PROMOTING PARTICIPATION FROM BENEFICIARIES IN IRRIGATION MANAGEMENT- THE CASE OF THE DAPINGDING AREA IN NANTOU COUNTY, TAIWAN

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ABSTRACT

Irrigation and drainage facilities are the foundation of agricultural development, such systems if well planned and maintained play an important role in achieving high crop yields. Nevertheless, implementing such systems is as important as integrating agricultural technologies with production-marketing systems, setting up distribution systems, and establishing brand image for each dedicated agriculture industry zonewhich are all important policy directions for future agricultural development.

A testament to the aforementioned policy is a new irrigation expansion program initiated by Nantou Irrigation Association for the Dapingding area in Nantou County. The irrigation and water storage system for the area was first established with subsidies from Taiwan's central government. A water use group was formed within the irrigation association, in which farmers who receive water participate in water allotment practices. The government also helped the Association by setting up a monitoring and management system for flows of irrigation water. In the past two years the program has achieved its key objectives. In addition to stabilizing local irrigation water delivery, the program which resulted in income increases in the area has also attracted many younger expatriates to move back. The program has become an important case for evolution of agriculture and irrigation in Taiwan.

Keywords: Beneficiary Participation, Public Pipeline Irrigation System, Irrigation Monitoring System.

1. INTRODUCTION

Taiwan has in recent history seen adversities in agriculture, such as low operating efficiency associated with prevalent smallholder farming and the exodus of the younger generations from rural communities that result in lack of labor force for agricultural operations. To promote agricultural transition, current agricultural policy-making has shifted towards cross-field co-operations. In addition to incorporating implementations of agriculture-related policies, invigorating the private sector is also one of the foci. As the competent authority for Taiwan's agriculture, the Council of Agriculture, Executive Yuan (hereafter referred to as the COA) has in recent years taken a multitude measures to address the above issues. Among the most important are integrating new and existing irrigation systems, promoting participation from stakeholders, marketing oflocal agricultural harvests and processed products, and creating agriculture industry clusters based on local irrigation systems.

The business involving irrigation and drainage is the cornerstone for the agriculture industry and is pivotal for its prosperity. A well-built system of those facilities can not only elevate production efficiency, but lower the risks from natural disasters. In last 400 years, Taiwan has built systems of irrigation and drainage that comprise conduits

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of almost 70,000 kilometers in length was developed, for which a dual management system by both the local irrigation association and farmers wasestablished, for each irrigation district. To create agriculture industry clusters as a measure to address current issues, the COA has implemented a new policy to mandate expansion of irrigation coverage into the 360,000-hectare farmlands (about 55% of all food crops production areas) previously not covered by any local irrigation association's service. Which of these non-irrigated farmlands are to be included in the expansion is based on whether or not the specific land is in environmentally sensitive zone, is feasible to deliver water, has good topographic condition, is growing the kind of crop that qualifies under the irrigation policy, etc. This expansion has added 4,454 hectares to irrigation coverage since 2017. The results are summarized in Table 1.

Table 1. Results of Taiwan government's efforts in expanding irrigation coverage into previously unirrigated farmlands from 2017 to 2019

Year	Irrigation Association	Newly covered area (in hectares)	Area subtotal (in hectares)
2017	Nantou	231	1,858
	Hualien	798	
	Taitung	828	
2018	Yilan	31	2,164
	Kaohsiung	425	
	Hsinchu	53	
	Pingtung	144	
	Hualien	1,509	
2019	Nantou	392	432
	Taitung	40	
Total area covered by irrigation systems currently (in hectares)			4,455

Though increased irrigation coverage is certainly a highlight of this new policy, the intentions behind a policy like this are to promote agricultural policies in general and to improve the quality of rural life. Therefore, while formulating this policy, the COA was in the meantime laying out three principles for future policy making.

