processes

Pressure on the land resource is increasing at all scales from local to global due to human factors, notably: (1) growing demand for food in terms of both quantity (kilojoules of energy) and quality (proportion of animal protein in the diet) for an expanding and more wealthy world population; (2) competition for productive land for biofuel, urban expansion and other non-productive uses; and (3) decrease or lack of growth in productivity due to decline in soil health indicated by lower nutrient status and organic matter, and other degradation processes. Pressures also arise from natural factors such as climate variability, extreme weather events and wildfire; these add to the challenge of matching management practices to environmental conditions for optimal yields and for sustainable use of the land resource. Anthropogenic climate change is projected to exacerbate variations in year-to-year yields and income from agriculture, threatening the resilience of agroecosystems and stability of food production systems.

Practices for sustainable intensification of production – that will produce more on existing productive lands, while using fewer resources – will be increasingly necessary to meet demand for food and fibre.

Some limited expansion in land for production through deforestation and conversion of new land areas is occurring. The potential additional arable area for producing food and animal feed, however, is realistically assessed as insufficient to meet future demand without producing more per hectare. Sustainable intensification involves increased inputs, particularly of nutrients and water; this adds both to costs for land managers and to risks to the environment from processes such as nutrient leaching and greenhouse gas emissions.

Land degradation on various scales may result from a range of natural and management pressures on land resources. In Australia, for example, rangeland degradation results from the coincidence of prolonged drought with high grazing pressure from both domestic stock and native animals. The ability to reduce stock numbers to match feed availability during drought may be affected by economic and logistical circumstances (e.g. labour and distances). Similarly, extended dry periods have been a factor in land degradation in sub-Saharan Africa. But, in this case, as in other developing countries, the direct impact on human populations suffering under-nutrition and with little or no capacity to rehabilitate land is often much greater. Thus, while the combination of human and natural pressures on land can limit land-holder capacity to implement good practice, land management, policy and socioeconomic constraints can also influence the adoption of SLM practices.

Sustainable land management for food security

By the middle of this century, the Earth will need to feed more than 9 billion people; scientists predict this will occur with little additional land coming into production. Many of the approximately 850 million people who are chronically hungry today live in regions of sub-Saharan Africa and southern Asia subject to factors that increase the risk of land degradation: high climate variability, water scarcity, steep slopes and shallow, fragile and nutrient-poor soils. Sustainable intensification of agriculture has been identified as essential to achieving food security now and in the future. As a result, higher inputs, especially of nutrients and water, and adoption of technologies will need to be part of the solution for higher and more sustainable production. Importantly, however, sustainable intensification does not have to be uniform across agroecosystems; it can be applied differentially in a way that is compatible with other food production strategies such as matching use to land capability and “land sparing” for conservation of high-value ecosystems. Sustainable land management will also contribute to food security through addressing the “yield gap” (the difference between actual yield and maximum attainable yield), which is part of the vision for sustainable intensification. Closing the yield gap represents an important opportunity for increasing current and future food and fibre production; this can occur, in part, by introducing more sustainable management practices to rehabilitate areas with decreased productive capacity.

In addition to productivity increase, achieving global food security will require attention to the social and economic dimensions of SLM, since access, wastage and affordability contribute to situations of chronic hunger. Improved yields for smallholder farmers and greater self-sufficiency in local food production provide the basis for sustainable land management. An integrated response to food security and sustainable use of land and other natural resources, however, also requires global action on sustainable intensification. This includes overcoming policy barriers to access of adequate nutrition.

Soil health and processes of land degradation

The Food and Agriculture Organization of the United Nations (FAO) has estimated the extent of land degradation globally at 2 billion hectares (ha). Hence, the potential benefits in terms of improvement in ecosystem services and gains in productivity for food and fibre from implementation of SLM practices is very large. On the African continent alone, degradation is estimated to affect 124 million ha. Forms of soil degradation include nutrient decline, wind and water erosion, loss of soil biodiversity, soil sealing (due to expanding industrial and urban uses), contamination, salinization and compaction. However, impacts extend beyond soil health to processes such as pollution of aquifers and freshwater resources, water depletion, deforestation and biodiversity loss. Understanding these processes and their impacts on ecosystem services facilitates development of effective good practice for SLM, both to help prevent further degradation and to help rehabilitate or restore affected areas. Analysis of the processes and scales of degradation also helps to develop metrics and monitoring programs targeted to local or regional circumstances to more accurately quantify damage and monitor recovery.

