

Kingdom of Bhutan

FY2021 Ex-Post Evaluation Report of Japanese Grant Aid Project

“The Project for the Rehabilitation of Taklai Irrigation System in Sarpang District”

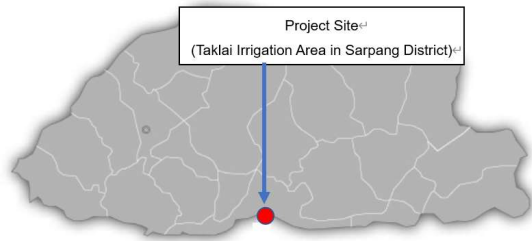
External Evaluator: Masumi Shimamura, Mitsubishi UFJ Research and Consulting Co., Ltd.

0. Summary

This project improved headwork (fixed weir, bed protection) and canals, etc. to ensure stable supply of irrigation water in Taklai Irrigation System located in Sershong Geog and Chuzagang Geog in Sarpang District, Bhutan. The project, which aims to increase rice production by strengthening irrigation systems, is consistent with Bhutan’s development policies and development needs, and project plan and approach were appropriate. The project is also consistent with Japan’s development cooperation policy and concrete results can be confirmed through collaboration with other JICA projects as well as with organizations outside JICA. Therefore, relevance and coherence of the project are high. In terms of project implementation, both project cost and project period were within the plan and thus efficiency of the project is very high. Regarding project effects, of the indicators of quantitative effects set at the time of planning, the actual value of “paddy area in dry season” have not achieved the target. Regarding impacts, the results of interviews with the executing agency and farmers in the project area indicate that irrigation water supply have improved in both rainy and dry seasons, irrigation area has increased, and farmers are making better use of agricultural machinery. Farmers are using irrigation water to grow vegetables and cash crops during dry season, and they also make effective use of irrigation water for raising livestock. For this reason, farmers feel that irrigation water has improved during dry season, which together with increase in rice production due to improved irrigation water during rainy season, has generated concrete effects. However, the key indicator for judging the effectiveness of the project, “expansion of double cropping of rice due to stable irrigation water during dry season,” has not been achieved. Thus, while other indicators gave mostly achieved the target as planned, effectiveness and impacts cannot be considered as high. Therefore, effectiveness and impacts of the project are moderately low. No negative impacts on natural environment have been reported. Land acquisition and resettlement did not take place. Regarding operation and maintenance, slight issues have been observed in the financial and the current status, however, there are good prospects for improvement/resolution. Therefore, sustainability of the project effects is high.

In light of the above, this project is evaluated to be satisfactory.

1. Project Description



Project Location

(Source: Processed the map posted on the JICA website)



Water Intake

1.1 Background

Bhutan's Sarpang District is blessed with an exceptionally warm climate and vast, flat farmland, and has high potential for agricultural production, but has been left out of development. Development of irrigation facilities in the district has played an important role in increasing rice production in the country. In particular, Taklai Irrigation Scheme in the District is the largest irrigation system in the country and was developed in the 1980s with the support of the United Nations Development Programme (UNDP) and other organizations. It supplied irrigation water to approximately 1,300 ha (planned value) of land and 535 farm households. However, the facilities were damaged by repeated flooding, and the Bhutanese government has repeatedly carried out temporary repair work every time floods occur during rainy season. In particular, the flood in 2010 severely eroded the right bank of Taklai River, washing away more than 500m of the main canal as well as the headwork. Although emergency reconstruction work was carried out, the need for more durable facilities became an urgent issue to ensure a long-term and stable water supply. In addition, due to repeated damage to facilities caused by flooding, the irrigated area was only about 70% of the originally planned area (880 ha), and the facilities were not fully functioning at their capacity.

1.2 Project Outline

The objective of this project is to provide stable supply of irrigation water to the target areas by improving the headwork and the canal of Taklai irrigation system, thereby contributing to the increase of rice production in the area.

Grant Limit / Actual Grant Amount	1,097 million yen (detailed design: 46 million yen, main work: 1,051 million yen) / 1,094 million yen (detailed design: 44 million yen, main work: 1,050 million yen)
Exchange of Notes Date /Grant Agreement Date	February 2013 (detailed design), June 2013 (main work) / February 2013 (detailed design), June 2013 (main work), January 2016 (amended Grant Agreement for main work)
Executing Agency	Department of Agriculture, Ministry of Agriculture and Forests
Project Completion	April 2016
Target Area	Sershong Geog and Chuzagang Geog in Sarpang District
Main Contractor	Dai Nippon Construction
Main Consultant	Sanyu Consultants Inc.
Preparatory Survey	December 2011–November 2012
Related Projects	[Technical Cooperation] <ul style="list-style-type: none"> • The Strengthening Farm Mechanization Project (2008–2011) • The Strengthening Farm Mechanization Project Phase 2 (2014–2018) [Grant Aid] <ul style="list-style-type: none"> • Improvement of Farm Machinery for Hiring Services of Tillage (2016–2019) [EU] <ul style="list-style-type: none"> • Construction of rice mill and provision of post-harvest processing equipment in Sarpang District (2009)

2. Outline of the Evaluation Study

2.1 External Evaluator

Masumi Shimamura, Mitsubishi UFJ Research and Consulting Co., Ltd.

2.2 Duration of Evaluation Study

This ex-post evaluation study was conducted with the following schedule.

Duration of the Study: October 2021–February 2023

Duration of the Field Study: April 25–May 12, 2022, September 19–23, 2022

3. Results of the Evaluation (Overall Rating: B¹)

3.1 Relevance/Coherence (Rating: ③²)

3.1.1 Relevance (Rating: ③)

3.1.1.1 Consistency with the Development Plan of Bhutan

At the time of planning, Bhutanese government's *Tenth Five Year Plan (2008–2013)* set out the improvement of agricultural productivity as a priority goal. This project was regarded as the major project of the “Irrigation and Water Management Program,” (the objective of which was to expand irrigated paddy area in dry season from 40% to 70%) implemented by the Ministry of Agriculture and Forests to achieve the goal.

