23rd International Congress on Irrigation and Drainage

8-14 October 2017, Mexico City, Mexico

Symposium on
'Global Review of Institutional Reforms in Irrigation Sector for Sustainable Agriculture Water Management, including Water Users' Association'

Pre-Symposium Combined Summary

Volume I

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INTERNATIONAL COMMISSION ON IRRIGATION AND DRAINAGE
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SYMPOSIUM
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1.0 BACKGROUND

There are at least five integrated aspects that must be properly maintained in order to secure the functional sustainability of irrigation/drainage in particular and development and maintenance functions of infrastructures in general. These are: (i) Human resources; (ii) Institution and Organization (iii) Technology for sustainable O&M; (iv) Sustainable O&M budget; and (v) Effective Regulatory Instrument and enforcement. The absence or unbalance of an integrated relationship among any of the five aspects would bring about ineffectiveness of infrastructural functions so the five aspects cannot be seen in isolation. During the operation phase of irrigation/drainage infrastructure, human resources in conjunction with appropriate Institutional and organisational setting are of particular importance.

It has been observed that different countries have a variety of institutional and organizational arrangements for Irrigation and drainage development and management especially related to reforms undertaken in relation with organizational arrangement, approaches for successful participatory irrigation and drainage management (PIDM), working mechanism and involvement of the public private partnership (PPP), mechanism of charging of irrigation and drainage services as well as determination of the level of cost recovery etc. In an attempt to grasps the global perspective of such a large interdisciplinary areas of institutional and organizational aspects of irrigation and drainage and to deliberate on the issues related institutional reforms needed for sustainable agriculture management, ICID's Working Group on Institutional and Organizational Aspects (WG-IOA)[1] is organizing an international symposium on the theme 'Global Review of Institutional Reform in Irrigation Sector for Sustainable Agriculture Water Management, including WUA' on 8 October 2017 during the 23rd ICID Congress at Mexico.

Symposium will provide a platform for irrigation and drainage professionals and other stakeholders to share their knowledge and experience related to sustainable agriculture water management with focus on institutional and organizational reforms in irrigation sector, participatory irrigation management, water users' associations and other relevant stakeholders etc. Symposium will deliberate on the following topics:

i. **Topic–1:** Legal Framework and organizational structure including WUA for Water Supply Services;
ii. **Topic–2:** Participatory Irrigation Management and Management Transfer - Approaches and condition for successful PIDM;
iii. **Topic–3:** Public–Private–Partnership (PPPs) in Irrigation and drainage operation and maintenance toward sustainable Irrigated agricultural water management.

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Given the large scope of interdisciplinary interconnectivity, for efficiency and effectiveness of symposium the number of papers has been limited from ICID National Committees (NCs) representing geographical region of small, medium and large land holding irrigation and drainage practices as well as levels of Irrigation and drainage technology and modernization practices covering aspects related to themes and topics for giving global comparative review amongst the related organizations and institutions on general perspective. In order to facilitate preparation of country papers and case studies and to ensure broad similarity of information provided by various countries in these papers, an outline of country paper and case study was shared with the National Committees (NCs) covering following main aspects (i) Basic information about the development of irrigation and drainage in the country; (ii) Legal Frameworks covering among others issues and challenges related to land and water, review of institutional and organizational aspects of irrigation and drainage sector, need for institutional reforms, institutional and organizational structure for sustainable water management and so on; (iii) Participatory Irrigation Management (PIM) and Irrigation Management Transfer, elaborating the approach of PIM, status of PIM - WUAs, their roles and responsibilities, condition that are required for successful PIDM and so on; (iv) Observed Impacts of PIM including water allocation and service delivery, cost recovery aspect, water use efficiency; (v) Challenges, including water accounting and auditing; mechanism for determination of cost recovery and water charges, engineering challenges, possibility of Public Private Partnership (PPP) for financing and improved service delivery, issues in upscaling of PIM, capacity development and so on; and (vi) The Way Forward and Recommendations elaborating and giving example of the best practices for replication; future plans and so on.

Brief summary of institutional and organisational aspects in terms of issue and challenges, legal frameworks, approaches to PIM and its impact etc. in respect of various countries and regions is given below.

2.0 OVERVIEW OF COUNTRY PAPERS AND CASE STUDIES

For the symposium, 14 NCs/Committee submitted their country papers and case studies. Their general characteristics relevant to AWM are shown in Table 1 below. Overview of the significant observations on various aspects are synthesized in this section followed by the country and region-wise summary of various identified aspects of institutional and organisational aspects in subsequent sections.

Table 1: General Characteristics

	Total population (1000 inhabitants)	Average annual rainfall (mm/year)	Total area of the country (1000 ha)	Arable land area (1000 ha)	Area equipped for irrigation: total (1000 ha)	Agriculture, value added (% GDP) (%)
Australia	23969	534	774122	46957	2550	2.38
China	1407306	645	960001	106298	69390	8.99
India	1311051	1083	328726	156360	66700	17.39
Indonesia	257564	2702	191093	23500	6722	13.52
Iran	79109	228	174515	14687	9553	9.34
Japan	126573	1668	37796	4223	2469	1.17
South Korea	50293	1274	10028	1476	778	2.31
Malaysia	30331	2875	33080	954	380	8.43
Mexico	127017	758	196438	22993	6500	3.71
Nepal	28514	1500	14718	2114	1332	32.79
Sudan	40235	250	187936	19823	1890	28.62
Chinese Taipei	23361	2610	3596.1	797	387	11.08
Turkey	78666	593	78535	20706	5215	8.59
Ukraine	44824	565	60355	32531	2167	14.04

Source: AQUASTAT (FAO); FAOSTAT

These countries and regions represent a vast diversity of geography, climate, governance, socio-economic conditions and level of development, and this is very clearly reflected in their reports. While Australia represents a separate continent with its own unique geographical and climatic features, other countries and regions are from monsoon governed East, Southeast, and South Asia, and low-precipitation arid Middle East and Africa regions. Turkey and Ukraine characterize to some extent the features of Europe. With regard to the main source of freshwater, variation in annual rainfall in spatial-temporal dimensions is quite significant among the countries as well as within the large countries such as Australia, China, India and Indonesia. As with all the countries in the world, agriculture has been a historical livelihood or subsistence activity in all these countries too and continues to remain a mainstay of many rural populations. However, its role in national economy is gradually declining in most countries; the food security issue keeps it as a development priority in national planning process. In the countries with smaller land areas and high technology manufacturing, such as Japan and Korea, agriculture is now being viewed as technology driven food factories of future. Countries with significant base population and population increase rates, such as China, India, and Indonesia, agriculture will continue to dominate development debate. Newly established countries such as Ukraine have a different challenge, i.e., where to place agriculture in an open market economy environment; this is more of a governance issue rather than natural resources availability. Sudan, with large untapped potential in agriculture, views agriculture as the main national development platform. Despite all the variations described here, national food security seems the main consideration in all the countries. And, accordingly the importance of irrigation and drainage in maintaining a satisfactory level food security at present and in foreseeable future is recognized by all the countries. The other main common issue is the physical deterioration of national irrigation and drainage systems in addition to building the future water management infrastructure. Much of the development in major infrastructure took place after the Second World War and this infrastructure is rapidly aging, making repairs and maintenance more expensive every day and more challenging in emerging development models.

Legal and Institutional Framework for AWM: In terms of legal and institutional framework for water management at different levels, very few countries have achieved a satisfactory state. The problem is further compounded by diminishing priority to agricultural development as it is giving way to more remunerative sectors (industry, urban, consumers) in national development plans. Consequently, the irrigation and drainage sector has suffered significantly due to frequent changes in the parent ministry of agricultural water management and water resources development in general. This policy blur at the national level has disturbed the traditional roles of local communities in running or managing local canals and other irrigation infrastructure. While most countries have reported drafting of law and regulations or guidance for formation of farmers' groups, under different names, their actual implementation at ground level is far less than satisfactory, and even disturbing the traditional rural socio-economic fabric. Quantitatively the reported numbers of such groups may be large, but the quality of their capacity has much to achieve. Few countries, such as South Korea, are not even encouraging formation of such groups and have placed the O&M responsibilities with rural development agencies, departments or private companies. Ageing farming populations, lack of youth interest in rural livelihoods, confusing water pricing structures, inadequate government support and competing water demands from other sectors have all contributed in making agriculture water management and also family-based agriculture less attractive for youth energy and private investment. Such social and demographic phenomenon has further eroded the self-governance capacity of rural communities. Malaysia has reported some efforts to strengthen the water user groups, but it is too early and it would be interesting to see the outcome in future. Japan has its own unique model, named, Land Improvement District (LID), which has had significant success in stabilizing the rural water situation, and JICA is already testing the success factors of LID in 16 different developing countries. Several recommendations have emerged to make institutions responsible for water planning more broad-based, multi-disciplinary, coherent and holistic.

