MILLENNIUM CHALLENGE CORPORATION

PRINCIPLES *into* PRACTICE

Irrigated Agriculture

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The Millennium Challenge Corporation was founded with a focused mandate to reduce poverty through economic growth. MCC's model is based on a set of core principles essential for development to take place and for development assistance to be effective—good governance, country ownership, focus on results, and transparency.

The MCC Principles into Practice *series offers a frank look at what it takes to make these principles operational. The experiences captured in this series will inform MCC's ongoing efforts to refine and strengthen its own model. In implementation of the U.S. Global Development Policy, which emphasizes many of the principles at the core of MCC's model, MCC hopes this series will allow others to benefit from and build on MCC's lessons.*

The series also offers insights into MCC's experience with the technical and operational approaches it uses to support poverty reduction through economic growth. Consistent with MCC's focus on results, MCC is committed to learning from experience and applying lessons learned to its programs. Consistent with MCC's commitment to transparency, and in the spirit of ongoing collaboration with other development practitioners, MCC will share this learning publicly, even when it reflects challenges that MCC and partner countries have faced. The full Principles into Practice *series is available at www.mcc.gov/principlesintopractice.*

In Principle:MCC's Approach to Irrigated Agriculture

Two of MCC's founding principles are country ownership and a focus on results. These principles lead MCC to support investments that reflect countries' own priorities for poverty reduction, and offer the most promise for returns in terms of increased incomes. MCC empowers partner countries to prioritize investments that address the most binding constraints to economic growth and poverty reduction. Many partner countries—including not only governments but citizens, civil society organizations and private enterprises—have prioritized irrigation projects for MCC investment. These investments seek to increase rural incomes by improving agricultural productivity and access to markets, and seek to enhance food security by expanding local food supplies and creating new income opportunities.

This paper offers lessons learned drawn from MCC's portfolio of irrigated agriculture investments. The lessons in this paper focus on project *implementation*, not impact. MCC's portfolio of impact evaluations will soon begin to yield additional lessons about the impact of MCC's irrigation and related investments on farming practices, agricultural productivity, and income generation.

In Practice: MCC's Approach to Irrigated Agriculture

MCC's investments in irrigation total almost $1 billion. These investments are one component of MCC's broader investments, totaling $4.4 billion, in agriculture, rural development and food security.[1] Taken together, these investments contribute significantly to the United States' support of global efforts to reduce hunger and poverty, increase food security, and reduce the impact of climate change on agriculture.

MCC's investments in irrigated agriculture include infrastructure, water management, value chain and market development, access to rural finance, and land tenure activities. These investments, collectively referred to as "irrigation projects," figure prominently in MCC's program portfolio. MCC has irrigation projects in various stages of implementation in nine partner countries. These projects are expected to result in over 252,000 hectares of new or improved irrigation.

MCC's irrigation projects cover a variety of investments, reflecting partner countries' own priorities for poverty reduction. These projects include construction of small water retention and water control structures in Cape Verde and Honduras; rehabilitation of existing main irrigation systems in Armenia, Moldova, Ghana, Mali, Morocco and Senegal; and construction of new irrigated perimeters that expand existing systems in Ghana, Mali, Burkina Faso and Senegal. Similar to MCC's compact portfolio as a whole, the majority of irrigation investments are focused in Africa, providing support in a part

1 As of December 31, 2011.

of the developing world that currently has some of the world's lowest share of irrigated land and greatest food insecurity. Annex 1 provides an overview of these irrigation projects.

Accountability for results is a hallmark of the MCC model. This principle demands that MCC-funded investments are cost-effective and have strong potential for impact and sustainability. As with all MCC investments, irrigation projects proposed by countries eligible for MCC compacts must meet high standards in order to be selected for compact funding. Selected projects must address a key constraint to economic growth, as identified by rigorous economic analysis; be identified as a national priority by the government, civil society and the private sector; have promising returns in terms of increased incomes; be cost-effective, in terms of potential benefits justifying the expenditure of scarce development resources; be technically and financially feasible within the five-year compact period; and be implemented in accordance with MCC's environmental and social safeguard standards.[2]

Box 1: **The Global Context**

The irrigation sector has experienced a global investment surge over the last half-century. Between 1950 and 2008, the amount of land under irrigation worldwide doubled, increasing from 139 million hectares to 280 million hectares, with most of this growth occurring between 1950 and 1980. South and East Asia account for 67 percent of irrigated land in developing countries; Sub-Saharan Africa accounts for only five percent.

In the 1960s and 70s, governments invested heavily in the development of large-scale irrigation schemes that contributed to rapid increases in food production, averted famine and were an important success factor of the Green Revolution. However, many of these earlier investments performed below expectations partly because they lacked the necessary complementary investments for sustainability. Nearly two-thirds of recent international financing for irrigation and drainage has been dedicated to rehabilitation and modernization of large-scale irrigation systems.[1] MCC's investments in irrigation systems, most of which serve small farmers and many of which are in Africa, mirror this global trend. The majority of these funds support irrigation rehabilitation, with an additional focus on policy reforms critical to sustaining those investments, such as improved operations and maintenance.

Studies by the Food and Agriculture Organization argue that food security can be achieved by 2030 through an expansion of irrigated areas and improved productivity on existing irrigated lands, and estimates that large-scale irrigation schemes contribute to about 40 percent of the world's food and fiber production, indeed a significant contribution toward global food security.[2, 3]

(1) The World Bank, *Reengaging in Agricultural Water Management – Challenges and Opportunities,* 2006.

(2) *Ibid*. Reference is made to FAO/IPTRID, *The Irrigation Challenge: Increasing Irrigation Contribution to Food Security through Higher Water Productivity from Canal Irrigation,* 2003.

(3)Plusquellec, Herve, "Modernization of Large Scale Irrigation Systems: Is it an Achievable Objective or a Lost Cause?" Irrigation and Drainage 58: S104-S120, John Wiley & Sons, Ltd., 2009.