At the time of the ex-post evaluation, Bhutanese government's *Twelfth Five Year Plan (2018–2023)* identified “food security” and “improved nutrition and livelihoods” as key objectives. In order to improve food self-sufficiency rate, it is essential to secure arable and highly productive land and government has specified “expansion and strengthening of irrigation system” as one of the strategies to achieve this goal. This project is also consistent with *Economic Contingency Plan (2020)*, which Bhutanese government has prepared and is implementing to address the effects of the spread of COVID-19, and *Comprehensive Development Plan for Bhutan 2030*, which was formulated in 2019 in collaboration with JICA. Agriculture is one of the key sectors in Bhutan's regional economic development and national food security, and irrigation projects are regarded as important driver for improving agricultural production and local livelihoods. Thus, the implementation of the project is also consistent with the development policy of Bhutan at the time of the ex-post evaluation.

3.1.1.2 Consistency with the Development Needs of Bhutan

At the time of planning, Taklai Irrigation System was the largest facility in Bhutan and played an important role in increasing rice production. However, every year the headwork was washed away by floods during rainy season, and Bhutanese government repeatedly carried out temporary restoration work each time. In particular, the flood in 2010 severely eroded the right bank of Taklai River, washing away not only the headwork but also more than 500 m of the main canal. For a long-term and stable water supply, development of more durable facilities was an urgent issue.

At the time of the ex-post evaluation, flooding occurred every year due to overflow of Taklai River, and stable supply of irrigation water was necessary for double cropping of rice remains a challenge. After completion of construction of the project, sediment flowed into the culvert (head race) and water flow stopped. At the time of the ex-post evaluation, the follow-up

¹ A: Highly satisfactory, B: Satisfactory, C: Partially satisfactory, D: Unsatisfactory

² ④: Very High, ③: High, ②: Moderately Low, ①: Low

cooperation has been conducted additionally for emergency measures in order to solve the culvert blockage problem. Thus, developing durable irrigation facilities continues to be a pressing issue. (Refer to “3.1.1.3 Appropriateness of the Project Plan and Approach”) Therefore, the project continues to meet the country’s development needs at the time of the ex-post evaluation.

3.1.1.3 Appropriateness of the Project Plan and Approach

The project has not realized “paddy area in dry season” and “expansion of double cropping of rice in dry season” that were expected at the time of planning. According to the obtained documents and interviews with the consultant in charge of construction supervision of the project, the following four points can be cited as the main reasons.

- Farmers less willing to carry out double cropping of rice: Farm Machinery Corporation Limited (hereinafter referred to as “FMCL”) conducted dry-season crop demonstrations in 2017 and 2018 after the project. It is reported that although farmers were initially motivated to carry out double cropping, but after they found that animal damage by wild elephants was significant and rice yields were low, they became less enthusiastic.
- Problems with dry-season rice varieties: Dry-season crop varieties developed by Agriculture Research and Development Centre (hereinafter referred to as “ARDC”) have a harvest time that coincides with rainy season, causing concerns about rain damage, and there is no non-crop period between dry-season and rainy-season crops to allow injection of fertilizer.
- Problem of guaranteed purchase: Food Corporation Bhutan purchases surplus crops that farmers cannot sell to the market based on its own standards, but it did not have standards for dry-season crops and was not likely to be able to guarantee the purchase of surplus rice.
- Problem of rice distribution: Chuzagang Agriculture Farmers Cooperative encountered management problems, which limited the distribution of Taklai brand rice.

According to interviews with the consultant in charge of construction supervision of the project, the most significant factor among the above four factors is considered to be the decline in farmers’ motivation to double crop. But all of these factors were due to significant changes in the environment surrounding local farm management since the planning stage, and it would have been difficult to foresee these changes at the time of planning.

In addition, based on lessons learned from past similar projects, this project adopted high-strength concrete containing rail method (hereinafter referred to as “rail method”), which has been adopted in Japanese rivers, especially for the headwork section, which is vulnerable to damage from sediment contained in floodwaters. However, after construction was completed,

the high-strength concrete was worn away by the annual floods and rolling stones that flowed down with the floods, and some of the rails were washed away. When interviewed the executing agency of this case at the time of the ex-post evaluation, they explained that hydrological and flood records/data had not been adequately maintained at the time of planning. In addition, according to the construction supervision consultant, risk factors and their countermeasures were taken into account in the project design at the time of planning, but risks beyond expectations surfaced. Considering the situation at that time, the rail method was adopted under the situation where quantitative flow data was not prepared, but an unexpected sediment flowed down during the flood season, resulting in this incident. It would have been difficult to anticipate these situations and their impacts on the project at the time of planning. (Refer to “4.3 Lessons Learned”) The chronological history of this case is as follows.

<Chronology of incidents related to sedimentation and blockage in culverts and suspension of water flow>

- April 2015: Completion of construction (initial)
- June 2015: Blockage due to sediment accumulation in culvert, and water flow stopped
- January–April 2016: Implemented countermeasure work (detailed design and construction) using the remaining funds from the project, and completed construction
- June 2016: Recurrence of culvert clogging and stoppage of water supply
- July 2017: JICA established a Technical Review Committee consisting of an external expert and senior advisors
- March 2018: Technical Review Committee members submit position paper to JICA
- August 2018: JICA formulated a response policy based on the views of the Technical Review Committee, etc.
- The Follow-up cooperation is underway at the time of the post-evaluation (scheduled for completion in September 2024)

From the standpoint of equity, consideration have been given in the formulation and implementation of the project so that irrigation water would be distributed fairly and appropriately to the farmers in the target area. For example, the soft component (capacity building program) of the project includes discussions with Water Users Associations (hereinafter referred to as “WUA”) to which farmers in the project target area belong, in order to ensure fair water distribution between high and low level areas, such as guidance on how to operate the gates and rules for necessary items are provided in the WUA’s articles in order to distribute water appropriately. In addition, according to the executing agency, most of the farmers own the same area of farmland, and there are no vulnerable groups that require special consideration in the allocating irrigation water. Furthermore, it was pointed out that Water User

Committee (hereinafter referred to as “WUC”), which is the upper body of WUA selects members based on an equal rotation system, regardless of gender or social status and thus there is no particular problem from fairness and impartiality.