PPP in Irrigation and Drainage Systems: Major irrigation and drainage infrastructure has always been the mandate of national governments and it will continue to be so for many decades. Water as an input for food production has never been an economic or monetary entity in itself, unlike fertilizer or seeds or pesticides, skewing the food price calculations in open market systems. Even the capital cost of farming-family land generally does not figure in such calculations. Private sector being profit-oriented comes into picture only when agricultural raw material is harvested and arrives in market for further processing, storage, packaging, retailing and value addition. Or, the agricultural inputs such as fertilizer or seeds, which are not considered natural resources or public good, are able to draw attention of the private sector. PPP models in rural infrastructure developments including roads and irrigation-drainage systems have rarely demonstrated

success, let alone a proven business model. In the country reports discussed here private sector involvement is indicated generally in the O&M part and that too in very few countries when water user groups failed. Lack of policy clarity across the countries and social value attached with water rather than its economic value are considered major hurdles in larger private sector investments in irrigation-drainage infrastructure. Though, like electrical power distribution, water may incentivize private sector involvement and eventual investment in this rather neglected, yet future critical, sector for sustainable development.

Way Forward: All reports have indicated some activity on this front at least at planning stage. Climate change, increasing population pressure in some cases, food security, depreciation of irrigation-drainage infrastructure, uneven or declining availability of freshwater for food are some of major determiners of future plans. At the governance level, inclusive planning and equitable allocation are major considerations. While some countries have reported intensions for more specific investments in irrigation-drainage infrastructure, others have identified human capacity building at the water use level as priority. Integrated water management plans right from nation and province/state to local district/village levels seems an emerging consensus in all reports. Some of the institutional reforms have been more like trial runs or experiments, rather than some long-term vision-based commitments. Inter-community, inter-sector, inter-state and even international cross-boundary water conflicts are rearing their heads, and therefore, international networks have much bigger challenges to deal with when it comes to agricultural water management. All kinds of collaborations, joint deliberations, human resource sharing, research cooperation, and capacity building are the main keywords that will guide the future path of sustainable development in an uncertain climate.

3.0 LEGAL FRAMEWORKS

3.1 AUSTRALIA: Water 'ownership' in the Australian context is denoted by licenses/water entitlements. A water access licence or other approval from the state is generally required to extract water from rivers or aquifers to use for commercial purposes. This also applies to rainfall runoff and flood flows on an individual farm. Trading in water, sometimes referred to as transferable water entitlements (TWEs), is now recognized as a successful innovation, with transfers now occurring between irrigators in different states and between sectors (irrigation districts and riparian/river pumpers, irrigation to urban water supply) and discussions about trading ground water (between interconnected systems) or sewage effluent. A service sector has developed which facilitates this trading. Trades are placed on a register which includes volumes traded and price.

In the current phase, National Water Initiative and Commonwealth Water Bill 2007 imposed a clear rule of allocation of water for consumptive use. The direct outcome for the farmer is that previous allocated volumes of water are replaced by a percentage share of an annual sustainable yield or surface water or groundwater. Accordingly, irrigators (and other right holders) have a right to that share but the quantum varies annually.

As an illustration of the complexity of the issue in Australian context, the cross-section of basic institutional arrangements for water resources management, in the four states of the Murray-Darling Basin: State of Queensland, State of New South Wales and Tasmania, State of Victoria and the State of South Australia.

3.2 CHINA: In 2005, government issued guidelines for establishing new mechanisms for constructing irrigation and drainage systems. In 2016, the General Office of State Council issued the "Guidelines on Comprehensive Reform of Agricultural Water Pricing." For large and medium sized irrigation and drainage projects in China, the government has appointed specialized regulatory bodies staffed with professionals whereas on-farm and small irrigation and drainage projects are managed by the general public. The government has launched reforms to improve the efficiency of small irrigation and drainage projects under which rural water cooperation organizations are established by project beneficiaries for the purposes of facility construction, maintenance, operation and management. Therefore, the current management organization of China's irrigation and drainage sector is a combination of irrigation district authorities and rural water cooperation organizations.

For specialized regulatory bodies of key irrigation and drainage projects, the expenditure is covered by the public finance and agricultural water fees. Participatory irrigation management (PIM) by farmers, mainly in

the form of rural water cooperation organizations, is vigorously promoted by the Chinese government. These organizations are the managers of small irrigation and drainage projects. The cost of management is repaid in the form of water fees, and water pricing is subject to government guidance and consultation within the organization.

3.3 INDIA: The irrigation development in India is a state subject. The funding through the states are supported by the Rural Infrastructure Development Fund (RIDF) setup by Government of India in NABARD (National Bank for Agriculture and Rural Development). In terms of source of water, the irrigation sector is broadly classified as surface water and groundwater irrigation. In terms of extent of coverage (Culturable Command Area, CCA), the irrigation projects are further classified as under: (i) Major Irrigation Projects: CCA > 10,000 ha. (ii) Medium Irrigation Projects: 10,000 ha > CCA > 2,000 ha. (iii) Minor Irrigation Projects: CCA < 2,000 ha. All Major and Medium Irrigation (MMI) projects are supported by public investment by the Central and State Governments; whereas a significant part of the Minor Irrigation (MI) development, especially groundwater development, is supported through private investment.

The Ministry of Water Resources is supported by the Central Water Commission (CWC) in matters related to surface water development, and the Central Groundwater Board (CGWB) for groundwater subjects, Ministry of Agriculture and Farmers' Welfare dealing mostly with development of micro-irrigation and Ministry of Rural Development/Department of Land Resources dealing with watershed development. One of the most crucial component of institutional framework envisaged for the success of irrigation is 'Water Users' Association (WUAs)' and their federations operating at higher levels (i.e., Distributory Committees and Project Committee). It is estimated that there are over 85,000 WUAs which have been formed under various projects with the help of interventions taken under Command Area Development and Water Management (CADWM) program. However, in most cases the WUAs have not been adequately developed in terms of capacities needed for taking over the control and management of irrigation system.

3.4 INDONESIA: The main issues and challenges related to land and water are due to institutional set-up. The support for 'irrigated agriculture' over the last decades has been very fragmented and as a result not very effective. This has resulted in degradation of catchment areas, limitedness of irrigated land area, damages of existing irrigation schemes, agricultural land conversions, increasing demand for non-agricultural water, and inadequacy of irrigation budget allocation from regional governments. The 2004 Water Law allowed trading of water, but it was later rejected by the Court of Justice. Since 2014 Irrigation Commissions, established at provincial and district levels, work with government agencies, WUAs and other users.

Particularly for irrigation sector, the prominent central government agencies having tasks and responsibilities are the Ministry of Public Works and Public Housing (infrastructure development, operation and maintenance); the Ministry of Agriculture (utilization of irrigation water for farmers and empowerment of WUAs); the Ministry of Home Affairs (strengthening regional governments and the National Development Planning Agency regarding national planning). Meanwhile, at provincial and district levels, irrigation sector is under three agencies, namely, the Public Works/Water Resources Development Agency, the Agriculture Agency and the Regional Planning Agency. At the field level, there are WUAs who have responsibilities of tertiary unit of irrigation schemes and village irrigation systems. Coordination for irrigation management involving government's agencies, water users' association and other water users is carried out by Irrigation Commissions established at provincial and district levels. Considering the complexity of water and irrigation management by diverse stakeholders, since 2006 the roles of National Development Planning Agency (*Bappenas*), Ministry of Public Works, Ministry of Agriculture and Ministry of Home Affairs have been oriented towards implementation of Participatory Irrigation Management and Development (PPSIP).

3.5 IRAN: In 1991, the government of Iran established the Operation and Maintenance of Irrigation Networks Company (OMIC) as an autonomous body under the Ministry of Energy. A multilateral agreement signed by Ministry of Jihad-Agriculture (JAM), Ministry of Energy (MOE), and Management and Planning Organization (MPO) to mandate OMIC with the transfer of operation, maintenance and administration of the Irrigation Networks (INet) to local communities. Each OMIC had concession of performing O&M in each INet.

