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RELATIONSHIP BETWEEN AGRICULTURAL LAND SYSTEMS AND WATER USE DURING THE APPLICATION OF PARTICIPATORY IRRIGATION MANAGEMENT

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Abstract

The identification of water rights is essential to the application of Participatory Irrigation Management (PIM) policies. Water and agricultural land have traditionally had strong relationships. We must clarify land tenure conditions and their relationships with water rights. This paper presents the results of studies focused on the relationships between agricultural land systems and water use in several African and Asian countries. It describes different situations related to land systems and water use, as well as the relationships between them. In study areas, in addition to historical backgrounds, land tenure may be associated with the extent to which state, customary, and individual involvements affect farmers' de facto water rights. In general, water rights are clearly established in developed countries because formal administration of land and water resources has been functional and well-established. In developing countries, further institutional arrangements may be required to enable farmers to maintain water rights and increase efficient water use and management. However, no single solution is available. This paper describes how local contexts may vary with respect to land and water tenure. When PIM is introduced into irrigation schemes, it must be carefully integrated into agricultural land systems and the regulation of water rights in target areas. First, a land management system must be developed that secures farmers' rights to ensure rational/optimal use of irrigation water. This offers important implications for rice irrigation and other crops that requires relatively intense and long-term investments in land development and advanced water management.

***Key words*:** irrigation management, rice**,** tenure system, water right

INTRODUCTION

During the application of Participatory Irrigation Management (PIM) policies, it is essential to identify water rights because those rights could stabilize the environment for agricultural production, ensure equality in water delivery, and avoid conflicts that result from demands for limited water resources. To identify the nature of water rights in a particular location, we must clarify the conditions of land tenure related to those water rights. Forni [7] stated, Land tenure can be defined as the group of rights of individuals, households, or communities with respect to land. Water also can be accessed under different types of rights. Tenure includes not only property rights, but also use rights of a permanent or seasonal nature. A tenure system may include rights sanctioned both by law and by custom. That is, alongside the formal legal systems, following defined administrative procedures, there also exist customary rules accepted by the majority of users.

To clarify agricultural land systems and water use and their relationship in different contexts,

we conducted literature reviews and field surveys in several Asian and African countries. The results are presented below.

MATERIALS AND METHODS

Study areas are Anuradhapura District in Sri Lanka, Egypt, Ethiopia, Ghana and Japan. As regards information sources, the study depended on literature review, field observation, unpublished documents (Sri Lanka, Ethiopia, Ghana and Japan), and published data by the Ministry of Agriculture and Land Reclamation (MALR) and Ministry of Water Resources and Irrigation (MWRI) for Egyptian case.

RESULTS AND DISCUSSIONS

1. Anuradhapura District, Sri Lanka

(a) Types of rice fields

Anuradhapura District is located in a Dry Zone in Sri Lanka that receives a mean annual rainfall of less than 1750 mm. A distinct dry season occurs between May and September [20]. To make the most efficient use of this seasonally fluctuating rainfall, many reservoirs have been created by building dams across streams. These reservoirs are known as "tanks." Farmers use rainwater and tank water during rice cultivation. Tanks used to irrigate land less than 80 ha in size are classified as minor irrigation schemes. They are often referred to as "village tanks" because they serve as the central infrastructure of village life.

Rice fields that are irrigated from village tanks can be categorized into several types. One is known as *Purana-wela*, which means "old fields." *Purana-wela* is type of rice field that was certified as privately owned during the colonial period. Another type of rice field is known as *Akkara-wela*, which means "acre field." *Akkara-wela* were developed after the colonial period ended. These fields were sold to farmers by the government. They are usually located downstream of or close to *Purana-wela*. *Badu-idama* is an additional type of field that was developed and leased by the government after the Land Development Ordinance was enforced in 1935 [16]. Nakamura [16] noted that land tenancy at that time was not consistent with current land tenancy, as demonstrated by the *Thattumaru* system, in which farmland is shared among members and cultivation is performed in rotation every few years.

(b) Water rights and water distribution from village tanks

According to the Sri Lankan government, a multitude of acts and ordinances – more than 40 in all- govern many aspects of water. These laws are administered by various government departments, authorities, statutory boards, and local authorities. Still, there are some lacunae, such as the absence of an overall authority for rivers and the absence of mechanisms of allocation to different users, as well as for conflict resolution [20]. However, with respect to minor tanks, no acts or ordinances have been enacted to regulate water rights. Rather, customary water rights and water allocation practices that exist are shown in Table 1.

