

Republic of Zimbabwe

FY2022 Ex-Post Evaluation Report of Japanese Grant Aid Project
“The Project for Irrigation Development for Nyakomba Irrigation Scheme”

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0. Summary

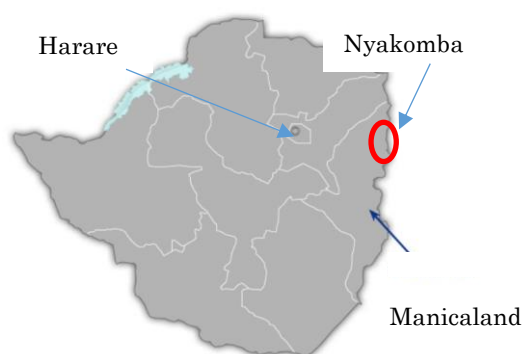
The objective of this project is to ensure a stable supply of irrigation water to the target area to installing new irrigation facilities and rehabilitating existing ones in the Nyakomba irrigation area, Manicaland Province, and thereby contributing to improving the agricultural productivity of smallholder farmers in the area.

The project is in line with the development policy of the government of Zimbabwe, which emphasizes food security and the development of irrigation facilities, and there is a high demand for development in the target area, where the rainfall and the percentage of irrigation land owned by smallholder farmers are low. This project is also consistent with Japan’s development cooperation policy in Zimbabwe, which aims to stabilize food production and improve the livelihoods of smallholder farmers, and specific cooperation with other JICA projects and assistance were confirmed. Therefore, its relevance and coherence are high. In terms of efficiency, the cost for the land leveling and VAT (value-added tax, hereinafter referred to as “VAT”) refunds in the total cost borne by the government of Zimbabwe exceeded the plan. The overall project cost, including the Japanese side, slightly exceeded the plan. The project period exceeded the plan, mainly due to the time required to divide equipment procurement and facilities construction into lots at the time of detailed planning and the result of a review of the construction period considering the rainy season. Therefore, its efficiency is moderately low. The irrigated developed area and actual production values of the top-three crops in the project achieved the targets; however, the cultivating area was slightly short but generally close to the target of the quantitative effect. The qualitative study confirmed that 1) the food supply in the target area was stabilized and profitable crops were introduced to be linked with the technical cooperation project, 2) the executing agency and related agencies including the water user’s association members, acquired skills in the maintenance, and management of irrigation facilities, 3) actual crop production values and the number of harvests per year increased, and 4) the quality of life was improved through increased income. Positive impacts were also observed, such as the reduced burden of water-fetching labor for women and children and improved nutritional status due to the better availability of sufficient subsistence crops and other food sources. Therefore, the effectiveness and impacts of the project are high. In terms of sustainability, there are no particular concerns regarding the institutional, structural, or technical aspects of the executing agency, the Department of Irrigation, Ministry of Lands, Agriculture, Fisheries, Water and Rural Development (hereinafter

referred to as the “Department of Irrigation”), the Zimbabwe National Water Authority (hereinafter referred to as “ZINWA”), the Irrigation Management Committee (hereinafter referred to as “IMC”), and Directorate of Agricultural Advisory & Rural Development Service (hereafter referred to as “AARDS”). In addition, there have been no major problems with budget allocation and the operation and maintenance on the irrigation facilities developed by the project. Therefore, sustainability of the project effects is high.

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

1. Project Description



Project Location (source: JICA, Evaluator added the location name)



New irrigation facility in Block A (source: Evaluator)

1.1 Background

The agricultural sector in Zimbabwe accounted for 14% of the country’s gross domestic product, and the agricultural population accounted for 50% of the total labor population (2011).¹ Until 2000, Zimbabwe exported major cereals such as maize and wheat; however, after its land reform,² cereal production stagnated, and, as a result, the country became an importer. The government of Zimbabwe planned to introduce irrigation farming to manage small communal lands, which had markedly low agricultural productivity and production amount, and were vulnerable to droughts, and requested assistance from the government of Japan for irrigation development in 1985. In response to the request, JICA conducted a Development Study and Feasibility Study (hereinafter referred to as “F/S”). As a result of the F/S, the government of Zimbabwe requested grant aid for the development of irrigation facilities. The Nyakomba irrigation area, the target area of this project, is one of smallholder farming areas where productivity was declining. As the area has an

¹ Census 2012 National Report.

² In 2000, “fast-tracking,” which is the forced expropriation of large White-owned farms and their redistribution to Blacks working on communal farms, was initiated. The redistribution without adequate infrastructure not only resulted in the loss of commercial agricultural production techniques but also paralyzed the entire agricultural policy, seriously affecting Zimbabwe’s food supply.

annual rainfall of less than 600 mm where rain-fed farming is practiced, it was expected to contribute for stabilization and improvement of agricultural productivity by the installation of irrigation facilities in the Nyakomba irrigation area, and the irrigation facilities were installed in Blocks B, C, and D, from 1996 to 2000. The Nyakomba irrigation area was flooded by hurricanes in 2000 and 2006, and the pumping equipment installed in the basement of the pump station was submerged. Subsequently, JICA conducted a field survey and found there was a problem with the capacity to pump water to the irrigation area. Based on the survey, it was decided in the project to construct new irrigation facilities (Block A) and rehabilitate existing irrigation ones (Blocks B, C, and D) in the Nyakomba irrigation area. At the time of planning, the irrigation facilities in Block A were undeveloped, and in Blocks B, C, and D, the irrigated area was approximately 50% to 60% of the developed area. With this background information, it was expected that the development of irrigation facilities would increase agricultural production in the Nyakomba area and contribute to the continuous implementation of stable agricultural production activities.

1.2 Project Outline

The objective of this project is to ensure a stable supply of irrigation water to the target area to installing new irrigation facilities and rehabilitating existing ones in the Nyakomba irrigation area, Manicaland Province, and thereby contributing to improving the agricultural productivity of smallholder farmers in the area.

Grant Limit / Actual Grant Amount	1,791 million yen / 1,789 million yen
Exchange of Notes Date / Grant Agreement Date	November 2015 / November 2015
Executing Agency(ies)	At the planning stage: Department of Irrigation, Ministry of Agriculture, Mechanization and Irrigation Development At the evaluation stage: Department of Irrigation, Ministry of Lands, Agriculture, Fisheries, Water and Rural Development
Project Completion	June 2019
Target Area	Nyakomba Irrigation area, Nyanga district, Manicaland Province (580 hectares 760 households)
Main Contractor	KONOIKE Construction Co., LTD.
Main Consultant	NTC International Co., LTD.

