Research article

Comparison of Land and Water Improvement Projects and the Water Management System between Japan and Nigeria

DAYYABU MUHAMMAD ZAHARADDEEN
Graduate School of Agriculture, Tottori University, Tottori, Japan

KATSUYUKI SHIMIZU*
Faculty of Agriculture, Tottori University, Tottori, Japan
Email: shimizu@muses.tottori-u.ac.jp

YUMI YOSHIOKA
Faculty of Agriculture, Tottori University, Tottori, Japan

Received 19 December 2016 Accepted 11 May 2017 (*Corresponding Author)

Abstract Food security is strongly linked to water security. Irrigation is recognized as a means to substantially increase agricultural productivity. Consequently, the Food and Agriculture Organization indicated that 75% of agricultural growth required in Nigeria by 2025 would have to result from intensification, with the remaining 25% resulting from arable land expansion. However, the total water demand in Nigeria was estimated to be 5.93 billion cubic meters (BCM)/year in 2010, which is expected to increase to 16.58 BCM/year by 2030. Irrigation water demands will increase from 30% to 40% under minimal utilization. Accordingly, as irrigated agriculture is likely to be promoted and expanded, there is a need for appropriate on-farm water management of the available water resources to avoid the potentially alarming problem of water shortage. Water improvement projects and the management system were described through a comparative study to investigate the major differences in water management systems. The aim was to formulate equitable and effective water management practices that can improve water use and increase food production in Nigeria. In this study, some major differences identified between Japan and Nigeria were the procedure for the development of water improvement projects; system of operation, management, and maintenance; and the relationship between water managers and farmers, which were found to be bottom-up and top-down processes, dependent and independent, and mutual relationship and individuality, respectively. A realistic solution to improve the Nigerian water management system has been proposed through an in-depth analysis based on a questionnaire and interview survey.

Keywords on-farm water management, water user association, water scarcity, Nigeria

INTRODUCTION

Food security is strongly linked to water security. Irrigation is recognized as a means to substantially increase agricultural productivity. Consequently, the Food and Agriculture Organization (FAO) indicated that 75% of agricultural growth required in Nigeria by 2025 would have to result from intensification, with the remaining 25% resulting from arable land expansion (FAO, 2005).

This will probably have to be achieved with reduced water use; this is particularly because agriculture is the major user of water, accounting for approximately 40% of a country's water resources. Accordingly, if irrigated agriculture is aggressively promoted and expanded, there is a need for appropriate water management of available water resources to avoid the potentially alarming problem of water shortage.

However, the total water demand in Nigeria was estimated to be 5.93 billion cubic meters (BCM)/year in 2010, which is expected to increase to 16.58 BCM/year by 2030; irrigation water demands will increase from 30% to 40% under minimal utilization (Sanyu Consultants Inc., 2013).

The irrigation potential estimated in Nigeria varies from 1.5 to 3.2 million ha. The latest estimate provides a total irrigation potential of approximately 2.1 million ha, of which approximately 1.6 million ha can be realized from surface water resources and 0.5 million ha from groundwater resources. During the oil boom in the 1970s, an investment program in support of public irrigation was launched. Public irrigation in the Nigerian context translates to schemes run by River Basin Development Authorities.

The schemes that were developed have not yet been fully operationalized, or they have been implemented with inappropriate infrastructure and management processes. By 2004, only approximately 20% of the area planned for public sector irrigation had been developed and only 32% of the developed area was being irrigated.

The poor utilization of the developed irrigation area in the public irrigation sector in Nigeria can be attributed to a number of factors. These include 1) the lack of a coherent irrigation subsector development policy and strategy; 2) insufficient attention to management systems; 3) inadequate funding (including poor cost recovery); 4) high capital and operating costs; 5) inadequate farm support services; 6) poor operation, repair, and maintenance of irrigation facilities; 7) a low level of project ownership acceptance by direct beneficiaries; and 8) uncertain financial and economic viability. These factors result in inequity and inefficient water management practices, consequently resulting in a number of these schemes deteriorating considerably; these schemes are now in urgent need of major renovation and repair, less than 20 years after their inception (FAO, 2005).