Table 1. Types of rice fields and water rights

Types of rice fields	Customary water rights	Allocation order of water
Purana-wela: old paddy fields	With	1
Akkara-wela: one-acre paddy fields owned by one person, newer than *Purana-wela*	Without	2
Badu-idama: leased paddy fields	Without	3

Source: [16]

Tank water distribution is decided at *Kanna* meetings that cultivators join to discuss cultivation issues, including water distribution. *Kanna* meetings are hold prior to each cultivation season. All meetings are conducted in front of administrative officers. Serious discussions are held during dry season meetings because expected rainfall amounts will be low and cultivators must decide on appropriate area to be cultivated. Issues to be decided at *Kanna* meetings include cultivation areas, plowing periods, the number of times dams and canals should be cleaned, water distribution patterns, and fines to be imposed.

The implementation of a system known as *Bethma* is one of several issues that must be determined at *Kanna* meetings. Under the *Bethma* system, paddy fields are redistributed temporarily among farmers to meet with

amount of water in a tank. *Bethma* is considered an "effective water use system" that offers cultivation opportunities to all farmers [10]. However, it has been reported that the implementation of *Bethma* has decreased [19].

In areas that rely on village tanks, water is the main resource that must be allocated among the people. The allocation of water is achieved by farmers during *Kanna* meetings in which farmers participate.

2. EGYPT

(a)Landownership and water rights in Egypt

The history of water rights in the Islamic world is complex. However, the application of water rights varies significantly. Most countries permit the ownership of customary private water rights to coexist with state-owned water rights administered by a permission scheme. Several countries, and, in particular, Egypt, tie water rights exclusively to land. The rights and obligations that accompany water rights vary from country to country.

In Egypt, land and water tenure cannot be separated, especially in older rural areas. This exerts a direct impact on water tenure. Thus, water rights are used solely for irrigation. According to Islamic regulations, water cannot be sold. No fees are charged for water used for irrigation of either old or newly-reclaimed lands, with the exception of some locations within newly-reclaimed lands in which fees charged to cover the costs of electrical consumption by water pumping stations are paid by land owners [11]. Therefore, water from the Nile River and public canals is considered the property of all Egyptians. However, it is managed by the State through the Ministry of Water Resources and Irrigation ("MWRI"). Wells are available for public use, as well as for private use as personal property on newly reclaimed lands.

Water used for agriculture consumes about 85% of the annual amount of Egypt's water resources (55.5 billion m^3). Based on the current policy that rations agricultural water, attempts to save water have been emphasized through agricultural water management (AWM) efforts and improvements made to the conveyance system. Therefore, landowners must submit irrigation schedules that will dictate the amount of water to be allocated. Irrigation scheduling is performed by the Water Users Associations ("WUAs"), with the assistance of an innovative governmental entity known as the Irrigation Advisory Service ("IAS"). Water allocation to farmers is primarily based on the amounts of land involved and cropping patterns. However, in the case of water deficits in *mesqa* (tertiary canal) discharges, water is proportionally distributed among farmers by WUAs [13]. Irrigation schedules list each farmer's irrigation times and the number of hours *mesqa* gates or valves will remain open. These schedules are implemented by *mesqa* leaders and leaders of gates or valves located along the *mesqa*.

Landowners have certain responsibilities that accompany their water use rights. These responsibilities include keeping the drains, *mesqas*, and canals clean and free of debris. For landowners who hold water rights, a variety of actions are prohibited:

- Wasteful use of irrigation water through drains, fallow land, or unlicensed land.
- Impeding irrigation networks.
- Preventing flows in the main canals or any other actions that might compromise water elevation. In addition, opening or closing any locks or any other regulated works.
- Demolishing any hydraulic infrastructures constructed by the MWRI.
- Excavating the banks or changing their elevations (hack filling mud or).
- Licenses are required for any water-related works or equipment operation.

(b) Allocation of public water in Egypt

The MWRI intends to create a flexible system of water allocation based on factors such as land size and crop rotations. The MWRI is responsible for water distribution in all waterways up to the *mesqa* level and for determining and publishing the irrigation calendar. MWRI reserves the right to modify the system in accordance with agricultural

needs. In fact, the Irrigation Director is empowered to stop the diversion of water from a main canal to ensure more equitable distribution or to avoid over-application.