Preparatory Survey	November 2014-July 2015
Related Projects	<p><Technical Cooperation Project> <u>Technical Cooperation Project for Development Planning</u> -Nyakomba Irrigation Development Plan (1989-1990) <u>Dispatch of Individual Expert</u> -Irrigation Development and Management Advisor (2012-2017) -Zimbabwe Smallholder Horticulture Empowerment and Promotion (2019-2025) <Grant Aid Project> -Nyakomba Irrigation Development Plan (1995, 1996) -Nyakomba Irrigation Development Plan Phase 2 (1999, 2000)</p>

2. Outline of the Evaluation Study

2.1 External Evaluator

Yumiko Yoshizawa, Ruiko Hino, Atsushi Kimura,³ Foundation for Advanced Studies on International Development

2.2 Duration of Evaluation Study

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

Duration of the Study: November 2022-February 2024

Duration of the Field Study: April 22, 2023-May 12, 2023, July 23, 2023-July 29, 2023

2.3 Constraints during the Evaluation Study

A part of the project's evaluation was based on information from interviews, as budget allocations and actual expenditures for the maintenance were not shared. Records of operation and maintenance agreements among related agencies that were completed before the project's initiation were also unavailable. Additionally, one irrigation area design drawing necessary for satellite data analysis was not shared, resulting in an analysis conducted without such data.

³ Kimura (in charge of satellite data analysis) belongs to Pasco Corporation and participated in the evaluation as a reinforcement.

3. Results of the Evaluation (Overall Rating: A⁴)

3.1 Relevance/Coherence (Rating: ③⁵)

3.1.1. Relevance (Rating: ③)

3.1.1.1 Consistency with the Development Plan of Zimbabwe

Prior to the start of this project, Zimbabwe promoted policy objectives on agricultural and rural development and irrigation policies in its national policies such as the *Zimbabwe Agenda for Sustainable Socio-Economic Transformation*, *Zim Asset*, the *Comprehensive Agricultural Policy Framework (2012-2032)*, and the *Food and Nutrition Security Policy*.

At the time of the ex-post evaluation, the national development plan *Vision 2030* and the *National Development Strategy I (2021-2025)* set the goal of expanding irrigation development in order to improve food self-sufficiency and the productivity of agricultural products for export. In addition, the *Accelerated Irrigation Rehabilitation and Development Plan 2021-2025* states that the construction of new irrigation schemes and the rehabilitation of existing irrigation ones are important to promote climate-smart agriculture and that it requires collaboration with development partners to achieve its target of 200 hectares/province/year of irrigation area by 2025.

3.1.1.2 Consistency with the Development Needs of Zimbabwe

Prior to the project, rainfall in dry season (May to October) is significantly less than rainfall in rainy season (November to April) in Zimbabwe. However, only 35,000 hectares was the area of the irrigated farmland farmed by smallholder who grew the basic crops of corn and wheat. This accounted for approximately 17.5% of the total irrigated farmland and 0.8% of the entire farmland area. To meet the increasing demand for food in Zimbabwe, irrigation development for smallholder farmers was required.

At the time of the ex-post evaluation, the rainfall in the project area was 3.36 mm/day on average in the rainy season and 0.04 mm/day in the dry season, which means the rainfall remained remarkably low in the dry season. In addition, the area of irrigated farmland for smallholder farmers has not changed since the start of the project, indicating that irrigation development needs remain high.

The results above indicate that the dry season rainfall, the ratio of irrigated farmland area for smallholder farmers in the project area to total farmland area, and the ratio of irrigated farmland area for smallholder farmers in the project area to total irrigated farmland area have not changed since before the start of the project until now, at the time of the ex-post evaluation. In addition to that, given the emphasis on meeting food demand, the consistency between the project and

⁴ A: Highly satisfactory, B: Satisfactory, C: Partially satisfactory, D: Unsatisfactory.

⁵ ④: Very High, ③: High, ②: Moderately Low, ①: Low.

the development needs has been confirmed.

3.1.1.3 Appropriateness of the Project Plan and Approach

In the ex-ante evaluation sheet, as lessons learned from a similar project in the past, it was clearly stated that in order to ensure being fully effective, as a soft component activity, the capacity-building training should be implemented for extension officers and IMC members to acquire not only the skill of maintenance and management of the irrigation facilities, but also to introduce cash crops to have contract farming. In the project, the capacity-building program through training on the necessary skills for the maintenance and management of irrigation and pumping facilities. In addition, activities were undertaken to introduce new contract farming companies to the extension officers and the IMC's marketing committee in order to promote contract farming. It should be noted that no major differences between the project plan and actual performance were identified in this project. As a result, it can be concluded that past project lessons learned were effectively applied, by the maintenance and management of irrigation facilities and implementation activities to support contract farming as a soft component.

3.1.2 Coherence (Rating: ③)

3.1.2.1 Consistency with Japan's ODA Policy

Prior to the start of this project, Japan's Rolling Plan for the Republic of Zimbabwe positioned agriculture as part of the humanitarian aid program from the perspective of stabilizing food production and improving the livelihoods of smallholder farmers. Because this project contributes to the improvement of agricultural productivity in Zimbabwe through the development of irrigation facilities, it is in line with the above, and it can be said that the project is consistent with Japan's assistant policy.

3.1.2.2 Internal Coherence

At the time of planning of this project, an individual expert (Irrigation Development Management Advisor) assigned to the Department of Irrigation was working to strengthen the capacity of the executing agency for irrigation development and maintenance and rural development. The ex-ante evaluation report indicated that the advisor collaborates with the project. Specifically, the expert participated in the project's monthly meeting as an advisor, received information shared on the progress, and was involved in the formulation of the project. In addition, the expectation of the synergy effects between this project and the technical cooperation project, Project for Zimbabwe Smallholder Horticulture Empowerment and Promotion (hereinafter referred to as "ZIM-SHEP"), which is a market-oriented agriculture promotion project, was also indicated in the ex-ante evaluation report. At the time of the ex-

post evaluation, it was confirmed that farmers in the Nyakomba irrigation area had participated in the training conducted by ZIM-SHEP. This has deepened their understanding of the importance of crop cultivation with an eye on market demand and has improved their income by putting it into practice.

Agricultural assistance in Zimbabwe was comprehensive through three JICA schemes; starting with the formulation of grant aid project by an individual expert, the implementation of this project, and the selection of the Nyakomba irrigation area as ZIM-SHEP's target area after the project.

3.1.2.3 External Coherence

There were not discussions or agreements on collaborative projects between donor organizations and the executing agency or JICA regarding the content of cooperation or expected outcomes before and during the project. Additionally, the government of Zimbabwe was trying to move away from aid dependency and promote cooperation with business partners, which was another reason why it did not actively cooperate with other donor organizations.

The objective of the project is consistent with its need to develop irrigation for smallholder farmers in response to its food security development plans in the national development plan. The approach was also appropriate in view of applying lessons learned from a similar project in the past. In terms of consistency, the objective of the project was consistent with Japan's ODA policy for Zimbabwe at the time of the ex-ante evaluation report, and its specific linkages with other projects and assistance within JICA were confirmed. At the same time, there were no specific linkages or coordination with organizations other than JICA. Therefore, its relevance and coherence are high.

3.2 Efficiency (Rating: ②)

3.2.1 Project Outputs

The planned and actual outputs of the project are shown in Table 1.