Under the system of Land Improvement Districts (LIDs) in Japan, which are farmers' autonomous irrigation associations with total responsibility for irrigation system management, Japanese water management is one of the successful forms of participatory irrigation management (PIM) (Ishii and Satoh 2003). Therefore, the introduction of the basic ideas of LIDs to the irrigation management of large-scale projects in Asia, Africa, and Central and South America may be effective to improve their irrigation management (Minami, 2002).

Hence, successful knowledge transfer is important in anticipating future failures or difficulties in land and water improvement projects and the management system in Nigeria. This will assist in discussing how to adopt improved options for better agricultural production and sustainability. The objective of the present study is to investigate problems, causes, and solutions associated with the water improvement projects and the management system in Nigeria through a comparative study between Japan and Nigeria.

METHODOLOGY

Study Site

The Hadejia Valley Irrigation Project (HVIP) is one of the biggest public irrigation projects in Nigeria, and it considerably contributes to agricultural food production. This project is located in the Hadejia Local Government Area of Jigawa State, between the Hadejia River and its tributaries in the northern part of Nigeria. The average annual precipitation in Hadejia (project location) is 595 mm. The initial area proposed for development under the HVIP in the late 1970s was 12,500 ha under Phase I (Fig. 1), which consisted of stages I and II; however, work has not yet started on Stage II. Stage I was constructed in different steps; however, this stage remains incomplete. Stage I has a total command area of 5,300 ha, divided into 19 sectors (15 constructed, 4 unfinished) with 6,000 farmers cultivating approximately 90% rice and other crops such as maize and vegetables.

The major water source for the project is the Hadejia River, on which two dams (Tiga and Challawa dams) are situated at the upstream site, and the Hadejia Barrage is situated at the downstream site, which supplies water to the northern main canal through the feeder canal by gravity.

Although, land consolidation is yet to be done in HVIP unlike the Japanese land which undergoes a land consolidation to improve performance and productivity of the farmlands (through Land Improvement act 1949), making it into a regular shape for easy use of machineries and paddy rice cultivation. However, the standard agricultural lot in HVIP is 4 ha while it is 0.3 ha in Japan.

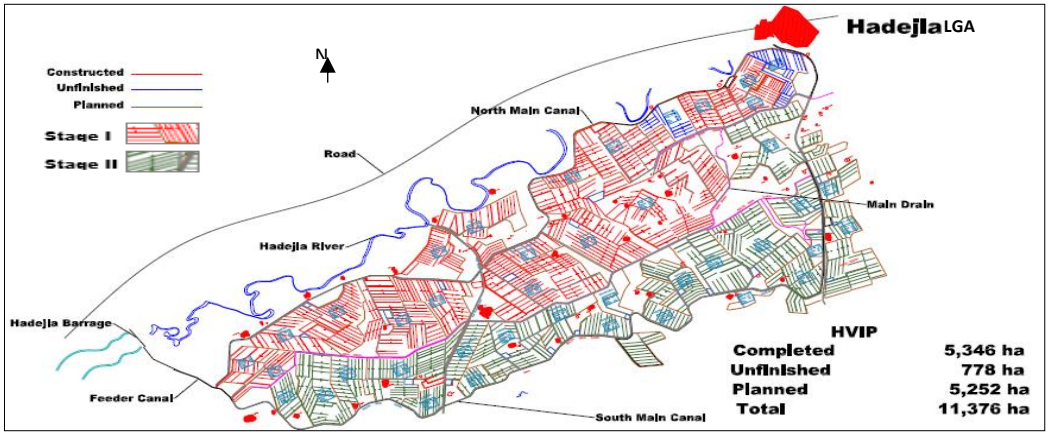

Fig. 1 Layout of Hadejia Valley Irrigation Project (HVIP) phase I (stages I and II)

