Paddy Irrigation and Bio-environment Management in Taiwan

Tsai, Ming-Hua[1]; & Lin, Po-Hua[2]

[1]*Chief, Irrigation and Engineering Division, Forestry Department,*
Council of Agriculture, Executive Yuan, 37 Nanhai Road, Taipei 100, Taiwan, R.O.C.
E-Mail: mhtsai@mail.coa.gov.tw
[2]*Assistant researcher, Irrigation and Engineering Division,*
Council of Agriculture, Executive Yuan
E-Mail: polin@mail.coa.gov.tw

ABSTRACT

Human beings ignorantly developed and made use of natural resources by water-consuming socio-economic activities. Genetic diversity, species diversity and ecosystem diversity, upon which sustainable global development relies, were tremendously deteriorated. The earth summit Rio de Janeiro of 1992, Biodiversity Convention had been signed jointly with 158 chiefs worldwide. Being a member of global village Taiwan, although not the nations concluded the treaty, ought to abide by the agreement. The New Plan on Agriculture for the 21st Century of Taiwan agricultural administration incorporated this broad unanimity.

Agricultural water-land resources are closely related to agro-ecosystems, which are highly dependent on human activities for their existence and maintenance. Biodiversity, upon which agricultural varietals improvement depends, provides the raw materials for new combinations of genes, which produces the plant varieties and animal breeds. For a long time, high agricultural production levels have been sustained through maximizing productive function of paddy irrigation services, which held ecological and live externalities as well. Credible value and economic contribution of rice paddies had been typically judged according to the productive externalities; in consequence the other two were not completely demonstrated. Public externalities and outputs of ecology and livelihood should be addressed ever since.

To achieve paddy ecosystems preservation and reinforce biological diversity conservation, the invigorative measures are as follows, to highlight on cropping diversity in exquisite agriculture by fostering upland crop irrigation, develop ecological engineering on farmland consolidation and amelioration of irrigation/drainage waterways, promoting green beatification on canals & ponds to create visual evaluation and aesthetic enjoyment from superior rural landscape, strengthening monitoring and protection of irrigation water quality, performing paddy and water environment conservation, employing fallow paddy fields to improve flood storing & regulating function and recharge aquifers as well.

Keywords: Paddy Irrigation, Conservation, Bio-environment

1. FARMLAND IRRIGATION, BIODIVERSITY, SUSTAINABLE DEVELOPEMNT

Activities addressing bio-environment management need to consider the multiple goods and services provided by the different levels (species and gene) and functions of biodiversity and the interactions between its various components, such as nutrient cycling, regulation of the water cycle and the maintenance of local wildlife and their habitats. Management approaches to

ecosystems, particularly agro-ecosystems, must be focused, however, not only on the biological organization but also on the human interactions that shape and influence them. It has been the international consensus that, upon development & utilization strategies for natural resources, bioenvironmental management should not only aggressively preserve biodiversity but passively diminish its impairment also. Policy authorities have cognized this is fundamental to sustainable development of national resources and should be carried out with the view to promote responsible and sustainable practices.

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The climate in Taiwan is warm and humid. Farmland irrigation enterprise is the most eligible mode to Taiwan's geographical environment for integrated utilization of water-land resources. Paddy fields, about 380 thousand hectares which were under jurisdiction of 17 irrigation associations, irrigation and drainage waterways, overall length nearly 68 thousand kilometers, and surrounding wetlands close to streams attract numerous wild fauna and flora and often serve as sheltered habitats for organisms.

With upland crop irrigation promotion, dry farmland has obliged that biodiversity has been enriched and cropping diversity in upland crop field drew in various insects, bees, butterflies and water fowls residing and foraging. From 1983 to 2001 there are more than 20 thousands hectares of irrigated land with water-saving pipelines by sprinkler or dripping. Especially in sand soil and gravel regions, through irrigation water supply, lots of barren marginal lands have been transformed into fertile oasis of higher outputs; meanwhile, organism phases switch to rather abundant.

2. GENERATION MISSION : BIOENVIRONMENTAL CONSERVATION

Management approaches to agro-ecosystems must be focused not only on the biological organization but also on the human interactions that shape and influence them. Future efforts for management of paddy irrigation, except fulfilling agricultural requirements, should be carried out with the view to build up responsible and sustainable practices and act on the premise of respect for the nature such that artificial hydraulic work coexists and mutual benefits in harmony with living environment.

To inspect and monitor main composition of biodiversity and procedures or activities seriously influencing biodiversity, paddy irrigation management could play an active character upon biosphere rehabilitation. By taking various techniques available to eradicate causes of ecosystem degeneration and reconstruct steps by steps, the physical environment and biome before degeneration might be retrieved.

Irrigation canals artificially transfer water in large quantities to regions where natural runoff can not reach. A massive change of paddy area definitely has an adverse effect on the flood control and drainage of downstream. It might be advised that environmental impact assessment be performed in advance whenever examining the necessity of discarding or cutting down paddy field acreage.