3.1.2 Coherence(Rating: ③)

3.1.2.1 Consistency with Japan’s ODA Policy

At the time of the plan, Japanese government placed agriculture as the most important area of cooperation with Bhutan and gave special priority to this area. This project aims to provide stable supply of irrigation water to the project areas through rehabilitation of irrigation system, and contributes to increasing rice production by increasing irrigated areas and expanding double cropping of rice through stable supply of irrigation water in dry season. Therefore, it can be said that the project purpose was consistent with Japan’s development cooperation policy at the time of planning.

3.1.2.2 Internal Coherence

Collaboration with technical cooperation projects “The Strengthening Farm Mechanization Project” (2008–2011) and “The Strengthening Farm Mechanization Project Phase 2” (2014–2018) took place for this project. In both projects, as in this project, Department of Agriculture, Ministry of Agriculture and Forests was the counterpart agency, and agricultural machinery rental service model has been established and undertaken by FMCL to farmers in the target areas of this project. In addition, agricultural machinery is maintained under Grant Aid “Improvement of Farm Machinery for Hiring Services of Tillage.” Internal consistency has been secured since concrete effects of collaboration, such as increased production of rice in rainy season. (Refer to Impacts for specific synergistic effects.)

3.1.2.3 External Coherence

Collaboration with EU assistance implemented by EU in 2009 (with this assistance, rice mill was constructed and post-harvest processing equipment was provided in Sarpang District) took place for this project. Concrete synergistic effects have been generated such as increase in rice for sale, as rice produced by farmers is milled at the rice mills constructed by EU support. On the other hand, at the time of planning, this project was expected to secure irrigation water in dry season, expand double cropping, and increase rice production in cooperation with canal rehabilitation project implemented by the Bhutanese side. However, the expected double crop of rice has not been realized, and project effects from collaboration have not realized. (Refer to Impacts for specific synergistic effects.)

In terms of consistency with international frameworks, interviews with the executing agency

confirmed that the project contributes to SDG targets 1, 2, 6, and 13.³

The project is consistent with Bhutan’s development policy and development needs, and the project plan and approach were appropriate. The project is also consistent with Japan’s development cooperation policy, and collaboration with other projects within JICA is taking place. Regarding collaborations with organizations outside of JICA and with international frameworks, coordination and collaboration that was initially expected has achieved, and concrete results can be confirmed. Therefore, its relevance and coherence are high.

3.2 Efficiency (Rating: ④)

3.2.1 Project Outputs

This project aims to secure stable irrigation water supply by improving the headwork and the canal of Taklai irrigation system in Sershong Geog and Chuzagang Geog in Sarpang District. Major outputs are shown in Table 1. According to the executing agency, all items were implemented almost as planned.

Table 1: Major Outputs of the Project

Item	Description
Integrated Headwork	<ul style="list-style-type: none"> • Fixed weir: Length 38.9 m x 1.0 m • Bed protection: Length 30.0 m
Head Race and Sedimentation Basin	<ul style="list-style-type: none"> • Box culvert: Length 358.9 m • Open canal: Length 631.2 m • Sedimentation basin: Length 37.5 m • Retaining wall: Height 3.9 m x Length 410 m
Link Canal	<ul style="list-style-type: none"> • Rise up wall: Length 654.6 m • Improvement: Length 109.6 m
Confluence between Link Canal and Low Level Intake	<ul style="list-style-type: none"> • L type retaining wall: Height 2 m x Length 4.65 m • Newly constructing gate: One gate
High and Low Level Canal	<ul style="list-style-type: none"> • Restoration of wet masonry: Length 123.7 m • Rise up wall: Length 165 m • Covered by concrete: Length 205.8 m • Rehabilitation of leakage at 2nd siphon outlet: Covered by concrete

³ Goal 1: No poverty, Goal 2: Zero hunger, Goal 6: Clean water and sanitation, Goal 13: Climate action.

	<ul style="list-style-type: none"> • Rehabilitation of leakage at aqueduct: Length 50 m • Safe fence around siphon: Six places • Improvement of siphon: Covered by reinforce concrete • Waterway crossing bridge: Concrete bridge (width, bridge length 4 m) x 2 bridges
Exposed Siphon Pipe on High Level Canal	<ul style="list-style-type: none"> • Protection of exposed siphon pipe at 3rd siphon: Length 45 m
Gate on High and Low Level Canal	<ul style="list-style-type: none"> • Check and distribution gate: 10 gates • Check gate: two gates
Water Gauge at Integrated Headwork	<ul style="list-style-type: none"> • Water gauge: Sound wave type one set
Protection Dike at Downstream of Taklai River	<ul style="list-style-type: none"> • Dike: Width 4.0 m x Height 3.0 m x Length 340 m • Retaining wall: Height 3.9 m x Length 340 m
Soft Component (Capacity Building Program)	<ul style="list-style-type: none"> • Instruction and assistance for operation of facility, water management, and maintenance

Source: Preparatory Survey, results from questionnaire survey of the executing agency

Regarding construction of facilities, there were some changes from the original plan, such as changes in some structures, changes in the number of new gates on the main canal, and changes in the canal slope and canal elevation for headwork. All of these changes were made based on an accurate grasp of the situation through field surveys and measurement results during detailed design stage and were appropriate changes. In addition, as mentioned earlier in “3.1.1.3 Appropriateness of the Project Plan and Approach,” culvert was blocked by sediment after construction was completed and water flow was stopped, and thus countermeasure work was carried out using the remaining funds from this project.