2 Please see MCC's Principles into Practice papers "Focus on Results" and "Country Ownership" for more discussion on how MCC and partner countries design and implement MCC investments.

In addition to complying with the above criteria, the following three operational premises are recognized as international best practice guidance in the development and management of productive and sustainable irrigation systems.

1. **An irrigation system is a complex land-water-economic-social system**. Irrigation infrastructure is ultimately built to serve farmers' needs, and while it can be said that their primary objectives are to increase income and reduce vulnerability, farmers' motivations and behavior are also influenced by environmental and institutional factors. Therefore, understanding local market dynamics (including how access to technology, inputs and services will shape farmer responses to market signals), economic incentives, land tenure issues, socio-economic relationships and cultural norms is critical to developing functional and sustainable irrigation systems that improve livelihoods.

2. **An irrigation system provides a service to water users**. Technology choices in design and investment, particularly in regards to alternatives for water delivery and control, should respond to water users' requirements and focus on how these systems will be operated and maintained reliably, efficiently and equitably. Moreover, achieving the desired "service approach" to irrigation systems requires that water users participate fully during the design stage and that their continued engagement throughout the life of the infrastructure is an integral part of the eventual design. Such an approach is essential to gaining the user buy-in and satisfaction on which sustainability depends.

3. **An irrigation project is one element of an overall river basin or watershed, with multiple objectives competing for limited land and water resources.** Understanding the water requirements of all users is essential to effective watershed management and, in that context, to the design of sustainable irrigation investments. The effect of climate change on water supply, outflow requirements to meet downstream needs and drainage considerations are key factors that may complicate irrigation design.

Box 2:
Five Lessons in Irrigated Agriculture

Lesson 1: Policies matter. Incentivizing efficiency and promoting sustainability is key to success.

Lesson 2: Design matters. Irrigation sustainability requires designing with farmers' needs in mind.

Lesson 3: Management matters. There are tradeoffs between being ambitious and being manageable.

Lesson 4: Water is for more than irrigation. Early attention to surface and groundwater resource availability and competing uses is important to ensure sustainability and maximize benefits.

Lesson 5: Prepare to adapt. Unanticipated cost escalations and implementation delays may require project scope changes during implementation.

Five Lessons: MCC's Experience with Irrigated Agriculture

The MCC irrigation portfolio, implemented by partner countries through "accountable entities" (Millennium Challenge Accounts, or MCAs) established to administer MCC-funded compacts, includes a wide range of irrigation systems and related investments. The portfolio reflects partner countries' own priorities, and each project is designed to address country-specific conditions reflecting the current state of irrigation systems, diverse topographies, agro-climatic characteristics, cultural and social conventions, institutional structures, and cropping and marketing systems.

This paper offers lessons learned about program implementation, not about impact, drawn from MCC's portfolio of irrigated agriculture investments. The five lessons share two common themes: managing irrigation investments in the context of country ownership; and addressing the tradeoffs inherent in an ambitious approach that includes both infrastructure investments and complementary activities to increase impact and sustainability.

As a learning organization, this paper takes a frank look at how MCC and its partner countries have grappled with some common challenges in efforts to improve irrigated agriculture in a cost-effective manner, and demonstrates how the lessons learned in early compacts have benefitted later compacts.

Lesson 1:
Policies matter. Incentivizing efficiency and promoting sustainability is key to success.

To achieve a full and lasting impact, MCC investments cannot happen in isolation. Consistent with MCC's principle that policies and good governance matter for economic growth and poverty reduction, MCC and its partner countries look closely at the environment in which MCC is investing, and assess what policies or practices might limit the investments' impact and sustainability.

In the case of irrigation infrastructure, MCC works with partner countries to support their efforts to establish a policy environment that provides incentives for farmers to use water efficiently and for institutions to effectively operate and maintain new or rehabilitated infrastructure. As with design and institutional issues, the policy issues associated with irrigation are as varied as the countries and systems with which MCC works. Policies requiring review and reform often include setting the price of water to reflect costs of service delivery and water scarcity, devolving the responsibility for irrigation management to water users, enabling efficient input and output markets, establishing

secure land tenure arrangements, and facilitating access to cost-effective technology through open markets and agricultural research. Inherent in policy and regulatory change is the challenge of behavioral changes of government entities and water users.

During compact development, MCC has worked with partner countries to pair irrigation investments with policy and institutional changes to help ensure investments translate into sustained income gains for targeted farmers. This has included introduction of policy milestones within compact projects, such as the introduction of laws, regulations and reforms in Armenia, Moldova, Burkina Faso and Senegal; and introduction of explicit compact activities, such as land tenure reform in Mali and Senegal. MCC and its partner countries have learned that achieving these complementary changes can be as difficult as, or more difficult than, completing the investments they support. Unexpected delays in policy and institutional reforms can affect the pace of implementation progress, particularly if reforms must be completed before infrastructure works begin, or if needed reforms are identified after implementation begins.

MCC has learned the importance of early engagement and efforts to build such requirements into compact agreements up front. Once implementation plans are set, there is little time, leverage or incentive for governments to effect change—especially when change is controversial. Below are several examples of this experience.

- ★ In **Mali**, although the compact embodied a service-oriented system design and introduced a new land tenure regime, specific requirements for water management institutions in the project area were not established during the design phase. Moreover, the compact agreement included little specific language to ensure a transparent and self-sustaining water management institution, and these arrangements are not fully in place as the compact enters its final year. To ensure that the important policy and institutional reforms proceed, MCC is collaborating with USAID-Mali as part of their Feed the Future activities to continue institutional development beyond the five-year compact period.[3]
- ★ The **Moldova** Compact, in contrast, implements a series of incremental steps to demonstrate water users' commitment to assume operation and maintenance of MCC-funded irrigation systems. Moldova's initial compact proposal focused solely on irrigation infrastructure rehabilitation and lacked attention to the environmental, social and policy context in which the irrigation sector operates. MCC worked with the Government of Moldova to identify ways in which Moldova could not only modernize its infrastructure, but also initiate major reforms in the irrigation sector as a specific compact objective. The country developed a revised proposal to revolutionize its water management institutions, embodied by a new law allowing membership-driven water user institutions to operate and maintain irrigation systems from primary to tertiary levels.