3. CONTEMPORY FARMLAND IRRIGATION WITH CONSERTING AGRO-ECOSYSTEM CONSERVATION

3.1 Sound Configuration – Agricultural Hydro-Zone

The irrigation and drainage waterways in Taiwan, overall length nearly 68 thousand kilometers, spread over irrigated paddy fields, about 380 thousands hectares which were under jurisdiction of 17 irrigation associations, configure akin to vessels web of territory body to furnish farmlands with immeasurable productivity and vitality. Meanwhile, these agricultural irrigation reservoirs, ponds, waterways and surrounding wetlands close to streams form the agricultural hydro-zone to attract numerous wild fauna and flora and often serve as sheltered habitats for organisms.

3.2 Dedication of Farmland Irrigation/Drainage to Conservation of Ecosystems and Biodiversity

The farmland hydraulics facilities and its irrigation/drainage practices not only contribute to agricultural production growth but also make concrete dedication to conservation of ecosystems and biodiversity, some illustrations are the following:

(i) Preservation of hydrological water circulation : To improve normal circulation of hydrological system, stabilize surface runoff, minimize soil erosion, mitigate flood by ponding of rain water, replenish aquifer recharge, buffer extravagant flood or drought, lessen sedimentation or silt, keep superior water quality, all are active roles taken regularly by farmland irrigation & drainage operation and management.

(ii) Preventing soil erosion and soil eroded by wind : Paddy irrigation & drainage infrastructures like those for the purpose of executing farmland consolidation, land preparation and grading, might prolong detention time of runoff or irrigation water thus advantageously alleviating the condition of soil erosion and wind erosion.

(iii) With benefit of storage and recycle for organism nutrients : Farmland irrigation infrastructures comprised an expansive canal system of irrigation and drainage, which increased occasions for fauna and flora in aquatic network to spawn, feed and grow. Irrigation & drainage water networks also convey nutrients into paddy ecosystem; they are sources of water plant and animal protein for creating the diversity of bio-organisms and microorganisms and fostering vivid circulation of nutrient chains.

(iv) Preference for dilution, decomposition and absorption of contaminated irrigation water quality : Farmland irrigation system provides flowing water with self-purification function, effective in nitrogen and phosphorous elimination; it works against pollution sources to dilute, decompose and absorb pollutants. This gives help to reduce the loss of biodiversity.

(v) Microclimate alleviation and excess CO_2 absorption : Farmland irrigation construction supports growth of paddy farming, maintains broad paddy fields in ponding condition and allow paddy rice growing regularly when paddy plot is impounded. This helped local climate steadily alleviated and effected apparent absorption of excessive carbon dioxide. Continual development of biodiversity has been withstood accordingly.

What is more, the capacity of deliberately pumping of groundwater has been estimated to be around 7 billion cubic meters, far exceeding the safe recharge amount of 4 billion cubic meters; saltwater intrusion and land stratum subsidence has long been one headache. In Taiwan, farmland drainage canals were often designed without base-pavement; they were not against percolation and easily let water permeable for recharging groundwater, hence the contribution of ground water recharge by paddy irrigation is worthy to examine and evaluate its economic value particularly.

Table Evaluation of aquifers recharge benefit by Paddy Irrigation

Year	Volume estimated (10^8 cubic meters)
1982	58.33
1987	44.45
1992	35.19
2002	53.20*

* use 14 mm/day as seepage rate on overall areas of irrigated paddy fields, 380 thousands hectares.

4. IMPLEMENTATION REVIEWS

Over the past decades, paddy irrigation represented a vital agriculture production manner in eastern Asia regions; it is well known that a unique paddy rice culture had been developed.

Water resources and farmlands have been reckoned as recyclable resources, and they are sustainable merely within specific limits. The paddy field hydro-zone is most eligible to Taiwan's geographical environment for integrated utilization of water-land resources. A brief implementation review is listed below :

(i) Rice has been the staple food in Taiwan for long time. In early stage of irrigation development, paddy rice irrigation is predominating. Because characteristics of paddy irrigation possessed multifunctionalities of ecology and livelihood, except raising rice production, e.g. flood regulation, to replenish aquifers recharge, as previously mentioned. Agricultural water has become the indispensable resource for farming and rural living.

(ii) Recent years due to fallow or diverted cropping on rather wide paddy fields in Taiwan, along with river water quality polluted, paddy ecosystem and water environment were gradually deteriorated. It has been noted that disappearance phenomenon of aquatic organisms is prevalent.

(iii) Because of citizens' living standard upgraded and rapid expansion in economic/industrial development, the call for for water resource is enlarged year by year. While the exploit of fresh water resources often encounter barricades, the strain of transferring portion of agricultural water to uphold domestic and industrial insufficiency has become greater day after day.

