

Investment in Agricultural Water for Poverty Reduction and Economic Growth in Sub-Saharan Africa

A collaborative programme of ADB, FAO, IFAD, IWMI and World Bank

Synthesis Report

Draft February 21, 2007

Investment in Agricultural Water for Poverty Reduction and Economic Growth in Sub-Saharan Africa

SYNTHESIS REPORT

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FOREWORD

This report summarizes the results of a Collaborative Programme of a group of international development agencies – AfDB, FAO, IFAD, IWMI and the World Bank – to review the experience of agricultural water investment in sub-Saharan Africa to date and to identify the conditions for successful investment in sustainable, cost-effective agricultural water development.

The Collaborative Programme

In 2001, AfDB, FAO, IFAD, IWMI and the World Bank identified the low level of investment in agricultural water in sub-Saharan Africa as a major development issue. The agencies, therefore, decided on a joint Collaborative Programme to review the current state of agricultural water development and experience gained to date in Sub-Saharan Africa in order to (a) better understand its performance and potential, (b) identify changes in the development context and (c) develop recommendations to improve investment performance. The objective was to improve the quality of assistance to governments and induce greater investment flows, as well as influencing the assistance provided by bilateral donors.

As a first step, in June 2001 a stakeholders' workshop was convened in Harare to define the problems and to chart the scope and course of the Collaborative Programme. At the workshop, stakeholders identified factors contributing to low levels of investment. The principal concerns were perception of low economic returns compared to alternative investments; of a lack of financial viability; of poor sustainability; and of the relative wastefulness of agricultural water use. The programme was thus designed to assess the validity of these perceptions and to propose ways to overcome the underlying constraints.

At the Harare workshop, it was also decided that there were a number of strategic topics that required study before the overall question of how to catalyze increased investment in agricultural water development for crop production in sub-Saharan Africa could be addressed. Guided by a steering committee and a working group, detailed component studies were prepared on the following topics¹:

- Demand for products of irrigated agriculture;
- Assessment of potential of agricultural water management for food supply;
- Agricultural water development for poverty reduction;
- Costs of agricultural water development;
- Private sector participation in agricultural water development;
- Health and environmental aspects;
- Irrigation development planning and implementation; and
- Integrated water-livestock-crop production.

In 2002, NEPAD developed the Comprehensive Africa Agricultural Development Programme (CAADP), which gives a central place to the development of agricultural water. With FAO support, NEPAD member states are currently preparing National Medium Term Investment Plans proposing a significant increase in investment in agricultural water. This report is expected to support these planning processes.

¹ The reports on component studies are listed in Annex 1.

The Synthesis Report

This Synthesis Report has been prepared on the basis of the detailed component studies and other sources as an input to a process of discussion and decision making aimed at increasing investment in agricultural water in sub-Saharan Africa. The Report represents the consolidated views of the agencies concerned on how to improve the effectiveness of agricultural water development in the region and thereby to increase investment levels.

The report analyses the contribution to date of agricultural water management to poverty reduction and growth in the region, the reasons for its slow expansion and apparently poor track record, as well as the ways in which increased investment in agricultural water management could make a sustainable contribution to further poverty reduction and growth.

Chapter 1 of the report places agricultural water management in the context of the Millennium Development Goals and paths to poverty reduction through agricultural growth. Chapters 2 to 5 contain a regional diagnostic that looks at the role of agricultural water management in sub-Saharan Africa, examines the contribution that investment projects have made, reviews the changing institutional context and assesses the potential for further development. Chapter 6 then summarizes the lessons and recommendations for increasing the contribution of agricultural water management to poverty reduction and growth in the region.

ACKNOWLEDGEMENTS

The Synthesis Report was prepared by Tony Peacock¹ and Christopher Ward² with Gretel Gambarelli³ under the guidance of the members of a steering committee and working group comprising Tefera Woudeneh (AfDB), Jacob Burke (FAO), Edward Heinemann (IFAD), Arlene Inocencio (IWMI), Doug Merrey/Aciça Bahry (IWMI), Salah Darghouth (World Bank) and IJsbrand de Jong (World Bank). Thanks are due to the authors of the component studies and to the staff of the participating agencies for their assistance during preparation of the report.

The report benefited from a review of the draft by a panel of experts in agricultural water development drawn from the sub-Saharan Africa region, comprising Carlos Bonete (Mozambique), Amadou Allahoury Diallo (Niger), Nuhu Hatibu (Tanzania), Marna de Lange (South Africa), Inuwa K. Musa (Nigeria), Harifidy Ramilison (Madagascar), Gamal Dafalla Taha (Sudan) and Doudou Toure (Mali). The partners in the Collaborative Programme gratefully acknowledge this valuable contribution. Any errors and omissions remain, however, the responsibility of the partners.

¹ IFAD consultant (also member of Working Group)

² World Bank consultant

³ World Bank

ACRONYMS AND ABBREVIATIONS

ADB	Asian Development Bank
AfDB	African Development Bank
CAADP	Comprehensive Africa Agriculture Development Programme
CP	Collaborative Programme
CPIA	Country Policy and Institutional Assessment
DFID	UK Department for International Development
DRC	Domestic resource cost
ERR/EIRR	Economic Rate of Return/Economic Internal Rate of Return
EAP	East Asia and the Pacific
ECA	Europe and Central Asia
EU	European Union
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
HYV	High-yielding variety
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
IPTRID	International Programme for Technology and Research in Irrigation and Drainage.
IWMI	International Water Management Institute
IWRM	Integrated Water Resources Management
LAC	Latin America and the Caribbean
MCM	Million cubic metres
MDG	Millennium Development Goal
MENA	Middle East and North Africa
M&E	Monitoring and evaluation
NEPAD	New Partnership for Africa's Development
NGO	Non Governmental Organization
NMTIP	National Medium-Term Investment Plan
O&M	Operation and Maintenance
PPAR	Project Performance Assessment Report
PPP	Public-private partnership
PRSP	Poverty Reduction Strategy Paper
SA	South Asia
SADC	Southern African Development Community
SSA	Sub-Saharan Africa
WARDA	West African Rice Development Agency
WB	World Bank
WP	Working Paper
WUA	Water Users' Association

GLOSSARY

Agro-ecological zones

Agro-ecological zones are defined by FAO on the basis of average annual length of growing period for crops, which depends *inter alia* on precipitation and temperature. The lengths are: humid > 270 days; moist subhumid 180-269 days; dry subhumid 120-179 days; semiarid 60-119 days and arid 0-59 days.

Deficit irrigation

Deficit irrigation is the application of less irrigation water than that required for maximum plant growth, to optimize yield per unit of water rather than land – in other words, to optimize water productivity.

Diversification

Diversification is defined as a modification of the farm enterprise pattern to exploit new or existing market opportunities, thereby to increase farm income or reduce income variability.

Drainage

Drainage is the removal of excess water from agricultural land.

Dryland crops

Dryland crops are those crops grown under naturally occurring rainfall without irrigation, drainage, or taking advantage of rising or falling water tables.

Empowerment

Empowerment is defined as strengthening the social and economic rights of people – and helping them gain the confidence to assume a meaningful role in developing their own livelihoods. It involves enabling people, by providing them with the necessary skills and knowledge to influence all decisions that affect their livelihoods and by building institutions (i.e. policies, legal frameworks and community-based organizations) that are responsive their needs.

Farmers' Field Schools

Farmer Field Schools are a way of testing and adapting new technologies. They consist of a community-based, practically oriented, field study programme, involving a group of farmers, facilitated by extension staff (public or private) or, increasingly, by other farmers, in which farmers learn together and test and adapt practices, using practical, 'hands-on' methods of discovery learning that emphasize observation, discussion and analysis to combine local indigenous knowledge with new concepts.

Food security

Food security is the condition of being able supply one's food needs either from one's own production or by buying in from other sources, whichever is more economically advantageous. Food security may be expressed in terms of the household, the nation or the region.

Food self-sufficiency

Food self-sufficiency is the condition of being able to meet one's food needs from own production without resorting to other sources. Food self-sufficiency may be expressed in terms of the individual household, the nation or the region.

In-field rainwater management

In-field rainwater management consists of operations to enhance the effectiveness of rainfall for dryland crop growth.

Integrated Water Resources Management

Integrated water resources management is the approach that evolved from the 1992 *Dublin Statement on Water and Sustainable Development* that called for an integrated, intersectoral approach to water management and allocation. The IWRM approach emphasizes: (a) the need for a whole catchment approach to development and subsidiarity in planning and decision-making; (b) the pivotal institutional role of women; (c) basic human rights to clean water and sanitation at an affordable price; and (d) the need for economic efficiency in water use.

Intensification

Intensification is defined as producing more per unit of land.

Irrigation

Irrigation consists of operations to supply additional water to agricultural land to augment rainwater (if any) for the purpose of crop growth. Irrigation water may be supplied from groundwater, surface water, agricultural drainage wastewater or other wastewater (including that from domestic or industrial use). For the purpose of this report, reference to irrigation should also be taken to include drainage where appropriate.

Large, medium, small and micro-scale

For the purposes of this report, 'large-scale' refers to an irrigated area of 1,000 ha and more; 'medium-scale' refers to an irrigated area of at least 100 ha but less than 1,000 ha; 'small-scale' refers to an irrigated area of more than 1 ha but less than 100 ha; 'micro-scale' refers to an

irrigated area of up to 1 ha, such as irrigated vegetable gardens¹. Each of these scale categories could be operated by either the public or private sector, although the smaller areas are usually operated by individuals or groups of individuals.

Market linkages

Market linkages are defined as arrangements under which agricultural processing or marketing companies enter into mutually beneficial contract arrangements with producers to provide technical support and inputs in return for an assured throughput of produce.

Supplemental (or supplementary) irrigation

‘Supplemental’ (or supplementary) irrigation involves providing water to augment rainfall for crop growth. Most irrigation is supplementary, except where it is provided entirely within a dry season.

Water harvesting

Water harvesting (or rainwater harvesting or runoff harvesting) is the collection and concentration of runoff, with or without storage, for use in irrigating crops. The use of large, medium and small dams and weirs for irrigation may be considered as a form of water harvesting, but the term is generally used to refer to the collection of runoff from very small catchment areas (from as small as the roof of a house to as much as 200 ha).

Watershed management

Watershed management consists of operations to conserve catchment areas by sustainable land use practices, to maintain or enhance the quality and quantity of their water flows.

¹ The definition of ‘large’ in the context of scale of agricultural water developments varies from country to country.

EXECUTIVE SUMMARY

Poverty and agricultural growth

The multiple facets of poverty can be divided into two broad types: income poverty and non-income poverty. Because people who are income poor tend to be also poor in the other respects, the Millennium Development Goals consider poverty in terms of income and use a *per capita* income of \$1 a day as the threshold for extreme poverty. This is significant, since it focuses attention on the overarching importance to poverty reduction of increasing household incomes.

Although the world as a whole is roughly on track to do so, sub-Saharan Africa is unlikely on present trends to reach Target 1 of the MDGs – i.e. to halve, by 2015, the number of people living on less than \$1 a day. Indeed, if nothing changes, the absolute numbers of poor in the region will continue to increase and by 2015 close to half the world's poor will live in this region.

Eighty-five percent of sub-Saharan Africa's poor live in the rural areas and depend largely on agriculture for their livelihoods. Agricultural growth is therefore clearly key to poverty reduction; it can also help drive national economic growth. Yet agriculture in the region remains a largely subsistence activity, production has not kept pace with population growth, food self-sufficiency has declined, the household income required to afford bought-in food has not been generated and the numbers of malnourished people are consequently rising.

Agricultural water development, growth and poverty reduction

Investment in agricultural water can contribute to agricultural growth and reduce poverty directly by: (a) permitting intensification and diversification and hence increased farm outputs and incomes; (b) increasing agricultural wage employment; and (c) reducing local food prices and hence improving real net incomes. It can also reduce poverty indirectly via increased rural and urban employment as a result of the multiplier effect on growth in rural and urban non-farm economies – and the potential multipliers from agricultural water investment are generally higher than those from comparable investment in dryland agriculture.

And yet sub-Saharan Africa's agricultural water remains underdeveloped: there are only 9 million ha of land under water management in the region today, representing just 5% of the total cultivated area of 183 million ha – by far the lowest proportion of any region in the world. Of this, 7 million ha are equipped for full or partial irrigation – less than a fifth of the estimated physical potential of 39 million ha – while the balance of 2 million ha is under 'other forms of water management' such as flood recession cropping. Only about 70% (5 million ha) of the equipped area is operational. Water withdrawals for agriculture are therefore limited – less than 3% of total renewable resources – and although a number of basins are currently experiencing, or are approaching, water scarcity this is mainly because of a lack of storage rather than absolute scarcity.

One of the reasons for underdevelopment of the subsector is that there has in the past been a lack of strategic vision linking agricultural water development to poverty reduction and growth. Water sector strategies (including those based on integrated water resources management – IWRM – principles) are generally neutral – or even negative – towards agricultural water use, possibly because of perceptions of economic and water use inefficiency. Furthermore, even though most poverty reduction strategies are predicated on agricultural growth, agricultural water development has generally not been seen as a vehicle for achieving this; consequently it has had a low profile in PRSPs.

Costs and performance of irrigation development

Although the cost of public irrigation development in sub-Saharan Africa has been excessively high in the past, a new generation of well-designed and implemented irrigation projects has proved to be only marginally more costly than those of other regions. However, irrigated cropping in the region continues to be characterized by low productivity and hence low profitability. This has serious implications for poverty reduction and growth, since without profitability the necessary income gains cannot be achieved and without profitability there is unlikely to be economic viability – without which projects will not contribute to national economic growth.

Low productivity is correlated with unreliable water supplies, low input use (sub-Saharan Africa's farmers use an average of only 9 kg fertilizer per ha compared with 100 kg/ha in South Asia and 135 kg/ha in East Asia) and difficulty in accessing profitable output markets. Low productivity can also be attributed to inadequate assessment and mitigation of negative environmental and health impacts – including the impact of HIV/AIDS. Yet, where water supplies have been reliable, with good access to markets and a conducive institutional environment – all of which have encouraged investment in yield-enhancing inputs – productivity has proved comparable with that of post-Green Revolution Asia. Clearly, providing irrigation water alone will not guarantee increased productivity: not only must water supplies be reliable but they must be provided as part of a comprehensive and sustainable package that empowers farmers to commercialize their yields and production, as well as giving them incentives to do so – including improved access to input and output markets.

Irrigation for cereal crops

The demand for cereal crops will expand rapidly in the coming years and, unless domestic production can be increased, imports will continue to rise. Since more than half of the currently irrigated area is already used for growing cereals, recent policy analyses have considered irrigation as a means of reducing these imports. Irrigated rice cultivation has proved profitable, at least for the local market, where yields are relatively good and investment costs are not too high. But at the yields typically obtained by smallholders, other cereals – such as maize and wheat – have proved less profitable under irrigation, particularly with the continuing decline in world prices. If investment in expansion of irrigation for non-rice cereal crops is to be justified, significant productivity improvements or cost reductions will have to be achieved, failing which any increased supply of these crops from within the region is likely to have to depend largely on improving dryland production.

In-field rainwater management

Recent decades have therefore seen increased interest in technologies for in-field rainwater management for dryland crops, the objective of which is to increase the effectiveness of rainfall to stabilize and enhance yields. The most promising of these are the various types of conservation farming, including deep tillage, reduced tillage, zero tillage and various types of planting basins, all of which have been successfully demonstrated in many parts of the region, both in the semi-arid and dry subhumid zones. The results have been impressive, particularly when the various technologies have been combined with use of yield-enhancing inputs. Yet adoption by smallholders has generally been poor, except where it has been possible to establish a market linkage with a processor (e.g. for cotton) who has been prepared to provide technical support, in-kind credit and a viable guaranteed market price. Otherwise, adopters have tended to lose interest in the technology once project support has ended. Either the technology was not

profitable enough, or there were sector-wide constraints of a lack of support services and poor access to input and output markets.

Yet the rationale for investment in in-field rainwater management is sound: improved dryland cropping could have as much potential – in terms of cropped area and numbers of potential beneficiaries – as irrigation development. It could also be the answer to meeting the region's mounting food import bills. What is required is to identify profitable technologies and the specific barriers to their adoption and to invest in overcoming these and market-led dissemination of the technology.

Development potential and constraints to further investment

Since less than a fifth of the physical potential for irrigation has been developed to date there is clearly significant potential for expansion (although this would require the construction of some additional water storage). In addition, there is potential for improving the productivity of the 5 million ha currently under irrigation and for bringing back into production the 2 million ha of land that is equipped for irrigation but currently unused. A mix of interventions is likely to be required to realize these potentials, such as the development of new irrigation infrastructure and improvement of existing areas (for large, medium, small and micro-scale schemes, including water harvesting), as well as improved in-field water management and crop husbandry. There is also potential for improving water control on the 2 million ha of land under 'other forms of water management' – i.e. in wetlands and valley bottoms. Some of this may require the development of irrigation and drainage schemes shared by a number of farmers, but in many cases the development of small areas by individual smallholder irrigators, using micro-irrigation technologies (e.g. treadle pumps), will be more appropriate. There is also, as mentioned, considerable potential – possibly several times greater than that for irrigation, in terms of cropped areas and numbers of beneficiaries – for improving dryland crop production, particularly of staple food crops but also of cash crops such as cotton, by in-field rainwater management.

The main constraints to developing this potential are interrelated: they are both economic and institutional. Economic constraints include macro-economic and sectoral policies, lack of profitable markets, and the costs of development and production. Institutional constraints include the legal frameworks for land, water and farmers' organizations, the organization of public agencies for investment and management, and lack of empowerment of farmers to manage their water resources and to access effective agricultural support services, finance and markets. Without reforms, productivity and farm level profitability will continue to be constrained. However, reforms require capacity building, time and consistent approaches by both governments and donors, and the inclusion of other stakeholders – especially farmer representatives.

Agro-ecological zones, farming systems and targeting

The major farming systems of the region broadly correspond with the main agro-ecological zones. Although the arid and semi-arid zones cover 39% of the land area of the region the share of agricultural population of these zones is only 16%. The great majority of people depending on agriculture for their livelihoods therefore live in the higher potential subhumid and humid zones – which consequently also coincide with the greatest pressure for agricultural intensification. The greater opportunities for poverty reduction and growth are therefore likely to be found in the more humid zones than in the arid and semi-arid zones. The corollary is that it is not necessarily pro-poor to target the drier agro-ecological zones, where agricultural water development is often more costly – and markets more remote – than in the more humid zones, making profitability, economic viability and sustainability difficult to achieve. That said, where land, water and

markets combine favourably agricultural water development in the drier areas can be successful. The key is to ensure that this combination is in place for investments in these areas.

Targeting the poor and women

Past attempts at targeting the poorest socio-economic stratum have not been very successful. It has been found instead to be better to adopt a more inclusive approach based on principles of equity but geared to maximizing profitability and household incomes. Since the vast majority of people in the rural areas fall within the category of 'extreme poor' (i.e. they subsist on less than \$1 a day), such an inclusive approach results in most beneficiaries being drawn from this category anyway. Also, the inclusion of some of the better-off can help to drive profitability and household incomes for the less well-off. Furthermore, where the poorest cannot for some reason benefit directly as participants they can benefit directly from increased agricultural wage employment.

However, specific measures are necessary to ensure that the poorest (as distinct from the 'poor') are not excluded or further marginalized, and that if the poorest do not benefit as producers or through wage employment, they do so in other ways, such as improved access to domestic or livestock water or possibly crop by-products for livestock feed. It is also essential to recognize the important role played by women in most production systems. Specifically targeting women and encouraging their participation in governance structures has been found to enhance productivity and poverty reduction impacts.

Monitoring and evaluation

Monitoring and evaluation of the implementation of agricultural water investment projects has generally been poor. Effective M&E of implementation is required not only to provide details of how well the project is managing its resources to achieve intended results or targets, but also the extent to which the achievement of targets actually contributes to the overall objective of the project. Moreover, this information is required by all of the actors involved, including farmers, implementers, project supervisors and financiers.

Monitoring of such key production indicators as input and output prices, use of inputs, yields, areas planted and production is also essential for subsequent farm management purposes, since farmers need to know how profitable their application of resources and technology is from season to season, to enable them to make adjustments as required. Monitoring of these indicators is also necessary to permit estimates of changes in household incomes and evaluation of income poverty reduction: qualitative proxies will not do. It is also necessary to monitor other factors that affect yields and production, such as water availability.

The general lack of effective M&E of implementation and subsequent performance of the investment to date is likely to have had a negative impact on project outcomes, since those responsible have not been alerted to weaknesses soon enough to enable them to take effective remedial action. While farmers are better placed than anyone else to carry out monitoring at the farm level, projects have an important role to play in establishing farmer-based M&E systems and carrying out higher level monitoring.

Implementation and supervision

The design and implementation of projects – large, medium, small and micro-scale – has in the past been largely top down. The quality of projects has been reduced by common weaknesses in preparation, particularly poor treatment of the key land and water security issues, lack of

evaluation of markets and profitability, lack of an agricultural support package, over-estimation of institutional capacity, and poor technical design. However, recent more participatory approaches have begun to produce better, more sustainable results, and quality has improved as the arrangements for project design, implementation and management have reflected the comparative advantages of the public sector, private sector, NGOs and farmers. Supervision by government and donors has too often focussed on reaching physical and disbursement targets at the expense of development effectiveness, and has not been supportive and flexible enough to help managers to deal with the complex technical, financial and social problems that arise during implementation.

Key Recommendations

1. Adopt a strategic vision

The governments of sub-Saharan African countries should promote national agricultural water development strategies that recognize (a) the potential contribution of agricultural water to poverty reduction and growth, (b) the imperatives of farm level profitability and economic viability and (c) the need for a conducive institutional environment (i.e. policies, legal frameworks and organizations that foster profitable, sustainable water-managed farming by smallholders).

The strategies should be supported by analyses of institutions, identifying: (a) the respective roles of the public and private sectors, the organization and incentives for the public organizations involved, and ways to foster participation of the private sector; (b) the rules of engagement of the public sector – its role in investment and management, and the place of subsidies; and (c) the barriers to commercialization of agricultural water management by smallholders and specific ways to overcome them.

The strategies should also analyse the various investment options, including:

- increasing the productivity and profitability of existing irrigation schemes;
- expansion or new construction of viable large, medium, small and micro-scale irrigation systems (including systems based on water harvesting);
- testing and dissemination of viable, farmer-financed in-field rainwater management technologies, as a low-cost alternative to irrigation; and.
- development of sustainable supply chains for micro-scale irrigation and in-field rainwater management equipment.
- investment in research on agricultural water management, both adaptive research at the national and regional levels, and basic research at the regional level.

The new strategies should then be incorporated into wider sectoral strategies – for agriculture, rural development and water. Water strategies should be based on IWRM principles, making an economically efficient allocation of water to the agricultural sector, and ensuring that water allocation and management takes account of the needs of the poor and providing for effective participation by smallholders in basin planning. The whole should then be clearly reflected in PRSPs or similar national development strategies.

2. Invest in institutional reforms

The new sectoral strategies should then form the basis for sectoral programmes, which should combine investment in infrastructure with investment in institutional reforms, including reforms to macro-economic policies, legal frameworks and organizations for agricultural water management. In some cases the changes may involve public sector reform: integrating or better coordinating the responsibilities of government organizations for infrastructure development (e.g. a ministry of water) with those for irrigated farming (e.g. a ministry of agriculture); developing the instruments needed for PPP; making transparent the role of farmers in cost sharing and in operation and maintenance; and building capacity and incentives for public agencies to adopt a new agricultural water development paradigm.

Responsibility for development should as far as possible be decentralized, based on the principle of subsidiarity. Therefore, in almost all cases, reforms will focus on empowering potential users of agricultural water to cope effectively with their new roles and responsibilities, and to deal effectively with service providers, including irrigation agencies (who should now become accountable to their farmer clients), credit organisations, and input supply and output markets. This should be accompanied by investment in capacity building for farmer organizations. .

Such programmes of institutional reform – which will require time and patience – should, where possible, be implemented through sector wide approaches that encourage harmonization of development efforts.

3. Invest only in viable and sustainable projects and design for maximum profitability

Avoid long-term subsidies and unviable investments for ‘social’ or ‘strategic’ purposes. Future designs and investment decisions should be based solely on considerations of economic viability, farm level profitability and sustainability. Unviable investments for so-called ‘social’ or ‘strategic’ purposes should be avoided. Where subsidies are necessary, these should be limited to (a) items having a medium to long-term economic life span (e.g. headworks and main canals on larger schemes), the cost of which is beyond the capacity of most smallholders to pay, rather than for lower-cost investments with a short economic lifespan (e.g. treadle pumps or on-farm development for improved in-field rainwater management) and (b) technology development and promotion. Subsidies for support services and/or O&M should preferably be avoided or otherwise carefully targeted and provided only in the short-term (e.g. for a single season) to ‘kick start’ commercial production.

Provide agricultural water as part of a comprehensive package, where possible market linked. Agricultural water should only be provided when all necessary conditions for its sustainable, profitable use are in place, including: empowered farmer organizations; sustainable, efficient and accountable agricultural support services; and accessible, profitable markets. Where such conditions are not already in place, investment in agricultural water should be part of a comprehensive package that provides for them to be established on a sustainable basis (i.e. for at least the intended economic life of the investment and not just for the life of the project).

Inclusively target the poor and women. Socio-economic and production systems surveys should be carried out as part of project preparation studies to provide an understanding of how agricultural water management, as an input to the farming system, could assist the various socio-economic strata of communities to improve their livelihood status to mutual advantage. Equipped with this knowledge the approach to targeting should be inclusive, rather than exclusive. The priority should be to focus on making the investment ‘pro-poor’ by selecting technology that is low risk and affordable to the poor, and by seeking to maximize farm level profitability and

agricultural wage employment, as well as other, indirect, employment opportunities. In addition, institutional design should ensure that the development is equitable, that the poorest socio-economic stratum is not excluded or further marginalized, and that the important role of women in production systems and their management is taken into account and built on.

Ensure that the proposed management arrangements are sustainable. Where possible, farmers should own, finance, operate and maintain schemes. Capacity building and development of the needed cost recovery arrangements should be an integral part of project design. The management arrangements for large schemes should follow modern best practice by giving responsibility to water user associations for operation and maintenance below, for example, secondary canal level, and should wherever possible provide at some stage for transfer of management and financing of higher level operations, or even of the entire scheme. Major infrastructure that is clearly beyond the capacity of the users to operate and maintain (with or without a service provider) should be managed jointly by an agency and users, or by an agency accountable to the users.

Management transfer on existing irrigation schemes should be attempted only where it can be demonstrated that irrigators can sustainably bear the on-going O&M costs, including any subsequent replacement costs. Thus, not only should the costs be covered by incremental farm incomes, but there should be sufficient margin to leave irrigators with an incentive to operate and maintain the facilities. The users should be fully empowered to own and operate the system. Capacity building will be needed, for which adequate time should be allowed prior to transfer.

Attempt to maximize socio-economic benefits whilst minimizing negative environmental and health impacts. The social, environmental and health costs and benefits of agricultural water investments should be taken fully into account in appraisals and investment decisions. The challenge is to design, implement and manage projects in such a way that socio-economic benefits are maximized whilst negative impacts are minimized. Project designs should therefore not only assess and provide mitigation measures for potentially negative impacts (such as conflicts with pastoralists) but also seek to exploit potential synergies and positive impacts (such as providing water and feed for livestock). Since, in many cases, the effectiveness of mitigation measures, or measures to exploit positive impacts, will be constrained by institutional weaknesses, support should be provided where possible for reforming and strengthening the institutions concerned. Project designs should specifically address the attrition of staff and farmers from HIV/AIDS-related infections.