Regarding obligation of Bhutanese government, results of questionnaire survey and interviews with the executing agencies confirmed that all items were carried out in a timely manner without any problems.



Gate on Canal



High Level Canal



Head Race

3.2.2 Project Inputs

3.2.2.1 Project Cost

The total project cost was initially planned to be 1,106 million yen (1,097 million yen on the Japanese side, 9 million yen on the Bhutanese side). In actuality, the total project cost was 1,103 million yen (1,094 million yen on the Japanese side, 9 million yen on the Bhutanese side), which is within the plan (100% of the planned amount).

3.2.2.2 Project Period

The overall project period was planned as 33 months as opposed to 31 months in actuality, which is within the plan (94% of the planned period). Since sediment accumulation in the culvert, blockage and water supply stoppage could not have been foreseen at the time of

planning, the time required for the countermeasure work (4 months), which was carried out using the remaining funds, was added to the originally planned period (29 months), resulting in a period of 33 months at the time of planning. In addition, the actual period was set to 31 months, including the actual period for countermeasure work to the actual period for original plan (27 months). Table 2 summarizes the project period, including the period required for countermeasures. (Refer to “3.1.1.3 Appropriateness of the Project Plan and Approach” for background on the incident of culvert blockage and water stoppage)

Table 2: Comparison of Planned and Actual Project Period

Planned Period	Actual Period	Comparison
33 months (29 months + 4 months)	31 months (27 months + 4 months)	94% of the planned period
Originally Planned Period	Actual Period for Original Plan	Actual Period for Countermeasure Work Using the Remaining Funds
February 2013–June 2015 (29 months)	February 2013–April 2015 (27 months)	January 2016–April 2016 (4 months)

Source: Information provided by JICA and results from questionnaire survey of the executing agency

Note 1: The starting point of the project period is the conclusion of Grant Agreement. The starting point for the countermeasure work is the conclusion of amended Grant Agreement.

Note 2: The definition of project completion at the time of original planning was upon completion of construction.

Note 3: At the time of the ex-post evaluation, it was agreed with the executing agency that the final completion of this project would be when countermeasures for the blocked culverts were completed.

Therefore, efficiency of the project is very high.

3.3 Effectiveness and Impacts⁴ (Rating: ②)

3.3.1 Effectiveness

3.3.1.1 Quantitative Effects (Operation and Effect Indicators)

At the time of planning, “irrigation water supply in dry season,” “irrigation area,” “paddy area in dry season,” and “annual maintenance cost” were set as quantitative effects of the project. Table 3 summarizes baseline, target and actual values between 2018 and 2021 for each indicator. As the project completion is April 2016, the target year to be compared is 2019, three years after completion.

⁴ When providing the sub-rating, Effectiveness and Impacts are to be considered together.

Table 3: Quantitative Effects of the Project

Indicators	Baseline Value 2012	Target value 2018 3 Years After Completion	Remarks	Actual Value			
				2018	2019	2020	2021
Irrigation water supply in dry season (m ³ /s)	0	Max. 2.24 (Note 1)	Enable to supply irrigation water by construction of head works	Max. 1.8 (80% of target value)	Max. 1.8 (80% of target value)	Max. 1.8 (80% of target value)	Max. 1.8 (80% of target value)
Irrigation area (ha)	883	Max. 1,120 (Note 2)	Enable to supply irrigation water by rehabilitation of damaged siphon	Max. 1,120	Max. 1,120	Max. 1,120	Max. 1,120
Paddy area in dry season (ha)	10	560	Expand the double crop area by supplied stable water in dry season. As the condition of assumptions, the cropping pattern of irrigation area is divided to vegetable and rice by a half respectively.	N.A. (Note 3)	0	0	0
Annual maintenance cost (Nu)	Average 3,500,000	1,750,000	Reduce cost of rehabilitation works for the head race and protection wall by gabions.	183,400 (Note 4)	186,400 (Note 4)	194,200 (Note 4)	177,700 (Note 4)

Source: Ex-ante evaluation report, Preparatory Survey and results from questionnaire survey of the executing agency and WUC

Note 1: Considering the probability of drought year, it is possible that drought discharge of Taklai river (minimum discharge in the dry season) will fall below the planned maximum water intake of 2.24m³/s.

Note 2: Based on rainy season. Actual registered households and beneficiaries in Taklai irrigation area are approximately 530 and 4,300 respectively at the time of planning. Those were expected to receive the benefit directly. Actual registered households in Taklai irrigation area are 442 (Chuzagang Geog: 396 households, Sershong Geog: 46 households) at the time of the ex-post evaluation.

Note 3: FMCL conducted demonstration in dry season, but the planted area is unknown. (“Very limited” according to FMCL)

Note 4: Total cost of fuel for excavator procured through the follow-up cooperation for excavating temporary head race and water usage fees collected by the WUA from the members.

The actual values for “irrigation area” and “annual maintenance cost” met their targets, and “irrigation water supply in dry season” was generally achieved as planned (80% achievement rate). However, the actual value for “paddy area in dry season” is zero and the target has not been met. This is because double cropping of rice has not been realized, and the reasons for this are explained earlier in “3.1.1.3 Appropriateness of the Project Plan and Approach.”

3.3.1.2 Qualitative Effects (Other Effects)

Qualitative effects were classified as impacts.