Table 1 Outputs of the project (planned and actual)

Plan (2015)	Actual (2019)
<p>【Planned outputs from the Japanese side】</p> <p>1) Civil work and equipment procurement : lifting pump, headrace (A: steel pipe dia. 500 x 980 m, D: steel pipe dia. 600 x 365 m), farm pond, distribution canal (4.4 km), branch irrigation canal (10.6 km), farm road</p>	<p>【Actual outputs from the Japanese side】</p> <p>1) Civil work and equipment procurement : lifting pump, headrace (A: steel pipe dia. <u>600</u> x 980 m, D : steel pipe dia. 600 x <u>400 m</u>), farm pond, distribution canal (4.4 km), branch irrigation canal (10.6 km),</p>

<p>(4.69 km + 0.30 km), drainage (18.7 km), RC retaining wall, replacement of pump electrical facilities and arrangement of mechanical conditions.</p> <p>2) Soft component: Capacity-building program: Strengthening of capacity for operation and maintenance of irrigation and pump facilities, and promotion of contract farming, and Promotion of contract farming.</p>	<p>farm road (4.69 km + 0.30 km), drainage (18.7 km), RC retaining wall, replacement of pump electrical facilities and arrangement of mechanical conditions.</p> <p>2) Soft component: Capacity-building program: Training on operation and maintenance techniques for irrigation and pumping facilities was conducted as planned, and the related agencies staff acquired the skills. In terms of the promotion of contract farming, a system to increase the number of contract farmers and contract crops was strengthened under the initiative of extension officers of AARDS. Meanwhile, Zimbabwe has been experiencing a nationwide cash shortage since around July 2017, which has left companies short of funds, so the output was not achieved.</p>
<p>【Planned output from the Zimbabwe side】</p> <ol style="list-style-type: none"> 1) Securing land for major facilities 2) Land reclamation and land leveling (146 ha) 3) Submission of EMP to EMA and approval of environmental certificate 4) Water intake permit 5) Agreement for operation and maintenance, and property of irrigation facilities 6) Securing electric sources (installation of transformer and extension of cable) 7) Assistance to refund VAT for procurement of construction material (March 2018) 8) Assistance to exempt import tax 	<p>【Actual output from the Zimbabwe side】¹</p> <ol style="list-style-type: none"> 1), 3), 4), 5), and 8) have been completed as planned. 2) Land leveling in Block A has not yet been completed. 6) Replacement of transformer (500 KVA to 630 KVA) has not yet been completed. 7) VAT refunds have been delayed; however, it was completed in November 2022.

Source : Documents provided by JICA.

1 : The actual outputs from the Zimbabwe side have been confirmed by the Department of Irrigation and the Japanese consultant.

As for the outputs on the Japanese side of the project, there were minor design changes reflecting changes on site conditions, but the outputs of new construction and rehabilitation of irrigation facilities were produced as planned. As for the outputs on the Zimbabwe side, progress on land leveling in Block A is behind schedule, and irrigation was completed in 50 hectares out of 146 hectares, as of June 2023. The reasons for the delay in land leveling despite the willingness and efforts of the Department of Irrigation, were higher fuel costs and constraints on the deployment of heavy machinery and timing of operation. At the time of the ex-post evaluation, the Department of Irrigation had 7,000 liters of fuel for heavy machinery to resume the land leveling process, which is aiming to be completed by the end of December 2023. Although the replacement of the transformer in Block A has not been completed partly because it is difficult to obtain 630 KVA transformers in Zimbabwe, two of the three pumps are in operation to provide the necessary water volume for irrigation. Thus, it has been determined that there are no operational problems.

3.2.2 Project Inputs

3.2.2.1 Project Cost

As for the total cost of this project, the actual cost borne by Japan was 1,789 million yen, compared to a planned cost of 1,791 million yen. On the other hand, the cost for land leveling and VAT refunds in the total cost borne by the government of Zimbabwe exceeded the plan, with the planned amount of 68.4 million yen versus the actual amount of 171.2 million yen as of the ex-post evaluation. Land leveling costs are expected to increase in the future. The project cost slightly exceeded the plan (105% of the planned amount).

3.2.2.2 Project Period

This project was initially scheduled to be implemented from October 2015 to March 2018 (30 months). The actual project period was from October 2015 to June 2019 (44 months), exceeding the plan. The main reasons for the prolongation are as follows: (1) During the detailed design period, it took time to divide equipment procurement and facility construction into lots, resulting in an actual period of 11 months compared to the planned 7 months; and (2) the actual construction period was 33 months compared to the planned 23 months due to a review of the construction period based on the rainy season. In addition, as a result of the review of the construction period which was scheduled to be completed by the end of March 2019, was delayed, because of the delay the procurement of materials from outside the country due to a change in Zimbabwe's currency policy.⁶ Therefore the performance deadline of the main

⁶ The changes promulgated in October 2018 regarding the regulation of US dollar transfers out of the country and the handling of bank funds have made it difficult to transfer US dollars from subcontractors in Zimbabwe out of the country (South Africa) due to these regulations and changes.

construction work was extended by an additional 4 months. The 4-month extension of the implementation period due to the change in Zimbabwe’s currency policy was considered an external condition, therefore the 4-month extension was not included in the actual project period. Thus, the project period was 40 months (133% of the planned period) (Table 2).

Table 2 Plan and actual result of the project period

	Plan	Actual
Total	October 2015 - March 2018 (30 months) Starting point is G/A ¹ conclusion	November 2015 - June 2019 (44 months, 146% compared to plan) Starting point is G/A conclusion
Details	G/A conclusion: Detailed design planning (3 months) Detailed design period (7 months) ² Main construction period (23 months)	G/A conclusion: November 2015 Detailed design period: December 2015 - October 2016 (11 months) Main construction period: October 2016 - June 2019 (33 months) Completion: June 2019 (completion date: June 18, 2019) ³

Source : Documents provided by JICA.

1: Grant agreement.

2: Detailed design period includes bidding period.

3: Completion means when the construction is done.

Based on the above, the project cost slightly exceeded the plan, and the project period exceeded the plan. Therefore, efficiency of the project is moderately low.

3.3 Effectiveness and Impacts⁷ (Rating: ③)

3.3.1 Effectiveness

3.3.3.1 Quantitative Effects (Operation and Effect Indicators)

Table 3 shows the quantitative effectiveness indicators (baseline, target, and actual values) for the Nyakomba irrigation area.

⁷ When providing the sub-rating, effectiveness and impacts are to be considered together.

Table 3 Quantitative effect indicators of the project (baseline, target, and actual values)

	Baseline value	Target value	Actual value
	2015	2022	2022
		3 years after completion	3 years after completion
Indicator 1: Irrigation area (unit: hectare)	261	580	580
Indicator 2: Cultivating area (unit: hectare) ¹	764	1,045	1,002
Indicator 3: Crop production in the top-three crops (unit: ton)			
Green maize	485	1,727	1,970
Sugar bean	333	534	626
Onion	648	2,160	2,699

Source : Documents provided by JICA (baseline, target value); answers to the questionnaires conducted by related agencies (actual value).

