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Chapter 5

INSTITUTIONAL RESPONSES FOR SUSTAINABLE LAND AND WATER MANAGEMENT

The main food production systems are at risk of being degraded to the point at which global food security is compromised. Land and water management practice on these large areas of moderate– to high-potential lands needs to be improved urgently to reverse trends in degradation and maintain levels of productivity. Adaptation to climate change in the major food producing areas of the world will also be vital. Given these trends, what pathways towards more sustainable intensification can be set?

A focus on systems at risk will be a priority for certain countries and regions. But beyond this, sustainable land and water management will need to be translated into national agendas. This chapter sets a direction for the implementation of such agendas, given the current and projected state of land and water. It also indicates how national institutions can be strengthened to ensure that rights in use are protected; how knowledge and technology can be adapted in cooperation with users; and how mechanisms for planning and managing land and water resources can be effectively delegated.

The overall policy environment

The macro settings

The need for differentiated planning processes and implementation practices that can be scaled across systems at risk has been emphasized. The degree to which these processes and practices can be 'joined up' in a coherent approach to land and water management to achieve desired environmental outcomes will be determined by two factors. First, the urgency of the environmental problem and the political attention it attracts. Second, the competence of the institutional arrangement to address public good concerns. Contextual approaches that relate to specific scales may be nested and orderly in a well-defined and agreed planning framework. In practice, it has proved difficult to extend and sustain natural resource governance from national institutions down to local land and water management to the point where social and economic benefits can be spread and environmental trends can be reversed. Much of the 'blame' could be levelled at the institutions (public and private) that are responsible for making decisions over land and water use.

Farmers and agriculture policy-makers are under pressure to make choices between alternative approaches to natural resource management. The selection of a sustainable pathway will be scale-dependent. At the local level, livelihoods and ecosystem compatibility will determine patterns of use. At the subnational administrative scale (e.g. district or sub-basin level), considerations of land and water planning and environmental regulation will be factored in, setting norms and bounds for agricultural development. At the national level, policy objectives of economic development, food security, poverty reduction and conservation of nature will be important drivers. At the global level, concern for growth with equity in developing countries will be matched by the imperative of conserving global commons of freshwater across transboundary river basins, forest cover, marine environments, climate and biodiversity.

Prioritization from a neutral planning perspective will be driven by four main considerations. First, the priorities need to be clear with respect to national development objectives for sustainable, equitable and efficient growth. For low- and middle-income countries, they are likely to be pro-poor and promote local food security. Specific growth targets for the rural sector or for commodities (food, fibre), or socio-economic goals such as poverty reduction for marginalized groups or prevention of land and water conflicts, may also drive priorities. Second, the investments need to offer the best cost–benefit ratio. Third, the choices must offer the biggest ecological boost, including considerations of climate change mitigation and adaptation. Finally, priorities will need to be feasible in the light of national and local socio-economic and political realities, or at least there must be the possibility of adjusting the incentive structure so that local stakeholders are motivated to adopt sustainable practices.

Trade-offs between 'development' and 'conservation', and between commercial farming and staple production, between growth and income distribution, between urban and rural will be inevitable. What is vital is that the analysis should be explicit and decisions taken in the public interest where livelihoods and agricultural productivity are at risk.

The role of public investment

Public investment in research and development, in technology transfer, and in land and water infrastructure and roads may be the most politically acceptable and efficient means for governments to promote sustainable land and water management. One key role of government is to invest in pilot programmes that demonstrate the technology and economics of sustainable agriculture. This was successfully adopted in Brazil's Empresa Brasileira de Pesquisa Agropecuária (EMBRAPA) programme, which fostered conservation agriculture and demonstrated how it could be run on profitable lines as agri-business. Governments may also support farmer-based institutions through smarter agricultural services. Advisory services to farmers can now include a much broader array of information 'push', and even credit services through mobile technology. The adoption of information kiosks based on ATM models in rural India has been trialled together with dissemination of near-real-time remote-sensing products. These types of innovation will go beyond the conventional 'extension service' models used by agricultural and rural development agencies.

Setting incentives for sustainable land and water management

Incentives to promote or constrain agricultural production are most commonly transmitted through the tax regime, input subsidies, support prices, regulatory measures, infrastructure investment (e.g. in water-saving technology) and support measures such as extension or product market development. Policies that affect the price of production or consumption, such as trade policy to ban exports or impose import tariffs, can also quickly transmit new levels of demand for agricultural production, and hence feed directly through to land- and water-use decisions.

Removing distortions in the existing incentive framework that encourage less sustainable land and water management practices will be essential. An example is where low energy prices drive intensive groundwater abstraction. Governments typically control energy prices. Raising the price of energy to border parity levels will increase the cost of pumping groundwater, and should moderate over-extraction. However, altering a distorted incentive structure by raising prices can be politically unpalatable. Often governments opt to allow subsidies to dwindle through the unseen hand of inflation rather than to raise the price of politically sensitive commodities. In addition, knock-on effects may be hard to manage. Energy price rises will put up the cost of transport and increase consumer prices across the board. Higher-cost agricultural production will increase the cost of food or shrink the incomes of poor farmers. Resetting the incentive framework, therefore, has to be carefully designed and managed, with a clear political and economic strategy. A further problem is the impact on household incomes and the rural economy, which may be dependent on benefits generated by the existing incentive framework. Raising subsidized energy prices may save water, but it will also reduce farm incomes and employment. These risks underline the need to balance adjustments to distorted incentive frameworks with positive incentives designed to restore farm incomes.

For poor farmers living on the margin, change, including the adoption of appropriate technologies, can increase risk. The same is true of irrigation farmers being encouraged to take over the management of public assets for which operation and maintenance were previously under publicly funded agencies. The change has to yield tangible benefits. Clearly any incentive structure has to meet the combination of ecosystem conservation, intensified natural resource use and livelihoods objectives, with an eye on poverty-related impacts. Designing a structure that will achieve multiple objectives requires careful study and will inevitably involve trade-offs.

Dealing with externalities

Incentives to switch to more productive and sustainable land and water management practices may not be present in the market. One reason for this is the existence of strong 'externalities'. Costs of poor land and water management may be felt, for example, far downstream in dam siltation. Benefits of switching to alternative practices may be felt not by the farmer but by his neighbours in the community (e.g. reduced groundwater overdraft), or at basin level (e.g. reduced pollutant load), or at national level (reduced desertification or atmospheric dust), or even at global level (enhanced conservation of biodiversity or cultural landscape values, or reduced carbon emissions). Farmers will reason on the basis of their own livelihoods, and are unlikely to change attitude in the public interest unless returns to livelihoods (including household health) are apparent.

One of the key challenges in promoting more ecologically sound intensification is thus to design an incentive framework that can 'internalize' these externalities, and so correct the 'asymmetry of interest' among stakeholders. The framework has essentially to cope with this asymmetry both in the status quo, where the farmer garners the benefits and the remote stakeholder bears the costs, and in corrective measures (e.g. watershed management), where the farmer may bear the costs and the remote stakeholder (e.g. downstream urban dweller) gains the benefits. In addition, the incentive framework has to deal with the fact that time horizons are different – investing in corrective measures may bring benefit to the farmer, but only in a few years' time (terracing or tree planting, for example), and smallholders cannot wait to feed their families.

In some cases, productivity improvements that solve both the farmer's and the public good problem may be possible; for example, integrated approaches such as conservation agriculture or agroforestry, or improved irrigation and drainage management. In other cases, there may be a contradiction between the intensification path and public interest, as in increased use of chemical inputs. The incentive package needs to correct the mismatch between farmer interest and the public good.

One example of correction of this asymmetry of benefits is conservation of soil moisture, which extends the period of stress-free growth, but may be unattractive to a farmer because of the high cost of investment or of lag in benefits. Terraces, for example, require high initial investment in labour and materials, although they provide significant long-term benefits. However, investment in soil moisture conservation may also deliver downstream benefits. Mechanisms have been developed for PES, by which land users upstream are remunerated for their contribution to the provision of reliable water quantity and quality downstream.

An extension of this could be to soil carbon sequestration. Restoration of soil organic carbon will improve agricultural productivity. Farmers have an incentive to invest in this kind of agriculture, but may find it slower to yield and less financially profitable in the short run than less conservation-friendly approaches. However, soil carbon restoration also contributes to improving the agriculture carbon balance. Many forms of agriculture-based soil carbon sequestration are low-cost means of mitigating climate change that can be readily implemented through a range of proven land and water management technologies. In this sense, there is a justification for a mechanism to support farmers who invest in soil carbon.

The principle of PES is therefore based on the acceptance that practices adopted by one category of stakeholders benefit other stakeholders, either downstream (erosion or pollution control in watersheds) or at global level (carbon sequestration, biodiversity maintenance). PES can be used to encourage the adoption of more sustainable land- and water-use systems, and to enhance the economic viability of a given management system. Table 5.1 shows who benefits from a given practice (on- or off-site) – a first step towards recognition of environmental services.

