

# **New Asset Management Approach to Sustainability of Participatory Irrigation Organizations — A Case Study in Taiwan**

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## **ABSTRACT**

Taiwan's irrigated agriculture in the aftermath of admission to the World Trade Organization has been increasingly struck by impacts. Areas of irrigated crops and irrigation service are menaced to be shrinking, which implicates less revenue to the concerned irrigation associations (IAs). Resources of Taiwan's IAs, principally the membership fees, have been perpetually inadequate and will become worse for adequate asset management (AM), mainly the operation and maintenance of irrigation and drainage infrastructure. The Government has annually given subsidies to IAs for AM on account of maintaining national food self-sufficiency. In view of their coming financial dilemma due to the Government's declining subsidies, the IAs are trying to adopt new approach to expand the scope of their AM to boost revenues, through effective and efficient utilization of assets. For instance, the Chianan IA has diversified the functions of one irrigation-purposed reservoir to purposes of water supply, tourism and small-scale hydropower generation. In this paper, only the last one invested by the IA was taken for case study. The new power plant, as of May 2003, had been operated for 15 months, but only four months to its full capacity, which is far less than as expected. This paper noted the main constraint leading to the phenomenon. However, from the long-term view, the prospect of this new project is deemed promising.

**Keywords:** Asset management, irrigation service, irrigation operation & maintenance, membership fees, B-C ratio

## **1. INTRODUCTION**

Taiwan, the small island country with the world's most dense population, has nowadays become one of the newly developed economies. Agriculture, previously Taiwan's keystone of social structure and economy, is today among the weakest enterprises in terms of gross domestic product (GDP) due to rapid progresses of industries and commerce. Although the agricultural production values have been generally on the growth over the past years, their percentages among the yearly GDPs have been gradually decreasing.

However, being the root of the nation's development, the agriculture sector has been always well protected by the Government. Taiwan's phenomenal economic growth began about 30 years ago. Its industrial and trade progresses and decreasing rural manpower have caused the agricultural sector in the GDP in Taiwan to become among the smallest. Yet to keep the storage of staple to safely supply the domestic people for sustenance of their livings in the minimum duration, Taiwan's people and Government therefore have been determined to sustain the agricultural development. This is viewed from the fact that, besides maintaining the traditional function of producing crops, agriculture also serves other two functions of

maintaining livings and ecology.

Food crop production in Taiwan is dominated by farmers who are a great majority of small farmholders (< 1.0 ha). After Taiwan joined the World Trade Center (WTO) in January 2001, the nation's foreign trades including agricultural products are subject to gradual internationalization and liberation. This has been bringing severe blow to local agricultural development, and hence a certain extent of further reduction of irrigated farmlands will be unavoidable, besides the steady need of agriculture lands from the new industrial projects and urbanization. Consequently, the strategies for agricultural development including the irrigation asset management (AM) aspect in Taiwan are in need of due adjustment to meet the challenges of emerging dynamic changes in agri-business.

In Taiwan nearly all the existing irrigation and drainage (I&D) infrastructure and registered water rights for irrigation systems are the main assets of the irrigation associations (IAs), which have been long renowned with participatory irrigation management (PIM). And the Government only renders the role of supervision and guidance in this regard. The AM of I&D infrastructure is entirely implemented by respective IAs with insourcing and outsourcing, financed by own resources, although the Government usually provides subsidies and special funds for respective IAs for procurements of major works and special equipment. Depending on the characteristics of the activities and works of AM, the insourcing and outsourcing will be applied to.

Conventionally the IA annual revenues are membership fees (MFs) collected by each IA in line with laws and regulations concerned. MFs are charged on area size basis, and the Government, on the grounds of maintaining the staple rice prices as low as practicable to allow most people to be affordable to purchase, always controls the MF rates. Due to Government's policy of this coupled with that of lowering farmers' burdens of farming costs, the IAs are not permitted to charge MFs on cost plus basis. So besides saving costs of AM, they have to find new sources of funds by themselves, because they cannot totally rely on Government's subsidies that are also limited.