Barriers to adoption of good practice for sustainable land management

Good practice for SLM will enhance the balance across the multiple facets of agroecosystem management. However, the complexity and the potential for synergies and trade-offs between aspects of the resource, social and economic base can impede both development of effective good practice and its adoption. Better understanding of the drivers of land degradation will support efforts to develop good practice for the diverse local conditions of the world's agroecosystems. Principles for SLM include increased water-use efficiency, improved soil fertility, use of good quality plant species adapted to local conditions and creation of favourable growing conditions at the micro-climatic level.

Practices that can be developed into locally applicable SLM guidance include: (1) building soil organic matter for better soil moisture storage and nutrient status and improved soil structure; (2) integrated nutrient management with locally appropriate combinations of organic and inorganic sources of nutrients; (3) better crop selection targeting seed quality and locally adapted varieties combined with management for local conditions; (4) high efficiency of use of rain water to promote infiltration and minimize run-off and erosion in both crop and grazing lands; and (5) management of surface crusting and compaction of soils through maintaining ground cover, reduced tillage and improvements of permeability and hence better seedbed conditions and soil rooting depth. These practices have the potential to make a significant contribution to rehabilitation or restoration of degraded areas.

Adoption of good practice will be enhanced by implementation of programs in education and effective SLM implementation that also take into account the socioeconomic constraints that limit uptake of particular land management practices. Important barriers for smallholder land managers could include poverty, lack of knowledge or confidence to make a change, and labour constraints (human resources) needed to implement a change of practice. Monitoring the effectiveness of SLM programs is also complex for two reasons: the need to consider cross-scale aspects, and the huge diversity in natural and human factors that affect capacity to adopt good practice and the uniformity of response.

Metrics for monitoring land condition and evaluation of sustainable land management programs

A wide range of indicators has been proposed over past years for all or some aspects of assessing the sustainability of land management. The level of complexity and diversity necessitates a composite set of indicators in an assessment framework to monitor the impacts of an intervention program and to avoid trade-offs or perverse outcomes. Two substantial challenges for development of SLM and monitoring and evaluation frameworks relate to the temporal and spatial scope of actions. Introduction of improved practices for sustainability may deliver benefits over several decades rather than on the shorter timeframes over which monitoring of investment in assistance programs is normally required. This is especially the case for programs targeting recovery of degraded lands or where off-site impacts occur. Metrics for evaluating programs in SLM also need to consider assessment across spatial scales where programs aim to extend good practice from intervention at a field site to regional, national and global scales.

Metrics should be capable of assessing both socioeconomic and biophysical impacts and to identify opportunities for, and support, horizontal and vertical up-scaling. There may be a disjunct between the technical need for clearly defined, quantifiable indicators of sustainability to monitor the effectiveness of investment, and the less tangible, often qualitative, social, cultural and human well-being values required for policy development. Nevertheless, review of experience in developing metrics for environmental programs that consider all three pillars of sustainability indicated that the GEF would be well-placed to lead a synthesis of guidance on monitoring and future evaluation of interventions in SLM.

Summary and recommendations for investment in sustainable land management

Global environmental benefits from addressing land degradation potentially include:

- improved provision of agroecosystem and forest ecosystem goods and services, including food and fibre production
- mitigated/avoided greenhouse gas emissions and increased carbon sequestration in landscapes managed for production
- reduced vulnerability of agroecosystems and forest ecosystems to climate change and other human-induced impacts
- conservation of, and sustainable use of, biodiversity in natural and production landscapes
- reduced pollution, eutrophication and siltation of international waters and enhanced buffering of flood damage.

The timeframe for realizing benefits following interventions for SLM will vary. It may be decades before improvements can be measured, but the need is both immediate and growing. Delaying the initiation of SLM practices until full certainty in the outcomes is known can lead to additional degradation of the environment and greater human suffering due to food insecurity.

The process of prioritizing SLM investment strategies should consider selected immediate and achievable targets, which are described below:

1. Sustainable land management is critical to the global response to food security, climate change, land degradation and threats to biodiversity and loss of other ecosystem services critical to human well-being. SLM requires commitment and investment in research, innovation, governance and implementation programs on global scales. It also demands investment in capacity building at local scales through immediate actions based on existing scientific and local/indigenous knowledge, and a willingness to trial or test “best-bet” candidates immediately without waiting for greater theoretical certainty. This is fundamental to preventing further increases in land degradation and starting to restore degrading areas before rehabilitation or restoration becomes more costly and long term.

2. Early interventions to implement SLM practices can act to arrest and reverse land degradation most cost effectively. Practices such as conservation agriculture, agroforestry, increasing soil organic matter, integrated soil fertility management and sustainable intensification can arrest and reverse some or all aspects of land degradation. Delaying the initiation of SLM programs until impacts become severe will likely increase both the financial burden and recovery time with adverse production and socioeconomic outcomes for communities.