Valuing costs and benefits and their distribution

In order to provide justification for adjusting the incentive structure to compensate for externalities and asymmetry of interest, it is necessary to have a method of calculating costs, benefits and their distribution, and also a mechanism for checking outcomes. However, at present methodologies are weak (Box 5.1). More work is required to develop widely accepted technical and economic approaches to measure and assess the cost of direct relationships such as those between soil loss

TABLE 5.1: INDICATIVE TRENDS IN THE DISTRIBUTION OF COSTS AND BENEFITS OF VARIOUS TECHNOLOGIES OR PRACTICES

Technology or practice	Short-term	Long-term	Benefit on-site*	Benefit off-site*	Comments
Conservation agriculture (CA)	+/–	++	++	+	The establishment of CA may have relatively low entry costs: hand tools, seed for new crops and cover crops. However, the availability and affordability of these tools and seeds can be a major obstacle, especially for small-scale land users.
Integrated soil fertility management	++	+++	+	++	Relatively small extra inputs in the form of organic and/or inorganic fertilizer can have a noticeable impact on crop production, so this technology can be introduced progressively, allowing testing and risk management. However, profitability depends on price.
Pollution control/ integrated pest management	+	+++	+/–	++	Integrated pest management and the control of pollution through pesticides requires more specialized skills and may not be seen as immediately attractive to users. Beneficiaries include both on-farm and downstream water users.
Groundwater monitoring and controlled extraction	–	+	–	+	Controlling and limiting groundwater extraction implies reduction of pumping by all users sharing a common aquifer. The short-term impact on individual farmers is negative, while the long-term impact on the community is positive. Such practices imply a good knowledge of aquifer recharge mechanisms and strong community management mechanisms.
Agroforestry, vegetative strips	+	+++	+/–	+	The establishment of seedling nurseries and distribution of plants at community/ catchment levels need to be taken into account, as well as community/individual costs of protecting planted trees from livestock and fire. Vegetative strips can be used as cost-effective contour farming measures for reduction of runoff or as wind barriers. They have similar effects as structural barriers and also require labour, but the investment cost overall is lower.
Structural barriers	+/–	+++	+	+/–	The establishment of structural measures such as terraces and stone lines requires high initial investments in material and labour. They may be very effective on steep lands and in dry conditions, but their construction often needs financial and or material support.

Key: Positive when benefits outweigh costs, negative otherwise.

* Benefits are on-site, when farmers benefit from proposed changes and off-site, when others benefit from the change.

BOX 5.1: COUNTING THE COST OF LAND DEGRADATION

In the wake of the original GLASOD study from 1987–1990, a debate developed on the cost of land degradation. One earlier argument contended that *'soil erosion is a major environmental threat to the sustainability and productive capacity of agriculture. During the last 40 years, nearly one-third of the world's arable land has been lost by erosion and continues to be lost at a rate of more than 10 Mha per year. With the addition of a quarter of a million people each day, the world population's food demand is increasing at a time when per capita food productivity is beginning to decline'* (Pimentel *et al.*, 1995).

More recently a study on soil erosion and food security (den Biggelaar *et al.*, 2003) stated that *'production loss estimates vary across crops, soils, and regions but average 0.3 percent yr^{-1} at the global level, assuming that farmers' practices do not change. Reducing production losses by limiting soil erosion would, therefore, go a long way to attain food security, especially in the developing countries of the tropics and subtropics'*.

However, there is no clear methodology for measuring the actual cost of the productivity losses incurred, as there are no consistent empirically demonstrated relations between soil losses and productivity (Eswaran *et al.*, 2001). In addition, most studies only estimate costs of soil erosion, not of land degradation, which may be magnitudes higher when biomass, water and biodiversity are considered. There is no accepted costing of other ecosystem services, or there are widely varying estimates – carbon markets, for example, show differences in carbon prices at a ratio of 1:10 in different markets. Unless the environmental cost (loss of carbon, decline in water resources, loss of cultural services) is correctly valued, economic valuation results will largely underestimate the costs. What is needed are both more developed approaches to measuring the soil loss/productivity relationship, and agreed methodologies for valuation of ecosystem goods and services. Until that is achieved, no progress will be made in accurately estimating the real global or national cost of land degradation.

Source: Nachtergaele et al. (2006d)

and production, and also the overall costs, benefits and trade-offs of action on degradation within the overall ecosystem (FAO, 2006d).

Securing access to land and water resources

The need for inclusive and stable land tenure

Per capita shares of land in low-income countries are expected to halve by 2050, creating pressures for opening of new lands for agriculture. Although there is considerable land theoretically suitable for cultivation, almost all of it is either in use for economic production or providing essential ecosystem services to both the local area and the biosphere. In addition, availability of land is not well matched with areas where demand is likely to be strongest. Nonetheless, some expectations are that 120 Mha of new land may be brought into cultivation by 2050.

At the level of global and national policy, expansion of the cultivated area has to be balanced with current use and the need to maintain existing ecosystem functions, protect global gene pools and enhance terrestrial carbon pools. Decisions to expand the cultivated area should be the product of well-reasoned and negotiated national policy, with involvement of the global community where appropriate. Careful evaluation of limitations and risks under alternative land uses is also a prerequisite.

Once policy is set and expansion of cropland is decided at the policy level, what then are the conditions for optimal use of new land? First, strategies for orderly management of pressures on land will become increasingly important. This requires well-functioning institutions, particularly for administering land tenure. Second, there needs to be policy and institutional support to ensure that when land conversion takes place, land and water use are appropriately regulated to retain the integrity of a sustainable and ecosystem-friendly production system. Incentives and regulatory frameworks that encourage managed development and sustainable farming are required. Research and technology transfer, farmer advisory services, access to capital and credit, and market development need to be in place. Finally, the crops and production system need to be profitable and sustainable, and compatible with sustainable land and water management principles and approaches. Farming should minimize trade-offs and mitigate loss of ecosystem services. Participatory monitoring and evaluation will be a useful support to decision-making.

Sustainable agriculture requires that the user of land and water resources have a long-term interest in the integrity of the resource base to ensure future production. In most countries, systems of individual freehold or long leasehold tenure provide this security. But where communal rights are poorly defined and not protected by law, clarity needs to be sought. Two options are most commonly applied. One is to assist communal land tenure systems to adapt (for example, by legal recognition and protection, demarcation of lands, and strengthening of the institutional capacity of landholders for self-management and self-regulation). This has been done in South Africa, Ghana, India and Brazil. Another solution is to introduce legal and institutional changes to enable the equitable conversion of communal rights to formal individual property rights. Individual plots inside communal areas or communities as a whole may convert to individual property rights. Land laws in some countries, for example in Mozambique and Tanzania, provide for such a negotiated process.

Land markets can help manage competing uses and growing scarcity. Land rental markets have been shown to enhance efficiency and equity in land allocation. However, rental markets have often been constrained by insecurity of land ownership, or by prohibitions or controls on land rental and share-cropping. For rental markets to reach their full potential, land tenure security and registration need to be improved, and regulation of rental markets needs to be eased. Land sales markets also require well-developed property rights and administration.

Land reform and redistribution have occurred periodically across most countries. State-owned land is hard to manage by governments, as it is often subject to invasion, settlement, historic ownership claims, and non-transparent and corrupt allocation via rental and sales. Often governments do not even know how much land they own and where, and if they do they are reluctant to dispose of it. Any reform initiative therefore needs to ensure the maintenance of an accurate cadastral register and the application of fiduciary safeguards on disposal of state assets. However, recent land reform has a mixed track record. Initiatives need to be accompanied by access to capital and credit, by beneficiary empowerment in planning and implementation, and by training and capacity-building.

Reforms are often opposed by existing right holders if they do not recognize their pre-existing rights. Beneficiaries of distortions, subsidies and other privileges will also staunchly defend them: *Even if new laws and regulations are enacted, they may remain unimplemented, opposed by powerful stakeholders, constrained by lack of institutional capacity or crippled by unworkable stipulation. Registration procedures may make it difficult or impossible for some existing users to have their rights recognized. Security for some users may come at a cost of reinforcing inequities and institutional rigidity that excludes others. Reforms may achieve economic gains, but leave environmental demands unmet* (Bruns *et al.*, 2005). It is therefore important to choose the objectives and sequencing of reforms carefully, as well as the specific policy, rights and institutional changes that are most likely to be adopted and implemented given the existing historical and political context.

Securing access to water and ensuring flexible water allocation

With water availability as the prime determinant of further intensification, physical and economic water scarcity will continue to pose a constraint to production and environmental management in areas which use a high proportion of their renewable water resources.

Setting up systems of modern water rights to enable responsible engagement with water resources, and at the same time promote responsible land use, may not be a realistic presumption in all cases (FAO, 2006e). But two principles emerge. First, that securing basic access to water for productive land use still requires effort to be inclusive of all users. Second, once secured, the ability to be flexible in use and regulation of that use will demand higher orders of knowledge on the part of both the user and the regulator.

Securing basic rights in use for agricultural users will still require progressive transformation of customary use into formally accepted and defendable rights where new resources are sought (FAO, 2009). Making use of water-use rights in a flexible manner is a key issue for WUAs. The scale of the association needs to be commensurate to the natural system and the level of practical networking to make effective resource allocation decisions and transfers among members. To be successful as an association, the primary prerequisite is information flow from the basin or water regulator and information flow among users. User associations thus have to be knowledge-rich.

These patterns of use happen in a basin or aquifer context for which the resource basin is changing on a day to day basis. Any basin manager or regulator has to find a way to relate to end users (the user associations), adjudicate over allocations, maintain levels of productivity derived from water and comply with environmental legislation. In the same way that WUAs can adjust within certain degrees of freedom, the regulator is also in a position to apply rules and regulations in a flexible manner. At the very minimum, irrespective of technology and investment levels, the flow of high-quality information is essential. Under conditions of competition, this information flow becomes even more important. Policy adjustments can correct the imbalance between supply and demand, improving the efficiency, equity and sustainability of water allocation and use. Integrated water management suggests four basic elements: a system of water allocation; incentives to efficient water use; promoting water efficient technology; and decentralization and partnership approaches to water management.

Most modern water administrations give the state powers to allocate water between uses, to regulate water rights and use in the public interest, to ensure maintenance of water quality, and to support users and local institutions with research and knowledge. Given the complexity of regulating local water management, decentralized solutions have begun to emerge for both surface and groundwater management on a partnership basis with local users. In the case of irrigation schemes, this has taken the form of participatory irrigation management, with users increasingly involved through WUAs in scheme management, operation and maintenance, and in financing the running of the scheme through user fees. For other forms of agricultural water management, initiatives have focused on reviving or creating communal water management institutions. For groundwater, the bypassing of traditional institutions and weak regulatory capacity have contributed to competition, with rapid depletion of groundwater stocks. Self-regulation and management by user groups has been shown to be effective in conserving groundwater resources. Support may be provided by official agencies, and the communal institutions may be linked to local government or to specific hydrological units (Box 5.2).

