

Post-Evaluation Report (2012-2)

Irrigation and Paddy Rice Project in Bagré, Burkina Faso

Prepared by

Chen Shu-ping (Project Manager, Auditing Office, TaiwanICDF)

Dr. Song Shiun

**Wu Chii-Reid (Division Chief, Irrigation Affairs, Water Resources Management
and Policy Research Center, Tamkang University)**

International Cooperation and Development Fund

February 2013

EXECUTIVE SUMMARY

The Taiwan Technical Mission (TTM) of the Republic of China (Taiwan) assisted Burkina Faso in irrigation development within a 2,170-hectare area downstream of the Bagré Dam from 1995 to 2003. Upon the completion of the irrigation system, a net production area of 1,800 hectares for paddy rice production was reclaimed. Subsequently, as part of technical cooperation between Taiwan and Burkina Faso that continued until 2009, the project provided technical training and assistance in paddy rice production, as well as related agricultural production, within the project area.

To ensure that the project objectives were achieved and to learn from the experience of implementing the project, the TaiwanICDF dispatched a mission in December 2012 to perform project post-evaluation.

In terms of the applicability of project design to local needs and conditions, the overall layout and design of irrigation canals was economical and facilitated construction. The completion of the project was slightly delayed because initial project planning did not account for the space to be occupied by irrigation facilities when calculating cultivable rice production areas, for which reason additional hectares of land needed to be developed to compensate for such losses. For paddy rice production, 15 percent to 20 percent of the total area planned for irrigation development needs to be set aside for irrigation canals and field levees.

The project's performance in managing the construction of infrastructure involved delays to the schedule and overruns. Moreover, there were some setbacks during the early years of project implementation. Involving personnel with experience in construction work from the planning and design stage of the project would have improved construction quality and reduced the possibility of the structural failure of infrastructure.

In terms of the project's performance in paddy rice production, as of 2012, annual rice production along the western bank of the Nakambe River had achieved 80 percent of its objective of 10,000 tons, while annual rice production along the eastern bank had exceeded its objective of 6,000 tons. Overall production could be improved by increasing rice planting rates or yields. Given the apparent uniformity in soil texture and chemistry across the region, farming practices represent the main factor in the variability of rice yields, and improving such practices would therefore be the key to achieving rice production objectives. Farmers' cooperative organizations, established on the model in the project design, have been ineffective, while rice milling stations established during the project have been ineffective in helping village farmers to vertically integrate rice production, processing, packaging and marketing. Establishing effective cooperation through the development of trust and social relations among farmers takes time, and should have been nurtured,

initially through farmers' participation in project planning, from the very beginning of the project.

Detailed project outputs and their completion status are listed below:

Output	Completion Status	Evaluation in 2012 and Comments
1. 18.5 km of irrigation and drainage canal along western bank.	Completed by 2003.	Inadequate maintenance and management at local agency due to a lack of human resources dedicated to irrigation management, as well as the lack of a sufficient source of independent funding.
2. Development of 1,200 hectares of land for 1,000 hectares of irrigated rice planting along western bank.	Not fully completed.	1. Land development should have been completed by 2000 according to initial project design; was actually completed by 2003. 2. Moreover, the actual planting area for irrigated rice was 931 hectares by 2003.
3 Annual paddy rice production of 10,000 tons along western bank.	Not fully completed.	During the dry season, 888.63 hectares of paddy fields were planted for total production of 4,016.6 tons. Assuming the same level of production for the wet season, annual production would be approximately 8,000 tons, or 80 percent of the production target. The target was not achieved because the planting rates and yields have both been lower than were originally expected. Declining soil fertility and diminishing profitability may be the respective causes of diminishing yields and planting rates.
4. 600 hectares of paddy preparation along eastern bank.	Completed by 2003.	Construction development finished by 2003, on schedule and on budget.
5. Annual paddy rice production of 6,000 tons along eastern bank.	Completed.	During the first cropping season, 599.36 hectares of paddies were planted for total production of 3,302.5 tons. Assuming the same level of production for the second cropping season, annual production would be approximately 6,600 tons.
6. Introduction of Taiwanese rice varieties TS2 and TCS10 to Burkina Faso; naming of seeds introduced to Burkina Faso.	Not fully completed.	TS2 and TCS10 have been introduced to Burkina Faso but the naming of seeds has not been completed. Production of high-yield TS2 and TCS10 was successful; however, monoculture of pure varieties is prone to quick spread of pests and diseases.
7. Establishment of three-step rice seed propagation system to ensure planting with pure, high-yield rice varieties.	Completed by 2009.	Most local farmers are purchasing pure, high-yield rice seeds for planting; however, some farmers are planting seeds from previous harvests.
8. Consultation services in rice production and marketing for 10	Completed by 2009.	As part of this post-evaluation mission, it was observed that farmers in Bagré were not engaging in joint marketing and were not

Output	Completion Status	Evaluation in 2012 and Comments
demonstration fields.		following the rice planting schedule taught by the project Executing Agency.
9. Assistance toward building one rice milling station in each of the 16 project villages.	Completed by 2009.	This post-evaluation mission visited five rice milling stations which were out of service or had been appropriated as private property.
10. Establishment of revolving funds in the 16 project villages.	Completed by 2009.	Fund collection and management has become defunct due to the lack of an effective local farmers' organization.

In terms of project outputs delivered and the project's performance in increasing the employment rate in Burkina Faso, it has been calculated that about 1,662 farmers are presently active in the Bagré Reclamation Area, meaning that the project directly generated 1,662 employment opportunities in the area. However, since the project's design did not establish a quantifiable outcome, it is not possible to objectively compare the differences between the design and the realization of the project outcome. Detailed project outcomes and their completion status are listed below:

Outcome	Completion Status	Evaluation in 2012 and Comments
1. Increase in the employment rate in the Bagré Reclamation Area.	Completed.	Statistics published by International Institute for Environment and Development (IIED) as of 2011 showed that irrigated agriculture in the Bagré Reclamation Area supported the livelihoods of 1,662 farmers ¹ .

In terms of the project impact, the project enabled the further economic development and diversification of the project area and the surrounding region. However, since the project's design did not establish a quantifiable impact, it is not possible to objectively compare the differences between the design and the realization of the project impact.

Impact	Completion Status	Evaluation in 2012 and Comments
1. Increase in economic development in the Bagré Reclamation Area.	Completed.	The project was implemented in combination with migration and resettlement from other areas of the country. Therefore, the project has indeed promoted economic development in the Bagré Reclamation Area and the surrounding region.

Moreover, irrigation development along trans-boundary rivers such as the Nakambe River would also have an impact that had not been evaluated in the project

¹International Institute for Environment and Development. 2011. Sharing the Water, Sharing the Benefits.

design, that is that the project's impact on downstream nations, and the sharing of water resources along such rivers should be an important consideration in the irrigation planning stage.

Compared to other irrigated agricultural production areas in Burkina Faso, the Bagré Reclamation Area has achieved production efficiency in terms of paddy yield, gross value of production per unit land area, produce marketed and cropping intensity. Yet because of inadequate management and the design of open-channel irrigation canals, the productivity of irrigation water supplies and the gross value of production per unit of water supplied are both low. The agency responsible for maintaining and managing irrigation systems, Maitrise d'Ouvrage de Bagré (MOB), lacks technical capacity, funding and human resources. A water-supplying agency such as the MOB would best function as a financially independent organization with its own discrete accounts, which would support better accountability in terms of irrigation financing. Yet currently, instead of being used to support irrigation activities, the water fee collected by the MOB is surrendered to the national treasury.

In terms of project sustainability, training provided by the project to MOB personnel took place within only 162 days, which was insufficient to build adequate local irrigation management capacities. Moreover, the project alone would not have been sufficient, as commitment on the part of local government agencies and farmers would also have been necessary to ensure the sustainability of irrigation operations.

Recommendations following post-evaluation are as follows:

- (a) Project implementation should proceed following the completion of each of the preceding phases of the project cycle.** In this project a detailed feasibility study was not conducted, causing problems to arise during project implementation that affected project performance.
- (b) Establish a master plan and proper project indicators for each stage of a project.** Project design should set out all of the activities that would potentially allow a project to attain the outputs and outcomes that have been designed. Setting a time limit and/or timetable for the completion of such indicators would allow a project to be monitored over time and measured in terms of effectiveness and efficiency, and ensure that its operations would be sustainable after the EA withdrew later on.
- (c) For construction-based development projects, capacity building for the cooperating country should still be included in project design and made a part of project implementation.** The early stage of the project focused mainly on irrigation construction. Operating farmers' organizations and marketing programming were only implemented after construction was completed, which

extended the project implementation period.

- (d) For construction-based development projects, the roles involved in designing, implementing and monitoring project components should be performed by different actors.** For this project, both the design and implementation of irrigation construction work was done by the EA, while no agency was appointed to monitor construction. This led to the structural collapses along a 220 meter section of irrigation canal after it had been in operation for only two to three years.
- (e) The success of farmers' organizations depends on an appropriate organizational structure, composition, working rules and level of management efficiency, as well as the participation of farmers in such organizations.** Strong and vibrant farmers' organizations can provide opportunities for farmers to play an effective role in the market economy and to benefit from it. In this project, farmers' organizations were mainly established in order to benefit from subsidies being offered by the EA, and when the EA withdrew from the project, these farmers' organizations collapsed, as a result of which village-based farmers' cooperative organizations, such as rice milling stations and revolving funds, became defunct.

