Improving Livelihoods by Improving Water Access for Small-Scale Agriculture:

Two Case Studies of Improved Farming Inputs and Financing in Toya and Tiby, Mali

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Introduction

Water is a crucial limiting factor for economic development in places such as Mali. Previous development approaches, while beneficial, have failed to achieve robust, sustainable outcomes for various reasons. Chief among these reasons has been the inability to provide a mechanism for the long-term financial sustainability and ongoing maintenance of irrigation infrastructure. Much of the development efforts in Mali have addressed either the establishment of large pump-irrigated perimeters (anywhere from 40 ha to 200 ha) that draw water directly from the Niger river (or its channels), or have relied on irrigation projects with low-head dams designed to divert part of the river flow (during its peak flow period) to flood irrigate thousands of hectares of rice. These projects primarily provide irrigation access in one single “on season” for rice, but do not utilize stored sub-soil moisture during the “off season”.

The premise of this project was to explore the idea of creating access to water in the “off-season” to women for growing fruits and vegetables. Creating vegetable gardening at the small-scale while targeting women serves to economically empower women, something vital in a society where otherwise rice farming income goes almost exclusively to men. Before the project was implemented, the primary constraints to successful and sustainable vegetable gardens were lack of i) capital for pumps, fences and lack of credit for seeds; ii) agronomic advice; and iii) organized transport for access to markets.

The Columbia Water Center’s (CWC) pilot project, conducted in cooperation with the Millennium Villages Project (MVP), developed and tested new economically and socially sustainable approaches to addressing these issues in order to improve farmer livelihood. Through value chain analysis, the project helped women decide on and plan production for the most profitable crops, thus making more cost-effective the use of investments in access to water. Financing was arranged through the project on repayment terms that allowed capital expenses to be paid back on a three-year cycle and expenses for seeds and fertilizer to be paid back after the
harvest. In these vegetable gardens, financing of farming inputs, market analysis and technical advisement led to positive results, and the income for participating farmers more than doubled.

The project had initially started work in the Millennium Village cluster of Toya (near Timbuktu) where investments in two new irrigation pumps assisted with creating “off-season” access to water for rice. In this part of Mali, at the beginning of the delta region, one finds that off-season agriculture when the river levels are low is feasible if one expands the pump capacities to bring in surface water from receding channels that are now far away from the farm, as opposed to drawing from nearby water sources in the wet-season. This intervention helped increase yields and size of area farmed, resulting in significant increases in production. Due to security issues which arose soon after the work started, the project site was moved to the Tiby cluster where the team worked with women horticultural farmers.

**Background**

With an annual per capita income of just $680, Mali is one of poorest nations on earth. It is a society that is primarily reliant on agriculture and livestock incomes, and the poor especially depend on land and water for their livelihoods. Most of this land-locked country lies in the Sahel, which forms the semi-arid northern band of that region covering much of Mali’s land (Figure 1).
The Niger River and its tributaries are Mali’s lifeblood, the source for most of what grows and lives in this dry place—especially toward the north, where a semi-arid landscape becomes even drier (Figure 2). Most importantly, irrigated agriculture of any sort depends on the rise and fall of the river through wet and dry seasons and years.

Close to the river, the farmers of Mali grow rice. However, only a short distance from its edge, most access to water vanishes, leaving farmers largely dependent on the brief rainy season. In spite of the enormous potential for irrigation from the river, poverty and lack of infrastructure means that there is inadequate water access for growing food, which remains a major limiting factor for economic development, higher incomes or better livelihoods for these farmers.

Designing and implementing sustainable, scalable means to use existing water resources and increase revenues from crops, therefore, is a key step in breaking the nation’s cycle of poverty. In particular, the efficient development of water resources for food production holds strong potential for reducing poverty.
while increasing health through better nutrition. Development professionals have known for years that developing water resources for irrigation would be a key ingredient to building a more robust and profitable agricultural sector in Mali and other West African nations. In 2002 a joint USAID/Mali commissioned study of agriculture saw “enormous” potential for the irrigation subsector, and listed investment in irrigation as the top recommendation among major proposed interventions to improve livelihoods (Abt Associates Inc., 2002).