  In addition to this law, the Government of Moldova is taking steps to establish

3 At the time of publication, MCC is reviewing the operational status of the Mali Compact due to a military coup in March 2012 inconsistent with MCC's eligibility criteria. All Mali-related examples cited in this document predate the operational review.

legislation that would overhaul existing water codes to increase compliance with the European Union's Water Framework Directive.[4] Both of these key pieces of legislation were requirements to trigger MCC's disbursement of project funds.

- ★ In **Armenia**, the MCA led an effort to usher momentous irrigation policy changes through the country's legislative process. The resulting *National Irrigation and Drainage Policy*, developed with MCC funding, is the first such policy in Armenia's history. It serves as a framework to support improved development, management and financial sustainability of the Armenian irrigation and drainage sector. Under the new policy, water user associations, or WUAs, are now exempt from profit and value-added taxes. This revision allows WUAs to establish maintenance funds previously subject to profit taxes and therefore nonexistent. These changes are important steps toward making WUAs financially self-sufficient, reducing dependence on public subsidies and ensuring WUAs can set aside funds to maintain infrastructure.
- ★ In **Burkina Faso**, MCC worked with the government to reform its Water Management Agency, AMVS, to provide a more supportive and operational structure for WUAs and operations and maintenance activities in the Sourou Valley. This included creation of a maintenance directorate within AMVS, establishment of a separate co-managed fund for operations and maintenance, and reduction of AMVS's scope to focus primarily on operations and maintenance issues.
- ★ In **Senegal**, prior to compact signature, maintenance of existing irrigation networks was deficient and a constraint to economic growth. The compact's irrigation project seeks to reduce poverty by improving productivity of the agricultural sector through extended and improved irrigation systems, including rehabilitation of an existing irrigation network experiencing significant losses. To address this, the compact agreement requires the Government of Senegal's Ministry of Agriculture to conduct an audit of irrigation network maintenance, and develop an action plan to address identified weaknesses. Specific milestones include MCC's approval of the action plan and the ministry's progress throughout compact implementation. This establishes institutional reform as a clear priority for sustainability, but embraces country ownership in leaving the precise nature of the reforms in the hands of the Senegalese.

Lesson 2
Design matters. Irrigation sustainability requires designing with farmers' needs in mind.

Achieving sustainable economic benefits from irrigation infrastructure depends not only on reliable water delivery structures, but also institutional capacity to operate and maintain these systems. Putting these in place often involves changing ingrained practices of government agencies, water management institutions and farmers. MCC and its partner countries have tried several approaches to addressing these long-term

4 The European Union Water Framework Directive establishes a framework for EU community action in the field of water policy to maintain and improve the community's aquatic environment. More information is accessible at http://ec.europa.eu/environment/water/water-framework/index_en.html.

sustainability issues, both in regards to infrastructure design and in-country management systems.

Irrigation design: An irrigation investment will only have a positive and sustained impact if it meets farmers' needs and farmers are willing to pay for reliable water delivery. To this end, MCC has sought to introduce "service orientation" and "modernization" into irrigation designs to help enhance the performance and efficiency of water delivery through improvements in infrastructure design and technology (see Box 3). Adapting modern irrigation design concepts to individual country contexts requires the application of hydraulic engineering, agronomy and social science to arrive at the simplest and most workable solution to meet operational requirements and serve farmers' needs. Below are several examples of how MCC and partner countries have used irrigation design to increase impact and sustainability.

Box 3:
Terms of the Trade

"Service orientation" means focusing first on what outcomes one wants to achieve with a given investment; then pursuing design, maintenance and sustainability plans with these goals in mind.

"Modernization" means technical, managerial and organizational upgrading of irrigation systems, as opposed to mere physical rehabilitation, to improve resource utilization and water delivery to farmers.[1]

(1) Adapted from Burt, Charles M, *The Irrigation Shift from Construction to Modernization: What is Required for Success?,* USCID Newsletter 109, Fall 2011.

★ In **Mali**, the existing irrigation complex in the Niger River Basin, known as the *Office du Niger*, faces increasing demands on water availability and access as plans for new irrigation perimeters continue. In this context, the compact is introducing a new communications network designed to monitor, transmit and analyze water levels and control gate information throughout the *Office du Niger* irrigation system. Traditionally, managers of the main irrigation system have relied on manual readings and telephone communication to inform a central control operator of water levels and control gate positions. This information was manually analyzed by a central unit, which then instructed field operators to adjust gate levels to meet crop water requirements.

The first harvest of rice in the Mali irrigated agriculture project.

Installation of the new communications network, Supervisory Control and Data Acquisition, or SCADA, will introduce automatic water level sensors in control gates. This information will be transmitted to central units by radio, providing more regular, accurate and reliable readings. This information will be stored in a central unit with data processing capabilities, enabling system managers with enhanced capabilities to meet farmers' needs and achieve more transparent and equitable water distribution throughout the system. SCADA will improve safety, preventing unnecessary overtopping of embankments; and improve production by providing early warning of low water levels.

Another innovative design aspect of the Mali Compact involves introduction of land titling to farm families and equal allocation of scarce dual-season land. With respect to land rights, the *Office du Niger*'s administrative irrigation district has traditionally issued short-term land leases of one to two hectares in size. Farmers unable to pay land leases and water fees could no longer farm the land, which would then be leased to other farmers. MCC anticipates that land titling will introduce a greater sense of security and ownership in farmers' land. When land is titled, it can be used as collateral for lending and risks of losing cultivation rights are eliminated. Farmers can invest more in agricultural production and improved maintenance of irrigation infrastructure.