BOX 5.2: COLLECTIVE PARTICIPATORY MANAGEMENT OF GROUNDWATER IN ANDHRA PRADESH

The Andhra Pradesh Farmer Managed Groundwater Systems (APFAMGS) project was supported by the government of the Netherlands and FAO between 2006 and 2010 in response to widespread drought and out-migration across the state. The project aimed to improve groundwater-use efficiency by empowering farmers in monitoring and managing groundwater resources. Groundwater management committees in each aquifer or hydrological unit came together to estimate the total groundwater resource available and work out the appropriate cropping systems to match. The committees then disseminated the information to the entire farming community and acted as pressure groups encouraging appropriate water saving/harvesting projects, promoting low-investment organic agriculture and helping to formulate rules that would ensure inter-annual sustainability of limited groundwater resources.

Some 6 500 farmers in 643 communities have been trained to collect data fundamental to the understanding the local aquifers. Farmers record daily rainfall at 191 rain gauge stations. At more than 2 000 observation wells, they carry out regular measurements of groundwater levels. In all, more than 4 500 farmers, men and women, are voluntarily collecting data. The data are maintained in registers kept at the groundwater management committee offices and are also entered on village display boards. At the aquifer level, 'hydrological unit members' are trained to use these data for estimation of groundwater recharge following the end of the summer monsoonal rains. In terms of cumulative water abstractions, 42 percent of the hydrological units have consistently reduced the *rabi* (dry season) draught over the three years of project operation, while 51 percent have reduced the draught intermittently, and only 7 percent have witnessed an increase in groundwater draught during this period. This impact is unprecedented, in terms of reductions actually being realized in groundwater withdrawals and, in terms of the geographic extent of this impact, covering dozens of aquifers, hundreds of communities, and approximate outreach of 1 million farmers.

Sources: FAO; www.apfamgs.org; World Bank (2010a) Photo: J. Burke

The absence of cooperation frameworks on some major transboundary rivers has led to suboptimal investment and to tensions between riparians. As demand for land and water grows, further unilateral development may take place, leading to loss of the added value that would have come from investments in land and water planned to optimize returns and to share benefits at the basin scale. Where possible, moves towards a cooperation framework may be taken, starting at the technical level and leading to mutually beneficial development and management and, ultimately, to agreements on international waters.

Defining national strategies

This section discusses institutional approaches that are likely to become increasingly important. Well-informed diagnosis and participatory planning approaches reflect the need for bottom-up identification of problems and solutions. For irrigation management, the search for production and environmental performance will remain a priority whether through public or private agencies.

Diagnosis

Packages for sustainable land and water management depend on the integration of knowledge stemming from research combined with local diagnosis to identify the appropriate entry points. Substantial knowledge already exists at the global, regional and national levels, and agricultural and land and water agencies need to bring this together and to work with farmers to match knowledge to need.

Choices of priority at the local level will need to be guided by knowledge of options, and have to be made on a partnership basis between local communities and public and other institutions. Private sector interests and investment opportunities have to be factored in. The balance between short-term revenue and long-term sustainability will need to be considered. Choices will be expressed through local and individual plans, supported where needed by public agencies and financing. Local priorities will be developed in interaction with national priorities, and in partnership between local and national institutions.

At system level and/or national level, mapping the spatial extent, including causes and impact of land degradation and conservation, indicates where investments can best be made, which practices have the potential to spread and what support is required. It also helps to set the agenda for further research and development. In many places, large-scale irrigation schemes are underperforming due to a combination of infrastructure degradation and outmoded management approaches.

Choices at the national level will also benefit from flexibility and open debate, and will be based on lessons learned and best practice from field experience and global knowledge. These choices will also need to find expression in laws, policies, programmes and investments. Diagnostic approaches can also be applied to more general agricultural variables. An example of one area of diagnosis is assessment of soil health and its relation to current and potential productivity in terms of crop yield and profitability. Box 5.3 describes how soil health can be evaluated within an ecosystem framework as a component of an integrated appraisal.

Setting strategies – invoking pluralism and participation

A key lesson from the past is that technical approaches in land and water management, however correct, cannot be imposed. Formal land and water management institutions rarely have monopolies over knowledge and capacity. A specific project may provide incentives to change behaviour for a period, but such approaches rarely produce sustainable improvements. More effective participatory planning approaches can engage local people and create lasting ownership. They can also tap local knowledge and match that with new ideas in order to identify solutions that can be integrated into sustainable farming practices. In this sense, pluralistic approaches to land and water management need both recognition and application. Additionally, while the concept of participatory planning is not new, its concrete application remains a challenge in many places where technological solutions prevail over a more balanced approach to problem-solving.

BOX 5.3: EVALUATING SOIL HEALTH WITHIN AN ECOSYSTEMS FRAMEWORK

An integrated appraisal of land and water, and their potential for sustainable agricultural development, would include an appreciation of the effects of soil life on soil physical, chemical and biological properties and processes, and on the air and water resources with which the soil interacts, as well as an assessment of the effects of agricultural practices on soil biota and their functions. Also, gauging the current and likely environmental effects from drainage, leaching, runoff and erosion is essential in order to evaluate the likely sustainability and externalities of various land and water management strategies. The diagnosis also needs to evaluate the impact of those interactions on soil degradation, and related effects on food production and environmental problems, including the greenhouse gas effect and water pollution. Improved understanding of the organisms and related processes and their interactions within the agricultural system, in regard to climate, soil type, plant species and diversity, and farm practices, will help build the appropriate land and water management package. The challenge is to develop approaches for assessing soil quality and health that are useful to producers, specialists and policy-makers. Soil health thresholds could then be used as tools to facilitate a change in direction towards more sustainable crop production intensification practices.

Participatory approaches and community watershed management plans have been used to reconcile the overlay of human activity on naturally defined watersheds. In wider watershed management projects, for example, participatory approaches have been employed to establish management plans. The participatory processes succeeded where there were common purposes that could interest all or most of the population, where the participatory process was flexible and provided for capacity-building and genuine empowerment, and where there were income and livelihoods incentives. Where communities could see the economic benefits, they were more willing to invest in long-term conservation.

Participation does not, however, guarantee outcomes. It involves shifts in decision-making power between the state and local communities, and also between different segments of the local community. Participatory processes therefore have to be designed for the intended development and distributional outcomes. Participatory approaches impose a demanding set of requirements – political commitment and equitable rules, time for the process to mature, inclusion of all stakeholders in the process, public agencies that understand the rationale and process of participation, and sustained capacity-building at all levels for both stakeholders and public agencies.

Experience in recent years has allowed certain practical lessons to emerge on how to introduce and scale up successful innovations, with particular focus on community action and partnerships. A set of basic principles includes the following:

- **Stakeholder involvement is critical.** This needs to start at the identification of the problem, followed by the planning and implementation stage, and to carry on to monitoring, evaluation and research. There are a variety of approaches that have been tested and documented on how to motivate land users to implement and further refine technologies.

- **The work has to start and end at the local level.** Local land and water users have detailed knowledge of their ecosystem. This needs to be complemented by access to knowledge from outside the local context through partners, as well as to advisory services, professional training, and technical and financial assistance. Partners can jointly identify, evaluate, select and implement potential strategies at the local scale. Once plans are agreed and support measures are in place, local stakeholders can take primary responsibility for implementation.

- **Knowledge and dissemination are key.** Stakeholders need easily accessible information that is based on sound knowledge and experience. For this purpose, decision support systems are essential. Mapping, monitoring and evaluation, and other decision support tools ensure that decisions about investments are based on facts, and implementation can be adjusted in the light of emerging impacts.

- **Permanent partnership approaches are required.** Changes require collaboration and partnership at all levels (land users, technical experts and policy-makers) to ensure that the causes of the degradation and corrective measures are correctly identified. Partnerships involving governmental institutions, non-governmental organizations, civil society organizations, private sector and individual land owners and users foster mutual respect and allow negotiation among these diverse stakeholder groups for a common sustainable future. Expert networks are key to these partnerships.

- **Diagnoses and programmes have to cover not just technologies but the local- and higher-level enabling environment, including the key question of incentives.** 'No farm is an island', and it is necessary to broaden the scope of the diagnostic and related solutions through nested approaches, from the farm or household level upwards. Many conditions are essential if change is to take off; they range from the question of incentives and financial support to markets and prices, services and infrastructure, legislation and regulations, education and promotion, and documentation and knowledge management. Through partnerships and participatory approaches, these framework conditions have to be identified alongside the technical solutions.

Modernizing management in irrigation

Large-scale irrigation schemes offer a privileged entry point for intensification as they provide both a means to manage crop production at scale and a platform on which to concentrate transfer of knowledge, supply of inputs and access to output markets. However, many institutional and business models for managing large-scale schemes have given mixed results, with some achieving neither fiscal efficiency nor demand-responsive water service (World Bank, 2006; Molden, 2007). As a result, user involvement through WUAs, increasing delegation of water management functions and cost recovery, and progressive stages of irrigation management transfer have been on the agenda of many countries, with the purpose to relieve governments of both the fiscal burden and the responsibility for asset management and maintenance, and thus to improve efficiency by empowering farmers.

To this extent, success depend on the intrinsic profitability and physical sustainability of the scheme, as well as capacity-building for scheme management, operation and maintenance, secure land and water rights, and careful management of the WUA formation / management transfer process, including post-handover support. Where scale and complexity preclude full farmer management and there is no alternative to management by a professional agency, this needs to be financially self-sustaining.