By early 1992 up to 20 OMICs were established to perform following tasks: (1) Improving the quality of Operation and maintenance of Irrigation networks; (2) Increasing water use efficiency; (3) Improving the

efficiency of water fee collection; (4) Irrigation agency structure's reforms and reducing the number of employees; (5) Improving the water users' structure, in order to promoting the Irrigation management systematically; (6) Enhancing the collaboration and communication between water users and related public sectors; (7) Developing the participatory Irrigation management. (8) At the beginning, the ownership of OMICs should be shared between water users (51%) and governmental organizations.

However, Iranian PIM working group (IRPIM) in 2002 identified following constraints: (1) Confusing shared responsibilities among the farmers; (2) Transfer of responsibility to the Water User Cooperatives (WUCs) with insufficient authorities; (3) Financial Burden on WUCs with undefined budget sources; (4) Insufficient capacity of WUCs to carry out such transferred responsibilities; (5) Lack of legality to carry out the responsibilities; (6) Related local governments left the WUCs just after establishment; and (7) the majority of water users, which had to play the main roles, had no sufficient incentives.

3.6 JAPAN: The basic plan for Food, Agriculture and Rural Areas (approved by the Cabinet in 2015 through Land Improvement Act) requires systematic and efficient implementation of the acceleration of agricultural structural reform and the development of agricultural production bases for strengthening of national resilience. Under the Land Improvement Act, Land Improvement Districts (LIDs), farmer-based organizations, are formed with a purpose to implement land improvement programs based on the Act. As of 2016, there were 4,646 LIDs, including many large-scale LIDs, as seen in the case of Nishi-Kanbara LID in Niigata Prefecture with an area of 19,678 ha, 14,302 farmers and 155 staff members. LIDs can impose payment of money, labour, goods, and/or membership fee on the members in the district to spend on the operation. LIDs are under the supervision of the prefectural governor, and their management and operations are inspected on a regular basis. Land improvement projects are public projects that are initiated by the voluntary initiative of beneficiaries. Thereby, the Land Improvement Act stipulates that its implementation must be environmentally friendly, contribute to comprehensive development and conservation of national resources, and meet the development needs of the national economy. Legal procedures for land improvement projects are stipulated in the Land Improvement Act for each project operator. The scale of the project decides who is going to be the main body to implement the project (national government, prefectural government, municipal government, or organization, etc.), and the Act stipulates the rate of subsidies from the national government according to the main body. Agricultural irrigation or drainage facilities constructed by the national government or a prefectural government belong to them as property and they are responsible for its management. Daily management of the facility, however, is principally commissioned to the LID, which is the beneficiary group organized by the farmers.

3.7 SOUTH KOREA: Since the year 2000, Korea Rural Corporation (KRC), a government agency, has the responsibility of irrigation facilities and operations under a national law. KRC now employs rural people for irrigation channels mainly for branch channels and lateral turnouts. The irrigation water is provided free of charge and the operational expenses of KRC are met by the central government. Hence, the Participatory Irrigation Management (PIM) by farmers has almost disappeared since 2000. Due to aging farming population, aging facilities, and lower priority of agriculture in the industrial policy, KRC has strived to improve the management and operational efficiencies by introducing TM/TC (tele-metering & tele-control) technology. Also, higher priority to environment and climate change issues are affecting the agriculture sector and rural water management. Emerging technologies are being considered for greater role in dealing with these issues.

3.8 MALAYSIA: Inclusiveness and sustainability are the key themes of Malaysia's ongoing National Transformation Program to make it a "high income country." Accordingly, to serve the population of over 53,000 farmers of Muda Area, the main granary of Malaysia, 27 Farmers' Organizations (FOs) have been established through the Act of Parliament (FO Act 110). After the completion of the Muda Irrigation Project, the Muda Agricultural Development Authority (MADA) Act was enacted by the Parliament of Malaysia to: (1) develop, promote, facilitate and execute socio-economic development in the Muda Area; and (2) plan and execute in the Muda Area any agriculture development that has been authorized by the local State Governments of Kedah and Perlis. Administratively, MADA serves the functions of three departments of the Federal Agency – the Department of Agriculture (DOA), the Department of Irrigation and Drainage (DID) and the Farmers' Organization (LPP). MADA covers an area of 100,685 ha divided into four rice-growing regions. The main objective is irrigation of two rice crops every year to achieve self-sufficiency and increase rice yield to 8 t/ha by 2020. A coordination committee is set up for MADA-FO cooperation.

3.9 MEXICO: The present Constitution, which originated in 1917, is the basis of a set of general, national, and local laws in which water is considered as an asset that is owned by the nation and its use in the hydro-agriculture sector has the highest social priority. In 1989, the Secretariat of Agriculture, Livestock, Rural Development, Fisheries and Food and the National Water Commission were formed under which the Federal Government serves the national hydro-agricultural sector. Mexico has 86 Irrigation Districts (IDs) and more than 40,000 Irrigation Units (IUs) distributed throughout the national territory. Fifty percent of the national agricultural production is harvested on irrigated land, producing 2.4 times more, per unit area, than in rainfed areas. Globally, Mexico ranks seventh in terms of availability of hydro-agricultural infrastructure.

3.10 NEPAL: Nepal introduced an Irrigation Policy Amendment (2013) with following features: (1) Irrigation Master Plan based on Integrated Development and Management of River Basin shall be prepared at the National as well as District Level; (2) The Government of Nepal shall declare Irrigated Area where the irrigation facilities are made available and use of such land other than for agricultural purposes shall require prior approval of the government; (3) Coordination and partnership between the stakeholders shall be promoted to enhance the productivity in the irrigated area; (4) Appropriate Irrigation Technology suitable to particular geographical location and topography shall be promoted; (5) Irrigation projects shall be planned based on Integrated Water Resources Management (IWRM) principles; (6) In order to provide round the year irrigation from existing seasonal irrigation systems, reservoirs, rain water harvesting and ground water irrigation shall be developed; (7) Priority shall be accorded to develop large reservoir and inter basin water transfer type of projects; (8) Private sector, cooperatives, communities shall be involved in the development, operation and management of irrigation systems; (9) To mitigate the impact of climate change in the irrigation systems, programs related to adaption and mitigation measures shall be implemented.

In addition, the currently proposed Irrigation Act (No. 2074) through Irrigation Bill (year 2015) drafted by the Ministry of Irrigation has been tabled in parliament for approval. The Bill proposes following measures for the sustainable development and effective management of all major irrigation systems: (1) provide license to the person or organization planning to survey and develop irrigation system; (2) collaborate with private sector for complete management of irrigation system on the basis of public private partnership (PPP) modality; (3) handover the irrigation systems constructed, developed or managed by it to the WUA; (4) can declare an irrigated area as special irrigated area, where use of land for other purposes shall be prohibited, without permission of the Government; (5) The related Users willing to develop, use, maintain and protect any irrigation system can form Water Users Association by following the prescribed provision; (6) The functions, responsibility and authority of the Water Users Association would include update and maintain the asset of an irrigation system amongst other activities (7) form an Irrigation Management Committee; (8) establish a Central Irrigation Development Fund.

3.11 SUDAN: In 2015, a Presidential decree (No. 32) shifted irrigation O/M Directorate from Ministry of Agriculture to the Ministry of Water Resources, Irrigation and Electricity (MWRIE). Now MWRIE is responsible for monitoring, assessment, planning and development of the water resources, including surface water, groundwater and drinking water and sanitation at the national level. Institutional reforms coupled with legal enforcement bodies are needed to meet the challenges such as internal disagreements, institutional overlap, unclear mandate, lack of capacity and lack of vertical and horizontal coordination. More awareness for the role of the stakeholders' involvement in planning and decision-making is required. This was reflected in moves which resulted in the formulation of the Gezira Scheme Act (GSA) of 2005 and the development of Water Users Associations (WUAs) in the Gezira Irrigation Scheme (GIS).

3.12 CHINESE TAIPEI: Irrigation in much of Chinese Taipei is governed by seventeen Irrigation Associations (IAs) – parastatal organizations collectively owned by farmers, supervised by governments at multiple jurisdiction levels, managed by professional managers, led by local politicians chosen by farmers, and supported by a network of Irrigation Groups (IGs) through which farmers organize collective action for irrigation operation and maintenance (PIM) at the local level. By the year of 2015, the irrigation area of Chinese Taipei reduced to around 387,346 ha, of which about 368,576 ha, with an overall length of about 44,061 km of irrigation canals and 25,604 km of drainage ditches, was serviced by the existing 17 irrigation associations.