4. Translate project designs into effective development

Improve implementation arrangements. The implementers and implementation arrangements should be oriented to achieving maximum development impact for target group households, in terms of production and incomes. Where investment is in a programme of sub-projects to be selected during implementation of an overall project, mechanisms for subproject screening, appraisal and approval should be designed to avoid non-viable investments, with clearly defined objectives, roles and responsibilities for those involved in the process. Local authorities and/or farmer organizations should be empowered to participate fully in sub-project identification, feasibility studies, appraisal, selection and implementation. The arrangements for the provision of any technical services required to support project and sub-project implementation should be based on the respective strengths, weaknesses and accountability of the public sector, the private sector, NGOs and farmers. Where services are contracted out, the terms of reference should clearly specify the intentions with regard to the 'deliverables' and accountability for them, as well as the proposed exit strategy. In particular, services for design and construction supervision of

infrastructure should be obtained from the best qualified source, regardless of origin – whether this be domestic, regional or international. These providers should also be given clear terms of reference specifying the intentions with regard to the quality and cost-effectiveness of technical designs, the objective of providing agricultural users with reliable water supplies and accountability for defective design and construction supervision.

Overcome the neglect of monitoring and evaluation. Monitoring and evaluation should be regarded as an essential management tool for farmers, implementing agencies and financing partners. The current weaknesses and neglect of M&E should therefore be addressed as a matter of urgency. Systems should be farmer-based and designed in such a way that they can be used for both farm management and project management decisions, to measure the contribution of agricultural water development to achievement of the MDGs and to inform future strategic planning and project design. As a minimum requirement, M&E systems should, therefore, measure inputs, costs, and changes in production, incomes, employment, health and the environment. Since it is usually not practical to prepare a detailed design for an M&E system at appraisal, the requirements should be clearly spelt out in the loan or grant agreements and followed up effectively by supervision missions as a matter of priority.

Focus implementation and supervision on quality assurance, productivity, profitability and increased household incomes. Much greater importance should now be attached by the financiers (including farmers, governments and others), implementers and supervisors to ensuring that implementation effectively achieves the immediate targets of the project and that these contribute to the overall objectives as intended. Supervision should be strengthened to provide effective implementation support and quality assurance, focusing on achieving the intended outcomes of sustainable productivity, profitability and income poverty reduction (as well as demonstrating this by reliable M&E).

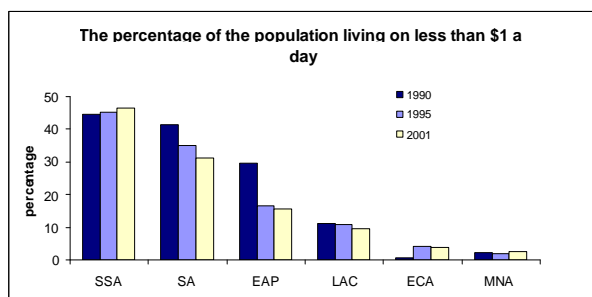
Chapter 1

Rural Poverty and Agricultural Water Development in sub-Saharan Africa

1.1 The Millennium Development Goals, agricultural growth and rural poverty

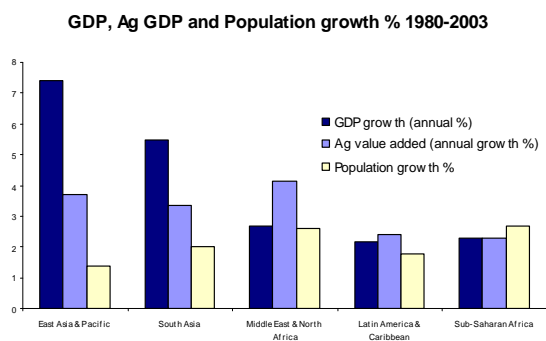
In 2000, the Millennium Declaration committed countries – rich and poor – to eradicate poverty. The first of the Millennium Development Goals (MDGs – Annex 2) is to eradicate extreme poverty and hunger, with targets of halving, by the year 2015, the proportion of people (a) whose income is less than \$1 per day and (b) who suffer from hunger.

Figure 1.1: Sub-Saharan Africa is the poorest region in the world – and getting poorer



Source: Based on World Bank data

Figure 1.2: Population growth in sub-Saharan Africa has exceeded the growth of both overall and agricultural GDP, so that the population has become poorer



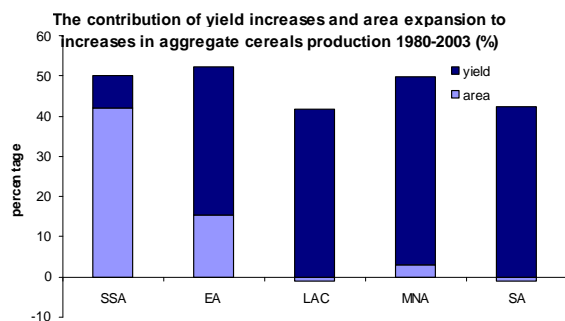
Source: World Bank

Although the world as a whole is roughly on track to reach these key development targets, sub-Saharan Africa is unlikely on present trends to do so. If nothing changes, the absolute numbers of poor in the region will continue to increase (Figure 1.1) and by 2015 close to half the world's poor will live in sub-Saharan Africa.

Meanwhile, agriculture in the region remains a largely subsistence activity and production is concentrated in low value food crops. Overall, in money terms, cereals, roots and plantains account for over two thirds of the region's agricultural output and higher value traditional and non-traditional agricultural export crops for only 8% (FAO 2006)¹. Agricultural productivity is the lowest in the world, with per capita output only 56% of the world average (FAO 2006). Output has not kept pace with population increase (Figure 1.2, FAO 2003a, Rosegrant *et al* 2005) and growth has taken place largely through expansion of the harvested area: over 80% of output growth since 1980 has come from expansion of the cropped area, compared to less than 20% for all other regions (Figure 1.3).

¹ Underlining denotes report on component study for the Collaborative Programme.

Figure 1.3: Area expansion has been the biggest source of agricultural growth by far in sub-Saharan Africa



Source: Based on FAO data

Farm families have remained locked in a low input-low income system, with yields low and stagnating (NEPAD 2005a, Rosegrant et al 2005). There has been little technology-driven jump in productivity. As population outstrips production, the numbers of malnourished are rising. Food self sufficiency has declined (from 97% in the mid-sixties to 82% in 1997/9) without the household income being generated to afford purchased food (NEPAD 2005a, FAO 2003a). Agricultural markets have remained segmented and transaction costs are high. The agricultural 'extensification'

process has also produced some negative consequences for the environment, such as loss of forest and rangeland, soil depletion and catchment degradation.

Agricultural growth is clearly the key to income poverty reduction¹. Rural poverty accounts for 83% of the total extreme poverty in sub-Saharan Africa, and 85% of the poor depend for their livelihoods at least partly on agriculture. Agricultural income growth is therefore key to rural poverty reduction. It will also help drive national economic growth (Timmer 1997, Mellor 2001, Diao et al 2003, Byerlee et al 2005, IWMI 2005g).

1.2 Agricultural water, growth and farming systems

Intensification and diversification are expected to become the major sources of future agricultural growth and poverty reduction in the region, and agricultural water will play a major part in this. Growth and poverty reduction in agriculture will come principally from two sources (Dixon et al 2001, World Bank 2005m):

- intensification i.e. producing more per unit of land, either by the generation and adoption of technologies, such as improved in-field water management, or by investments that relax key binding constraints, such as water availability
- diversification i.e. adjustment of the farm enterprise pattern, exploiting new market opportunities or existing market niches in order to increase farm income or to reduce income variability.

FAO, in its perspective on world agriculture towards 2015/2030 (FAO 2003a), concluded that 73% of the growth in crop production expected for sub-Saharan Africa by 2030 would come from yield increases and increases in cropping intensity. The remaining 27% was expected to come

¹ Participatory poverty assessments have found that poor people define their poverty in terms of material deprivation (i.e. not enough money, employment, food, clothing and housing), inadequate access to health services and clean water, and non-material factors such as security, peace and power over decisions affecting their lives (Robb 1999, cited in IFAD 2001). These components of poverty are usually divided into income poverty and non-income poverty. Reducing income poverty enables households to achieve food security, accumulate assets, reduce vulnerability to external shocks and provide for the future. Reduction of income poverty often also improves access to education, health services and clean water. Thus, although poverty is a multi-faceted condition, this report, in line with the Millennium Declaration, considers poverty in terms of the \$1 a day income threshold for extreme poverty rather than the other aspects of material deprivation or lack of access to services..

from expansion of the area under crops – mainly for maize – in the limited number of countries that still have room for this¹.

The potential for agricultural growth and poverty reduction varies by farming system and agro-ecological zone. The potential for agricultural growth and the mechanisms by which growth and poverty reduction will occur differ according to farming system. Fifteen major farming systems have been identified for the region (see Map 2, Annex 3 and Dixon *et al* 2001). These broadly fit within the main agro-ecological zones (see Map 3) defined by FAO on the basis of average annual length of growing period for crops², although local factors – particularly market access – create potential for more intensive farming or for diversification within the zones. In the region as a whole, the arid and semi-arid agro-ecological zones (crop growing period less than 120 days) cover 43% of the land area; and the sub-humid and humid zones (growing period greater than 120 days) cover 53% of the land area (Dixon *et al* 2001 and Annex 3).

Irrigated farming systems have high growth potential but cover a limited area. Only one of the fifteen farming systems identified is predominantly irrigated. In this system, which covers just 1% of the land area and 2% of the farming population – about 7 million people – poverty is limited and growth potential is high. Apart from expansion of the irrigated area, the principal sources of growth under irrigated systems are expected to be continued intensification and diversification, for which further market development and improved in-field water management will be vital factors.

Market-oriented intensification and diversification in the humid and sub humid zones will drive agricultural growth and poverty reduction, although the prospects are limited for some farming systems within these zones. Prospects for growth and poverty reduction in the Highland Perennial system (covering 8% of the agricultural population of the region) are limited and off-farm income and exit from agriculture will be the principal household strategies. For systems that have high or medium potential for growth and poverty reduction such as the Cereals-Root Crop Mixed (15% of the agricultural population), Maize Mixed (15%) and Root Crops (11%), production is likely to continue to be oriented towards production of staples for household consumption and some non-perishable high value cash crops, but intensification and diversification in these systems could present good opportunities for agricultural growth and poverty reduction. The process of growth could be greatly stimulated by improved market access, which is currently limited by: (a) physical location (producers isolated from densely populated areas with large active markets); (b) inadequate infrastructure and support services (communications, financial services and extension); and (c) weak purchasing power and demand in the markets themselves. Agricultural water development will be an important factor in aiding market-linked growth, and may range from investment in simple forms of water management to full irrigation, depending on local resources and the needs and profitability of the market opportunity.

Only limited opportunities for agricultural growth and poverty reduction exist in the lower potential farming systems in the marginal arid and semi-arid zones. The lower potential farming systems of the marginal arid and semi-arid areas present quite a different growth challenge. In

¹ FAO 2003a focuses on increases in crop production rather than on farm income growth and does not quantify the expected growth impacts of diversification. The messages are, however, consistent: agricultural growth in sub-Saharan Africa will come predominantly from improved use of production factors on existing farms. An indication of the relative scope for expansion is provided by data in Summary Table 1, which shows that at least 13 of the 48 countries in sub-Saharan Africa are already cultivating more than 50% of their cultivable land, while a further five are approaching the 50% mark. Moreover, the total for cultivable land includes land in the drier agro-ecological zones, meaning that the pressure on higher potential land might be greater than suggested by Summary Table 1.

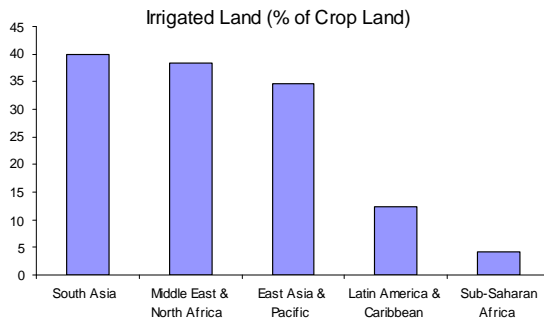
² For definitions see Glossary.

these farming systems (covering about 16% of the population of the region), the sparse population is dependent on subsistence Pastoral and Agro-Pastoral Millet/Sorghum systems characterized by poor access to markets, unstable production and food insecurity. Some production stability and growth may be achievable where agricultural water can be developed cheaply and markets can be developed. Overall, however, the potential for reducing poverty in these areas is generally low and exit from agriculture is likely to be the predominant household livelihood strategy (Dixon *et al* 2001, World Bank 2005m).

1.3 Agricultural water: the global picture and sub-Saharan Africa

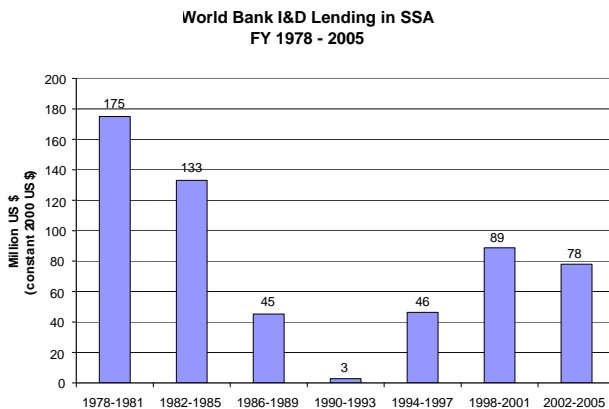
There has been less agricultural water development to date in sub-Saharan Africa than in any other region. At just 4.9% of the total cultivated area of 183 million ha, the area developed is by far the lowest of any region of the world (Figure 1.4). Three countries (Sudan, South Africa and Madagascar) account for two thirds of the irrigable area developed (see Summary Table 5 and Map 4).

Figure 1.4: Sub-Saharan Africa has a far lower share of its arable land under irrigation than other regions



Source: WB 2005b

Figure 1.5: World Bank lending for irrigation and drainage in sub-Saharan Africa is only half of levels twenty years ago



Source: World Bank ESSD database

Expansion of irrigation has been slow. Over the last forty years, only 4 million ha of new irrigation has been developed in the region, far and away the smallest expansion of any region. Over the same period, China added 25 million ha, and India added 32 million ha (FAO 2003a). Between 1994 and 2004, growth in the equipped area in Sub-Saharan Africa was only 0.85 million ha (FAO 2005a).

Until recently, investments in agricultural water in the region have been declining. Levels and trends of donor financing are conventionally taken as a proxy for investment levels. In the most recent three-year period for which partial data are available (1994-1996) the total cost of projects funded by all donors for irrigation and drainage was less than 10% of levels of twenty years previously – just \$127 million from all sources. World Bank lending for irrigation and drainage, for example, fell sharply after 1985. Even though lending levels partially recovered in the late 1990s, 2002-2005 lending was still below half the level of 1978-1981 (Figure 1.5). In addition, World Bank lending for irrigation and drainage in the region is very small compared to lending in other regions. Over the period 1996-2005, World Bank lending to sub-Saharan Africa for irrigation and drainage was just 6% of the resources

directed to irrigation and drainage in Asia.

...and investment in agricultural water has received only a small proportion of that for the water sector as a whole. For example, African Development Bank lending for agricultural water over the period 1968-2001 was \$630 million, which amounted to only 14% of its lending to the water sector as a whole (\$4,574 million).

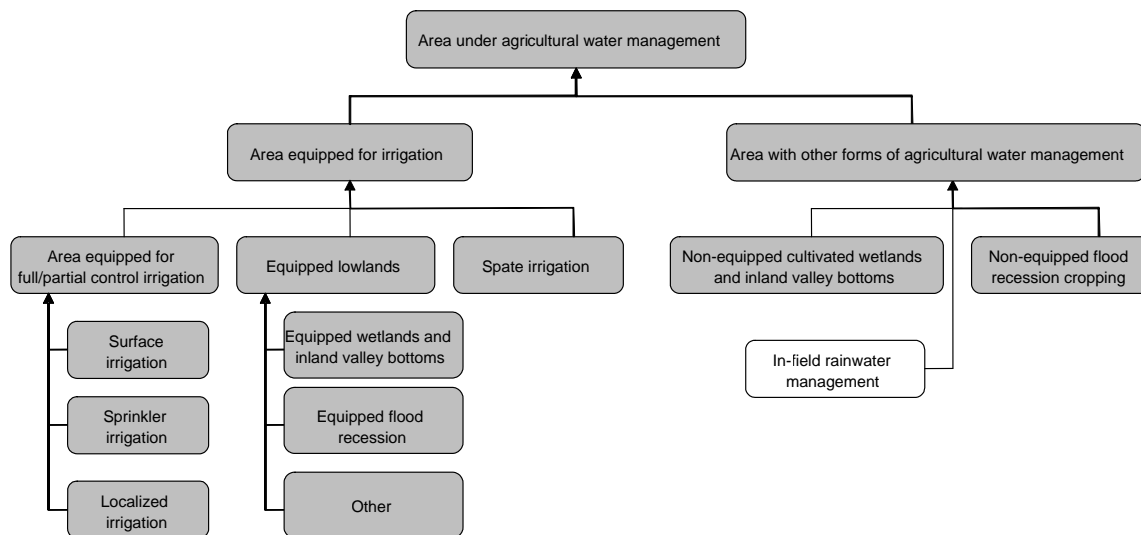
Chapter 2

Profile of Agricultural Water Development

2.1 Agricultural water management typology

The agricultural water management typology used in this report generally follows that adopted by FAO for AQUASTAT, its global database on water and agriculture, (<http://www.fao.org/ag/aquastat>). The AQUASTAT typology (Figure 2.1; see also the Glossary) distinguishes between areas ‘equipped for irrigation’¹ and those with ‘other forms of agricultural water management’.

▪ **Figure 2.1: Agricultural water management typology**



Note: Adapted from FAO 2005a (areas in grey correspond to the AQUASTAT typology)

Although ‘water harvesting’ has generated considerable interest in recent years, it was not included in the typology shown in Figure 2.1. The main reason for this was that although it was listed in the AQUASTAT survey questionnaire, few data were received for this type of water management and there were apparently some doubts over their reliability. Part of the problem appeared to be the lack of a commonly accepted definition of the term.

Nevertheless, water harvesting can be defined as *the collection of rainfall for direct application to a cropped area, either stored in the soil profile for immediate uptake by the crop or stored in a*

¹ According to the terminology adopted in FAO (2005a), ‘equipped lowlands’ include: (a) cultivated wetlands and inland valley bottoms which have been equipped with water control structures for irrigation and drainage; (b) areas along rivers where cultivation occurs making use of water from receding floods and where structures have been built to retain the receding water and (c) mangrove swamps developed for agriculture.

reservoir for future productive use (FAO 2005a). Thus, in the present context water harvesting consists of the collection and concentration of water for irrigation. What distinguishes it from other types of operations to collect water for irrigation is scale: FAO 2005a defined three categories of water harvesting on the basis of catchment area, varying from roof catchments to areas of up to 200 ha. For the purpose of this report, therefore, water harvesting is considered to be *micro-scale collection of rainfall runoff for irrigation* (see also Annex 4 and IFAD 2005). It is therefore assumed to fall under the category of ‘areas equipped for irrigation’ in Figure 2.1 – even though it may not have been fully captured by the AQUASTAT survey¹.

Because this report is concerned with agricultural water management in its widest sense, it has adopted a modification to the typology described by FAO 2005a (see Figure 2.1) to include ‘in-field rainwater management’ for dryland crop production. This was not considered by the AQUASTAT survey but is defined here as *operations to enhance the effectiveness of rainfall for dryland crop growth*. What distinguishes it from water harvesting is that instead of *collecting* runoff for irrigation the purpose of in-field rainwater management is to *reduce* runoff and evaporation losses by improving infiltration and storage in the soil profile.

2.2 Agricultural water development characteristics

According to the 2005 AQUASTAT survey (FAO 2005a), there are about 9.1 million ha of land in sub-Saharan Africa under some form of water management today. Of the 9.1 million ha (see Table 2.1), 7.1 million ha are ‘equipped’ (i.e. developed with irrigation infrastructure). Of this, 6.2 million ha are under full or partial control irrigation and 0.9 million ha consist of spate irrigation and equipped lowlands. The remaining 2 million ha are flood recession and wetland cropping areas not equipped with any water control system. It is estimated that, of the equipped area of 7.1 million ha, only about 75% (around 5.3 million ha) is operational².

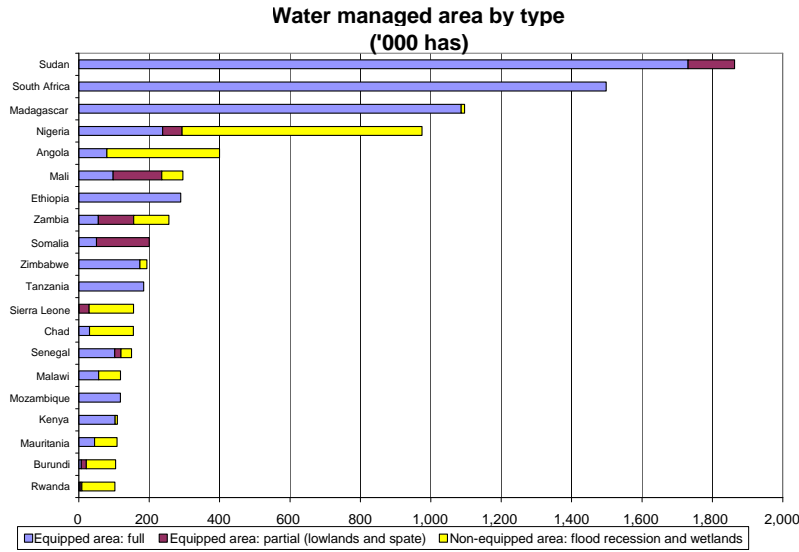
More than 33 million people derive their main income from agricultural water managed areas. Although there are no reliable data, it is estimated that at least six million households, representing more than 33 million people, live directly on earnings from the subsector³. These are almost certainly significant underestimates, since AQUASTAT probably under-reports areas under individual private smallholder irrigation (including urban and peri-urban irrigation), micro-scale irrigation (including water harvesting) and ‘other forms of water management’. Furthermore, the estimates take no account of those households engaged in wage labour for agricultural water management, including those employed in large-scale private commercial irrigation.

¹ This is not to suggest that this type of water development for irrigation is any less important to those who depend on it for their livelihoods

² The AQUASTAT database is compiled on the basis of national data provided by FAO member countries, with appropriate cross-checking and quality control. However, the quality of data is variable and definitions also often vary from country to country. Hence the statistics quoted should be regarded as indicative rather than firm.

³ This is based on the assumption that at least half the total of 9.1 million ha under water management is operated by smallholders, that each smallholder household consists of an average of 5.5 persons and that each household cultivates an average of 0.75 ha of water managed land.

**Figure 2.2: Water managed area by type
(‘000)**



Source: FAO 2005a

Zimbabwe, Mozambique, and Senegal. In several countries, equipped partial control irrigation (spate and lowlands) predominates: Somalia, Malawi, Mali and Zambia. In Nigeria, Angola, Sierra Leone, Chad and Zambia, non-equipped flood recession and wetlands cropping systems are important (see also Summary Table 4).

At least twenty countries have more than 100,000 ha of water managed areas. The distribution of the water managed area by the main sub-Saharan African countries where agricultural water management is important is shown in Figure 2.2¹. Sudan, South Africa, Madagascar and Nigeria are the main countries for irrigated agriculture. Other countries with more than 100,000 ha of full water control irrigation are: Ethiopia, Kenya, Tanzania,

¹ Summary Table 4 gives details of irrigated areas for all sub-Saharan Africa countries.

Table 2.1: Area in sub-Saharan Africa under agricultural water management by type

Type of water management	Million ha	%	Major countries	Other representative countries
1. Equipped				
<i>1.1 Full water control</i>				
Surface*	4.9	54%	Sudan, Madagascar, South Africa.	Ethiopia, Nigeria, Tanzania, Mozambique, Senegal, Mali, Angola, Somalia, Zimbabwe, Mauritania
Sprinkler	1.2	13%	South Africa.	Zimbabwe, Kenya, Malawi, Côte d'Ivoire, Swaziland, Zambia, Mauritius
Localized	0.2	2%	South Africa.	Zimbabwe, Zambia, Malawi
<i>Total full control</i>	<i>6.2</i>	<i>69%</i>		
<i>1.2 Partial water control</i>				
Lowlands	0.6	6%	Mali, Zambia, Guinea, Niger, Nigeria	Côte d'Ivoire, Senegal, Burundi, Guinea Bissau
Spate	0.3	3%	Somalia, Sudan.	Eritrea, Cameroon
<i>Total partial water control</i>	<i>0.9</i>	<i>9%</i>		
Total equipped area	7.1	78%		
2. Non-equipped**	2.0	22%	Nigeria, Angola	Sierra Leone, Chad, Zambia, Rwanda, Burundi, Mauritania, Malawi, Mali, Uganda
Total water managed area	9.1	100%		

* If irrigation type not specified, surface irrigation has been assumed.

** Other forms of water management (non-equipped flood recession and wetlands cropping, but excluding in-field rainwater management). Source: FAO (2005a)

Water withdrawals for agriculture are very limited – just under 2% of the total renewable water resource – and water storage is well below levels in other regions. Total withdrawals for agriculture in sub-Saharan Africa amount to 105 billion m³, less than 2% of the total renewable water resource (see Summary Table 3). Most countries in the region have low levels of water storage infrastructure, averaging 543 m³ per capita, compared to 2,428 m³ in South America and well below the world average of 963 m³ per capita. In Kenya, for example, total storage capacity per capita is only 126 m³ per capita, less than 4% of the level in Brazil (based on ICOLD data and on [IWMI 2005a](#), World Bank 2004a).¹

Surface water is overwhelmingly the water source for irrigation. FAO 2005a indicates that 90% of the area under full or partially controlled irrigation in sub-Saharan Africa is supplied from surface water. There is a concentration of irrigation directly linked to water courses in the Nile, Niger, Orange, Senegal, Volta and Zambezi river basins.

...but groundwater irrigation is also locally important. FAO 2005a also indicates that approximately 10% of the area under full or partially controlled irrigation is supplied from groundwater. However, since groundwater is used extensively by private individual small and micro-scale irrigators, many of whom would not be included in AQUASTAT survey data, this too is almost certainly an underestimate.

¹ In fact, water storage infrastructure for agricultural water is very much less than the figures cited, as a significant proportion of the infrastructure is largely for hydropower. In addition, regional averages are inflated by a small number of very large dams.

Large-scale irrigation schemes have generally been developed and managed by governments¹. Large-scale irrigation schemes have generally been developed by public agencies in several sub-Saharan Africa countries, particularly Sudan, Madagascar and Nigeria. On almost all these schemes, public agencies have been responsible for operation and maintenance, often with little or no recovery of costs from farmers. However, in recent years farmer organizations have been increasingly involved in management and operation and maintenance (see 4.6 below).

Development and management of smaller schemes increasingly involve farmers. Many of the small to medium-scale schemes were also constructed by government and are managed by public irrigation agencies, although they are increasingly being turned over to farmer-management – in Zimbabwe, Senegal, Mauritania, Niger, Mali and South Africa, for example. In recent years, most small scale development by the public sector has been done in partnership with farmers, and with the understanding that farmers will take over the scheme's operation and maintenance (see 4.6 below).

...but at least half of the water managed area is privately developed and operated. The privately developed and operated area includes some large-scale sugar estates in Southern Africa, thousands of smaller schemes operated by large-scale commercial farmers, and numerous informal smallholder schemes – as well as many thousands of individually owned and operated areas (mainly gardens). Some private smallholder irrigation is for subsistence (as with Malagasy paddy production in the *bas fonds*, which cover over 800,000 ha), but some is market-driven agriculture for urban markets, for example in peri-urban areas and in inland wetlands, often dependent on micro-irrigation technologies. *Dambo* irrigation in Zambia, for example, is thought to cover 100,000 ha.