For the purpose of comparison, the Toyogawa Irrigation Project in Aichi Prefecture, Japan, which is part of the Toyogawa Water Resource Development Project that was established in 1968, was selected as the study site. This project is one of the most successful modern water resource development projects in Japan. The study project covers newly developed irrigation areas of 16,000 ha (paddy: 5,000 ha, upland: 11,000 ha). This command area includes traditional paddy irrigation areas. The average annual rainfall is approximately 1,700 mm/year (Japan Meteorological Agency, 2016). However, dry spells in the region sometimes extend to 1 month; therefore, it is impossible for farmers to realize stable agricultural production without irrigation. The major water source is the Toyo River, and supplemental water originates from the adjacent Tenryu River basin. The Toyogawa Water Resource Development Project also encompasses the Ure and Ohshima dams in the upstream part of the Toyo River (Kono et al., 2012).

Data Collection and Analysis

A comparative analysis of land and water management systems between Japan and Nigeria was conducted through 1) a questionnaire and interview survey, 2) a literature review, and 3) field investigations in both Japan and Nigeria. A total of 36 farmers, consisting 12 farmers each from the upstream, mid-stream, and downstream sectors of the HVIP in Nigeria were randomly selected to answer the questionnaire, which contained 37 open ended and 10 close ended questions both related to water availability, the irrigation system, organization for water management, and the method of operation and maintenance cost of the scheme. The questionnaire was structured for easy understanding of water user activities for water management and to determine the opinions of farmers regarding the equity of water distribution and operation of irrigation facilities. Interviews were conducted with four project supervisors from Hadejia Jamaare River Basin Development Authority (HJRBDA) staff and the three zonal office staff, and 15 officials of Water User Associations (WUAs) from all sectors, to obtain detailed information regarding the performance and structure of WUAs, organizations for water management, water allocation planning, operation and maintenance system of

the facilities, and PIM in the HVIP (Nigeria). In addition, field visits to the study projects were conducted to visualize the scheme and to gain access to farmers to obtain information and answers to questionnaire structured for the study. However, after the analysis on irrigation water allocation, the project should be operated to achieve the purpose of fair water distribution among the entire beneficiary farmers. Thus, the WUAs and farmers will manage the irrigation facilities, as a result, the struggled and complained over inadequate water at the downstream will be resolved and farmers become more satisfied with the irrigation system.

In Japan, an interview with the head of Japan Water Agency (JWA) office in Kagawa Prefecture was conducted, where we discussed the operation of water resource systems (reservoirs, diversion dams, regulating reservoirs, and main canals) and their operation and maintenance arrangement. This was followed by a field visit to observe and understand what had been discussed. However, literature reviews containing detailed information concerning the Toyogawa Irrigation Project in Japan were also assessed for the comparison.

RESULTS AND DISCUSSION

Organizations for Water Management

According to the questionnaire and interview discussion, the organization currently responsible for water management in the HVIP is the HJRBDA, which is a public unit established to manage public irrigation schemes within state boundaries in Nigeria, and its zonal office, which assists the HJRBDA in the management of the HVIP. The HJRBDA is the agency responsible for the overall operation and maintenance of the main irrigation facilities (main and lateral canal and the drainage system including the Tiga Dam, Challawa Dam, and Hadejia Barrage). The zonal office manages on-farm facilities and also coordinates with farmers for the collection of water fees. A community of WUAs was formed, which assist the zonal office in collecting water charges and control certain secondary and tertiary canals. Although some members of the WUAs assist the zonal office, 60% of farmers interviewed at the downstream sector complained of inadequate water distribution during the maturity stage of their rice crop, whereas 90% of farmers at upstream and mid-stream sector were satisfied with the water distribution, although they were not involved in the management process. This shows that the participation of WUAs in partnership with the zonal office is poor, which leads to inequitable distribution of water among the farmers.