3.3.2 Impacts

3.3.2.1 Intended Impacts

As impacts of this project, state of generation of “increase in paddy area in dry season and expansion of double cropping of rice,” “improved utilization of agricultural machinery during fallow periods,” “improved operation and maintenance capacity through implementation of soft component,” “prevention of damage (erosion and loss) to farmland and irrigation facilities during floods by construction of river embankments,” “increase of rice production” and “increase in rice for sale” were evaluated.

1) Increase in paddy area in dry season and expansion of double cropping of rice

As mentioned earlier, rice planting in dry season and double cropping of rice have not been realized. As a result of interviews with 32 farmers⁵ in the project area, two farmers tried rice cultivation in dry season, but the yield was so low that they gave up on double cropping. However, all 32 farmers responded that irrigation water supply has improved significantly in both dry and rainy seasons compared to before the project, and that they were using irrigation water in dry season to grow vegetables and cash crops such as areca nuts, and also effectively using irrigation water for raising livestock.

2) Improved utilization of agricultural machinery during fallow periods

According to FMCL, which provides agricultural machinery rental services to farmers in the project area, agricultural machinery rental hours has increased over the years. In addition, as a result of interviews with farmers, 29 out of 32 (90%) responded that they have rented tractors from FMCL or individual (private sector) owners. Of the remaining three, two said they own agricultural machinery and one said they did not use it.

⁵ The 32 farmers consisted of 12 in Sershong High (seven men and five women), 12 Chuzagang High (seven men and five women), and eight in Chuzagang Low (five men and three women). Breakdown by gender and age is 19 men (one in 20s, five in 30s, five in 40s, one in 50s, and seven in 60s or older) and 13 women (three in 30s, four in 40s, one in 50s, and five in 60s or older). Interviewees include one WUA Chairman (one man in 40s) and five Gatekeepers (two men in 30s, one man in 50s, and two men in 60s).

3) Improved operation and maintenance capacity through implementation of soft component (capacity development program)

According to the executing agency, through soft component (capacity building program) of the project, WUC has improved the skills and techniques needed to maintain the facility, and is now able to collect data to properly share information within WUC, between WUC and WUA, and with other stakeholders. The results of interviews with farmers confirmed that Gatekeepers⁶ belonging to WUAs properly keep maintenance records in accordance with WUA regulations, and that Gatekeepers belonging to WUAs operate gates and control water flow, etc. based on manuals prepared in the soft component. Regarding the functions of facilities, measures such as preventing sediment inflow and ensuring water intake methods during rainy season have been taken in the on-going follow-up cooperation.

4) Prevention of damage (erosion and loss) to farmland and irrigation facilities during floods by construction of river embankments

According to the executing agency, the river embankment constructed by the project has prevented erosion of farmland along Taklai River. Interviews with farmers showed that, with the exception of one farmer who lost his farmland to flooding caused by severe rainfall, 31 farmers responded that they had no problems with erosion or loss of farmland or irrigation facilities.

5) Increase of rice production

Results of interviews with farmers showed that 30 of 32 farmers (97%) responded that production of rainy-season rice increased after the project. Two of them said that they started rice production after the project. However, it should be noted that production volume depends on rice varieties and cultivation efforts by farmers in addition to the project effects. The remaining two farmers were, one farmer who decided to focus on areca nuts cultivation because of reduced rice yield due to damage from animals, and another farmer whose land was eroded by floods caused by severe rainfall. As mentioned above, farmers commented that the irrigation water provided by the project has been very useful not only for rice, but also for growing cash crops such as vegetables and areca nuts, and for raising livestock.

Trends in rice production in the project area are shown in Table 4. In terms of total volume, it increased from 1,818.30 tons in 2015 to 2,181.79 tons in 2021, an increase of about 363 tons. It declined in 2019 but recovered the following year, and in 2021 it was at about the same level as the previous year.

⁶ In this report, those who manage the main canals and those who manage small canals (Water Guards) who deliver water to each farmer's fields are collectively referred to as Gatekeepers.

Table 4: Trends in Rice Production in the Project Area

(Unit: ton)

	2015	2016	2017	2018	2019	2020	2021
Sershong Geog	863	842	876	844	891.41	982.25	984.77
Chuzagang Geog	955.30	1,098.83	1,268.34	1,236.03	1,010.26	1,209.65	1,197.02
Total	1,818.30	1,940.83	2,144.34	2,080.03	1,901.67	2,191.90	2,181.79

Source: Data provided by Sershong Geog and Chuzagang Geog

6) Increase in rice for sale

Farmers sometimes sell rice in the informal market, and there are no data available to grasp the overall picture of rice sales volume. Results of interviews with farmers showed that 14 of the 32 farmers (44%) earned income from selling rice after the project.

3.3.2.2 Other Positive and Negative Impacts

1) Impacts on the Natural Environment

The project was classified as Category B based on the *JICA Guidelines for Confirmation of Environmental and Social Considerations* (April 2010) since it does not fall under any sensitive sectors/characteristics or sensitive areas, and its undesirable effects on the environment were considered to be not significant. According to the executing agency, Environmental Impact Assessment (EIA) was not required to be prepared under Bhutanese domestic law.

According to the executing agency, measures were taken during construction to meet Bhutanese standards for air quality, noise and vibration, and waste, and there were no major problems, such as exceeding standards. In addition, environmental mitigation measures were taken, such as watering during construction (countermeasures against dust), disposal of waste in designated places, and prevention of oil and garbage spills into river, and facility was constructed with consideration for the environment. As a result of environmental monitoring, no negative impacts on the natural environment have been reported, and no complaints have been received from local residents. Based on interviews with farmers and the results of the project site inspection, it can be considered that there were no major problems with the natural environment.

According to the consultant in charge of construction supervision, environmental monitoring is not being carried out because the follow-up cooperation underway is to restore the existing facilities, which would have minimal or no undesirable impacts on the environment and society.

2) Resettlement and Land Acquisition

Resettlement and land acquisition did not take place for this project.