The total extent of in-field rainwater management in the region is unknown but adoption is thought to have been limited. In-field rainwater management practices such as minimum tillage and other methods of water conservation farming have been promoted in the region, but details of how widely these have been adopted are difficult to find. Nevertheless, it is known that 7.8% of smallholder farmers in Zambia, for example, had adopted planting basins in the 1999/2000 season (Hageblade *et al* 2003). It was also reported that 97% of all households in 27 villages surveyed in one district of Niger in the 1990s had adopted planting pits, stone bunds or *demi-lunes* under the Indigenous Soil and Water Conservation in Africa Programme (Hassane *et al* 2000). “A good number of (smallholder) farmers” had also adopted tied ridges to create planting basins for cotton in southern Zimbabwe (Nyamudeza *et al* cited in IFAD 2005). Details of subsequent ‘disadoption’ were not available, although some of the Zambian farmers gave up after a period of time as a result of being unable to maintain conservation farming practices or when promotional input programmes ended (Hageblade *et al*). Overall, however, compared with the total area under dryland cropping in the region, adoption of in-field rainwater management for dryland cropping appears limited².

2.3 Water managed crops and productivity

Cereals, largely rice, are the principal irrigated crop. High value horticulture and industrial crops – largely cotton and sugar – are also important irrigated crops. Cereals are the predominant irrigated crop in sub-Saharan Africa, accounting for almost 50% of the harvested irrigated crop area (Table 2.2). Rice is the principal crop for 25% of the harvested irrigated crop

¹ For definitions of large, medium and small-scale, see Glossary.

² It could be argued that this impression is contradicted by the widespread construction of banded fields (known as *majaruba*) by rice farmers in East Africa. However, such fields are often constructed as a part of an irrigation system and water management is not strictly for dryland crops (IFAD 2005).

area, and is especially important in the humid and sub humid zones. Other irrigated cereals cover 24% of the harvested crop irrigated area and include irrigated maize and irrigated wheat. Irrigated wheat is important in Southern Africa and Ethiopia which together account for 80% of sub-Saharan Africa wheat production. High value horticulture, roots, tubers and industrial crops – largely cotton and sugar – are also important irrigated crops covering 33% of the harvested irrigated crop area. Fodder production and fruit trees together account for 12%, largely in Southern Africa and particularly in South Africa.

Table 2.2: Harvested irrigated crop area in sub-Saharan Africa (1,000 ha)

Region ^a	Rice	Other cereals	Vegetables, roots, tubers	Industrial Crops	Fodder	Tree crops	Other	Total
Sudano-Sahelian	242	721	181	397	142	5	5	1,693
Gulf of Guinea	28	38	73	50	-	-	32	221
Central	27	8	10	55	-	4	1	105
Eastern	108	193	169	123	-	6	85	684
Indian Ocean Islands	1,062	-	1	38	-	-	-	1,101
Southern	21	460	344	510	418	77	236	2,066
Total	1,488	1,420	778	1,173	560	92	359	5,870 ^b
%	25%	24%	13%	20%	10%	2%	6%	100%

Source: FAO 2005a

^{a/} The regions shown are those adopted by FAO 2005a. The grouping of countries within these regions is based on geographical and climatic homogeneity, which has a direct influence on irrigation. See Map 1 for the groupings.

^{b/} The total cropped area of 5.9 million ha in this table is commensurate with the equipped area of 5.3 million ha that is thought to be currently operational, assuming that overall cropping intensity exceeds 100%.

Table 2.3: Percentage of total production which is irrigated (2005 figures)

	Total sub-Saharan Africa production (million tonnes)	Irrigated production (million tonnes)	Percentage of production irrigated
Sorghum	21.6	0.9	4%
Maize	40.7	0.4	1%
Wheat	5.0	1.0	20%
Rice	12.4	4.1	33%
Fruits	57.5	15.0	26%
Vegetables	25.4	7.9	31%
Sugarcane	69.5	48.0	69%
Cotton	4.1	0.5	11%

Source: FAO (2006) based on FAOSTAT data

Irrigated production is a small contributor to sub-Saharan Africa's overall staple food production, but plays an important role for import substitution for wheat and rice and for cash crops. Irrigation is important (Table 2.3) for sugar cane (69% irrigated), for wheat production (20% irrigated), for rice (33% irrigated), for horticulture (26% irrigated), and for cotton (11% irrigated). For production of staple food crops other than rice and wheat,

irrigation plays only a minor role complementary to dryland crop production.

Table 2.4: Paddy yields in sub-Saharan Africa, South and East Asia

Region	Regional Paddy Yield (kg/ha)		
	1979/81	1989/91	1997/99
SSA	1,347	1,659	1,629
South Asia	1,910	2,602	2,917
East Asia	3,374	4,134	4,180

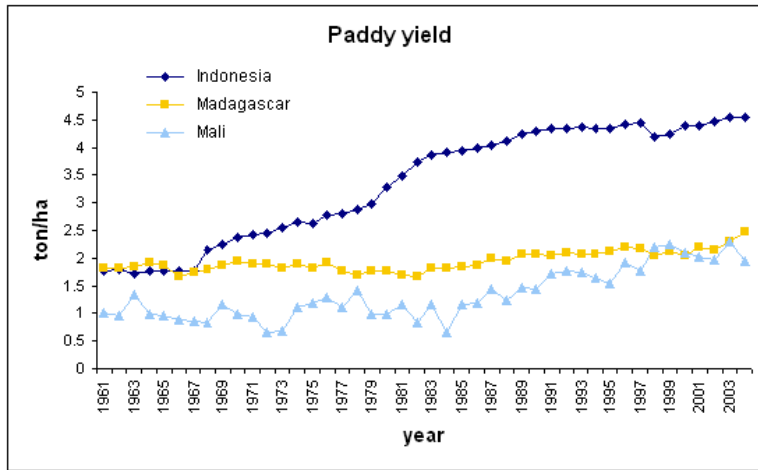
Source: FAO 2003a

Africa is even more stark: the average paddy yield in Egypt for 2004 was 9.8 t/ha (FAOSTAT). There have been some yield increases in the region in recent years (average paddy yields up 20% 1979-1999) but much less fast than in Asia (South Asia up 53% in the same period). Essentially, Green Revolution intensification of paddy cultivation has not yet occurred in sub-Saharan Africa. Average paddy yields in Madagascar for example have increased by just 20% in the last twenty years, to about 2t/ha, whilst those of Asian countries that were once at the same level have more than doubled (see Figure 2.3). However, in a few large-scale well managed sub-Saharan Africa schemes like the *Office du Niger* in Mali, yields have attained 'Asian' levels (5-6t/ha).

Overall, irrigated production in sub-Saharan Africa is characterized by low productivity. Low yields in irrigated production in sub-Saharan Africa can be attributed to unreliable water supplies, poor water control and management, low input use and poor crop husbandry, and to difficulty in accessing profitable output markets. In Madagascar, irrigated paddy yields could be increased by 50-80% simply by improved water control and in-field management (Table 2.5). Farmers in sub-Saharan Africa still lag far behind other developing areas in fertilizer use. Average fertilizer use remains at 9 kg per ha in 2002/3 compared with 100 kg/ha in South Asia, and 135 kg/ha in East Asia (FAO 2004).

Irrigated cereals yields achieved by smallholders are generally low by global standards and have improved only slowly in recent years. In 1997/9, the average paddy yield in sub-Saharan Africa was 1.6 t/ha, compared with 2.9 t/ha in South Asia and 4.2 t/ha in East Asia (Table 2.4). The contrast with yields in North

Figure 2.3: Paddy Yields in Madagascar, Mali and Indonesia



Source: FAOSTAT

Table 2.5: Madagascar: Effect of water management on paddy yields (kg of paddy per hectare)

Level of water management	Lac Alaotra	High plateaux
High	3,282	3,535
Moderate	2,490	3,424
Low	2,139	2,740

Source: World Bank 2003:67

Table 2.6: Madagascar: regional comparison of irrigated rice yields

	Average irrigated yield of paddy (kg/ha)	Fertilizer use (% of cultivated area)
High plateaux	3,200	76%
Lake Alaotra	2,632	40%
Middle West	1,966	22%

Source: World Bank 2003:67

management practices, the few available results indicate that, as for irrigated cropping, productivity gains can be considerable when farmers also have access to yield-enhancing inputs but declines when access is reduced. Farmers' yields obtained from conservation farming plots have often been more than double those from plots on which conventional tillage is practised.¹ However, these increases appear to be closely connected to the level of extension support and input packages (including HYV seeds) provided by projects. Once project support falls away, so do yields (Hageblade *et al* 2003).

In Madagascar, 69% of the area under irrigated rice is cropped without any mineral or organic fertilizer application, and the relation between fertilizer use and yields is transparent (Table 2.6, World Bank 2003). But perhaps the single most important factor is access to markets: the correlation of low irrigated productivity with remoteness from markets is very strong in sub-Saharan Africa. In Madagascar, the distance of a rice plot from a road was found to have a strong negative effect on paddy yields (World Bank 2003). It is probably the market factor which most influences other determinants of productivity. For example, where market-driven incentives are present, Malagasy farmers will invest in water control structures, fertilizers and crop husbandry improvements.

Although less is known of dryland crop production under in-field rainwater

¹ For example, the mean maize yield achieved by farmers in the 2001/02 season in Thaba Nchu, South Africa was 2.4 t/ha maize with in-field rainwater management compared with 1.7 t/ha without water management (Botha *et al* cited in Beukes *et al* 2003). Similarly, farmers' mean maize yields in Zambia during the 2001/02 season were 1.5 t/ha with conventional ploughing but 2.9 t/ha with planting pits (Hageblade *et al*). Farmers' mean millet yields for 1991-1996 were 125 kg/ha without water management and 765 kg/ha with *tassa* planting pits (Hassane *et al* 2000; see also Annex 4). And maize yields in Tanzania's Arusha Region were 2-3 times higher with conservation tillage than without (Jonsson *et al* 1998).

2.4 What kinds of crops have proved viable under water management?

Staple food crops

Irrigated rice cultivation in sub-Saharan Africa has proved viable, at least for the local market, provided that yields are relatively good and investment costs are not too high. In Sierra Leone, irrigated production shows both good farmer returns and economic viability for local sale (domestic resource costs – DRCs – well below unity, see Table 2.7), but not for export (DRCs above unity). In Mali, intensive irrigated rice production (yields of up to 6t/ha and cropping intensities of 1.2) is competitive for the domestic market and for some border areas of neighbouring countries (World Bank 2005k). In general, irrigated rice production in the sub humid zones of sub-Saharan Africa is viable if: (a) investment costs are relatively low (\$5000/ha has been suggested as a ‘cut off point’ for single cropped paddy at an average yield of 3.3t/ha, – [IFAD 2005¹](#)); (b) more intensive production systems are used (yields up to 5-6 t/ha and double cropping may be needed to justify a high cost irrigation schemes); and (c) production is for import substitution. Many factors influence the cut off point. For example, investment in rice production with simple run off and bunding techniques in valley bottoms in Madagascar can be viable even at yield levels of 2 t/ha. Market isolation is another factor, as this will increase economic farm gate prices for local rice production and hence the cut off point ([IFAD 2005](#)): see Box 2.1 for an example from Mali.

Table 2.7: Returns to irrigated rice production in Sierra Leone

	Net financial return USD/ha	DRC import parity	DRC export parity
Boliland with intensive production (including High Yield Varieties)	653	0.73	1.33
Riverine flood recession with intensive production (including HYVs)	892	0.72	1.31

Source: World Bank 2005h

Non-rice cereals have proved less viable under irrigation, particularly with the continuing decline in world prices. The relatively low value of other cereals on the world market means that domestic market prices may not be high enough to make irrigated production a viable investment in sub-Saharan Africa, particularly as yields are typically below world averages (see 2.3 above). For example, in Nigeria, most public irrigation schemes were designed for cereals production when priorities were self-sufficiency in food rather than increased farmer incomes and economic viability. With the liberalization of the Nigerian economy and the continued decline of world cereals prices, much of this food crop production (especially on pump schemes) has become uneconomic (World Bank 2001). That there are 1.4 million ha of irrigated land in sub-Saharan Africa cropped to non-rice cereals is probably a reflection of subsidies on capital and O&M costs, rather than viability ([FAO 2006](#) and Annex 5).

¹ The ceiling cost would be higher if double cropping were possible..

Box 2.1: In Mali both rice with higher value cash crops and rice monoculture irrigated systems are expected to be profitable

Under the Mali National Rural Infrastructure Project, various types of new irrigation schemes are being developed for rice production, some with cash crops in the rotation, some in monoculture.

- At the large M'Bewani scheme, Office du Niger will develop 1,300 ha of new irrigated land. Paddy yields are expected to be 5.0-5.5 t/ha, and onions, shallots and tomatoes will also be grown. Cropping intensity is assumed to be 120%. For an investment cost of \$4,230/ha, the estimated economic rate of return at project appraisal is 16%.
- Farmer-managed small-scale irrigation perimeters (250-500 ha) are expected to pursue rice monoculture as the schemes are very far from market centres where cash crops could be sold. For the same reason, local rice prices are relatively high. Paddy yields are expected to be 4.0-5.0 t/ha and cropping intensity to be 120-150%. For an investment cost of \$5,000/ha, expected rates of return are 12-18%.

Source: World Bank 2005k

Mixed cropping of cereals and cash crops can boost viability. On large-scale schemes in Mali close to markets, for example, combining paddy and cash crops contributes to good rates of return (Box 2.1). Irrigated dry beans have also been found to be highly profitable by smallholders in Southern Africa and can considerably boost viability in mixed cropping systems.

But improving dryland production could be the better option for non-rice cereals – and in-field rainwater management could be the key to this. Research to date on in-field rainwater management for dryland crop production has demonstrated its agronomic feasibility - but the issue of viability has received less attention. However, monitoring data obtained from a pilot project in Niger (Box 2.2) have provided one of the few opportunities for benefit-cost analysis on in-field rainwater management for dryland crops – i.e. the *tassa* planting pit system. The *tassa* cost approximately \$100/ha to construct and have an economic life of three years, after which they must be re-dug. In a year of poor rainfall, farmers' yields of millet from the *tassa* systems were a massive 50-60 times those obtained from the control plot, although the difference was much less in years of good rainfall (Hassane *et al* 2000). Taking account of the good and bad years over a six year period, an analysis prepared for the component study on poverty reduction (IFAD 2005) indicated a benefit-cost ratio of 1.9 at a discount rate of 10% – meaning that the ERR would have been far greater than 10%. This one example shows that investment in in-field rainwater management can be viable for non-rice cereals crops such as millet – even in the semi-arid zones. There is thus good reason to suppose that viable technologies exist or can be found to increase the effectiveness of rainfall for other deep-rooted non-rice staples, such as maize and wheat, produced under dryland conditions.

Horticulture

Irrigated horticulture is a fast growing activity. Markets for irrigated horticulture have been growing, with most production for local markets: in Kenya, for example, total production of fruits and vegetables in 1996 was 3.1 million tons, of which more than 3 million tons was consumed locally or used as an input to processing, and only 90,000 t was exported as fresh produce (Sally and Abernethy 2002).

Horticulture is developing especially fast around cities – and even within them. Peri-urban and urban horticulture is a rapidly growing phenomenon. In Accra, for example, it is estimated that 60% of all urban households are engaged in subsistence-oriented backyard farming, while market-oriented urban vegetable production on urban open spaces supplies 60-90% of the city's consumption of perishable vegetables, feeding more than 200,000 people every day (Obuobie *et*

al. 2006). As urbanization puts more pressure on the land, intensification of urban and peri-urban gardening is increasing.¹

Box 2.2 Improving in-field rainwater management in the semi-arid areas of Niger

In common with many semiarid areas, Niger has suffered land degradation as a result of population pressure and drought. An IFAD-assisted project tested a number of locally-based technologies to bring land back into production, reduce inter-annual variability of output and enhance the resilience of farming systems to climatic risk. One key success was the development of a modified form of the *tassa* practice. This continued to expand spontaneously to new plots after the project had closed.

The *tassa* practice consists of digging holes some 200 to 300 mm in diameter and 150 to 200 mm deep and covering the hole bottoms with manure. This helps to promote termite activity during the dry season, thus improving water infiltration further. Farmers then plant millet or sorghum in them. *Tassas* have allowed the region to attain average millet yields of over 480kg/ha, in comparison with only 130ha/kg without *tassas*. As a result *tassas* have become an integral part of the local technology base. The technique is spreading at a surprising rate.

Three main factors contributed to success: (a) an action-research approach that combines flexibility, openness to farmer initiatives, a forward-looking attitude and willingness to negotiate; (b) a technology that yields quick and tangible benefits, yet is simple, easily replicable and fits well with existing farming systems; and (c) a technology that can adjust to the changing local context. The *tassa* is based on a local practice that, although not high-performing, is effective.

Tassas appeal to farmers because they yield quick and appreciable results, restoring productivity of land that was previously unfit for cultivation while mitigating agro-climatic risks and increasing food availability in participating households by 20 to 40 percent. They are easily replicable because they entail only minor adjustments to local hand tools and do not involve any additional work during the critical sowing and weeding periods. Because they can be constructed by individual farmers without external assistance, *tassas* are particularly interesting to youths, since they make it possible to cultivate plateau lands, which have become a valuable resource in the face of growing pressure on land.

Source: Mascaretti in Dixon *et al* 2001

Horticultural production for export has become a boom area for some countries, and the poverty reduction impact is significant. High value irrigated horticulture is bringing ready benefits to smallholders. In countries such as Ethiopia, Kenya, Senegal, Mali, Niger, Zambia and Mauritania, entrepreneurs have developed new export markets for high value irrigated produce, and have recruited and supervised smallholder producers to supply customers. Fruits and vegetables are now Kenya's third ranking foreign exchange earner, providing livelihoods to as many as 100,000 small farmers (IWMI 2005f, Box 2.2).

¹ However, urban and peri-urban horticulture is often based on the use of untreated wastewater which, in the absence of regulation, is creating some environmental and health risks.

Box 2.2: Horticultural growth and the poor in Kenya

In Kenya, data from the 2000 Rural Household Survey suggest that almost all farmers, rich and poor, participate in some form of horticultural production. The percentage contribution of horticulture to income is fairly constant across income and farm size categories. Production is predominantly for market. Even amongst the poorest 20% of Kenyan farmers, 41% of the fruits and vegetable output is marketed (Minot:38).

Smallholders account for about 47% of Kenya's fresh produce exports. If the farm gate price is 60% of the f.o.b. price, this would bring gross revenue of \$47 million to Kenya's smallholders annually. Estimates of the number of smallholders benefiting vary considerably, between 20,000 and 100,000 households, so that average horticultural export earnings for a family would be in the range \$500-\$2350.

Source: IWMI 2002:185

The Rural Household Survey (2000) in Kenya found that gross margins per hectare are 6-20 times higher for irrigated French beans for export than for maize-dry bean intercropping. Half of the French bean growers owned their own irrigation equipment, against 10% for other farmers; and the average per capita income of the French bean growers was double that of other farmers (Minot in IWMI 2002). The poverty reduction impact is significant (see Box 2.2).

Horticulture is driving profitable investment in irrigation. In Kenya, about 48,000 ha are under small-scale irrigation schemes, largely for

horticulture (FAO 2005a). Most are farmer organized systems where farmers share the cost of a pump and distribution system (Ngigi in IWMI 2002). Rapid growth has been accompanied by new irrigation technologies. Small-scale drip irrigation systems have been improved by the Kenya Agricultural Research Institute, and disseminated by local NGOs. Several types of treadle pump costing less than \$80 have also been introduced (IFAD 2005).

Industrial crops

Crops such as sugar cane and cotton have been proven to be viable under irrigation, but only where relatively high yields are achieved. Large scale commercial estates throughout the region have demonstrated that investment in irrigation and transport infrastructure as well as processing plants can be viable where water supplies are adequate, the construction of new dam storage is not needed and relatively high cane yields can be obtained, as in Swaziland where yields averaged 94 tonnes per hectare in 2004 (FAOSTAT). Similarly, irrigated cotton can be viable if relatively high yields (e.g. of the order of 3-4.5 tonnes per hectare) can be obtained or where the bulk of investment costs have been sunk. Smallholders also cultivate industrial crops in some countries, usually under contract arrangements with the processing plants. In some cases, the industrial purchaser provides inputs, extension advice and a guaranteed market outlet and price under 'outgrower' arrangements.

Mixed agricultural water and livestock systems

Livestock are an integral part of most irrigated production systems. In irrigated agriculture in the region, livestock are important for animal products and for draught power and manure in irrigated crop production (IWMI-ILRI 2005e). In Madagascar, for example, irrigated paddy yields are positively correlated with the availability of animal draught, and areas of animal concentration have a much higher use of (organic) manure (World Bank 2003). Irrigated crop residues are used for animal feed within the region's mixed farming systems and large scale irrigation systems have the region's highest livestock densities: on the Gezira Irrigation Scheme in Sudan, for example, 90% of farmers keep animals, and 30% of income comes from livestock. Irrigated agriculture also interacts with pastoral systems: crop residues on the Gezira scheme maintain animals during the long trek to the Khartoum market.

However, irrigated fodder production is generally not viable in the region. Livestock production in sub-Saharan Africa depends more on grazing than in other regions of the world. FAO estimate that fodder currently accounts for only 3.5% of all crop output in the region (FAO 2006). Irrigated fodder production is rare except in South Africa (see 2.3 above). However, where there is good market access, irrigation water can be profitably used to grow fodder crops for fattening and the production of meat and milk – as in the intensive, stall-fed production systems around Mount Kenya. Since most fodder crops are perennial, their production under dryland conditions with in-field rainwater management is probably not an option except where rainfall patterns are bimodal.

Chapter 3 Investment Performance and Development Impact

3.1 Performance of irrigation projects

Rates of return

Although there were many failures in the 1970s and 1980s, recent irrigation projects have generally had acceptable rates of return. A component study for this report (IWMI 2005b) reviewed 45 donor-financed projects implemented in the region from 1970 onwards. The study found that externally financed projects in the 1970s and up to 1984 had often dismal outcomes: investment was largely in development of new large-scale irrigation, with very high costs per hectare and low or negative rates of return. Subsequent to 1985, outcomes improved: of the 22 sub-Saharan Africa projects reviewed which started in 1985 and after, only one had an ERR below 10%, and others had ERRs ranging up to 60% and above.¹

¹ See Annex 6 for details of these projects. ERR calculations for the sample include some projects where storage dams, diversion structures and long distance conveyance costs were included, and other projects where these costs were sunk. The concentration in the pre-1985 cohort of projects where all costs from storage dam downwards were included is plainly a factor in the lower rates of return recorded in the earlier period.

Table 3.1: Rates of return on externally financed irrigation projects in sub-Saharan Africa 1970-1999

	1970-4	1975-9	1980-4	1985-9	1990-4	1995-9
Number of projects	3	9	11	15	4	3
Cost/ha	\$4,684	24,496	11,319	7,669	8,287	8,347
Average EIRR	10%	2%	8%	16%	17%	30%

(Source: *IWMI 2005b*)

The key factors associated with higher rates of return include lower per hectare costs, market access, productivity, and institutional design. A number of factors influence rates of return. First, as the table above suggests, *cost matters*: the component study found that sub-Saharan Africa projects with higher per hectare costs tended to have lower ERRs, and ‘failure’ projects (those with ERRs below 10%) had, on average, unit costs/ha four times those of ‘successful’ projects (ERRs above 10%). The component study found that lower-cost ‘improvement’ projects have higher ERRs than new construction projects (*IWMI 2005b*), a finding which is confirmed by the Zimbabwe experience where upgrading cost 20% of new gravity development and 40% of new pumped supply and where upgrading projects had very much higher rates of return (IFAD 1999, cited in World Bank 2005c).²² Second, *market access matters*: projects where higher value crops can be sold profitably do better – in Zimbabwe, projects with good market access have rates of return generally at least three times higher than where market access is poor (IFAD 1999, cited in World Bank 2005c). Third, *productivity makes a difference*: in an example from Malawi, where 28 small-scale schemes were ranked according to the use of production factors, the low input-low output schemes all had significantly lower ERRs - and five had negative ERRs (Malawi Small-Scale Irrigation Development Project). Finally, *attention to institutional and software aspects of projects matters*, particularly empowerment of farmers and streamlining of the role of public agencies. Systems managed by farmers or jointly by farmers with government have performed significantly better than systems managed solely by a government agency (*IWMI 2005b*).

Sustainability

Returns to investments in irrigation can be high, but the risks are also high, and irrigation projects have a mixed track record on sustainability. Despite the findings of the component study that rates of return for completed projects have by and large improved, the record on sustainability has been mixed. The frequent need for rehabilitation projects in large-scale irrigation in sub-Saharan Africa (Sudan, Madagascar, Mali) is testament to the poor sustainability of some supposedly 50 year investments in the sector. Rates of return calculated for externally financed projects at completion of the construction phase have sometimes had to be revised downwards subsequently, and current reports of the performance of projects previously rated as ‘successful’ are sometimes not encouraging (Table 3.2).

²² See Section 3.2 below for a discussion of the factors affecting costs.

Table 3.2: Comparison of selected projects at completion and subsequent history

Project (and approval year)	ERR at completion	Subsequent history
Mali Office du Niger (WB, 1989)	30%	Sustained success, although there are concerns regarding accountability and transparency (Reference: Aw and Diemer 2005)
Madagascar Lac Alaotra (WB, 1984)	25%	“The hasty, unilateral and untimely dismantling of the irrigation agency was disastrous for the project. Water distribution has become chaotic, water charges are no longer collected, and farmer organizations have not survived.” (PPAR 1993)
Madagascar Analaiava Sugar Project (AfDB, 1983)	21%	ERR recalculated as negative in the PPAR (1995) ²³
Cameroon Second SEMRY Rice Project (WB, 1978)	20%	Current report (2005): “Performance is not good at the moment – a sort of pre-reform Office du Niger: parastatal management, no farmer involvement, low productivity, no cost recovery.” (Source: current report)
Ethiopia Amibara Irrigation Project (AfDB, 1987) and Revised Amibara Project (WB, 1987)	15% (AfDB);15% (WB)	ERR recalculated as 9% in the PPAR. Current report (2005): “The absence of drainage, high sedimentation and changing river beds have haunted the system. Yields are low now, and maintenance very expensive.” (Source: current report)

Source: Annex 7.

What sort of irrigation projects have performed best?

There have been successful recent project investments in small-scale community managed irrigation. Examples include small-scale run-of-the-river rice schemes developed at low cost (\$1,070/ha) under the Tanzania Participatory Irrigation Development Project which achieved a rate of return of 22% and increased farm incomes by 86% (IFAD 2005); and the Ethiopia Social Rehabilitation and Development Fund, where community based irrigation, supplied largely from earth dams and river diversions, benefited 40,000 households, with visible improvement in the lives of villagers, including increased purchase of water pumps, milk cows and radios, as well as regular schooling for the children (World Bank 2002a).

Individual market driven investments by smallholders with low cost technology have also done well. The Niger Pilot Private Irrigation Project spread a variety of both manual and small-scale mechanized irrigation technologies: manual pumping technology allowed a doubling of the cultivated area and earned a 68% ERR (World Bank 2002b). The DFID-funded Micro-Irrigation Pump Promotion Project (MIPP) and its predecessors created both a demand and a supply chain for treadle pumps in Kenya and Tanzania – the private sector was then able to manufacture and distribute the pumps at a profit but still at a price affordable to farmers (IFAD 2005).

Support to market linkage development combined with reliable water supplies also works well. Under the IFAD-funded Zimbabwe Pilot Market Linkage Project (PMLP), an NGO facilitated the establishment of growers’ associations and production of crops under contract to a local canner. Farmers also produced an irrigated crop of grain maize in the summer, for home consumption and local sale. With an assured market and reliable groundwater supplies, farmers risked investment in inputs to obtain higher yields and achieved a 265% increase in farm income (IFAD 2005).

²³ PPAR (Project Performance Audit Report) is the instrument used by AfDB and the World Bank to review the outcomes and impacts of projects subsequent to completion of implementation.