3.13 TURKEY: Population increase and migration from villages to cities since 1991 has raised water demand, leading to construction of intermediate and high-pressure piped irrigation networks to save water and allow optimal utilization. Theoretically, there are operational (conveyance) losses of 5% in main canals

and 5% in the schemes, adding up to 10%. Further, farm level efficiency in traditional irrigation systems is about 60%. If leakage, evaporation and operational losses are included, efficiency becomes 50% which means wasting of limited water resources, constructing distribution and drainage schemes with bigger capacities, thus increasing costs and additional power consumption for pumping. Instead of traditional methods, if sprinkler and drip irrigation methods are utilized, sprinkler irrigation increases water efficiency from 60% to 80% and drip irrigation raises water efficiency up to 95%. It means 20% and 30% water economy.

3.14 UKRAINE: The financing of the irrigation and drainage sector in Ukraine is carried out through the State Water Agency using the state budget and revenues from the payment for water services. Water supply to consumers to the point of water outlet is carried out by the state water organizations on a contractual basis in which water users pay for the water supply services provided (including the costs of operation and consumed electricity). There are 250 legal entities in the system of the State Water Agency, including 9 basins, 16 inter regional and 19 regional water resources departments, which implement state policy on the ground.

The existing management system of water resources and land reclamation in Ukraine is inefficient, not cost-effective and incapable of attracting investment for modernization, reconstruction and development. The need for its reform is also due to poor quality of surface water and groundwater, progressive degradation of environmental systems, low water availability during low flow seasons, the need for integrated management of water resources, lack of effective economic mechanisms for managing water resources and promoting sustainable water use, ineffective use of state water-reclamation infrastructure, lack of economic levers of operation of reclamation systems etc.

4.0 PARTICIPATORY IRRIGATION MANAGEMENT (PIM) AND IRRIGATION MANAGEMENT TRANSFER (IMT)

4.1 AUSTRALIA: In late 1990, there was a global call to shift the ownership and management of irrigation systems to the farmers. The World Bank provided a systematic classification of participatory management into: privately managed; individually managed; farmer managed; jointly managed; and agency managed. Privatization of water rights led to decentralization and corporate style water management. PIM, in Australia, is primarily called corporatisation/privatisation. PIM refers to the involvement of farmers (water users) in different aspects of irrigation management such as planning, designing, construction and supervision, policy and decision making, operation and maintenance and evaluation of irrigation systems. PIM is a subset of the broader concept of irrigation management transfer (IMT) which is the full or partial transfer of responsibility and authority for the governance, management and financing of irrigation systems from the government to water user associations (WUAs). In the Murray Darling Basin (MDB), major irrigation infrastructure is now operated/managed by WUAs through various types of ownership, these include private companies, cooperatives, trusts and state-owned corporations. In MDB in Australia, 30% area is managed by WUA and 55% jointly with other agencies, and remaining managed by agencies.

In conclusion, IMT has successfully been implemented in Australia and the key motivations seem to be farmers' perception of rising costs, poor operation of irrigation systems and their own initiative to take over management on one hand and governments seeing the renewal of aging infrastructure as a drain on the state Treasury, on the other.

4.2 CHINA: The initially formed rural water cooperation organizations for irrigation scheme renovation projects later evolved into self-managed water user associations (WUA). In 2016, the General Office of State Council issued the Guidelines on Comprehensive Reform of Agricultural Water Pricing to support the orderly establishment and innovative development of WUAs in constructing and managing water supply projects, managing water use, and collecting water fees. Today 83,000 rural water cooperation organization in the form of WUAs operate on 19 mha and covered 60.7 m rural households.

Rural water cooperation organizations perform following duties within their jurisdictions: (i) management of irrigation and drainage facility construction; (ii) maintenance of irrigation and drainage facilities; (iii) irrigation water management; (iv) participation in the water-pricing process, collect water bills, and manage the

income from water bills; and (v) cooperation with the water authorities, local governments and irrigation district authorities.

4.3 INDIA: The promotion of PIM in India is mainly guided by the Command Area Development program to develop adequate delivery system of irrigation water up to farmers' field with an objective to enhance water use efficiency and production and productivity of crops per unit of land and water for improving socio-economic condition of farmers. The Programme was restructured in 2004 and renamed as Command Area Development and Water Management (CADWM) Programme. So far, 84,779 Water Users' Associations have been formed in various States covering an area of 17.84 MHA under various commands of irrigation projects. The activities covered under CAD component of a Project are broadly categorized as Structural (survey, planning, design and execution activities) and Non-Structural (strengthening of PIM) interventions. However, as seen in other parts of the world, there are challenges in successful operation of PIM model in India too.

4.4 INDONESIA: PIM has been formulated to increase farmers' sense of belonging, sense of responsibility and enhance their capabilities in order to realize effective, efficient and sustainable irrigation systems. The government has responsibility of the main system and the farmer at the tertiary unit of the system. While the main principles of PIM reform continue to remain valid, transfer of irrigation management was not considered feasible for the primary and secondary levels as this was considered too much a burden for the poor farmers. Instead, in the new balanced irrigation paradigm, the water-users were made an active partner in every decision-making process, from the initial rapid rural appraisal (RRA), PAI-RP2I, survey, investigation and design (SID), Rehabilitation and O&M. Water User Organizations (WUOs) however remained fully responsible for village irrigation systems and for the tertiary level hydraulic infrastructure in government managed irrigation systems. Central Government is responsible for the O&M of primary and secondary irrigation systems of sizes of cultivable command area (CCA) more than 3,000 ha, provinces for systems of sizes between 1,000 and 3,000 ha, and districts for irrigation systems of up to 1,000 ha.

Maintenance of tertiary level systems is wholly financed and implemented by WUA. Irrigation management plan (IMP) includes an action plan identifying the responsibilities of each party in financing and implementing O&M within an agreed timeframe. For schemes with CCA larger than 3,000 ha, for which the national government is financially responsible, the task to manage these O&M tasks is delegated to lower water resources services. For schemes larger than 1,000 ha, but smaller than 3,000 ha, the O&M arrangements are guided by a separate agreement between a district and the province concerned. The IMPs and participatory irrigation management agreements (PIMAs) prepared for each scheme include a plan showing to what extent and for which tasks the WUA will be involved in actual scheme operation and/or implementation of routine and/or deferred maintenance either in SRR schemes or rehabilitation schemes. Such activities include de-silting, cutting weeds, earthworks to restore canal shape, etc.

4.5 IRAN: Irrigation management in Iran has faced several problems and constraints such as: (1) Inappropriate authority at various levels; (2) Insufficient capacity of WUCs to carry out transferred responsibilities; (3) Inability to set up and jointly work together for effective irrigation reform; (4) Lack of defined common incentives between GOs and water users with regard to IMT; (5) Lack of clear legal position for WUCs in decision-making on water resource management; (6) Lack of practical bylaws; (7) Lack of acceptable methodology for IMT process; and (8) lack of mutual understanding about IMT process, among the different related governmental sectors.

4.6 JAPAN: When a land improvement program is completed, the LID is entrusted by the national or prefectural government with the maintenance and management of the facilities constructed in the area. Maintenance and management of land improvement facilities include operation of water supply and drainage plants, monitoring of canals (including operation of floodgates, etc.), and mowing of the areas around canals. The LID collects membership fees for maintenance and management in the form of irrigation and drainage management fee (ordinary charge) from the members based on the article. The fee is determined based on the size of the farmland owned by the specific member and other factors. The amount of the fees is decided at the annual meeting of general assembly (or the annual meeting with representatives).

Facilities constructed in national projects can be more efficiently managed by local LIDs, who directly benefit from the use of such facilities and can manage them in a way to meet the actual conditions of usage. Thus, the management in these cases is in principle entrusted to the LIDs. While the development of agricultural irrigation and drainage facilities enabled the mechanization of rice paddy farming and independent irrigation and drainage systems for each parcel of land, new challenges have arisen with the emergence of part-time farming and aging of farmers.

4.7 SOUTH KOREA: Since 2000, the irrigation water is free of charge and the management and operational expenses of KRC are met by the central government. This has resulted in difficulties in managing the automated lateral turnouts because the farmers struggle to supply water first to his/her field and then eventually there is break in the turnout function, causing the low irrigation efficiency. Considering the crops grown in South Korea, two tracks of PIM recovery are needed for rice paddies irrigation and dry crops irrigation. For the rice paddy PIM, introduction of incentive granting program and for the dry crop PIM, the co-utilization of groundwater well can be implemented. Now, the irrigation management transfer (IMT) from local government to KRC is an emerging social issue for better I&D service and the concept of PIM should be revived and direct subsidies for loyal farmers as an incentive for their labour should be provided.