★ In **Armenia**, the compact, completed in 2011, introduced new approaches to reduce maintenance costs and water loss. During the Soviet era, common technology for field irrigation included use of pre-fabricated concrete slabs, which shifted under repeated icing and thawing. This caused increased maintenance costs and resulted in water loss through seepage. The MCC project introduced more rapid and effective infrastructure construction methods, such as sprayed concrete; and, on a pilot basis, demonstrated how geo-membrane linings can be installed more rapidly and are less susceptible to ground shifts on pervious soils. While there was some initial reticence among government irrigation planners to unfamiliar technologies,

Rehabilitation and construction of irrigation canals in Armavir, Armenia. Technologies used, and accompanying policy and institutional reforms, are designed to increase sustainability.

these technologies proved to be practical and economical. In addition, a system of diagnostic analysis was introduced that resulted in many canal sections previously slated for re-lining becoming effectively rehabilitated with minor and much more cost-effective repairs.

★ **Cape Verde's** first compact, completed in 2010, included an irrigation project tailored to the capacity of water users. The water management system for irrigation infrastructure is community-based and led by small farmer associations that tend to have limited experience with water management. Simple rain-fed and spring-fed water systems facilitated easy and low-cost management, operations and maintenance. For example, the spring-fed systems in the Paul Basin of Santo Antão Island consisted of a catchment dike to capture spring water, piping to a concrete closed-top reservoir, and piping to individual farmers with valves and flow meters. Although farmers can use the water with a variety of systems, they received training in the installation of drip irrigation as an efficient use of limited resources.

Irrigation Management: International experience confirms that new or rehabilitated irrigation infrastructure will only offer sustained benefits if operated and maintained by technically qualified and financially self-sufficient water management institutions. Whether farmer-based, public, or private concessions, management of water delivery and system maintenance are always considered during MCC project design. To increase institutional capacity and effectiveness for water management, MCC and partner countries have endeavored to incorporate three key principles into irrigation project design. These principles directly echo MCC's institutional commitments to country ownership, accountability, transparency and sustainability.

4. *User involvement*: Water users should be engaged as partners at all stages, including irrigation design, decision-making, water system management, operation and maintenance, and financial management. User involvement instills a sense of accountability, demand-driven service delivery, and, ultimately, ownership over the system.

5. *Transparency and financial accountability*: Service agencies should provide clear policies, contractually agreed upon in writing, for water fee development, collection, and enforcement; and should clearly demonstrate how water fees are used for operations and maintenance purposes.

6. *Autonomy*: Service agencies should have the financial and authoritative autonomy to create reliable service and incentives to collect, thus enabling the agency to respond to farmers' needs. The agency should be able to keep the revenues it collects and use them to improve the service, investing, for example, in improved infrastructure to provide better water control.

Below are several examples of MCC projects that have built on these principles in irrigation water management.

- ★ In **Ghana**, prior to the MCC compact, the Ghana Irrigation Development Authority (GIDA) managed the country's irrigation schemes with limited funding and capacity. The compact project, which was completed in February 2012, emphasized accountability, transparency, institutional autonomy and collaboration with the private sector, and led to a new arrangement: MCC-funded schemes will be managed by private entities, with a management contract to include both GIDA and the farmers' cooperative as signatories. A governing board with private sector, government and farmer representation will oversee operations, increasing accountability and transparency to key stakeholders. Additionally, fees collected from irrigation service charges will be placed in a guarded account and will be used only for documented operations and maintenance.

- ★ In **Moldova**, the compact reflects a focus on user involvement and capacity building. It will establish fully-functioning WUAs with capacity to effectively manage and maintain rehabilitated systems, and facilitate legal transfer of operation and management responsibilities of 11 irrigation systems from the Government of Moldova to those WUAs. The irrigation project will be sequenced such that construction tenders will be released only for those irrigation systems in which WUAs have demonstrated willingness and ability to conduct operation and maintenance. MCC funding will support technical assistance and training to assist WUA formation in a manner consistent with Moldova's new *Law on Water Users Associations*, adopting best practices of financially and operationally sustainable water service entities.

- ★ In **Armenia**, alongside irrigation infrastructure rehabilitation, the compact also sought to improve the effectiveness of the irrigation sector through improved capacity of the nation's 44 WUAs and related organizations. All 44 WUAs completed Management Improvement Plans based on the results of need assessments and subsequent individual consultations. These Management Improvement Plans included operational goals, such as increased water fee recovery rates, additional general assembly meetings, improved dispute resolution mechanisms, staff training, and improved accounting practices. Consultations and on-the-job training efforts were provided to improve performance. Software, including Geographical Information System (GIS), accounting, and budget management software, and equipment upgrades, including furniture and heavy equipment for the maintenance of irrigation systems, were granted to WUAs to improve performance of water service delivery functions. The Armenia Compact was completed in 2011; independent evaluators are in the process of assessing the results of the institutional strengthening activities.

- ★ In **Burkina Faso**, the compact emphasizes user involvement by supporting the development of a co-management system for operations and maintenance, involving the Sourou Valley Development Authority and newly established WUAs on developed and existing perimeters. This includes the formulation of an integrated

operational and maintenance management and GIS system to provide an updated inventory of infrastructure and maintenance in the Sourou Valley.

★ In **Cape Verde**, the first compact included a project designed to introduce a community-based water management approach. Small spring- and rain-fed systems built with MCC funds are intended to be managed locally by community farmers organized into farmer associations. Previously, most systems were operated by the government or operated with little organization. Within each of the three project intervention areas, a water commission was established to oversee, guide, and assist the farmer associations. The water commissions were comprised of farmers, municipality representatives, and government representatives. A system of fee collection was developed and implemented and used for the sole purpose of system operation and management. Farmers in the systems are now responsible for basic management and operation of the systems, as well as simple maintenance.

Lesson 3:
Management matters. There are tradeoffs between being ambitious and being manageable.

MCC's investments seek to address poverty reduction by breaking down fundamental barriers to growth and generating additional income for beneficiaries, both during program implementation and after programs end. As discussed in Lesson 1, this often includes a focus on policy and institutional reforms. However, partner countries' initial project proposals have often focused on infrastructure alone, with insufficient attention to physical, social, economic, policy, and institutional arrangements, or management dimensions, each of which influence impact and sustainability.