Many years ago, the management of Chianan IA, one of Taiwan's IAs, were aware of the tendency of agricultural sector growth, and hence its implications to the IAs. They then began trying other businesses than the traditional one – irrigation service by means of AM. For instance, Chianan IA has been engaged in sale of raw bulk water available from an irrigation-purposed reservoir to the water supply company and later in tourism at the scenery and landscape of the reservoir as well as its surroundings. In view of the success of these additional businesses, the Association then in 1980s planned to use the available hydraulic energy from the discharges released from the same reservoir to generate and sell electricity to the power company, which was in pressingly need of expanding electricity generation to meet the growing demand of the nation due to prominently growing industries and economy.

This paper briefed the new AM strategy undertaken by Chianan IA in small-scale hydropower generation development project as a case study. The contents include the backgrounds and development process of the project, and operation mode and initial performance of the completed project.

## **2. GENERAL ASSETS OF CHIANAN IRRIGATION ASSOCIATION**

The Chianan IA possesses the largest asset among the IAs, consisting of water resources as

stated in the water rights registers, irrigation infrastructure such as the Wusantor reservoir, Chianan Irrigation Main System, drains, irrigation ponds and deep wells; research and experiment facilities, lands, office compounds, etc. Its service area presently covers about 78,000 ha farmlands, including especially about 68,000 ha irrigated by the Wusantou reservoir, spreading in four counties and cities in south Taiwan.

The association's I&D infrastructure consists of, according to categories, are as follows: irrigation systems - main canals of 1,257 km including 0.88-km tunnel channels, and ancillary structures - 7,870 units of regulators and 22,720 units of others, and tertiary canals of 8,970 km; drainage ditches - 18,971 km; reservoirs/ponds - 28 numbers; and pumping stations - 46 numbers. And the water resources registered with water rights are between 29.943 cms for December and 229.363 cms for September, with a monthly average of 104.877 cms. It possesses also the lands of about 667 ha that are not used for I&D infrastructure and appurtenant structures.

All the items of assets are recorded in the asset registers (ARs) of the association's databank. And the situations of the systems together with irrigated farmlands are periodically monitored with GPS as well as GIS, supported with routine patrols and periodical inspections. The data serve as the basis for consideration of maintenance requirements of infrastructure: maintenance, repair/replacement, rehabilitation/renovation, improvement, and modernization.

### **3. NECESSITY TO RENOVATE IRRIGATION ASSOCIATIONS'S ASSET MANAGEMENT**

Due to the weak situation of present and future agricultural environments in Taiwan, the management and performance of IAs lost its brilliance as they were before. Moreover, because of the general public's less enthusiasm in agriculture sector, the importance and necessity of irrigation aspect to the people is diminishing. Also, the irrigation undertaking encounters difficulty caused by the thrust of changing social and economic development. These situations are really worrisome.

However, for economically and environmentally sustaining the national development, the Government still views that it is necessary to maintain the nation's crop production and hence irrigation service area at some minimum level. The Government reasoned the multi-functions of irrigation as well as paddy fields : the groundwater can be recharged with irrigation water through the paddy farms irrigated, biological diversification maintained by the paddy fields and their surroundings, flood peaks reduced by the vast ponds of paddy fields, green-belt landscapes presented along the canals and ditches, and others; in addition to the food crop production, the major function.

As such, the Government in promulgation of the Cross-century Agricultural Policy has contained the Program for Adjustment of Uses of Paddy Fields and Rainfed Farms, to specially take care of the gross area of paddy farms and concerned irrigation associations. According to the Program, the IAs of Taiwan have to strengthen and renovate AM, upgrade service levels, and actively participate in the nation's comprehensive economic development including diversification of the functions of I&D infrastructure for acquiring additional revenues for their respective budgets. These are the opportunities for the IAs to re-energize their vitality, especially for Chianan IA that serves the farmlands mostly located in the typical agricultural region of Taiwan.

#### **4. EXPERIENCE IN BUSINESS DIVERSIFICATION**

As mentioned previously, Chianan IA has been long squeezed by the resources constraint due to comparatively lower incomes of farmers members. Originally it tried hard to collect revenues, in addition to MFs, from supply of additional irrigation water to farmers in need of more water than planned, and from charges to the non-irrigation purposed customers using the facilities of IA to convey the bulk water to the destinations they requested.