To irrigate new lands, (i.e. lands that never received irrigation licenses), the MWRI must approve all appropriations to ensure sufficient water is available. Licenses must be obtained from the Irrigation Director. Each licensee must include the following information in the license application: acreage, soil classification, irrigation source, irrigation technology, and cropping calendars. The Irrigation Director must validate the data and determine the amount of water to be allocated and the particular irrigation technology to be used. The law also requires that licenses must be obtained for any water works to be completed on public lands, for any water intakes established on the Nile or on main canals, for the construction of pumping stations, and even for land cultivation. These requirements are designed to increase control of the withdrawal and use of public water resources drawn from the Nile [18].

3. ETHIOPIA

(a)Water rights and land tenure system in Ethiopia

Land, as well as natural resources located on it, is considered property owned by the state in Ethiopia. This has been a constitutional right since 1974. Regional states administer land and other natural resources in accordance with federal and regional states laws. Land is not subject to sale. Individual farmers may own land and they have land use rights. However, they may not sell their land rights. For many years, land owned by farmers was insecure because land-administrators often conducted land redistribution. However, since the early 2000s, rural land ownership has grown increasingly secure because of rural land certification policies. In land certification, each plot owned by a farmer is demarked, registered, and certified. With the exception of selling a plot, a farmer can rent the plot and include it as an inheritance for family members in a legal written agreement. The system has equity advantages. However, the extent to which land-tenancy will affect sustainability and water use efficiency requires further study.

Ethiopian farmers can access irrigation water from their land and this constitutes their water rights. Other than the right to use the land they own (implicitly, the accessible water), no specific water rights are available in Ethiopia [3] [9]. Basically, water rights regulate farmers' use, access, withdrawal, and alienation of water [3]. Water rights have been established by various legal orders. The lack of defined water rights in Ethiopia limits use and access to water. For instance, because the sale of irrigation land is illegal, only famers who own land near irrigation water can irrigate. This limitation may cause inefficiency. However, the tenure system does not totally restrict other farmers from accessing water. If a farmer whose land is located far from a scheme wants access to irrigation water, he/she must enter into a written contractual agreement with the farmer who owns a plot located near the scheme to temporarily rent irrigable land. Therefore, more efficient farmers can access irrigable land by renting. Another method used to access irrigation water occurs when the government or a community invests in a new irrigation scheme. At this time, the distribution of irrigation land depends on whether the scheme was constructed on new farmland areas or developed on previously existing farmland area. In a newly developed farmland, the distribution of irrigable land can be easy. However, in previously developed farmlands, individual farmers' access to irrigable land depends on prior agreements made among farmers who belong to water use associations. However, land-related conflicts frequently arise among farmers, despite the existence of prior agreements. These conflicts weaken AWM. With respect to fees in communal irrigation, based on water policies, users pay continuous fees to cover operation and maintenance (O&M) and capital costs.

(b) Water collection methods - Case studies from Ethiopia

Ethiopia's water resource development policies provide evidence that the government has invested in irrigation projects and has

established and implemented procedures for the sustainability and viability of irrigation projects. Based on this objective, the government has implemented a stage-by-stage cost recovery approach. In this approach, fees are based on crop-choices and farm-level profits, scheme efficiency, and simple and clear cost recovery systems [4].

Until now, the per capita membership fee served as the implemented water fee collection system. This is apparent in, for instance, Koga irrigation project in North Ethiopia. The command area of Koga irrigation project occupies 7000 ha. Approximately 12,000 households are the beneficiaries. Per-household irrigable land shares are 0.58 ha per household [6]. In this scheme, beneficiaries are expected to cover all O&M and capital costs [1]. The estimated annual fee per household is about $251.8/ha/year [14] over the scheme's lifespan. Two vital issues have arisen. First, farmers have objected to the fee: They say it is unaffordable. In addition, Dowa et al. [6] discussed the fact that the scheme appears inequitable: Only farmers must pay for the scheme. Other beneficiaries (i.e. backward and forward linked users such as cattle ranchers) frequently do not pay for shared water. Their failure to pay for shared water could weakens AWM. Furthermore, throughout the lifespan of the project, in many cases, the irrigation fees are constant (similar to the per-household fee for irrigated landholdings). These fees may not cover the full costs because of inflated material costs.

The land administration regulations indicate that farmers who own irrigation lands are not permitted to sell them. However, they are allowed to rent their land. Efficient farmers may face land shortages because they possess small irrigation landholdings (i.e. 0.58 ha). In contrast, inefficient farmers might possess excess land. Land rentals and contract farming can reduce inefficiency. However, in Ethiopia, land rentals frequently depend on social attachments that develop between farmers (i.e. kinship, friendship) rather than on competitive rental fees. Therefore, it can be difficult to conclude that the tenure system leads to efficient water allocation. The advantage of this type of land tenure lies in the equity created by the distribution of irrigable land.