MCC's early pre-compact analyses have pointed to a need to more deeply address such issues. In several cases, this has led to expansion of a project's scope to include additional activities deemed critical to the success of the infrastructure investment. These additional activities have varied based on local context, and have included resettlement, agricultural extension, land tenure reform, institutional support, and improved access to markets. Yet, broadening of project scope has created additional and significant management challenges for newly established MCAs, particularly within MCC's operational model of a fixed five-year time frame and fixed budget.

Although every project has its own circumstances and requirements, MCC and its partner countries increasingly recognize an internal tension between additional complexity in project design (consistent with complexity of local systems) and MCA's ability to successfully implement the program as designed on time and on budget. A one-dimensional project that simply builds new infrastructure likely will not lead to sustainable new irrigation services, but neither will a multifaceted integrated program that, despite best intentions, experiences failure on one or more critical dimensions.

In MCC's first generation of compacts, most notably in Mali and Armenia, MCC and its partner countries responded to the challenge of managing complex projects by introducing the services of professional and experienced project management consultants to assist MCAs with project management responsibilities. In addition, MCC provided project management training programs for MCA staff, and committed significant financial and human resources to strengthen project implementation support and oversight. MCC infrastructure, agriculture, and environment personnel conducted supervisory missions on roughly a quarterly basis.

For newer compacts under development, MCC is applying lessons learned in irrigated agriculture in two key ways.

First, MCC is placing increasing emphasis on the management dimension as early as possible. Second, MCC has attempted to simplify its own investments in a manner that leverages other donor and governmental initiatives. MCC's newest irrigation projects, in Senegal and Moldova, embody these lessons by leveraging USAID-funded value-chain activities to support the farmer behavior side of MCC's irrigation investments. Programs in Senegal and Moldova also place more emphasis on implementation planning, appropriate financial contingency plans, and setting up project management teams with the right skills to manage change and achieve results—further elaborated in Lesson 5 of this paper.

MCC continues to address management challenges inherent in integrated, multi-faceted projects, and it remains supportive of an approach that assesses factors influencing the impact and sustainability of irrigation investments, directly financing them when cost-effective and feasible, or identifying partnerships to support complementary activities. MCC is currently funding several rigorous impact evaluations that will enhance learning about the impact of irrigation schemes and complementary projects affecting farming practices, agricultural productivity, and income.

The following country examples illustrate how MCC has dealt with the challenges of managing multi-disciplinary and integrated irrigation projects, and how it has incorporated lessons learned from early compacts in more recent irrigation projects.

- In **Armenia**, the Government of Armenia's original proposal for the compact's Irrigated Agriculture Project focused largely on infrastructure, including rehabilitation of pumping stations, main canals, gravity schemes, drainage systems, and tertiary systems. During technical project assessments, a series of focus group sessions with key stakeholders identified a number of weaknesses with the potential to limit sustainability of the investment. Consequently, the scope of the proposed project was expanded to include a "Water-to-Market" Activity, a value-chain approach to development of the irrigated agriculture sector. The new activity built upon World Bank efforts to modernize Soviet-era water user associations, address key irrigation policy constraints to sector development, improve access to credit in the agriculture sector, and undertake a value-chain approach to production and marketing of high-value agriculture products. By addressing weaknesses in the value chain, the program was designed to improve

profitability for stakeholders throughout the value chain. As profit increases, farmers are increasingly able to pay for ongoing operations and maintenance, ultimately improving the sustainability of irrigation infrastructure. MCC has commissioned a rigorous impact evaluation of the Water-to-Market activities in Armenia and, upon analyzing the results, will be able to tell a more definitive story about changes in farmers' behavior, the cost-effectiveness of this program approach, and farmers' change in income. Initial results are expected in September 2012.

★ In MCC's compact in Morocco, the value-chain approach involves complementing infrastructure investment with production and marketing assistance. In this case, the compact project was specifically designed to avoid interference with complex internal institutional arrangements that have evolved over centuries. Instead, the project seeks to improve targeted technical aspects of fruit tree crop cultivation and soil and water management, as well as post-harvest handling, processing, and packaging of products. National initiatives for olive certification, market research and the establishment of a market information system for olives and dates are supporting development of farmer groups and enterprises. Management issues have not been a major problem in Morocco, where the project is being led by a highly-experienced Ministry of Agriculture team.

Following these experiences, management arrangements and mission focus were in the forefront of the design of the Senegal and Moldova compacts.

★ In **Senegal**, the government asked MCC to contribute to the master plan for irrigation and water resource management in the Senegal River Valley. Project activities include rehabilitation and expansion of selected main irrigation channels, drains, and pumping stations to remove constraints on water availability due to limited capacities of main channels. This project focuses primarily on irrigation infrastructure because numerous other private and public initiatives in agricultural extension and marketing are already in place, with two major exceptions: land tenure security and system operations and maintenance. Accordingly, the compact was designed to build upon previous efforts to improve the system for securing land tenure rights for farm families in the Senegal River Valley. It requires the Government of Senegal to conduct an audit to understand where current operations and maintenance practices fall short, and requires the government to adopt recommended reforms. Implementation of the Senegal Compact began in September 2010; at the time of publication, it is too early to assess the relative benefits and challenges associated with this approach.

★ The MCA in **Moldova** responded early to the need for project management capacity by retaining the services of a professional project implementation manager to address complicated sequencing issues related to institutional reform and rehabilitation, and to compensate for weak capacity in the assets' owners and managers. The project implementation manager is responsible for day-to-day management of irrigation infrastructure rehabilitation and irrigation reform consultants, and coordinates with other implementers as appropriate.

Lesson 4:

Water is for more than irrigation. Early attention to water availability and competing uses is important to ensure sustainability and maximize benefits.