Table of Contents

1	BASIC DATA	1
2	PURPOSE OF EVALUATION.....	3
3	BACKGROUND	3
3.1	Technical Cooperation between Taiwan and Burkina Faso in the Bagré Reclamation Area between 1994 and 2009	3
3.2	World Bank Evaluation of Previous Development Efforts in the Bagré Reclamation Area	4
4	EVALUATION OF PROJECT DESIGN AND IMPLEMENTATION	7
4.1	Relevance of Design and Formulation.....	7
4.2	Project Outputs	12
4.3	Project Outcome	18
4.4	Project Impact	19
4.5	Implementation Arrangements.....	20
4.6	Related Technical Assistance	21
4.7	Performance of the Executing Agency	21
4.8	Performance of the Irrigation System	23
5	EVALUATION OF PERFORMANCE.....	27
5.1	Relevance	27
5.2	Effectiveness and Efficiency in Achieving Project Outputs and Outcome.....	27
5.3	Preliminary Assessment of Sustainability	28
5.4	Impact.....	30
6	OVERALL ASSESSMENT AND RECOMMENDATIONS.....	30
6.1	Overall Assessment	30
6.2	Lessons Learned	31
6.3	Recommendations	33

Appendix A Field Reconnaissance Log

Appendix B Survey Questionnaires Results

Appendix C Household Questionnaires

1 BASIC DATA

Project Name	Irrigation and Paddy Rice Project in Bagré, Burkina Faso	
Objectives	<ul style="list-style-type: none"> ● Increase food production in Burkina Faso. ● Create employment opportunities for the local population. ● Promote economic prosperity in the surrounding areas. ● Raise the effectiveness of technical cooperation between Burkina Faso and Taiwan. 	
Implementation Period	1995 to 2009	
Implementation Organizations	<ul style="list-style-type: none"> ● Taiwan Technical Mission, ROC (TTM), also referred to in this report as the Executing Agency (EA) ● Oumarou Kanazoe (contractor of another European donor) ● Burkina Faso government ● Maitrise d’Ouvrage de Bagré (MOB) ● Local farmers ● Village farmers’ cooperative organizations 	
Costs	Irrigation development of western bank ('95-'03) ² Irrigation development of eastern bank ('02-'03) ³ Rice production training for local farmers ('04-'06) Sustaining rice production and culturing high-yield rice ('06-'09) TOTAL	US\$ 13,213,680 US\$ 2,196,658 US\$ 2,249,869 US\$ 2,147,323 US\$19,807,530
Scope	<ul style="list-style-type: none"> ● Irrigation development and land preparation for paddy rice production along western bank. ● Continued irrigation development and land preparation for paddy rice production along eastern bank. ● Establishing farmer's organizations and introducing high-yield rice varieties: Assistance to build rice milling stations, storehouses and purchase equipment; introduction of high-yield Taiwanese paddy rice varieties for planting and production in the Bagré Reclamation Area; technical training of local irrigation management staff; production and marketing training for local farmers; establishment of local farmers’ organizations and revolving fund; establishment of three-step rice seed propagation system to ensure planting with pure, high-yield seeds. 	

²Total project cost is estimated by summing annual budget estimates from 1995 to 2000 and verified project expenditures from 2001 to 2003. The total area developed was 1,200 hectares, from which paddy rice planting could be achieved over 1,000 hectares.

³A total of 685 hectares of irrigation development along the eastern bank was carried out by Oumarou Kanazoe from 1998 to 2001. Due to serious project cost overruns and delays under the management of Oumarou Kanazoe, this project component was taken over by the TTM in 2002. At that time, the completion rate of the irrigation system was 60 percent, and the completion of field preparation was at 40 percent. The project cost listed does not include expenditures incurred prior to 2002. Of the 685 hectares developed, the planting of paddy rice could be achieved over 600 hectares.

Figure 1. Location of the Bagré Reclamation Area



Figure 2. Bagré Reclamation Plan (November 1995 - June 2000)

2 PURPOSE OF EVALUATION

The project, Agricultural Technology Cooperation in Paddy Rice Production in the Bagré Reclamation Area between Burkina Faso and Taiwan, ROC, under implementation from 1994 to 2009, is herein evaluated in terms of project outputs and outcomes, its broader economic and social benefits, the satisfaction of the local stakeholders, and the sustainability of irrigated agricultural production. Based on this project evaluation, recommendations are made as to improving the overall operational performance of future Taiwan International Cooperation and Development Fund (TaiwanICDF) projects.

3 BACKGROUND

3.1 Technical Cooperation between Taiwan and Burkina Faso in the Bagré Reclamation Area between 1994 and 2009

Burkina Faso and Taiwan, ROC, resumed diplomatic relations in 1994. Under the bilateral agreement then signed between the two countries, Taiwan began providing technical assistance to increase rice production in the Bagré Reclamation Area, which is located along the White Volta River, also known as the Nakambe River, in Burkina Faso (Figure 1).

The Bagré Reclamation Area was developed in association with the construction of the Bagré Dam, which was built primarily to provide electricity for the national grid. The irrigation potential of the dam was estimated to be 31,000 hectares⁴, of which 7,400 hectares could be achieved through gravity irrigation, with the remaining land requiring irrigation by pump. Between 1994 and 2003, the project developed 2,200 hectares of land along the western and eastern banks of the Nakambe River downstream of the dam, of which 1,800 hectares were devoted to planting paddy rice, with the remaining land occupied by irrigation facilities and levees. From 2004 to 2006, the project focused on training local farmers in the production and marketing of paddy rice. In 2006, the project Executing Agency made several recommendations in response to several challenges that had arisen as part of project implementation:

- Lacking funding and resources, local farmers rely on the project Executing Agency for production inputs such as fertilizers. In order to sustain long-term production, local farmers need to establish a revolving or recirculating fund, saving a portion of their income to pay for fertilizers, the

⁴International Institute for Environment and Development. 2011. Sharing the Water, Sharing the Benefits.

maintenance of irrigation facilities and other recurring production costs.

- Compared to paddy rice cultivation, the development of upland rice fields is easier and less costly. The promotion of upland rice production would be a more effective means of raising national grain production.
- To sustain local rice production, local farmers' associations need to be established and supported to build capacity in the Bagré Reclamation Area.
- The local labor force for rice production is small. Several farming families should synchronize planting and harvesting such that cooperation amongst families can increase output per worker. Furthermore, the mixed varieties of rice being planted ripen at different times, making cultivation and harvesting difficult. A local rice seed bank and research center is needed to breed and supply local farmers with seeds that are optimally acclimatized to local growing conditions. In addition to developing local capacity for rice production, there is also the need to develop local facilities and capacity for rice processing and marketing, so that local farmers can obtain added-value benefits from rice cultivation.

From 2007 to 2009, the project continued to provide technical training in paddy rice production in the Bagré Reclamation Area, as well as provide assistance to local farmers to establish rice processing and packaging facilities with which to conduct final marketing. In 2009, the project handed management responsibilities for irrigation and other rice production assets over to the Maitrise d'Ouvrage de Bagré (MOB), which is in particular responsible for (i) the establishment, operation and maintenance of the irrigation systems; (ii) the allocation of irrigated land to agricultural producers; and (iii) providing support services to farmers and their associations.

3.2 World Bank Evaluation of Previous Development Efforts in the Bagré Reclamation Area

When the government of Burkina Faso applied for a World Bank (WB) loan to finance the Bagré Growth Pole Project, the WB completed an assessment of development efforts prior to 2009 as part of the loan approval process, thereby providing an "external" evaluation of previous work carried out in the Bagré Reclamation Area. Text and information presented throughout this Section 3.2 and its subsections is drawn from World Bank Report No. AB5668, a Project Information Document (PID) covering the Concept Stage of the Bagré Growth Pole Project⁵.

The WB's report explains that after a sustained growth spurt between 1994 and

⁵World Bank. 2010. Burkina Faso - Bagre Growth Pole Project. Washington D.C. - The Worldbank. <http://documents.worldbank.org/curated/en/2010/04/12108202/burkina-faso-bagre-growth-pole-project>

2007, Burkina's economy began to face new challenges, and that since 2007, the global financial crisis has presented a serious challenge to Burkina's growth ambitions. Economic diversification outside of the cotton sector is seen as paramount to reducing vulnerability, enhancing export performance and ensuring sustainable growth in the medium to longer term. The report suggests that the country can choose to shift from low-input/low output subsistence farming to diversified and high income-enhancing agriculture, and move towards sustainable growth.

The report states that the government's 2009 Schéma National d'Aménagement du Territoire (SNAT) presented a comprehensive diagnostic of the country's social and economic challenges, providing recommendations for economic growth and diversification which included: (i) the improvement of economic infrastructure; (ii) establishing support mechanisms for commerce; (iii) facilitating access by economic actors to resources (finances, production inputs, technology etc); (iv) attracting foreign and domestic investment in high potential sectors; (v) increased revenue generation for the population through better access to markets; and (vi) support to small and medium processing industries.

The report further explains that under such new development strategies, the government of Burkina Faso decided to focus public resources in key economic development areas, including the Bagré Reclamation Area.