Relative to the available resource, however, very little irrigation infrastructure has been developed. According to a 2007 joint report on agricultural water use in sub-Saharan Africa by the Asian Development Bank, the Food and Agriculture Organization of the United Nations, the International Fund for Agricultural Development, the International Water Management Institute and the World Bank (ADB, FAO, IFAD, IWMI and World Bank, 2007):

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.

Yet according to the same report, “Water withdrawals for agriculture are . . . limited – less than three percent 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.”
While there is some debate over the exact amount of land currently irrigated in different regions, according to the USAID/Mali study, by some calculations, “less than ten percent of [Mali’s] theoretical potential is currently being irrigated.”

In other words, unlike some parts of the world that face absolute scarcity in the form of tapped out surface water and depleted underground aquifers, Mali’s water resources are relatively undeveloped. The Columbia Water Center’s approach to the project in Mali was to develop plans involving local community engagement, capacity building and scalable business models, with a goal of seeing how seed funding capital intensive inputs for agriculture could generate a payback that could then be leveraged by communities themselves.

**Security Crises**

Unfortunately, security threats in 2008 and 2009 led the U.S. State Department to issue an alert warning against travel to Northern Mali, including the region of the Toya Millennium Village cluster. While local Millennium Village staff stayed engaged with the villagers, the security threat effectively cut off the CWC’s close follow-through on the Mali irrigation project and dampened nascent efforts to develop a broader water-use plan.

Then, in 2012, an attempted political coup in Mali caused the State Department to expand the travel warning to all of Mali due to political instability and other security concerns. By this time, the team’s work had moved to the Tiby village cluster and the political situation caused disruption even in the work of the local Millennium Village staff, causing long delays in project implementation.
First Project Site: Toya

Intervention

When the project began in 2008, the Millennium Village cluster of Toya was the first site in Mali where the CWC/MVP team started working on this intervention (Figure 3). Toya is located on the Niger River approximately 30 kilometers southeast of the famed ancient trading town, Timbuktu (also spelled Tombouctou), at the southern edge of the Sahara where rain is unpredictable at best and the dry season lasts 9 to 10 months each year.

For its initial study of the area, the CWC/MVP team surveyed residents, studied current irrigation practices, and analyzed the landform to identify water-related factors limiting productivity and incomes for the 600 hectares of land used by the village cluster. The cost of irrigation emerged as one of the main constraints limiting food production. In particular, the inefficiency of pumps and lack of ability to maintain them made designing sustainable interventions difficult.

Based on extensive meetings with residents, along with the findings of other NGOs in the Timbuktu region, the team developed a strategy to provide better irrigation access by purchasing new pumps and designing a system to maintain
them. Two villages within the cluster, Iloa and Djéguelia, were chosen as the sites for the new pumps.

After investigating different pump options, the team settled on a system using a 45hp Hatz generator and a Rotavii pump (Figure 4); the system was chosen after consulting with an NGO funded by GTZ, a German development cooperation that had established itself in the area with a facility that specialized in assembling and dissemination of pump units. This facility was equipped for the maintenance of pumps, and its staff had experience in training local mechanics and gas station attendants to maintain them.

![Figure 4: Members of the community unloading the pumpsets in the Toya cluster.](image)

In order to promote the most effective adoption of the pumps, the team:

- Initiated outreach among the communities to explain the benefits of a new approach to efficient use of water pumps;
- Purchased two pumps that had replacement parts readily available in the region;
- Identified two attendants and a site engineer, and trained local residents on the management and maintenance of the pumps;
- Established a mechanism to monitor the management of pumps on an ongoing basis (including the creation of a daily monitoring sheet and regular site visits from team members, among other steps);
- Arranged for the rehabilitation of existing irrigation infrastructure, including the construction of catchment, lining of canals at the top of the network and re-profiling of all canals in the ground;
- Engaged the community to ensure strong local involvement in the management process and input supply (including diesel, filters, oil, etc.).
- Signed a memorandum of understanding notifying recipients of cooperative responsibility and commitment of both parties (beneficiaries and MVP) regarding responsibility for the pumps. Beneficiaries understood that money for the pump purchase was a loan.