3. In areas where yield of crops and pasture is markedly below the potential achievable yield, there is a large opportunity for substantial gains in food production. The “yield gap” has been reported to be as high as 80% in some locations. High priority should be given to investment in SLM programs targeting these areas to identify the reasons and, where possible, close the yield gap. The highest priority will be those areas also associated with under-nutrition in vulnerable communities. Constraints to efficient and sustainable land resource use will need to be identified. These might include biophysical or agronomic causes, social and economic factors such as market access, and policy barriers. Closing the yield gap on existing productive lands can also contribute significantly to conserving natural landscapes for biodiversity and other ecosystem services, as well as meeting current and future food demands.

4. When initiating a program in SLM, three key considerations are: (1) local biophysical conditions and socioeconomic circumstances; (2) requirements for sustainable intensification of production based on estimated best options for land use and knowledge of approaches such as land sharing, land sparing and land capability assessment; and (3) opportunities for scaling up from field trials to increase the number of land managers adopting SLM practices. Local knowledge combined with scientific understanding will help develop locally-acceptable and effective strategies for SLM. At the same time, ongoing investment in research and development is important to develop novel methods and more efficient resource use and to increase production on fragile soils with limited water assets. Also important are programs to increase the social and economic standing of communities to enable management to focus on longer-term sustainability objectives, as well as the critical immediate needs for nutrition, health and financial survival.

5. Sustainable land management programs require better metrics and indicators, including to measure baselines (benchmarking where we are now) and monitor change. This is challenging for investment agencies, but equally important for local trials to convince land managers of the merits of an approach, and promote adoption regionally. It will provide a basis for scaling up horizontally (to larger land areas) and vertically (e.g. to promote institutional and policy support) and to provide accountability for investment. Long-term commitment to monitoring and evaluation is needed to detect slow recovery or slowing decline in degradation. Monitoring is also critical for detecting off-site impacts. The GEF is well-placed to lead the synthesis of principles and guidelines for identification of metrics or indicators for sustainable land management, providing a defensible basis for prioritization of SLM activities and for monitoring progress across the diverse conditions relevant to investment in this area. The process to achieve this guidance could include:

    i. Development of a framework and check list of land properties for assessment of the land's capacity to provide vital ecosystem services. This would involve monitoring the soil, climate, landform and water properties to assess whether specific land management practices are sustainable. The list of properties would need to account for the productivity and yield potential of the soil.
    ii. Identification of the site-specific land degradation risks resulting from these land properties. This would be based on sound on-ground understanding of land degradation processes and ecosystems services, as well as identification of practices to manage the land degradation risks to prevent long-term deterioration of soil health.
    iii. Identification of a set of indicators to assess what management strategies are economically rational, viable and useful within the context of a community. Criteria for regional monitoring may supplement locally relevant indicators. In addition, evaluating the impact of SLM practices on ecosystem services at national and global scales will support policy and planning by governments and international agencies. Important indicators for land management generally include soil health, soil organic carbon, water resource measures (water scarcity and water quality), biodiversity loss and indicators of locally relevant social and economic status and change.

Concluding remarks on the value of SLM for global environmental benefits

Land degradation, climate change and food security are arguably the three greatest challenges facing the world today and SLM is fundamental to all three. In 1987, the Brundtland report, *Our Common Future* (United Nations, 1987), warned that if human needs are to be met, the Earth's natural resources must be conserved and, in particular, land use for agriculture and forestry must be based on a scientific assessment of both land capacity and the annual depletion of topsoil. Addressing the problem of land degradation through SLM approaches is truly multi-faceted with challenges on multiple levels of environmental, social and economic disciplines, as well as human well-being and socio-cultural values.

The GEF–6 approach (GEF, 2013d) seeks to base activities on better understanding of the causal chains of environmental degradation and the drivers of global land degradation. In so doing, it lays the foundation for effective multidisciplinary solutions. Devising effective programs for interventions to increase sustainable land management relies on analysis of the many intersecting natural and anthropogenic pressures on agroecosystems. Understanding the consequences of unsustainable land management for key global issues of concern, including the compounding problems of food security and anthropogenic climate change, will help to prioritize these interventions. In view of these complex interactions, a focus on the drivers of environmental degradation which, in its many forms, is the clearest manifestation of unsustainable land management will assist in directing investment. At the same time, building on the synergies across programs paves the way for real improvement in the cost effectiveness of interventions, and delivers multi-faceted outcomes toward environmental, social and economic sustainability.