First, irrigation is to be in alignment with policies for food crops: Ever since Taiwan's admission to the WTO, its agriculture industry has been in keen global competition. As a result, the proportion of all cultivatable farmlands used for rice cultivation needs to be adjusted. Under the "Land-focused Green Environment Payment Plan" that was implemented in 2018, farmers are encouraged to switch to growing or contract farming other water-saving crops, such as non-genetically modified soy beans and corns. Given this context, the food crop policies tend to set higher priorities for dryland farming and growing crops with higher economical values. In addition, there has been a trend for local governments to set up various dedicated agriculture industry zones to promote local agricultural speciality products. In order to have a synergy effect among government resources, when planning future irrigation expansions, the COA would take into account current food crop policies and local specialties so as to give priorities to key sectors.

Second, there is a need to promote water-saving crops: Despite the fact that the water consumption by Taiwan's agricultural sector appears to be moderate compared to world average, irrigation water usage is still under stress and in competition from other industries due to change in economic structure and global climate change. This is made worse during the droughts, when domestic and industrial water supplies are given higher priorities as these two sectors have lower tolerance to water stress than agriculture, and many farmlands would have no choice but to keep fallow. Therefore, new policies are needed to promote water-saving crops.

Third, there is a need to vitalize rural agricultural communities and promote participation from farmers in public affairs: Taiwan's rural agricultural communities have been facing two dire situations; i.e., the lack of labor force and aging population. To overcome these, a well-planned irrigation system shall be built first for the area and the combined supports from local governments and related policies, altogether improve the production-marketing systems, resulting in rejuvenation of the local agriculture industry and attraction for younger farmers. The irrigation management practices shall have participation from farmers so as to reduce waste of water and solidify the effects of infrastructure investments.

The Dapingding (Nantou) case proves to be the most iconic among all cases associated with this policy in the previous year. In this case, the Central Government works with local irrigation association to construct irrigation facilities, while farmers conserve water with the help of a data-driven water allotment system, as well as taking part in the irrigation management practice by joining the water use group within the association. Such participation features made the case a paradigm of success for the COA to plan for future farmland irrigation improvements.

2. CASE STUDY: THE DAPINGDING DISTRICT, NANTOU IRRIGATION ASSOCIATION

2.1 Geographical Description

The case discussed in this paper is located in the Dapingding area in Puli Township, Nantou County (See Figure 1), which is encompassed within the boundary of Nantou Irrigation Association's Dapingding District. Geographically, this area is a plateau within the Puli basin with altitudes ranging from 450 m to 730 m. The plateau stands alone in the basin and has no surface water sources. This makes it impossible to convey external waterfor irrigationinthe area with only gravity flows. The topographic conditions also make it expensive to bring in irrigation water from outside. Originally intending to irrigate the plateau with water from Neng-Gao Canal that is the major surface water source for farming around the basin, owner Nantou Irrigation Association failed to materialize the plan due to disagreement in cost-sharing among the beneficiaries.

Figure 1. Geographical description of the Dapingding case

The Dapingding area has a mild climate, perfect for growing all types of crops, and is particularly known for daikon, loofah, ginger, yam, passion fruit, and grape harvested in summer. There is already a fully developed irrigation pipeline system for dryland farming. More than ten production-marketing companies have been established, including production cooperatives, farms, production and marketing groups, and marketing cooperatives.

A survey revealed that before the irrigation service expansion, about 70% of farmlands used groundwater for irrigation, for whichsome used shared wells, some used exclusive wells, and the rest had no access to any well. In addition, about 20% used surface water, and about 10% had no specific water sources. Pumping groundwater as the main irrigation source is typically associated with issues such as high electric bills, falling water table, groundwater depletion and high costs of drilling deep wells, which greatly increase the risks in farming operations.

After receiving petitions from local farmers about water supply problems, Nantou Irrigation Association, with the support of COA's irrigation expansion policy, began the planning for the Dapingding irrigation expansion project, which, after completion, would cover an additional newly irrigated area of 624 hectares, including 232 hectares in Stage 1 and 392 hectares in Stage 2, as shown in Figure 2.

