

Agricultural water sustaining Transferal and Countermeasures of Drought Management

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ABSTRACT

Recent years in Taiwan, due to living standard upgraded, urbanization and development of industrial and technology park, water consumption by domestic and industrial sectors increases dramatically. Additionally, development of new water source encounter barriers and the cost of raw water have been raised; thus, it became common that domestic and industrial utilization provide by agricultural water exchange. On the other hand, since 1986 irrigation volume had ceased to grow up and descended annually along with paddy fields diversion acreage ascending. Meanwhile, irrigation water quantity decreased from 15 billion tons to current 12.2 billion, the range of curtailment is about 19%.

While there is insufficient opportunity to exploit short-term domestic and industrial source to meet the demand for water in Taiwan, along with global climate change and warming effects, the frequency of nature drought is intensified. Future ways to satisfy the demand of individual utilization by using limited and unstable water resources, once water deficit has occurred, measures of agricultural water transferal to sustain other usages, and drought management in the agricultural sector itself should all be formulated in advance. This will be an inevitable subject to be focused among critical issues of water resource.

Keywords : Agricultural water transferal, Agricultural drought, Domestic and Industrial water deficit

1. FOREWORDS

The annual average precipitation in Taiwan areas is amounting to 2,510 mm, which is rather abundant. Resulted from dense population on constricted lands plus significant spatial and temporal difference of quantity, there is about 80% of annual precipitation concentrated from May to November. Aside from great variations between wet periods and dry periods, owing to topographic and geographic factors such as steep mountains, short rivers and quick runoff, rainfall is rapidly returned to the seas, leading to water deficit and drought occurred irregularly.

Agricultural water takes most portions among utilization of water resource. Based on statistics data in 2000, the proportion of irrigation, aquaculture and livestock water occupied 69.1% of the total utilization. During drought or water deficit period, due to higher durability of water shortage than domestic and industrial usage, the agricultural sector has modestly carried out

water resource allocation and transfer settlement with domestic and industrial users. Meanwhile, the irrigation associations not only actively practiced professional irrigating operation through organization mechanism, but also performed modern water conservation measures such as rotational irrigation, sprinkler irrigation, drip irrigation, even suspension irrigation or fallow. Over past natural drought events or domestic & industrial water deficit, agricultural administration had fully supported and collaborated to attain the objective of social stabilization.

In late February of 2002 the North Water Resources Office of Ministry of Economic Affairs responded that water supply in Tao-Yuan & Hsin-Chu districts appeared deficiency; agricultural irrigation water sustaining transferal was requested in order to satisfy demand of domestic utilization and industrial development. Later Water Resource Agency, Ministry of Economic Affairs, invited related agencies including National Science Council, Administration of Hsin-chu Science-Based Industrial Park, Tao-Yuan Irrigation Association, Shih-Men Irrigation Association, Hsin-Chu Irrigation Association, Taiwan Water Supply Corporation, and Council of Agriculture to resolve this dilemma by consultation. The meeting concluded that first crop farmland in water scarcity districts commenced irrigation Sabbath since March 1st, 2002. Sabbath scope covered jurisdictions of Shih-Men Irrigation Association and Hsin-Chu Irrigation Association, the total area covered by irrigation Sabbath was around 14,778 hectares.

2. COUNTERMEASURES AGAINST AGRICULTURAL DROUGHT

The existing arable land of Taiwan is approximately 851,495 hectares, including 442,005 hectares for paddy fields. The Council of Agriculture governs 17 irrigation associations, and there are entire irrigated areas of 376,046 ha under jurisdiction. As the main crop irrigated is paddy rice and irrigation water occupies the most portion of agricultural water, paddy rice becomes the target subject among suffers during drought period.

In Taiwan, on account of economic concerns and crop's dry tolerance, drought occurrence of 4 to 5 years return period was ordinarily chosen for base year of plan for irrigation water supply; it is not a safe design for overall agricultural irrigation requirement. Under such circumstances, the irrigation volume available for agricultural sector is not plentiful essentially; once encountered dry climate beyond base year, it is hard to avoid water scarcity situation at all.