Water service charges need to be adequate to cover the real costs of operation and maintenance, and overhead costs need to be kept to the minimum. Above all, the agency needs to be transparent and accountable to the users – a condition that can usually only be achieved when there is genuine participation of users in its management. Future stages in the process need to be designed after ample study and consultation, and to be well-adapted to the context. In some cases, governments have opted for continuing with state management, but with a new, service-oriented approach, as promoted by FAO's MASSCOTE programme (Box 5.4). Other countries are increasing farmer involvement either through assigning operation and maintenance responsibilities to farmers' organizations or through processes of irrigation management transfer.

BOX 5.4: FAO'S MASSCOTE: ENCOURAGING IRRIGATION STAFF TO MODERNIZE

FAO defines modernization of irrigation as a process of technical and managerial upgrading (as opposed to mere rehabilitation) with the objective to improve resources use productivity through better water delivery services. The MASSCOTE programme (Mapping System and Services for Canal Operation Techniques; FAO, 2007e), is a methodology for analyzing and evaluating different components of an irrigation system in order to develop a modernization plan. The plan consists of a set of physical, technical, institutional and managerial innovations to improve water delivery services and cost effectiveness of operations and maintenance.

The programme is introduced to engineers and managers in large irrigation systems to promote the concept of service-oriented management and to help them design their system's modernization plan. As an example, since MASSCOTE was introduced in Karnataka, India in 2006, staff have shifted their focus from being supply-oriented to service-oriented and have improved the way in which they target investment planning. This approach has been introduced more recently in other countries of South and Central Asia, the Middle East and North Africa.

Photo: R.Wahaj

Increased private or user involvement in management may offer a further way forward. Often termed public–private partnerships (PPPs), these involve finding a viable ‘third party’ between farmers and governments. This could be a public entity, such as a reformed or financially autonomous government agency. Alternatively, it might be private, such as a contracting firm or WUA turned into a private corporation or a farmers’ company. Such PPPs have arisen in the water and sanitation sector over the last two decades with mixed results, but are less widespread in the irrigation sector. A part of the PPP could involve unbundling management of large irrigation canal systems into, for example, reservoirs, main canals and distribution networks, in a way similar to reforms that have taken place in the power sector. PPPs could be useful in mobilizing financing, implementing investment programmes and improving the water delivery service. Morocco (Guerdane) and Egypt (West Delta) have successfully negotiated PPP arrangements for irrigation. China has experimented with using private contractors, with some success (Box 5.5). Sri Lanka has also experimented with a farmer-managed irrigation company. Experiences in Mali, France and New Zealand also support the notion that the private sector can efficiently manage irrigation systems and collect water charges, even in the absence of formal WUAs.

Developing national investment frameworks

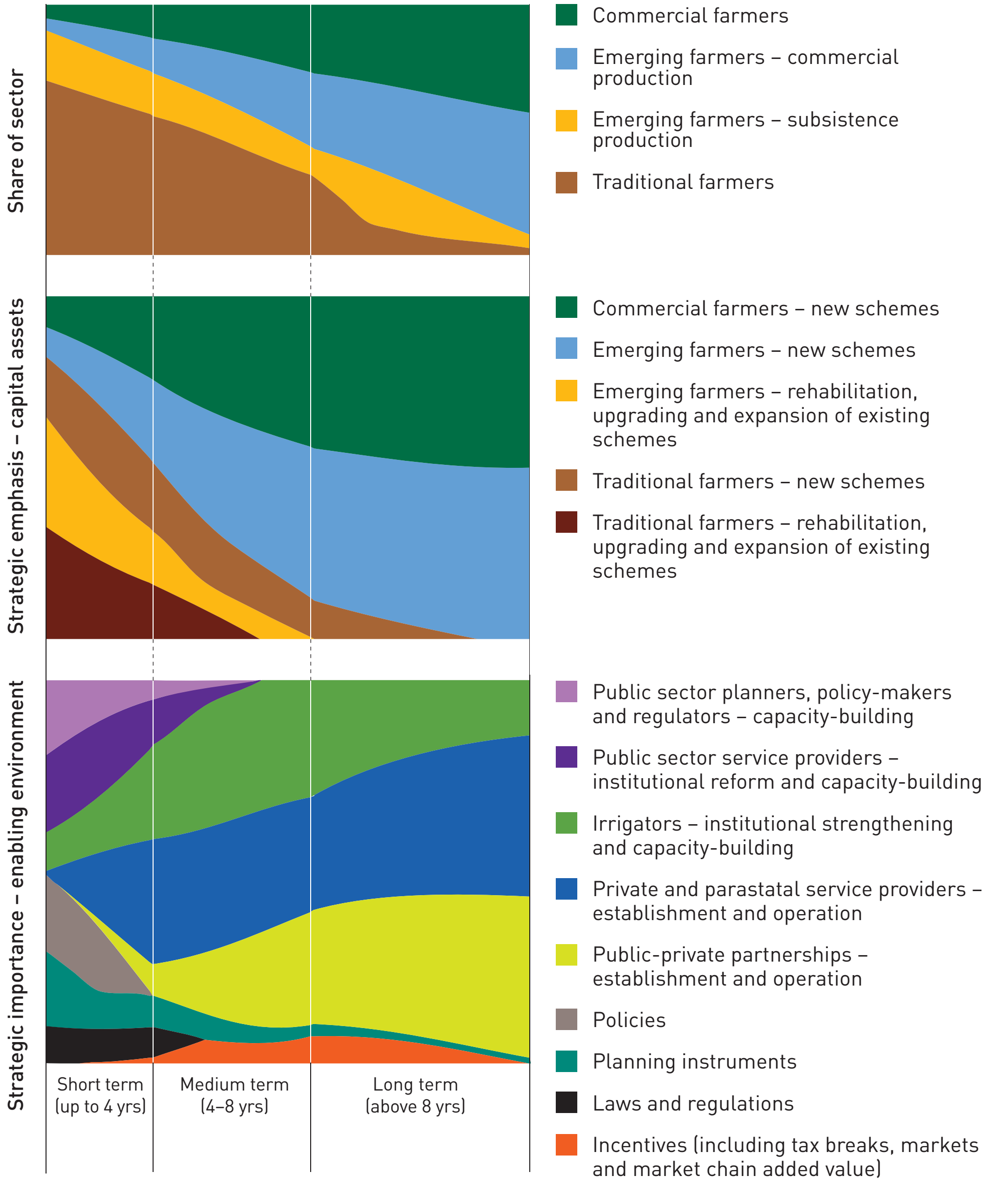
Developing implementation approaches into national programmes that can mobilize and sustain public and private investment in land and water management requires another level of effort and institutional commitment. For instance, to be effective, national irrigation strategies may require a package of technical and managerial

BOX 5.5: SCOPE FOR INVOLVING THE PRIVATE SECTOR IN IRRIGATION MANAGEMENT

Transfer of responsibility to users has its limits, and PPP may be one way of bringing in efficient management skills and fresh funds, and relieving government of fiscal and administrative burdens. Experience in the water supply sector has shown that, under some circumstances, the private sector can help mobilize financing, implement investment programmes and improve performance of service delivery. Under PPP, governance functions typically remain with government, although there is some scope for contracting out. Operation, management and maintenance functions have proved the easiest functions to contract out. Regarding investment, the private sector is essentially risk-averse and, faced with relatively high levels of risk, is reluctant to commit investment capital unless government assumes much of that risk. Although efficiency and service delivery have certainly improved, charges have usually gone up at the same time, and there have been social problems over the need to downsize staff. Overall, experience in the water supply sector shows that PPP may not entirely relieve government’s investment burden, but is useful to establish the principle of financial autonomy and to raise professional standards.

Sources: FAO (2007a); World Bank (2007b) upgrading that ensures that they can respond to the needs of high-value agriculture through improved reliability, flexibility and equity in water services. Decisions over the allocation of public resources and the promotion of private investment need to be programmed and monitored. Investment frameworks can be used as a tool for programming public and private resources to restructure the irrigated subsector in line with national development objectives, and also allow the investments to be tracked. In this way, overall monitoring and evaluation of any national irrigation investment can be monitored and evaluated. Figure 5.1 illustrates how a notional

FIGURE 5.1: NOTIONAL STRATEGY MODEL FOR AN IRRIGATION INVESTMENT FRAMEWORK



Source: FAO Generic Investment Framework, Land and Water Division internal reports strategy model for such a framework can be applied to a national irrigation strategy. Finally, monitoring and evaluation allow progress to be tracked, and technical and economic evaluations of outcomes and impacts to be made, which can then be fed back into improving and scaling up investment programmes. Within such investment programme, individual schemes can be appraised and 'benchmarked'.

The role of river basin agencies

In the future, the intensity of economic development across river basins and the degree of interdependence and competition over land and water resources can be expected to force a return to integration. However, despite the functional systemic integration of land and water, modern law and institutions now tend to deal with land and water separately. Even basin agencies, in principle dedicated to integrated resource management, deal primarily with a single resource, rather than with land and water jointly. Up to now, river basin management has had little direct influence over land use and land-use planning, except where it has contributed to remediation of non-point source pollution or has restricted agricultural water use. Basin management has largely been restricted to river functions such as hydropower, navigation and fish resources.

Current institutional trends in river basin management tend to be driven by either 'water development' or an 'ecosystem approach'. For example, major water transfer projects in China and India have been conceived within a water development planning framework, while the EU Water Framework Directive and Murray-Darling Basin planning follow an ecosystems conservation approach. In between, a range of solutions that respond to development priorities expressed at national and transboundary level have become apparent, with greater or lesser degrees of economic and environmental priority.

Irrespective of the agenda, whether development or environmental, to have a truly integrated effect on land and water use across a basin, planning and negotiation need to go beyond dealing only with in-stream water use along the course of the river. River basin audits offer an entry point. These audits give a basic account of land and water use throughout the basin in social, economic and environmental terms. This stage may be followed by the development of a vision for the basin in terms of feasible development and environmental outcomes. This requires extensive consultation with basin users to set measurable objectives for social, economic and environmental performance.