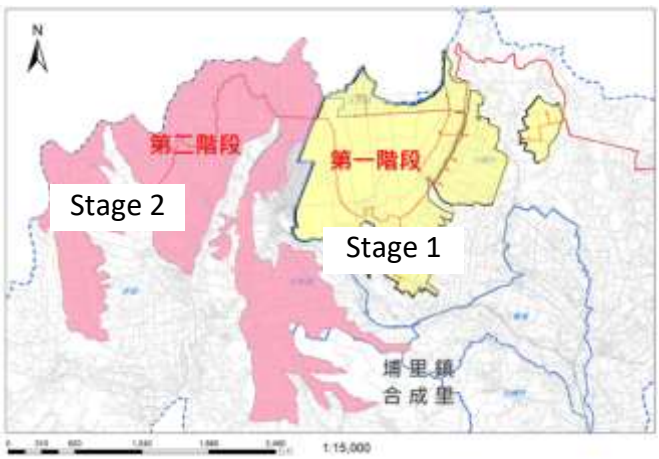


Figure 2. Map showing the irrigation expansion areas and irrigation lines in the Dapingding Irrigation District

2.2 About the project

The Neng-Gao Canal draws water from Jiuhsian River and Guandao River, some 16 kilometers from Puli, using a gravity-fed system that includes tunnels and flumes to convey water to Rongkeng before bifurcating into the East Branch that sends water to Puli via an inverted siphon, and the West Branch that sends water along the Rongkeng foothills via concrete channels and flumes to Dapingding, the project area.

The construction of the project was done in two parts. The first part was to build a gravity-fed main (about 3,620 m), which begins from the original terminal of the West Branch of Neng-Gao Canal on the east side of Xian Road (Station 2+400). The main includes a siphon and retention ponds, and follows the originally planned Canal alignment into the project area. The second part was for the branch pipelines (about 2,000 m to Beiliao Irrigation Area and about 1,500 m to Taiping Elementary School)

and related distribution facilities as well as connection points for farmers. On higher grounds, storage ponds and towers were also built.

3. Governance based on innovative collaboration- discussion on stakeholder participation methodology

3.1 About the management system employed in Dapingding case

3.1.1 Design for the dual water management system

After completion of the expansion project, the facilities were handed over to Nantou Irrigation Association and the newly served areas were incorporated into Association's service areas. The Association set up the DapingdingWork Station for the operations and maintenance of the new facilities. In addition, a water use group was formed to oversee the management of irrigation practices. The meters mark the dividing points for responsibilities: The Association is responsible for the operations and maintenance of pipelines, storage and other facilities, whereas the farmers are responsible for everything downstream of the meters. The responsibilities structure is depicted in Figure 3.