3) Gender Equality

According to the interviews with the executing agency and farmers, development of irrigation facilities by the project will not increase workload of farm work and operation and maintenance only for women.

4) Marginalized People

According to the executing agencies and interviews with farmers, there are no vulnerable groups that require special consideration in the allocation of irrigation water. (Refer to “3.1.1.3 Appropriateness of the Project Plan and Approach”)

5) Social Systems and Norms, Human Well-being and Human Rights

Interviews with 32 farmers confirmed that the project contributed to the improvement of farmers’ subjective life satisfaction. Positive changes in livelihoods were the most significant factor. Specifically, when asked about changes in “income and living conditions” before and after the project, all 32 farmers (100%) responded in favor of positive changes, saying “increased rice production increased income and improved living conditions.”

In addition, when asked about changes in their “confidence in irrigated agriculture” before and after the project, 31 farmers (97%) self-evaluated that “they were able to increase their confidence in irrigated agriculture” after the project. One respondent who stated that there was no change before and after the project gave the reason of “getting older and having no successor in the family.” In addition, 28 farmers (88%) answered that there were positive change in the “awareness of cooperation among farmers” before and after the project, while four answered that there had been no change. Reasons for positive changes include “WUA has been able to resolve conflicts among farmers amicably” and “better organizational formulation has been realized through WUAs,” indicating that WUAs play an important role in conflict resolution, cooperation, and coordination among farmers. Regarding changes in “willingness to increase production” before and after the project, 17 farmers (53%) responded that there were positive changes. On the other hand, 14 farmers (44%) responded that there was no change, and one farmer answered that there was a negative change. The most common responses for no change were “no more farmland available for cultivation” and “no one else in the family can do the farm work,” both of which were due to external factors external of the project. The one farmer who gave a negative response said “I am older

and can no longer work as much as I used to” as the reason, which is also due to external factor.

6) Unintended Positive/Negative Impacts

This project is considered as a “climate change adaptation project” by JICA. In southern Bhutan, where Taklai Irrigation System is located, meteorological and hydrological data for the last 10 years at the time of planning showed an increasing trend in short-term rainfall, and the flood of 2010 caused abnormal runoff. According to the executing agency, if the project were not implemented and the past trend continued, farmlands along the Taklai River would be eroded by annual floods and the supply of irrigation water would become unstable, discouraging farmers from cultivating their land. In addition, it was explained that the government had to construct temporary head race as a measure against flooding every year during rainy season, which would have further increased government’s maintenance costs.

<Synergies with other projects in JICA>

Through questionnaire survey and interviews with the executing agency, it was confirmed that agricultural mechanization of farmers in the project target area has been promoted through collaboration between this project and “The Strengthening Farm Mechanization Project Phase 1, 2.” In these technical cooperation projects, agricultural machinery rental service model has been established, and FMCL has been providing agricultural machinery rental services to farmers in the project area. In addition, agricultural machinery is maintained under Grant Aid “Improvement of Farm Machinery for Hiring Services of Tillage.” From the results of the interviews with the farmers, it was also confirmed that they are cultivating rice by renting tractors and rice harvesters from FMCL, leading to increased production of rice during rainy season. (Refer to “3.3.2.1 Intended Impacts”)

<Synergies with organizations outside of JICA>

Through questionnaire survey and interviews with the executing agency, it was confirmed that rice produced by the farmers in the project target area has been milled and commercialized at the rice mill through collaboration between this project and the EU support (construction of rice mill and provision of post-harvest processing equipment in Sarpang District).

This project was expected to secure irrigation water during dry season, expand double cropping, and increase rice production in collaboration with the canal improvement project to be implemented by the Bhutanese side. However, the expected double cropping of rice has not been realized, and the project effects of collaboration have not been realized as expected.

In light of the above, the key indicator for judging the effectiveness of the project, “expansion of double cropping of rice due to stable irrigation water during dry season,” has not been achieved, and although other indicators have mostly achieved the targets as planned, effectiveness and impacts cannot be considered as high. This project has achieved its objectives only to a certain extent. Therefore, effectiveness and impacts of the project are moderately low.

3.4 Sustainability (Rating: ③)

3.4.1 Policy and System

According to the executing agency, there are no policy or system changes with respect to Taklai Irrigation System and farming conditions. Albeit the spread of COVID-19, crop selection is left to the discretion of farmers and there is no government policy intervention. Even after project completion, farmers are encouraged to expand rice production for self-sufficiency. In addition, vegetable production in winter is recommended in order to make effective use of irrigation facilities developed by the project.

From the above, sustainability of policy and system of the project is assured.

3.4.2 Institutional/Organizational Aspect

WUAs are responsible for operation and maintenance of the project after project completion. WUAs conduct operation and maintenance work based on its standard operating procedures, rules, and by-laws, and the division of roles, decision-making process, authority, etc. are also clear. WUAs operate with decisions made without intervention from other agencies. WUAs keep track of irrigation water user fees, remuneration of Gatekeepers, division of labor among members (farmers), etc. Issues that need to be agreed upon at WUAs are discussed at the annual general meetings.

WUC, which is the upper body of WUA, has the necessary personnel for operation and maintenance. Members of WUC are shown in Table 5.

Table 5: Members of WUC

Position	Number of Persons
Chairman	1
Vice Chairman	1
Secretary	1
Accountant	1
Gate Keeper	14
Total	18

Source: From interviews with WUC

Since the temporary head race near the headwork requires dredging, an excavator operator has been dispatched from Central Machinery Unit (hereinafter referred to as “CMU”) to excavate the canal. WUA and CMU are in constant communication and have a smooth cooperation system in place.

From the above, no particular problem has been identified regarding the institutional/organizational aspect of operation and maintenance.