Generally speaking, agricultural drought often took place during period of land preparation, when applied water switches soil-moisture content from dry into saturation, very field application depth is as high as 120 to 200 mm, but for block water requirement is equivalent 15 to 25 times more than that of normal water consumption (本田正常用水). In another words, when drought happened, only breakthrough bottleneck of that water requirement to carry out land preparation & seedling smoothly then it is possible to moderate the drought threat to the least amount. During this period, when dry season began, owing to evapotranspiration from crop and field surface increasing along with effective rainfall decreased and the farming pattern gradually switched to mechanization operation, the field preparation period had been shortened and concentrated; so unit water requirement is higher than normal time resulting in the frequency of agricultural consumption deficiency intensified.

With comprehensive view on irrigation management framework of irrigation association, except routine irrigation plan; for drought event, according to bearable dearth of water in irrigation system of individual irrigated area by different requisites, distinct plans for water conservation, water allocation and drought mitigation measures should be established in advance

and ratified by supervisory authority to stand by for execution. Moreover, it has been presumed in preparation and rehearsal about elements and procedures for operation; machinery and facilities for drought mitigation have been made up whenever needed.

For this reason Council of Agriculture had regulated “Allocation standard of water adjustment for drought year and institution of drought mitigation execution” in 1986, organized primary principle of irrigation management countermeasures in terms of shortage rate; the key points are as follows,

- (i) In case of source supply volume (水源供水量) above 75% of the water requirement scheduled, the distribution operation of farm irrigation employs intensified irrigation management; maintaining original irrigation interval to supply distributed amount modified with scheduled quantity deducting volume by water requirement rate.
- (ii) If source supply volume is below 75% of the water requirement scheduled, the distribution scheme should be based upon actual situation to extend irrigation interval to execute extraordinary irrigation management (非常灌溉); according water deficit evaluation, select alternatives of rotational irrigation in rotation block, secondary canal and branch canal, or in main canals.
- (iii) For irrigation areas supplied by reservoir storage and river flow, once the speculating source supply available volume is less than 50% of the water requirement scheduled, management and operation agencies should not only execute abnormal irrigation regularly but submit to supervisory authority the request for promulgation of partial field diversion or suspended irrigation under critical circumstances.
- (iv) Use stand-by pumps equipped with drought remedy to get water from supplementary water sources.
- (v) Beforehand establishing sequence of districting for crop diversion and suspended irrigation during water shortage period, and promulgate at the earliest instant.

Right after that, in fiscal year of 1988 and 1989 Council of Agriculture had assisted in finalizing “Guideline for irrigation management measures against various levels of drought” in terms of individual irrigation system within jurisdiction of 17 irrigation associations all over the island; it was a basis for the guidance of water-saving and drought remedy for irrigation associations. By now for those irrigation associations located in water shortage districts, when water scarcity happened, quickly performed rotational irrigation and intermittent irrigation according to that Guideline, hence efficiently diminished damages caused by drought.

3. PRINCIPLE AND MECHANISM OF AGRICULTURAL WATER TRANSFERAL

Agricultural water takes most portions among utilization of water resource. Based on statistics data in 2000, the proportion of irrigation, aquaculture and livestock water occupied 69.1% of the total utilization; the consumption was about 12.3 billion cubic meters. During drought or water deficit period, due to higher durability of water shortage than domestic and industrial usage, at time of domestic and industrial water deficiency the sustaining allocation of agricultural water is requested; however, the agricultural sector, by equivalently considering principles of food security, privileges of rural people and irrigation associations, has modestly carried out water resource allocation and transfer settlement with domestic and industrial users.

Moreover, the irrigation associations not only actively practiced professional irrigation management through organization mechanism, but also conducted water conservation measures such as rotational irrigation, even irrigation suspension or fallow. It was suggested and focused that those farmers' rights and interests should never be neglected and those damages brought by irrigation Sabbath had to give rational compensation in return.