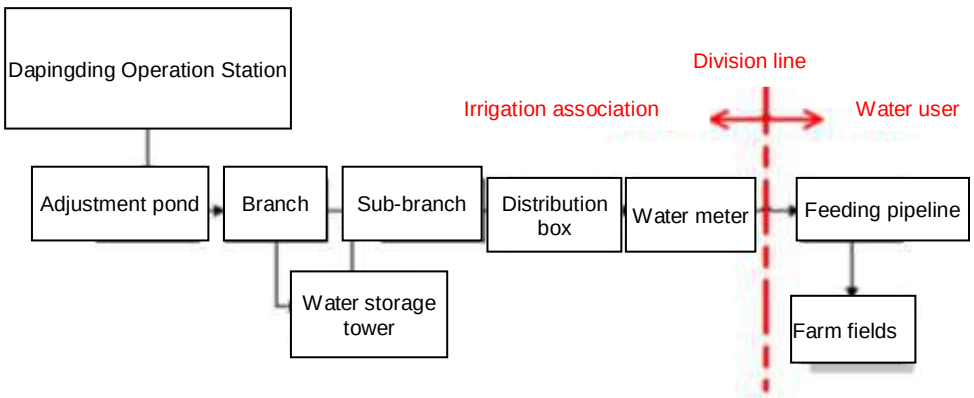


Figure 3. Division for responsibilities over facility management

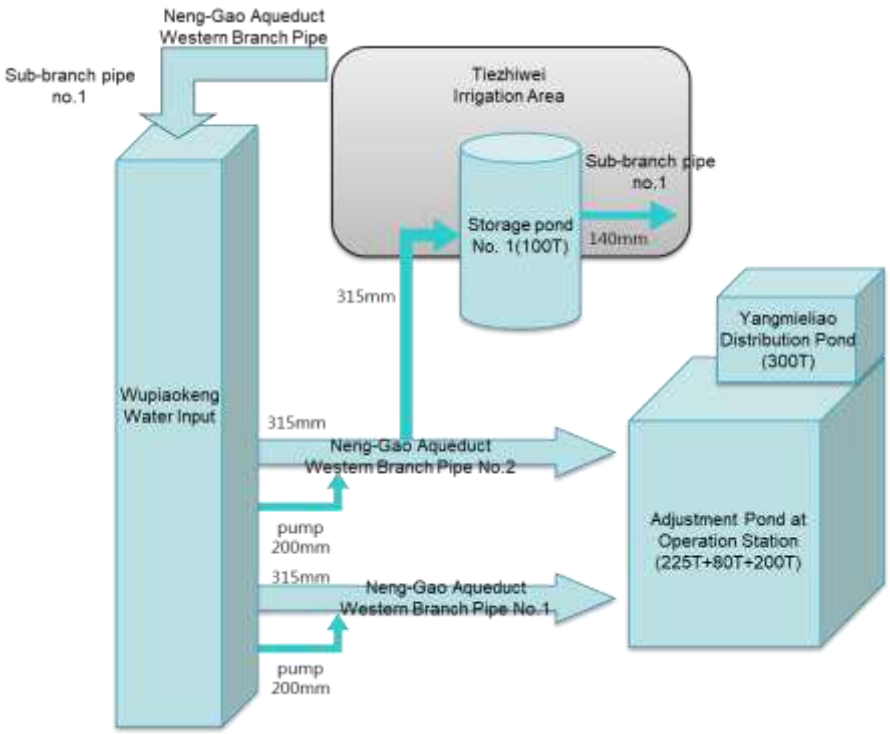
3.1.2 Water is billed according to The Irrigation Water Pricing Standard for the Dapingding District, and all Association members work together to conserve water

The Dapingding area is water-stressed. To address this, Nantou Irrigation Association set up a pricing structure for the area, which was approved by the COA. The bill includes a flat fee in addition a unit charge based on actual usage. For gravity-fed water, the flat fee is NT$50 per month, and the charge is NT$5 per cubic meter. If the water delivery involves pumping, the flat fee is NT$100 while the charge is either NT$7 per cubic meter if the pumping head is 30 meters and below or NT$9 if the head is up to 60 meters. For the deliveries for which water is pumped more than 60 meters, the actual bill will then depend on the situation, and will be different from case to case.

To ensure the stability of the water delivery systems and the dynamic equilibrium for retention and storage ponds, the Association sets up an information system which employs automatic controls, PLC and graphic control technologies in aiding water management as well as monitoring water flows at all key locations throughout the Association's jurisdiction.

The information system for the Dapingding District can separately monitor the gravity distribution system and the pumped distribution system. The Dapingding system includes Pumped Retention Pond No. 1 and Pumped Retention Pond No. 2. Water level signals are transmitted to the work station via fiber optic cables and are used for dynamic control for the intakes and effluents of the ponds. With this dynamic flow control, every drop of water can be utilized effectively.

The water level signals are processed at the graphical control center by either remote logic control (preset automatic control) or remote computer control (manual control on computers), as shown in Figure 4. Remote logic control directs the operations of all water pumps at the retention ponds based on water levels, as shown in the figure, allowing effective control on water transfer and distribution. Through the water management information system already in operation, the Association can send important notices to customers in real time. During water shortages, this information system can also serve as an information clearing house to coordinate conservation and rotational irrigation measures.



3.2 Cross-field governance and cooperations mechanism: Creating innovative agriculture through water usages

3.2.1 Deregulation mandated by government

The irrigation service within the boundary of any irrigation association's jurisdiction is for members only. Previously, to become a member and thus to apply for a farmland to have the association's new irrigation service, a farmer would have needed to gather consenting votes from more than half of the association's existing members in addition to approval from the board of trustees. This made new membership and new irrigation service quite difficult to obtain. To address this, the COA promulgated an executive order in 2016 titled "Operational Procedure for a Non-Irrigated Farmland to Be Incorporated into Irrigation Association's Service Area." By this order, new

memberships no longer require consents of half of all members; instead, it now requires the consents of half of all land owners in the proposed area to be included for new irrigation service or if the applicant owns over half of the total area. If the Association still cannot reach a consensus to approve the new membership, the COA can override Association's decision and approve the inclusion if necessary.

