Planning to develop infrastructure for rice production

A presentation for “Promotion of African Rice Development through strengthening coordination between CARD and CAADP for SSA Countries”

FUJIMOTO, Naoya
NTC International Co., Ltd.
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1. Key points to plan rice field development

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1-1. Introduction

Figure 1: Aspects considered to successfully lead rice production projects. Source: Author
1-2. Key elements for developing infrastructure

- (a) Temperature
- (b) water resource
- (c) Soil condition
- (d) Shape of the land
(a) Temperature

- Temperature isn’t a killer-factor (Fujimoto et al., 2013).
  - Hokkaido, average monthly temperature of which is ranging from -4.6 degree (in January) to 21.7 degree (in August)

- **Special treatment**: such as introducing low-temperature tolerant species.

- **Counter-measure**: such as keeping deep water in the paddy field during the nights.
(b) Water resource (rainfall)

- Rainfall is indispensable to start rice production.

- 400mm in rice cropping season for upland NERICA is needed (Kitanaka, 2010).

- 800mm & 1,300mm of annual average rainfall (AAR) are threshold volume for rice production (Fujimoto, 2005).
Figure 2-1: Relation between precipitation and rice cropping ration in China
Source: Fujimoto, 2005

\[ y = 0.0767x - 30.086 \]
Figure 2-2: Relation between precipitation and wheat cropping ratio in China
Source: Fujimoto, 2005
(c) Soil condition

• Soil condition is sometimes more critical than other elements.
  – In Africa, lack of Magnesium (Mg), Phosphate (P), Sulfite (S) and Zink (Zn) have already reported (Takahashi, 2008).

• Adding Burkina Faso phosphate rock (BPR) is effective for rice yield (JIRCAS, 2014).
Figure 3: Effect of BPR direct application on lowland rice yield in Ghana
Error bars: Indicating standard error (n=3). Soil pH in each site were as follows, Site 1; 5.60, Site 2; 5.83, Site 3; 4.53, Site 4; 5.70.
Source: JIRCAS research highlight 2013
(d) Shape of the land (slope)

- Flood-plain area are usually installed with big-project facilities to convey much water for both irrigation and drainage.
  - but large scale irrigation projects have implementation problems of cost (Sakurai, 2008).

- Concerning the slope of the land, slope area is recommended for Sawah * system (Fujimoto, 2013).
  - since gravity irrigation is easier to be applied there than flood-plain area where irrigation water runs highest part of the command area or runs through pipe-lines.

* Sawah is a Malay language same meaning to Asian-type paddy field.
1-3. Planning style

• Top-down method
  – If you plan the rice field development by top-down method, it is very challenging. Although project could get results faster, but provability of failure is large.

• Bottom up method (see 2-2-5. Farmer’s participation)
  – If you plan, instead, the rice field development by bottom-up method considering field reality, Japanese experience is very useful to understand successful implementation.
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2-1. Characteristics of project planning and implementation in Japan

(2-1-1) Roles of Land Improvement District (LID)

(2-1-2) Planning and designing of new projects
Figure 4: Water disputes among farmers over distribution and allocation in a period of water shortage
2-1-1 roles of LID

- LID is the farmer’s organization clearly stated in the Land Improvement Law (LIL, effective on 6th June 1949), and to maintain facilities constructed. When the new project is started, it also plays important roles.

- Also, triangle structure is observed all over Japan for agricultural activities in Japan. These 3 are (i) LID, (ii) Farmers Association (FA) and (iii) governmental institutes.
Farmers Organization

Post harvesting, Agro-technique, Fund

Land Improvement District (LID)
Water management

Planning Projects

Government

Producing new scheme, Planning Projects

City Level

Figure 5: Triangle structure for agricultural activities
Figure 5: Triangle structure for agricultural activities

- Government: Producing new scheme, Planning Projects
- Land Improvement District (LID)
- Farmers Organization Agro-technique

Prefecture Level
Farmers Organization

Post harvesting, Agro-technique, Fund

Land Improvement District (LID)

Water management

Government

Producing new scheme, Planning Projects

Figure 5: Triangle structure for agricultural activities

Land Improvement District (LID)

Farmer Organization

City Level  Prefecture Level  State Level
(2-1-2) Planning and designing of new projects

• When an application of a new project by farmers arrives to governmental institute, planning and designing the project will be implemented by a government organization of each level according to the size * of the project.