Without water, irrigation infrastructure is rendered useless. Initial partner countries' project proposals have tended to be over-optimistic in regards to availability of water for proposed irrigation investments. In such cases, MCC and partner countries have worked together to directly address availability of water resources, with the goal of ensuring sustainability and coordination with other development efforts. The results of this analytical process sometimes lead to changes in project scope and design parameters.

MCC has consistently required water source and water use assessments as part of its proposal evaluation process. Over time, MCC has learned that its programs can add greater value in achieving sustainable outcomes by directly addressing watershed management issues. For example, studies conducted in Mali revealed pertinent information that required major changes in irrigation design and scope before implementation began, while similar changes in Cape Verde occurred after their first compact was signed. More recent projects, such as those in Burkina Faso and Moldova, have proactively incorporated broader water availability concerns by developing river basin management plans and improved policy frameworks.

The following examples demonstrate the importance of early attention to surface and groundwater resource availability and competing uses of water sources.

★ While Mali's Office du Niger irrigation zone is reported to have an irrigation potential of some one million hectares, continued expansion within the system has been constrained by limited capacity to deliver sufficient water to newly irrigated areas while ensuring continued service to existing perimeters. In this context, MCC conducted a detailed hydraulics analysis that concluded that the conveyance capacity of the main canal serving the proposed new irrigation perimeter was not adequate to serve the proposed new perimeter and other areas currently served and planned.

  This analysis led to the addition of a project component to expand the main canal's conveyance capacity. This component increased the project cost, but was essential for ensuring sustainability and was expected to generate significant additional benefits to the larger system.

Works to expand the conveyance capacity of the main canal in Mali to ensure adequate water supply.

Even with this investment, cultivation during the dry season was designed to be restricted to 20 percent or less of the service area to ensure regular supplies would be available to other downstream users and industrial crops.

★ **Cape Verde's** first compact included a $2.6 million investment in well drilling and associated infrastructure to extract, store, and distribute groundwater for irrigation purposes in support of an agricultural services project affecting several islands. After the compact was signed, MCC financed a detailed aquifer mapping and yield assessment study to confirm availability of groundwater. The study revealed very slow aquifer recharge rates and highlighted the risk of the project contributing to over-extraction of limited groundwater supplies, which could trigger the intrusion of salt water into potable water supplies. As a result, MCC withdrew funding for several of the planned wells and redirected some of these funds to provide training and technical assistance to local government representatives to support their ability to sustainably manage groundwater extraction on the islands. Moving forward, MCC is making every effort to conduct environmental impact assessments early to ensure possible environmental risks are mitigated prior to compact signature.

★ In **Burkina Faso**, assessments during early project design found that information was inadequate to determine whether sufficient water was available annually to support proposed irrigation developments in the Mouhoun and Comoé Basins. Accordingly, the compact included funding for computer modeling to show the supply capacity of water sources in relation to expected demand for various water uses in the river basin. This analysis will be accompanied by the creation of two River Basin Authorities that will use the resulting model to formulate strategies to lay the foundation for eventually establishing water usage fees and ensuring long-term sustainability.

★ **Morocco** has experienced reduced rainfall and precipitation levels are expected to further decline and become increasingly variable. [5] Consequently, the compact includes funding for water balance studies in irrigated perimeters where canals are being lined to improve water delivery efficiency. These studies compare irrigation crop water requirements with the available water supply over the course of one year. The studies have demonstrated that during the wet season, when there is abundant water supply, lining canals substantially increases the volume of water reaching farm gates. However, during the dry season, volumes of water from seasonal rivers or springs are significantly lower, such that the lining improves—but does not completely

Lining tertiary canals in Morocco to improve delivery efficiency.

5 Regional climate projections for the Sahel and North Africa forecast changes in temperature, precipitation and evaporation. Examples of such models are: Bates, B.C., Z.W. Kundzewicz, S. Wu and J.P. Palutikof, Eds., "Climate Change and Water," Technical Paper of the Intergovernmental Panel on Climate Change, IPCC Secretariat, Geneva, 2008; and Patricola, Christina M. and Kerry H. Cook, "Northern African Climate at the End of the Twenty-first Century: An Integrated Application of Regional and Global Climate Models," Clim. Dyn. 35:193-212, 2010.

eliminate—water deficit stress on crops. In this context, the infrastructure investment is purposefully complemented by extension services in soil and water management to maximize use of scarce water availability during the dry season, minimize water deficit stress, and produce optimum crop yields.

★ **Moldova's** compact development process also revealed the need for a national watershed framework to address water quality and quantity concerns of the country's two main rivers, the Prut and the Nistru. Analysis of climate models showed that Moldova is expected to experience increasing variability in precipitation, resulting in increased probability of both floods and seasonal droughts. [6] As a consequence, the hydrological regimes of large and small rivers will change substantially.

An assessment of institutional capacity indicated that the two primary government agencies involved in water management, Apele Moldovei and the Ministry of Environment, lacked the capacity to monitor, plan and manage this natural resource. Consequently, the compact includes a river basin management component to build institutional capacity of water authorities in various government agencies to support implementation of a new law enabling a modern system of secure, long-term water rights, and efforts to sustainably manage the country's water resources. This will be accomplished with participatory methods to balance water demands through a network of river basin district councils, a shared hydrological database and modeling capability, and integrated water resource management plans.

Lesson 5:
Prepare to adapt. Unanticipated cost escalations and implementation delays may require project scope changes during implementation.

Infrastructure projects are always susceptible to changing costs and implementation delays. MCC's model of fixed budgets and five-year timelines means that when these pressures emerge, MCC and partner countries have to think quickly and creatively about scaling back or altering investments to maintain MCC's principle of ensuring the most cost-effective and impactful use of limited resources. Many MCC-funded infrastructure projects have been restructured to respond to these pressures. This was particularly true for projects designed in MCC's early years, when MCC needed to establish itself fairly quickly with the first cohort of compacts.