1 : Actual value of the cultivating area is the total figure of the rainy season and the dry season. The rainy season is usually from November to April, and the dry season is usually from May to October in Zimbabwe.

The project aimed to see increase in 1) the irrigation area, 2) the cultivating area, and 3) crop production in the top-three crops in the Nyakomba irrigation area, after the construction and rehabilitation of irrigation facilities. At the time of planning, the target year was set as the third year after the project's completion. Since the third year of completion is 2022, the ex-post evaluation compared the targets with the actual data in 2022 to judge the quantitative impact.

1) The irrigation area refers to the area that can be irrigated by distributing water to farmland through the intake from the Gairezi River, which is the source of water for the Nyakomba irrigation area. The actual value achieved the target value.⁸

2) Cultivating area refers to the area where crops are actually planted throughout the year. The actual cultivating area fell slightly short of the target, but it was possible to cultivate crops in farmland that had not been planted during dry season by irrigation schemes, as a result of the actual cultivating area increased. According to AARDS, the target was not reached because some farmland in Block A had not been leveled off and irrigation had not yet been realized.

3) The actual crop production in the top-three crops exceeded the target.

⁸ In farmlands that have not yet been leveled in Block A, farmers themselves are digging canals to their own fields and establishing a system to irrigate them so that about 90% of the fields can be irrigated.



Photo 1 Wheat cultivation in the project site (source: Evaluator)

Next, Table 4 shows the estimates of irrigated area based on satellite data analysis for reference. It was assumed that the farmland where irrigation functions could be supplied with water regardless of the rainy or dry season, allowing crops to grow there. For example, the farmland where the soil is wet or crops grow in the dry season is considered as irrigated farmland. Therefore, estimates of irrigated area were judged using values of vegetation activity and soil moisture from satellite data analysis for each rainy and dry season. As shown in Table 4, the estimated irrigated area was similar to or larger than the planned irrigated area according to the report JICA provided. Some of estimates were larger than planned possible because irrigation was progressing outside the planned area and that the area was determined to be large due to the coarse resolution of the satellite imagery. The certainty of the results of the satellite data analysis was confirmed by checking both the results of the satellite data analysis and the data from the field survey (see column for details).

Table 4 Estimated value utilizing satellite data and planned value of irrigation area
(unit: hectare)

Block	A	B	C	D	Total
Estimated irrigation area value by the satellite data	183	128	141	219	671
Planned irrigation area value by the report	146	128	115	191	580

Source : Estimated value is provided by the evaluator and planned value is from the JICA report.

3.3.1.2 Qualitative Effects (Other Effects)

Through the qualitative study, the effects on the following items were evaluated: 1) stabilization of food supply in the target area through increased crop production; 2) introduction

of highly profitable crops through irrigation farming; 3) acquisition by IMC members of skills required to repair irrigation facilities downstream of farm ponds; and 4) acquisition by both ZINWA officials in charge of pump stations and the Department of Irrigation officials of skills required to regular maintenance skills of pump equipment. Interviews were conducted with farmers and IMC members in the Nyakomba irrigation area regarding 1), 2), and 3) listed above.⁹

With regard to 1), change in the production amounts of white maize, chili, wheat, and potatoes, which were cultivated in a large area at the time of the project's planning, was used as an indicator, and the increase in production was confirmed by AARDS and then it was concluded food supply to farmers stabilized.

Regarding 2), by asking AARDS about the production amount of potatoes, tomatoes, paprika, tobacco, and chili which were considered highly profitable at the time of the project's planning stage, it was found that the production of tomatoes, paprika, and chili had increased as a result of the shift to these crops. However, farmers avoided cultivating potatoes and tobacco due to the high investment costs of farming. Another reason of tobacco production was a lack of trust in tobacco companies, as the farmers had experienced being unpaid for delivering crops to the contract company prior to the COVID-19 pandemic. While the number of farmers who produced cotton and cabbage for contract farming increased.

Concerning 3) the acquisition of skills for repairing IMC members' irrigation facilities, the average percentage of correct answers by trainees in the basic understanding test related to irrigation facilities increased from 53.1% (average of trainees) to 100% after the training. The practical skills were also used without delay, and high-quality repairs had been carried out. From the above, it can be concluded that IMC members in Blocks A through D have acquired the skills to conduct repairs of irrigation facilities downstream of farm ponds. Under the project's capacity-building program, training (lecture and practice) was provided to engineers and technicians of the Department of Irrigation and ZINWA on the acquisition of regular maintenance of pumping equipment, identification of malfunctions, and repair of pumping equipment in 4). Based on the results of the post-training questionnaire, it was concluded that sufficient technical skills were acquired.

3.3.2 Impacts

3.3.2.1 Intended Impacts

In terms of the project's impact on the livelihoods of residents in the project site, all 30 farm households interviewed have become able to irrigate water to their farmland, and as a result

⁹ 30 farmers were interviewed (Block A: 5 men and 3 women, Block B: 5 men and 2 women, Block C: 5 men and 2 women, Block D: 4 men and 4 women); IMC members were interviewed (7 members in Block A, 6 members in B, 6 members in C, and 7 members in D).

their incomes increased. Farmers who harvested once a year before the project increased the number of harvests to an average of 2.8 times a year, confirming an increase in total annual production. All the farmers increased the number of harvests even during the dry season using irrigation, consequently their production increased, thus it has been decided that the farmers are able to conduct intensive and efficient farming operations. In addition, as a result of activities to introduce contract farming companies to extension officers and IMC marketing committee, and ZIM-SHEP training aiming market-oriented agriculture, farmers have shifted to more profitable crop productions, which has improved their income. Crops that were previously intended for subsistence purposes can now be shipped to the market as horticultural crops to generate income. Additionally, access to irrigation has enabled increased planting of vegetables and other crops that require water instead of cereals, which are less productive, ensuring quantity and quality, thereby it also has led to increased income. The specific amount of income could not be confirmed because the farmers were not able to answer precisely, so they were interviewed about how to use their income. The result of the interviews are as follows:

- The most common answer was payment for school fees (24 out of 30 respondents). According to their responses, the increase in income has made their children's education more affordable.
- The next most common responses were investments in farming (18 out of 30 respondents), such as seeds, fertilizers, and materials. The increase in income not only allows the farmers to purchase seeds and seedlings, which require high initial investments, but also increases agricultural production through fertilization, creating a favorable cycle that improves the quality of agriculture.
- The purchase of livestock (15 out of 30 respondents) followed. The ability to plant maize two or three times a year has made it possible to secure feed not only for the market but also for livestock, which is thought to have further improved income by increasing the amount of livestock.
- Other responses from the farmers were the expenditure of house renovations (13 out of 30 respondents) and grocery expenses (8 out of 30 respondents), indicating that their daily lives are more enriched than before the installation of irrigation.