In the Toyogawa Irrigation Project in Japan, five types of organizations are involved in the water management of the project, which have different functions to ensure equity and fair management: 1) the JWA, which is a public entity that manages the construction project; 2) Toyogawa LID, which is an autonomous irrigation association of farmers established for the Toyogawa Irrigation Project; 3) local LIDs, which are established based on the administrative boundaries of cities or towns; 4) Management Districts, each of which corresponds to a traditional local community; and 5) Management Groups, which are established by beneficiary farmers of an on-farm irrigation facility (all LIDs are established after agreement by 2/3 of the beneficiary farmers). All these organizations are assigned roles in water management according to the level of a facility, from main to on-farm level. The JWA manages the main infrastructure of an irrigation facility (reservoirs, diversion dams, and regulating reservoirs) and main canals and is also responsible for delivering water to lateral canals. The Toyogawa LID manages lateral canals and diverts water to farm ponds. The Toyogawa LID staff patrol farm ponds daily to assess stored water, and they adjust the allocation of water to lateral canals as required. Local LIDs assemble requests from Management Districts and request water from the Toyogawa LID according to the need. Local LIDs, Management Districts, and Management Groups manage farm ponds and on-farm facilities in a group. Management Group leaders in a Management District adjust the water distribution among themselves (Kozuki, 2000).

Therefore, in the Toyogawa Irrigation Project, it is evident that farmers are responsible for the management of their irrigation; most farmers are categorized into different groups (Toyogawa LID, local LIDs, Management Districts, and Management Groups) and are assigned a certain responsibility to ensure equity distribution and fair management of the irrigation project. In contrast, in the HVIP, farmers are not responsible for the management of irrigation, and only certain selected WUAs assist the zonal office. To solve the problem of inequitable water distribution among farmers, water managers (the HJRBDA and zonal office) should be assigned to manage the construction of the project and the farmers should be divided into different groups, with each group assigned the responsibility of managing a different level of irrigation facilities. This will assist in resolving the inequitable and unfair distribution of water among farmers in the HVIP as was achieved in the Toyogawa Irrigation Project.

Water Allocation Planning

The result of the questionnaire and interviews shows that in the HVIP, the zonal office of the HJRBDA controls water gates from the dam (Hadejia Barrage) to main canals by constant releasing water at a fixed amount of 10 m^3/s (this is now the maximum carrying capacity of the main canal), which is a decreased amount from the actual designed capacity of 15 m^3/s. However, water allocation planning is completely absent from the zonal office, and only farmers (WUAs) arrange their water planning for distribution to the secondary and tertiary canals based on their experience, without any investigation on the water demand of each sector. This causes improper water planning and inequitable water distribution, resulting in the upstream water users using more water and in dissatisfaction by downstream water users, as stated by 60% of farmers at the downstream sector during interviews. The current water supply method in the HVIP is shown in Fig. 2.