In these compacts, much of the detailed project preparation work essential for finalizing budgets and timelines, including feasibility and design studies and environmental and social impact assessments, was completed after compact signing. As programs progressed to detailed design and contract bidding, and external factors like exchange rate fluctuations took effect, costs became more clearly defined and some original objectives

6 Climate models by Corobov, 2008; Lalikin and Sirodoev, 2004; Sirodoev and Knight, 2007; and Sirodoev, 2008; were consulted, as well as information from the World Bank Climate Change Data Portal, accessible at http://sdwebx.worldbank.org/climateportal/.

had to be scaled back. In such cases, MCC worked with MCA partners to revise projects to meet as many original objectives as possible within tighter budgets.

These dynamics are inherent in projects with fixed budgets and timelines, and will continue to exist for MCC and its partner countries. To better buffer MCC and its partner countries against these pressures, MCC now conducts more rigorous design, cost estimation and budgeting prior to making final investment decisions; and builds greater project management capacity to deal with complex projects and their inevitable challenges. MCC now strives to design infrastructure components in a scalable fashion where appropriate, so that management teams can balance scope with cost and time considerations should one factor experience overruns. Understanding that adjustments in project scope are often unavoidable, MCC is applying lessons learned in early compacts to later (and future) compacts to be better prepared for these inevitable changes.

The country examples below illustrate MCC's experience revising projects in early compacts.

★ In **Armenia**, appreciation of the country's currency, the dram (AMD), in September 2008, combined with inflation and other factors, resulted in an effective 50 percent increase in estimated costs of the MCC compact's irrigation investments. In response, the MCA and MCC teams carried out a comprehensive re-scoping exercise, leading to a re-prioritization of investments based on technical, economic, environmental and social considerations.

  Project components were prioritized to meet budget constraints. The number of proposed gravity systems was reduced from 18 to 5, and planned pumping stations reduced from 68 to 17. The number of new hectares under irrigation at the end of the compact was revised from 20,340 to 9,000. However, an additional 38,000 hectares not originally in the compact were rehabilitated. All of the final irrigation improvements included in the program were required to generate a minimum 12.5 percent economic rate of return. As a result of these project scope realignments, the number of estimated beneficiaries actually increased from 250,000 to 420,000. The compact project ultimately proved to be one of the country's largest irrigation infrastructure refurbishments, and enhanced the irrigation system's long-term sustainability through strategic assistance to Armenia's farmers, agribusinesses and water supply institutions.

★ As noted earlier in this paper, the **Mali** Compact's Alatona Irrigation Project was conceived as a pioneering effort in the Office du Niger, including, for the first time, establishing formal land titling programs and locally-managed irrigation perimeters. Prior to the MCC compact, institutions did not yet exist for these activities. Initial construction cost estimates were significantly underestimated. Higher costs, combined with delays in implementing necessary resettlement and other interlocking components, led the MCC and MCA teams to reassess and scale back their objectives to work within the compact's fixed budget and timeline.

In particular, while the compact finances detailed design of the originally planned 14,000 hectares, it will finance construction of only a main system conveyance expansion and 5,200 hectares of new development. As of 2011, the project has achieved two seasons of irrigated rice cultivation. The existence of detailed designs for the remaining hectares and the establishment of basic institutional structures throughout the new 5,200 hectares is expected to create a platform for other public and private investments to leverage the MCC investment, and there has already been significant interest in expanding on MCC's outputs.

Extensive resettlement activities associated with this project included new housing, markets, agricultural warehouses, healthcare centers, schools, water and sanitation, and opportunity for herdsmen to have access to reliable irrigation water. MCC is already seeing benefits to these populations through increased access to social services like schools and health centers. The transition from rain-fed-based subsistence lifestyles to irrigated agriculture is expected to bring economic benefits as well. An impact evaluation is under way and is designed to provide an objective measure of benefits of the interventions, in terms of gains in household incomes and other measures of well-being, by comparing project-affected households with other households that have similar key characteristics but did not participate in the project.

MCC is applying lessons from these early compacts to more recent compacts. Examples of such applications are described below.

- ★ The **Senegal** Compact's irrigation project, by design, includes fewer components than earlier irrigation projects. The project seeks to fill a funding gap and concentrate on two key constraints to development: main system capacity to deliver water, and land security for the farmers. During compact preparation, particular attention was paid to calibrating the amount of budget contingencies to the types and precision levels of designs at the time. Although this program is less complex, it involves environmental and social management and resettlement components, which will need to be carefully managed to ensure success. MCC is working closely with MCA-Senegal to establish a cohesive management team, and to establish project management tools to achieve completion within the prescribed time frame and budget.

- ★ In **Morocco**, the irrigation project focuses on improving irrigation of small- and medium-scale olive orchards and date orchards. The infrastructure investments were designed to be scalable; for example, if construction costs of the larger water diversion structures are higher than anticipated, it is possible to reduce the number of canals being lined with concrete.

- ★ As noted earlier, the **Moldova** Compact retained the services of a professional project implementation manager to assist MCA-Moldova in managing complicated sequencing issues related to institutional reform activity and irrigation system rehabilitation. These services are now just getting underway.

MCC continues **to learn and evolve as early projects conclude.**

MCC is not alone in investing in irrigated agriculture, or in facing challenges along the way. Many of the issues with which MCC and partner countries have grappled are common. However, MCC's commitment to results and to learning demands a frank and open discussion of these lessons, even when they are learned the hard way. The emerging body of lessons learned from MCC's early compacts continues to inform later compacts and guide how future irrigation projects are evaluated and funded.

Given the often multi-disciplinary nature of irrigated agriculture investments, the particular challenge for MCC lies in determining how best to intervene within a five-year window, such that long-term developmental goals are met in a manner that is cost-effective and sustainable. MCC continues to learn, leverage international experience, and apply lessons learned to improve investment design and management capacity, and to better help partner countries anticipate and meet operational challenges. MCC's portfolio of impact evaluations will soon begin to yield additional learning about the impact of MCC's irrigation and related investments on farming practices, agricultural productivity, and the income of farming households.