Irrigation canal and drain improvement is steadily implemented to increase irrigation efficiency. Earth, lined and flume canals are quite typical waterways for irrigation in Korea and drop, chute and gates are usually used for slope declining and water distribution in irrigation networks. Structured canal ratio has been increased due to the effort for irrigation efficiency improvement. In addition, the use of ICT applications for agricultural water resources management is being made due to its benefits in terms of efficiency improvement and cost effectiveness. Since 2000, after the farmers' water fee was exempted, the O&M costs were provided by the central government and KRC. The O&M cost increased from $214 million in 2000 to $339 million in 2013. The cost share in 2013 was 36.6% for government and 63.4% for KRC. The KRC requests more government funds with the maintenance cost share between central government: local government: KRC: farmer of 4:3:2:1.

4.8 MALAYSIA: Currently, Irrigation management in Muda Area is a consultative process. This consultative process is part of the Quality Management System (QMS) of Malaysian Standards (MS) ISO 9001. MADA has been implementing it since 2001 and has further encompassed PIM as a mandatory requirement. In the Muda Area, it is envisaged to have WUA in all the 172 irrigation blocks. Each irrigation block has its definite irrigation and drainage boundaries. The farmers' representation in the irrigation block is through their elected leaders in the village called Small Farming Unit (SFU). In the Muda Area, WUAs evolved from the previously practiced group farming projects carried out by the farmers. The formation of WUA in the Muda Area aims to benefit farmers in the following forms: (i) The WUA will convene to establish their irrigation block schedule to carry out the farming activities. (ii) The WUA can reduce conflicts during the supply of irrigation water. (iii) The formation of WUA is to inculcate the awareness on water productivity among the farmers. The farmers will get incentives with the increase in yield. (iv) Better optimized water consumption by the farmers will increase water productivity.

The purpose of the formation of the WUA is to have interaction between the committee of the WUA with the operational staff in the water management section at the locality office. Matters related to field water management, maintenance of waterways and operation and maintenance of tertiary level irrigation and drainage structures is handled by this combined unit called the Secretariat of the WUA. With the present approach of forming WUA based on SFU in the respective irrigation blocks, 8 WUAs have been established by 2016 in the Muda Area. An intensified approach in 2017 is targeted to establish 19 more WUAs in the selected irrigation blocks. A WUA covers an area between 500 to 1000 hectares.

4.9 MEXICO: Among the major transformations and reforms promoted in the hydro-agricultural sector in Mexico, the "transfer of irrigation districts to users" is most important. The administration and operation of the districts, except for supply sources and headworks, become responsibility of the users. The transfer of Irrigation Districts drives a series of processes that give rise to a productive reconversion in Mexico. This reconversion secures the transfer to the users, including not only the physical infrastructure, but also the responsibilities for the operation, conduction, distribution, and delivery of water for irrigation. The main objective of the water reform in terms of water resources management in irrigation districts is achieved by transferring the hydraulic infrastructure and its integrated management to the users, which implies for them taking on the responsibility of making an efficient and sustainable use of water resources.

The transfer of the 86 irrigation districts involved the creation of 474 irrigation modules and 16 LRSs in order to manage an area of 3,495,085 hectares. These administrative structures are made up of 557,381 irrigation users. The area per module varies between 5,000 and 15,000 ha. Small owners are 139,345 in number compared to the 418,036 communal land holders. The State, through the National Water Commission, maintains the control and management of the headworks in the irrigation districts, that is, of the supply sources. Thus, dams and other bodies of water, as well as the series of wells, are managed and operated by the National Water Commission. This form of management has made it possible to organize both small and large irrigation districts in the country.

4.10 NEPAL: The National Water Plan (NWP) 2005 puts a set of physical targets in irrigation sector for increased agriculture production. Taking the irrigation facility base as 1.2 million ha in 2011, by 2027 (within 15 years) 442,000 ha irrigated area is to be added if 97% of irrigable area is to be provided irrigation facility. This will require adding about 30,000 ha irrigation facility each year for the next 15 years according to NWP of Nepal.

Agency managed irrigation systems have poor performance and can be potentially improved through IMT. IMT attempts to address the problem of below capacity performance, poor O&M, negligible cost recovery, inadequate funds for the management of irrigation systems and finally the problem to increase agriculture production. Performance improvement are needed for: (1) improving the service delivery through responsibility division between the agency personnel of Department of Irrigation (DOI) and WUAs; and (2) strengthening of WUAs. Agencies need to consider that IMT is not only physical improvement, but also institutional reforms to improve and agriculture productivity.

It is estimated that 70% irrigated area in Nepal falls in the category of farmer managed irrigation systems (FMISs) which can be improved through: (i) flood irrigation; (ii) establishment of control structure at the intake point; (iii) installation of number of control structures and field channels in the command area; (iv) automation of the regulators to let the water flow according to the size of the command area and demand of the users; (v) water distribution regulated by ICT based on the moisture requirement of the crop roots.

Medium sized FMISs are owned and managed by the farmers themselves. At present, about 40% of food requirement of the country is met by these irrigation systems. Hence, they have an important role for food security as well their contribution to the Nepalese economy. Other important segment of irrigation sector is the small irrigation systems (below 25 ha), utilization of groundwater through individually owned shallow tube well (STW), and micro-irrigation systems utilizing small local sources of water and different technologies.

4.11 SUDAN: Data of water supply and cultivated areas for the period from 1970 to 2014 showed that after the adoption of the WUAs in 2005 the flows increased without any increase in the cultivated areas in the irrigation scheme. Last year MWRIE assigned to one of its companies the collection of irrigation water charges and it succeeded to collect almost 80% of the charges.

4.12 CHINESE TAIPEI: A major feature of Chinese Taipei's irrigation institutions is that they provide arenas and logistic support for problem solving by farmers at the field level. Farmers are organized into self-organized Irrigation Groups (IGs), which are responsible for irrigation O&M in the field. Farmers in an IG elect an IG leader, who is given the mandate to coordinate and liaise with the IG members concerning O&M activities. A major feature of the IGs is that they are organized on the basis of hydraulic boundaries. In the implementation of water distribution in an irrigation system, duties and functions between canal water distribution and farm irrigation should be separated to avoid uneven water distribution. Canal water distribution should be carried out by the canal working station or canal management technicians, while irrigation area (rotation unit) should be managed by irrigation working station or irrigation management technicians. Common irrigator may be employed for each rotation unit. In case there is no common irrigator, it may be operated by the irrigation group (PIM). Farm practices can be done by the common irrigator or the member farmer themselves in accordance with the irrigation schedule.

Coordination in actual water delivery in Chinese Taipei is maintained not by a grand plan or a pacemaker, but by an array of institutional arrangements that encourage local problem solving on one hand, and local mutual adjustments on the other. The flexibility of the institutions can cope with the low incentive mode of

agriculture on one hand, and retain a certain level of vibrancy in irrigation management on the other. The viability of the flexible institutional arrangements in Chinese Taipei depends on the willingness of a small group of IG leaders who serve as the bridges connecting up farmers. Although many IGs are no longer as active as before, the role of the IG leaders has become increasingly important for the purpose of coordination.

4.13 TURKEY: After 1993, DSI started to improve irrigation schemes by adopting participatory principles. State provided reductions in water charges for Irrigation Communities who completed their maintenance work of irrigation facilities. These initial works provided successful transition to Irrigation Management Transfer. In current situation, the budgets of irrigation unions are put into force with the approval of Mayor soon after adopted by union assembly. DSI General Directorate has no legally sanctioned power over allocations regarding staff, vehicle, energy, maintenance and repair which are all required for running of the irrigation facility and over determination of irrigation wages which form nearly all income of the union for obtaining the allocation required.

Participatory Privatization of Irrigation Management and Investments Project **(PPIMIP)** has been developed to buy machinery and equipment needed by water user organizations taking over the responsibility of operation and maintenance services of irrigation facilities developed by DSI. Irrigation organizations financed 60-80% of cost of equipment by their own sources, and 20-40% by the project. The project also supported rehabilitation of irrigation facilities.

WUAs in Turkey are non-profit organizations having the right to irrigate within their hydraulic boundary within a range of 300 ha-35 000 ha. There are more than 300 WUAs in Turkey. Main responsibilities of WUAs are setting water tariff together with DSI, implementing O&M activities, repaying the investment costs of irrigation facilities, planning the crop pattern in cooperation with the Ministry of Food, Agriculture and Livestock. Income of WUAs: water tariffs are financial penalties and donations. Water is not priced. O&M costs are charged to users. DSI provides training and monitors activities of WUAs.