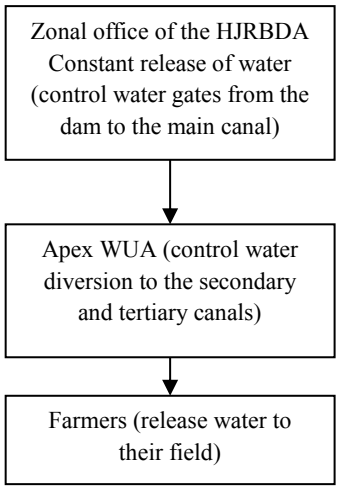

Fig. 2 Water supply method in the Hadejia Valley Irrigation Project

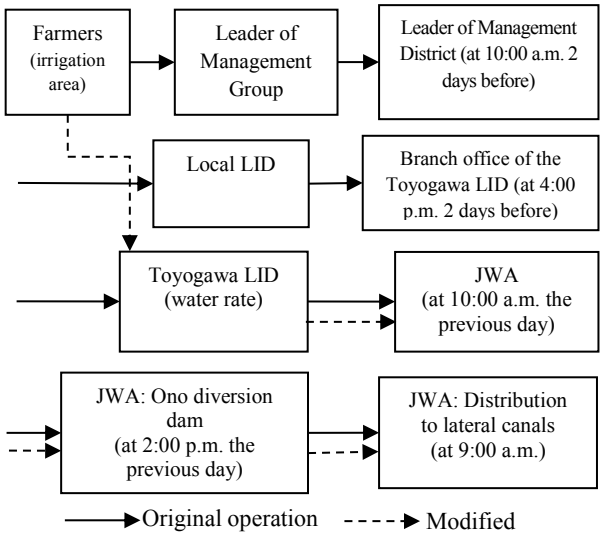

Fig. 3 The original and modified water allocation method and distribution process in Toyokawa irrigation project

In the Toyogawa Irrigation Project, some in-depth studies have been conducted to determine the water demand of each sector and a simplified process was established to meet the water demands of farmers following the process depicted in Fig. 3, which reflects the original water distribution method applied to the project. The water demand was calculated based on the declared daily irrigation area by farmers. The total area of irrigation was conveyed through the LID's hierarchical system, converted to

a flow rate, and forwarded to the JWA. Because of the long procedure and resulting complaints by farmers, the water allocation and distribution system was improved to avoid this complicated procedure and the problems it induced. In the new system, the first four steps in the previous system are disregarded, and the Toyogawa LID branch offices take the first step to request water on behalf of farmers.

Therefore, water demand studies in each sector (upstream, mid-stream, and downstream) of the HVIP are important to avoid water conflict among upstream and downstream water users and also to determine whether the amount of water released is sufficient to irrigate crops or if there is a need to reconstruct or rehabilitate the main canal to meet the capacity of the water requirement identified. Again, after investigating the water demand, the water managers (the HJRBDA and zonal office staff) should simplify guidelines and support their procedures by providing proof of logical and technical information and also explain the effect of over-irrigation on crops and agricultural lands such as water logging and salinization problems to avoid the overconsumption of water by farmers. Likewise, water allocation plans in the HVIP should be decided in meetings attended by all delegates from different interest groups (beneficiary farmers, the HJRBDA, zonal office authority, and Chad basin management office). This will assist in achieving equitable distribution and improved understanding of the importance of appropriate water allocation planning among farmers which will increase the amount of water utilized effectively for irrigation and ensured water availability to all farmers.

System of Operation and Management Cost of Irrigation Facilities

From the result of the interviews and the field visit to the HVIP, farmers and water managers said government is responsible for the construction, operation, maintenance, and management costs of irrigation facilities; however, it was found that proper system operation is currently not possible at all levels of the systems. The main findings are that 1) operation and management (O&M) of the facilities has long since fallen to a level below what is required; 2) the water fee (0.4 $/ha) collected is insufficient to maintain the irrigation facilities, even when considering the amount provided by the government to cover the O&M cost of the irrigation facilities; 3) the systems are currently in such a technically poor condition that rendering proper system operation at most levels is impossible; 4) there has been a substantial loss of command area; 5) a weakened organization responsible for O&M has not been able to rectify the situation; and 6) farmers have developed mistrust in the HJRBDA's capacity and capability to perform its maintenance duties for which they are supposed to pay.