3.3.2.2 Other Positive and Negative Impacts

1) Impacts on the Environment

The project was classified as Category B according to the *Japan International Cooperation Agency Guidelines for Environmental and Social Considerations* (April 2010), as it was judged that the project does not fall under any of the sensitive sectors, features, or areas listed in the guidelines and that adverse impact on the environment and society would not be

significant. The *Environmental Management Act of Zimbabwe* requires that an Environmental Impact Assessment (EIA) of the project carried out and therefore the executing agency submitted an Environmental Management Plan (EMP) to the Environmental Management Authority (EMA) and then got approval by the EMA. Through questionnaires and interviews, it was confirmed that no negative impacts on the natural environment (air pollution, water pollution, waste, water use, working environment, construction impacts etc.) were observed during the project implementation and after the project completion and that no complaints were received. As for air pollution countermeasures, water was sprayed to prevent dust from affecting residents, and the standard value (PM: 100 mg/m³) was not exceeded. As for the water pollution countermeasure, sandbags were installed at the pumping station to prevent the turbidity from rising, and the sandbags were installed slowly so as not to discharge turbid water. There was no direct discharge of oil or wastewater into the river that could affect water quality. As a result, suspended solids levels did not exceed the standard (25.0+/-0.1 mgL⁻¹) during the construction period. In terms of waste management, construction waste soil generated during construction was reused as fill and backfill material. Waste generated during the rehabilitation of existing structures was temporarily stored away from the village and the river and then disposed of at a site designated by the community. In addition, a field survey was conducted to determine whether the excessive application of pesticides and chemical fertilizers had an impact on the soil. According to AARDS, it has been instructing farmers on the proper use of pesticides and chemical fertilizers, as well as monitoring through soil sampling, and it has been found to have no negative impact on the soil.

2) Resettlement and Land Acquisition

The project did not receive any complaints of resettlement or land acquisition¹⁰ from residents or other parties. In the ex-ante evaluation report, it was stated that “Although the target land is owned by the government of Zimbabwe, farmers who customarily use the land may be affected by the land acquisition. It has been agreed among the users that irrigated farmland will be distributed equally; however, for those farmers whose farmland will be reduced from what it is prior to the offering, rainfed farmland will be provided as an alternative.” In Block A, where the irrigation facilities newly constructed, the related parties had already agreed in December 2014, prior to the start of the project, to deal with the redistribution of farmland by equitable allocation of land, and the farmers were affected by the reduction in their land that they had customarily used had also agreed. In addition, in January 2015, an agreement was made with the related parties that they would not demand

¹⁰ The land acquisition is to be made from farmers who are temporarily using land owned by the government of Zimbabwe, and the associated compensation is to be resolved on the basis of equal land allocation among farmers, and no problems have arisen to date (source: Documents provided by JICA). Relating to land acquisition and reduction of farmland, target was only Block A, which was installed new irrigation facilities.

compensation for the partial acquisition of land for the construction of irrigation facilities. In the interviews with farmers during the field survey revealed that 4 out of 8 farmers' land area had decreased compared to before the project started. Although no alternative land had been provided to the farmers whose land area had decreased, they did not complain about this but rather welcome to accept the increases in productivity and income that had resulted from the allocation of irrigated farmland.

3) Gender Equality, Marginalized People

Before the project, women and children in each household had to fetch water from the river. However, after the introduction of irrigation, they were able to access water for domestic use from nearby canals developed by the project, thereby reducing the burden of water-fetching labor. Women responded to their interview that in addition to farm work, housework, and childcare, they also go to church and engage in group microfinance activities¹¹ in their free time. Children were also able to play with friends, play soccer, and watch sports.



Photo 2 Buckets from each household are prepared near the canal for domestic water use (source: Evaluator)

4) Unintended Positive/Negative Impacts

The target area of this project was the project site of the JICA technical cooperation project, ZIM-SHEP. The farmers who participated in the ZIM-SHEP training learned the importance of conducting market research, selecting crops that are in demand, understanding the quality and quantity demanded by the market, and growing competitive crops. The farmers who actually conducted market research began to develop a crop calendar and cultivation practices in order to systematically grow crops based on demand. Furthermore, farmers said they are now able to set appropriate prices and manage their finances. Additionally, the extension officers of AARDS who received the ZIM-SHEP ToT¹² training were planning to provide the training of the farming techniques they learned through the ZIM-SHEP training to neighboring areas that were not selected as project sites.

Farmers reported improved nutrition and health, as they had more crops for their own consumption and have been able to purchase other food items with their increased cash income.

¹¹ Group activities to support each other through microfinance redistribution acts.

¹² Training of trainers.

As described above, the project provided a stable supply of irrigation water to the target area through the construction and rehabilitation of irrigation facilities, thereby contributing to the improvement of agricultural production by smallholder farmers in the area. This project has mostly achieved its objectives. Therefore, effectiveness and impacts of the project are high.

3.4 Sustainability (Rating: ③)

3.4.1 Policy and System

At the time of the ex-post evaluation, the government of Zimbabwe was taking steps to provide adequate water sources and electricity to irrigation land owned by smallholder farmers in order to improve food self-sufficiency. Therefore, the policy sustainability necessary for the project's effectiveness was ensured.¹³

3.4.2 Institutional/Organizational Aspect

The executing agency of the project is the Department of Irrigation, under the Ministry of Land, Agriculture, Fisheries, Water and Rural Development. Although the Department of Irrigation is responsible for the overall management of the project, the Manicaland Provincial Office, a regional department of the Department of Irrigation, is responsible for the operation and maintenance of the irrigation facilities established under the project. In addition, ZINWA and IMC are recognized as the agencies involved in the maintenance and management of Nyakomba irrigation. The responsibilities of each agency are as follows: the Department of Irrigation is responsible for the irrigation facilities and farm roads downstream of the farm pond outlet; ZINWA is responsible for the irrigation facilities from the pump intake to the farm pond; and the IMC is responsible for the irrigation facilities downstream of the farm pond. In fact, the farmers themselves are repairing minor defects in the canals downstream of the farm pond, whereas the Department of Irrigation takes over when problems are too complex to solve at the farmers' level. To clarify the responsibilities and financial resources for the maintenance mentioned above, the Department of Irrigation, ZINWA, and IMC discussed and reached a consensus on the maintenance in February 2015, prior to the start of this project. At the time of the ex-post evaluation, it was confirmed that the three parties have been working together to maintain and manage the irrigation system based on the consensus and that the cooperative system of coordination established smooth irrigation maintenance and management operations. In particular, farmers are not overly dependent on the government, and when problems arise, they are willing to try to solve them first through self-help efforts. In addition, although not directly

¹³ Amid a growing global food security crisis, Zimbabwe has successfully increased its wheat production from a wheat importer to meet its self-sufficiency and is expected to start exporting. URL <https://www.herald.co.zw/zim-ready-to-export-wheat-this-year/> (accessed July 28, 2023).

involved in the maintenance of irrigation facilities, the extension officers of AARDS provide agricultural advice, help farmers improve their incomes, and serve as a link between farmers and the government, contributing to smooth communication. Regarding the management of the IMC, although there are some differences depending on the block, it is confirmed that a management system based on division of roles is in place and functioning well.