One frequent feature of recent investments has been the use of a decentralized 'programme approach', in which the criteria for sub-project selection are agreed up front but the process of selection is decentralized, typically to the level of a joint identification and appraisal process between a project unit and irrigator organizations. The 'programme' may be restricted to irrigation investments – for example, the Nigeria National Fadama Development Project – or irrigation may be offered as an item on a broader menu of investments, as in the Batha Rural Development Project in Chad. However, there is a risk of poor investment decisions being taken if adequate provision is not made to build capacity for subproject appraisals and subsequent cost control and supervision (see below, 4.4).

The challenge of large-scale irrigation

There are few examples of successful public investment in large-scale irrigation, owing to top down planning, shaky economics and institutional failures. Several sub-Saharan Africa countries have invested heavily in large-scale irrigation. The Sudan Gezira scheme is the largest irrigation area in the world under single management – 880,000 ha. Several countries – Madagascar, Sudan, Mali, Kenya – have a history of large-scale irrigation that goes back 50 years or more. Yet it is hard to find examples of successful, or even adequate, results from these investments in recent years, and there have been a number of spectacular failures – for example at Kenya Bura. The case of publicly developed and managed large-scale schemes in Nigeria (see Box 3.1) illustrates the problems often encountered: 'top down' planning, poor investment decisions, lack of transparency and accountability in public sector management agencies, inadequate skills to manage schemes, high costs, lack of financial viability (and hence poor farmer motivation) and failure to involve farmers in any of the processes.

Box 3.1: The failure of public large-scale irrigation schemes in Nigeria

In Nigeria the public investment programme in irrigation initiated during the oil boom of the 1970s included the construction of 162 large dams, enough to irrigate 725,000 ha. However, only 95,000 ha of irrigation were developed (13% of the potential), mostly in large-scale schemes up to 15,000 ha each. Costs were very high, as much as \$27,000/ha in 2000 terms.

In 2003/4, only 29,000 ha of these lands were being farmed (30% of the area developed for irrigation and just 4% of the irrigable area commanded by the dams). The problems were *economic*, stemming from the basic lack of profitability of the farming system which is dominated by rice, maize and wheat, *technical* (water control was poor as the schemes were in bad shape), and *institutional*, with weak management, low cost recovery and little accountability to farmers. Now the government has recognized the importance of making the agencies more service-oriented, involving farmers through WUAs.

Source: World Bank 2001 WP8-10-14, FAO 2004b

Even rehabilitation investments in large-scale irrigation may be marginal if the irrigation technology and cropping pattern are not viable. In Nigeria, for example, rehabilitation of gravity irrigation is only viable up to an investment ceiling of \$1,800/ha for rice/wheat systems, and up to \$2,500/ha for vegetable production. For some large-scale irrigation schemes in Nigeria that use pumped irrigation, costs are higher than revenues and no rehabilitation can be economically justified (World Bank 2001: WP8-20).¹

Physical rehabilitation alone, without institutional change, has been largely unsuccessful. Even in cases where the technology and cropping pattern promise adequate economic returns,

¹ In Nigeria, the failure of public sector management has played as important a role as poor economics in undermining the viability of large-scale irrigation.

rehabilitation projects undertaken without a workable institutional model have proved uneconomic. A number of projects that focused on physical rehabilitation turned out to be economic failures – Sudan Gezira Rehabilitation Project (1985), Madagascar Lac Alaotra Rice Intensification Project (1984), Sudan Blue Nile Pump Scheme Rehabilitation Project (1982).

Transparent, accountable, efficient and financially self sustaining institutions are key for successful improvement of large-scale irrigation: the improvement conducted by the Mali Office du Niger is a good example of the impact of comprehensive but gradual institutional reforms. The *Office* has achieved a turnaround from a *dirigiste* approach to one that is more service oriented and which, by combining selective investment in hardware with institutional change, has produced impressive results – paddy yields up from 1.6 t/ha to 6.0 t/ha (Box 3.2). This experience is a beacon that can show how other large-scale irrigation schemes may be turned around, provided that the underlying economic profitability is there. Other countries have tried similar approaches with less comforting results: in Madagascar the improvement programme was compromised by an over-hasty withdrawal of the state without continuing support for the user organizations which were supposed to take over (see 4.6 below). One reason for the success of *Office du Niger* was that institutional reforms were introduced gradually, allowing time to overcome resistance to change and allowing time for adjustment, adaptation and fine-tuning.

Box 3.2: Successful public large-scale irrigation in Mali: the Office du Niger

The Office du Niger (ON), located in the heart of Mali, is one of oldest and largest smallholder irrigation schemes in sub-Saharan Africa. When development of the scheme began in 1932 it had been intended to develop about 1 million ha over a period of 50 years. By 1982, however, only 60,000 ha had been developed, of which a large part had been abandoned owing to poor maintenance and operation. Cotton production had ceased, and average paddy yields had slumped to 1.6 t/ha. Attempts to rehabilitate the scheme proved successful when physical investments to improve water security were matched with institutional reforms. An impressive turnaround has been achieved: in addition to the 50,000 ha that was still in use at the time, about 10,000 ha of previously abandoned land was reclaimed and put to productive use, and average paddy yields have increased to 6 t/ha. O&M cost recovery has reached 97%.

These results are attributable to a combination of factors, including:

- irrigation system improvement and modernization
- improved water control and management
- adoption of improved technologies - high-yielding varieties, fertilizers, improved husbandry practices
- liberalization of paddy marketing and processing, facilitated by an improved macro-economic climate
- improved land tenure security
- institutional restructuring, including: privatization of most commercial functions, contracting out of maintenance works to the private sector, downsizing of the management agency and concentration on its core activities of bulk water supply, land administration and agricultural extension
- more participatory approaches that engage farmers in management decisions – e.g. on O&M fees

Underpinning this success were the long term commitment of government and managers, and the sustained support of external partners. The work at ON is, however, not yet complete: there is more to be done on strengthening farmers' organizations, improving land tenure security and making the agency more accountable to farmers.

Sources: Aw and Dejou (1996), Couture et al (2002), Aw and Diemer (2005)

3.2 Are irrigation investment costs higher than elsewhere?

Past studies found the cost of irrigation development in the region to be excessively high. A 1995 study found that World Bank-financed irrigation projects in sub-Saharan Africa cost an average \$18,000 per ha, compared to an average world-wide of \$4,800 per ha (World Bank 1995). These findings reflected the very high cost of the generation of large-scale schemes constructed in the region in the 1970s and 1980s – the nine major donor financed projects in the period 1975-9 had an average cost per hectare of \$24,500 (Table 3.1). Not surprisingly, governments and financiers tended to view irrigation investments as high cost and uneconomic, particularly large-scale investments which also carry greater environmental and social risk. Investment behaviour has been risk averse in recent years and investment in irrigation has dropped (see 1.3 above).

...but the component study on irrigation investment costs found that the new generation of irrigation projects is not much more costly than those in other regions. The component study on irrigation costs (IWMI 2005b)¹ found that irrigation projects in sub-Saharan Africa that could be called ‘successful’, because their rate of return at completion was more than 10%, did not have costs that were very much higher than those of developing countries as a whole (Table 3.3). For new construction, sub-Saharan Africa ‘successful’ projects cost somewhat more than successful projects in Asia, but less than those of the highest cost region, the Middle East and North Africa².

**Table 3.3: Average unit cost/ha of ‘successful’ projects 1970-1999
(constant 2000 terms)**

	New construction		Upgrading	
	Total cost/ha	Hardware cost/ha	Total cost/ha	Hardware cost/ha
Successful projects in the entire sample	\$4,785	\$3,748	\$1,969	\$1,488
Successful projects in sub-Saharan Africa	\$5,726	\$3,566	\$3,488	\$2,303

Source: *IWMI 2005b*

... although the cost of ‘failure’ projects in sub-Saharan Africa was significantly higher than for developing countries as a whole. The costs of ‘failed’ projects in the region (EIRR < 10%) averaged \$16,000-\$23,000/ha. However, as noted above, project performance appears to have improved in recent years – only one post-1990 project appears amongst the ‘failures’ in the sample.

Main factors affecting costs

The biggest determinant of project costs is the type of irrigation investment financed. The range of costs in the sample for the component study is huge – from \$225/ha for simple rehabilitation to \$55,000/ha for a large-scale multi-purpose project. The principal reason for the lower unit costs of projects in recent years is the move away from the construction of large-scale schemes in the

¹ The methodology consisted in analyzing 314 projects from a world-wide sample (of which 45 were in sub-Saharan Africa), and assessing the costs per hectare of the 226 ‘successful’ projects (of which 25 were in sub-Saharan Africa), defined as those which had EIRRs of 10% or higher. See Annex 5 for a list of the sub-Saharan Africa ‘successful’ projects.

² This result was confirmed by an FAO study (FAO 2005b) which reviewed the cost of 256 projects on the FAO database and found that the “purely physical costs of irrigation development in sub-Saharan Africa are only slightly higher than in other regions”. The FAO study did, however, find somewhat different mean costs (in constant 2000 terms) of \$6,500/ha for new schemes and only \$1,900/ha for rehabilitated schemes.

1970s and 1980s to rehabilitation projects and, more recently, to small-scale and micro-irrigation projects. Evidently, the lessons of the past have, to some extent at least, been learned. This change is also linked to the continuing decline in cereals prices and hence to the deteriorating economics of large-scale irrigation for staples, and to the improving economics of horticulture, for which smaller scale and micro-irrigation is well adapted (IWMI 2005b).

The evidence on economies of scale is mixed. The component study found that unit costs vary inversely with project size i.e. there are economies of scale, but that within larger projects smaller scale schemes had higher economic returns (IWMI 2005b). By contrast, an FAO study (2005b) found only weak correlation between project size and unit costs. Although the sample sizes in the studies are too small and the population too heterogeneous to establish very clear conclusions, it is likely that the region's high software costs do reduce when apportioned over larger projects.

Community empowerment may keep costs down – and improve performance. The component study found that community involvement in decision making keeps costs down and improves performance. Projects where farmers themselves made larger capital contributions and managed irrigation systems, or shared management with a government irrigation agency, record significantly better results in terms of project performance and unit costs (IWMI 2005b).

To some extent, these lessons on keeping costs down are already being reflected within recent projects. More recent projects are selective in choice of technology and are often decentralized and farmer-driven, with higher farmer contribution, leading to lower unit costs. For example, for new development at Mali's *Office du Niger*, farmers were asked to contribute 20% of the total cost. As a result, development costs, which have typically exceeded \$10,000/ha for large scale development, were only \$2,518/ha (Aw and Diemer 2005).

3.3 Experience of design and implementation

The component study on the design and implementation processes (IWMI 2005d) found that project design in the past was largely top down, although newer projects are adopting more participatory approaches. Although there was a wide divergence of experience, the study found that past project design was generally characterized by a lack of fit of projects to goals, by lack of consideration of alternatives, and by lack of demand drive. Schemes developed by governments were often based on imperfect understanding of markets, farming systems and livelihoods strategies. The component study found that newer projects have adopted a less top-down approach. In some countries, a start has been made on integrating user participation (intellectual and financial) into project planning and implementation.¹ Some of these projects are carried out through decentralized units as part of larger community driven rural development programmes. In fact, many of the donor-financed projects that have been evaluated as successful on completion in recent years have been characterized by both decentralized and participatory approaches. It is, however, too early to tell whether these approaches consistently improve project performance, and decentralization has encountered problems (see 4.5 below).

The quality of projects has been reduced by common weaknesses in preparation. Weaknesses include: (i) poor treatment of the key land and water security issues, (ii) lack of adequate environmental assessment (see 3.6 below); (iii) lack of evaluation of markets and profitability; lack of a related realistic agricultural support package; (v) over-estimation of institutional capacity, evidenced by too complex designs and too many components; and (vi) poor technical

¹ For example, the Bewani scheme in the Office du Niger area, and the Dodicha Small-scale Irrigation Project in Ethiopia (IWMI 2005d).

design and over-optimistic hydrological analysis (IFAD 2005), resulting in technology choices and costs that were not appropriate for the market prospects of the crops grown (IWMI 2005d).

Farmer empowerment appears to improve project quality. Underlying these weaknesses, the study found a pervasive top down approach and neglect of farmer ownership. By contrast, approaches that empower farmers by taking them in as partners and decision makers from the beginning and supporting their development as commercial agents equipped to deal in the market place from the beginning appear to have the potential to improve the economics and prospects for sustainability of projects. Approaches to empowerment found to significantly improve project quality at entry include moving responsibility and capacity for project implementation and services to the local level, increasing the participation of disadvantaged groups in decision making, improving the accountability of service providers, and helping smallholders form strong organizations (IWMI 2005d, World Bank 2005m).

Weaknesses in institutional capacity have impaired project implementation. The study found that implementing agencies have often proved inadequate to the tasks they were set. Weaknesses reflect in many cases the complexity of the organizational structures set up and the performance of the staff involved. Public agencies have often lacked the skills, resources and incentives to do the job assigned to them, and the comparative advantage of the private sector or NGOs for certain tasks has been generally ignored. Project agencies also had difficulty in coping with change needed in design as implementation proceeded. A particularly difficult challenge has been dealing with the social and cultural problems encountered where institutional changes like irrigation management transfer or private sector participation were part of project implementation (IWMI 2005d, FAO 2006).

Inadequate support to the implementing agencies has also been a cause of poor quality. In general, the component study found that governments and donors have provided a supervision process that did not match the challenge of implementation under conditions in the region, and this support has stopped too early in the cycle. There has been overemphasis on reaching physical and disbursement targets at the expense of development effectiveness (IWMI 2005d; IFAD 2005). Even where promising new approaches like decentralization and participation were incorporated into projects, success has not been automatic: problems of technical, financial and social feasibility have constantly arisen during implementation. The managers of even well implemented projects have sometimes lost sight of the poverty reduction and cost effectiveness imperatives. In general, governments and donors have not reacted with a supportive and flexible approach to help managers trying to implement projects.

Weaknesses in the learning process have made it hard to assess project impacts and to rectify shortcomings as they have occurred. Monitoring and evaluation have generally been poorly handled, with design only loosely tied to the Log Frame – which should form the basis for the monitoring and evaluation system. Implementation of M&E systems has typically started far too late in the cycle and there has been an almost complete failure to recognize that (a) information systems are not only a fundamental requirement for project level M&E but also for farmers' enterprise management purposes and (b) that farm level information systems are required to feed into project level M&E systems. Thus, although many projects have poverty reduction objectives, almost none has monitored indicators of income such as input levels, yields, production and prices (IWMI 2005d). In a study of six projects in the region, in not one single case were inputs, yields, prices and farmer incomes systematically measured. As a result it was not possible for farmers to accurately judge the effectiveness of improved technologies, nor was it possible for the projects to provide adequate *ex post* justification for the investments made. No realistic assessment of the poverty reduction impacts of these projects could be made. Moreover,

the lack of monitoring applies equally to environmental and health aspects (see 3.6 below), despite their obvious relevance to sustainability ([IFAD 2005](#)).

Poor sustainability in subsequent operations reflects weaknesses in design and implementation. The component study found that weakness in scheme operations after completion of the physical works largely stemmed from weaknesses earlier in the project cycle: over-estimate of water resource availability, poor design and construction, inadequate attention to institutional arrangements and to agricultural support services, and above all the general neglect of farmer empowerment and of underlying conditions of profitability. The most telling indictment is that in many cases farmers have refused to take over responsibility for operation and maintenance of schemes supposedly developed for their interest ([IWMI 2005d](#); [FAO 2006](#)).

3.4 Performance of in-field rainwater management for dryland crops

Projects intended to promote in-field rainwater management in the past have been mainly funded by NGOs and/or bilateral donors and have not necessarily been investment oriented. The promising results of various in-field rainwater management practices were mentioned above (2.3). However, these results are largely based on research studies and pilot projects. Apart from the experience in Niger discussed in Section 2.4, there has been little or no involvement of the international financing institutions in this type of water management in sub-Saharan Africa, possibly because there was no perceived need for infrastructure investment and the support of these institutions was neither offered nor sought. As a result, although a wealth of academic and research literature on the topic exists, there has been a dearth of investment analysis. There have, for example, been few if any project appraisals, project completion reports or evaluations of the sort carried out for irrigation investment projects. The knowledge base is therefore thin in respect of investment performance analysis and evaluation.

The component study on agricultural water development for poverty reduction in Eastern and Southern Africa (IFAD 2005) however included field and desk studies of alternative interventions to irrigation, including in-field rainwater management. The results were found to be mixed. A wide range of technologies was reviewed, including deep planting pits and trenches in Kenya, Tanzania and Zimbabwe; *fanya juu/chini* terracing and *negarim* micro-catchments in Kenya; low-gradient broad-crested contour ridges and furrows in wetlands in Zimbabwe; and tied ridges and other forms of conservation farming in South Africa, Zambia and Zimbabwe.

The wide adoption of *fanya juu/chini* terracing in East Africa has been well documented. However the component study concluded that, since there appeared to be little or no evidence that the intervention increased the availability of soil moisture for cropping, its main purpose was soil conservation. As for the other techniques considered, the component study found little evidence that deep planting pits and trenches had any impact on the availability of water for crops – a finding that appeared to be reflected by negligible adoption. Similarly, demonstrations of *negarim* were unsuccessful. Low-gradient broad-crested contour ridges and furrows in Zimbabwe, which required heavy machinery for their construction, made double cropping possible. But the site visited had been abandoned and there had been no adoption elsewhere – no doubt because of the high cost of development, estimated at \$3,600 per hectare, which was beyond the reach of smallholder farmers¹. Many of the interventions seen had clearly been supply-led by projects, rather than demand-led by farmers, and the promoters had given inadequate thought to physical feasibility, affordability, profitability and replicability by farmers.

¹ It could be argued that this was a case in which a government subsidy would be justified, but the component study estimated that investment would result in a benefit-cost ratio of only 0.1 at a discount rate of 8%, whereas the minimum requirement would have been a benefit-cost ratio of unity.

Despite this rather bleak assessment, the component study did find some successes. Four years of field trials of tied ridges in southern Zimbabwe showed an average increase of 20% in the yields of sorghum and maize. Yet tied ridges rarely improved yields on the shallow sandy soils that are widespread in the semi-arid areas of Southern Africa and there was a lack of adoption despite considerable efforts to promote such systems. The high labour requirement was apparently an important constraint: analysis indicated that the construction of ridges and ties was not seen as profitable by farmers, unless they had access to a (subsidized) mechanical ridger (Twomlow *et al* 1997 cited in IFAD 2005). Nevertheless, there had been successful adoption for the production of cotton on the heavier soils. The key here appeared to be the involvement of a private sector cotton marketing company that had supported on-farm trials and vigorously promoted the crop by providing technical support and in-kind credit. The crop then became profitable enough for farmers to invest in tractor power for land preparation (Nyamudeza *et al* 1992 cited in IFAD 2005).

The most promising prospect, however, appeared to be the various types of conservation farming. These cover a range of non-inversion practices from zero to reduced and deep tillage. The potential yield gains for dryland field crops can be impressive – in the case of Zambia as much as double those obtainable by conventional tillage (Hageblade *et al* 2003). But these gains come at a cost – part of which includes increased investment in implements and yield enhancing inputs, such as HYV seeds, fertilizer, crop protection chemicals and sometimes higher labour costs or lower yields in the first few seasons (because of increased weed pressure unless investment is also made in herbicides). And the initial additional labour costs had obviously been perceived as a disadvantage by some Zambian farmers: one smallholder farmer, for example, commented that the labour demands of conservation basins caused him to “lose a lot of energy and grow thin” and another suggested that digging basins “reduces the lifespan of an individual” (Hageblade *et al* 2003). The researchers’ response to this was that conservation farming represents a ‘long-term investment’. Nevertheless, unless investment in physical works was accompanied by access to the necessary equipment¹ and investment in yield-enhancing inputs, the results were much less impressive and farmers lost interest – raising doubts over replicability and sustainability.

The *tassa* system promoted in Niger and referred to earlier (2.4) appears to be a much lower input-lower output system that that promoted in Zambia – possibly reflecting the differences in agro-ecological conditions between the two countries². The results have been just as impressive, although adoption depended to some extent on the provision of food-for-work for construction of the planting basins and demi-lunes (Hassane *et al*)³, again raising doubts over replicability – since governments and/or donors cannot be everywhere with food relief, particularly if, as mentioned, the economic life of the investment is only three years.

Overall, the indications are that there are in-field management technologies that are potentially viable and sustainable for enhancing dryland crop production but that there are barriers to adoption that need to be identified and overcome. It is possible that the barriers are sectoral in nature, affecting agricultural production in general, and revolve around institutions, empowerment and access to input and output markets.

¹ Referring to a land management programme in Tanzania, other research found that conservation tillage is a “non-starter” if the required implements are not available to farmers (Jonsson *et al* 1998).

² The *tassa* were promoted in the semi-arid zone for the production of millet, while in Zambia the technologies were promoted for maize and cotton entirely in the dry subhumid or moister zones.

³ In fairness, it was reported that food-for-work was only provided in dry years. However, since the programme was located in the semi-arid zone it might have been expected that almost every year was a dry year.

3.5 Agricultural water projects and poverty reduction

For the reasons discussed in Chapter 1, agricultural water investments are generally intended to make a significant contribution to poverty reduction in sub-Saharan Africa. Two of the component studies of the Collaborative Program (IFAD 2005, IWMI 2005g) provided material for the following analysis, which looks at the evidence for how poverty reduction impacts are achieved by agricultural water projects, and then at the experience in the region with targeting, both the poor and women.

Direct and indirect impacts on income poverty reduction

Investment in agricultural water management can reduce income poverty directly and indirectly. The first direct effect is on farm incomes: agricultural water management can increase yields, allow an increase in the intensity of cropping and a change to higher value crops, and hence increase farm outputs and incomes. Farm outputs and incomes can also be increased because irrigation itself justifies the use of complementary yield-enhancing inputs.

For example, the component study on agricultural water development for poverty reduction in Eastern and Southern Africa (IFAD 2005) reviewed three irrigation development programs, in Madagascar, Tanzania and Zimbabwe. Average increases in *per capita* farm incomes ‘with project’ on rice projects in Madagascar and Tanzania were found to be in the range of 86-220%, whilst incomes on non-rice projects in Zimbabwe increased between 14% and 600% (see also Annex 8). The average increase in *per capita* farm incomes across the sets of case study projects was 226%.

Investment in irrigation in these cases more than trebled average *per capita* incomes. Moreover, none of the projects studied was achieving anywhere near optimum yields and outputs. For example, the weighted average paddy yields ‘with project’ at one project studied (Upper Mandrare Basin Project, Madagascar) were only 1.9 t/ha and 1.3 t/ha respectively for the main and off-season crop – clearly well below potential (see above, 2.3). Similarly, average irrigated grain maize yields at three non-rice projects studied in Zimbabwe were only 2.5-3.4 t/ha – also well below potential. The lesson is clear: even moderately performing investment in irrigation can have significant impacts on farm incomes and hence on poverty reduction. The corollary is that such projects could have a far greater impact on poverty reduction if they performed better.

The second direct effect of agricultural water management on income poverty is via rural employment: additional demand for labour is created firstly for construction and on-going maintenance of canals, wells, pumps and the like (or land preparation in the case of investments in in-field rainwater management), and secondly for crop production and farm to market activities. Thus, agricultural water development increases both the numbers of workers required and (because of multiple cropping) their period of employment (Lipton *et al*, 2003). In the projects analyzed in the component study (see Annex 8), investment in irrigation was found to have resulted in an incremental 45 days/ha of wage labour on average, over and above farm family labour, valued at approximately \$1/labour-day (IFAD 2005).

The third direct effect is via food prices: increased food output can reduce local food prices and so improve real net incomes among net food purchasers, including both rural and urban poor. At the same time, positive effects on real net incomes will still be experienced by net food producers and wage labourers provided the effect of reduced prices is offset by increased output and employment. On the other hand, negative effects may be experienced by surplus producers in remote dryland cropping areas when agricultural water development is introduced. However, since the majority of the poor in sub-Saharan Africa are net food purchasers, the overall net effect

of reduced food prices on income poverty reduction and hunger can be expected to be positive (Lipton *et al* 2003).

The indirect impacts of agricultural water development on income poverty can include those obtained via rural and urban employment as a result of growth in the rural and urban non-farm economy. Agricultural growth can influence non-farm activity in at least three ways: through production, consumption and labour demand linkages (Rosegrant *et al* 2005). Income and employment multipliers within the surrounding non-farm economy can be particularly large: between 1.5 and 2.0¹ in Asia (Haggblade *et al* 1989; Hazell *et al* 1991 – both cited in Rosegrant *et al* 2005) although they are only about half as large in Africa (Dorosh *et al* 2000; Haggblade *et al* 1989 – both also cited in Rosegrant *et al* 2005). Lower multipliers in Africa were attributed by Dorosh *et al* to low per capita incomes, poor infrastructure, and farming technologies that required few purchased inputs – in other words to a less developed agriculture sector.

Since water-managed agriculture intrinsically involves higher levels of inputs – including labour – and results in greater employment, outputs and incomes than dryland agriculture, the multipliers from successful agricultural water investment are likely to be higher than those for investment in dryland agriculture in general. Although no information was available on the non-farm employment impacts of agricultural water development in sub-Saharan Africa, non-farm employment in India has been found to be higher in irrigated villages than in non-irrigated villages (Dasgupta *et al* 1997, Jayaraj 1992, Saleth 1996, all cited in Rosegrant *et al* 2005). At the large-scale Muda Irrigation Project in Malaysia, for example, for every dollar of income generated directly by the project another 83 cents was generated in the form of indirect or downstream income benefits (Bell *et al* 1982, cited in Rosegrant *et al* 2005).

To sum up, even moderately successful investment in agricultural water development can treble per capita farm incomes and provide additional wage employment of approximately 45 labour-days/ha – which in itself has a significant impact on income poverty reduction. Every dollar of income so generated probably generates at least US\$0.40-0.50 in the form of indirect income benefits. And this is so even for investment projects that perform no better than modestly.

Agricultural water development could also be one of the better alternatives for poverty reduction. Clearly, investment in agricultural water development can have substantial impacts on income poverty reduction, but is it the best of the available alternatives? As discussed in Chapter 1, when up to 90% of rural people are poor and rely on agriculture for their primary livelihoods, significant growth in agriculture is a necessary step towards poverty reduction. Although improved primary education, better health services, clean water and better roads are all important and appropriate investments, they are not sufficient in and of themselves to generate increased rural incomes (Brooks, 2005). Since agricultural growth is so important for poverty reduction when compared with the available alternatives, agricultural water development could be even more so, since the potential income growth per hectare from successful investment in agricultural water is greater than that from dryland agriculture. Although data are not available to prove the validity of this assumption for sub-Saharan Africa, differences in the rate of growth of average agricultural output per unit of crop area were important in explaining cross-state differences in rural poverty reduction in India, for example, where the impact of irrigation in reducing poverty was found to be even higher than that of rural literacy and significantly higher than roads, fertilizers and modern varieties (Datt *et al* 1997, cited in Rosegrant *et al* 2005). If this is the case

¹ That is, each \$1.0 increase in agricultural value leads to an additional \$0.5 to \$1.0 of additional income created in the local non-farm economy.

elsewhere, there would appear to be no reason why the same should not apply in sub-Saharan Africa.

Furthermore, the income poverty reduction impacts of agricultural water investment can induce positive impacts on other MDGs. The income poverty reduction impacts of agricultural water investment induce important positive impacts on other MDGs, including reduced hunger, improved access to primary education, safe drinking water and basic sanitation, as well as a contribution to improved maternal health, reduced child mortality and generally better nutrition and health (IFAD 2005 and Box 3.3).