The WB concluded that the prior development approach of the scheme in the Bagré Reclamation Area did not appear to be either economically efficient or sustainable. However, the WB also pointed out that there had been a spontaneous expansion of fruit and vegetable production by private operators on small irrigated (pumping, hand) plots, without any government support, in the areas of the "zone de concentration" which had not yet been developed, and that this clearly indicated that small-scale irrigation offers considerable potential for development without massive public investments.

The WB identified key areas that require further strengthening in order for Bagré Growth Pole Project to succeed, including institutions, infrastructure and services, and local capacity.

3.2.1 Institutions

From the WB report:

The efficiency of the current Zone Authority (Maitrisé'Ouvrage de Bagré-MOB) has been low, partly due to its parastatal status which severely limits its management flexibility, understaffing and a management team which was until recently located in Ouagadougou. It is clear that the MOB,

in its current institutional set-up, will not be able to cater to the needs of varied and demanding crops/production systems. It will require that the management (operation and maintenance, O&M) of the irrigation system be carried out by an institution with the necessary technical/managerial capacity, with sufficient autonomy and flexibility to meet any planned or unplanned circumstances in a timely and efficient manner and accountable to both the Government and the users who will be asked to meet the full O&M cost through appropriate water charges.

3.2.2 Infrastructures and Services

From the WB report:

There is a lack of critical services and infrastructure to make Bagré attractive to private sector: Although the hydroelectric power exists in Bagré, power for industrial usage is not made available to Bagré, and it requires investment in transforming infrastructure. Also the many critical services are missing such as fuel supply (there is no service station in Bagré, the first one being at 30km), communication/connectivity, input suppliers or providers of maintenance and repair services; banking facilities to provide funding for the development of irrigation infrastructure and productive investments (tertiary channels and plot development, tractors etc.) especially for small holders; collective productive infrastructure (storage, cold chain); technical advisory services (e.g. quality and standard, skills development etc.). The government has set up a guarantee fund for promoting credit from the banking system for small holders under an ongoing nationwide Agricultural Value Chain Support Project (PAFASP). MEBF has opened in September 2009 a service center in the Bagré region.

3.2.3 Local Capacity

From the WB report:

An essential factor of broadening the impact of the development projects is to generate employment opportunities for the local population, whether through direct employment or through strengthening the capacity of local firms, especially small and medium enterprises (SMEs). Some of the issues that need to be addressed include: lack of access to market intelligence and marketing skills; insufficient number of small holders with adequate 'value-add capability and capacity' to be competitive, the disparity between technical/competency skills available and the business opportunities available from international firms the project aims to attract; the gap between international health safety environment and quality

standards and Burkina standards; the lack of general and business management skills/experience amongst SMEs; and the lack of SME's access to suitable forms of credit/finance and business development services.

4 EVALUATION OF PROJECT DESIGN AND IMPLEMENTATION

4.1 Relevance of Design and Formulation

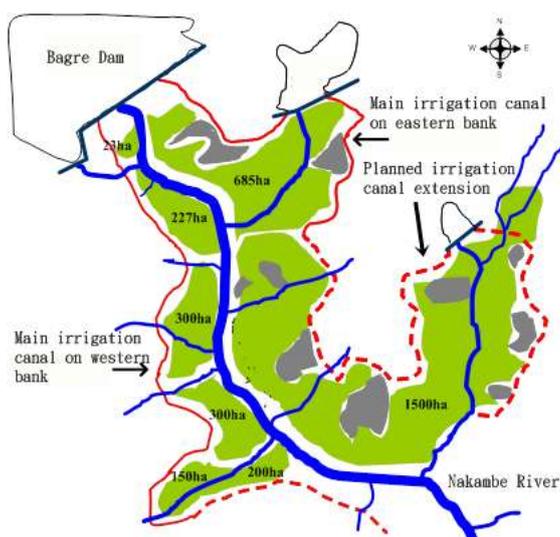


Figure 3. Irrigation Development Plan at Bagré (2006 and onward)

4.1.1. Formulation and Relevance

Burkina Faso and Taiwan, ROC, resumed diplomatic relations in 1994. At that time, Taiwan promised to enhance rice production in Burkina Faso, and consequently dispatched a team to establish a technical mission in the country later in the same year. Therefore, the project was consistent with Taiwanese government policy. The project also assisted a partner country to develop its economy by drawing upon the comparative advantages of Taiwan's own development experience, for which reason the project can be said to have been consistent with the TaiwanICDF's assistance strategy.

According to the malnutrition prevalence index⁶, incidence of child malnutrition in Burkina Faso exceeds both the world average and that of Sub-Saharan Africa (Figure 4). In terms of the trend in food security deficiencies in Burkina Faso, Burkina has obvious food security deficiencies (Figure 5). These data indicate that the project was consistent with Burkina's development-related demand for solving food security

⁶Prevalence of child malnutrition is the percentage of children under age 5 whose weight for age is more than two standard deviations below the median for the international reference population ages 0-59 months.

deficiencies.

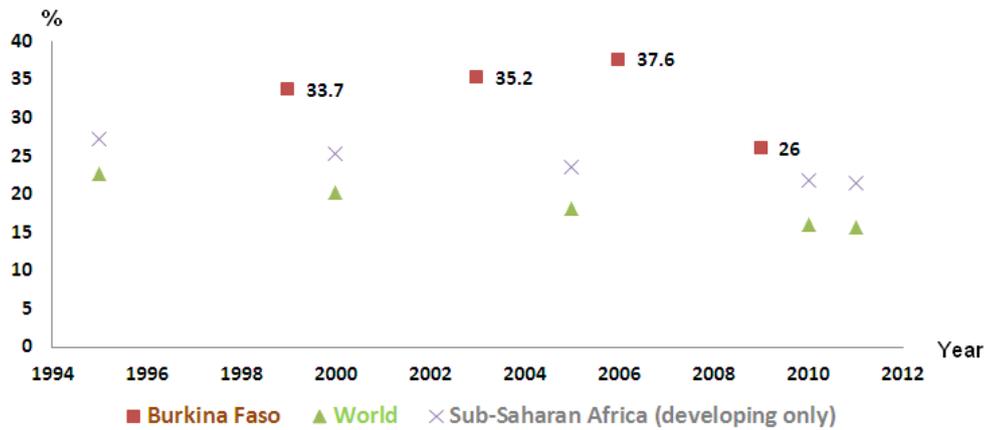


Figure 4. Malnutrition prevalence, weight for age (% of children under 5)
Source: Country data, World Bank website.

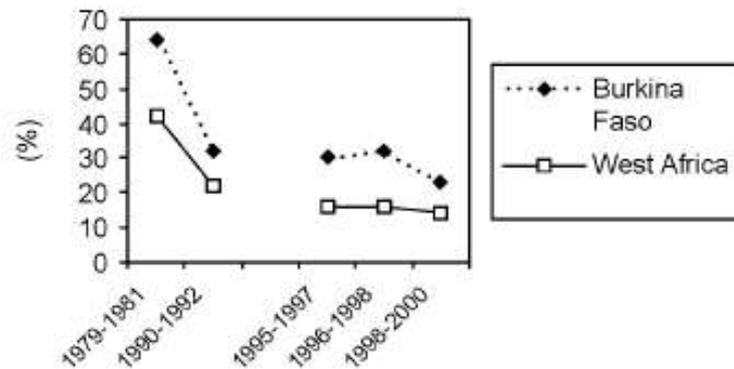


Figure 5. Trend of food security deficiencies in Burkina Faso and West Africa as proportion of undernourished people in total population. The gap between 1992–1995 is due to lack of data.
Source: Vulnerability Profile of Burkina Faso, Louise Simonsson, Stockholm Environment Institute, March 2005.

However, a detailed feasibility study was not conducted for the project, nor was a master plan drafted at the beginning of the venture. The lack of such actions is not consistent with the project cycle. As a result, when the project’s construction work got underway, detailed measurements of site topography and a complete, detailed construction design were unavailable, so project costs and the construction period had not been correctly estimated. This, in turn, meant that the construction design was revised many times while construction was in progress, causing construction fees to increase and the project implementation period to overrun.

Moreover, the lack of a project master plan meant that sub-projects were simply carried out as part of project implementation, again contributing to the increase in various fees and the overrunning of the project implementation period. A further

critical problem was that as a result of this lack of organization, certain sub-projects which should have been included in the project, such as maintenance and operational work, were ignored. Problems only came to light after project completion.

4.1.2 Suitability of Technical Aspects of Project Design

4.1.2.1 Irrigation System Design

- *Irrigation potential:*

The flow capacities at the two built-in sluice gates on the Bagré Dam are 28 cubic meters per second (m^3/s) for the western bank and 10 m^3/s for the eastern bank. Downstream of the Bagré Dam, the soil texture of the potential irrigation area is mostly sandy clay loam. For this type of soil, previous irrigation development experiences in Taiwan show that irrigation of 470 to 780 hectares of paddy rice production can be supported per 1 m^3/s of water flow⁷. Assuming that 1 m^3/s of water flow could irrigate 500 hectares of rice paddy, the total irrigation potential of the Bagré Reservoir was estimated to be 19,000 hectares.

- *Flow capacity of the main irrigation canals:*

From the sluice gates, the project constructed two main irrigation canals: one along the western bank, and one along the eastern bank. The canals were of open-channel design with a trapezoidal cross section, the top of the trapezoid being 10 meters wide, and the bank slope ratio being 1.5. Assuming a gradient of 1/5,000, a roughness coefficient of 0.015 and a water depth of 2 meters, the design flow capacity of the main irrigation canal would be 15 m^3/s . Assuming that each 1 m^3/s of flow could specifically support 430 hectares of paddy rice production on the western bank, the design flow capacity of 5 m^3/s would be sufficient for irrigating 2,150 hectares of paddy rice. As of December 2012, field observations confirmed the adequacy of irrigation canal flow capacity in meeting current irrigation needs.