The range of policy tools now at the disposal of river basin agencies include: (1) statutory minimum environmental flow requirements to maintain a healthy ecology and fish populations; (2) requirements for environmental impact assessments (EIAs) as a precondition for granting licences for water use (most frequently surface and groundwater abstractions, and waste disposal); (3) declaration and supervision of reserves and protected areas (for example, wetlands) to maintain biodiversity and protect land and water quality; and (4) negotiation and supervision of measures to protect the watershed (e.g. through watershed management projects or other forms of PES).

The role of knowledge

The research and development agenda

Most research will have to be adaptive. For example, in rainfed agriculture, extending the positive environmental and soil moisture conservation benefits of conservation agriculture techniques will depend on mechanization capacity to respond rapidly to rainfall events. Techniques are known, but they need to be adapted to specific land and water and socio-economic settings. Where low-technology, opportunistic runoff farming is practised, which falls short of full water control over the whole cropping calendar, techniques to manage risk, particularly under more erratic rainfall regimes, need to be devised.

Sustainable intensification is more than improved land and water management. Agronomic practices such as earlier sowing, fertility management, weed control and the use of improved varieties play a key role too (Wani *et al.*, 2009). Efforts to stabilize production from existing rainfed systems in the face of climate change will need a better analysis of climate in relation to farming – rainfall patterns and soil moisture deficits linked to socio-economic vulnerability, not just in order to forecast food production volatility but also to structure inputs and services.

In irrigated systems, knowledge-based precision irrigation that offers farmers reliable and flexible water application will continue to form a major platform for intensification. In future, components like fertigation technology, deficit irrigation and recycling of treated wastewater, in particular for orchard crops (Winpenny *et al.*, 2010), are likely to become more widely used. All techniques are expected to become better integrated within irrigation systems that offer on-demand, just-in-time water delivery. Research and development will be needed to adapt these technologies to local farming practices.

Measures to modernize large-scale irrigation schemes will also require government intervention because of the scale and cost of investments. But in many cases, research and development may be best conducted by the private sector. Developing countries, for example, have already seen the promotion of low-head drip kits and pressurized subsoil drip for horticulture. In addition, the availability of cheap plastic moulded products and plastic sheeting for plasticulture will expand.

However, the broad-scale adoption of alternatives (e.g. solar technologies) or avoidance of polluting technology (plastic) will need to be led by government regulatory measures with effective policing of compliance.

Farming systems research will also be essential to determine intensification strategies. If rainfed production is to be stabilized with a contribution from enhanced soil moisture storage, the physical and socio-economic circumstances under which this can occur need to be well identified. There are also knowledge gaps that need to be filled, particularly on the economic and financial aspects, but also monitoring and evaluation of land and water degradation and of the positive impact of sustainable management measures.

Transferring the message

Sustainable intensification of land and water management will require inducing a very large number of farmers to improve their farming systems, adopting approaches to land and water productivity enhancement that fit their soils, water availability, labour force, access to inputs and markets, and also their income objectives. Thus, intensification packages must be accessible and feasible in technical and financial terms, and ensure an economic return on farmers' investment of labour and resources. There is ample evidence that technology-driven top-down approaches are non-sustainable. Therefore, this match of intensification packages with farmer endowment and objectives requires a 'demand-driven' approach that addresses the constraints as identified by the farmers themselves.

The capacity of existing extension systems to convey messages and technical packages to farmers is often limited. Site-specific behavioural changes would be best served by educational means (e.g. through Farmers' Field Schools, which reinforce farmers' decision-making capacities to adopt changes to land and water management). Flexible curricula need to be developed that specifically address problems of sustainable and environmentally sound land and water management for increased production. Where possible, indigenous knowledge and traditional practices should be integrated. Farmers should typically be addressed above the individual level, as land and water management generally requires cooperation.

Although a wealth of information exists on technologies and approaches, there is insufficient sharing of experiences at all levels, and between countries or regions. Existing knowledge bases are generally not widely accessible and may have sectoral or institutional biases. The knowledge is not always very user-friendly and is rarely directly accessible by the land users. Systems are largely 'passive', with few possibilities for regular updating. Key steps in putting in place an enabling environment will therefore be to develop the networks, forums and media for exchanging and disseminating knowledge, and for identifying and filling knowledge gaps.

Strengthening international partnerships

Resource inventory and use monitoring

As the challenges of sustainable land and water management mount, managers and users need accurate and timely data to monitor changes in land and water. New technologies, particularly remote sensing, are contributing to mapping and monitoring a wide range of parameters. A number of international programmes are developing resource inventory and monitoring tools. The potential of these spatial technologies for improving land and water management is enormous. One challenge is to ensure that there is access by all, and some programmes (such as the UNEP/FAO Digital Chart of the World and FAO's Geonetwork) have developed spatial data infrastructure and geospatial standards to increase data exchange between platforms.

New partnerships are sourcing data and interpreting it specifically for management purposes (Table 5.2). GEOSS initiatives (Box 5.6) comprise projects to support decision-taking on land and water across Asia and sub-Saharan Africa, including forest carbon tracking. The Millennium Ecosystem Assessment is a collaborative effort to track the impact of human activities on ecosystem services. In addition to its educational impact and influence on scientific research and policy, the coopera-

BOX 5.6: GLOBAL EARTH OBSERVATION SYSTEM OF SYSTEMS (GEOSS)

The global challenges posed by desertification, biodiversity loss and climate change have created an urgent need for an integrated system to monitor environmental changes and provide the information needed to move towards, a more sustainable management of natural resources. The group on Earth Observation (GEO), a voluntary partnership of governments and international organizations, was created in 2005 to build a Global Earth Observation System of Systems (GEOSS) to generate, disseminate and manage Earth observation data collected from a vast array of observation systems (oceanic buoys, hydrological and meteorological stations, and satellites), and to facilitate analysis in areas ranging from disaster risk mitigation to adaptation to climate change, integrated water resource management, biodiversity conservation, sustainable agriculture and forestry, public health, and weather monitoring.

In 2008 GEO launched the Forest Carbon Tracking Task (FCT) in collaboration with FAO, the European Space Agency (ESA) and the Committee on Earth Observation Satellites (CEOS). The goal of FCT is to develop a system of forest observation and carbon monitoring, reporting and verification based on satellites, airborne and *in situ* forest measurement data, and thus support countries that wish to monitor their forests, and create a system of carbon accounting.

Source: GEO (2010)

TABLE 5.2: INTERNATIONAL PROGRAMMES FOR DATA GENERATION, HARMONIZATION AND SHARING

Programme	Goal related to land and water	URL
AQUASTAT (FAO)	Global information system on water resources, water uses and agricultural water management, with an emphasis on countries in Africa, Asia, Latin America and the Caribbean	www.fao.org/nr/aquastat
FAO Land and Water Digital Media Series	Provides a wide suite of data as well as educational resources on land and water issues	www.fao.org/landandwater/lwdms.stm
FAOSTAT	The largest global source of agricultural data, with over one million time series	faostat.fao.org
Geonetwork	FAO's geospatial clearing house is a standardized and decentralized catalogue giving wide access to geo-referenced data, cartographic products and their metadata	www.fao.org/geonetwork/srv/en/main.home
GEOSS	Earth geospatial data network	www.earthobservations.org
Global Soil Map Consortium	Soil analysis to inform land management practices	www.globalsoilmap.net
Global soil partnership (under discussion)	Harmonization of global soil databases	www.fao.org/nr/water/news/soil-db.html www.iiasa.ac.at/Research/LUC/External-World-soil-database/HTML/index.html
GTOS	Inter-agency coordinating mechanism for improving earth observation of natural resources	www.glcn.org
LADA	Land degradation assessment in drylands	www.fao.org/nr/lada/
UNEP/FAO digital charts of the world	Provide information on land cover and population density	www.fao.org/docrep/009/a0310e/A0310E09.htm
UN-Water	Fostering information-sharing and knowledge-building across all UN agencies and external partners dealing with freshwater management	www.unwater.org/flashindex.html
Wocat	Global network to disseminate knowledge on SLM practices	www.fao.org/ag/agL/agll/wocat/default.stm

Source: Nkonya et al. (2010)

tion process itself has produced a deeper understanding of relationships between humans and natural systems.

But while progress has been made, efforts remain fragmented, financing for key functions has been dropping, and measures to ensure harmonization, accessibility and the sharing and use of data require further strengthening. On climate and water, global hydrological data and observation networks are still inadequate, and many countries have limited access to data. Data production needs to be further harmonized and dissemination needs to be broadened. Despite the potential of remote-sensing technologies, data are still not sufficiently tapped, and lack of data has been a key constraint to cooperation and investment. There is also a need for further effort to translate data into a usable format. International cooperation is required to facilitate the sharing of knowledge, and education and training in the application of information by decision-makers and managers needs strengthening (WWAP, 2009).

Coordinated policies and actions

Regional cooperation on land and water has been driven by the existence of multiple shared agendas – economic linkages, shared land and water resources, and common development challenges. There are numerous regional initiatives, with a particular concentration in sub-Saharan Africa, reflecting the poverty impact of the high levels of resource degradation prevailing in the region (Table 5.3).

International approaches for joint management and protection of land and water

Successive international conferences have resulted in international agreements relating to management and protection of aspects of land and water resources. Several UN agencies share responsibility for supporting their implementation, including FAO, UNEP and the World Bank. This section discusses the progress with implementation of some of these agreements.

In land, the UN Convention to Combat Desertification (UNCCD) supports national action plans and collaboration between donors and countries for combating degradation of land and water resources in dry areas. UNCCD has raised awareness and created some political momentum, but financial resources and a clearer mandate are needed to have significant impact.