Box 3.3: Irrigation considerably enhances farm incomes, livelihoods and employment opportunities at irrigation schemes in Tanzania and Zimbabwe

At the Participatory Irrigation Development Project in Tanzania, irrigator households achieved an increase of 86% in income with-project, which enabled them to enjoy better quality housing, acquire agricultural and household assets, access health services, and finance children's education. In four representative sub-project areas (totalling approximately 400 ha), ownership of ox-carts and cattle increased considerably, the number of grinding mills increased from two to 12, and the number of shops increased from two to 74.

Irrigator households at the EU-funded Maunganidze Irrigation Scheme in Zimbabwe increased their incomes by over 200% and turned a food deficit into a surplus sufficient to feed two additional households. Farmers' own investments in new housing and in water and sanitation were the most obvious sign of improved livelihoods, with a number of modern 2-3 roomed houses, ventilated pit latrines and, in a number of cases, own protected water well. Traders reported increased sales of agricultural inputs and implements, and increased demand for groceries and for house building materials and construction services. New grinding mills had been established, as well as new workshops for manufacturing farming equipment such as ox-carts. There was no doubt that these impacts were the result of investment in irrigation, since there were no other sources of income in the area. Excellent road access, for example, by itself had not had any discernible impacts on poverty in the area.

Source: IFAD 2005

Targeting the poor and women

Some irrigation project designs of the past two to three decades have attempted – usually unsuccessfully – to target the poorest. Defining extreme poverty in terms of the MDG income poverty level has now simplified targeting. Where targeting the poorest socio-economic stratum has been specified in the past, it has rarely been implemented as planned (IFAD 2005). Either the technology was inappropriate for the poorest, the targeting methodology was weak, or implementation staff had not fully understood the intentions or found it socially infeasible to carry out because of the socio-geographical and political implications of excluding the less poor. Defining extreme poverty in terms of *per capita* income of less than a dollar a day (see 1.1 above) has simplified targeting, as most rural people in the region have to subsist on less than this amount. For example, in the Madagascar, Tanzania and Zimbabwe cases cited above, no attempt was made at targeting, yet it is clear that it was mainly the extreme poor who benefited, since average without project farm incomes ranged from only \$0.03 to \$0.13 *per capita*-day (see Annex 8).

Agricultural water investments, even without targeting, will therefore mainly benefit the extreme poor, although in a range of different ways. It is likely that the vast majority of the rural populations of sub-Saharan Africa fall into the category of 'extreme poor' and almost any agricultural water development based on principles of profitability and equity will benefit a

majority of poor people. However, different poor people may benefit in different ways: some will benefit from direct participation as producers, others will benefit directly from agricultural wage employment, others from access to crop by-products for livestock and others from employment in upstream and downstream economic activities generated by the investment. Moreover, it is usually the poorest stratum that benefits most from the additional wage employment opportunities generated by investment in agricultural water (IFAD 2005).

There are however a number of ways in which the poverty reduction impacts of investments can be enhanced. The first step is to understand the socio-economic profile of the communities, how they derive their livelihoods, what their constraints are, how they interact socio-economically and how agricultural water management can improve their livelihoods. Based on this knowledge, measures can be included to make projects more pro-poor. These measures include: (a) capacity building and empowering the poor to participate effectively, (b) ensuring that the voice of the poorer segments of communities is adequately heard in participatory planning and land and water allocation decisions; (c) minimizing involuntary resettlement and ensuring that the poor are not excluded or further marginalized by the development; (d) strengthening the bargaining powers of the poor through institutional reform and facilitating their access to land and water; (e) targeting the poor with extra technical support; (f) ensuring that the entry price is affordable to the poorest stratum, for example by the use of affordable technologies; (g) ensuring that cost-recovery arrangements/water charges are not unfairly weighted against the poorest stratum; and (h) optimizing the potential for direct and indirect employment gains. Annex 8 provides a checklist (based on World Bank 2005b) for improving the pro-poor impacts of agricultural water projects.

Targeting agro-ecological zones and farming systems with high agricultural potential and concentrations of poverty can also be pro-poor. It was found that when arid and semi-arid zones had been targeted for poverty reduction, the results were mixed, mainly because of the generally high costs of water development in such zones, their general remoteness from markets and their sparse populations (IFAD 2005). In contrast, the more humid agro-ecological zones, which also coincide with high incidences of poverty, provide better potential for investing in agricultural water for poverty reduction (Dixon *et al*, 2003). This perhaps surprising suggestion may be explained by considering that, as population densities increase, farmers gradually shift from extensive to increasingly intensive production systems. The trend is encouraged once significant market opportunities emerge. Where population densities are high, where a process of intensification has already started and where market opportunities are emerging, investment in agricultural water development is therefore likely to be more successful than in the drier zones. This does not, of course, exclude the possibility that there will be opportunities for investment in agricultural water management in the arid and semi-arid zones and that these could also make a significant contribution to poverty reduction and growth – provided they are demonstrably economically viable and physically sustainable.

In addition to considerations of gender equity, targeting women can also enhance poverty reduction impacts. Women contribute 60-80% of labour for food production in sub-Saharan Africa, typically with a major role in planting, weeding, application of fertilizers and pesticides, harvesting, threshing, food processing, transporting and marketing, while men are generally responsible for land clearing and preparation, including ploughing (FAO 2003a). This division of labour also applies in irrigated agriculture. In many Southern African countries, the proportion of female-headed rural households and women-led farms may exceed 50% (IWMI 2005g). At selected schemes in Zimbabwe, for example, 20-64% of the plot holders were female-headed households (IFAD 2005). In rice growing areas in West Africa and parts of Southern and Eastern Africa, paddy cultivation is increasingly becoming a ‘female farming system’ in which women are often the decision-makers on formerly male-managed farms as a consequence of male

migration to towns for work ([IWMI 2005g](#)). Women often take the lead in fruit and vegetable production (Box 3.4), as well as in production support activities, such as savings groups (IFAD 2002). Studies have shown that gender-equitable agricultural production boosts productivity ([IWMI 2005g](#)). Clearly, targeting women for training and support services and ensuring their equitable participation in the benefits of agricultural water investments can improve productivity and enhance poverty reduction.

Box 3.4: Women and treadle pumps for fruit and vegetable production in Tanzania

Monitoring of treadle pumps sold in Tanzania for fruit and vegetable production found that 95% of pumps sold were bought by men. At the start, 40% of these pumps were managed by women, but this share went up to over 60% within a year. One explanation is that proceeds from the newly irrigated agriculture had enabled the men to move on to other income generating activities.

Source: IFAD 2005

Yet, despite the rhetoric, most staff in support services are male and policies and communications strategies are biased towards males. Projects can compensate for these biases by building gender considerations into design and implementation from the outset ([IWMI 2005g](#)).

3.6 Environmental and health aspects of agricultural water projects

The component study on environmental and health aspects ([IWMI 2005c](#)) found that well-designed and well-implemented agricultural water development can have positive impacts. Environmental benefits of agricultural water development can include reduced flooding and reduced soil erosion and silt loads. In addition, intensification (rather than ‘extensification’) of agriculture may preserve natural areas of intrinsic worth from development. Agricultural water development also directly improves nutrition and health through higher incomes and improved food supply, and can have a particularly marked impact when targeted at the poor and at women. Health and food security may also be improved indirectly through the strengthening of institutions associated with agricultural water development.

However, failure to manage environmental impacts has sometimes reduced productivity and even led to the failure of some agricultural water projects in the region. There are multiple and reciprocal interactions between agricultural water and the environment; failing to manage environmental factors has sometimes been a cause of reduced productivity and even failure of projects. At the 350 ha Gem-Rae rice scheme in Kenya, deterioration in the catchment led to such large sediment flows that farmers were clearing sediment daily instead of farming. The scheme has been virtually abandoned. At the Chokwe irrigation scheme in Mozambique, poor drainage has led to the loss of about 5,000 ha out of a total 30,000 ha due to salinization. In Somalia, the Jowhar off-stream reservoir constructed to collect flood flows for dry season irrigation has become so silted up that large-scale irrigation in southern Somalia has virtually collapsed.

Some hydraulic developments have also harmed the health of the population. In Ethiopia, the construction of small dams in the semi-arid northern region of Tigre led to increased spread of malaria, even at altitudes over 2000 m. In Burkina Faso, around 1,500 small dams have been constructed since 1974 but no measures were taken to control adverse health impacts, and urinary schistosomiasis has spread. Although individual environmental impacts may be small, the cumulative environmental impacts of many small interventions therefore need to be taken into account. Potential health impacts require public sector forethought at the design stage: evidence

shows that farmers are often aware of environmental and health problems as they emerge but that corrective actions are beyond the capability of small farmers.

Box 3.6: In Nigeria large-scale irrigation, national procedures are not adequate to protect the environment or reduce social harms

In Nigeria, the basin authorities did not give adequate attention to the environmental impacts of the large-scale irrigation schemes they constructed in the 1970s and 1980s. As a result, these schemes have done considerable environmental damage. Downstream hydrology has been severely modified, especially in the north, wiping out extensive areas of *fadama*, capture fisheries and wildlife habitat. Now Environmental Impact Assessments are required for irrigation schemes or wetland drainage over 100 ha, but the adverse environmental effects of earlier development persist. The economic benefits from irrigation upstream of the Hadejia-Nguru wetlands were significantly outweighed by economic losses arising from the damage caused to the wetlands by the irrigation scheme

Most large schemes in Nigeria have also run into serious social problems. Fulani herdsmen generally have no security of tenure, and as irrigation schemes expanded, Fulani were forced out, creating conflicts. Also disadvantaged were families displaced by dams and reservoirs. Resettlement was not organized, and the dispossessed were basically left to their own devices.

Source: World Bank 2001; Barbier et al 1991.

Many of these problems are attributable to the weaknesses of public sector institutional capacity for regulating environmental and health aspects. The regulatory and enforcement framework in countries in the region is often inadequate. National procedures may be too weak (Box 3.6), and national institutions may lack the capacity to handle environmental, social and health aspects. Often, adverse consequences occur because schemes are developed in isolation of other developments in the basin, and all too often environmental flows have been neglected. Where externally financed projects are concerned, donors have their requirements but these differ amongst donors and usually do little to build national consciousness and institutional capacity. Negative environmental

and health outcomes may also result from unregulated private agricultural water development (Box 4.1). The problems are not lessened by decentralization and private sector development: small-scale projects and informal peri-urban irrigation using wastewater can cause environmental and health problems too. Lack of environmental and health monitoring is also a very considerable learning weakness (see also 3.4).

However, many environmental and health risks can be managed at the project level. Many adverse socio-environmental and health effects can be prevented by carrying out integrated and participatory impact assessments during preparation in order to identify alternative designs or mitigation measures. For example, a watershed management component may be added to a project to tackle anticipated siltation problems (World Bank 2006a); a closed conduit system may be implemented in place of open canals to reduce the breeding ground for mosquitoes; or a drainage system may be added to avoid water logging and salinization. Box 3.7 describes how an irrigation project was engineered to reduce disease risk. Project level monitoring and evaluation systems can capture environmental and health impacts.

Box 3.7: Engineering schistosomiasis control into irrigation

In the Mushandike scheme in Zimbabwe, the need to control schistosomiasis determined the final design of a 400 ha smallholder irrigation scheme. The scheme was located as far as possible from villages. Canals were all lined with concrete with a flow velocity sufficient to dislodge snails. Hydraulic structures were designed to allow quick drainage and so avoid standing water. In the operation of the system, regular drying out of the canals, water level fluctuation in night reservoirs and routine cleaning contributed to the continuous control of snails. As a result, snail hosts have been greatly reduced, and a ten year study showed both snail populations and schistosomiasis infection rates lower than in comparable villages where only treatment was used.

Source: IWMI 2005c

Agricultural water management also needs to take account of HIV/AIDS. The scourge of HIV/AIDS has a pervasive impact on life in the region. Agricultural water management has an important role to play in mitigating the impacts – increased incomes and food availability are recognized as being key to helping people fight HIV/AIDS-related infections. One important negative factor is the loss of skilled engineers, professionals and farmer leaders responsible for the development, operation and maintenance of schemes. There is a need for specific strategies within agricultural water projects, especially increased capacity building and, where possible, health components to address the attrition of staff and farmers.

Chapter 4

The Changing Institutional Context

4.1 Transboundary water

Given the high level of transboundary resources in sub-Saharan Africa, agreement on their use is key to sustainable agricultural water investment. Current processes are therefore emphasizing cooperative and mutually beneficial development. Shared basins cover 63% of the land area of sub-Saharan Africa and twelve countries of the region depend on external resources for more than half their total water resources. With this large proportion of shared water resources, regional planning and coordination for transboundary resource allocation, for IWRM and for catchment management are particularly important (FAO 2006). A number of states have been cooperating under various programmes. For example, Mauritania, Senegal and Mali established the *Organisation de Mise en Valeur du Fleuve Senegal (OMVS)* in 1972, and have since constructed dams at Daima in Senegal and Manantali in Mali for irrigation, hydropower and navigation. Lake Victoria faces the threat of environmental degradation, which may be aggravated by increased irrigation upstream, and although there is as yet no formal treaty relationship riparian states are cooperating on the preparation of a joint ‘Vision and Strategy Framework’ for its management (Box 4.11). However, this framework may prove inadequate to stem negative impacts on the environment arising from, for example, releases for hydropower which are causing lake levels to drop excessively. An initial focus on the benefits of cooperative management – say, for water flow and quality – and of agreed or cooperative development for irrigation and hydropower can lead in due course to more formal relationships and viable transboundary institutions.

Box 4.1: Kenya has started by cooperation with Lake Victoria riparians on environmental issues – but envisages broader cooperation on water resources development in the future

Kenya shares over half its rivers, lakes and aquifers with neighbouring countries, but has not yet entered into any formal agreement with any riparian state. However, Kenya is keen to develop the water resources of the Lake Victoria Basin for agriculture and other uses and has joined with other riparians in preparing a joint 'Vision and Strategy Framework' for its management. Collective action is being triggered by the increasing eutrophication of the lake from excess nutrient loads, a substantial portion of which stems from Kenya fertilizer use.

Source: World Bank 2004a

This creates opportunities for optimizing investment strategies at the basin scale, and partnerships for joint management and development of a number of sub-Saharan Africa shared basins have been created. For example, to achieve sustainable water security, Nile Basin riparians are working on shared waters. The Nile Basin Initiative offers considerable potential for major cooperative development of the basin, including large-scale irrigation and hydropower development. In addition, opportunities for regional cooperation and integration in a range of activities beyond the river have arisen as a consequence of strengthened relations built up from the Initiative (World Bank 2005f, World Bank 2005b).

Regional organizations and donors have helped to forge these partnerships and have provided investment support, for example for the OMVS and for the Nile Basin Initiative. With donor support, the SADC countries agreed a Protocol on Shared Watercourses in 1995 as a basis for regional integration in water resources management and investment. This led to the 1998 Regional Strategic Action Plan for IWRM in SADC countries and has now triggered the Zambezi Process amongst the eight riparian states and the establishment of a permanent Zambezi Watercourse Commission (World Bank 2005c). These partnerships give priority to investment in agricultural water and hydropower.

4.2 Strategic planning and agricultural water

The last decade has witnessed important changes in approaches to international development assistance. These have included the unprecedented consensus on development objectives in the form of the MDGs, as well as the commitment in Paris in 2005 by a large number of development assistance stakeholders as to how those objectives may be pursued more effectively.¹ Poverty reduction strategy papers (PRSPs), or other forms of strategies for poverty reduction, have provided the point of reference for national development efforts in most sub-Saharan Africa countries.

However, not all poverty reduction strategies have recognized the role that agriculture can play in poverty reduction and few have acknowledged the importance to the sector of agricultural water development. Early PRSPs did not always explicitly recognize the critical role of the

¹ At the Paris High Level Forum on aid effectiveness held in February/March 2005, the international community endorsed the *Paris Declaration on Harmonization and Alignment*, making a commitment to a series of measures to achieve greater aid effectiveness: (a) countries should take responsibility for setting *country-led development strategies*; (b) aid should be *harmonized* through common arrangements for financing and technical assistance; (c) aid should be *aligned* on national development strategies and institutions and on strengthened country systems; (d) aid should be *managed by results*; and (e) there should be *mutual accountability*, for example, through joint assessments of donor actions.

agriculture sector in poverty reduction and growth, although more recent examples have done so. They have, however, generally still not assigned much prominence to agricultural water development. Consequently, the subsector has tended to be neglected in investment programmes for the agriculture and water sectors. The reason for this neglect lies partly in the negative perceptions of agricultural water referred to earlier in this report (see 3.2 above) and partly in the fact that in many countries agriculture and water are served by separate ministries, which, because of divided responsibility, has too often led both to neglect the subsector (IFAD 2002).

On the other hand, agricultural water development strategies have, in the past, not been entirely consistent with PRSP objectives. Specific poverty reduction objectives have not featured prominently in water sector and irrigation strategies, and often they have not reflected the poverty reduction objectives of the PRSPs. For example, the 1995 Mozambique National Water Plan mentions smallholder irrigation only briefly, despite the prominence given to the subsector in the PRSP.

There has been an absence of a strategic approach to investment in agricultural water. In general, a strategic approach to agricultural water has not been adopted, and agricultural water investment programmes have often been poorly integrated with overall development objectives and policies (IWMI 2005d). In some cases, projects have been selected in pursuit of goals such as food sufficiency and have lacked basic economic viability: an example is the development of pump irrigation schemes for cereals production in Nigeria discussed above (see 2.3 and 3.1).

However, a new generation of irrigation strategies in sub-Saharan Africa has begun to emerge in recent years. These respect the need for an integrated, strategic approach to agricultural water development and take advantage of potential synergies with macro-economic and sectoral policies (WB 2005b). The best of these strategies also reflect the new development paradigms and recognize the need for community empowerment and participation in design and implementation, as well as a market driven approach (Box 4.1). In particular, they acknowledge that productivity and profitability are the keys to sustainability and that it is necessary to remove the constraints to their achievement. They emphasize the need for farmer initiative and financing, with a reduced but tactical role for public financing. The irrigation strategies of Ethiopia and Zambia are good examples of this new generation. Although it is taking time for these strategies to be fully owned and agreed by stakeholders – both national and donor – some results are now being achieved. In the case of Mali, for example, the integrated strategy exercise has resulted in a switch of irrigation investment away from large-scale public projects to participatory approaches, public private partnerships and more emphasis on smaller scale schemes.

Box 4.1: Recent irrigation strategies are in line with a market driven approach

Working with the FAO, six West African governments – Mali, Mauritania, Senegal, Ivory Coast, Niger and Burkina Faso¹ - have developed irrigation strategies with approaches in common. These include:

- a redefinition of the roles of the state, farmers and the private sector, with a new emphasis on liberalization, farmer empowerment and minimal government involvement;
- participatory approaches from identification of projects through to management of the works;
- prioritization of individual or small group schemes;
- review of more alternative interventions to find solutions that are least cost and most profitable for farmers;
- accounting for environmental impacts and social equity;
- requirements that farmers cover O&M costs and a share of the capital costs;
- removal of administrative and fiscal obstacles; and
- promotion of demand driven research.

Source: Gadelle in Sally et al, 2002

*The strategic planning process has also received impetus from the preparation of National Medium-Term Investment Programmes under CAADP (IWMI 2005d; AfDB/FAO 2005). At the regional level NEPAD's 2002 CAADP adopted land and water management as the first of its four pillars for priority investment and proposed extending the area under "sustainable land management and reliable water control systems" to 20 million ha (i.e. approximately double the area currently under water management in sub-Saharan Africa) by 2015², although the rationale for this was principally to reduce national and regional food imports, rather than poverty reduction *per se*. The main emphasis was on investment in infrastructure rather than in institutions. However, a 2005 progress review drew attention to the low level of investment actually achieved since CAADP's launch in 2002 (only \$0.5 billion, compared with its target of \$9.9 billion, with only a modest pipeline). The review observed that a lack of implementation capacity in public agencies and private service providers was a constraint and concluded, *inter alia*, that CAADP needed to be rescheduled to take account of this. The review also observed that increased productivity could not be achieved through investment in water management infrastructure alone: there needed to be investment in a package of institutional measures and market access/post-harvest rural infrastructure (AfDB/FAO 2005). Currently, countries in the region are preparing, with FAO assistance, National Medium Term Investment Plans and a portfolio of bankable projects (Annex 9).*

4.3 Policy reforms and agricultural water development strategies

Macro-economic and public sector reforms

A number of countries have undertaken policy reforms intended to improve the macro-economy and so to improve the performance of the productive sectors. These have often included liberalization of exchange rates and controls, removal of tariff barriers, market liberalization and a generally pro-enterprise framework. Public sector reforms have involved redefinition of the core functions of government – essentially allowing it to concentrate more on policy matters, strategic

¹ Mali *Stratégie de l'Irrigation* 1999; Mauritanie *Stratégie du Développement Rural* 1997; Senegal *Stratégie de Développement de la Petite Irrigation* 1999; Ivory Coast *Stratégie de Développement de la Petite Irrigation* 1999; Niger *Stratégie Nationale de Développement de l'Irrigation et de Collecte des Eaux de Ruissellement* 2001; and Burkina Faso *Stratégie de Développement Durable de l'Agriculture Irriguée* 2004.

² NEPAD has since proposed extending this time horizon.

planning, regulation and facilitation of development and less on being an investor, implementer and service provider – with greater reliance on the private sector and the market.

Agriculture sector reforms

In parallel with the above, a number of countries of the region have prepared new agriculture sector development strategies and embarked on reforms intended to promote agricultural growth. The emphasis has been on increasing productivity and profitability in the smallholder sector (Box 4.2) and greater recognition of the role that the private sector – from smallholder farmers to large-scale commercial estates and agribusinesses – can and does play in the agriculture sector (IFAD 2002).

Box 4.2: Reforms under the Agriculture Sector Development Strategy, Tanzania

Tanzania's *Agriculture Sector Development Strategy* (ASDS), which was published in October 2001, comprises a set of innovative and practical actions intended to stimulate agricultural growth and reduce rural poverty. These include a focus on commercialization of the agricultural sector and increasing its **productivity** and **profitability**.

Arrangements for implementation of the ASDS are elaborated in the *Agriculture Sector Development Programme* (ASDP) *Draft Framework and Process Document* (September 2002). At the heart of ASDP is a sector-wide approach to changing the function of central government from an executive role to a facilitating one, to empowering local government and communities to reassume control of their planning and implementation processes, and to encouraging private sector participation in all aspects of agriculture – including investment, processing and marketing. Under this new approach, 70-80% of public (government and/or donor) funding of the sector will now be managed by district councils and utilized through *District Agricultural Development Plans* (DADPs). Greater use will be made of outsourcing through contracts with private sector service providers, and greater awareness of cross cutting issues, including gender and the environment, will also be promoted.

The new approach will require a transformation in the way public investments in the smallholder irrigation subsector are analysed, planned and implemented. In conformity with the ASDS and ASDP, planning and implementation of smallholder irrigation subsector investment projects must now be based on the need for them to be **driven by irrigators** (or potential irrigators), **responsive to market opportunities, coordinated at the local level** and **profitable**. This implies a need for more critical analysis of proposed investments and greater farmer participation in this process and that of their subsequent planning and implementation. It also implies a need to recognize that participation means more than mere consultation and that it takes time. It furthermore implies a need to recognize that farmers are the best judges of their own investment priorities and that these may not necessarily include investment in physical irrigation works, which do not always present the best opportunities for increasing output and incomes. Farmers may instead, for example, have identified a marketing opportunity or constraint that, if seized or addressed, would achieve their objectives more effectively.

Source: Ministry of Agriculture and Food Security, Tanzania (2003)

Nevertheless, the impacts of agriculture sector reforms have not yet reached their 'steady state' and delivered the anticipated benefits. In particular, reductions in the scope and operations of public agricultural support services have in some cases left smallholder farmers without the technology or finance to increase their productivity (although this is not to say that the previous level of service was in any way adequate). At the same time, although the withdrawal of the state from marketing has removed some distortions that would often have disadvantaged smallholder producers, it has often left farmers unprepared to deal with the market. Preparing smallholders to meet this challenge is critical for success in agricultural development generally. Hence, organizational development, training and capacity building to link smallholder farmers to markets have now become at least as important as infrastructural development (Box 4.3; IFAD 2003).

Box 4.3: Supporting policy reform in Tanzania

The \$42 million Agricultural Marketing Systems Development Programme, cofinanced by AfDB, IFAD, Ireland Aid and others, has been assisting the government of Tanzania in bringing about a comprehensive change in the agricultural marketing sector with the objective of making rural markets work better and empowering smallholders within them. The programme is: (a) strengthening about 1,000 producer groups to enable them to enjoy a stronger bargaining position and more leverage on policy formulation, identification of marketing opportunities and price negotiations for both inputs and outputs; (b) supporting local government reforms by capacity building intended to lead to rationalization of regulation and taxation regimes, to promote improved efficiency in the marketing system as a whole; (c) improving market infrastructure through construction or rehabilitation of 700 km of rural roads, 200 km of access roads and 30 market centres, and through financing of post-harvest facilities; (d) strengthening the capacity of the Ministry of Cooperatives and Marketing (now the Ministry of Marketing); (e) helping producer groups, grass-roots institutions, traders and processors to access loans from commercial banks for promotion of marketing activities; and (f) establishing and strengthening market linkages between producer groups, grass-roots institutions, processors, local marketing chains and exporters.

Source: IFAD 2001

Efforts are being made to assist small farmers to meet the challenges posed by reforms. These include efforts to empower smallholders to develop their own capacity to respond to their needs for financial services – through membership-based organizations, such as savings and credit cooperatives and credit unions. These farmer-owned organizations are proving particularly well-suited to the financing of individual irrigation investments, where the entry cost can be as low as \$15 (see Table 4.1) and where success can generate the credit rating and cash flow that allow an irrigator to progress to higher levels of investment. Some farmer owned organisations, for example CECAM in Madagascar, have developed products such as leasing which are well adapted to individual irrigation investment. In Niger, local artisans have supplied treadle pumps to farmers on a hire-purchase basis.

Table 4.1: Investment and working capital requirements for intensive irrigated production in Kenya

Investment	Area irrigated	Investment cost	Production costs
Bucket kit – drip irrigation	50 m ²	\$15	< \$9
Drum kit – drip irrigation	500 m ²	\$110	< \$95
Treadle pump	6,000 m ²	\$185	< \$880
Motorized system (4HP)	10,000 m ²	\$610	< \$1,480

Source: Financing Small Scale Irrigation in Sub-Saharan Africa, interim results of a World Bank/GTZ study

Smallholders have also been empowered to access extension services, through a range of service providers contracted directly by farmers, as well as participatory approaches such as farmer field schools (Box 4.4).

Box 4.4: Farmer empowerment through Farmer Field Schools in Kenya

The Integrated Production and Pest Management Programme in Kenya was implemented by the Ministry of Agriculture in Kenya with the collaboration of the Global IPM facility of FAO and financial support from IFAD. It adopted the Farmer Field School approach, which can be described as a community-based, practically oriented field study programme involving a group of farmers, facilitated by extension staff (public or private) or, increasingly, by other farmers. The FFS provides an opportunity for farmers to learn together and adapt practices, using practical hands on methods of discovery learning that emphasize observation, discussion, analysis and collective decision-making. The process aims to build self-confidence and to improve group and community skills. The knowledge acquired during the learning process enables farmers to adapt their existing technologies to be more productive, profitable and responsive to changing conditions, or to test and adopt new technologies.

The IPPM-FFS Programme was implemented over three seasons in three districts of Kenya's Western Province – all of them poor districts, badly affected by HIV/AIDS, high population densities, declining farm sizes and deteriorating soil fertility. In total 471 FFSs were established under the programme, with an average of 25-30 members each, or a total of about 13,000 farmers, of which approximately 60% were women. Self-targeting resulted in the vast majority of the membership being drawn from the middle and poorest socio-economic stratum.