4. GHANA

(a) Agricultural land system and water use in Ghana

Land distribution in Ghana is primarily governed by customary laws that are partially recognized in the legal framework [17]. Traditional authorities often manage land allocation in rural areas, although allocation patterns vary from region to region based on local customs. The authorities administer water rights in localities and manage water conservation, pollution control, and the protection of catchments and fisheries [21]. With respect to irrigation scheme sites, traditional authorities continue to play substantial roles in land allocation, and water use monitoring and management. They create and enforce rules and engage in conflict resolution related to land and water access [5]. Prevailing customary systems generally characterize the tenurial conditions under which farmers cultivate lands (implicitly, they affect water allocation because riparian water rights are commonly acknowledged in Ghana). These conditions are associated with the multi-layered and dynamic nature of land rights that may pose challenges to successful PIM establishment in areas that include inland valley bottoms located in southern regions considered suitable for the installation of small-scale rice irrigation systems.

(b)Land-water relationships: Small-scale rice irrigation in Southern Ghana

In southern Ghana, chiefs and their extended families customarily possess land titles (stool lands). A specific farmlands holds several individuals (e.g. the chief, family, and cultivator) who possess potential claims over the landholding. Formal land registration (i.e. titles) to ensure individualized rights is precluded. Therefore, an individual will not possess exclusive rights to improve his/her cultivated land over time. This creates a challenge that may impede the extended transformation of valley bottoms into irrigated rice fields.

In contrast to policy approaches that tend to require clearly-defined property rights, African customary systems are characterized by ambiguity that has allowed people to create tenure arrangements that require further (re-) interpretation & (re-)negotiation to accommodate different norms and interests based on ethnicity, ancestry, gender, and age [2]. In southern Ghana, cash crops (e.g. cocoa) have attracted settlers from other regions for decades. Several types of power mechanisms, including mechanisms used to control land holdings (e.g. indigenous and immigrant) and transactions (e.g. matrilineal and patrilineal) exist simultaneously. However, these mechanisms have gradually changed because of the existence of different modes of individual adoption and revision [12]. This dynamic nature sometimes creates tensions during tenant cultivation, which might compromise the contracts (e.g.–rent might increase), militate against tenants' shares of the return (and, thus, reinvestments), and, ultimately, cause their eviction. These risks should be anticipated, particularly in leased rice fields, for the following reasons: 1) because farmlands suitable for rice irrigation are, among others, limited, they may attract relatively high local demand. Hence, tensions related to access and use can readily arise. 2) These tensions may accelerate as land values and prices increase because of improvements made to field and irrigation infrastructures. 3) Risks will be protracted by long-term land tenancy that is often arranged to enable farmers to recoup their upfront investments. 4) Risks may increase because of the successive arrival of new settlers (the landless) who hope to discover relatively accessible farm lands, such as rice fields used for irrigation.

To weather the above challenges and to sustain PIM, it is essential to foster local institutions that promote farmers' collaboration in AWM for rice fields, as well as to consider the tenure status embedded in farmers' social customs and relationships.

5. JAPAN

(a) Farmland management system in Japan

Rights to farmland in Japan are managed by the Agricultural Land Act that addresses the following issues: 1) only farmers and farmers' groups whose main businesses is farming are allowed to own, use, derive profits, and transfer farmland; 2) to transfer ownership, permission must be obtained from an agricultural committee comprised of farmers who reside in the same municipality, based on the Public Officers' Election Act; and, 3) to change the purposes of farmland, permission must be obtained from the Minister of the Ministry of Agriculture, Forestry, and Fisheries ("MAFF") or the Governor of the Prefecture.

(b) Institutional characteristics of water rights related to agricultural water use

Japan enjoys an average annual precipitation of 1,690 mm. However, seasonal gaps in rainfall occur frequently. The amount of available water resources in Japan fluctuates widely on a yearly basis. For example, the amount of useable water resources available during a standard dry-year that occurs once every ten years stochastically (10-year volume) equals two-thirds of the amount of useable water resources available during a normal year [15]. Because many stakeholders want to use river water, limited water rights that include fixed terms are provided to each stakeholder by the river administrator ("RA") (either MLITT or the local government). Therefore, all stakeholders can use the same amount of water they might use to achieve 10-year volume. If a new stakeholder wants to obtain new water rights to use river water, the stakeholder must apply to the RA for permission to use the volume of water the stakeholder requires. The RA may provide water rights if a distributive surplus water resource is available. However, the RA might provide water rights later if further water resource development is required. Almost all cases that requested new water rights for agricultural water during the past few decades required new water resource development.