Then, in 1950s and 1960s, it started contemplating diversification of its businesses through more effective AM including the water resources registered, irrigation infrastructure, lands, and also the human resources it employed. The new businesses ever proposed by the association comprised, among other projects, rural banking service, cement industry, and tourism. However only the tourism project at its Wusantou reservoir has been approved by the Government, whereas the others were rejected on the grounds of their irrelevant to irrigation water or infrastructure. The tourism project was realized and commenced operation by the IA in 1969. But this kind of management did not produce any profits for the association until 1999 when the business was entrusted to a qualified contractor and further in 2000 a water-friendly park was built at the tourist compound.

But it is noticed that, beginning from 1960s, there has been an undertaking obliged to be done as instructed by the Government: to allocate some amount of water for irrigation to local water supply company. For this, compensation was annually paid to the IA by the bulk water buyer. The compensation amounts have since then become the additional revenues of the IA. And from 1970s, the Government has agreed the IA, as well as other IAs, to dispose of its land lots no longer used for I&D purposes, but based on local market prices, as a source of its incomes.

Having sensed the more urgency to raise its own financial sources, in 1990s when anticipating the nation's admission to WTO, Chianan IA again proposed a new project for such a purpose. Chianan IA, as the major investor, co-financed in 2000 of a small-scale hydropower plant development project by using the hydraulic energy from the Wusantou reservoir. The plant commenced operation in August 2002. And its business deems quite promising, in view of its market potential. About the processing of the hydropower project is further described in the following section.

#### **5. PROCESSING OF THE SMALL-SCALE HYDROPOWER DEVELOPMENT**

Hydropower is the cleanest renewable energy. Its electric generators, during operation, do not pollute air and water, nor consume water. Meanwhile, the Government's national energy target, which sets that by 2020 this nation's renewable energy supply will reach over 3 % of the total.

In view of these background reasons, the Chiana IA management thought it would be appropriate to execute a small-scale hydropower plant development project, which would utilize the water head differences available at the outlet of the Wusantou reservoir belong to the IA. As such, the IA completed in 1986 the feasible planning for the project, which concluded the project was technical feasible and economic viable (B-C ratio about 0.05).

Legally the project was reviewed and permitted in 1994 by the cabinet's Council of Agriculture (COA), the competent authority for irrigation and agriculture; and then by the

Ministry of Economic Affairs, the authority in charge of power and energy development. But, in view of the need of co-financier for the project, the IA had to have a partner. The association commenced construction of the plant in 1999, while looking for the partner. It did find one, and jointly set up in early 2000 a new firm named Chianan Enterprise Co., Ltd. (CEC) to handle the project and be responsible for operating the plant after its completion.

## 6. THE WUSANTOU POWER PLANT

The Wusantou reservoir provides water for the new power plant at its outlet. It is the major source of irrigation water for the farmlands, which totaled about 70,000 ha in 1970s, yet decreased to recent 60,000 ha due to the expanding housing area, urbanization and recent years' growing industrial estates in its service area. Consequently, as mentioned before, the IA has been supplementing raw water from the reservoir to local water supply company. Later in 1980s, the IA then invested with landscaping and tourist facilities at the reservoir, and commenced tourism business there. The power plant investment is the recent approach to use of the IA's own water resources and infrastructure.

Since the power project is not directly related to irrigation and to somewhat degree the power plant operation conflicts with the interest of irrigation, in the AM of the Wusantou reservoir, therefore the operations of the power plant have to abide by a set of principles formulated by the IA and approved by the COA. The following are the principles:

- The facilities utilizing the water heads for power generation should not interfere with the existing functions and operation of the discharge pipe of the reservoir.
- Without impeding the water demands of various uses downstream of the reservoir's east intake on the Tsengwen River, the river flows spill over that intake will be diverted for power generation for raising the power generation benefits.
- Simulation of the power plant's operation should be conducted, based on the previous records of inflows and outflows of reservoir, to determine the optimum flows to be released from reservoir.
- When supplying irrigation and domestic uses water under normal operational conditions of the reservoir, the flows released from reservoir should exceed 8.0 cms, the minimum flow for the plant.