Whenever water supply shortage took place, for domestic and industrial usages it is prompted, according to the "Guidelines for coordination of transfer use of agricultural water" prescribed by Ministry of Economic Affairs in July of 2001, to get in touch with relevant irrigation association as early as possible to beforehand reach agreement on transfer volume, transfer period, compensation amounts and way of payment with the water transferee. The water transferee, base on those numerical data, thus were capable of proceed internal operation to strengthen irrigation measure, which included rotational irrigation of wide area, irrigation of water requirement rate, slippage flow irrigation (滑流灌溉), groundwater pumping and supplementary water source. Only after above measures have been performed with no conquest received, then partial region's Sabbath or irrigation suspension might be carried out as substitute. In this situation the loss suffered by farming, farmers and agro-ecosystem could be reduced to minimum degree, and the impact brought on the whole society might be moderated. Besides, the burden of compensation fee funding would be less charged to accomplish success in most aspects.

The water transferee (被調用水者) need to process precision irrigation management to lift efficiency of water utilization and increase the ability of sustaining transferal and allocation. The latest two promulgation of irrigation suspension were against natural drought events, they were for the first crop of 1994 and 1996. But the origination of 2002 promulgation of irrigation Sabbath in Northern Taiwan differed from that of agricultural drought; according to doctrine of payment made by users, the full cost of agricultural water transferal should be born by Administration of Hsinchu Science-Based Industrial Park and Taiwan Water Supply Corporation.

4. SUSTAINABLE UTILIZATION OF AGRICULTURAL WATER RESOURCE

Multinational scholars of water resources had forecasted consecutively that an era of water shortage is coming. There are great possibilities led on water resources conflicts from different level all over the world, even outbreak of war.

In view of global climate change and greenhouse warming there are fierce fluctuation derived upon atmospheric temperature, precipitations and runoffs at regional and global level. For this reason, recently relevant researches and assessments of water management have switching their objective from supply direction to demand allocation. By now seasonal shortage of water supply and conflicts among competing users have emerged consecutively in Taiwan, in order to resolve this unavoidable agricultural water transferal and drought management affairs, it is still requested to be focused by industry, government, educational and research institutions. Take national sustainable development into consideration, emphasize synergistically on integrated benefits of ecology, environment, economy and society, and deal in conformity with laws to accomplish win-win in most aspects.

The following describes the integration development objectives and prospects of water resources together with related projects promoted by Council of Agriculture,

4.1 For upgrading benefits of agricultural utilization, aggressively support the project of water-saving irrigation

Since 1983 Council of agriculture has continuously supported and promoted “water-saving pipeline irrigation project” for economic upland crops. Up to finish of 2001, at end section of irrigation facilities there were beneficial area of 20,978 hectares and 4,508 farming households were advantaged. This project aimed on assisting and directing farmers to install water-saving pipeline facilities and take appropriate irrigation process for water conservation. Elevating both quantity and quality of upland crop to facilitate upgrading competitiveness, lower management man-hour and enhance operation modernization to accomplish the objective of cost down and profit growth.

It had been studied that pipeline irrigation method can achieve water savings of more than 50 percent than traditional flooding or channel irrigation. If compared with double cropping field, estimation of farmland irrigated by pipeline reveals that there is an increment of 10 thousands cubic meters available water per hectare. Increased irrigation water of 0.2 billion tons could be acquired annually by adding up every promotion area. Because of prominent performances achieved and rewarded from the project by promoting quality, quantity and competitiveness with agricultural products, contribution of recovering deficiency in agricultural labor also being made, the Council of Agriculture shall support irrigation associations in those districts of higher frequency of water deficit to actively drive and proceed this movement.

4.2 Enhancement of Construction of renewal & modernization of farmland irrigation facilities

The Council of Agriculture has consecutively assisted Irrigation Associations to strengthen present farmland irrigation facilities in renewal and improvement; in view of vital hydraulic structures and operation works, it has been aimed to think about foresighted blueprints for adapting contemporary management and measures. Under implementation of renewal & amelioration of engineering projects, the order of priority in irrigation system is main, secondary and branch canals, lining for field ditches; based upon rules of conveyance & distribution loss reduction and assurance of waterways safety, it has been estimated that 1.5 billion cubic meters irrigation conveyance loss was avoided every year.