The main irrigation canals were built with a concrete lining. Based on the *Technical Handbook for Irrigation Canal Design* published in Taiwan, concrete lining for open channels can withstand water flow rates of up to 4 m^3/s . By comparison, the flow speed of 0.69-0.77 m^3/s designed for, as recommended by the project consultant in 1998, would not cause damage to the canal lining.

⁷Ministry of Economics of Taiwan, ROC. 2008. Operational Guidelines for Reviewing Water Rights Applications.

- *Evaluation of design in terms of ease of construction, operation and maintenance:*

The 1998 project work status report documented construction difficulties by inexperienced project staff and local personnel due to overly complicated construction design. It was recommended in the report that the design of the irrigation system should be kept simple for ease of construction and maintenance.

Correspondence among TaiwanICDF staff on June 9, 1999 documented structural collapses along a 220 meter section of irrigation canal and of a large crossing aqueduct that had only been in operation for two to three years. The project personnel cited many contributing factors for the structural collapses, including an inappropriate design by water resources engineers lacking in construction experience and a lack of quality testing (such as of the compressive strength of concrete) during construction.

In addition, local roads were designed and built by local government contractors, which resulted in an increase in overland runoff and the scouring of the irrigation canals' soil foundations. Compatibility between road and irrigation system layouts is also an important factor in project design and implementation.

In 2000, part of the project's irrigation construction collapsed. The project was therefore extended by two years. However, at the end of this extension period, irrigation construction had still not been completed, requiring the project implementation period to be extended by one more year, and further requiring revisions to part of the construction design and an increase in the project budget. The development of 1,200 hectares of irrigated land along the western bank was finally completed by 2003.

During 2002, irrigation development of 600 hectares by a government contractor named Oumarou Kanazoe along the eastern bank encountered project cost overruns and was delayed, resulting in a request for the project Executing Agency to take over the development of the irrigation of the eastern bank.

Several strengths in the project's irrigation overlay and canal design were cited in the project report: Firstly, the project Executing Agency took topography into account when designing the layout of irrigation systems, reclaiming sloping land through terracing instead of flattening; secondly, in comparison to canals with a square cross-section, the canals with a trapezoid cross-section were much easier and less costly to excavate; thirdly, the land near to irrigation canals was divided into uniform squares for ease of irrigation management; and finally, special attention had been given to improving drainage as part of planning for irrigation development.

- *Drainage capacity of paddy rice production area:*

Another contributing factor in the structural collapses of irrigation systems was the instability of soil at the foundation of such infrastructure due to poor drainage and the subsequent saturation of water. Effective drainage is not only important for optimal crop growth, but also for maintaining the structural integrity of irrigation canals.

However, increasing drainage capacity by increasing the size of drainage canals would be costly in terms of construction materials and land use. During the early stages of irrigation development in Taiwan, the drainage capacity built into designs was limited by funding, with the drainage rate being set such that the cumulative amount of rainfall from a typical three-day rainfall event was allowed to drain slowly over the subsequent three-day period.

During the rainy season, precipitation in Burkina Faso is often sudden and intense. When the banks of the Nakambe River in the Bagré Reclamation Area become scoured by flood water during extreme weather events, damage to irrigation systems is unavoidable.

4.1.2.2 Technical Training in Irrigation System Construction, Maintenance and Management

During field reconnaissance of the Bagré Reclamation Area, the mission observed several sections of the irrigation canals to be in poor condition (see Section 4.7). Local capacity in the maintenance and management of the irrigation systems is apparently lacking. Project documentation indicates that during the first five years of project implementation, personnel of the project Executing Agency included water resources engineers and agricultural experts only, and that an irrigation schedule was not established until 2009.

Local capacity building in the construction, maintenance and management of irrigation systems should have been an integral part of the design of this technical cooperation project, with irrigation experts from Taiwanese irrigation associations involved in the project from the very beginning.

4.1.2.3 Development Planning of Paddy Rice Production

At the beginning of the project, it was required, in accordance with signed diplomatic agreements, to develop 1,000 hectares of land along the western bank for paddy rice production by 2000, so that 1 hectare of paddy could be assigned to each of 1,000 applicant households. At the beginning of the project, the project set out to develop only 1,000 hectares of land. Subsequently, however, by subtracting the spaces occupied by irrigation canals and field levees, and areas of poor soil quality,

each of the 1,000 applicant households would only obtain 0.85 hectares of paddy⁸. As a result, the project was required to develop an additional 200 hectares of land. Based on development experience of paddy rice production in Taiwan, of the total area drawn up for irrigation development, only 80 percent would be available for paddy rice production following the subtraction of spaces set aside for irrigation infrastructure⁹. A feasibility study was not conducted as part of the project, and therefore no technical analysis (including soil tests) took place; and as a result, project design was unrealistic in its expectations. Furthermore, the project was not designed in accordance with the relationship between land which was earmarked for development and actually cultivable land.

4.1.2.4 Plot Size or Scale of Agricultural Production Unit

The plot size of 1 hectare allocated in the original irrigation development scheme was tailored for small-scale or family farming. Because importing expensive equipment for mechanized farming is cost-prohibitive, small plot sizes that would require manual planting, weeding and harvesting seemed most suitable. However, small plot sizes cannot achieve economy of scale in production, for which reason the price of rice grown in Bagré is roughly the same as imported rice. In order to increase the competitiveness of local agricultural production, the government of Burkina Faso has relaxed legal restrictions for farmland ownership, allowing commercial farms to cultivate larger areas in excess of 50 hectares¹⁰.

4.1.2.5 Crop Choice

The choice of paddy rice cultivation as the focus of agricultural technology cooperation was driven by the fact that Taiwan was more experienced with paddy rice techniques than with upland rice cultivation techniques, and the fact that intensive farming of paddy rice has helped many developing countries in Asia to achieve food security. However, evaporation loss in Bagré from flood irrigation of paddy rice would be much higher than in other countries, leading the project to recommend, in 2006, that upland rice cultivation be promoted in other parts of the country.

4.2 Project Outputs

The project involved ten outputs, seven of which had been completed by 2009, and three of which remain outstanding. The details are listed below:

⁸According to the experience of reclamation in Taiwan, between 75 percent and 85 percent of the total land area as seen on a map will ultimately be developed.

⁹Water Resources Bureau of Taiwan, ROC. 1967. Irrigation and Drainage Planning Manual.

¹⁰World Bank. 2010. Burkina Faso - Bagre Growth Pole Project. Washington D.C. - The Worldbank. <http://documents.worldbank.org/curated/en/2010/04/12108202/burkina-faso-bagre-growth-pole-project>

4.2.1 Irrigation Construction

- 4.2.1.1 The construction of 18,545 meters of main irrigation canal, and of subsidiary irrigation and drainage canals for the planned irrigation area on the western bank of Nakambe River. Such canals are now experiencing maintenance and management problems.
- 4.2.1.2 The development of 600 hectares of farmland and the construction of irrigation and drainage canals on the eastern bank of the Nakambe River downstream of the Bagré Dam.
- 4.2.1.3 The development of 1,200 hectares of irrigated farmland for biannual cultivations of paddy rice on the western bank of Nakambe River downstream of the Bagré Dam. According to the initial project design this output should have been completed by 2000, but was actually completed by 2003.

Satellite images taken in 2011 confirmed the irrigated area covered a total of 1,227 hectares of land area along the eastern bank and 1,427 hectares of land area along the western bank (Figure 6). Within this irrigation area, assuming 20 percent of the land area was occupied by irrigation canals and field levees, the rice planting area totaled 981 hectares along the eastern bank and 1,187 hectares along the western bank, of which 1,600 hectares of paddy was prepared by the project.



Figure 6. Satellite image showing irrigated area downstream of the Bagré Dam

Table 1. Project Progress along the Western Bank from 1996 to 2003

Year	1996	1997	1998	1999	2000	2001	2002	2003	Total
Canal Engineering (m)	1,500	3,500	3,500	4,000	2,500	60	1,900	40	17,000
Reclamation Area (ha)	23	227	300	300	150	50	120	30	1,200

Note: As of 2009, the total length of irrigation canals was 18.5 km, and the total area reclaimed was 1,885 hectares.

4.2.2 Paddy Rice Production

4.2.2.1 Introduction of Taiwanese paddy rice varieties Tai Sen 2 (TS2) and Taichung Sen 10 (TCS10) to Burkina Faso (Figure 7). However, due to limitations in Burkina's laws and regulations, the project has not formally named the Taiwanese varieties of paddy rice grown in Burkina Faso.



Figure 7. High-yield rice varieties Tai Sen 2 (left) and Taichung Sen 10 (right)

- 4.2.2.2 The establishment of a three-step rice seed propagation system for breeder seed, foundation seed and seed stock.
- 4.2.2.3 Programming annual paddy rice production of 10,000 tons along the western bank, and annual paddy rice production of 6,000 tons along the eastern bank.