The staffing allocation by the Department of Irrigation at the time of the post-evaluation was approximately the same as at the time of the defect inspection. On the other hand, the staffing allocation by ZINWA has one less pump operator; however, one operator is in charge of Blocks A and B, which is not a problem at the present time. Table 5 below shows the staffing allocations of each organization.

Table 5 Staffing allocations of each organization

Organization	Title and staffing allocation
Department of Irrigation	Chief Engineer in Manicaland 1, Engineer in Manicaland 1, Engineer in Nyakomba 1, Technician in Nyakomba 1, Total: 4
ZINWA	Nyanga Service Team Leader 1, Supervisor 1, Block Operator 3 (One operator is in charge Blocks A and B), Total: 5 * Electrician 1, Boiler maker 1 and Fit and turner ¹ 1, support as necessary
DAARDS	Nyanga extension officer 1, Nyakomba supervisor 1, extension officer 1 x 4 blocks, Total: 6
IMC	Each block of IMC : Chairperson 1, Vice-chairperson 1, Secretary 1, Vice-secretary 1, Treasurer 1, Committee 2, Maintenance chair 1, Vice-maintenance chair 1, Total: 9 *Vice maintenance chair is absence in block C

Source: Answer to the questionnaire and interview to executing agency and related agencies.

1: Maintenance team

3.4.3 Technical Aspect

During the project period, the capacity-building training (soft component) in Japan, which focused on strengthening the capacity of irrigation pump maintenance and management, was conducted for the Department of Irrigation and ZINWA staff. At the time of the ex-post evaluation, one of the two Irrigation Department officials who participated in the Japanese training is now with the Ministry headquarters, and the other is with Manicaland Province office. Both visit irrigation sites as needed to provide guidance and advice on maintenance and management. Both of the two ZINWA technicians and engineers who participated in the training in Japan are no longer in charge of Nyakomba.

Although there has been no need for spare parts for pump equipment since the completion of

the project, it was envisioned that if their spare parts procurement became necessary, local procurement would be used, and if that is not possible, Ebara Pumps South Africa (PTY) LTD, based in South Africa, would be used.

At the time of the ex-post evaluation, it was confirmed that the pump maintenance manual was properly kept at the Department of Irrigation and that ZINWA referred to it as necessary. On the other hand, the “Maintenance and Repair Manual of Irrigation Branch Canal,” which was prepared at the time of the project implementation and had not been utilized because IMC members and farmers were unaware of the existence of it. It was found that the manual was prepared only in English, and that the manual translated in the local language is needed for the farmers who wanted to refer it. The IMC members who were trained in the capacity-building training did not share their knowledge and skills with other members or farmers. Whereas the Department of Irrigation provides technical training to the farmers, and when minor repairs to irrigation facilities are needed, the farmers take the lead, and skilled local engineers work with them free of charge to maintain and manage the facilities. When repairs are too technically difficult for the farmers to carry out on their own, the Department of Irrigation provides assistance. To date, there have been no major problems with this operation.

3.4.4 Financial Aspect

Budgetary measures for the maintenance of the irrigation facilities that have been established are taken according to the jurisdiction of the Department of Irrigation, ZINWA, and IMC. The Department of Irrigation has established a maintenance fund for irrigation schemes in the country. The fund is financed by a collection of 150 USD/year/hectare from farmers in irrigation areas and inputs from the Ministry of Land, Agriculture, Fisheries and Water Rural Development. The Manicaland Province office of the Department of Irrigation estimates the amount of money needed for the maintenance and management of the Nyakomba Irrigation Scheme, and when the budgetary request is submitted to the Ministry, the requested amount is divided and distributed and necessary budget for the maintenance and management of the irrigation facilities is secured for now. The budget allocation for pump maintenance to ZINWA is estimated by multiplying the previous year’s water supply to Nyakomba irrigation Scheme by the unit cost (2.06 USD/Mega Liter). Because of the low unit cost of water for irrigation, the budget allocation based on this estimation does not provide sufficient financial resources for maintenance. On the other hand, since the unit cost of water used for mining and commercial purposes is high, the income from these is added to the irrigation budget as a subsidy, as a result, currently the allocated budget meets the necessary amount for maintenance. The financial situation of IMC, which is responsible for the management of the canals downstream of the farm pond, has been stable, with about 90% of water fees paid and collected since the introduction of irrigation, as farmers’ income has increased. To secure additional financial resources, each block has contract farming

block-by-block, and the income from contract farming can be utilized for maintenance and management expenses.

3.4.5 Environmental and Social Aspect

There were no specific negative environmental or social impacts that were confirmed at the aforementioned impact (3.3.2.2) and were not anticipated at the time of planning.

3.4.6 Preventative Measures to Risks

Since March 2023, electricity supply has been stable at around 95% of maximum supply¹⁴. In addition, the Nyakomba irrigation area is supplied with electricity from a nearby small hydropower plant, resulting in a more stable supply. In case of a power outage during the day, ZINWA's pump operators respond by running pumps at night so that irrigation is not affected. In addition, the government of Zimbabwe installed a power grid to the area at the timing of the irrigation scheme installation in Nyakomba. At the time of the ex-post evaluation, the government of Zimbabwe was promoting wheat production by prioritizing electricity supply to irrigated farmland where wheat is grown, and Nyakomba was one of the target areas. As for prospects for future supply in Zimbabwe, which have been suffering from power shortages, the *National Renewable Energy Policy* (August 2019) states that the country aims to secure electricity from renewable sources in addition to hydropower, solar and other sources are actively being deployed.¹⁵ The executing agency also reported that the Zimbabwe Electric Supply Authority has made capital investments and that the power generation system is showing some improvement.

3.4.7 Status of Operation and Maintenance

As far as the field survey was concerned, no serious damage was found in the newly constructed and renovated facilities. When there were problems, they were able to be repaired or managed by the responsible agencies. Specifically, among the items reported for repair during the defect inspection, the malfunction of the water intake sensor cable in Block D had recurred. The malfunction causes the pump to automatically shut down, so the operator in charge of ZINWA visually checks the water level each time and operates the pump manually. It is confirmed that the technical team at ZINWA's Nyanga Service Center conducts regular inspections of the pump station twice a month, and repairs are made as necessary to ensure proper maintenance and management. Appropriate repairs were also carried out using the techniques acquired during the capacity-building training. One of the problems observed during the ex-post evaluation was the accumulation of sediment at the water intake. The water intake of Block A had the most

¹⁴ Power outage occurs around 8 hours per week.

¹⁵ URL https://www.zera.co.zw/National_Renewable_Energy_Policy_Final.pdf (accessed August 23, 2023).

accumulation of sediment. This was caused by the water flow near the intake. ZINWA and farmers are dealing with the problem by removing the sediment, and when heavy machinery is needed, they request the assistance of the Department of Irrigation.