All costs for water management in the Toyogawa Irrigation Project are covered by beneficiary farmers. The Toyogawa LID assists the JWA in the collection of money from farmers. The membership fees are based on acreage as well as on the land use of paddy or upland fields. The JWA, Toyogawa LID, local LIDs, Management Districts, and Management Groups form a hierarchical system corresponding to facility levels and operate in an environment of functional role sharing in the Toyogawa Irrigation Project. In this environment, a directly interested organization is not allowed to operate independently, and instead, a higher level of organization is assigned responsibility. In this way, it is easy to distribute water in a fair and neutral way following the decisions made. It is difficult for farmers or farmers' organizations to operate modern, large-scale, complicated irrigation facilities as specialized knowledge and skills are required. Therefore, role sharing in the facility operation of a large-scale irrigation project is inevitable. In addition, a bulletin is periodically distributed by the JWA to every member farmer, thereby supporting the understanding of the state and functions of facilities and the processes of water management by every farmer, which includes the decisions, operation, monitoring, and feedback (Satoh, 2003).

Therefore, for the sustainability and proper performance of the operation and management of the HVIP, the water fee to be collected from farmers should be adjusted and added to the budget provided by the government for the operational and management costs of the project to enable the budget to fully cover the operation, management, and maintenance costs of irrigation facilities, under the

supervision of a higher organization (HJRBDA). In addition, the government should disseminate information regarding how the fee collected was used for the operational, management, and maintenance costs of the facilities and also the status of irrigation facilities to local farmers. This will encourage farmers to contribute to management and operational costs. All related organizations should be assigned specific roles within operation and management at different levels of the facilities. By this practice, costs will be reduced and a physical transparency system of the operation and management of facilities will be implemented that will encourage beneficiaries to contribute to the operational and management costs for achieving the sustainability of the project.

CONCLUSION

The main points analyzed for the HVIP to develop an appropriate system to achieve water improvement and management practices include the following;

1) Involvement of farmers in management organization in such a way that farmers are categorized into different groups (e.g., HVIP WUAs, local WUAs, Management Districts, and Management Groups) and assigned a certain responsibility to ensure equitable distribution and fair management of the irrigation project.

2) Water demand studies for water allocation are important in the HVIP to determine the demand in each sector to avoid water conflicts among water users in the upstream and downstream sectors. The water demands should be decided in meetings attended by all delegates from different interest groups.

3) The water fee to be collected from farmers should be adjusted and added to the budget provided by the government for the operational and management costs of the project to enable the budget to cover the operation, management, and maintenance costs of the irrigation facilities, under the supervision of a higher organization (HJRBDA).

Therefore, the adoption and implementation of the identified processes of land and water improvement projects and the management system in the HVIP will play an important role in enhancing the equitable distribution of irrigation water. Similarly, this will enable a system of physical transparency of operation and management of irrigation facilities for better water use in Nigeria.

ACKNOWLEDGEMENTS

This study was conducted under the project titled “Development of crop husbandry technology in marginal rain fed environment using dryland plant resources” by Tottori University.

REFERENCES

FAO. 2005. Irrigation in Africa in figures. AQUASTAT Survey, Nigeria.

Ishii, A. and Satoh, M. 2003. PIM, Journal of Rural Planning Association, 22 (3), 239-240.

Japan Meteorological Agency. 2016. Meteorological statistics, http://www.data.jma.go.jp/obd/stats/etrn/index.php

Kono, S., Ounvichit, T., Ishii, A. and Satoh, M. 2012. Participatory system for water management in the Toyogawa Irrigation Project, Japan. Paddy Water Environment, 10 (1), 75-81.

Kozuki, R. 2000. Japanese case. In Kuroda (ed) Management of Irrigation Systems, The Japan Association for Irrigation and Drainage Mechanization, Tokyo, 199-202

Minami, I. 2002. Public irrigation scheme development and management in Japan, Country case studies on irrigation institutions. The 6th International Seminar on Participatory Irrigation Management, Beijing.

Sanyu Consultants Inc. 2013. The study on the “National Water Resources Master Plan of Nigeria 2014”. Federal Ministry of Water Resources, 4, 4-18.

Satoh, M. 2003. Principles for participatory irrigation management by organized farmers. Keynote Speech at the 3rd World Water Forum JBIC-JICA Session Report "Sustainable and Efficient Use of Irrigation System & Water, and Farmers' Participation", 1-9.