The most important lessons learned were:

- FFS encouraged communities to validate and adapt improved technologies and empowered them to find solutions to their problems.
- Farmer management of FFS funds, particularly payments for extension services, substantially improved the accountability and performance of extension providers.
- The promotion of farmer-led FFS, with farmers (rather than extension staff) as facilitators allowed the programme to reach a much larger number of farmers than would otherwise have been the case.
- FFS empowered communities and raised their profile at district level, hence increasing their ability to influence local level planning.
- Women seemed to especially value the approach, owing to its practical, field-based learning focus and the social value of the FFS groups.

Source: Khisa et al in Penning de Vries et al (2005)

Efforts are also being made to empower smallholders and their organizations to collectively engage with input and output markets. These include attempts to develop market linkages, in which the various actors – private commercial entities (such as agri-processors and exporters, smallholder producers, the public sector and NGOs) – are brought together into 'win-win' partnerships intended to ensure equitable returns to both smallholders and the private sector entities concerned. (Box 4.5). Establishing a supportive policy and legal framework, as well as capacity-building to assist smallholders to adapt to transformation, is essential.

Box 4.5: Win-win partnerships for market linkages in Zambia and Zimbabwe

Despite abundant land and water resources, Zambian agriculture is poor, with weak markets and rudimentary irrigation techniques. The Zambia Agribusiness Technical Assistance Centre (ZATAC) has promoted outgrower horticulture schemes directly linked to ready markets through agribusinesses. This strategy offers small growers an opportunity to be partners in the value chain and offers agribusinesses a chance to increase their supply base and benefit from economies of scale without the associated capital investment. ZATAC helped override the water constraint by providing credit for irrigation equipment. For the first time in the history of Zambia, smallholders now grow fresh vegetables for markets in Europe in an alliance between smallholder producers and agribusinesses.

Farmers at Maunganidze and Mupangwa/Mutaradzi irrigation schemes in Zimbabwe have benefited from an IFAD grant-assisted pilot market linkage support programme implemented by a national NGO. This focused on contract growing of various crops, such as tomatoes and Michigan Pea Beans (for baked beans), for a local canner. The NGO facilitated contract negotiations for the growers' associations, under which (a) the canner would provide crop inputs against a deposit of 10% of the total costs paid into a bank account operated jointly by the canner and the association, (b) the association would undertake to deliver a quota of crops grown and (c) the canner would purchase the crop at a fixed price. The NGO for its part also provided technical support to the growers.

In Niger, an entrepreneur has set up a grading and packing plant with a capacity of 60,000 t for export of the prized Galmi onion. A small nucleus estate is providing about 10,000 t of onions. The firm is contracting with outgrowers for the balance, and is providing extension advice and credit.

Source: IFAD (2005); World Bank (2005a), World Bank (2005b)

Water sector reforms

The many functions and inter-related impacts of water require an integrated inter-sectoral planning approach. As elsewhere in the world, agriculture is the largest user of water in most countries of sub-Saharan Africa. Its use therefore has the most interactions and impacts with other parts of the hydrological, environmental, social and economic system and must fit within a rational allocation of water resources between the environment, agricultural, hydropower, urban and industrial withdrawals, as well as for other economic uses such as for transport and tourism.

*The 1992 Dublin Statement on Water and Sustainable Development reflected international consensus that, in the light of intersectoral competition for water use and growing water scarcity worldwide, effective management of water resources was essential. The Dublin Statement called for an integrated, intersectoral approach to water management and allocation, from which the concept of integrated water resources management (IWRM) evolved. Significantly, the IWRM approach emphasizes *inter alia* the need for economic efficiency in water use¹. Five sub-Saharan African countries have responded by adopting IWRM as a policy instrument, and several others plan to do so.*

*IWRM approaches are increasingly needed as water constraints grow, to reduce the social, economic and political costs of unmanaged appropriations, uncertain water rights and environmental externalities. In Kenya, for example, the costs of a lack of integrated water management have been high (Box 4.6), with *social costs* from unmanaged water appropriations, *economic costs* from hydrological variations and from unclear water rights and allocations, and*

¹ The IWRM approach also emphasizes: (a) the need for a whole catchment approach to development; (b) subsidiarity in planning and decision-making; (c) the pivotal institutional role of women and (d) basic human rights to clean water and sanitation at an affordable price.

political costs from uncertainties over transboundary water resources. These costs arise from a vicious circle of lack of integrated resource management, underinvestment in infrastructure and management, consequent degradation of catchments and limited buffering capacity for extreme events, and consequent reductions in growth (World Bank 2004a).

Box 4.6: Kenya needs IWRM to manage irrigation expansion

Uncontrolled irrigation expansion in Kenya's Laikipia district, is destroying downstream livelihoods and habitats. In the period 1990-3 there was a 300% increase in water use in the district arising mainly from an expansion of irrigated agriculture. Over 90% of these abstractions were unauthorized. Downstream, the median flow of the Ewaso N'giri River in February has dropped from 9 m³/sec to just 0.9 m³/sec (a 90% reduction). Now downstream users can no longer obtain essential water, the ecological functioning of the river is impaired, lakes and wetlands are drying up, and fish catches – a source of protein for the poor – are declining.

Sources: World Bank 2004a

Yet IWRM has presented operational challenges. It is not clear, for example, that the agriculture sector has effectively engaged in IWRM stakeholder debates. In some instances, national agriculture policy has been silent on water development for the sector. In addition, while water reforms may have addressed historic imbalances in access to agricultural water by providing for decentralized catchment planning authorities and agricultural water user associations, it is not clear that implementation of IWRM practices to date has empowered disadvantaged groups to participate effectively in water allocation and use decision processes (Perry *et al*, 1997 and Derman *et al*, 2002). Although IWRM considers the basin as the unit for planning, the experience so far with basin level approaches in the region has been mixed: some river basin organizations have played more of a development and operational role than a resource planning and management role. The Nigerian River Basin Development Authorities, for example, began not only as water resources managers but also as major investors in large public schemes, both dams and irrigation.

Notwithstanding these challenges, the issue is not whether IWRM and an inter-sectoral planning approach should be adopted, but how to improve the process to obtain the best possible results for agricultural use and poverty reduction. A decentralized, inter-sectoral approach to water resources management, as well as self-regulating and self-enforcing mechanisms for sustainable management that considers all needs within a catchment and ensure that smallholder farmers are adequately represented in governance, stakeholder debates and allocation decision-making are central to the IWRM concept. The challenge is to put such approaches into practice. IWRM needs to build on and integrate traditional and indigenous water practices where appropriate. Full accountability of river basin organizations will be essential (World Bank 2001).

4.4 Sector wide approaches

The development effectiveness of past project approaches has often been limited. Past public investment in agricultural water has been principally through individual projects, often financed in part by donors. The development effectiveness of project approaches has been limited not only by problems of design and implementation but by their inherent fragmentation and duplication. At the policy and institutional level, project approaches have lacked shared strategy and prioritization, and have given inadequate attention to systemic issues and structured institutional development. At the implementation level, projects have often reflected a donor-driven agenda

and resource allocation, and have created parallel systems and ‘project empires’ rather than building national capacity. The transaction costs of project approaches have been high.

Sector-wide approaches (SWAps) generally, and agricultural SWAps in particular, are intended as a means of coordinating and harmonizing efforts at policy dialogue, institutional reform and efficient investment. In recent years, a number of countries in the region have begun to develop ‘sector wide approaches’, moving progressively away from project to programme approaches within a coherent strategic framework, and this movement has been strengthened by the Paris agreements on aid effectiveness (see 4.1 above). Sector wide approaches are based on a partnership between: (a) the *government*, which is expected to provide leadership and to develop a coherent sectoral strategy; (b) *international development partners*, who are expected to align their support on the country-led strategy and, to the extent possible, harmonize their support through common arrangements for financing and technical assistance and (c) other stakeholders, including *civil society* and the *private sector*. In contrast to earlier approaches, sector wide approaches are intended to focus not only on the financing of a comprehensive investment programme, but also on policy dialogue and change, and on the provision of support to, and reform of, national institutions (IFAD 2005).

The potential benefits from sector wide approaches are, essentially, enhanced development impact and lower transaction costs. At the strategy level, this should be characterized by stronger country ownership and leadership, a coordinated and open policy dialogue, and prioritized and rational resource allocation. At the institutional level, the approach should help strengthen national capacity, systems and institutions. At the implementation level, scaling up of best practice and benefits to the entire sector should be easier; there should be sector wide accountability, ultimately with common fiduciary practices and environmental and social safeguards; and there should be a focus on results and reduced duplication in reporting and transactions.

*Sector wide approaches have potential but are hard to put together and experience in sectoral approaches to agriculture or water in the region is limited.*¹ The approach could be adopted to address the specific problems identified throughout this report, particularly strategic planning, institutional development and capacity building, and cost-effective public investment. In most countries in the region, the fiduciary pre-conditions for budget support are absent, but there have been attempts to bring all stakeholders behind a coordinated irrigation sector strategy and program. In Niger, for example, several years of effort have produced consensus on the national irrigation strategy, and the related action plan was adopted by Presidential Decree in late 2006. A permanent secretariat is responsible for coordination and follow-up. However, even with this background, donors have been slow to commit financing within the programme framework.

4.5 Decentralized development

Traditionally, the governments of most developing countries have employed conventional public sector organizations to provide infrastructure and services at the local level. However, alternative approaches to local development have evolved over the past two to three decades. As part of wider public service reforms, a number of countries in the region have engaged (or plan to engage) in decentralization of their public development efforts, to increase the participation and ownership of rural communities in planning, budgeting and implementing public rural development programmes, including those for agricultural water.

¹ A number of countries have applied the approach in the health and education sector (Zambia, South Africa, Ghana, Mozambique, Tanzania, Uganda, Ethiopia, Burkina Faso).

Essentially, two forms of decentralization have evolved: ‘decentralized sectoral’ and ‘decentralized local government’. Under the first of these, development is budgeted for, coordinated and implemented by sectoral ministries through their local level (i.e. provincial and/or district) staff.¹ Under ‘decentralized local government’ approaches, however, a proportion of public (government and/or donor) sectoral funding is managed by local authorities and utilized through locally prepared development plans.

Decentralization is not an end in itself; it is rather a means to developing effective, responsive, demand-led services and, in particular, to making government services more locally accountable to rural people. Taken in isolation there is no particular reason why decentralization should enhance accountability; on the contrary, it may well entrench the influence and power of local elites – and it may lead to even greater inefficiencies than before (Box 4.10). The key to successful decentralization is to empower rural people, enabling them to develop the skills, the knowledge, the confidence and the organization that they require to participate in local political processes and to hold government and private service providers accountable to them. Thus, while decentralization could enhance the development impact of agricultural water investments, it presents a complex political, technical and administrative challenge to governments and demands strong management capacity to guide the process forward. It needs to be accompanied by programmes of support to develop good governance, as well as capacity building and empowerment (IFAD 2002).

Box 4.10: Decentralized agricultural water development without empowerment

The 5 ha Dombolidenje Dam and Irrigation Scheme in Zimbabwe was financed through a national project but was planned and decided upon at district council level following a lengthy participatory process which included extensive training and capacity building for local communities. Implementation was managed by district council staff with the support of district-level line ministry staff. It cost \$82,000/ha and earns farmers 1 cent a day. The experience suggested that decentralization and participation do not on their own guarantee good outcomes. In this case, the communities concerned had not been empowered to take an informed investment decision: had they been aware of the costs and alternative investment options, they may well have chosen a more profitable use of the available funds. Neither had they been empowered to ensure cost control, since the service providers – both public sector and private – were not accountable to them. The experience not only highlighted a lack of empowerment, but also a lack of capacity within the local planning structures for subproject screening, appraisal, approval and subsequent implementation.

Source: IFAD 2005

4.6 Management of publicly financed irrigation schemes

As in most other regions, the sustainability of publicly-funded irrigation schemes in sub-Saharan Africa has been poor, mainly because of over-reliance on government support for scheme management and O&M, declining government budgets for recurrent costs and low levels of cost recovery from the users. As discussed above (3.1), governments in many countries of the region have, in the past, not only financed the capital costs of irrigation projects – large, medium and small-scale – but they have then played a major role in scheme management, particularly of the larger schemes, and have also taken responsibility for the bulk of O&M costs too. Public management of schemes has been plagued by numerous problems. Water service has often been poor, and many schemes have needed rehabilitation to make up for delayed maintenance.

¹ This approach is sometimes referred to as ‘deconcentration’ to distinguish it from decentralized local government.

*In recent years, the trend has been to encourage the users, organized in WUAs, of publicly financed irrigation schemes to take responsibility for their management and O&M. Although this has applied to both new and existing developments (see Box 3.2 for the case of the *Office du Niger*), the extent to which this responsibility is accepted by scheme users depends on a variety of factors, including the scale and complexity of the scheme, its technical suitability for farmer-management, the capacity or otherwise of the users and the intrinsic profitability of the scheme. In the case of new development, therefore, it is now usual to ensure that technical designs are appropriate for farmer-management, with estimated O&M costs that can be afforded from the proceeds of crop sales whilst still leaving sufficient margin to provide an incentive to irrigate. It is also common practice to adopt participatory processes for identification, design and implementation of schemes, to promote user ownership and commitment, as well as to establish sustainable farmers' organizations – such as water users' associations (WUAs) – to take over full management and O&M responsibility (although this is unlikely to be achieved without secure land tenure, as well as clarity regarding legal rights over infrastructure and equipment).*

Small to medium-scale interventions are generally intrinsically more suited to farmer management than large-scale schemes. Small to medium-scale schemes are intrinsically easier for farmers' organizations to manage than larger ones, although capacity building for scheme management is essential even for small-scale schemes. The Participatory Irrigation Development Project in Tanzania, for example, facilitates the establishment of WUAs on a demand driven basis and works with them to upgrade existing small-scale irrigation schemes or develop new ones, on the understanding (recorded in memoranda of understanding) that the association accepts full responsibility for O&M¹.

...but there will be cases in which important economies or market opportunities are presented by new investment in larger scale developments, which may be beyond the ability of WUAs to manage, operate and maintain. In these cases, there may be a continuing role for government in scheme management and O&M – increasingly in partnership with a federation of WUAs, an irrigation district or the like, with government taking responsibility for the major infrastructure, and user organizations responsible for secondary or tertiary units. The latest innovations, for example, will include that of the Lower Usuthu Smallholder Irrigation Project, a 11,500 ha smallholder sugar project in Swaziland, where it is intended that the entire system, including a diversion weir, off-river storage and canal system, will be governed by an irrigation district that will contract out O&M to a private sector water service provider (Box 4.7).

Box 4.7: Swaziland adopts an innovative approach to water service provision and cost recovery

The 11,500 ha Lower Usuthu Smallholder Irrigation Project is intended to be operated by smallholder organizations for commercial sugar cane production. The main, secondary and tertiary infrastructure will be grant-funded by the government. Farmer organizations will pay 100% of the capital cost of on-farm works by taking commercial loans to be repaid from the proceeds of sugar cane production. In addition, they will pay a charge that covers the cost of O&M by a private sector water service provider contracted by the farmers' apex organization, replicating an existing arrangement by large-scale private estates in the parallel Mhlume basin. Part of these costs may be cross-subsidized by the existing large-scale sugar cane growers who currently pay nothing for water drawn from run-of-river supplies.

Source: IFAD 2001a

¹ The experience has been used as the basis for new guidelines for decentralized participatory irrigation development that have been prepared by the Ministry of Agriculture and Food Security (Government of Tanzania 2003).

The experience with farmer-management of public irrigation schemes has been mixed. WUAs formed for small-scale rice schemes under the Upper Mandrare Development Project in Madagascar were only weakly established and unclear as to their responsibility for repairs in the event of flood damage to the headworks. At the Participatory Irrigation Development Programme in Tanzania, although WUAs were aware that they were responsible for major repairs they were not clear how they would finance such repairs should they become necessary. At Maunganidze in Zimbabwe, although the WUA was well-established and well-organized, it would probably have found it difficult to raise the cash for major repairs to borehole pumps. In none of these cases, therefore, was financial sustainability – one of the principal objectives of farmer management – assured (IFAD 2005). In both cases, greater effort needed to have been made to ensure that the O&M costs really were within the users' capacity to sustain in the long term.

Irrigation management transfer on existing schemes has also not always proceeded according to plan. For example, on the *Petits Perimetres Irrigués* Project in Madagascar, water user groups were set up to manage O&M and subsequently to take over the schemes from government. However, formal transfer was extremely slow, a relatively small percentage of schemes were transferred, and less than 10% of the user groups remain in operation (IWMI 2005g:34).

In some cases, the state has exited too rapidly after irrigation management transfer and farmers have been left to pick up the pieces, unprepared for the task, with severely negative consequences for productivity. Sometimes irrigation management transfer has failed when irrigators simply inherited a scheme for which financial profitability and institutional capacity for sustainable irrigation did not exist (Box 4.8). For example, in Madagascar, the government passed a law in 1990 governing irrigation management transfer and embarked on a programme, with donor support, to rehabilitate schemes, increase cost recovery, and hand over to WUAs. However, by 2003, only 3% of the public sector scheme area had been transferred (8,607 ha out of a total of 270,000 ha). Meanwhile, government expenditures for O&M decreased from 50% of the budget of the Ministry of Agriculture to just \$42,000, and very little advisory or management support had been provided. Irrigation service charges had been set at just \$6/ha, so far below the required level (at least \$23-\$38) that schemes were not being maintained. In effect, the process resembled abandonment more than transfer, and this undermined production. Consequently previously highly productive schemes in which the nation had heavily invested for more than fifty years have been almost completely lost. (World Bank 2003).

Box 4.8: Withdrawal symptoms – examples of poorly handled irrigation management transfer

In the Arabie-Olifants scheme in South Africa, the cropped area declined by 70% the year after the Agricultural and Rural Development Corporation withdrew. Smallholders were unable to access the working capital to pay for inputs and services.

In the handover of pump schemes in Niger, land ownership was not transferred. Irrigators could be evicted and replaced, so they had no incentive to invest and no sense of ownership of the scheme they were supposed to pay for and operate.

Source: IWMI 2002

Yet the problems encountered are not inherent in the concept of irrigation management transfer. Much of the irrigation management transfer in the region has failed simply because it was badly handled and did not respect essential institutional and financial preconditions. Too often governments and projects stopped short of genuine capacity building and farmer empowerment, and service providers (public sector or private) have not been accountable to farmers for the services (such as design and construction, extension, water supply, O&M) they provide.

Successes in WUA formation and irrigation management transfer do exist, and they indicate pathways for the future (Box 4.9). For example, in the irrigation management transfer programme in Senegal supported under the World Bank-financed Fourth Irrigation Project 1988-1993 a number of large-scale schemes in the Senegal River Delta were transferred to *Unions Hydrauliques*, which had been set up to manage electric pump stations and to recover costs from farmers. After a difficult start, these organizations succeeded in obtaining bank credit to finance operations and improved the water service; they also reduced theft. The *Unions* invested in research and extension, and with new rice varieties from WARDA profitability improved and output revived. Now the *Unions* are moving into input supply and output processing and marketing in order to increase value added and incomes. The keys to this success appear to have been: continuing capacity building from the state and NGOs; access to working capital; and a sense of ownership that brought out the needed entrepreneurial and management skills within the *Unions* (Ibrahima Dia *Private Irrigation in the Senegal River Delta*, in IWMI 2002:121ff).

Box 4.9: Examples of successful irrigation management transfer

In South Africa, the Small Growers Development Trust runs a programme of financial, training and support services that has helped 42,000 smallholder cane growers in Natal/Kwazulu and KaNgwane to take over and manage their irrigation schemes.

IPTRID studied irrigation management transfer in twelve rice schemes in five West African countries (Burkina Faso, Mali, Mauritania, Niger and Senegal). Schemes were all pump then gravity distribution models. The study found that despite many problems, farmers had found ingenious solutions, with the help either of state irrigation agencies or of NGOs. Examples include: contracting (with the help of the state irrigation agency) with a local engineering firm for water distribution, maintenance and financial management; using software to calculate the optimum cropping calendar and water scheduling (with the help of an NGO); and acquiring a rice mill and selling high quality rice direct to groceries in the capital for a substantial premium (Ingrid Hermiteau *Assisting Sustainable Irrigation Management Transfer* in IWMI 2002).

A group of smallholders at Hereford in South Africa took over their irrigation scheme. They received support from an NGO, Africare and this enabled them to develop a contract farming arrangement for vegetables for export to Hong Kong and France and for sale to the national market. The export company provided a strict planting programme and extension advice. Incomes increased and farmers were able to finance the O&M of the scheme and to improve their standard of living.

Source: IWMI 2002

Since in most cases government funding for scheme management and O&M is unlikely to increase, the issue is not whether schemes should be farmer-managed, but how to ensure that schemes are effectively managed and O&M costs recovered. Although it is unlikely that farmers will be able to meet the capital costs of major infrastructure, it is essential for sustainability that they at least meet the full O&M costs. Ideally, schemes should be entirely farmer-managed, or managed by their apex organizations. Success depends on: (a) the intrinsic profitability and physical sustainability of the scheme; (b) capacity building for scheme management, operation and maintenance; (c) secure land and water rights; and (d) careful management of the WUA formation/management transfer process, including post-handover support (Box 4.9). Cases like that of Niger, where twenty five years after cooperatives took over, they still need support – and the schemes still need periodic rehabilitation – demonstrate the difficulty of achieving these conditions. Where scale and complexity preclude full farmer management and there is no alternative to management by a government agency, the agency needs to be financially self-sustaining. Water service charges must be adequate to cover the real costs of O&M, and overhead costs need to be kept to the minimum. Above all, the agency needs to be transparent

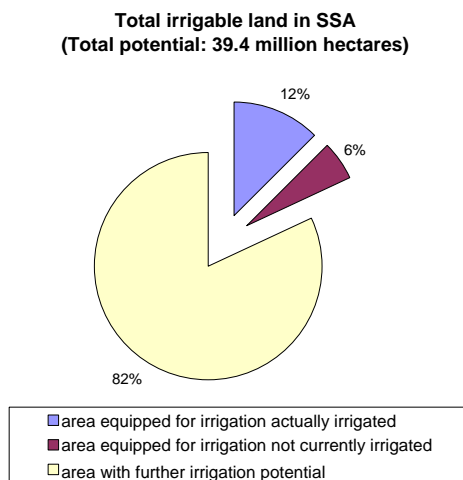
and accountable to the users – a condition that can usually only be achieved when there is genuine participation of the users in its management. The case of the Office du Niger (Box 3.2) shows that these conditions, although difficult, can be achieved in the region.

Chapter 5 Development Potential, Market Demand and Investment Opportunities

5.1 Physical potential for agricultural water development

According to FAO 2005a, the total physical potential for irrigation in sub-Saharan Africa is estimated at 39.4 million ha. As mentioned (1.3 above), approximately 18% – or 7.1 million ha – of this has already been developed. The remaining physical potential for new irrigation is therefore approximately 32.4 million ha¹.

Figure 5.1: Irrigation potential in sub-Saharan Africa



Source: FAO 2005a

Not all of this will be suitable for development, mainly for economic reasons. Almost one third of the potential is concentrated in two very humid countries, namely Angola and the Democratic Republic of the Congo – although the humidity of these countries does not necessarily mean that they do not need irrigation or other forms of water management (the already large areas of wetlands cultivation and flood recession planting in Angola are testament to this). The remaining potential in the other countries of the region is therefore of the order of 23 million ha (Summary Table 1).

This is not evenly distributed: some countries, notably Madagascar, Mauritius, Somalia, South Africa and Sudan, have already developed more than 60% of their potential for irrigation (Summary Table 1)².

Current water abstractions in the region as a whole are low – but a growing number of countries risk becoming water scarce. Current abstractions for all purposes amount to only 2.2% of the total renewable resource (Summary Table 3 and Map 5). Abstractions for agriculture (mostly irrigation) are less than 2% of the total renewable water resource (2.1 above and Summary Table 2). If the full irrigation potential of 39.4 million ha was to be developed the demand for agriculture would increase from 2% to only 12% of the total renewable water resource³. Even if

¹ This includes the potential for ‘water harvesting’, which, as discussed, (2.1) is considered to be water development for small and micro-scale irrigation.

² As opposed to ‘other forms’ of water management in the AQUASTAT terminology (other countries may use more than 60% of their potential if these other forms of water management are taken into account).

³ This assumes that development and utilization of the remaining 32.4 million ha would consume an additional 630 billion m³/year (at an average of 16,000 m³/ha/year). From Summary Table 2 the Total Renewable Water

an annual growth in demand for urban and industrial water supplies of 5% was to be factored in, total abstractions for all purposes for the region as a whole would still only reach 13% of renewable resources by 2030 (Summary Table 3). However, the region-wide average of water availability masks considerable variation between countries: if all the irrigable area were developed by 2030, renewable water resource availability would vary from a massive 114,000 m³ of available water per person per year (Democratic Republic of Congo) to a minimal 68 m³ per person per year (in South Africa). If all the area were developed, nineteen of the 48 countries in the region would risk falling below 1,000 m³ per person per year, which is usually considered to be the threshold of water scarcity.

Surface water resources are often concentrated in a seasonal window and can be extremely variable. In the upper Zambezi, for example, some 80-90% of water resources occur as stream flow in the wet season between December and May while in the six months from June to November stream flow is either rapidly falling or extremely low or non-existent. Rice farmers on run-of-river irrigation schemes in Tanzania, for example, often complain of water shortages between and within seasons, with dramatic variations in the areas that can be fully irrigated from year to year (Box 5.1). Climate change is likely to aggravate the situation.

Box 5.1: Run-of-the-river improvements are not enough for rice development in Tanzania

Farmers at run-of-river rice schemes developed under the Participatory Irrigation Development Project (PIDP) in Tanzania complained that one of their main constraints was irrigation water. Government and farmers had just invested more than \$1,000 per hectare to improve the diversion and distribution of irrigation water, but this had not improved water availability or reliability. In some years, only one-quarter of the command area could be irrigated, and it was too risky for farmers to invest in inputs, so that even in a year of adequate irrigation supplies, average paddy yields (3.3 t/ha) remained below potential. Farmers are now pressing for dams to regulate flow to the schemes.

Source: IFAD (2005)

In an increasing number of river basins, there is also competition between different users. Despite the overall ‘abundance’ of water implied by the low rates of abstraction, cases are emerging of competition between users. This can lead to shortages, friction, suboptimal production and environmental degradation (Box 5.2). In some cases the problem is institutional – a lack of a regulatory framework, water rights and organizations to cooperate over water resource allocation and management.

Resource for the region is 5,450 billion m³/year. Thus at full development the demand for agriculture would amount to $630/5,450 \times 100 = 11.6\%$ of the total.

Box 5.2: Competing demands for water in Tanzania

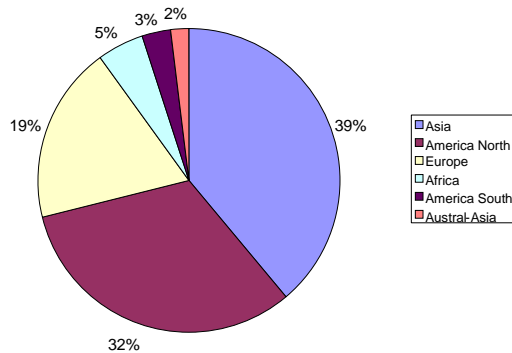
The Great Ruaha River is the lifeline of the Ruaha National Park and its ecosystem. It also drives the Mtera and Kidatu hydropower stations that provide 85% Tanzania's power supply. However, upstream irrigation development in the Usangu plains competes for Ruaha water.

Smallholder irrigation systems in Usangu were developed by smallholder farmers from the 1940s, mostly for wet season irrigation of rice. As Tanzania's demand for rice increased, a number of large-scale parastatal rice farms were also developed. Water shortages in the Ruaha began to occur and in 1993 the river dried up in the Ruaha National Park. Flows for hydropower generation were also reduced, which resulted in electricity cuts in Dar es Salaam. Upstream irrigation development was blamed for the shortages.