As early as 2004, annual paddy rice production in the Bagré Reclamation Area had reached 12,000 to 13,000 tons (Table 2; Figure 8). In 2007, the planting acreage in the dry season and the wet season totaled 2,773 hectares, the average yield was 4,600 kg per hectare and the total output of rice production was 12,788 tons. For the dry season in 2012, the planting acreage was 1,487 hectares, the average yield was 5,020 kg per

hectare and the total output of rice production was 7,465 tons. Extrapolating the planting area and yields for the dry season, total rice production in 2012 would have been approximately 15,000 tons, which is approximately 94 percent of the 16,000 tons set as the project's original rice production target.

Table 2. Area planted, yield and annual production documented

Year ^{c,d}	Area planted (hectares)		Yield (tons/hectare)		Annual production (tons)
	Dry season	Wet season	Dry season	Wet season	
2004	1,334	1,462	4.919	4.520	13,170
2005	1,457	1,511	4.192	4.052	12,230
2006	1,487	1,543	4.280	No data	12,968 ^a
2007	2,773		4.600		12,788
2012	1,488	No data	5.016	No data	14,928 ^b

Notes:

- a. For 2006, annual production is estimated by assuming yields in the wet season to be the same as those in the dry season.
- b. For 2012, annual production is estimated by assuming the area planted and yields in the wet season to be the same as those of the dry season.
- c. Data from 2004 to 2006 were documented by the TTM during project implementation as the first crop of the year.
- d. Data for 2007 and 2012 are obtained from the Bagré Growth Pole Project status report¹¹.



Figure 8. A bumper harvest field

¹¹Burkina Faso Premier Ministere. 2012. Rapport d'Activites de la Direction de la Production. B. F. P. Ministere.

The production statistics published by the Bagré Growth Pole Project for the dry season of 2012 were obtained from a random sampling of 10 percent of farms (Table 3). The statistics show high variability in per-hectare yield across the Bagré Reclamation Area. Table 4 shows separate statistics for planting areas along the eastern and western banks.

Table 3. Average rice yield per hectare during dry season of 2012

Eastern bank	Village	V1A	V1B	V2	V3	V4	V5	Average				
	Unit area paddy rice grains production (T/ha)	4	6.37	6.27	No data	5.3	5.61	5.51				
Western bank	Village	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	Average
	Unit area paddy rice grains production (T/ha)	4.06	No data	No data	4.1	5	No data	No data	No data	4.92	4.53	4.52

Table 4. Comparison of planned and actual rice production

	Area Planned (ha)	Actual Planting (ha)	Yield rice grains (t/ha)	Production (tons)	% of planned targets
Eastern Bank	629.53	599.36	5.51	3,302.50	87.4
Western Bank	926.39	888.63	4.52	4,016.60	72.3
Total	1,555.91	1,487.99	5.02	7,319.10	79.8

As shown in Table 3, on average, rice yields on the eastern bank were 1 ton higher than on the western bank, yet no conclusions can really be drawn due to the sparseness of data. Assuming the same yield for the dry and wet seasons, current annual paddy rice production is estimated to be around 14,638 tons of rice, which is equivalent to a 91 percent achievement rate of the annual rice production target of 16,000 tons (Table 4).

4.2.3 Vertical Integration of Production and Marketing at Village Level

In terms of the operation of farmers' organizations, the project was due to involve the following three outputs:

- Rice production and marketing in 10 demonstration fields.
- Ten rice-milling stations on the western bank and six rice-milling stations on the eastern bank.
- Revolving Funds for 10 farming villages, so that farmers could have a supply of capital before harvests.

The above three outputs were attained when the EA was still involved in the project.

However, since the EA left the area, the following observations can be made about these three outputs:

- Farmers do not follow the rice planting schedules designed as part of the project and have completely abandoned marketing practices.
- Some of the rice-milling stations have fallen out of service and some had been appropriated as private property.
- The Revolving Funds have become defunct.

The farmers' cooperative organizations and Revolving Funds at the village level had become defunct. Many factors had contributed to organizational failure at the village level. Firstly, farmers originally migrated from elsewhere to settle in the Bagré Reclamation Area, so that farmers belonging to the same village had not established the levels of trust and social relations necessary for effective cooperation. Reportedly, many farmers were migrant workers on short-term and temporary contracts with the commercial companies operating in the area. Secondly, the scale of village operations was not large enough to be of commercial success.

During project implementation, rice milling stations were established at each of the 16 villages in the Bagré Reclamation Area to support the vertical integration of rice production and marketing by village collectives. In 2007, the project estimated that such integration would allow farmers to gain an 85.84 percent increase in profitability.



Figure 9. Rice milling equipment at a village milling station

However, such vertical integration at village level has not been achieved. At the time of field reconnaissance in 2012, many milling stations had fallen into disuse due to several reasons: firstly, due to a lack of spare parts the maintenance of the milling equipment, which had been imported from Taiwan, had been difficult (Figure 9); and secondly, because the milling stations are small-scale and such equipment cannot deal with high volumes of grain very quickly, these milling stations are relatively inefficient compared with local commercial milling stations. At 15 CFA, the cost of processing 1 kg of rice at village mills is higher than sending locally produced rice to commercial mills elsewhere, where larger scale operations are in place.

Farming costs and income per hectare for paddy rice production in Bagré were estimated from the results of questionnaires filled out during interviews with a few randomly selected farmers (see Appendices B and C). The cost of farming inputs per hectare ranged from 118,000 CFA to 315,000 CFA, with an average of 260,800 CFA, which would be equivalent to the value of 1.7 tons of unprocessed rice selling for 150 CFA per kilogram. Farmers interviewed reported per-hectare yields ranging from 3 to 7 tons. They typically retained 10 percent to 20 percent of their production for household consumption, and sold the remaining surplus to commercial companies operating in the Bagré Reclamation Area.

Local farmers handed in unthreshed grain to commercial companies for either cash payments, or in exchange for farming inputs for the next planting season, or as payment for farming inputs that had already been supplied on credit. Some local farmers even had formal production contracts with commercial companies.

4.3 Project Outcome

Under the original project design, the project was intended to raise employment in the Bagré Reclamation Area. Statistics published by International Institute for Environment and Development (IIED) as of 2011 showed that irrigated agriculture in the Bagré Reclamation listed below (Figure 10)¹²:

- New settlements within the irrigated perimeter now house 1,662 resettled farmers (six villages on the eastern bank, farming 680 hectares; and 10 villages on the western bank, farming 1200 hectares).
- At the time of their resettlement, each farmer was supposed to receive 0.1 hectares for housing, 0.4 hectares of village fields, 1 hectare of irrigated land for rice growing and 1.5 hectares of non-irrigated land for other crops.

¹²International Institute for Environment and Development. 2011. Sharing the Water, Sharing the Benefits.

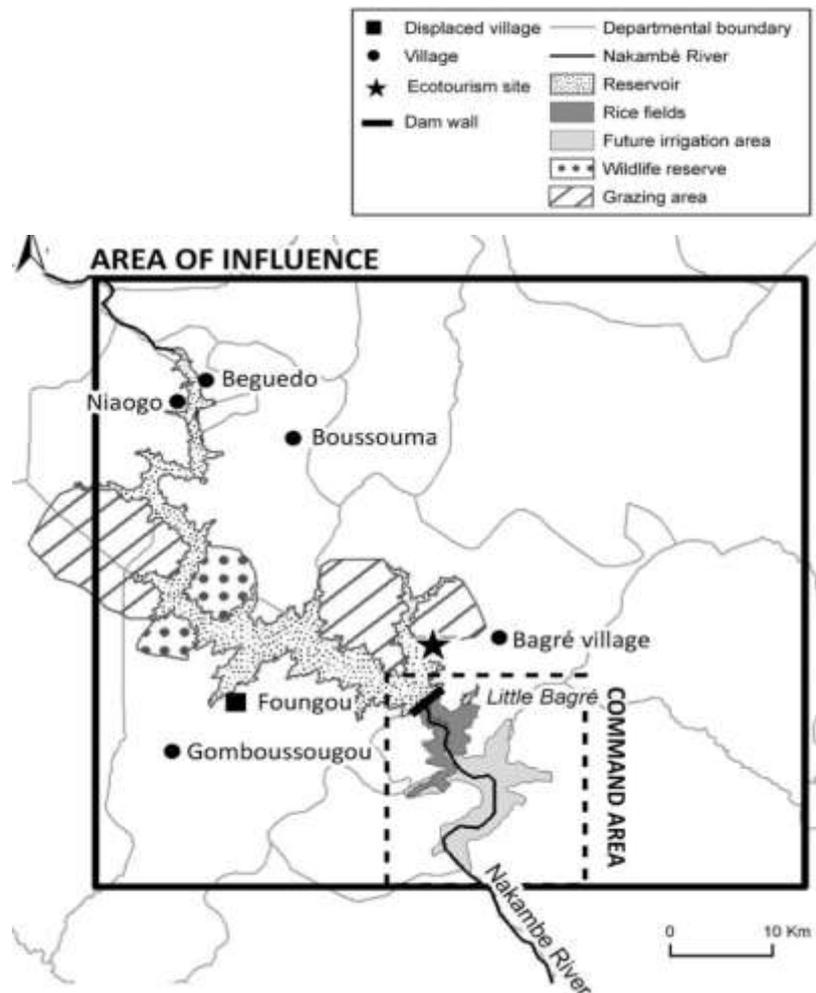


Figure 10. Bagré Area Development Status as of 2011 (IIED, 2011)

The above statistics indicate that the project directly generated 1,662 employment opportunities in the Bagré Reclamation Area. However, since the project’s design did not establish a quantifiable outcome, it is not possible to objectively compare the differences between the design and the realization of the project outcome.