5. CONCLUSIONS

People have recognized that massive farmland undertaken irrigation Sabbath resulted in inverse impact upon paddy ecosystem; therefore, relevant irrigation associations is advised to hold extra water for long crops, planting green manure and ecosystem preservation. Applied countermeasures of intensified irrigation management, for the central and southern Taiwan regions a principle of no irrigation suspension and no fallow might be advocated as well.

5.1 Mechanism Formulation according to Legal institutions and Hierarchy

In 2002 the promulgation of Shih-Men Irrigation Association & Hsin-Chu Irrigation Association Sabbath, which significantly differed from past irrigation suspension accused agricultural drought executed by agricultural administration, its nature belonged to water transferal of sustaining domestic and industrial requirement. While in connection with precedent

irrigation suspension measures of relief fund, which intrinsic character was simply accused of natural drought; resolution should be made according to “Guidelines for coordination of transfer use of agricultural water” prescribed by Ministry of Economic Affairs in July of 2001. Pursuant this guideline the water demander, Taiwan Water Supply Corporation, should first consult with the water transferee to settle transfer volume, transfer period, compensation amounts and way of payment; relevant expenditures should be fulfilled by the water demander. In this manner, go back to legal institutions and hierarchy and water demander coordinates with water transferee in advance to formulate mechanism of quotation charge transferal, so as to proceed with a minor price in smooth, congenial and satisfied way.

5.2 Mastering proper occasion for agriculture fallow to carry out agricultural water sustaining transferal

Depending on local climate situation the proper occasion for crop cultivation is varied with distinct cropping pattern. For Paddy rice cultivation within Tao-Yuan & Hsin-Chu districts of northern Taiwan, irrigation period of nursery bed is from the first day of February to end of February; land preparation & seedling period begin with last ten days of February up to last ten days of March. In this connection, provided there is anxiety about water scarcity, and no other means but to consider executing agricultural fallow and irrigation Sabbath. The advised timeline of first crop is before the end of prior December, along immediately urge relevant irrigation association to apply for agricultural water transferal. On the contrary, those investment being made in land preparation, seedling and fertilization were desolated with Sabbath and transferal at once; definitely resulted in huge losses to farmers and farming industry, and evoked widespread discontent among rural people.

5.3 Stay away from large farmland irrigation Sabbath to avoid jeopardizing three paddy irrigation functions

It has been well-known that agricultural irrigation water possessed three functions of production, livelihood and ecology, which are especially prominent in Monsoon region of Asia and critical important for agriculture sustainability. Ecosystems conservation belongs to our responsibility of generation for descendants, and this mission has been stressed by most nations of the world for human sustainability. Nearly 14 thousand hectares of paddy fields was determined to execute irrigation Sabbath in jurisdiction of Shih-Men Irrigation Association and Hsin-Chu Irrigation Association. From this irrigation Sabbath derived negative impacts on ecosystem, since aquifer charging amount declined as well, simultaneously influenced neighboring irrigation zones with return flow volume trimmed down. As a result, conflicts between stakeholders are easily induced.

5.4 Advise to develop new water source at opportune moment against domestic and industrial water deficit

Water quality and quantity reckoned as fine and reliable in irrigation water is those supply of reservoirs, ponds and aquifers; the estimated volume is approximately 1.8 billion cubic meters as a whole. While water available for domestic & industrial sustaining transfer is held by the reservoir storage, it is summed into 1.1 billion cubic meters. Even though this takes merely 10% of the full operational capacity, 10.6 billion tons, of Irrigation Associations, it illustrates the lifeblood for most critical agricultural production zone of Taiwan and takes account of integrated

agricultural development and farmer's welfares greatly. An effort to help domestic & industrial sectors relieve from temporary dilemma of water deficit inheres applicable expediency; nevertheless, it is less practicable for long-term concern. The average annual precipitation in Taiwan amounts nearly 90.5 billion cubic meter, but the utilization so far is about 18 billion cubic meter, only consuming 20% of the total precipitation and the rest 80% returned to the ocean. With a view to holistic national development perspective and fulfill the shortage of domestic & industrial utilization, in addition to consistently executing water resource initiatives at a scale suitable for regional development, it is hoped that well-timed exploration of new water source should be managed to cope with drought event.