The river basin authority then had to arbitrate between the competing water demands of agriculture, power, the environment and tourism, although research by Sokoine University, the University of East Anglia and IWMI indicates that electricity shortages were primarily the result of poor management of the hydropower dams rather than upstream irrigation abstractions. There is considerable scope for increasing upstream water-use efficiencies, but options for improved water management in the plains wetlands also need to be considered.

Source: Lankford, 2004; Fox, 2004

Figure 5.2: Breakdown of dams by geographical zone



Source: World Registry of Dams

In many cases, however, the problem is not absolute water scarcity but a lack of infrastructure to regulate supplies for use in dry seasons and dry years. Most sub-Saharan Africa countries have low levels of water storage infrastructure: only 5% of the world's dams are located in sub-Saharan Africa (see Figure 5.2 and World Bank 2005c). The implication is that in many countries development of the physical potential for irrigation will have to be accompanied by the construction of new storages to cope with seasonal variability

and local water scarcity.

The potential for further groundwater irrigation could also be important – particularly for private individual irrigators. In most of the region, the transmissivity of the underlying geology tends to be too low to furnish reliable quantities of water for irrigation on any scale. There are notable exceptions, for example in the karstic aquifers of the Zambian Copperbelt, and there are limited reserves of renewable groundwater in most countries, which are extensively used by individual private irrigators mainly for gardens. Despite the localized nature of these resources, there could be substantial scope for expansion of this type of irrigation (Giordano 2005).¹ In

¹ For the present report, however, it is assumed that the indicative potential for new irrigation discussed above includes the groundwater potential.

Zimbabwe, for example, where smallholders are already exploiting shallow groundwater with low-cost technology in the *dambo* wetland areas, renewable groundwater resources could potentially irrigate a further 80,000 ha – an area equal to about a quarter of the official estimates of remaining irrigable land. At the *Office du Niger*, irrigation of paddy in the wet season results in groundwater replenishment which is lifted by individually operated groundwater pumps for dry-season irrigation, when water deliveries by the *Office* are in short supply. Similar opportunities are likely to exist in many other rice growing areas.

In-field rainwater management could become as important as the other alternatives, particularly for the production of non-rice cereals. The FAO estimates of potential exclude in-field rainwater management for dryland crops. Although it is thought that the total area currently under this type of agricultural water management is small compared with the area under irrigation, in-field rainwater management could in theory be practised on all cultivable land that is not already developed for agricultural water management. In practice, however, physical, agro-ecological and market constraints will limit such development. Assuming that it was possible to develop in-field rainwater management for dryland crops on only 25% of the land currently cultivated, the indicative physical potential would amount to approximately 46 million ha¹.

5.2 Current region-wide development proposals

Recent reviews of Africa's development status have highlighted the trend of underinvestment in agricultural water and the need for concerted and immediate efforts to reverse this trend. In 2005 the Commission for Africa recommended doubling the area under “irrigation” in sub-Saharan Africa by 2010. CAADP (see 4.2 above) was recently revised to call for investment in improved water control on an even larger incremental area of 15.9 million ha by 2030. Of this 6.6 million ha would consist of expansion of irrigation schemes as well as water-managed wetlands and valley bottom systems, 2.1 million ha would consist of the rehabilitation of large irrigation schemes, and 7.2 million ha would be in new “water harvesting and soil and water conservation” interventions² (Table 5.1). This implies a rate of increase in the water managed area (excluding irrigation rehabilitation and water harvesting and soil and water conservation) of approximately 260,000 ha annually, more than three times the current rate of increase (1.3 above and FAO 2005a). As discussed above (4.2), NEPAD, with FAO assistance, is currently reassessing actual national potential for increasing the equipped area by developing National Medium Term Investment Programmes, and will reassess the original targets by building up from this base.

¹ This is based on the assumption that such development would take place mainly in the dry sub-humid zone and partly in the semi-arid zone and is the equivalent of 25%/100*182.7 million ha.

² In this context, ‘soil and water conservation’ is interpreted to mean ‘in-field rainwater management’.

Table 5.1: CAADP programme for investment in agricultural water to 2030

R e g i o n	Area of investment by type (1,000 ha)					Total
	New Large-scale irrigation schemes	Rehabilitation of large-scale irrigation schemes	New small-scale irrigation schemes	Wetlands and inland valley bottoms	Water harvesting/ soil and water conservation	
Sudano-Sahelian	208	1,200	516	729	1,684	4,337
Gulf of Guinea	68	110	350	1,061	2,109	3,698
Central	40	99	163	281	169	752
Eastern	110	143	411	914	1,570	3,147
Southern	208	485	533	443	1,566	3,235
Islands	39	77	332	200	100	748
TOTAL	673	2,114	2,305	3,628	7,198	15,917

(Source: AfDB/FAO 2005)

5.3 Market demand and economics of investment

Market demand

Demand for basic staples and other foods will increase strongly. While sub-Saharan Africa is currently self-sufficient in most of its major staples, and imports less than 5% of its needs for food other than rice and wheat – the only food crops for which irrigation is currently important (see 2.2)¹ – domestic food markets are expected to double in volume by 2015, with some increase in demand for superior foods as incomes rise. At current levels of productivity and rates of growth, net imports of wheat and rice are expected to reach 40 million tons by 2030 – Table 5.2), while imports of maize and vegetable oils are also expected to increase substantially. Overall, on a region-wide basis, cereals self-sufficiency is expected to decline marginally from 82% in 1997/9 to 81% in 2030 (FAO 2003a:68).

Table 5.2: Projected sub-regional and regional net trade in cereals in 2030 (tonnes)

Sub-region/ crop	Central	Eastern	Gulf of Guinea	Islands and Others	South Africa	Southern	Sudano- Sahelian	Total Sub- Saharan Africa
Wheat	(4 373 200)	(3 646 700)	(6 249 900)	(664 500)	(500 000)	(1 388 700)	(4 311 700)	(21 134 700)
Rice	(2 329 100)	(1 212 900)	(7 848 200)	(912 400)	(1 078 000)	(400 200)	(4 233 900)	(18 014 700)
Maize	(1 475 900)	(1 749 000)	(268 000)	(339 600)	1 000 000	(1 926 800)	(830 000)	(5 589 300)
Barley	(380 700)	(270 300)	(253 500)	(48 400)	(300 000)	(71 800)	(130 300)	(1 455 000)
Millet	(200)	(2 400)	7 100	(300)	0	300	(70 000)	(65 500)
Sorghum	(76 900)	(126 400)	0	(3 000)	2 800	(40 400)	(85 000)	(328 900)
Other	(16 500)	(33 200)	(56 200)	(14 500)	(10 800)	(79 900)	(174 300)	(385 400)
Total	(8 652 500)	(7 040 900)	(14 668 700)	(1 982 700)	(886 000)	(3 907 500)	(9 835 200)	(46 973 500)

Source: FAO 2005a

There will be some growth in world demand for sugar and cotton – but while cotton prices may rise, sugar prices are likely to remain volatile. Irrigated industrial crops, especially sugar and cotton, will continue to supply domestic and export markets (Table 5.3). Growth in domestic demand will continue to expand and cotton export prices could rise strongly if US and EU protection and subsidies are reduced under the Doha Round (FAO 2006; Diao). However, the combined impact of the EU sugar policy reform and an increase in global demand (partly driven by demand for ethanol) could increase prices for sugar, but with increased volatility.

¹ Food imports are predominantly of wheat, rice and vegetable oil. Cereals imports currently total 24 million tons, of which 21 million tons are from commercial imports and the remaining 3 million tons from food aid.

Table 5.3: Projected water managed production in 2030 (1,000 tonnes)

Crop	Baseline 1998	Projected 2030	Increase (%)
Sugarcane	32 411	80 807	149
Wheat	1 697	2 281	34
Rice	3 800	10 097	166
Fruit	3 975	2 784	(30)
Vegetables	6 239	11 688	87
Potatoes	1 583	425	(73)
Citrus	1 681	850	(49)
Cotton	413	1 079	161
Groundnut	491	838	71
Bananas	351	469	34
Sorghum	750	1 564	109
Tobacco	18	13	(28)
Teas	21	65	210
Barley	41	18	(56)
Sunflower	28	0	(100)
Soybean	23	25	9
Pulses	184	253	38
Maize	830	978	18
Coconut	9	65	622
Coffee	4	17	325

Source: FAO 2006

Horticulture demand will continue to grow. There are substantial growth prospects for irrigated horticulture, as the range of potential products is vast (over eighty different commodities in the ‘vegetables and fruits’ UN trade classification) and sub-Saharan Africa’s current share of world trade in these products is small (Diao *et al* 2003:61). There are many high value niches to explore for exports, although the market is highly competitive and risky. However, low wage rates are likely to preserve the region’s comparative advantage and exports could grow fast. The large domestic market, which absorbs most horticultural production, will also expand steadily.

Demand for fodder will increase – but from a small base. Fodder production is expected to account for only 4.7% of total crop output by 2030 (FAO 2006 and 2.4 above), of which only a small proportion is likely to be irrigated. Although fattening and intensive stall-fed systems for milk and meat can be highly profitable where demand for meat and dairy products is firm, and although the projected increase in demand for these commodities is higher than other developing regions and the world as a whole, the increase will be from a relatively small base. Nevertheless, some increase in irrigated production of feed barley, maize, alfalfa and other green fodder crops is likely.

Box 5.3: Why economic viability is imperative for agricultural water investments

Firstly, investment that results in an economic return less than the opportunity cost of capital can only lead to an increase in a country's debt burden that will act as a brake on all sectors of the economy, constraining economic growth and poverty reduction. Economic viability is an essential condition for an investment to contribute to economic growth. The corollary is that investment in non-viable projects is a sure way to limit development.

Secondly, a policy of investment in non-viable projects often results in agricultural water development at any cost. Since annual maintenance costs are usually directly proportional to the initial capital cost, development at any cost often translates into annual maintenance costs that cannot be supported by the users. Unless public funding is then made available, maintenance is deferred to the point that the investment will no longer function without new investment in rehabilitation. By definition, this is not sustainable development.

And thirdly, economic efficiency (or maximising the net benefit of an investment to the economy) is one of the guiding principles of IWRM.

Source: Current study

Whether this growing demand creates opportunities for viable investment depends on economics. Strong market demand for cereals and the benefit of natural protection and low labour rates indicate some potential to displace imports, particularly for rice and, in the more temperate zones, perhaps for wheat. However, although sub-Saharan Africa countries may have more leeway to apply domestic support under the Doha Round, there is no indication that real prices of cereals will improve (FAO 2006, Diao et al 2003). It is thus unlikely that the economic viability of cereals under irrigation will change much in the foreseeable future. Rice-based schemes and those where other cereals are produced with higher value crops are likely to prove more viable than non-rice cereals monocrop schemes. At the average capital cost of recent well-designed projects (i.e. \$6,000 per hectare), and current productivity levels, new irrigation development is

unlikely to be viable for growing non-rice cereal crops. Thus growth in irrigated cereals production is likely to be mainly in rice, and to a lesser extent in wheat (Table 5.1)¹. Other crops (such as cotton, sugar and horticulture) and certain investments (such as irrigation improvement and run-of-river schemes) will be more viable, even at moderate levels of productivity, although this will be highly specific to sites and market opportunities.

Nevertheless, the benefits of agricultural water investment are often underestimated. Project appraisal techniques have in the past failed to capture the full benefits of agricultural water investment, particularly the benefits induced by the multiplier effect (see 3.5 above). Where these benefits can be quantified and valued the return to agricultural water investment may be much higher than previously thought: although no comparable study is available for sub-Saharan Africa, a study on Pakistan found that while the on-site productivity of irrigation water was \$0.04/m³ this increased to \$0.24/m³ when other local benefits were factored in, and to \$0.48/m³ – 12 times the on-site benefits – when all quantifiable national level economic and social benefits were accounted for (IWMI 2005h, World Bank 2005a:149).

Also, the economics of investment can improve if investments are multi-functional. Multifunctional projects can sometimes bring otherwise unviable rates of return to agricultural water investment up to acceptable levels. There are often opportunities to invest in irrigation development that, on their own, would be judged unviable but when combined, for example, with small to medium hydropower generation could result in an acceptable economic rate of return (World Bank 2005f: 9). The association of irrigation with livestock (Box 5.4) or fisheries is

¹ The projected imports of 18 million tonnes of rice in 2030 (Table 5.2) could be met from an additional 6 million ha of new irrigation single cropped at an average yield of 3 t/ha.

another example of potentially mutually reinforcing economics ([IWMI-ILRI 2005e](#); **Error! Reference source not found.**).

Box 5.4: Taking account of livestock in agricultural water investments

Crops and livestock are closely linked components of irrigated production systems, and both can be potentially fast growing and profitable enterprises where rapid urban growth generates demand. Growth in associated irrigated crop and livestock production is most likely in countries and areas with large animal populations and good access to urban markets.

To exploit possible complementarities between agricultural water development and livestock production, planners should work with stakeholders to assess *ex ante* the likely impact of irrigation development and correlated changes in land use on livestock keepers. Taking account of livestock in this way will minimize costs to livestock keepers of lost access to land and water resources and passageways, and mitigate any social tension or risk of impoverishment. In most cases it will also allow complementary investment and management that can improve livestock productivity – access to watering points, land and paths zoned for livestock and encourage the adoption of cropping patterns that have significant quality residue for use as animal feed or the development of zero-grazing systems based on irrigated crops and residues. Beyond the irrigation scheme itself, it may be possible to integrate management of upland catchment areas with downstream agricultural water service, which may involve investments and management to ensure that pastoral systems upstream remain profitable whilst conserving soil and water resources.

Source: IWMI-ILRI 2005e

Some storage investments will be economically justified, but past scepticism needs to be overcome. Since development of the physical potential on any significant scale will require the construction of new storage, it will be necessary to overcome the prevailing scepticism regarding the viability of such investments and their associated social and environmental costs. In fact, the thousands of privately financed irrigation dams in Southern Africa (and even publicly financed dams such as those constructed under the Mara Region Farmers' Initiative Project in Tanzania – IFAD 2005) are proof that such investment, if soundly and cost-effectively designed, can be viable and sustainable. Furthermore, the World Commission on Dams (Annex 10) has also acknowledged that dams can make an important contribution to human development and that negative externalities can be minimized or mitigated with careful planning.

5.4 Possible Investment Opportunities

There are significant opportunities for development and a wide range of water management investments are possible. As discussed, the theoretical potential for new irrigation, including groundwater irrigation, amounts to approximately 32 million ha – almost five times the area currently developed. In addition, the prospect of bringing back into production the 2 million ha of land that is equipped for irrigation but currently unused presents an opportunity to benefit from significant sunk costs. Improving water control on the 2 million ha of land under 'other forms of water management' in wetlands and flood recession areas also presents a similar opportunity for relatively low-cost investment. Finally there is the potential for improving in-field rainwater management on existing dryland crop areas – possibly up to 46 million ha. There is thus a very wide range of opportunities for investment in agricultural water development, from rehabilitation and expansion of existing irrigation schemes, to the development of new irrigation from surface

and groundwater resources, improved water control in cultivated wetlands and flood recession planting areas, to improved in-field rainwater management for dryland crops. There may also be opportunities for investment in watershed management to conserve catchments and stabilize or enhance flows for irrigation.

Development of new irrigation could take several forms and benefit many people. New irrigation development could consist of a wide range of technologies, ranging from individually operated micro-scale irrigation (e.g. using treadle pumps at very low cost) through to large scale. In many cases the development of small areas by individual smallholder irrigators, using micro-irrigation technologies (such as treadle pumps) will be appropriate. Small to medium scale communally managed schemes also have potential, although where these conveyance structures are needed, they may require some public investment support. Large scale irrigation would probably only be developed in cases where economies of scale and specific market linkages can be exploited (e.g. for industrial crops such as sugarcane).

Some development is likely to require new storage, which again might range from micro-scale water harvesting systems to large dams, providing opportunities to exploit synergies between irrigation and other uses (e.g. domestic and livestock water supplies, fisheries or hydropower). Other development is also likely to involve complementary investment in associated watersheds.

New irrigation is likely to be used for a range of crops from rice to horticulture or other high value crops. The range of costs is very great, depending on the water management technology employed (see Tables 3.1, 3.3 and 4.1). At an assumed average holding size of 0.75 ha per household, investment in 32 million ha of new irrigation development could directly benefit some 43 million irrigator households (or approximately 237 million people) plus a further 10-20 million households who would engage in increased opportunities for agricultural wage labour¹ (Table 5.4).

...as could the revival of equipped but currently unused areas. A mix of interventions is likely to be required to bring back into production the 2 million ha of land that is equipped for irrigation but currently not used. This land is located in large, medium and small-scale schemes and will require a mix of interventions, such as rehabilitation and upgrading of physical works, changes in the institutional set-up, and improved water management and crop husbandry. At an average cost of \$3,500 per hectare for recent well-designed rehabilitation projects, these investments could prove viable economically. However, these schemes would involve similar O&M costs to those for new irrigation schemes, and the cropping pattern would have to be sufficiently high value to cover those costs and to provide an incentive income to farmers. Again, at an assumed average holding size of 0.75 ha per household, investment in these schemes could directly benefit some 2.7 million households (or 15 million people) plus a further 0.7-1.3 million households engaging in increased agricultural wage employment.

¹ This assumes that for every household benefiting directly from irrigation an additional 0.25-0.50 households would benefit from incremental wage employment.

Table 5.4: Indicative summary of opportunities for investment in agricultural water development

Type of Opportunity	Theoretical Potential (million ha)	Possible Crops	Potential Direct Beneficiaries ^{/a} (million households)	Indicative Cost ^{/b} (\$/ha)	Scope for Investment (million \$)
New irrigation	32	Rice, sugar, cotton, dry beans, fodder, horticulture, other high value crops	58	6,000	192,000
Irrigation rehabilitation ^{/c}	2	Ditto	4	3,500	7,000
Improved water control in wetlands and flood recession areas	2	Rice and non-rice cereals, cotton, dry beans, fodder	4	2,000	4,000
Improved in-field rainwater management for dryland crops ^{/d}	46	Barley, maize, wheat, cotton, teff, dry beans, coffee, fodder	20	250	11,500
Totals	82		86		214,500

^{/a/} Assumes an average of 0.75 ha/household on irrigated land, wetlands and flood recession areas and 2.5 ha/household on dryland areas. Also that direct beneficiaries increase by 25-50% on irrigated land, wetlands and flood recession areas and by 10% on dryland areas, as a result of increased agricultural wage employment resulting from investment

^{/b/} Includes both software and hardware where applicable.

^{/c/} Likely to be an underestimate, since some of the 5 million ha currently under irrigation could be in need of rehabilitation

^{/d/} Assumes only 25% of current cultivated area will be developed.

Source: Current study

There is potential for improving water control in wetlands and flood recession areas. Improving water control on the 2 million ha of land under ‘other forms of water management’ in wetlands and flood recession planting areas might involve the development of flood protection and drainage systems, or even irrigation systems. However, in many cases the development of small areas by individual smallholder irrigators, using micro-irrigation technologies (such as treadle pumps) will be appropriate. Such investments are likely to involve lower capital and O&M costs than new or rehabilitated irrigation schemes and may be justified by the production of lower value crops. However, cropping patterns could include rice and other cereals, cotton, dry beans, fodder and, in a number of cases, horticulture. Average land holding size could be similar to that for new irrigation and the total numbers of direct beneficiaries could be of a similar order to those from investment in the rehabilitation or upgrading of existing, but unused, irrigation schemes, perhaps a total of four million households region-wide..

Solving the problem of low productivity on existing irrigated land presents a major investment opportunity. As discussed (2.3), irrigated production in sub-Saharan Africa is characterized by low productivity, constrained by unreliable water supplies, poor water management, low input use and poor crop husbandry, as well as poor access to input and output markets. Apart from unreliable water supplies, the constraints highlighted are mainly institutional and require investment in software rather than hardware. This opportunity would therefore involve only a fraction of the cost of physical works suggested in Table 5.4 and represents a first class investment opportunity.

Finally, improving in-field rainwater management for dryland crops clearly presents a further major opportunity. Improving in-field rainwater management is an attractive possibility because of the vast areas that might be involved, so that even a small yield increase could have a large production impact. For example, the area currently planted to dryland maize amounts to 24 million ha (FAO 2005a). An incremental yield of just 250 kg/ha on this area would amount to 6 million tonnes – i.e. more than the total projected imports of maize in 2030. In addition, the poverty reduction impact would be immediate, as dryland farming is the production system of the

poor. Improvements could involve a range of interventions, although all would have the common objective of increasing the effectiveness of rainfall for dryland crops. As discussed, various technologies have been successfully demonstrated in the region but, apart from one or two cases (e.g. the *tassa* in Niger and conservation tillage in Zambia) adoption has been poor. The constraints to wider adoption by smallholders are likely to be similar to those that are thought to currently limit productivity on irrigated land – i.e. a lack of farmer empowerment to access to input and output markets, poor agricultural support services (including extension and credit) and a lack of supply chains for implements and equipment. The theoretical potential is 174 million ha. For the present purpose it has been assumed that 25% of the currently cultivated area, or 46 million ha, might eventually be developed. Success is likely to be greater in the higher potential agro-ecological zones, particularly in the dry subhumid zone, but the experience from Niger suggests that good results can also be achieved in the semi-arid zone. Although the possible impact of this development on overall runoff, streamflow and ecosystems has not been quantified, it is unlikely that this would be significant.

5.5 Choices facing governments at the country level

At the country level, there are many constraints to developing the physical and economic potential identified. These constraints are typically *economic* (for example the identified projects are not economically viable), *financial* (for example, investment costs are too high for available finance), *institutional* (for example, the institutional model is unlikely to deliver good water service or will not prove financially and socially sustainable), *environmental* (for example, irrigation is viable but the regulatory framework cannot control adverse environmental impacts), *capacity-related* (local capacity to implement projects efficiently is weak), and *poverty related* (for example, poor farmers cannot invest in profitable agricultural water technology to improve productivity because they are resource poor and risk averse). These many possible constraints operate in every country in different degrees.

For each country situation, institutional and investment responses need to be devised to allow the potential to be realized despite the constraints. Essentially, choices will be required that reflect the development priorities and absorptive capacity of each country. The general principles that can guide governments in preparing strategies for agricultural water use were discussed above (Chapter 5.4). In each country adapting these principles to the specific opportunities and constraints that exist will require a painstaking iterative process.

5.6 The role of governments in developing the potential

The lessons of private and public investment

Private investors have proved more successful than public ones. Investment in agricultural water can certainly contribute to growth and poverty reduction by enabling farmers to intensify and diversify their production and to expand into new irrigated areas. The countless private schemes all over the region are testament to the ability of the private sector to identify viable opportunities, to implement projects and to manage them sustainably. Private schemes range in size and nature from agribusiness estates such as the world's largest irrigated sugar estate – the Kenana scheme in the Sudan – through smallholdings successfully supplying high value horticulture for export from many countries, to traditional small-scale paddy irrigation schemes in Madagascar. Key factors in success have been investment choices based on confirmed demand, and subsequent ability to manage the investment profitably and sustainably (NEPAD 2005:12).

By contrast, public investment has encountered problems of both implementation and subsequent management. Although the reasons for these problems are many and various, the principal have

been: (a) the pursuit of multiple objectives such as resettlement or poverty reduction that have led planners to take investment decisions that neglected basic conditions of economic viability, profitability and sustainability; (b) high capital costs due to over-design and implementation cost overruns; and (c) lack of a sustainable model for operation and maintenance. The best performing public investments have been those where farmers had a large say in design and implementation, and subsequently took over responsibility for management.

A new development paradigm

Developing agricultural water requires a new development paradigm in which market-driven profitability and private investment lead development and government plays a facilitating and public interest role. Across the region, governments have adopted increasingly a market driven, private sector led vision of agricultural development (see 4.2 above) in which the role of the public sector is to help the private sector to serve commercial farmers and to concentrate public resources on serving the poor by (a) improving the incomes and reducing the vulnerability of small-scale market oriented farmers and (b) enabling subsistence farmers to enter the market (or to exit agriculture altogether). Developing irrigation and other forms of water management within this approach to agricultural growth requires a new paradigm in which market-driven profitability is the over-riding concern, in which the private sector – from smallholder to major business – is the investor and manager of choice, and in which governments play a role in facilitating private market-driven development and in investing in economically viable and financially sustainable schemes where the private sector cannot and where there is a clear public interest of poverty reduction. With this approach, smallholders are expected to become essentially commercial farmers: governments, therefore, have a major role to play in empowering smallholders to participate fully in commercial agriculture.

Thus in general terms, the role of governments in promoting market-driven development of agricultural water within an overall pro-poor development strategy is to:

- **establish a pro-growth macroeconomic framework:** agricultural growth requires the macro and sectoral measures outlined above (see 4.2) to expand markets and facilitate investment.
- **integrate approaches to agricultural growth:** growth strategies need to be driven by a vision of how agricultural growth can reduce poverty. This requires a PRSP that gives priority to market-led agricultural growth and the role of agricultural water in that growth, and structural and institutional linkages between poverty reduction and sectoral strategies for agriculture and water (see 4.2).
- **invest in rural development:** public investment is required in rural infrastructure to raise farm profitability by (a) improving links to markets (e.g. by investment in roads and information systems); (b) developing institutional structures that empower farmers to engage with markets and service providers; and (c) stepping up research and development on technologies that enhance the productivity of water and other inputs.
- **promote investment in agricultural water:** governments have a role in facilitating private investment in agricultural water (see below). There is also a clear role for public investment in agricultural water where the private sector will not invest, for projects which meet the criteria of economic viability, profitability and sustainability and which are based on institutional models that provide for farmer empowerment, participation and ownership. The key in all investment is to focus on efficient and least cost water services

that are responsive to farmers' needs, and on the resulting increments in production and farmers' incomes.

Government's role in promoting private investment in agricultural water

Governments can promote private investment by developing the legal and institutional framework and by investing in infrastructure and research and development. Within this general definition of government's role, there are specific steps that governments can take to promote private investment in agricultural water by both large and smallholder investors. A priority is to develop secure arrangements for *land and water tenure* that encourage private, long term investment and the development of efficient land and water markets. Particularly important will be to ensure stable integrated and participatory water planning and regulation to underpin stable water rights and reduce the risk of negative externalities. The promotion of *financial market development* will be important, ranging from encouraging the development of local financial organisations that can serve smallholder needs (see 4.3) to formal sector instruments like guarantees. It will also be important to develop a range of *public private partnership instruments* to reduce commercial risks and mitigate risks from change in government policy (see Box 5.4). *Infrastructure development* to reduce market transaction costs will also be important. Finally, investment in *market-oriented research and development*, wherever possible in partnership with the private sector, will be required in order to develop cost effective technology for agricultural water management for commercial production.

Box 5.5: Public private partnerships in agricultural water

Government plays an essential role as guarantor of rights and equity, investor in public goods, guardian of natural resources, and enabler and facilitator of private sector enterprise. Where the risks are too high for the private sector, governments can devise public-private partnership arrangements. Examples include:

- partnerships for research and development of new technologies, for example through NGO/SME partnerships with NGOs or small enterprises for treadle pump promotion
- partnerships to help the private sector develop supply chains to enable smallholder irrigation farmers to respond to market opportunities, such as the Smallholder Irrigation Market Initiative
- partnerships to promote linkages between small and large enterprises, as in the Green Scheme in Namibia, or in Swaziland LUSIP, or in contract farming at Maunganidze in Zimbabwe);
- partnerships in irrigation management and service provision;
- partnerships in development and operation of major agricultural water infrastructure;
- partnerships in irrigation development, such as the partnership in Mali where government has invested in the Markala Dam and a private enterprise is developing 25,000 ha for sugar cane plantation

Source: IWMI 2005f

Improving public investment in irrigation

For existing publicly managed schemes, investment and institutional development should be targeted at empowerment of farmers, maximizing their participation and ownership and improving profitability. Governments should continue to test and scale up successful models for empowering farmers, investing in improving scheme infrastructure and developing sustainable O+M organizations where economically justified, and preparing where appropriate for irrigation

management transfer. A patient and iterative learning approach to institutional development will be needed, and sequencing will be critical: handover should only be considered when institutions are mature and when farming is profitable enough to cover costs.