The Global Environment Facility (GEF) was established in 1991. Its objective is to promote international cooperation to prevent global environmental degradation and to rehabilitate degraded natural resources. To date, the GEF has allocated US$8.8 billion, supplemented by over US$38.7 billion in cofinancing, for more than 2 400 projects. Through its Small Grants Programme, the GEF has also made more

TABLE 5.3: SELECTED REGIONAL COOPERATION EFFORTS ON LAND AND WATER MANAGEMENT

Regional cooperation	Activities related to land and water	Source
Cooperation institutions in Africa		
Comprehensive Africa Agriculture Development Programme (CAADP)	'Pillar 1' of the CAADP aims at extension of area under sustainable land management and reliable water control systems. Targets 6 percent growth in agricultural productivity and 10 percent public expenditure budget for agriculture.	www.africa-union.org/root/au/Documents/Treaties/treaties.htm
TerrAfrica	Partnership set up in 2005 that aims to address land degradation through country-driven sustainable land management (SLM) practices in sub-Saharan African countries.	www.terrafrica.org
Partnership for Agricultural Water in Africa (AgWA)	AgWA promotes and encourages investment in agricultural water management in Africa. Its five priorities are: advocacy; resource mobilization; knowledge sharing; donor harmonization; and capacity development. AgWA is a framework for coordination and for linkages with African subregional partnerships such IMAWESA, ARID and SARIA.	www.agwaterforafrica.org
AU (African Union)	Convention for the establishment of the African centre for fertilizer development; and African convention on the conservation of nature and natural resources	www.africa-union.org/root/au/Documents/Treaties/treaties.htm
SADC	Collaborative water management initiatives	Giordano and Wolf (2002)
Other cooperation institutions		
Association of Southeast Asian Nations (ASEAN)	Establish mechanisms for sustainable development through protection of the region's environment and natural resources	ASEAN Ministerial Meeting on Environment 2009 www.aseansec.org/19601.htm
Organization of American States (OAS)	Equitable and efficient land-tenure systems and increased agricultural productivity	www1.umn.edu/humanrts/iachr/oascharter.html
EU	Convention on Environmental Impact Assessment in a Transboundary Context (1991); Convention on the Protection and Use of Transboundary Watercourses and International Lakes (1992); Water framework directive for integrated river basin management (2000).	Giordano and Wolf (2002)

Source: this study

than 10 000 small grants directly to non-governmental and community organizations. With US$792 million invested to date in sustainable land management, the GEF is the largest global grant investor in this sector (Box 5.7). Issues concern insufficient synergies among GEF's various focal areas, and constraints experienced in scaling up from projects to a programme approach.

BOX 5.7: EXAMPLES OF GEF SUPPORT TO SUSTAINABLE LAND AND WATER MANAGEMENT

- In the coffee fields of Central America, the GEF is working with farmers to raise incomes by increasing their harvest of shade-grown coffee. This helps protect biodiversity, reduces dependence on pesticides and sequesters carbon.
- GEF funding to restore degraded wetlands in Romania has resulted in the removal of an estimated 55 tonnes of phosphorus, 1 200 tonnes of nitrogen and 40 000 tonnes of sediment from the Danube River before it enters the Black Sea.
- GEF projects in the humid tropics, Amazonia, Guyana Shield, the Caucasus and the Himalayas collectively work to conserve the largest remaining tracts of tropical rainforests, home to millions of species.
- The regions of southern Mexico and Central America are helping to restore the Mesoamerican Biological Corridor through a GEF-supported project that combines nature conservation with improving the standard of living for people in the area.
- Under a GEF project, Brazilian technicians are designing a biomass gas turbine that runs on the residue and waste from sugar refining, including waste from harvesting and bagasse, a residue from processing. The new turbines provide efficient clean energy, reducing emissions.

Source: GEF (2011)

The International Land Coalition was set up as a ‘convener’ of civil society, governmental and intergovernmental stakeholders on land policies and practices. It has an advocacy mission to increase access to land resources by the poor, particularly through more secure land tenure.

In water, the Global Water Partnership (GWP) was established in 1996 to promote integrated water resource management and the coordinated development and management of land and water. GWP provides advice to governments on management approaches. The World Water Council (WWC) was established in 1996 to promote awareness and build commitment on sustainable water resources management, and is best known for its flagship conference, the World Water Forum.

All of these agreements and organizations are pursuing agendas defined within the broad principles agreed at international conferences. They have contributed to raising awareness and have prompted action on land and water issues by member states. In some cases, these initiatives have strengthened institutions and governance. GWP partners, for example, have contributed substantially to awareness of integrated water resource management and to its adoption into national law, strategy and practice. All the initiatives subscribe to an approach that in principle integrates land and water issues together. However, in practice, approaches remain largely sectoral. The GWP, for example, focuses mainly on water; the ILC on land. An international convention on sustainable land and water management could help to resolve these difficulties.

Several of the organizations are working in the same field and with limited resources, which reduces focus and impact. There has been insufficient feedback on the successes and problems of these initiatives, so that the lessons of experience are not always being built in to new approaches. What is needed is a permanent forum and information exchange in which best practice and lessons can be pooled.

River basin cooperation

Although absence of a cooperative framework has been a constraint for the optimal development of many transboundary rivers, considerable progress has been made in recent years to reach varying degrees of cooperation. Cooperation on river basin development and management has usually started with technical cooperation, such as information exchange, leading over time to cooperation on planning, investment and benefit-sharing. The benefits of cooperation can be considerable: one study estimated that cooperation among Blue Nile riparian countries could increase net annual benefits from the river by US$5 billion (Whittington *et al.*, 2005).

The UN Convention on the Law of the Non-Navigational Uses of International Water Courses codified rules for equitable use, obligations of protection and conservation of international water bodies, information exchange, and settlement of disputes. The convention has not yet entered into force as insufficient members ratified it, but it provides a set of principles and standards to which riparians can refer.

In some basins, cooperation has resulted in a formal treaty and the legal establishment of a river basin organization: examples include the Mekong, the Senegal, the Volta and the Niger (Nkonya *et al.*, 2010). The Mekong River Basin Commission allowed planning to reduce flooding in the delta. Under the cooperative framework of the Lake Victoria Basin Commission, the water hyacinth problem in Lake Victoria was addressed (Foster and Briceño-Garmendia, 2010). However, experience shows that it may take decades before nations agree to joint development and management. For example, of the 18 initiatives for river basin cooperation in sub-Saharan Africa launched since the 1960s, only four have yet reached the stage of a legally established river basin committee (Grey and Sadoff, 2006). Some programmes are specifically addressing land and water management and degradation issues at the transboundary basin scale. Two GEF projects (the Fouta Djallon project in West Africa and the Kagera River Project in East Africa), as well as the Lake Chad Basin Sustainable Development Program (Box 5.8), are supporting environmental management and monitoring to improve land and water management, to mitigate carbon emissions and conserve biodiversity.

New partnerships and mechanisms

A number of recent initiatives and partnerships are likely to have positive effects on sustainable land and water management. Alongside traditional development

BOX 5.8: INTERNATIONAL SUPPORT TO SUSTAINABLE LAND AND WATER MANAGEMENT IN LAKE CHAD BASIN

The Lake Chad Basin Sustainable Development Program (PRODEBALT) was designed in 2007 as a contribution to the implementation of the Strategic Action Plan and Vision 2025 of the Lake Chad Basin Commission (LCBC). It aims for the rehabilitation and conservation of the productive capacities of Lake Chad basin ecosystems through an integrated and judicious management of the basin, so as to adapt the production systems to climate change, thus reducing poverty among the populations living around the lake. The programme started in 2009 and has a duration of six years. Its cost of approximately US$97 million is jointly financed by an African Development Bank grant for about half of the total and the rest from other donors: GIZ, BGR, European Union, World Bank and Islamic Development Bank.

In particular, the activities carried out within PRODEBALT are:

1. Protection of Lake Chad and its basin: soil conservation; regeneration of grazing-land ecosystems; control of invasive aquatic plants in water bodies; conservation of the Kouri cow species; study and plan of optimal management of reservoirs and water supply points of the basin.
2. Adaptation of production systems to climate change: extension of the piezometric observation network; sustainable management of forestry, pasture and fishery resources; establishment of local development funds to finance basic community infrastructure.
3. Institutional support: improvement of stakeholder skills; building of LCBC institutional capacities, including strengthening of the Lake Basin Observatory; conduct of studies and research, including preparation of the erosion and silting control master plan; contribution to the final design of the project of transfer of the Oubangui waters to Lake Chad.

Source: AfDB (2008)

partners, the civil society, NGOs and the private sector and private foundations are playing an increasingly important role in the promotion of sustainable development (Box 5.9).

Public–private partnerships have emerged in land and water development and management. Recent examples include Guerdane in Morocco, where an international consortium entered into a 30-year concession for the construction, cofinancing, operation and management of an irrigation water supply and distribution network; and Brazil’s semi-arid region where government invested in large-scale irrigation projects on 200 000 ha to demonstrate new cropping alternatives, technologies and productive processes, and so attracted private investment on a further 360 000 ha.

BOX 5.9: PRIVATE INITIATIVES IN SUSTAINABLE LAND AND WATER MANAGEMENT

Fairtrade: in addition to paying farmers a premium price for their produce, Fairtrade builds human and social capital in participating communities, as well as promoting good farm management practices with an emphasis on long-term sustainable production. Today, more than five million people across 58 developing countries benefit from Fairtrade. A good example is Thailand's Green Net Cooperative, which was established in 1993 by a group of producers and consumers. Farmers were suffering rises in their production costs and at the same time a decline in the prices of agricultural products. Meanwhile, Thai consumers were becoming increasingly conscious of the impact of pesticides on their health and on the environment. Green Net was the first (and is still the largest) wholesaler of fresh organic produce in Thailand. In 2002 Green Net was certified by Fairtrade Labelling Organizations International (FLO) and it now exports Fairtrade rice to Switzerland, Belgium, Germany, France, Italy, Austria, the Netherlands and Sweden (Fairtrade, 2011).