3.4.3 Technical Aspect

There are no specific qualifications required for WUC members, but they all have basic reading and writing skills. All WUC members have received training in the soft component (capacity building program) of the project and have acquired knowledge and skills related to basic knowledge of the facility, gate operations and rules, and formulation of annual maintenance activity plans, and are competent enough to carry out daily operation and maintenance tasks. In addition, a manual for maintenance and management of irrigation facilities was prepared under the soft component of the project, which is always available at maintenance sites for reference and use in daily operations. WUC members have not yet been replaced, but there will be a full handover when they are replaced.

From the above, technical staff in charge of operation and maintenance appears to have sufficient technical capacity to conduct usual operation and maintenance tasks, and there are no particular problems.

3.4.4 Financial Aspect

As regards operation and maintenance costs of the project, necessary amounts are estimated by WUC, and budget request will be made to Sershong Geog and Chuzagang Geog. Each Geog government scrutinizes and allocates the amount possible within the budget.

At the time of the ex-post evaluation, main operation and maintenance cost is the fuel cost for excavators, which is borne by CMU, due to incidents that occurred after completion of construction (sediment inflow and clogging of culvert). (Refer to Table 6) The excavator was procured as part of the follow-up cooperation, and excavator operators dispatched by CMU are removing debris near the headwork and excavating temporary head race.

Table 6: Operation and Maintenance Cost for the Project

(Unit: Nu)			
2018	2019	2020	2021
183,400	186,400	194,200	177,700

Source: Results from questionnaire survey of the executing agency and WUC

Note: Total cost of fuel for excavator procured through the follow-up cooperation for excavating temporary head race and water usage fees collected by the WUA from the members.

The irrigation water user fees (total amount) collected by WUA from its members (farmers) are shown in Table 7. The fee per member household is 300 Nu.

Table 7: Irrigation Water User Fees Collected by WUA from its Members (Total)

(Unit: Nu)			
2018	2019	2020	2021
83,400	86,400	94,200	77,700

Source: Results from questionnaire survey of the executing agency and WUC

Note: According to the executing agency, the 2021 amount was lower than the previous year due to the effects of the spread of COVID-19. Many farmers were unable to pay the fees due to the spread of COVID-19.

Due to the effect of the spread of COVID-19, many farmers are unable to pay their irrigation water user fees, and the collection rate in 2021 is about 60%.⁷ As a result, remunerations for WUC members other than Gatekeepers who operate the water gates have not been paid, and the fees will need to be increased in the future. Farmers' incomes are expected to recover once COVID-19 pandemic is over, and an increasing number of farmers are growing vegetables and cash crops after the project. In addition, WUAs are trying to secure budget from Geog governments, and there is a move to assign one official each from Sershong Geog and Chuzagang Geog as co-chairmen of WUC, and concrete discussions are underway. They are also considering raising the irrigation water user fees in the future. Therefore, prospects for improvement in the financial situation are considered to be high.

From the above, there are some minor problems with financial aspect of operation and maintenance, but various measures have been taken and the prospects for improvement are high.

3.4.5 Environmental and Social Aspect

As a result of confirming with the executing agency, there were no unexpected environmental and social considerations.

⁷ As the number of registered households (WUA members) in the Taklai irrigation area is 442, irrigation water user fee collection rate in 2021 is 58.9%.

3.4.6 Preventative Measures to Risks

The follow-up cooperation is conducted at the time of the ex-post evaluation. As mentioned earlier in “3.1.1.3 Appropriateness of the Project Plan and Approach,” a Technical Review Committee was established to investigate the cause and study countermeasures in light of the case in which a culvert was blocked by sediment after construction was completed and water flow was stopped. Based on the position paper submitted by the Committee, JICA has formulated a response policy, and in the follow-up cooperation, based on the policy, measures are taken such as changing the bar screens of water intake facility to mesh and installing a temporary head race.

3.4.7 Status of Operation and Maintenance

According to the results from questionnaire survey of the executing agency and interviews with farmers, facilities and equipment developed by the project are effectively utilized by farmers and CMU, and they continue to make efforts for maintenance in the field. Temporary head race is washed away every time floods occur during rainy season, requiring frequent excavation, and there are times when supply of irrigation water is not stable. In the follow-up cooperation, prevention of sediment inflow, ensuring of water intake methods during rainy season, and monitoring during rainy season, etc. are carried out. The mesh screens covering manholes are frequently clogged, and Gatekeepers are dealing with this problem in their daily maintenance work.

As a result of interviews with farmers, they answered that they could not predict the period required for maintenance work before the project, but that the predictability has increased after the project. They also said that the time required to clean water intake and maintain irrigation canals was reduced. Most of the work at the intake after floods has been undertaken by excavator, with operators dispatched from CMU quickly removing debris.

Spare parts are stored at the CMU Bhur Office, and there are no particular problems with procurement of spare parts.

From the above, there are some problems in the operation and maintenance status at the time of the ex-post evaluation, but as a whole, there is no problem because facilities are properly operated and maintained.

Slight issues have been observed in the financial and the current status of operation and maintenance, however, there are good prospects for improvement/resolution. Therefore, sustainability of the project effects is high.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