  * LIL describes a state operated project should be more than 3,000ha and prefecture's one more than 200ha.

• Several years later, the project will be implemented by the government of each level.

• Management of facilities is carried out by several bodies (Figure 6, Photo 1, 2).
(1) ------ Assignment under Article 94-3 of the Law (conditional assignment).
(2) ------ Assignment under regulations (rules under the Local Government Law and Subsidy Budget Rationalization Act).
(3) ------ State-operated management by petition under Article 85 of the Law.
(4), (5) -- Entrusted management under Article 94-6 Paragraph 1 of the Law.
(6) ------ Entrusted management under Article 94-10 of the Law or regulations.
(7), (8) -- Requested management under Article 93 or 96-4 of the Law.
(9) ------ Management under Article 57 of the Law (Obligation to manage of executing body for construction).

Figure 6: Management system of irrigation/drainage facilities.
Source: Nishimura, K. (1997)
Photo 1: The Ano Dam O&Md by Mie Prefecture. Photo taken by author.
Photo 2: The Hokuzan Dam O&Md by LID. Source: Leaflet of Saga LID.
2. Japanese experience

• 2-1. Characteristics of project planning and implementation in Japan

• 2-2. Typical irrigation system in Japan
2-2. Typical irrigation system in Japan

• (2-2-1) Water source
• (2-2-2) Calculation of water needed in the project
• (2-2-3) Subsidies or farmers cost sharing system
• (2-2-4) On farm irrigation project
• (2-2-5) Farmer’s participation
2-2-1 Water source

- Typical water source for irrigation in Japan is river. Water resources including river water are considered to be public property in Japan, but there have been many water conflicts between several organizations on usage of irrigation water (Fujimoto, 2003).
Figure 7: Typical Irrigation System in Japan
2-2-2 Calculation of water needed in the project

• Firstly calculate water volume needed in a particular field inside a project area.

• If we cannot, we must assume it, consulting experience of other projects nearby and/or similar to the project.
Water Cycle on Paddy Field (Figure 8)

- The water cycle on a paddy field involves various processes, including precipitation, transpiration, evaporation, ponding water release, and irrigation water provision.

- Key features of the diagram include:
  - Ponding water release at -660mm
  - Precipitation leading to +900mm
  - Transpiration leading to -600mm
  - Evaporation leading to +1,800mm
  - Horizontal percussion (Return flow) at -1,080mm
  - Vertical percussion at -360mm
  - Irrigation canal and horizontal percussion at +1,800mm

- The diagram also highlights invisible water flow and visible water flow through the plow layer and subsoil.
2-2-2. Calculation of water needed in the project (cont.)

1. Enough irrigation water requirement
   - to provide appropriate volume of irrigation water
   - to every paddy field
   - within expected time.

2. Consider functions of agricultural water
   - included in the project.
Figure 9: Aggregation of water requirement on project planning.
Multiple roles of Agricultural Water

Figure 10: Multiple roles of Agricultural Water
Source: Author modified from an internet info. of MAFF in 2002
2-2-3. Subsidies or farmers cost sharing system

- The cost of land improvement projects are born by the central government, prefectures, municipalities and LID (see Table 1 in JIID 2007).

Table 1: Standard cost bearing ratios in national and prefectural irrigation and drainage project (in the case of paddy fields).