The scale and capital for the power plant are summarized below:

- ◇ Design head: 24.1 m.
- ◇ Design discharge: 41 cms.
- ◇ Installed capacity: 8,750 kW (vertical-shaft Kaplan Turbine 1 unit).
- ◇ To connect the plant's outputs, through underground section and overhead section transmission lines, with the Taipower's 69kV transmission line of Lungtien – Nanhua not far from the plant.
- ◇ Main facilities: including penstock, plant building, tailrace channel, generation equipment, switchyard and transmission line.
- ◇ Investment partner: a private enterprise of chemical industry.
- ◇ Owner: CEC (Shareholders: Chianan IA and a chemical company of Taiwan), responsible for operation and management of the power plant.
- ◇ Capital: about NT\$ 350 million or US\$ 10 million at 1994 price, of which 70 % from the IA and the remaining from the co-investor.
- ◇ Benefit: profits for IA, about NT\$ 9 million per annum; plus, charge of water for power generation, about NT\$ 3 million per annum; so the yearly total about NT\$

12 million.

## **6.1 Initial Operation**

The Wusantou power plant began commercial operation in August 2002. It was noticed that, since the inception of its operation, long severe drought spell occurred except some rainfall in March 2003. The usual wet seasons of June – October did not take place in 2002 in the southern region of Taiwan including the catchment of the Wusantou reservoir. For the so short period of operation of the Wusantou power plant, as of the time this paper was prepared, in this paper there is no review of its performances.

But in the long run it is foreseeable that the power plant will be profitable. This is viewed from the facts that, due to the trend of electricity consumption on the island being steadily on the rise, the mid and long-term whole outputs as set for the project target of the plant are to be fulfilled and can be sold out at agreeable rates, so long as the operational costs including management and maintenance outlays are put under appropriate control.

## **7. CONCLUSIONS**

It is a must strategy for the AM of IAs in Taiwan to undertake appropriate new businesses of profit prospect, in order to strengthen their financial self-reliance. The IAs realize that it is the Government's policy not to allow the MFs to be charged on cost plus basis, because irrigation undertaking still is burdened with social responsibility – to assist the Government take care of the economically poorer people, the farmers, in this country. And although Government's subsidies for MFs and other AM needs of IAs, the amounts tend to not exceed present levels, as the Government's financial situations in the years to come are less optimistic.

Although in the initial operation period of the Wusantou hydro-power plant, the performance was not as desired due to severe long dry spell, in the long run the accumulated profits should be promising. This is viewed from the fact that the energy demands in Taiwan are still on the growth, which is attributable to the country's continuous robust industrial growth in the coming years. Therefore it is advisable that the utilization of available flows and water heads of an irrigation scheme, if assessed to be technical feasible and financially viable, open a new dimension for the AM toward profit-seeking to become an alternative way of financial resources for the PIM or even the public agency managed systems.

It is suggested the Government provide guidance on more than control over business diversification by IAs. In view of the variety of water resources and infrastructure and local socio-cultural features, the directions and scopes of business diversification have to be different. In giving guidance the Government should maintain its flexibility adapting to conditions of respective IAs.

As IAs have no such employees specializing at electrical power generation operation and management, therefore it is regarded as appropriate that a separate company is established to recruit employees with related expertise and experience qualified to run the power plant. And the IA supervises and monitors the power plant's overall performance through the board of directors, which a majority of directors are designated by the IA.

## REFERENCES:

- Tsai, M.H. (1998) Policies and Strategies for Irrigation and Drainage Undertakings in Taiwan, *Scientific Agriculture*, Vol. 46 Nos. 1-2, pp 28-33, Taipei, Taiwan.
- Council of Agriculture, Executive Yuan, R.O.C. (2002) *Annual Report on Taiwan's Irrigation Associations Performance Monitoring for Year 2001*, Taipei, Taiwan. (Chinese version)
- Chianan Irrigation Association (1997) *Brief Introduction of Chianan Irrigation Association*, Tainan, Taiwan.
- Chianan Irrigation Association (1997) *Brief on Discharge-release Works Rehabilitation and Improvement Project of Wusantou Reservoir*, Tainan, Taiwan.
- Chianan Irrigation Association (1986) *Feasibility Study on Wusantou Small-scale Hydropower Development Project*, Tainan, Taiwan. (Chinese version).