This project improved headwork (fixed weir, bed protection) and canals, etc. to ensure stable supply of irrigation water in Taklai Irrigation System located in Sershong Geog and Chuzagang Geog in Sarpang District, Bhutan. The project, which aims to increase rice production by strengthening irrigation systems, is consistent with Bhutan's development policies and development needs, and project plan and approach were appropriate. The project is also consistent with Japan's development cooperation policy and concrete results can be confirmed through collaboration with other JICA projects as well as with organizations outside JICA. Therefore, relevance and coherence of the project are high. In terms of project implementation, both project cost and project period were within the plan and thus efficiency of the project is very high. Regarding project effects, of the indicators of quantitative effects set at the time of planning, the actual value of "paddy area in dry season" have not achieved the target. Regarding impacts, the results of interviews with the executing agency and farmers in the project area indicate that irrigation water supply have improved in both rainy and dry seasons, irrigation area has increased, and farmers are making better use of agricultural machinery. Farmers are using irrigation water to grow vegetables and cash crops during dry season, and they also make effective use of irrigation water for raising livestock. For this reason, farmers feel that irrigation water has improved during dry season, which together with increase in rice production due to improved irrigation water during rainy season, has generated concrete effects. However, the key indicator for judging the effectiveness of the project, "expansion of double cropping of rice due to stable irrigation water during dry season," has not been achieved. Thus, while other indicators gave mostly achieved the target as planned, effectiveness and impacts cannot be considered as high. Therefore, effectiveness and impacts of the project are moderately low. No negative impacts on natural environment have been reported. Land acquisition and resettlement did not take place. Regarding operation and maintenance, slight issues have been observed in the financial and the current status, however, there are good prospects for improvement/resolution. Therefore, sustainability of the project effects is high.

In light of the above, this project is evaluated to be satisfactory.

4.2 Recommendations

4.2.1 Recommendations to the Executing Agency

Due to the effects of the spread of COVID-19, many farmers have not been able to pay water user fees, and remunerations to WUC members except Gatekeepers have not been paid. It has been suggested that there is a need to raise the user fees, but since this is an important matter

that needs to be agreed at the WUAs, WUAs are required to hold discussions at the annual general meeting in accordance with the WUA regulations, while taking into consideration the local COVID-19 situation and the farmers' economic situation, etc. Since this issue is an exclusive matter of WUAs, the executing agency is not in a position to give instructions to them, however, it is desirable that the executing agency follows up on the situation as appropriate.

The Excavator procured through the follow-up cooperation plays an extremely important role in maintenance work at the field. In the future, when it reaches the end of service life and is no longer operational, it will have a significant impact on daily maintenance. Therefore, it is important for Sershong Geog and Chuzagang Geog to work with WUAs to systematically record the excavator cost as depreciation expenses every year and procure new excavator in a timely manner at the end of its service life so that maintenance activities are not affected.

4.2.2 Recommendations to JICA

It was expected that the project would stabilize water intake during dry season and expand double cropping of rice. Expansion of double cropping of rice will lead to increased rice production, which will contribute to improving self-sufficiency rate of rice and higher income of farmers. However, there is a possibility that farmers will not carry out double cropping of rice even if the facilities are rehabilitated through the follow-up cooperation. Therefore, it is important for JICA to sort out the issues related to double cropping after the facilities are rehabilitated by the follow-up cooperation, and to discuss with the Bhutanese side whether to expand double cropping in the future. Irrigation water supplied by this project is useful not only for rice, but also for cultivation of vegetables and cash crops, as well as for raising livestock. Thus it is also desirable that JICA holds discussions with the Bhutanese side regarding realistic farm management such as growing two crops that combine other crops in dry season and livestock production, etc. Survey by farm management experts may be considered as an option when sorting out issues and discussing countermeasures.

4.3 Lessons Learned

Importance to strengthen risk mitigation measures through soft component activities with further emphasis on maintenance after project completion

In this project, the rail method used for rivers in Japan was adopted for the development of apron downstream of headwork. At the time of planning, this method was recognized as an appropriate construction method, but after construction was completed, it was found that the high-strength concrete was worn away by the annual floods and rolling stones that flowed down with the floods,

and some of the rails were washed away. According to the executing agency, it was pointed out that flood records, and rainfall and river water volume data were not sufficiently developed in Bhutan at the time of planning. On the other hand, according to the construction supervision consultants, even at the time of the ex-post evaluation, it would be technically difficult to predict damage caused by floods, including gravel and boulders, even if sufficient data were available at the time of planning and careful analysis was conducted. In addition, although more robust methods exist than the rail method, they are expensive protection construction methods and require larger project cost. As in this project, when similar projects are implemented in the future under both technical and budget constraints, in addition to adopting as robust a construction method as possible as in this project, it is conceivable to conduct soft component activities that emphasize post-completion maintenance (especially repairs in the event of damage). For example, risk assessment content could be added to the soft component activities to strengthen risk mitigation measures after project completion by adding new tasks such as (i) possible risks (e.g., damage), (ii) scenarios of events that could occur if risks are left as is, and (iii) specific construction methods that can take place by the recipient country side while risks (damage) are still small (what specific repairs should be conducted if any damage occurs) to avoid the situation described in (ii).

Importance of considering various support approaches to increase the feasibility of double cropping of rice (dry season crop)

In this project, double cropping of rice has not been realized as planned. This is due to changes in the local farming environment. Following issues were identified regarding the varieties developed by ARDC: 1. harvesting period coincides with rainy season, which raises concerns about rain damage; 2. there is no non-crop period between dry-season and rainy-season cropping, which makes it impossible to secure a period for fertilizer application. However, these issues were revealed in the dry-season crop demonstrations conducted by FMCL using irrigation water from the project after the project completion, and it was not realistic to address the issues during the project. The ARDC research team continues to develop new varieties, but it will take many years to develop and improve varieties by the Bhutanese themselves. Therefore, it would be important to include approaches that utilize a variety of support schemes in this sector, for example, in addition to development of irrigation facilities (hard support) and providing technical guidance on their maintenance, formulation of annual farming plans and assistance in selecting rice varieties, etc. can be included in a soft component, or separately providing research support for variety improvement, etc. through technical cooperation projects, dispatch of experts, overseas cooperation volunteers, etc. (soft support). In addition, taking into account the possibility that the environment surrounding farming may change from the time of planning, as in this project, it is

desirable take into account to support flexible farming that combines other crops in dry season and raising livestock, etc. rather than developing an irrigation system with only double cropping of rice in mind.

END