Future public investment should be based on economic criteria and on the presumption of future handover to farmers. Selective new public investments should be made following criteria for economic viability, profitability, sustainability and poverty reduction, basing schemes on farming systems and farmers' livelihood strategies, involving farmers as partners from the start and - except where scale is too great - handing over completed schemes for subsequent farmer management. Clear arrangements for any 'co-management' and co-financing of operation, maintenance and replacement costs are needed if there is an essential public role such as managing major headworks and networks. Monitoring and evaluation of project performance is needed to inform future strategic planning and project design, as well as to measure the contribution of agricultural water development to achievement of the MDGs.

Partnerships with private investors and service providers should be based on public interest and comparative advantage. Co-investment with the private sector can be justified where governments can underwrite part of the costs of a small-scale initiative that can later be taken to scale by the market (for example, promotion of a treadle pumps supply chain). In some cases, governments may share the costs of major investments with the private sector in order to stimulate growth (for example, the development of the Markala dam by the government of Mali and the private investment in developing the irrigated area). There has not yet been a case in the region of a 'build own operate' or 'build own transfer' arrangement in agricultural water, where the government taps the investment resources and management skills of private entrepreneurs to implement a public interest project, but examples from Morocco and Egypt indicate the potential. Governments may also promote the development of private or NGO service providers, and where they can provide an efficient and accountable service, may delegate some otherwise public service functions to them.

Governments have special responsibilities in the most resource-poor areas. In the marginal semi-arid areas, agricultural water investment opportunities are limited. Although in the longer run, household livelihood strategies are likely to be predominantly off-farm diversification and out-migration, where economically viable and financially sustainable agricultural water technologies are available, public investment is justified in promoting sustainable land and water use practices to use scarce resources optimally. The justification for government support is all the stronger where there are significant externalities: for example, investment in land and water conservation on hill slopes under watershed management programs.

Although there may also be windows of opportunity for specific market-oriented investments, for example in small-scale irrigation, most investments are likely to be in improving rainfed agriculture. However, proving such systems to be viable and replicable requires careful time-consuming adaptation. The public sector has a role in developing the technology and building replicable models, but scaling up depends on the market supplying the technology and on farmers finding the investment profitable. Where such low input technologies can be demonstrated to be technically and economically viable and profitable for farmers within local farming systems, governments can work on ways to scale up investment through the market by creating awareness and a critical mass of demand, and by encouraging the development of sustainable private sector supply chains through partnership arrangements. An approach adopted in Brazil shows how governments may support scaling up (Box 5.6).

Box 5.6 No-till development support strategy: the Brazil Experience

Large-scale expansion of no-till farming in Brazil to the current more than 10 million ha started in about 1980, after small and local initiatives during the 1960s and 1970s. Large farmers used methods and equipment first from the United States and later from local manufacturers. Small farmers, with animal or small mechanical draught power, followed more than a decade later. During this period, small manufacturers together with innovative farmers designed smaller prototypes and started producing and marketing equipment adapted to small farms, including knife rollers to manage crop residues and combined direct seeders/fertilizer applicators.

The success of NT/CA in Brazil cannot be attributed to technical parameters alone. In conjunction with technical innovation, an effective participatory approach to adaptive research and technology transfer was adopted that tied farmers into a development strategy suited to their specific requirements. Institutional support was demand driven and concentrated on training and education that equipped participating farmers with the skills to adapt and refine NT/CA on their own farms. The cornerstones of the development support strategy were:

- *Close collaboration between researchers, extensionists, the private sector and farmers* for the development, adoption and improvement of NT systems;
- *onfarm trials and participatory technology development*;
- *strengthening farmers' organisations*; creation of local "Friends of the Land Clubs" where farmers exchange information and experiences and improve their access to extension and other advisory services as well as input and output marketing;
- *close cooperation with existing and new cooperatives* concentrating primarily on marketing and training for vertical diversification into livestock and processing;
- *aggressive dissemination strategy of technical, economic and environmental information* through the media, written documents, meetings and conferences – controlled and managed by producers' organizations (Friends of the Land Clubs) with emphasis on farmer-to-farmer exchange of experiences;
- *the national NT farmers' organization FEBRAPDP* played a significant role in advocating and supporting the promotion of NT/CA on large and small farms. As NT systems are complex to manage and require efficient farm management, training in record-keeping and a holistic understanding of farming systems' dynamics have been an integral aspect of support to small farmers;
- *private-public partnerships*; agro-input companies (Zeneca and Monsanto) supported demonstration projects in large and small farms through the provisions of inputs and extension services;
- *targeted subsidies*; short-term subsidies played a significant part in supporting small farmer adoption of NT practices. In Parana much of the hand-held or animal-drawn equipment was acquired with financial support from the state in the context of development programmes (mainly World Bank). Subsidized or free equipment is still made available to groups of farmers. Apart from economic constraints to adoption, the rationale for public subsidies has been the generation of the offsite benefits from NT adoption. In some instances, private companies provided equipment for small farmers;
- *integration of crops and livestock*; special attention has been paid to the incorporation of crops and livestock (including poultry, hog and fish farming). A particular challenge is the development of rotational grazing patterns on cover crops, which do not jeopardize the sustainability of NT systems;
- *incorporation of environmental considerations*; correcting watershed degradation (e.g. soil erosion, pollution of streams and lakes and road damage) was a key reason for the adoption of NT farming practices. Environmental awareness raising among farmers also resulted in central facilities for the disposal of pesticide containers, household sanitation and recovery of gallery forests.

Source: FAO 2003

‘other forms of water management’. The constraints to this development are mainly economic – i.e. costs, productivity and access to profitable markets.

The theoretical physical potential for new irrigation development is estimated to be more than 32 million ha – almost five times the area currently developed. There is potential for all forms of irrigation development, from individual micro-scale irrigation to large-scale – the choice depending on whichever is the best investment in terms of physical conditions and possible economies of scale. Some development is likely to require new water storage, which could provide opportunities to exploit synergies between irrigation and hydropower.

In addition to new irrigation development there is potential for improving the productivity of the 5 million ha currently under irrigation and for bringing back into production the 2 million ha of land that is equipped for irrigation but currently unused. A mix of interventions is likely to be required to realize this potential – which is in large, medium and small-scale schemes – such as improvements to the physical works, and improved water management and crop husbandry. There is also potential for improving water control on the 2 million ha of land under ‘other forms of water management’ – i.e. in wetlands and valley bottoms. Some of this may require the development of irrigation and drainage schemes, but in many cases the development of small areas by individual smallholder irrigators, using micro-irrigation technologies (e.g. treadle pumps), will be more appropriate. The main constraints to developing the potential for irrigation are economic – i.e. costs, access to profitable markets and potential productivity in supplying these markets.

Since more than half of the currently irrigated area is used for growing staples, recent analyses have considered irrigation as an option for reducing the region’s future food imports. However, at the average capital costs of new irrigation (even recent well designed irrigation) and the yields typically obtained by smallholders, economic returns and profitability may be adequate for rice, particularly for local markets enjoying natural protection, but would generally be too low to justify investment for crops such as maize and wheat. The expansion of irrigation for staple food crops will therefore require either productivity improvements that increase returns or substantial reduction in costs. The expansion of irrigation for higher value crops such as cotton, sugar and horticulture is likely to be more viable, but returns will be highly specific to sites and market opportunities.

Recommendation: *The potential for irrigation should be seen as an opportunity to achieve poverty reduction and economic growth through the production of irrigated crops (including rice) for which there is a comparative advantage, rather than as a means of reducing the region’s imports of non-rice staples for which lower cost interventions would be more appropriate.*

A wide range of water management technologies – from individually operated micro-scale irrigation through to large scale irrigation, possibly with water storage – should be considered for the development of new irrigated areas. Also, the existence of 2 million ha of land that has already been equipped but is not currently used should be regarded as an opportunity to take advantage of significant sunk costs. Similarly, the 2 million ha of land under ‘other forms of water management’ in wetlands and valley bottoms should be regarded as an opportunity to improve water control at relatively low cost. In addition, investments should be made in institutional improvements to raise productivity on existing irrigated areas, especially as these investments cost comparatively little.

Improving rainfed farming

***Lesson:** A range of low-cost in-field rainwater management technologies is also available for stabilizing and increasing the yields of dryland crops. The results of demonstrations and pilot projects to date have been promising and the potential for scaling up – especially for production of non-rice staples and possibly cash crops such as cotton – could be considerable. Because dryland farming is the predominant production system, improving its productivity could have a very substantial impact on production and poverty reduction. However, adoption rates have so far been poor.*

Dryland farming is far and away the largest production system, and even a small improvement in yield would have a large impact on production and poverty reduction. The technologies involve very low capital investment costs (usually in the order of \$100 per ha) and can be shown to be viable for the production of non-rice staples and possibly other deep rooted cash crops such as cotton. However, they typically have a rather short economic life – suggesting that public financing of on-farm works would be impractical. Yet unless the constraints that have so far discouraged farmers to invest their own resources in the technologies are removed, adoption can be expected to remain poor. These constraints are probably similar to those faced by the agriculture sector as a whole and are likely to include a lack of empowerment, weak or non-existent agricultural support services, poor access to input and output markets and weak or non-existent supply chains for equipment.

***Recommendation:** Investment in in-field rainwater management for dryland crops should be considered as an alternative to irrigation for non-rice staples and, possibly, other deep-rooted cash crops. Future public investment should concentrate on developing promising technologies, facilitating the establishment of sustainable supply chains where necessary, removing the constraints to adoption, and supporting dissemination and market-led adoption.*

Agricultural water development strategies should now consider the development, dissemination and adoption of in-field rainwater management technologies as an opportunity to stabilize and increase the yields of non-rice staples under dryland production. Because it would be impractical for government to finance the on-farm works required (since government would be obliged to repeat the financing every few years) it is essential that the technologies should be suitable for and attract farmer-financing. This implies that the technology should not only be technically feasible but affordable and profitable at the farm level. The various constraints to affordability and profitability that have discouraged adoption to date should be identified and investments made to establish the conditions that will remove them. The next step in most countries should be renewed research and development programs to identify replicable technologies, combined with monitoring and evaluation to pinpoint the constraints to widespread adoption.

6.3 Designing and implementing better investment projects

Agricultural water as part of a comprehensive package

***Lesson:** Investment in agricultural water is not on its own sufficient to ensure optimal yields, productivity and incomes. Water supplies must be reliable and provided as part of a comprehensive package that enables farmers to maximize productivity and profitability as well as creating the incentives for them to do so.*

Investment in agricultural water requires accompanying investment in agricultural support services, including extension and credit to provide farmers with the necessary skills and resources to enable them to make the best use of infrastructure provided and to invest in yield enhancing

inputs. Agricultural water supplies must also be sufficiently reliable and access to output markets sufficiently profitable for farmers to invest confidently in using these inputs.

Ensuring that water supplies are reliable, although extremely important, could be the easiest of the above requirements to meet: it merely involves procurement of competent technical advice and following it – which is usually a matter of good project management and supervision. The other requirements will be more difficult to meet. Reductions in the scope and operations of public agricultural support services as governments have redefined their core functions have made the provision of technology and finance to smallholder farmers a major challenge in recent years. At the same time, the withdrawal of the state from marketing has left smallholder farmers unprepared to deal with both input and output markets. The provision of agricultural support services by projects is not a satisfactory long-term solution: the arrangements need to be sustained beyond project completion.

Recommendation: *Financing agencies, including governments, should make project finance available only for those projects that, apart from providing a reliable supply of agricultural water, also provide support to enable farmers use it to maximise the profitability of crop production on a sustainable basis.*

Project designs should provide for farmers to obtain access to competent, commercially oriented, efficient and accountable agricultural support services on a permanent basis. This may involve facilitating market linkages, in which a private sector processor provides agricultural support in return for a guaranteed throughput, or it may involve building the capacity of farmers to either provide these services themselves or obtain them from private sector service providers. Project design should provide for capacity building to empower farmers and their organizations to adapt to their new role and collectively negotiate with input and output markets beyond project completion. Sustainable and accountable local financial services should be promoted, both for seasonal and investment finance.

Targeting the poor and women

Lesson: *The design of agricultural water investments should address all strata within the community, ensuring that all benefit to their mutual advantage. Exclusively targeting the poorest socio-economic stratum is not necessarily effective in reducing poverty – although specifically targeting women can be. Similarly, targeting the driest agro-ecological zones is not necessarily ‘pro-poor’.*

Experience suggests that exclusively targeting the ‘poorest of the poor’ is not necessarily the most effective way of reducing rural poverty. Since the vast majority of the rural population of the region subsists on less than a dollar a day (and are therefore categorized as the ‘extreme poor’ in terms of the MDGs), a more inclusive approach is likely to bring better results. In this way, all strata within the community – including the poorest – can benefit from investment to their mutual advantage.

Understanding the socio-economic profile of the target group, how they derive their livelihoods, what their constraints are, how they interact socio-economically and how agricultural water management, as an input to their farming system, can assist them in improving their livelihood status is therefore essential for pro-poor design. In addition, since more than 50% of farmers and rural labourers are women, specifically targeting support to women and encouraging their participation in governance structures can enhance productivity, profitability and hence poverty reduction.

Targeting the arid and semi-arid agro-ecological zones is not necessarily pro-poor, since greater scope for reducing poverty and hunger, in terms of population density, incidence of poverty, agricultural potential and the available pathways for households to increase their agricultural incomes, lies in the areas of high potential, particularly in the subhumid and humid zones.

Recommendation: *Project studies and designs should be geared to enhancing the prospects for all strata of the community, including women, to benefit from the investment to mutual advantage without marginalization of the poorest stratum. Targeting areas of low agricultural potential should be avoided, unless clear market-linked, viable opportunities for development are available.*

Socio-economic and production systems surveys should be carried out to provide an understanding of the profile of the target population and its intra-community dynamics, with a view to exploiting these to the mutual benefit of all members of the community, including women. Special care should be taken to ensure that the investment takes account of the role of women in the production system and does not exclude or further marginalize the poorest stratum. Attention should focus on ensuring that the investment will be 'pro-poor' by seeking to maximize farm level profitability, employment and incomes, and by devising mechanisms to empower the poorest, including women, and improve their access to land, water and services. Investments should generally be targeted at the subhumid and humid zones except where land, water and markets combine favourably in the drier zones to ensure viability and sustainability.

Implementing and managing public investments

Lesson: *Organizational arrangements for project design, implementation and management are more efficient when they reflect the comparative advantages of the public sector, farmers, NGOs and the private sector. Sustainability is best achieved by involving farmers throughout and by handing over schemes to farmer organizations once complete. In many cases it can be more efficient to obtain implementation services from the private/NGO sector than to build public sector institutions for the purpose, even where local private/NGO sector capacities are weak.*

Weaknesses in public sector organizations have impaired the quality of project preparation, implementation and management, and inadequate support by governments and donors through the supervision process has also been a cause of poor quality. Experience of organizational arrangements for project development and management has shown that farmer involvement improves design and reduces costs, and that the most profitable and sustainable schemes are those where farmers are able to take over operation and maintenance once the scheme is developed. Private/NGO sector service providers can also play an effective role in agricultural water development, mainly because they can be held more accountable for their services than public sector service providers, although they need effective supervision. The choice is essentially a pragmatic one: which organization – public, NGO or private – can provide the most efficient and accountable service?

Recommendation: *Farmer management of schemes should be the first option, and clear arrangements need to be agreed for any joint management. Service provision arrangements and supervision thereof should be based on the respective strengths of the public sector, the private sector, NGOs and farmers. Governments and donors should improve the supervision process.*

Farmers and their organizations should be involved from the first conception of a project. In all cases, farmer management of schemes once they are complete should be the first option, and clear arrangements for any joint management and co-financing of operation, maintenance and replacements are needed if there is a task beyond farmer capacity such as managing major

headworks and networks. Farmer organizations will need to be strengthened and empowered to participate in project design, implementation and management. Where NGOs or the private sector are contracted to provide services, terms of reference should clearly specify the intentions with regard to the 'deliverables' and accountability for them, as well as exit strategies. Engineering design and construction supervision services should be obtained from the best qualified source, regardless of origin (i.e. national, regional or international), the objective being solely to ensure that farmers are provided with competent services. Supervision should be geared to quality assurance and keeping activities focused on the overall objectives. Governments and donors need to support implementation with adequate time and technical resources, and to be flexible enough to adjust in the light of experience.

Social, environmental and health impacts

Lesson: Agricultural water development can have both positive and negative social, environmental and health impacts. The challenge is to design, implement and manage projects in such a way that socio-economic benefits are maximized whilst negative impacts are minimized.

Agricultural water development can produce positive social, environmental and health impacts: improving pastoralists' access to water and feed, improving environmental flows, safeguarding natural habitats, improving nutrition, improving access to health facilities and health service provision, and providing water for domestic purposes. Agricultural water management can help mitigate the impacts of HIV/AIDS through increased incomes and better nutrition.

However, negative social, environmental and health impacts of agricultural water developments are widely documented. Inadequate assessment of potential impacts and absence of design measures to mitigate them, as well as weaknesses in the public sector institutions responsible for regulating environmental and health aspects, can lead to reduced productivity, project failure and increased human suffering.

Recommendation: Improved planning and management of social, environmental and health impacts is a prerequisite for ensuring the sustainability of future agricultural water development. Project designs should not only assess and provide mitigation measures for potentially negative impacts but also seek to exploit potentially positive impacts. Project designs should also, if necessary, make provision for strengthening the public sector institutions responsible.

Project designs should not only assess and provide mitigation measures for potentially negative impacts (such as conflicts with pastoralists, or spread of water-borne diseases) but also take advantage of opportunities for potential synergies and positive impacts (such as providing water and feed for livestock, or improving watersheds). In this way, projects can improve their prospects for productivity and sustainability, and may also contribute to the achievement of the MDGs for child mortality, maternal health, combating HIV/AIDS, malaria and other diseases, as well as the environment (including water and sanitation). The economic costs and benefits of environmental impacts need to be taken fully into account in appraisals and investment decisions. Given the interlinkages within catchments, consideration must be given to the potential environmental impacts on projects as well as the impacts they cause, and also to the potential cumulative effect of a number of projects.

Since, in many cases, the effectiveness of mitigation measures, or measures to exploit positive impacts, will be constrained by institutional weaknesses, support should be provided for reforming and strengthening institutions, possibly through sector-wide approaches. Public agencies need also to be equipped to manage the environmental impacts of private irrigation development. Methods of rapid appraisal need to be developed for small scale interventions

where it is unrealistic to expect full environmental and health assessments to be conducted. Initiatives that build local-level awareness of the social, environmental and health issues associated with agricultural water development should be encouraged. Specific strategies are needed to address the attrition of staff and farmer leaders from HIV/AIDS-related infections.

Monitoring and evaluation

***Lesson:** Monitoring and evaluation of project performance has been neglected in the past and needs to be improved in future to inform future strategic planning and project design, as well as to measure the contribution of agricultural water development to achievement of the MDGs.*

To measure the contribution of agricultural water investments to poverty reduction and the attainment of the MDGs, good monitoring information is needed, not only on inputs and outputs but also on outcomes like changes in income and employment, and on broader and longer term impacts such as those on poverty, hunger and health and on the environment. However, monitoring and evaluation has been one of the most common weaknesses in project design and implementation in the past. There is also a need for greater accountability by all concerned, including government and financing agencies, to ensure that monitoring and evaluation intentions at design are carried through on implementation.

***Recommendation:** Monitoring and evaluation as a management tool for farmers, implementing agencies and financing partners should now be given priority.*

Monitoring and evaluation, not only of physical and financial targets but also of changes in incomes and employment and of impacts on poverty, hunger and health and on the environment should be given priority. Systems should be designed in such a way that they can be used as a management tool for farmers, project implementers and supervisors.

6.4 Institutional reforms

***Lesson:** Institutional reforms can enhance the performance of agricultural water development and its contribution to sustainable agricultural growth and poverty reduction. However, reforms require time and consistent approaches by both governments and donors. Decentralizing development responsibility can also enhance impact. Reforms need to be accompanied by effective capacity building to equip the actors to cope with new roles and responsibilities.*

Institutional reforms can improve the performance of agricultural water investments, including large-scale irrigation. Without reforms, farm level profitability will generally be constrained and disincentives to investment will persist. Reforms to macro-economic policies facilitate business and encourage investment in agricultural intensification. Reforms to food security policies create efficient food markets and improve the ability of the poor to feed themselves. Water sector reforms ensure water entitlements and sustainable water resources management. Both private and public sector have a role to play: governments have an essential role in establishing a institutional framework conducive to private enterprise and in investing in key infrastructure where the private sector will not; the private sector will have a key role in investment (either in PPPs or on their own), manufacturing, service provision and market linkages. Decentralization can promote greater responsiveness to local needs and markets – although it has proceeded somewhat erratically to date and there is a need for support to develop good governance, capacity building and empowerment.

Reforms to legal and organizational frameworks for large-scale irrigation projects have indicated pathways for success. These have included: improved land tenure; downsizing management

agencies and improving transparency and accountability to farmers; farmer participation in management; and contracting out to private sector agencies for non-core activities, such as scheme maintenance. Some attempts at transferring management responsibility to farmers have not yielded the expected results. However, successful cases show what conditions are needed: a partnership approach between policy makers, irrigation agency and water users; a supportive policy and legal framework; scheme profitability and financial autonomy; the strengthening of user organizations; and a clear plan and timetable, with careful management of the process including post handover support; and political and managerial commitment.

Institutional reforms take time and patience, but experience has shown that a coordinated approach to reforms, applied gradually with consistency between governments and donors, can be successful. Most reforms need to be accompanied by programmes of capacity building to enable the actors to adapt to and capitalize on the change. Some reforms may be achievable within the context of a discrete project; for others a sector-wide approach may be appropriate.

Recommendation: *The on-going process of reforms to macro-economic policies, legal frameworks and organizations for agricultural water management should be supported and strengthened, with capacity building where appropriate, to create a favourable environment for profitable investment, to engage the energies of the private sector and of farmers, and to make service providers accountable. Decentralization of development responsibility and empowerment of farmers, including building the capacity of farmer organizations, are needed to improve the performance of investments. Improvements in land and water governance are needed to facilitate private investment and empower farmers. Organizational reform of large-scale irrigation should be based on user empowerment, private sector participation and irrigation management transfer. These reforms require time and consistent approaches by both governments and donors, for which sector wide approaches may be appropriate.*

The on-going process of reforms to macro-economic policies, legal frameworks and organizations for agricultural water management should be supported and strengthened, where appropriate with capacity building, to create a favourable environment for profitable investment. Particular areas for institutional reform should include:

- Completing reforms of macroeconomic, food security and water sector policies to promote profitable investment and employment in agricultural water, and encouraging greater involvement by the private sector, through policies that favour enterprise and through public private partnerships.
- Ensuring systematic attention in project design to issues of land and water governance and tenure.
- Supporting decentralized development through capacity building for local authorities, decentralized agencies and farmer groups.
- Developing coherent and sustained approaches to organizational reform of the large-scale irrigation sector, including best practice on user involvement, private sector participation and irrigation management transfer.
- Empowering farmer organizations to enable them to function in liberalized economies, ensuring that service providers are accountable and responsive to their needs, and that organizations are able to participate in project design, implementation and management, and to compete in markets.
- Building in incentives for all partners to change.

The design of programmes for institutional reform should recognize that time and sustained commitment are required. All partners involved in the sector need to work to a harmonized common agenda, to align support on national programmes and institutions, as well as to invest in capacity building.

6.5 Strategic Vision

***Lesson:** A strategic vision for agricultural water development has been lacking. Consequently, significant opportunities for achieving agricultural growth and poverty reduction are being missed. There is considerable potential for further development of agricultural water, but also significant constraints, of which only some can be overcome*

Although perceptions that agricultural water development has been inefficient – in terms of water use and economics – were probably justified in the past, a number of recent projects have demonstrated that, with careful project identification, design and appraisal, this need not always be the case. However, water sector strategies and programmes are generally neutral – or even negative – towards agricultural water development and use. They typically assign greater priority to other uses. Most poverty reduction strategies are predicated on agricultural growth, but agricultural water development generally has a low profile in PRSPs – possibly because of the negative perceptions referred to above. In effect, there has been a lack of a strategic vision for agricultural water development.

There are, as mentioned, economic and institutional constraints. Some of these can be resolved at the level of programmes and projects, others need to be resolved at the sectoral level or in the wider macroeconomy. Other constraints are difficult or impossible to alter, and provide a context within which the strategic vision needs to be developed. They include: poor terms of trade, limited and high cost access to world markets, the dispersed population, and poor agricultural potential in many areas, particularly in the arid and semi-arid zones.

***Recommendation:** Sub-Saharan African countries should now develop national strategies for the agricultural water subsector that recognize both its importance for agricultural growth and poverty reduction and the economic realities referred to in this report, as well as the need for water to be developed within a broader framework that promotes agricultural growth through profitable investment and market oriented production. Agricultural water strategies should be integrated with both broader water resources management strategy and with poverty reduction strategy. Strategies need to be supported by analysis of the role of public and private investment, of ways to foster private investment, and of the range of public investment options incorporated into an investment plan, and be implemented wherever possible through sector wide approaches.*

Sub-Saharan African countries should now develop a strategic vision for the agricultural water sector. This vision should be incorporated into a **national strategy for agricultural water development as a key component of both national agriculture policy and water policy**. The profile of agricultural water development should also be raised in water and agriculture sector strategies. Agricultural water development strategies should be linked to **water sector strategies** and based on IWRM principles, respecting and supporting **transboundary water agreements**, with investments optimized at the basin scale. IWRM approaches should strike a balance between demand and supply management, providing for new investment in supply where it is economically, socially and environmentally justified. They should also ensure that water allocation and management take account of the needs of the poor and provide for greater participation in sectoral and basin planning by smallholder farmers. Agriculture water

development strategies also need to figure prominently in **poverty reduction strategies**, as set out in PRSPs, to focus the attention of both governments and potential donors.

The strategies should be supported by a comparative analysis of the various **investment options**, including:

- Investment in increasing productivity and profitability of existing schemes.
- Expansion or new construction of large, medium, small and micro-scale irrigation schemes (including water harvesting) linked to profitable markets, following best practices for new storage and based on viable institutional models.
- Testing and scaling-up of technologies for in-field rainwater management, provided these are proven to be technically and financially feasible and replicable by smallholder farmers on a sustainable basis.
- Development of sustainable supply chains for micro-scale irrigation and in-field rainwater management equipment.

- Investment in research on agricultural water management, both adaptive research at the national and regional levels and basic research at the regional level. Particular emphasis will be needed on three components: (a) the technology, profitability, affordability and replicability of in-field rainwater management for dryland crops; (b) crops and crop husbandry improvements for staples; and (c) monitoring and evaluation of the performance of agricultural water investments *on a region wide basis* in order to provide the basis for rapid scaling up of emerging successes.

- Investment in institutional reforms, including those for decentralized development and all necessary capacity building.

All these investments should, if practically possible, be pursued using sector-wide approaches to ensure consistency of approach between government and donors.

Where existing policies and strategies reflect the strategic vision outlined above, they should become the basis of **new investment programmes**. Where they do not, policies and strategies should be revised and new investment programmes prepared. If external assistance is necessary for the formulation of the new strategies and investment programmes, this should be sought from international development agencies. Phased investment programmes should be based on (a) the available physical potential, the markets available and the feasibility of achieving levels of productivity and profitability that will justify the likely investment costs; (b) identifying where economic viability, farm level profitability and sustainability can best be achieved by the different investment options mentioned above; and (c) indicating the measures necessary to promote profitability. The programmes should be prioritized according to prospects for achieving farm level profitability, economic viability sustainability and, hence, poverty reduction and growth.