<table>
<thead>
<tr>
<th>Body</th>
<th>State operated projects (more than 3,000ha) %</th>
<th>Prefecture operated projects (more than 200ha) %</th>
</tr>
</thead>
<tbody>
<tr>
<td>State (MAFF)</td>
<td>66.6</td>
<td>50.0</td>
</tr>
<tr>
<td>Prefecture</td>
<td>17.0</td>
<td>25.0</td>
</tr>
<tr>
<td>Municipalities township etc.)</td>
<td>6.0</td>
<td>10.0</td>
</tr>
<tr>
<td>Organization (LID etc.)</td>
<td>10.4</td>
<td>15.0</td>
</tr>
</tbody>
</table>

Source: Guidelines for On-farm Irrigation Development and Management in Monsoon Asian Countries (JIID, 2007).
2-2-4. On farm irrigation project

Standard layout of facilities and farm plots in an OFID project in Japan is shown in the figure below.

![Diagram of farm irrigation layout]

**Figure 11:** Standard layout of facilities and farm plots in an OFID project in Japan
2-2-5. Farmer’s participation

- Participation of farmers is essential for on-farm irrigation development (OFID).

- In Japan, each area of a farm village has been on the base for an autonomous and voluntary agreement system established on the well-accepted community-first principle through the long history of a rice culture.

- Based on the situation, the water management system has been formed.
2-2-5. Farmer’s participation (cont.)

- Final judgment of project design needs to be studied and decided by the mutual consent of farmers, engineers and government officials.

- Engineers need to (i) have an adequate understanding of farmers’ needs, (ii) appropriately explain the advantages and disadvantages of various choices (the alignment and structure of canals, the structure and material of incidental facilities of water use, etc.) and (iii) provide information such as available budgets, farmer participation in construction and the necessity of O&M activities (JIID, 2007).
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• 3-1. Step-by-step development
  – Several information that help you develop rice production

• 3-2. Challenges
  – Other information useful when first step of development provides fruitful results.
Figure 12: Development stage of rice cultivation techniques
Source: Author
3-1. Step-by-step development

- (3-1-1) Most reliable measure to be implemented for development of rice production is to upgrade infrastructure, since it will help farmers reduce cost of transportation as well as up-lift income (Sakurai, 2008).

- (3-1-2) Effective use of local resource may enable developing up-land rice production in Africa (Kobayashi, 2008).

- Returning biomass to the field after harvested is important, since soil fertility is critical for rice production in Africa, especially in West Africa (Takahashi, 2008).
3-1. Step-by-step development (cont.)

- (3-1-3) You must seek **effectiveness of land use** for rice production by small farmers to contribute to development of crop production in Africa (Nanya, 2008).

- (3-1-4) It has been noticed that more than 60% of target farmers applied project techniques **after three years of demonstration** (JICA et al., 2014).

- (3-1-5) In Ashanti Region, Ghana where the validation study by JIRCAS was conducted using **Asian-type paddy field development**, some farmers have already enjoyed a twofold increase of rice yield to **4.2 ton/ha** whereas traditional practice produced only **2.0 ton/ha** (JIRCAS, 2011).
Note: Accessibility

• It is obvious that the farmers near by could decide their mind after looking good sites and talk to the farmers engaged in the sites,
  – You should carefully choose the site in a view of accessibility.
  – One of the reason JIRCAS contained accessibility into criteria of selecting validation study sites was this (Fujimoto et al., 2013).

• The demonstration plot should not be located in isolated area, but be accessible to farmers (JICA et al., 2014)

• Good access from a car-running road is important as well for farmers if they carry power tillers into project sites (Fujimoto et al., 2013).
Photo 3: Road-side site in Togo, Jchekounicope, a Japan funded SMART-IV project site (August, 2014).
3-2. Challenges

- (3-2-1) (i) Examining critical timing of shortage of water resource for rice production, (ii) shifting some activities to better timing and (iii) strengthening research activities are key issues to find appropriate cultivars that can survive under drought condition (Nemoto, 2008).

- (3-2-2) You could implement large scale irrigation projects for rice, after you’ve (iv) reviewed previous outcome of researches, (v) examined problems raised and (vi) carefully decided future prospect on such projects in your country (Nanya, 2008).

- (3-2-3) Land ownership is one of key elements to lead the irrigation project successfully (Oka et al. 2013).
References


References (cont.)


Thank you very much.