The newly installed pumps in Blocks A and D in this project are intrusion-type ones that are relatively easy to operate and maintain and have the advantages of convenient starting operation and low risk of failure due to fewer auxiliaries. In addition, the axis of the pumps is horizontal, which is more economical and easier to maintain. Also, the existing pumps in Blocks B and D have a horizontal axis, which ZINWA engineers are familiar with its operation. It should be noted that the existing pumps in Blocks B and C are the pumping-up type, slow starting, have a higher risk of failure than the intrusion type, and may be more expensive to maintain.

Slight issues have been observed in the operation and maintenance of the project; however, they are managed by routine operations. Therefore, sustainability of the project effects is high.

4. Conclusion, Lessons Learned, and Recommendations

4.1 Conclusion

The objective of this project is to ensure a stable supply of irrigation water to the target area to installing new irrigation facilities and rehabilitating existing ones in the Nyakomba irrigation area, Manicaland Province, and thereby contributing to improving the agricultural productivity of smallholder farmers in the area.

The project is in line with the development policy of the government of Zimbabwe, which emphasizes food security and the development of irrigation facilities, and there is a high demand for development in the target area, where the rainfall and the percentage of irrigation land owned by smallholder farmers are low. This project is also consistent with Japan's development cooperation policy in Zimbabwe, which aims to stabilize food production and improve the livelihoods of smallholder farmers, and specific cooperation with other JICA projects and assistance were confirmed. Therefore, its relevance and coherence are high. In terms of efficiency, the cost for the land leveling and VAT refunds in the total cost borne by the government of Zimbabwe exceeded the plan. The overall project cost, including the Japanese side, slightly exceeded the plan. The project period exceeded the plan, mainly due to the time required to divide equipment procurement and facilities construction into lots at the time of detailed planning and the result of a review of the construction period considering the rainy season. Therefore, its efficiency is moderately low. The irrigated developed area and actual production values of the top-three crops in the project achieved the targets; however, the cultivating area was slightly short but generally close to the target of the quantitative effect. The qualitative study confirmed that 1) the food supply in the target area was stabilized and profitable crops were introduced to be linked with the technical cooperation project, 2) the executing agency and related agencies including the

water user's association members, acquired skills in the maintenance, and management of irrigation facilities, 3) actual crop production values and the number of harvests per year increased, and 4) the quality of life was improved through increased income. Positive impacts were also observed, such as the reduced burden of water-fetching labor for women and children and improved nutritional status due to the better availability of sufficient subsistence crops and other food sources. Therefore, the effectiveness and impacts of the project are high. In terms of sustainability, there are no particular concerns regarding the institutional, structural, or technical aspects of the executing agency, the Department of Irrigation, ZINWA, IMC, and AARDS. In addition, there have been no major problems with budget allocation and the operation and maintenance on the irrigation facilities developed by the project. Therefore, sustainability of the project effects is high.

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

4.2 Recommendations

4.2.1 Recommendations to the Executing Agency

The land leveling of Block A, which was one of the outputs on the Zimbabwe side at the time of planning, had been completed for 50 out of 146 hectares at the time of the ex-post evaluation (June 2023). In the Minutes of Discussion (July 2015) prior to the start of the project, the land leveling was planned to start after the completion of irrigation construction, and no deadline was set for the completion of the work. Despite the Department of Irrigation's willingness and efforts to complete land leveling, progress has been slowed by high fuel costs, heavy machinery deployment, and timing constraints on the work. Farmers dug their own canals and established a system of irrigation from earthen ditches in areas that had not yet been leveled; however, some farmlands were not able to irrigate, and there were also concerns about soil erosion based on the contour lines. To distribute irrigation water from the canals to all farmlands as described above, it is recommended that the Department of Irrigation make a work plan and heavy machinery deployment plan, secure fuel, and complete the leveling of farmlands in Block A by the end of the year 2024.

4.2.2 Recommendations to JICA

It is recommended that the JICA Zimbabwe Office follows up the progress of the land leveling by the Zimbabwe side until the completion of the land leveling work with regular monitoring on the implementation status according to the work plan.

4.3 Lessons Learned

Importance of Ensuring Appropriate Operation and Maintenance Systems for Irrigation Facilities Based on Consensus

Cooperation between the executing agency, the Department of Irrigation, and other related agencies such as ZINWA and IMC, as well as the financial resources for maintenance and management, has been confirmed. To ensure an adequate maintenance regime in the Nyakomba Irrigation Scheme, the Department of Irrigation, ZINWA, and IMC agreed on the ownership, securing stable budgets, and operation and maintenance of the irrigation facilities, and clarified the scope of responsibility. Specifically, ownership of the irrigation facilities downstream of the farm pond is vested in the Department of Irrigation, maintenance is vested in IMC, and ownership, operation and maintenance of the pump station, headrace, and farm pond are vested in ZINWA. Although AARDS, the organization involved in this project, does not have a specific responsibility and budget for the maintenance and management of irrigation facilities, it plays an important role as a liaison between farmers and the government, including the details related to irrigation facilities, and contributes to improving farmers' incomes by supporting contract farming, thus indirectly contributing to the payment stability of the water fee and maintenance fees paid to IMC.

In view of the above will enable transparent, smooth, and long-term maintenance and management of irrigation facilities by clarifying the responsibilities and making use of social capital at the community level based on consensus, in terms of maintenance, management, and finance, when multiple related organizations are involved.

5. Non-Score Criteria

5.1. Performance

5.1.1 Objective Perspective

The former Individual Advisor (Irrigation Development Management Advisor) disseminated information through journals and blogs with the aim of presenting this project as a good practice at TICAD VII.

5.1. Additionality

None.

(End)

Column: Applications of Satellite Data

Regarding irrigation area in Nyakomba, Zimbabwe, it is required to spatially grasp whether irrigation was functioning as of 2021 after the project completion and to quantitatively evaluate if the area available for irrigation has been reached the target value originally planned for the project. Therefore, by using satellite data, the evaluator classified the area where irrigation systems developed in the project were functioning (irrigated areas) and where they were not functioning due to some troubles such as water leakage (non-irrigated areas). In addition, we carried out on-site investigation at those irrigated and non-irrigated fields classified by satellite data, inspected if irrigation was functioning, and interviewed residents to identify the cause of misclassification.

The specific study sites, data used, analysis methods, and results are as follows:

Irrigated Blocks developed in the project (Blocks) A to D (total area of 580 hectares with 760 households) of the Nyakomba irrigation area located in the Nyanga District of Manicaland Province, Eastern Zimbabwe, were selected as study sites. Figure 1 shows the locations and names of the irrigation districts developed by this project.