4.14 UKRAINE: In Ukraine irrigation and drainage infrastructure is divided into inter-farm and on-farm. Inter-farm reclamation infrastructure is state property and operated by the State Water Agency of Ukraine. On-farm reclamation networks in the Soviet period were and de jure still remain the property of the state, in spite of their transfer into communal ownership by the Government's decree. WUA formation is in active consideration in Ukraine.

5.0 OBSERVED IMPACT OF PIM

5.1 AUSTRALIA: With regard to the impact of IMT on water pricing, with management transfer, although water charges decreased, there was an overall increase in cost of irrigation to farmers collectively. The state government investment has decreased. The efficiency of fee collection, quality of maintenance and timeliness of water delivery showed improvements in the post-management transfer scenario. Investment by governments (principally via Sustainable Rural Water Use and Infrastructure Program [SRWUIP]) has seen dramatic improvements in water use efficiency in systems by reducing conveyance losses and on-farm by adoption of ‘state of the art’ micro, spray and surface irrigation systems. Irrigation infrastructure operators have often seen system efficiencies improve by more than 15% with some realising more than 30%. Within these companies, the irrigation water shareholders take decisions regarding land and water management plans. Efficiency in measurement and supply of irrigation water on a volumetric basis is demonstrated by the fact that nearly 98% of the irrigation water supply points are metered. As management transfer progressed in the MDB, although there was an increase in area irrigated, no change in crop yields or farm incomes was observed.

Although IMT/privatisation is a key component of water resource management reform in the MDB, there was no significant difference in water delivery efficiency between private and publicly run schemes. With regard to distribution efficiency, companies recorded more than 87% efficiency and in some cases reaching as high as 100%. Regarding the impact on the local and regional environment, no changes in salinity and waterlogging conditions due to management transfer were reported.

Consequent to IMT reforms in Australia, irrigation water providers (IWPs) in the MDB have been modernising (with government funds) irrigation management systems with volumetric water supply, advanced measuring systems, effective cost recovery, financial autonomy and effective enforcement. With regard to institutional arrangements and devolution of powers, Australian IMT showed greater decentralisation and autonomy compared to other regions. In the MDB, ownership and management of schemes have been transferred to the local customer-owned business organisations.

5.2 CHINA: Rural water cooperation organizations play significant roles in promoting participative irrigation management, maintaining irrigation and drainage facilities, ensuring facility functioning, collecting water bills, saving irrigation water, raising agricultural productivity, reducing conflicts over water use, and protecting the irrigation rights of the disadvantaged. After the organizations are established, water users are more active in project construction, operation and management as well as more accountable. In China, surface irrigation is the dominant irrigation method, which means relatively low water use efficiency. Since, irrigation water is now priced, it means increased irrigation efficiency.

Observing the principle of benefiting farmers and voluntary cooperation, some rural water cooperation organizations are assisting the process of land transfer. Farmers who own small pieces of farmland or do not want to manage farmland themselves could contract to lease farmland to the organizations. In this way, the service scope of the organizations could be extended, the efficiency of agricultural production improved, and the sustainability of irrigation and drainage facilities ensured.

After the foundation of rural water cooperation organizations, rules and regulations are set up, leading to enhanced water use management, higher irrigation efficiency, improved utilization ratio of agricultural means of production, and lower farming cost. Specialized staff is assigned to distribute water in orderly manner avoiding conflicts.

5.3 INDIA: The legal framework created out of PIM Acts is intended to result in creation of farmers' organizations at three different levels of irrigation system, namely: Water Users' Association (WUA), Distributory Committee (DC), and Project Committee (PC). The PIM can be leveraged upon for improving water use efficiency as well as equitable distribution through various interventions including land development related activities, optimizing water use in accordance with effective crop planning, land consolidation or land pooling, realignment of field channels, effective water rotational system, and system for water measurement. A total 16 states in India have formulated legislation especially for PIM.

Capacity building of WUAs along with training of farmers and extension of recommended package of practices, promotion of improved and advanced technologies to enhance agriculture production and productivity is an important component of CADWM program. Focus is also laid on effective crop planning, efficient water use and promotion of collective action to facilitate easy access to agriculture inputs and marketing with a view to enhance productivity, reduce cost of cultivation, reduce crop losses, increase profitability resulting in additional income.

5.4 INDONESIA: In Indonesia at scheme level the water-use efficiency is not very high for the following reasons: (1) Irrigation distribution based on 2-weekly planning which does not consider effective rainfall; (2) Most distribution structures at primary and secondary level can only distribute but not measure water flows; (3) As in Indonesia the application of geo-spatial information systems in irrigation management is not common yet the exact size of the irrigated area per tertiary block is not known; (4) Because of the relative poor status of the embankments in most cases when the irrigation system is filled up with 80 % of the design discharge, at several places overtopping occurs with irrigation water flowing directly into the drains; (5) Due to the small land-holdings most farmers are 'part-time' farmers and are not present during the entire growing season.

At present the river basins (for Java divided into sub basins) where 2030/2035 demands for irrigation; domestic, municipal, and industrial use; livestock; and fisheries exceed the 80% of assured river flow in any month, the available flow is corrected for existing and planned reservoirs, and for Java it is corrected also for inter-basin transfers identified in the Java Water Resources Strategic Study.

The contribution of industry to both gross domestic product and employment per cubic meter of water used

is higher than that of agriculture, and industries can generally use the same infrastructure as the agricultural sector. Operation and maintenance has not received the needed priority and funding resulting in deterioration of infrastructure and loss of functionality or reduction in the life span of infrastructure requiring high investments for rehabilitation of the existing or construction of new structures. At present, the *kabupaten* and provincial levels underperform in terms of O&M. Water utility (PDAM) performance also shows undervaluation of O&M.

After the decentralization in Indonesia, many of the interventions require investments by regional governments. The central obstacles to financing infrastructure are management and guarantee of cost recovery through tariffs. These obstacles are overcome with time through pressure of praising and exposing, greater transparency, accountability, monitoring, benchmarking, and tariff-payer involvement.

5.5 IRAN: Iran faces the challenge of finding out the right model to carry out the IMT as fast as possible. However, lack of proper methodology for such attempt and lack of mutual understanding about IMT process among the stakeholders are the main reasons for these challenges. It is clear that the transfer of irrigation management from the government to local level constituent (both in public and private sector) and forming irrigation participatory management, which are involved in organizing the operational and maintenance of irrigation network and administrative as well, needs a long-term program. Irrigation management reforms, if not implemented well, can lead to further constraints rather than improving irrigation performance.

The results of Rapid Diagnosis (RD) on IMT show: (i) In transitional time segment, more expenses will result to the farmers to carry out the new responsibilities, so looking for the solutions of such constraints should be paid before WUCs' constitution; (ii) After the WUCs were constituted, the local government organisations (GOs) like JAM&MOC, should pay continuous attentions to WUCs with respect to strengthening them; (iii) WUCs should be supported (not as a charity, not as a subsidy, but as a real means of participatory) and strengthened for a transitional time segment, while it is necessary; (iv) IMT has own defined process, which should be passed as well as possible.

5.6 JAPAN: Development of agricultural irrigation and drainage facilities enabled the mechanization of rice paddy farming and independent irrigation and drainage systems for each parcel of land, however, new challenges are part-time farming and the aging of farmers. Additionally, measures against the concentration of water consumption at peak times, automatization and labour-saving improvement of management of land improvement facilities, and energy-saving measures for agricultural irrigation and drainage facilities are needed. In water basins located in extremely populated large cities, where the facilities have a large impact on the water supply to meet the water demands unique to urban areas in the time of drought, LIDs cooperate with the local governments to coordinate water usage in the basin.

5.7 SOUTH KOREA: There was a recent study for the IMT with an extensive survey with structured questionnaires. The survey results showed that most of the farmers, KRC members, and local government officials agreed with the IMT from local government to the KRC. However, the transfer of assets revealed divided opinions for the farmers' contribution to the maintenance of canals, including clearing water weeds and dredging ditches. In addition, some actions have to be implemented to improve irrigation management by encouraging farmers' participation under the public irrigation management (PubIM) system.