In 1896, the original Water Law for the administration of river water-use was legislated. Prior to the law's enactment, river water was extracted for various purposes.

However, stakeholders in relevant areas voluntarily negotiated with one another to establish usage. Adjusted shares were later recognized as Traditional Possessions (TP) of water rights. Each user was expected to inform the RA of the volume of TP used. In all cases, when unanticipated water shortages occur, stakeholders must negotiate to keep damage to a minimum.

The following restrictions on water rights have been imposed (Fig. 1):

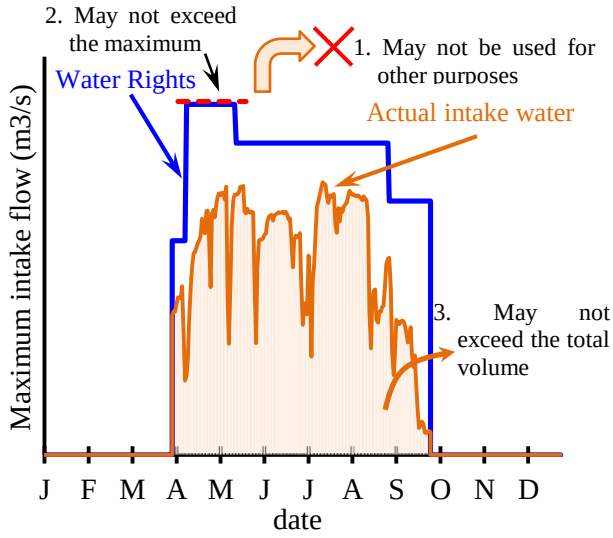

Fig.1. The concept of water right restrictions for the removal of river water

1. Do not use water for purposes other than the specified purpose and area.
2. Do not use water that exceeds the maximum flow during each period.
3. Do not use exceed the total allowable water volume during productive periods.

(c) Water charge collection methods in Japan

Developing countries struggle to collect water charges that can be used for O&M and/or management fees for irrigation facilities. However, this has not been problematic in Japan because Land Improvement District ("LID") offices can officially collect fees from member farmers. Approximately 95% of the LIDs in Japan collect fees based on farmland areas possessed by each individual member [8]. Overall, Japan has clearly defined land and water use rights. This ensures fair water allocation and timely fee collection. Clearly-defined water rights also ensure the collection of fees from individuals who share water (e.g.–municipalities) and improve AWM.

CONCLUSIONS

Based on the case studies described above:

In the Dry Zone of Sri Lanka:

- Water is the main property that must be considered. Land and land tenancy can be arranged to allow water use, as demonstrated in the *Tattumaru* and *Bethma* systems. Farmers' participation in irrigation management is achieved during *Kanna* meetings, as well as by the enforcement of customary water rights.

In Egypt:

- Water rights are tied to the land. Thus, they are tied to land ownership. Most agricultural land is privately owned. Water is distributed according to a defined time schedule among different land parcels within a certain location based on a conveyance that depends on the land's location and its proximity to the main source of water.

In Ethiopia:

- Land is owned by the state. The state offers land use opportunities to farmers. Water rights that should be connected to land use have often been transferred by farmers. Recently, land certification has created better opportunity for such a transfer than in the past.

In Ghana:

- Traditional systems frequently affect agricultural land-water relationships. In southern regions, the multi-layered and dynamic nature of land rights may negatively affect successful PIM in both owned and rented rice fields. It is crucial to understand the mechanism that operates behind local tenure arrangements (i.e. coping strategy) to foster farmers' organizations.

In Japan:

- Japan has determined clearly defined land and water-use rights that ensure fair water

allocation and timely fee collection. Clearly-defined water rights also ensure collection of fees from individuals who share water (e.g. municipalities) and improve AWM.

These results demonstrate that a proper understanding of the relationships that exist between agricultural land systems and water use is critical to the establishment of PIM. Therefore, irrigation projects should be carefully designed to match agricultural land systems and the regulation of water rights in target areas. Thus, it is important to develop land management systems that secure farmers' rights to make rational/optimal use of irrigation water. This has important implications for rice irrigation in particular because it requires relatively high and long-term investments in land development and advanced AWM.

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