Annex 1:
Summary Of MCC's Integrated Irrigated Agriculture Projects[1]

Country/Project	Integrated Irrigated Agriculture Project Activities ("Irrigation Projects")	New/Expanded Irrigation, in hectares	Rehabilitated/Improved Systems, in hectares	Beneficiaries[2]	Total Irrigation Project Investment, in millions of U.S. dollars[3]	Irrigation Infrastructure Investment, in millions of U.S. dollars
Africa						
Mali *Alatona Irrigation Project* *Sept 2007-2012 (Note: At the time of publication, MCC is conducting an operational review of the Mali Compact due to a military seizure of power inconsistent with MCC's eligibility criteria.)*	• Rehabilitation of main conveyance system and improved water management systems • Development of new irrigation perimeter • Development of water management institutions • Strengthening of land registry system • Training in improved farming practices • Improved access to rural finance • Resettlement activities **Value chains: Rice, horticulture**	5,200	104,881	649,559[4]	162.6	145.4

1 The reader is cautioned against deriving cost per hectare and cost per beneficiary estimates from this table due to a high degree of variation of investment composition across countries, including variations in type of infrastructure: for example, new versus rehabilitated systems, and supporting activities like farmer training and land tenure strengthening.

2. Beneficiaries are defined as individuals who realize improved standards of living, primarily through higher incomes, as a result of economic gains generated by the MCC-funded project. Beneficiary numbers listed here may encompass those outside of the irrigation perimeters but benefitting from irrigation infrastructure or other project activities.

3. For the purposes of this paper, the description and corresponding dollar amount for "integrated irrigated agriculture projects" include all interventions directly related to the sustainability of irrigation infrastructure investments; and exclude rural roads, though some projects officially include roads to meet their project objectives. For example, Ghana and Honduras are not integrated projects in that the irrigation investments are separate from the farmer training and capacity building activities.

4. This excludes beneficiaries of the Niono-Goma Road.

Senegal *Irrigation and Water Resources Management Project* *Sept 2010-2015*	• Rehabilitation of main conveyance and drainage system, enabling new and improved irrigation systems; development of new pilot perimeter • Strengthening of land registry system • Resettlement activities **Value chain: Rice**	10,950	26,000	268,000	170	166.2
Morocco *Fruit Tree Productivity Project* *Sept 2008-2013*	• Rehabilitation of traditional irrigation systems • Training in improved tree crop cultivation practices • Capacity building of water user associations • Strengthening of olive and date value chains, including agricultural research • Improved access to rural finance **Value chain: Fruit trees (date, olive, almond)**	--	33,983	212,508	151.2[5]	116.4
Burkina Faso *Agriculture Development Project* *July 2009-2014*	• Rehabilitation of dam and associated infrastructure • Development of new irrigation perimeter • Strengthening of water management institutions • Training in on-farm production diversification • Improved access to rural finance **Value chains: Staple crops, horticulture**	1,740	--	54,714	141.9	89.8

5 The Morocco Fruit Tree Project includes non-irrigation technical assistance that is not included in the irrigation project total.

Ghana *Irrigation Activity of the Agriculture Project* *Feb 2007-2012 (compact completed)*	• Rehabilitation of gravity-fed irrigation scheme • Development of new gravity-fed scheme **Value chains: Staple crops, horticulture**	1,450	840	9,784	24.5[6]	18.5
Cape Verde *Watershed Management and Agricultural Support Project* *Oct 2005- 2010 (compact completed)*	• Construction of dikes, terraces, vegetative barriers, and reservoirs to feed drip irrigation • Improved community water management plans • Training in improved farming practices • Construction of post-harvest infrastructure (inspection centers and packaging warehouses) • Agricultural research • Improved access to rural finance **Value chain: Horticulture**	111	--	1,685	8.7	6.2

6. Beneficiary count includes 31,283 beneficiaries from the Fruit Tree Development Activity (new to irrigation), and 4,448 expected beneficiaries from the compact's Agricultural Public Goods Grant Facility.

Eastern Europe						
Armenia *Irrigated Agriculture Project* *Sept 2006-2011 (compact completed)*	• Rehabilitation of main and tertiary canals, gravity schemes, pumping stations and drains • Construction of new tertiary canals • Capacity building of government and farmer-based water management entities • Training in on-farm high-value agriculture production, improved water management techniques, and marketing/enterprise assistance • Improved access to rural finance **Value chains: Horticulture, fruit trees**	9,000	38,000	421,407	152.2	120
Moldova *Transition to Higher-Value Agriculture Project* *Sept 2010-2015*	• Rehabilitation of irrigation systems, including pumping stations, drainage and secondary and tertiary pipes • Capacity building of water user associations and Irrigation Management Transfer • Improved river basin management • Improved access to rural finance • Training in support of high-value agriculture value chains **Value chain: Horticulture**	--	15,550	112,000	101.8	73.6

Latin America						
Honduras *Irrigation Activities of the Rural Development Project* *Sept 2005- 2010 (compact completed)*	• Development of new, community-based small-scale irrigation infra-structure (reservoirs and canals) to feed drip irrigation • Training in on-farm production and marketing of high-value agriculture products **Value chain: Horticulture**	400[7]	4,444[8]	35,731[9]	18.62	5.1
	TOTALS	28,851	223,698	1,770,000	931.5	741.2

7 The Farmer Training Development Activity ($26.6 million) of the Rural Development Project funded a training program and small grants program for farmers to use existing sources of water (streams, ponds, wells) to adopt more efficient irrigation practices, including drip irrigation. Farmers installed new drip irrigation systems covering a total of 4,444 hectares. Some farmers who received training may have practiced other forms of less efficient irrigation prior to the project.

8 Beneficiary count includes 31,283 beneficiaries from the Fruit Tree Development Activity (new to irrigation), and 4,448 expected beneficiaries from the compact's Agricultural Public Goods Grant Facility.

9 Beneficiary count includes 31,283 beneficiaries from the Fruit Tree Development Activity (new to irrigation), and 4,448 expected beneficiaries from the compact's Agricultural Public Goods Grant Facility.