Irrigation canal and drain improvement is steadily implemented to increase irrigation efficiency. Earth, lined and flume canals are quite typical waterways for irrigation in Korea and drop, chute and gates are usually used for slope declining and water distribution in irrigation networks. Structured canal ratio has been increased due to the effort for irrigation efficiency improvement. In addition, the use of ICT applications for agricultural water resources management is being made due to its benefits in terms of efficiency improvement and cost effectiveness**.**

5.8 MALAYSIA: The performance of the PIM can be assessed by the successful implementation of double cropping since the first double cropping in the Muda Area pilot project in *Kubang Sepat* took place in 1974. Double cropping has since been implemented annually except for the incidence of drought in 1978. The concept of *"neighbouring in the farm"* is difficult to practice among the farmers due to absenteeism among the farmers in the farm. This is due to the fact that the farmers tending their plot are not residing in the locality. Proposals by the Authority for the farmers to operate tertiary irrigation structures for water

supply also were not well received by the farmers. Situations arise, when irrigation turnouts and regulating structures were damaged probably due to unsatisfied individual farmer on water conflicts in the paddy field. The formation of WUA in the irrigation blocks with local participation from the same and neighbouring villages in Small Farming Units are more acceptable to the farming community.

5.9 MEXICO: In order to enhance the technical and administrative management of Irrigation Districts, the State, together with the users developed the "Master Plans for Irrigation Districts". The impact of investments and actions is evaluated through a set of social, technical, and economic indicators within a framework of action aimed at the sustainability of Irrigation Districts. Among the actions that the Mexican Government has prioritized through institutions such as the National Water Commission, together with the users, a series of programs have been promoted for the rehabilitation, modernization, and technification of irrigation districts; the efficient use of water and energy; the reimbursement of payments for block water supply; the technification of gravity irrigation; the recovery of saline soils with on-farm drainage; and the training of users on water resources management and agriculture.

Through the Modernization and Rehabilitation Program for Irrigated Areas, the State contributes up to 50% of the investments for high- and low-pressure irrigation systems, as well as for the technification of gravity irrigation. With regards to upgrading the machinery for the conservation of hydro-agricultural infrastructure, support is provided for the acquisition of various pieces of equipment. Thus, the users are in better conditions for carrying out maintenance and rehabilitation works in canals, drains, and roads within irrigation zones.

Very positive changes have been generated in the legal field, which have been reflected in the National Water Law, which regulates Article 27 of the Political Constitution of the United Mexican States. These instruments have made it possible to consolidate and formalize the transfer of Irrigation Districts. On the other hand, mechanisms have been established to promote and capitalize investments shared between the State and the users in favour of improvements in the technification of agricultural land and, consequently, in the hydro-agricultural productivity within the 3.5 million hectares under their responsibility. Achievements and impact of irrigated agriculture:

- Legal
  - Laws and regulation on national waters
  - Transfer of irrigation districts to users
- Construction and technification in irrigated agriculture
  - Hydro-agriculture infrastructure in 6.5 million ha
  - Federal support programs for hydro-agricultural infrastructure
- Transfer of science and technology to the Mexican countryside
  - Irrigation technification in 850,000 ha
  - Increase in agricultural production
  - Permanent training for irrigation users

The positive effects and impacts of these reforms are visible and quantified in a tangible way through the evidence associated with the construction of new dams to increase water availability for irrigation purposes; the construction and lining of canals to increase their conduction efficiency; the opening and piping of drains to drive surplus flow outside the irrigation areas, to lower elevated water levels, and to control salinity; the installation of wells and pumping plants to aid irrigation; and the transfer of irrigation technology itself, such as the Program for the Technification of Gravity Irrigation from which 200,000 ha have been benefited. From the agricultural statistics of irrigation zones, the evolution of water productivity has been increasing, from 1.1 kg/m3 in 1990 to 1.83 kg/m3 in 2014.

5.10 NEPAL: A study of 102 irrigation systems of Nepal at Indiana University revealed that the systems with high level of farmer participation perform better in terms of economic and technical efficiency. The physical conditions are considered much better. The difference of cropping intensity between head and tail is less. The water supply in head and tail is not much different. On the other hand, systems with low level participation have poor performance in economic and technical efficiency. The physical condition of the large percentage is not good, water supply between head and tail is different making scarce supply at the tail end.

The study shows clearly that the investment in physical infrastructure alone does not produce positive results. The formation of social capital compensates even in weak infrastructure. However, in the absence of social capital, permanent structures also would be less productive. Therefore, the social capital helps towards the self-management of irrigation systems. With such management type, the important issue of equity, participation of the farmers, accountability and transparency are institutionalized.

5.11 SUDAN: Gezira irrigation scheme (GIS) had witnessed a significant decrease in water management performance and agricultural productivity which led to many institutional changes aimed to put the system on the right path. There are many studies conducted to evaluate the policies related to the irrigation water management in Gezira scheme. When the Gezira Scheme Act of 2005 adopted and the WUAs were formed and given responsibility of maintaining the minor canals and water delivery to their farm, the situation has become worse and it is really a “disaster.”

The modern irrigated agriculture started with the Pumping Scheme in Zaidab, Northern Region. The irrigation water charges were introduced to encourage the farmers to increase their productivity. However, the farmers and the agricultural boards were reluctant to pay the amount to the government and consequently irrigation operations to deliver water were severely affected.

5.12 CHINESE TAIPEI: Water delivery achievement in Chinese Taipei might attribute to the technical renovation on water management and heavy investment in the improvement of irrigation facilities. Contemplatively, this practice had enabled water controllers to convince water users that the scarcity of water is being distributed equitably to a maximum extent so that the use of water in the field could maintain orderly, of which might ascribe equally or even more than the technical amelioration and heavy investment to the success and sustainability of water management.

A systematic research on water application methods for paddy rice was conducted in the Chianan Irrigation Association. Information from these experiments coupled with actual demonstration experiences in the new canal system gave confidence to the irrigation engineers to develop the specifics of "Rotational Irrigation." It has rapidly displaced the conventional continuous irrigation. The study found that the rotational irrigation compared to the conventional irrigation has the following advantages: (1) Rotational irrigation has shown to achieve water saving by 20-25 percent as compared with conventional continuous irrigation in the long-term; (2) Most cases indicate a higher yield with rotational irrigation; (2) Rotational irrigation decreases irrigation disputes and helps the development of cooperative atmosphere and order in the practicing irrigation in the rural areas; (3) Rotational irrigation encourages the use of the common irrigator, by which the farming time on irrigation by individual farmer can be saved resulting in farming efficiency.

5.13 TURKEY: Before the establishment of WUAs, there were low ratio of billing and collection rates, high water consumption, no cost recovery for investment, and no interest by local farmers to protect the infrastructure. The transfer of O&M services to the Water User Organizations has had positive impact on the O&M issues both from the technical and financial point of view. The participatory approach by the users has generated a sense of responsibility that did not exist before, to better use the resources and the facilities and protect them. Water use is more reliable and equitable, the plots situated at the upstream or the downstream of the irrigated land are equally served. State expenditure for O&M decreased by 80% in 15 years. With the establishment of WUAs all around the country, excessive use of water in irrigation decreased significantly. Accordingly, this resulted in protection of water resources and effected the soil and water quality (decrease in salinity). Improvement of O&M services enables the efficient use of irrigation water.

Irrigation efficiency has been attained. Overall, the area of irrigated land has increased for the same volume of water, a consequence of better operation and maintenance of the facilities provided by the local O&M (operation and maintenance) staff of the WUOs. Energy consumption of pump irrigation has decreased after the transfer.

6.0 CHALLENGES

6.1 AUSTRALIA: Accurate measurement of water use is a critical component of water management, particularly at the farm level. The National Water Account focuses on the volume of water in the

environment, its availability, the rights to abstract it and its actual abstraction over time. The framework was first issued in 2009 and revised in 2014 by the Water Accounting Standards Board, as part of the Bureau of Meteorology's water accounting function. The framework was developed by consulting water industry experts, financial accountants, and financial accounting standard setters. The 1994 Council of Australian Governments (COAG) agreement included general principles for pricing, including consumption-based pricing, full-cost recovery and (desirably) the removal of cross-subsidies. In respect of rural water supply, the agreement provided for a move to full cost-recovery and to achieve positive real rates of return on the written-down replacement costs of assets in rural water.

Irrigation infrastructure operator in Australia typically provides two main services to its customers: to make available capacity of its irrigation network for the delivery of water to be used in irrigation; and to make available capacity of its irrigation/drainage network for the drainage of water previously used in irrigation. The Australian government recognised that funding was required to these new system operators to undertake 'hot spot' analysis to identify where the systems had excessive leakage or operational constraints, which were seen as major contributors to poor irrigation delivery efficiency.

Irrigation providers are the organisations which undertake retail water distribution, primarily to agricultural and horticultural irrigators but also to agricultural stock water users, rural house and garden users and bulk purchasers including rural towns, factories and industry, and stock and domestic leagues. Irrigation providers divert water from the river systems released on an allocative basis which is matched to specific orders of irrigation providers.