Mechanics and the four pump attendants received training at the GTZ-funded facility in two phases, with the first phase primarily involving theory and the second hands-on, including fieldwork.

**Encouraging Results**

Nevertheless, in spite of the challenge of monitoring and evaluating the pump plan, villagers and Millennium Village staff reported that the initial irrigation plan had worked, increasing the average rice yield from 3 tons to 5 tons per hectare and expanding the cultivation area. The combined result of increased yields and area cultivated was a growth in production from 204 tons to 485 tons. The cash value of this increased revenue was approximately $84,000.

Looking at production for the villages of Djéguelia and Iloa combined, the introduction of the new pumps allowed for production of 281 additional tons of rice in the first year of use (Figure 5).
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Additional Rice 281

*Figure 5: Increased yields realized in Djéguelia and Iloa after pumps installed.*

**Sustainability and Scalability**

In line with the Millennium Village philosophy of promoting entrepreneurship and local business development, the Toya intervention was designed as a community loan requiring payback rather than as a grant. Millennium Village experts see such an approach as a way to solidify a sense of community ownership and investment in maintaining and sustaining improvements. Under the plan, farmer collectives would own the pumps, paying back the cost over several years.

By coupling local ownership with a long-term maintenance plan and incorporating both into a business plan and payback arrangement, the team created
an approach that was designed to circumvent the common problem of quickly degrading equipment with no provision for repair.

Villagers reported that having an ownership stake did indeed make a difference in maintenance and care for the pumps. When pump technicians, for example, left pumps uncovered after maintenance, villagers stepped in to report the problem, something that might not have happened without a personal investment in the devices.

The cost for the two pumps was $40,000. The additional revenue from these pumps was estimated to be $84,000. At the time that the CWC team had to pull back from the project due to security issues, farmers were still largely on-track with payments. In order to further leverage its profits, the project intended to use the money paid back on the pumps to purchase a tractor in order to reduce labor and expand productivity further. However, due to the security situation, this has not been realized yet.

This expansion highlights the longer-term potential for scaling up the project. Columbia Water Center project coordinators calculated that by using the aforementioned approaches, a second rice season could be added to 25 percent of the land area in the Inner Niger Delta region, amounting to greater productivity and income from thousands of hectares of land along or near the river.

**Second Project Site: Enriching Women in Tiby**

The Tiby Millennium Village cluster is located along the Niger River in one of the poorest areas of Mali and is characterized by high rates of child mortality, malaria and food insecurity (Figure 3). Soil degradation and loss of vegetative cover in the last forty years, along with the breakdown of traditional farming systems, has contributed to environmental losses that also take their toll on agricultural productivity.
Most villagers here are subsistence farmers, growing rain-fed millet, sorghum and some irrigated rice. However, as in Toya, irrigation practices are inconsistent and limited, and both irrigated and non-irrigated crop yields remain low.

Tibibas is a 365 hectare (901 acre) plain near Tiby where residents grow irrigated rice using an adjacent canal from the months of August to January when the Niger River rises. A crop of millet is typically grown from July to October. However, during the dry season when river levels are low from the months of February to June, the land was typically left barren or used as pasture for sheep and goats. However about 10 years ago, some villagers – mostly women - began growing vegetables in small plots during this dry period.

A New Approach

In 2009, an MVP/CWC initiative was put into place to assist the women in the commercialization of the produce grown at Tibibas. Prior to the initiative, each of the 360 women grew and sold their melons on their own. Small-scale wholesalers from neighboring villages, such as Koila-Bamana, would come to the garden and negotiate individually with each of the growers. Since the wholesalers could pick from so many growers, the women had very little negotiating power to gain a fair price. Worse, the local wholesalers, being poor themselves, often took melons and cucumbers on credit to resell at the weekly markets. Returning to the garden, they would rarely pay the full credit they owed. The producers of Tibibas had few options for sales and little choice between the buyers. As a result, what money they earned for the three months of labor did not compensate for their efforts.