4.4 Project Impact

Under the original project design, the project was intended to promote economic development and the diversification of the project area and the surrounding region. Since the project operations were combined with the government of Burkina Faso’s migrations policy, as part of which there was the intention to resettle people from other areas of the country, having been implemented in the Bagré Reclamation Area for 14 years, the project has helped migrants to access land, food and income and resettle in a new place, and gradually and indirectly increased livelihoods through economic activities in the area and the surrounding region. However, since the project’s design did not establish a

quantifiable impact, it is not possible to objectively compare the differences between the design and the realization of the project impact.

4.5 Implementation Arrangements

The project did not have a master plan. However, project implementation, in terms of how the project was actually implemented, can be divided into three stages.

First stage: (1) On the western bank: As part of the original design, from 2005 to 2010 the project was due to develop 1,000 hectares of irrigated farmland for the biannual cultivation of paddy rice on the western bank, harvesting 10,000 tons of rice per year. However, because of the need to separate each farmer’s farmland with bunds and footpaths, after developing irrigated farmland covering 1,000 hectares, the actual coverage of rice planting itself had not in fact been attained over 1,000 hectares. Therefore, construction was extended by two years (to 2002) in order to develop 200 more hectares of irrigated farmland, and was extended again in 2002 (to 2003) due to revisions to the construction design. (2) On the eastern bank: In 2002, Taiwan, at Burkina Faso’s request, began to develop 600 hectares of irrigated farmland (at that time, approximately 60 percent of development work was already finished). This construction was finished on time (2003) and under budget.

Second stage: From 2004 to 2006, farmers commenced training according to plan. Furthermore, because of the collapse of some infrastructure built during the first stage of project implementation, or the need to maintain similar infrastructure, maintenance and reconstruction work from the first stage was still underway during the second stage of implementation.

Third stage: From 2006 to 2009, implementation focused on establishing farmers’ organizations, facilities for paddy rice production, and processing and marketing operations.



Figure 11. Functions of a farmers’ organization

In accordance with the original project plan, by 2009 village farmers’ cooperatives should have been fully in charge of processing, packaging and marketing the locally produced rice belonging to each village. Such cooperatives

were also due to take over the training responsibilities for inexperienced farmers taking part in the project.

Technical cooperation between Burkina Faso and Taiwan in paddy rice production was concluded at the end of 2009. The transfer of responsibility for irrigation management to the MOB was preceded by the professional, field-based training of two to three MOB staff alongside TTM staff. Reportedly, the training was conducted in haste within such a short time period that it was rendered ineffective. To make matters worse, it was reported that some MOB staff who participated in the training did not possess enough technical knowledge to fully grasp the lessons taught, and that some might soon retire without passing on their technical knowledge to new staff.

4.6 Related Technical Assistance

Except for dispatching short-term technical consultants as part of construction and as part of the establishment of the three-step rice seed propagation system (breeder seed, foundation seed and seed stock), the project did not involve any other cooperative project, such as a government capacity building project.

4.7 Performance of the Executing Agency

To achieve the goals initially planned for the original implementation period, the implementation period was delayed and the budget overran. Several project design parameters – including the technical design of the irrigation systems, technical training in irrigation systems maintenance and management, plot size, crop choice and cropping patterns, the design of irrigation canals, and irrigation methods – could have been adjusted so as to increase positive socio-economic impacts and improve the sustainability of the development of irrigated agriculture.

- *Hydraulic engineering for paddy rice irrigation:*

Construction on the western bank started from 1995, but only two to three years after structures had been put into operation, in 1998 and 1999, structural collapses along a 220 meter section of irrigation canal and a large crossing aqueduct were reported.

In 2000, the last year that construction should have taken place by initial design, part of the project's irrigation construction collapsed and could not be reconstructed in time. The project was therefore extended by two years. However, at the end of this extension period, irrigation construction had still not been completed, requiring the project implementation period to be extended by one more year, and further requiring revisions to part of the construction design and an increase in the project

budget. The development of 1,200 hectares of irrigated land along the western bank was finally completed by 2003. The Executing Agency carried out construction on the western bank inefficiently.

In 2002, the Executing Agency was requested to take over the development of the irrigation of the eastern bank and carried out construction on the eastern bank efficiently.

- *Paddy rice and capacity building:*

In the fields that the mission visited, farmers who had participated in the project were qualified in paddy rice production skills, such as soil preparation, and weed and pest controls; and had associated technologies, such as fertilizers. Some farmers practiced concepts regarding the width of plating rows and distance between rice plants, which is the most basic means of enhancing rice yields per unit area and is worthy of continued promotion. The basic practice of enhancing rice yield by keeping specific spacing between rows and plants should also continue to be promoted. Manual land preparation by human- and animal-drawn plows is often less efficient than mechanized methods, and greater care needs to be taken when tilling near field ridges.

However, farmers have not abided by the cultivation calendar taught by the Executing Agency, with the result that they are not working according to the most optimal seasonal conditions (as Figure 12). Furthermore, in connection to this, the MOB cannot manage irrigation water use to meet this different cultivation calendar.

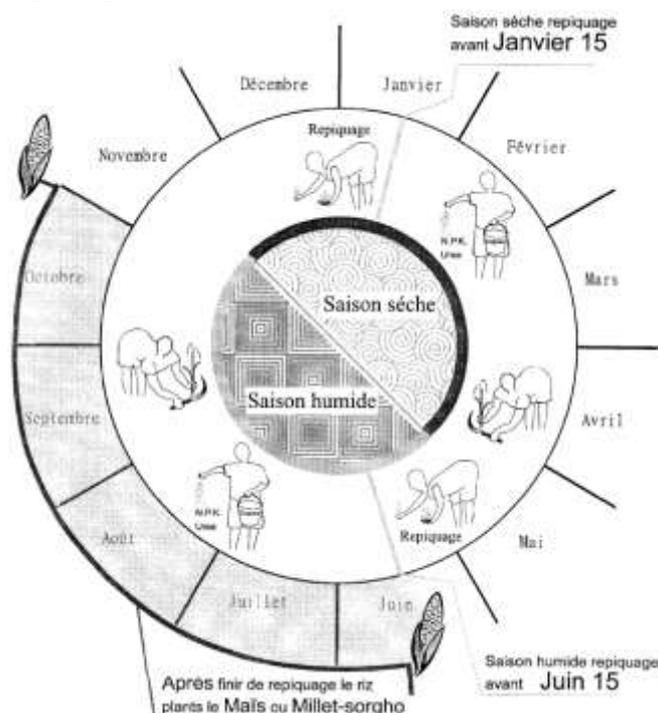


Figure 12. Irrigated rice cultivation in Bagré

The Executing Agency successfully introduced high-yield Taiwanese paddy rice varieties for planting and production in the Bagré Reclamation Area, but due to limitations in Burkina's laws and regulations, the project has not formally named the Taiwanese varieties of paddy rice grown in Burkina Faso.

The Executing Agency's performance in capacity building for farmers and local cooperative agencies was not good: Farmers' cooperative organizations exist in name only; the Revolving Funds associated with farmers' cooperative organizations have become defunct; some of the milling stations established by the project are out of service, or have been appropriated as private property; and irrigation systems face maintenance and management problems.

4.8 Performance of the Irrigation System

4.8.1 Cost of Irrigation

Irrigation construction comprised two components: 1,200 hectares of irrigation development along the western bank, and 600 hectares of irrigation development along eastern bank. Since work on the eastern bank was taken over by the EA when it was already almost 40 percent completed, for a more accurate evaluation of the project's unit cost of irrigation, we take irrigation development along the western bank as a baseline. The construction of irrigation facilities over 1,200 hectares of the western bank took place mainly during 1995 to 2003, at a total cost of US\$13,213,680. The per-hectare cost was US\$11,011.

In "Costs and Performance of Irrigation Projects: A Comparison of Sub-Saharan Africa and Other Developing Regions," a research report published by the International Water Management Institution (IWMI) in 2007, in terms of simple averages for the entire sample of projects implemented during 1965 to 2000, the average unit total cost for new construction projects was US\$14,500/ha in Sub-Saharan Africa (SSA). When the entire sample of projects was divided into 'successful' and 'failed' projects by using economic internal rate of return (EIRR) at project completion of 10 percent as the breakeven rate, the average unit hardware cost for 'successful' new construction projects was US\$3,600/ha throughout SSA.

Therefore, based on this research by the IWMI, the average unit irrigation construction cost for the project came in a little below the average cost in SSA. However, the project cannot be categorized as 'successful' by using EIRR at project completion of 10 percent as the breakeven rate.

4.8.2 Factors Contributing to Inadequate Maintenance

- *Field observations of system conditions:*

The mission observed damage to the irrigation system at numerous locations (Figure 13; also see photos in Appendix A). Of the 96 head regulators that had been installed along sub-branches and drainage ditches, only 16 percent, or 15, such regulators are still intact and functional. At several locations, the concrete lining of the main lines have been damaged by the growth of shrubs. Water flow at several locations was obstructed by rice, banana and taro plants within the irrigation ditches. Without proper maintenance, systematic problems in the distribution and drainage of irrigation water will likely appear within three years.