(iv) The annual overall irrigation consumption in Taiwan has been decreased from 13.7 billion cubic meters of 1982 to 10.7 billion tons of 2000; a huge curtailment had been made. The farmland irrigation operation, for sustainable and exquisite agriculture development, should hitherto accent maintenance of quantity and quality to

collaborate modern farming practice to orient towards precision management. By means of adapting water conservation facility and popularize water-saving measures, the efficiency & benefit of agricultural water utilization should be upgraded in consequence. Besides, agricultural water right for agriculture production and bio-environment conservation should be sustained.

(v) It is nearly 85% of irrigation water sources from stream intakes. To make proper use of abundant river flow in flooding times for paddy and water environment preservation, through incentive to elevate the ponding depth in paddy fields might also promote bioenvironmental diversity conservation.

(vi) "Man's determination will conquer Nature" presents the focal view of Taiwan's construction over past decades. It is common that deficiency of holistic ecosystem consideration and incorporated concerns about bio-environment appeared in engineering and architecture design. The ecological engineering method delineates that, prior installing public works; first judge the stability of bio-environment such as to enhance rational and effective assignment of resources by virtue of the self-adapting function of natural ecosystem. It also intends to carry out the integration feature of ecology and engineering, and act on the premise of respect for the Nature in order that artificial hydraulic work coexists and mutual benefits with living surroundings and Nature. It is encouraged that ecological engineering should be incorporated into farmland irrigation infrastructures.

From now on, the farmland irrigation operation, for sustainable and exquisite agriculture development, should accent maintenance of quantity and quality to collaborate modern farming practice to orient towards precision management. By means of adapting water conservation facility and popularize water-saving measures, the efficiency & benefit of agricultural water utilization should be upgraded in consequence.

5. STRATEGIES & POLICY OBJECTIVES

Future agricultural administration goals have been accented to enhance efficient utilization of agricultural resources, national lands reclamation & safe guard and biological diversity conservation; cooperatively exercise agricultural discharge and waste reduction, recovery and recycle activities and jointly preserve the natural environment to withstand resources sustainability & utilization and fulfill responsibility for biodiversity conservation at local and global level, in order that species extinction and ecosystem deterioration might be postponed.

To achieve paddy ecosystems preservation and reinforce biological diversity conservation, Taiwan's policy objectives for collaborating with agro-ecosystem advance across the island have been formulated by agricultural administration. The invigorative strategies and measures are as follows :

(i) Regarding amelioration of irrigation/drainage waterways and farmland consolidation should be worked in parallel with bio-environment management & biodiversity conservation by ecological engineering method, which belongs to new concept and technique further study and research required. Reference to gathered materials of native and overseas successful execution successively establish standards of planning and design, strengthen work force training, such

that comprehensive development is facilitating.

(ii) For upholding biological performance of farmlands, consistently undertake water quality monitoring and also execute farmland soil monitoring to achieve and actualize the aims of improving surroundings of farming districts, canals green beautification, enjoying riverside landscapes and preserving existence of amphibian fauna and flora.

(iii) Since paddy fields diversion acreage enlarged after Taiwan joining the World Trade Organization, attention will be paid to raise bunds around rice paddies, not only catching and storing rainwater in fallow farmland also maintaining paddy fields in good standing for rice cultivation. Through disseminate and educate farming people the idea that paddy field is "vessel for water ponding" to perform planting water action, increasingly enhance the function of agro-ecosystem conservation to replenish and recharge groundwater. Meanwhile, it is suggested to dredge estuarial lakes by seafront and excavate ponds in the depression.

6. EFFECTS and IMPACTS SPECULATED

(i) To conduct renewal and improvement of paddy irrigation facilities, also performing farmland consolidation and irrigation canals amelioration in consolidation districts, encourage irrigation/drainage operation and management towards modernization, in the meantime cooperating with agriculture modernization & sustainable development, finally exempt agricultural management from water deficit or poor drainage. This might assure agricultural outputs and farmer's earning, concert bioenvironmental conservation and additionally elevate the living environment quality of all citizens.

(ii) The promotion of upland crop irrigation, while making contribution to harvest rivalrous crops, is in harmony with exquisite agriculture development to foster growth of biodiversity and prosperity in farming districts.

(iii) Guide and assist irrigation associations in business innovation to serve as diversification and modernization. Efficiently allocate and operate agricultural irrigation water to sustain other utilization and consumers, thus collaborating with practical water transferal during drought deficit in favor of social stabilization and paddy ecosystem preservation; coupled with engage in improving irrigation water quality to elaborate three paddy irrigation functions to maximum extent.

(iv) Government subsidy and fund construction and expenditures to irrigation associations so as to relief financial loading of farmers; rural society is stabilized by this farmers' first-hand benefits.

7. CONCLUDING REMARKS

Water is the fountain of all living creatures, which derives from water originally. Although paddy irrigation chiefly provided service for rice production, it has been engaged in management mode of long-lasting ponding irrigation so that various biodiversity and numerous organisms have survived and lived on paddy bio-environment. Paddy irrigation concerting and harmonized with bio-environment conservation realizes the philosophy of paddy irrigation management in Taiwan.