In order to help the women maximize their income, the team also researched different ways to design a more lucrative business model. After studying the produce value chain as it applied to local markets, the team determined that the women were undercharging for their produce. By working with them to coordinate their efforts as a cooperative, they convinced the women to charge a fairer, higher, price for their labor (Figure 6).
The project team then took a series of actions to boost the women’s ability to gain a fair price. First, the producers agreed that they would stop selling individually; a sales committee was nominated which would undertake all of the negotiations with buyers. Secondly, MVP studied the melon value chain and shared with the women information on pricing throughout the chain. Thirdly, larger-scale wholesalers from the neighboring city of Ségou were brought to Tibibas, where they negotiated with the sales committee. The result was an immediate 18% jump in prices, from an average kilogram price for melon of 65 francs to an average price of 77 francs. Following that meeting, the Ségou wholesalers continued to purchase melons from the women, and the women reported reaching average prices of 100 francs per kilogram by the end of the season. The women earned a fair price for their melons, and were paid cash at the garden.
Project Activities

While deepening a canal in 2007 was meant to create the potential for greater horticulture production, and the commercialization support activities of 2009 aimed to improve the women’s marketing and sales results – no coordinated effort had yet been undertaken to improve performance across the entire horticulture value chain. In 2010, the team’s approach aimed to increase production while helping the Koila-Markala women’s group become better organized and sell into higher value markets by operating as a cooperative enterprise, with value-adding activities across each of the value chain’s links. This approach would allow the women to work together as opposed to acting as isolated individuals without best practices and reaping minimal benefits.

Organizers also purchased high-quality improved seeds and fertilizers that were stocked with the community group’s secretary. The team provided eight different varieties of vegetables, two of each crop grown at Tibibas. Seed varieties were chosen for their short growing cycles, ability to succeed in hot and dry climates, and for the high market value of their produce. Specifically, the team promoted watermelon, a fruit that is essentially unavailable in Mali during the Tibibas harvest months of June and July, in addition to cucumber, okra and melon.

When asking the women why they did not cultivate a larger area – as an entire 365 hectare plain lies at their disposal – they responded that the expense and difficulty of gathering brush to build a fence and the exhausting task of hauling water in buckets to water their plants by hand were limiting factors (Figure 7). Through many discussions with the men and women of the village, organizers designed a plan to overcome these two challenges.
The issue of animals eating the plants is a serious one; Koila-Markala is in an agro-pastoral zone, where livelihoods are based on the cultivation of cereals, such as rice, and herding. During the dry off-season, cattle, goats and sheep roam the plain of Tibibas seeking sustenance from the dry stalk remnants of the rice harvest; a green garden of melons would be quickly consumed by the cattle if not protected.

To address this problem, the team designed a system of chain-link fencing supported by bamboo poles, which was installed by a group of men from the village. The bamboo poles reduce the cost of the fencing, and make it easier to remove at the end of the season (Figure 8).
Project managers also researched irrigation methods that would liberate the women from hand watering practices and enable them to irrigate larger areas. They quickly discovered a drainage system used in other parts of Mali in which a motor pump is used to move water into a system of small canals, dykes and sub-canals, allowing two people to irrigate one hectare in two days. While the team promoted this system to the producers, and twelve motor pumps were made available – based on a target of 24 hectares destined for the irrigation scheme and 6 hectares reserved for hand watering – the irrigation system was slow to gain the producers’ buy-in.

By contrast several men in the village expressed interest in participating in the scheme, but were not as active in the field as was anticipated, leading team members to believe that they requested the motor pumps to use for other purposes – such as regulating the water in their rice fields. In Mali, traditional gender roles assign rice and other staple crop production to men, while women are in charge of managing the household and growing vegetables.
Lack of clear control of pumps thus became an impediment to sustainability and scalability of the intervention. In addition, pump maintenance became a challenge. As a result, some women resorted to hand watering vegetables as they had always done, even though the village as a whole benefitted from access to pumps for rice production. The multi-year nature of the project will allow these challenges to be addressed in future growing seasons.