Figure 13. Deterioration of irrigation facilities

- *Factors contributing to inadequate maintenance:*

As discussed in Section 4.5, the MOB, which took over management responsibilities for irrigation facilities from the TTM, has been lacking in human resources and technical capacity. The maintenance of close to 300,000 meters of irrigation and drainage systems (243,000 meters on the western bank and 48,800 meters on the eastern bank) fell upon three water patrol officers employed by the Bagré Growth Pole Project. They survey the system and report problems to TaiwanICDF experts stationed in the area, including Mr. Mingyi Tsai, who is the Commissioner of Agricultural Engineer, and Mr. SanonSouro Andre. Because of limited funding and manpower, Mr. Tsai needs to establish priorities for maintenance activities, which cannot all be completed.

Based on the Bagré Growth Pole Project status report for 2012, current irrigation system maintenance activities consist of cutting shrubs in the vicinity of primary channels (28 km in total, of which 13 km is located on the western bank and 15 km on the eastern bank), as well as cleaning and weeding secondary and tertiary irrigation channels and drains. The participation rate of local farmers in the maintenance of irrigation channels is only 50 percent. Many factors have contributed to the low level of irrigation system maintenance and local farmers' participation, including a lack of awareness among local farmers about the functions of the irrigation facilities, as well as the leasing of paddy fields to short-term migrant workers for whom there is no strong incentive for maintaining irrigation facilities over the long-term.

4.8.3 Evaluation of Irrigation Performance

Irrigation performance was evaluated using an assessment method that had been developed by the Institut International du Management de l'Irrigation-Projet Management de l'Irrigation au Burkina Faso. This methodology had already been applied to a region in the southwest of Burkina Faso in a previous study¹³, the results of which confirmed the suitability of the same method in evaluating complex hydraulic networks and economic activities on a greater scale, such as found in the Bagré Reclamation Area. The performance of paddy rice irrigation in the Bagré Reclamation Area is presented in Table 5.

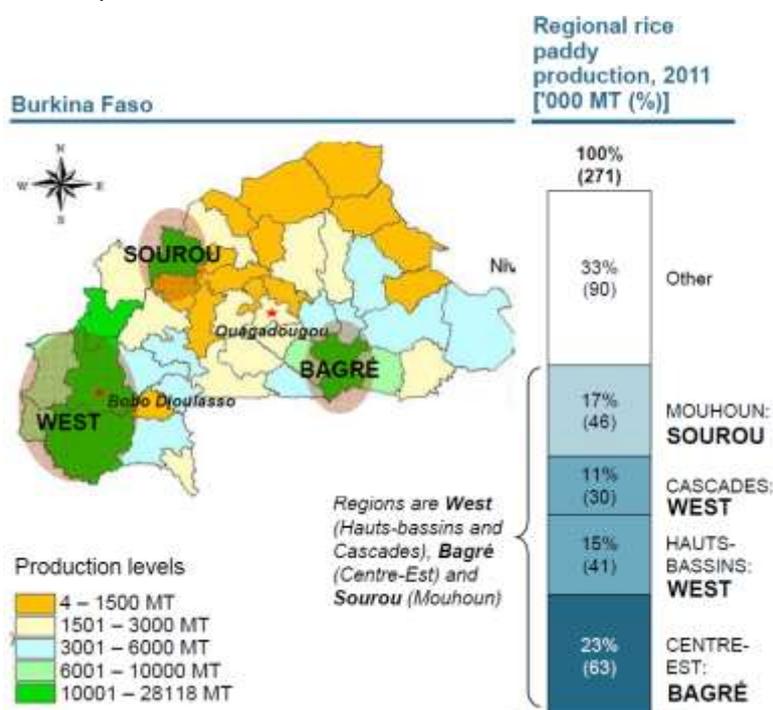


Figure 14. Rice production in Burkina Faso

¹³Dembele, Y., H. Yacouba, et al. 2011. "Assessment of irrigation system performance in south-western Burkina Faso." *Irrigation and Drainage* 61(3): 306-315.

Table 5. Irrigation performance of Bagré Reclamation Area

Indicators	Units	Measurements at Bagré Area	Reference value ¹³
1. Paddy yield	Kg/ha	5,020	≥ 5,000
2. Gross value of production per unit land area	CFA/ha	753,000	≥ 500,000
3. Productivity of irrigation water supply	Kg/m ³	<u>0.12</u>	≥ 0.6
4. Gross value of production per unit of water supply	CFA/m ³	<u>18.8</u>	≥ 80
5. Produce marketed	%	100	100
6. Cropping intensity	%	200	200
7. Water fee collection ratio	%	100	100

As shown in Table 5, with the exception of water use efficiency (as represented by *Productivity of irrigation water supply* and *Gross value of production per unit of water supply*), irrigated paddy rice production in Bagré has achieved performance levels that are acceptable in comparison to the national reference values.

The productivity of irrigation water supply and gross value of production per unit of water supply are, however, low. Based on statistical data available for the current Bagré Growth Pole Project, the total water diverted for irrigation in the project area is about 40,000 tons per hectare. The low water use efficiency can be attributed to loss of irrigation water along irrigation canals in poor condition. In addition, greater evaporation loss from open irrigation canals would be expected in a tropical climate, as compared to Taiwan. Due to a lack of water metering and damage to flow regulating facilities, regulating the amount and timing of irrigation would be impossible. Currently, the demand for water stored in the Bagré Dam is low due to a lack of infrastructure to deliver water to potential users. Therefore, water shortages and low water use efficiency have not yet become an issue.

In terms of rice yield, the production statistics published by the Bagré Growth Pole Project for the dry season of 2012 were obtained from a random sampling of 10 percent of farms (Table 5). The statistics show high variability in per-hectare yield across the Bagré Reclamation Area. The yield was approximately 5.5 tons per hectare on the eastern bank and approximately 4.5 tons per hectare on the western bank. Since there is no difference between soil chemistry on the eastern and western banks, the main reasons for the higher yield on the eastern bank are better drainage due to the steeper slope of land and more precise field irrigation management, which enhance the development of crops' root systems. However, less than 20 households were sampled for estimates of per-hectare rice yields, so the difference

may conceivably be due to random sampling errors.

Regarding the water fee collection ratio, it should be noted that even though the collection is 100 percent, the water fee is surrendered to the national treasury instead of being used as a dedicated fund supporting the operations and maintenance of irrigation systems. This could have implications for the sustainability of paddy rice production, as discussed later in Section 5.3.

5 EVALUATION OF PERFORMANCE

5.1 Relevance

The design and purpose of the project were relevant to Burkina Faso's development needs, and Taiwanese government policy. The project was also consistent with the TaiwanICDF's strategic policy of using the comparative advantages of Taiwan's development experience in agriculture to assist partner countries to develop their economies.

A detailed feasibility study was not conducted for the project, nor was a master plan drafted at the beginning of the venture. Since the project had not been comprehensively designed, project operations were unable to fully attain the project's objectives.

Moreover, during the project implementation period, except for the dispatch of certain technical consultants to offer limited comment, no relevant technical assistance projects were incorporated into project implementation.

5.2 Effectiveness and Efficiency in Achieving Project Outputs and Outcome

5.2.1 Effectiveness

Project operations were relevant to the project outputs, which included the development of 1,800 hectares of paddy field preparation along two sides of the riverbank, the introduction and naming of high-yield Taiwanese rice varieties, the establishment of three-step rice seed propagation system, the provision of consultation services in rice production and marketing for 10 demonstration fields, and the construction of rice milling stations and establishment of revolving funds in each of the 16 project villages. From 2009 to 2012, seven of the above ten outputs were achieved. However, three outputs failed to be sustained after the Executing Agency left, meaning that in the long term, only four outputs were achieved.

5.2.2 Efficiency

In terms of irrigation construction, construction on the western bank was delayed for three years and the budget increased by 57 percent. Construction on the

eastern bank was completed in time and executed at 96 percent of the budget. The project introduced high-yield paddy rice varieties for planting and production, and developed 1,800 hectares of land in Bagré Reclamation Area, but rice production of approximately 14,600 tons rice represents only approximately 91 percent of this outcome objective.

The factors for this include, but may not be limited to, the following: Firstly, a detailed feasibility study was not conducted and soil tests were not performed, as a result of which project design was unrealistic in its expectations; and secondly, the plot size or scale of agricultural production units was too small, as small plot size cannot achieve economy of scale in production.

To support the vertical integration of rice production and marketing in the Bagré Reclamation Area, the project established milling stations in each of the 16 project villages. However, such vertical integration at village level has not been achieved. Factors for this include a lack of spare parts to support the maintenance of milling equipment, and the fact that small-scale milling stations are relatively inefficient compared with local commercial milling stations.

In terms of farmers' cooperative organizations and revolving funds at village level, all of which have become defunct, many factors contributed to such organizational failure.

The project did increase the incomes and employment opportunities of farmers in the Bagré Reclamation Area. However, a detailed feasibility study was not conducted for the project, nor was a master plan drafted at the beginning of the venture. Therefore, project operations were unable to fully attain the project's objectives.

5.3 Preliminary Assessment of Sustainability

As discussed in Section 4.8.2, the current level of maintenance of the irrigation system is insufficient for sustaining a high level of irrigation performance in the long run. The MOB will need to increase its human resources and technical capacity in the management of the irrigation system, and may even require major restructuring as recommended by the World Bank (see Section 3.2). For future irrigation and paddy rice technical cooperation projects, greater emphasis should be placed on strengthening local institutional capacity in the operation and maintenance of irrigation infrastructure. Local farmers' level of participation would also need to be increased.