3.2.2 Integration of resources among agricultural offices and institutions

(1) Agricultural research and extension stations: Taichung District Agricultural Research and Extension Station, one of the affiliates of the COA, released a technical document titled "General Cultivation and Management Techniques for Passion Fruit" in 2017, which includes topics such as cultivation techniques, soil and fertilizers, diseases and pest management, budgeting, etc. It provides a detailed guidance for the farmers to learn the state-of-the-art farming techniques specifically tailored for passion fruit.

(2) Agriculture and Food Agency: Good agricultural practices are sets of standard methods for agricultural production and processing that aim to create safe and wholesome food. To make sure the passion fruit industry is sustainable, COA's affiliated Agriculture and Food Agency has also specified good practices, including production flow charts, risk management, and checklists.

(3) Farmers associations (FA) provides guidance for processing of passion fruit as a secondary industry: Passion fruit farmers can receive guidance and assistance from their local FA to process the harvest as a secondary industry such as producing juice, jelly, etc., and to market their products through e-commerce outlets. The FA also works in close liaison with local governments to promote the passion fruit industry as part of the tourism programs, so as to add values to the products and to establish the brand image as a local specialty.

Figure 5 above shows the concerted efforts by the governments, brought about by the integration of new irrigation and agricultural policies, which have successfully created a passion fruit farming and industry cluster in the Dapingding area. The stable delivery of irrigation water has greatly lowered risks in managing agricultural business, which in turn has triggered the return of expatriated young farmersand hence created an important opportunity for agricultural transition in Taiwan.

Technical document on cultivation and management for passion fruit released by Taichung District Agricultural Research and Extension Station

Local FA provides supports for the farmers to process the harvest and commercialize their products

Commercialized processed passion fruit products and the online marketing platform

Marketing passion fruit products at a tourism event sponsored by local government

Figure 5. Concerted efforts from governments for promoting the passion fruit industry in the Dapingding Area

CONCLUSION

An irrigation-based agriculture industry zone that is to be the model for future policy-makings

New agricultural policies in Taiwan are now more important than ever as the agriculture industry is at a pivotal moment for transition. In the case presented in this paper, the central government removed tight restriction for an unirrigated farmland to acquire new irrigation serviceand invested in the infrastructure to make the irrigation expansion come true. It then assisted local irrigation association to set up new pricing structure and to develop a new information system for effective water management. Through the forming of the water use group within the management organization, in which irrigation beneficiaries are members, the water allotment practices now have participation from water users. Also, success stories such as a business cluster based on establishment of an irrigation system, the integration of all agricultural and food policies, creation of the brand image of a dedicated agriculture industry zone for a local specialty, and invigoration of rural communities due to return of expatriated younger generations are testaments of a good policy, which can serve as a model for future policy-making efforts.

There are two priorities which should be focused:

4.1 Successful integration of cross-field cooperation mechanisms as an important prerequisite for promoting investment in irrigation facilities

If the operation of irrigation facilities must be maintained by the charging system, it is often difficult to operate continuously due to the fluctuation of farmers' income, which is influenced by policies. Therefore, when investing in relevant irrigation facilities, the integration among Agriculture and Food Agency, local government and relevant agricultural research institutes should be done first.

After creating the local farm industry, the farmers' income can be ensured and the development of irrigation facilities as well as technology can be facilitated in the next step. The satisfaction of water usage by farmers can be improved and they are encouraged to participate the management system. At last, the charging mechanism can be implemented. The core for sustainable operation of this case is through the promotion of cross-field cooperation.

4.2 To meet the agricultural transition policies, the participation of farmers in irrigation should be enhanced toraise the efficiency of water usage

In recent years, Taiwan’s government haspromoted agricultural transition policies and will continue to collaborateeachauthority from upstream to downstream. The priority is to increase the efficiency of water usage in the field of irrigation.Throughcooperation with farmers, the actual need of water usage can be reflected as well as applying innovative technology to achieve the goal.

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