Green and organic labels and certifications: there are many examples of labels and certifications on the products of organic agriculture systems. Smallholder farmers can benefit from commodity-specific certification programmes (for example, by forming cooperatives or through participating in contract-farming arrangements). Products concerned include coffee, tea, cocoa, non-wood forest products and cotton.

Ecotourism: the key to sustainable ecotourism is sustainable ecosystem management with benefit-sharing among local populations. Functioning ecosystems are vital for ecotourism to thrive, and ecotourism is a key mechanism to provide incentives for sustainable agriculture and forestry within a whole-ecosystem context.

Environmental interest groups: many are actively engaged in partnerships to promote sustainable land and water management. They play both a financing and an advocacy role to promote policies and programmes to address climate change impacts and enhance biodiversity, and water quality and quantity. The Zambia Agribusiness Technical Assistance Centre helps small farmers in Zambia to invest in sustainable irrigated market gardening linked to wholesalers for export. Smallholders now grow irrigated fresh 'organic' vegetables for markets in Europe.

Foundations: private foundations such as the Rockefeller Foundation and Ford Foundation are supporting sustainable agriculture. The Bill & Melinda Gates Foundation focuses on areas with the potential for high-impact, sustainable solutions, including agricultural development. Recent grants in sustainable agriculture include funding for legumes that fix nitrogen in the soil, higher-yielding varieties of sorghum and millet, and research on crops that can withstand drought and flooding. The foundation also funds research for improved agricultural water management in support of smallholder enterprise.

TABLE 5.4: VIRTUAL WATER TRADE OF SELECTED COUNTRIES

	Total use of domestic water resources in the agricultural sector (km^3/yr)	Water saving due to import of agricultural products (km^3/yr)	Water loss due to export of agricultural products (km^3/yr)	Net water saving due to trade in agricultural products (km^3/yr)	Ratio of net water saving to use of domestic water
China	n.a.	79	23	56	0.08
Mexico	94	83	18	65	0.69
Morocco	37	29	1.6	27	0.73
Italy	60	87	28	59	0.98
Algeria	23	46	0.5	45	1.96
Japan	21	96	1.9	94	4.48

Source: Hoekstra (2010)

Globalization has also increased opportunities for trading virtual water – water used in the production of goods or services. The concept of virtual water suggests that a well-functioning global trade system would induce countries to export or import goods based on their natural resource endowment. Water- and / or land-poor countries would be net importers of agricultural commodities produced by water-abundant countries. It is argued that such a system would be more likely to achieve an optimal use of both land and water resources. Many countries are already net importers of agricultural goods, therefore importing large volumes of virtual water. Jordan, for example, imports about 6 km^3 of virtual water per year and withdraws only 1 km^3 from domestic sources (Hoekstra and Chapagain, 2007). Table 5.4 shows the level of water savings due to international virtual water trading.

It is argued that the virtual water content in trade of agricultural products from relatively land- and water-abundant to more land- and water-scarce areas has helped to increase water- and land-use efficiency. In fact, the realization of apparent 'comparative advantage' is hard to establish (Wichelns, 2010) since national economic policies appraise a range of factor productivities, not just water 'content'. The contribution of labour or energy can be much more significant in determining the comparative advantage in a specific crop. In this respect, it is important not to 'oversell' the importance of water in agriculture. It may be critical, but other factors of production can be equally important or dominant.

Enhancing international cooperation and investment

Investment in land and water is essential to increasing agricultural productivity and production sustainably. Investment in land and water has increased slightly in the last five years, but levels remain below those necessary to intensify production while minimizing negative impacts on the ecosystem. A particular concern is the low level of investment in the more vulnerable rainfed systems, where poverty and food insecurity are prevalent and risks of land and water resource degradation are high.

Growing interest but unmet needs

International cooperation on land and water has become a higher level of priority in many quarters. Continuing preoccupations over food security, poverty reduction and environmental protection have been heightened by growing concern over climate change, the recent food price crisis and associated land acquisitions. Interest in sustainable land and water management as a core development approach has also been heightened by a shift in thinking towards the possibilities of a new 'green economy' (Box 5.10). However, despite these positive trends, the level of investment is small compared with the levels needed to stem negative trends in land and water status and to develop higher productivity sustainably within an ecosystems context.

The case for a focus on sustainable land and water management

Agriculture is vital to poverty reduction, and strong agricultural growth has been a consistent feature of countries that have successfully managed to reduce poverty. GDP growth generated in agriculture is four times more effective in benefiting the

BOX 5.10: A GREEN AGRICULTURE FOR A GREEN ECONOMY

Faced with multiple crises, many questions have been raised about how to overhaul the global business model. One notion is that a low-carbon 'green economy', which recognizes and assigns value to natural capital, helps to mitigate climate change and adapt to its impacts, and reverses current negative trends in ecosystems (water resources depletion, pollution, land degradation, loss of social and cultural values, fisheries collapse). A green agricultural economy would incorporate the best elements of the old 'green revolution' (improved adapted crop varieties and livestock breeds) into more ecologically friendly land and water management that would take an ecosystem/landscape approach to respond to global environmental threats, land degradation, biodiversity loss and, in particular, climate change. This kind of green agriculture is becoming an important direction proposed by the Rio+20 programme.

The fiscal stimulus packages that many countries prepared to respond to the recent financial crisis contained funds dedicated to green projects, many related to energy efficiency and low-carbon technologies, river restoration and water management (World Bank, 2009a; Robins *et al.*, 2009). This green stimulus showed that the economic turndown was taken as an opportunity for investing in the green sector (i.e. restoring growth through investing in a restructuring of the economic system). It also shows that a green economy requires substantial initial public investments and regulations, as well as a private sector ready to deliver on new technologies and markets.

Source: Salman et al. (2010)

poorest half of the population than growth generated outside agriculture (World Bank, 2007c). Increased agricultural productivity improves farmers' incomes, generates on-farm employment, lowers food prices, and has significant income and employment multipliers within the local non-farm economy, all of which reduce poverty, as the poor typically spend two-thirds of their income on food. Such increases in productivity will require increased investment in agriculture, and especially in land and water development.

The new focus on the green economy and on a win–win approach to productivity and maintenance of ecosystem services creates a powerful case for this strengthened focus on sustainable land and water management. Box 5.11 recapitulates the contribution of sustainable land and water management to multiple development goals. However, investment in these areas is decreasing, or at best stagnating. The drop-off in investment in agricultural land and water was mainly driven by the perception of a decline in rates of return compared to alternative investments in other sectors, but the recent surge in food prices and worsening of the food security situation show the limits of such short-sighted strategies. Moreover, the fact that the return on capital invested in agriculture rarely matches that in industry and urban services does not capture the multiplier and social benefits from rural investment, beyond the direct impacts on food security. Only a healthy agricultural sector, combined with a growing non-farm economy and effective safety nets and social protection programmes, will be sufficient to face the global recession, as well as to eradicate food insecurity and poverty.

Some successes and new initiatives

There are nonetheless encouraging signs. First, a policy favouring increased production by smallholders in food-deficit developing countries is being embraced at both international and national level. The Joint Statement on Global Food Security made at the 2008 G8 meeting in L'Aquila, Italy stressed the need to adopt a comprehensive strategy focusing on small farmers. Second, many countries have already made considerable steps towards hunger eradication. For example, Ghana, Malawi, Mozambique, Thailand, Turkey, Uganda and Vietnam have significantly reduced the number of undernourished people in their countries over the last five years. Although most have fallen short of the target, eight African countries have met the Maputo Declaration target of allocating 10 percent of the government budget to agriculture (Fan *et al.*, 2009). The foundations for increased agricultural productivity and production to foster food security have been laid: programmes, projects and plans already exist, and are simply waiting for the political will and financial resources to become operational.

Third, moves to increase aid efficiency and to align national programmes in accordance with the Paris Declaration on Aid Effectiveness and the Accra Agenda

BOX 5.11: SUSTAINABLE LAND AND WATER MANAGEMENT TO ACHIEVE BROAD DEVELOPMENT GOALS

Cooperation on land and water is not an end in itself. It is a means of achieving larger development goals – the MDGs, overall food security, poverty alleviation, conservation of local and global ecosystem services. Land and water investments are appropriate for financing from a large range of programmes and funds.

Key linkages between larger development goals and sustainable land and water management include:

- **Rural poverty reduction:** Reducing rural poverty depends directly on the productivity and profitability of land and water-based activities, all of which are threatened by land and water degradation.
- **Food security:** National-level food security depends heavily on sustainable production of food from land and water, which, in turn, requires sustainable land and water management. In addition, sustainable land and water management can reduce dependence on net food imports, and thus conserve important financial resources.
- **Provision of a range of livelihood products such as wood, fibre and biofuels:** Land and water degradation reduces the productivity of natural resources, not only for food production but also for the production of other outputs, such as fibre, building materials, bioenergy and non-timber forest products.
- **Mitigation and adaptation to climate change:** Poor land and water management contributes to greenhouse gases. More sustainable land and water management practices increase soil carbon sequestration and reduce GHG emissions in agriculture. They also often contribute to adaptation to climate change by increasing resilience in the face of climate variability and extreme events.

for Action have led to more programmatic approaches to financing in support of national policies and strategies. In this context, several new financing facilities have been established, such as the African Fertilizer Financing Mechanism or the Global Agricultural and Food Security Program created after the G8 summit in 2008. However the establishment of dedicated funds with narrow targets, may be less efficient than fungible resources available for financing integrated national development programmes.