**Sustainability and Scalability**

In accordance with Millennium Village goals of promoting self-reliance, the project structured a workable reimbursement plan for the project through multiple discussions with producers. The reimbursement per hectare was calculated and agreements were reached with producers, through which they would reimburse the funds invested in the fencing and motor pumps in full over three years. In total, $22,670 was invested, with $18,468 spent on the fencing and the pumps in 2010.

**Promising Results**

Initial results of this work were promising, with an overall increase in revenue of more than $30,000 for the entire project, or a more than doubling of income for most of the women. On a per hectare basis, vegetable growing yielded over five times the revenue of rice growing. In 2010, farmers made all agreed upon payments for the fence and one of the two motor pumps, and 92 percent of the agreed upon payments for the other pump. Payments continued on track in 2011 and 2012.

With improved fencing the women reported that no produce was damaged by animals—a significant improvement from previous years, when small goats were able to get through brush fences. In the past, animals ate a significant percentage of the fruit and vegetable crop.

Furthermore, as a result of the project some 34,000 people living in surrounding villages now have access to improved nutrition, as the gardens provide
melons and watermelon to markets at a time of year when fruits and vegetables are normally not available.

Using the results of the existing pilot, the team estimates that it would be possible to involve 25 percent of families in off-season vegetable gardens in the area. Each family could add $300 in household income based on current yields, with four families per hectare. Given that average per capita income in the nation is less than $700 per year, that extra money would amount to a significant increase in income for a large number of families (Figure 9).

The success of the project has also attracted the attention of neighboring villages, whose residents now approach project coordinators to ask for assistance in setting up their own interventions.

*Figure 9: Selling melon at Tibibas.*
Next Steps

The CWC/MVP team is currently designing an integrated plan to scale up the current successes of the project over a broader area, and to continue improving irrigation systems in the Tiby cluster. At the present time, the team is designing improved irrigation systems to expand interventions to five additional gardens in Tiby, all of which have potential for year-round horticulture. The team is also working with the Malian government to design an irrigation system for Tibibas, where rice is grown part of the year and vegetables are grown the rest of the year. Both systems will continue to improve yields and cut down on manual labor, and the Tibibas system will be flexible for rice or vegetable irrigation depending on the season. Eventually this latter irrigation system will be able to be spread to other fields where rice and vegetables are grown.

Conclusion

The work accomplished during this project shows that improving rural livelihoods is highly dependent on improving the social, economic, and physical infrastructure available to rural communities. By improving the resources available to farmers for irrigation, crop diversification, improved seeds, soil fertility and collective action, the project has increased crop yield and improved the market bargaining power of small producers, with particular benefits realized by women. All of these improvements are due to an underlying framework that promotes community capacity building, showing that sustainable change is possible on a small scale.

Irrigation projects in Mali have either been of generally large scale (e.g. Office du Riz), for infrastructure intensive efforts that start out well but, due to the inadequate maintenance over time, do not perform well over the long run. Moreover such projects generally serve to provide irrigation to a single crop, namely rice, over the course of a single season, rather than throughout year. As such, the project focused on areas that did not participate in large scale irrigation projects, but rather focused on improving irrigation and economic infrastructure on a smaller scale.
This emphasis on small, community-based improvements has shown positive results. By providing agronomic advice and by giving farmers access to finance, technology and the ability to aggregate value and move product to market, participating farmers were able to increase yields and increase household incomes. The results of this project also suggest that, in addition to finance, the other important factors in the development of water resources are local community capacity building, provisions for long term maintenance and business planning for the greatest livelihood impacts. These important factors are also often the most neglected. In particular, developing viable, self-sustaining, reproducible and scalable business models is key to generating favorable outcomes while optimizing water usage in agriculture.

By addressing these issues, organizations and agencies can lay the groundwork for further significant interventions that have the real potential to improve people's lives. As this project has shown, the provision of water is as much dependent on the social infrastructure as it is on physical infrastructure.

References