For the analysis, optical satellite data, Sentinel-2¹⁶, were used. To check whether irrigation was functioning as of 2021, satellite data for two periods in 2021 were obtained: data in the rainy season (April 8) and in the dry season (June 27). Then, to calculate the area of Block A to D, digital data (GIS data), including cultivated fields in each block, were created and used for analysis. The digital data were created referencing cultivated fields reported in “*The Feasible Study on the Nyakomba Irrigation Development Project.*”

For the analysis, data on vegetation (NDVI) and soil moisture (LSWI) were created using the satellite images. Then, by assuming irrigation is functioning at locations where vegetation is dense or the moisture content in soil is high, we classified the areas developed in the project into irrigated and non-irrigated areas (Figure 2). Based on these results, the evaluator conducted

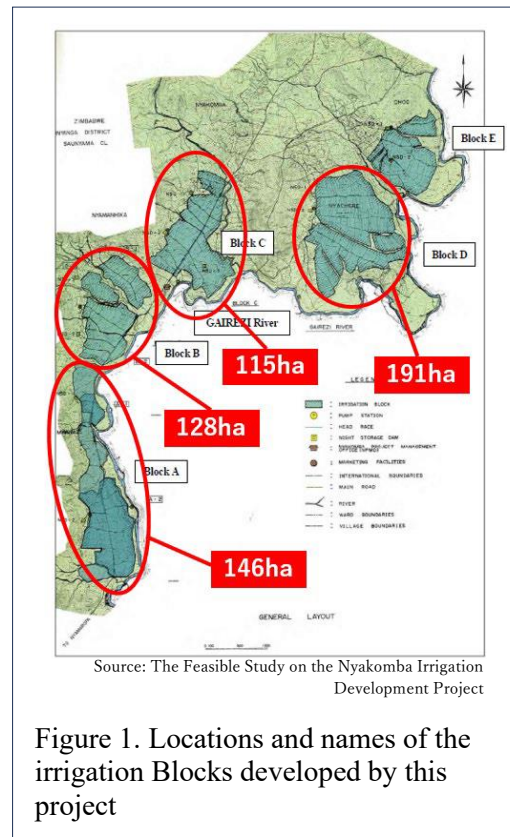
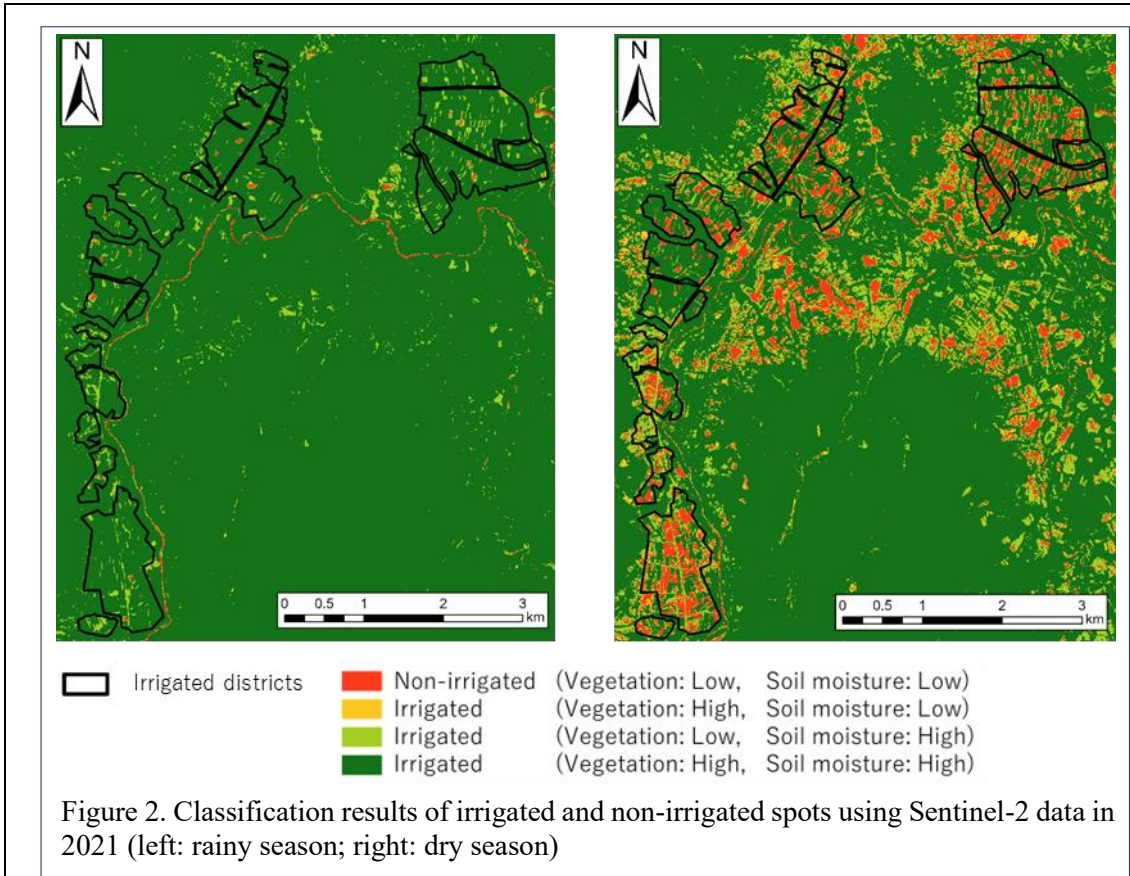


Figure 1. Locations and names of the irrigation Blocks developed by this project

¹⁶ Sentinel-2 MSL Level-2A data (spatial resolution of approximately 10 m for visible and near-infrared bands, 20 m for shortwave infrared band) were used. The data were obtained from the European Space Agency's (ESA's) Copernicus Open Access Hub.



a field survey and investigated the actual states of irrigation in irrigated and non-irrigated areas classified by satellite data, respectively. In areas where a misclassification was observed, we carried out interviews on the condition of the field to find out the cause. Finally, it was evaluated that if the actual irrigated area reached the target value originally planned for the project based on classification results by satellite data and the results of the field survey.

In the classification results from satellite data analysis, several non-irrigated spots were observed in the dry season (Figure 2). Therefore, based on the classification result of the dry season, we selected 36 irrigated spots and 18 non-irrigated ones and conducted field surveys in these areas (total of 54 areas). As a result, irrigation was functioning at all 36 spots classified as irrigated areas. In addition, we found that irrigation at 18 spots classified as a non-irrigated area was being unused temporarily due to the conditions of the fields, such as those being recently harvested and those under land leveling work. Thus, we confirmed that in all the 54 spots, including areas classified as non-irrigated ones despite development, irrigation was functioning without any problems such as water leakage.

The total irrigated area was estimated from the satellite data of each block and compared with the planned value stated in “*The Feasible Study on the Nyakomba Irrigation Development Project.*” Areas classified as non-irrigated ones based on satellite data analysis were not excluded from the estimation because field surveys showed irrigation was just being unused in

those areas. As a result, the irrigated area estimated based on satellite data analysis exceeded the originally planned value stated in the report. The reasons for that are thought to be that irrigation has been implemented outside the project or that the area was overestimated due to the coarse resolution of satellite images. Nevertheless, by considering the satellite data-classification results, field survey results, and estimated irrigated area, it is suggested that irrigation is mostly functioning in Blocks A through D of the irrigated districts in Nyakomba, and it has been decided that the irrigated area meets the requirements set in the development planning phase.

Thus, utilizing satellite data is useful as qualitative and quantitative evaluation indicators during on-site surveys as they enable a comprehensive, advanced understanding of the land use of the area.