Attracting carbon sequestration financing for land and water strategies

One important innovation is the development of carbon markets. But although the potential for mitigation through agriculture is vast, the regulatory markets, such as the CDM under the Kyoto protocol and the EU emissions trading scheme, exclude agriculture. However, work is underway to reverse this. In addition, new initiatives are under discussion under the UN-REDD initiative (Box 5.12) to allow

- **Preserving biodiversity:** The trend towards monoculture and poor land and water management have negatively affected biodiversity. Matching of land and water use with land potential, thereby promoting diverse landscapes and products and adapted land use systems, is important to preserve remaining biodiversity levels.
- **Maintenance of other ecosystem functions:** Sustainable land and water management can also support other ecological functions or services, including the breakdown of waste products, pollination, soil biological activity that maintains nutrient and organic matter cycles, and biological control of pests and diseases. These important regulatory functions and the process of soil formation can only be maintained through appropriate land and water management practices.
- **Natural disaster prevention/mitigation:** Sustainable land and water management can increase the resilience of ecosystems, thereby reducing the risk and impact of natural disasters, such as floods, droughts, hailstorms or pest infestations.
- **Ecosystem health:** Overall, sustainable land and water management can not only arrest ecosystem degradation but can positively improve certain services: biomass, soil health, water storage and supply, and economic productivity. Amenity, tourism and cultural heritage values of landscape may also be improved.
- **Social stability:** Wellbeing and social stability in rural areas are directly related to the feasibility of earning a living from natural resources, and therefore to issues of access to land and water resources, security of tenure, and capacity to manage these resources in the most profitable and sustainable manner, through sustainable land and water management.

Sources: Nkonya et al. (2010); Salman et al. (2010)

reward for carbon sequestration in all landscapes, including 'agriculture, forestry and other land uses'. Pilot projects are being implemented in developing countries under voluntary carbon standards. A global survey of agricultural mitigation projects identified 50 agricultural projects focusing on climate change, of which 22 are developed specifically with a GHG mitigation objective.

However, problems both in the design of schemes and in the development of qualifying strategies in developing countries are not yet fully resolved. The basic difficulty is in quantifying and monitoring agricultural mitigation strategies and the resulting low-confidence, high-transaction costs and low prices of certified emissions. Problems on the side of developing countries are both in policy (lack of public commitment to invest in climate change adaptation and mitigation) and in implementation (weak property rights, low institutional capacity). Several pilot projects are being developed to try to overcome these hurdles (Box 5.13).

BOX 5.12: THE UN COLLABORATIVE PROGRAMME ON REDUCING EMISSIONS FROM DEFORESTATION AND FOREST DEGRADATION IN DEVELOPING COUNTRIES (UN-REDD PROGRAMME)

The United Nations Collaborative initiative on Reducing Emissions from Deforestation and Forest Degradation (UN-REDD) in developing countries is an effort to create a financial value for the carbon stored in forests, offering incentives for developing countries to reduce emissions from forested lands and invest in low-carbon paths to sustainable development. REDD+ goes beyond deforestation and forest degradation, and includes the role of conservation, sustainable management of forests and enhancement of forest carbon stocks. The UN-REDD Programme was launched in September 2008 as a collaboration between FAO, UNDP and UNEP. A multidonor trust fund was established to allow donors to pool resources, and provides funding towards programme activities. The Copenhagen Accord recognizes the role of UN-REDD and calls for 'immediate' establishment of a REDD+ mechanism. Developed countries committed to new and additional resources approaching US$30 billion to support enhanced action on mitigation, including 'substantial finance' for REDD+.

Source: UN-REDD (2011)

BOX 5.13: PILOT CARBON FINANCE PROJECTS FOR SMALLHOLDERS IN CHINA

FAO is currently developing a sustainable grazing project in China in cooperation with Chinese national counterparts, which aims to increase the resilience of alpine grazing systems using carbon finance. In addition, FAO is currently developing through MICCA (Mitigation of Climate Change in Agriculture) several pilot projects to support efforts of smallholder farmers to mitigate climate change through agriculture and to move towards climate-smart agricultural practices. MICCA emphasizes supporting knowledge generation on GHG emissions and mitigation potential, and testing at country and field level how mitigation-promoting techniques can be integrated into agricultural practices.

Source: FAO (2010e)

There is also a voluntary carbon market financed by companies that wish to offset their carbon footprint (Box 5.14). If agriculture in developing countries can benefit from the carbon market, this has the potential to bring considerable funding to national and local sustainable land and water management strategies. Early research (Tennigkeit *et al.*, 2009) suggest that revenues from yield improvements through the improved management techniques far outweigh the payments to be received from carbon credits, so that carbon credits may simply have a complementary or catalytic role in well-designed land and water programmes.

If sustainable land and water management investments cannot be compensated under existing programmes or under possible future programmes such as

BOX 5.14: VOLUNTARY CARBON MARKETS

The voluntary carbon market, financed by companies that want to offset their carbon footprint as a way of corporate responsibility, can be separated into two categories, the Chicago Climate Exchange (CCX) and the 'over-the-counter' market. Currently, compliance markets (regulatory markets, such as CDM and the EU Trading Scheme) and voluntary carbon markets account for less than 2 percent of the global carbon market (Capoor and Ambrosi, 2009), but are increasing.

The CCX is the world's only voluntary cap-and-trade system, while the over-the-counter market is the non-binding offset market. The CCX is the only market with a considerable share of agricultural soil projects. However, from 2007 to 2008, this share fell from 48 to 15 percent. The drop in agricultural soil projects was due in part to the growth of the programme itself, and in part to modifications made to the agricultural soil protocol, which has led to a slowdown of the verification process (Hamilton *et al.*, 2009).

Source: Salman et al. (2010)

UN-REDD, an option is to set up special funds to finance adoption of sustainable land management practices by smallholder farmers, with specific rules and requirements, and linked to programmes designed to support policy, strategy and farmer-level implementation of sustainable land and water management along the lines recommended in this report.

Payment for environmental services

PES mechanisms have attracted interest and financing both within countries and from international investors. Systems exist for watershed services, biodiversity conservation, benefit-sharing in transboundary river basin development and reduction in carbon emissions (Box 5.15).

Lessons for the future

The prospects for the implementation of more forward-looking land and water management policies, to reverse degradation trends and conserve resources for the future, will only look bright if the institutional mechanisms prove adaptive to scale / environmental context and more comprehensive (pluralistic) engagement with users.

A combination of scale-specific policy responses, innovative institutional solutions and more inclusive (but more strategic) planning solutions can be packaged to meet human demand for agricultural production and environmental services. The test is whether any of these interventions will have a measurable impact in

BOX 5.15: PAYMENTS FOR ENVIRONMENTAL SERVICES

In recent years, several mechanisms have been developed to overcome the problem that the costs of sustainable resource management may be borne by one party but the benefits reaped by another. The practice of contracting between the parties for payments for environmental services (PES) takes several forms.

Under PES for **watershed services**, watershed management programmes typically invest in sustainable development for poor communities in the upper catchment of river basins, justifying public investment subsidy on the grounds that the benefits largely accrue downstream, in the form of clean water, flood control and reduced siltation.

Under PES for **biodiversity**, financial incentives are provided for land users to conserve biodiversity. For example, in 1996 Costa Rica implemented an innovative programme under which forest and plantation owners were financially rewarded and legally acknowledged for the environmental services their forests provide nationally and globally. The early years of the PES scheme showed that it mainly benefited larger farmers and people using their forest for leisure purposes. Since then a number of measures have been taken to promote participation of small farmers and indigenous communities.

At a larger scale, **benefit-sharing in transboundary river basin development** compensates the country that bears an undue share of the costs with other benefits. For example, loss of water due to upstream abstractions might be compensated by hydropower benefits.

PES through the **carbon market** has an important potential. For example, the African agriculture sector has an estimated 17 percent of the total global mitigation potential. This could potentially translate into an annual value stream for African countries of US$4.8 billion. However, carbon markets still need to refine their implementation mechanisms in order to allow poor land users to benefit from them.

Source: Nkonya et al. (2010)

conserving or lengthening the life of Earth's natural endowments. In places where the natural capital is stretched, national institutions are more likely to be driven by environmental agendas in the future. The case for making the value of land and water explicit, and providing incentives to resource users and investors, is now well established (World Bank, 2009b).

In terms of water management, the 'more crop per drop' slogan will still apply, but the pressures from competing demands for water will necessitate 'more crop with less drop and less environmental impact'. This implies that water management for sustainable crop production and intensification will need to anticipate smarter precision agriculture. This will be technology-intensive and knowledge-intensive. It will also require agriculture to become much more adept at accounting for its water use in economic, social and environmental terms. But it is at farm level that farmers self-interest can be harnessed to improve environmental outcomes. In addition, private sector interests (including fertilizer and agro-chemical supply) can be regulated and incentivized to support more sustainable irrigation. All this suggests a shift from government roles in operating and maintaining irrigation schemes into the business of smart regulation, which can promote adoption of proven water management technologies combined with knowledge-rich agronomic practice.

The time is right to put sustainable land and water management in its rightful place at the centre of the global development debate. A first priority might be to develop and agree an integrated shared vision at the global, regional and national levels. This vision would need to be reflected in a strategy and investment framework, setting out how a shared vision might be operationalized, with tangible milestones, human and financial resource requirements, and responsibilities of the various actors. This strategy and framework could then be translated at the regional and national level into strategies and investment programmes.

At the global level, financing is required for increased levels of investment, and this might be linked to carbon credits. Investment is needed at the farm level, at the level of the basin, watershed or irrigation scheme, and at macro level, through government investment in institutions, knowledge and public goods, and through private investment in research and development and in productive capacity. Implementation would require a supportive enabling environment and incentive structure, institutional support, and a strong monitoring and evaluation mechanism.

There is scope for increased international cooperation on land and water, engaging with private sector partners, NGOs and international foundations. In this context, there is a need for international cooperation to establish ‘rules of engagement’, to ensure that foreign investments are beneficial to the host countries and that small farmers and the poor have access to increased economic opportunity as a result.