The MOB began collecting a water fee of 25,000 CFA per hectare while the project was finalizing the transfer of responsibilities for the management of the irrigation system (see Table 6 for collection statistics for July to November 2012). As

mentioned in Section 4.8.3, the collection rate was 100 percent. However, water fees are surrendered to the national treasury (Ministry of Finance) instead of being used to pay for the operating and maintenance expenses of the system itself. The MOB continues to rely on centrally allocated funding from the national government, and, given competition with other public services which place a demand upon the national budget, centrally allocated funding is generally not the most reliable means of supporting recurring operation and maintenance costs. Given that the amount collected often falls short of maintenance needs, upon the direction by the President of Burkina Faso, the MOB is now planning to raise water fees to 100,000 CFA per hectare.

Table 6 Recovery of irrigation water fees (July-November 2012)

Village		Irrigation water fee collected (CFA)	Village		Irrigation water fee collected (CFA)
Western bank	V1A	1,437,500	Eastern bank	V1	1,600,000
	V1B	987,500		V2	1,962,500
	V2	1,567,000		V3	1,005,000
	V3	600,000		V4	900,000
	V4	962.5		V5	1,062,500
	V5	677,500		V6	1,345,000
	Subtotal	6.232 million		V7	650,000
		V8		1,047,500	
		V9		1,063,000	
		V10		212,000	
		Subtotal	10,848,000		
		Grand total	17,080,000		

Source: Premier Ministere Burkina Faso. Rapport D'Activites De La Direction De La Production Deuxieme Semestre 2012.

Based on the recommendations of many international water management research institutes, irrigation water pricing and fee collection should adhere to the “user pays principle,” and the total amount of water fees collected should, at the least, balance the operation and maintenance costs of the water supply system. Currently, the level of irrigation system maintenance is insufficient for optimal operations. A more in-depth study should be conducted to determine the desirable level of system maintenance, estimate operation and maintenance expenses at such a level, and then determine whether the current or proposed water fee will generate sufficient income. The ideal situation would be for operation and maintenance expenses to be fully recovered by the collection of water fees. Yet not many countries

have achieved such an ideal position. In Taiwan, the national government has stepped in to subsidize the operation and maintenance expenses of irrigation associations due to a decline in the income of the agricultural sector. In deciding the actual funding management of the MOB, the national government of Burkina Faso will no doubt need to take many other factors into consideration, including political opinions, the capacities of new agricultural producers to pay, and other national economic development goals.

5.4 Impact

According to the World Bank, the prior development approach in the Bagré Reclamation Area didn't appear to be either economically efficient or sustainable. However, the Bank also pointed out that there had been a spontaneous expansion of fruit and vegetable production by private operators on small, irrigated (hand-pumped) plots, without any government support outside of the government and foreign assisted irrigation development areas.

Intensive paddy rice cultivation has the potential to raise grain production, yet also relies on large amounts of fertilizers and pesticides. By 2007, after many years of double cropping, the soil fertility in the Bagré Reclamation Area had declined. The cost of paddy rice production was gradually increasing while the effectiveness of applications of fertilizer was decreasing. There were increasing problems with pests and weeds. Because the profitability of paddy rice production had declined, some farmers abandoned or delayed their second cropping of paddy rice in the Bagré Reclamation Area in order to attend to other crops grown elsewhere during the rainy season. Considering the climate and soil conditions of the project area, the multi-cropping of local varieties of crops would help to diversify agricultural production. Multi-cropping or crop rotation may also reduce requirements for fertilizers and pesticides.

6 OVERALL ASSESSMENT AND RECOMMENDATIONS

6.1 Overall Assessment

The project is rated as acceptable in terms of its relevance, effectiveness, and impact. But project did not have a master plan, implementation overran and project costs exceeded planned budgets. Therefore, the project was weak in terms of efficiency and sustainability.

The project developed an area for the mass production of high-quality rice in Burkina Faso, but project management, maintenance and the project's environmental effects have obviously affected its efficiency and impact, with the result that the

ultimate sustainability of the project is not clear.

6.2 Lessons Learned

6.2.1 Project Design.

1. A detailed feasibility study was not conducted for the project, nor was a master plan drafted at the beginning of the venture. Since the project had not been comprehensively designed, project operations were unable to fully attain the project's objectives.
2. Project design did not account for the country's road infrastructure and the space to be occupied by irrigation facilities when calculating cultivable rice production areas¹⁴, with the result that the cultivated area was smaller than the area developed.
3. The completion of the project was delayed because of this initial lack of project planning, with additional hectares needing to be developed to compensate for such losses.

6.2.2 Project Implementation.

1. In terms of the construction of infrastructure, there were some setbacks during the early years of project implementation. Involving staff with experience in construction work from the planning and design stage of the project would have improved construction quality and reduced the possibility of the structural failure of infrastructure. To ensure that irrigation infrastructure remained in good condition after the departure of the project, the planning of the project should have included provisions for training local staff on the maintenance and management of irrigation systems by staff with extensive experience in such operations.
2. The project's irrigation work only emphasized construction, and ignored the operation and maintenance work of the cooperating agency. As a result, the agency responsible for maintaining and managing irrigation systems now lacks technical capacity, funding and human resources.
3. Evaporation loss in Bagré due to flood irrigation of paddy rice and the open construction of irrigation canals would be higher than in other countries. If the need to further increase the efficiency of irrigation water use were to arise in the future, then irrigation methods and canals may require further upgrades to reduce such losses. Such projects would require additional, carefully conducted cost-benefit analysis.
4. The success of farmers' organizations depends on an appropriate

¹⁴For paddy rice production, 15 percent to 20 percent of the total area planned for irrigation development needs to be set aside for irrigation canals and field levees.

organizational structure, composition, working rules and efficient management, and farmers' participation in such organizations. Strong and vibrant farmers' organizations can provide opportunities for farmers to effectively play a role in the market economy and benefit from it. However, the project's farmers' organizations were hastily formed, mainly in order to benefit from subsidies being offered by the EA, with no regard for the social, cultural and economic structures of the farming communities. Therefore, when the EA withdrew from the project, these farmers' organizations collapsed, as a result of which village-based farmers' cooperative organizations, such as rice milling stations and revolving funds, became defunct.

6.2.3 Project Impact.

1. *Centralized government irrigation scheme versus groundwater irrigation by individual households.* According to the World Bank, the prior development approach in the Bagré Reclamation Area did not appear to be either economically efficient or sustainable. However, the Bank also pointed out that there had been a spontaneous expansion of fruit and vegetable production by private operators on small, irrigated (hand-pumped) plots, without any government support outside of the government and foreign assisted irrigation development areas.
2. *Mono-cropping versus multi-cropping.* Intensive paddy rice cultivation has the potential to raise grain production, yet also relies on large amounts of fertilizers and pesticides. By 2007, after many years of double cropping, the soil fertility in the Bagré Reclamation Area had declined. The cost of paddy rice production was gradually increasing while the effectiveness of applications of fertilizer was decreasing. There were increasing problems with pests and weeds. Because the profitability of paddy rice production had declined, some farmers abandoned or delayed their second cropping of paddy rice in the Bagré Reclamation Area in order to attend to other crops grown elsewhere during the rainy season. Considering the climate and soil conditions of the project area, the multi-cropping of local varieties of crops would help to diversify agricultural production. Multi-cropping or crop rotation may also reduce requirements for fertilizers and pesticides.
3. The development of irrigated agriculture in the Bagré Reclamation Area had supported the area in its capacity as one of the country's top three rice-producing areas. The technical training provided by the project enabled the further economic development and diversification of the project area and the surrounding region in the form of the Bagré Growth Pole Project.

6.3 Recommendations

- 1. Project implementation should proceed following the completion of each of the preceding phases of the project cycle.** In this project a detailed feasibility study was not conducted, causing problems to arise during project implementation that affected project performance.
- 2. Establish a master plan and proper project indicators for each stage of a project.** Project design should set out all of the activities that would potentially allow a project to attain the outputs and outcomes that have been designed. Setting a time limit and/or timetable for the completion of such indicators would allow a project to be monitored over time and measured in terms of effectiveness and efficiency, and ensure that its operations would be sustainable after the EA withdrew later on.
- 3. For construction-based development projects, capacity building for the cooperating country should still be included in project design and made a part of project implementation.** The early stage of the project focused mainly on irrigation construction. Operating farmers' organizations and marketing programming were only implemented after construction was completed, which extended the project implementation period.
- 4. For construction-based development projects, the roles involved in designing, implementing and monitoring project components should be performed by different actors.** For this project, both the design and implementation of irrigation construction work was done by the EA, while no agency was appointed to monitor construction. This led to the structural collapses along a 220 meter section of irrigation canal after it had been in operation for only two to three years.
- 5. The success of farmers' organizations depends on an appropriate organizational structure, composition, working rules and level of management efficiency, as well as the participation of farmers in such organizations.** Strong and vibrant farmers' organizations can provide opportunities for farmers to play an effective role in the market economy and to benefit from it. In this project, farmers' organizations were mainly established in order to benefit from subsidies being offered by the EA, and when the EA withdrew from the project, these farmers' organizations collapsed, as a result of which village-based farmers' cooperative organizations, such as rice milling stations and revolving funds, became defunct.