PPP in the irrigation sector is about investment by both private enterprise and principally by the Australian government in improvements to irrigation infrastructure, both off farm and on-farm, that results in an outcome for both of improved delivery and water use efficiency with most savings being transferred to the environment and hence the people of Australia.

In Australia and in particular in the MDB, water markets operate within all irrigation management systems, both surface and groundwater. The existence of this water market mechanism, has enabled irrigators to manage the risk of increased supply uncertainty.

6.2 CHINA: With a relatively weak basis, rural water cooperation organizations lack capacities for making small irrigation and drainage facility construction plans, participating in construction and management, water-pricing for farm-level canals, collecting water bills, upholding property rights, and managing independently. For the purposes of enhancing irrigation water management and establishing rural water cooperation organizations as the governing body of irrigation water, the monitoring and supervising mechanisms of water consumption have to be improved further. Currently, Chinese government is promoting comprehensive reform of agricultural water price, gradually increasing the de facto water price to the level of running cost water price. The Chinese government is investing heavily in the renovation and construction of irrigation and drainage facilities, targeting at improving the irrigation and drainage system and increasing auxiliary projects and is actively encouraging private capital to participate in the construction and management of irrigation and drainage facilities. Rules and regulations have been issued, and pilot projects launched.

To improve the currently inadequate capacity of rural water cooperation organizations, in addition to achieving standardized management through formulating policies, rules and regulations, irrigation district authorities should enhance technical guidance, and the local governments should organize training sessions and experience sharing conferences, and provide funding to subsidize their operation, management, and office equipment.

6.3 INDIA: The challenge of development and management of irrigation system is essentially a challenge of bridging the gap in demand and supply of irrigation water, with water delivered in right quantity and right time to every individual farmer's field. This challenge of demand and supply imbalance can be managed by enhancing supply (Supply-side solution) and curtailing demand (Demand-side solution).

6.4 INDONESIA: The average water footprint (defined as the total amount of water that is used to produce goods and services) in Indonesia in relation to consumption of crop products is 1,131 cubic meters

per capita per year (m^3/cap/year), but there are large regional differences. All island groups except Java have a net export of water in virtual form. Java, the most water-scarce island, has a net virtual water import and the most significant external water footprint. This large external water footprint is relieving the water scarcity on this island.

In Indonesia in particular on Java rainfall is relative abundant as a result of which Indonesia has no history of efforts to determine cost recovery and/or charge for water. However, with regards to cost-sharing for future development in non-irrigation sectors Indonesia has developed the following vehicles: SFWRM (service fee for water resources management); Tariff of PDAM (fee for processed drinking water by water utility); and Tariff for Sanitation.

Other Challenges include: (i) Engineering challenges related to infrastructure; (ii) Possibility of Public Private Partnership (PPP) for financing and improved service delivery; (iii) Issues in up-scaling PPSIP (Participatory Irrigation Management and Development); and (iv) Capacity Development.

6.5 IRAN: Execution of PIM in national level needs holistic plan for enhancing the institutional capacities (including: GOs, NGOs, private sectors and local communities) at all levels. In this regards we need some more investments. To carry out the PIM process or to combine the traditional and modern forms of participatory management needs a special knowledge and specific skills. Due to insufficient professional experts and lack of proper methodology adaptable to different social-physical characteristics of Irrigation networks, to conduct any plan of PIM in Iran needs a mid-term program in some pilots. This might help develop a sound methodology and ground rules for PIM in Iran.

6.6 JAPAN: Agricultural water supply systems can play a full role only when the whole series of facilities—from the main facilities to tertiary facilities—function in a united form. While agricultural field improvement projects are completed in about 64% of rice paddies in Japan, measures to deal with the anticipated conditions, where the number of farming households involved in local agricultural irrigation and drainage facilities, and their maintenance and management, should be taken. Large-scale renewal of irrigation and drainage facilities that requires huge cost has become difficult. Consequently, LIDs have to obtain information on the health of facilities with a diagnosis of their functions, while engaging in the routine facility management.

The conditions surrounding local agriculture and LIDs are changing, while roles demanded for LIDs have become more diverse and complicated. Against this backdrop, and when the conditions of financial foundation, such as member fees and savings, and human resources including executives and officers are concerned, small-scale LIDs are facing the possibility that they cannot survive in the *status quo*. Maintenance and management of tertiary canals (i.e., those at agricultural field levels) are conducted by cooperative activities of individual farms and settlements. The recent decline in the functions of settlements are facing a concern in the ability to excise their functions.

6.7 SOUTH KOREA: The following issues have been major challenges in South Korea in the implementation of PIM:

- Proper implementation of water accounting and auditing
- Engineering challenges in soft-infrastructure building for the fourth industrial revolution and linking of institutional and organizational structures in irrigation sector and the related sectors
- The direction of Public Private Partnership (PPP) in South Korea through reorganization of the Water User Groups (WUGs) to revive the concept of PIM through the autonomously reinforced new type of WUGs and recover the rights of collecting water fees from the farmers for the better irrigation service adjusted by PPP between WUGs and KRC (Korea Rural Community Corporation).

6.8 MALAYSIA: As Muda Area is the major contributor/player of irrigated agriculture in the country, management of water resources available for water savings and environmental conservation need a policy review for the benefits of other consumers in the region. The present wet seeding culture in Muda Area consumes very high amount of water annually (1600 mm-1800 mm). Direct seeding in standing water can reduce water consumption for paddy planting substantially and will provide better water management in the Muda region. The MADA's irrigation management practice is in collaboration with the farmers' leaders when

fixing the planting schedule for every season needs improvement with effective communications so that there are no delays in the planned activities.

6.9 MEXICO: The main challenges for the irrigation sector in Mexico are: water and food security in the face of climate change; to increase agricultural productivity in irrigated areas; opening of new irrigation zones in southern Mexico; sustainable optimization of water resources; greater technological transfer to the Mexican countryside; to improve governance and to consolidate the governability of institutions within the hydro-agricultural sector; application and adaption of the National Water Law and its bylaws; to introduce systems to control excess moisture; to develop and design new irrigation infrastructure for diverting and using the water from the multiple and large rivers; to increase the overall efficiency with which irrigation water from surface sources is managed, distributed, and supplied, and to implement countermeasures for poor irrigation practices and excessive water withdrawals leading to over-drafter aquifers.

6.10 NEPAL: The water share arrangement should ensure that each member of the irrigation community has a legitimate access to water within the arranged rules, and it confers an obligation to contribute an agreed-upon share of the cost of managing water in the system. The concept of water shares unites two essential aspects of organizational operations — resource acquisition for operation and maintenance and water allocations along the canals. Members of the irrigation committee should be irrigators who represent the various reaches of the canal system and are fully accountable to their fellow irrigators.

Almost all schemes of management transfer suffer from a dependency of the new organizations upon the government. Researchers have concluded, “Water Users’ Associations have not been effective because they did not reflect the multiple needs of the farmers, rather they work as an extension of the irrigation department in many places. Water Users’ Associations should develop a self-reliant basis for their functioning, in their areas of jurisdiction, while they pursue an interdependent relationship with the government agencies.” This pattern of dependency on the promoting agency has been reported frequently, and from many different types of economic and political environment.

The core of the problem is that the new organizations are initially accountable to the promoting agency of government. The direction of accountability must change, so that they become accountable to their own membership. If this does not happen, they are not likely to become sustainable as independent organizations. So, when researchers suggest that the organizations must "develop a self-reliant basis," we should recognize that development of self-reliance does not depend only on actions and behaviour of the organizations and their own leaders. It will be decisively influenced by actions and behaviour of the promoting agency, and of agency officials who are in frequent contact with the water users' or irrigators' organisation.

6.11 SUDAN: The system adopted for water delivery makes it difficult to run a water accounting and auditing on an individual water user. This is main cause of the inefficient water usage. The irrigation system needs to adopt a metering system to charge the farmer according to his abstraction. In view of the vast areas and the cultural behaviour of the farmers, a sophisticated metering method will not be advisable. The actual amount of water delivered at the head of a minor for a group of farmers may be calculated and water charges may be divided equally between them. This may be the most practical method at hand.

The GIS was a gravity irrigation scheme where most of the scheme is commanded from Sennar dam on the Blue Nile River. However, during the operation and maintenance work, due to excessive digging the minor canals resulted in deeper channels, so gravity irrigation could not be practiced and many farmers are now obliged to use pumps in order to irrigate which resulted in extra costs to the farmers. Also, due to water shortage in some areas the farmers practiced vandalism and damaged many cross regulators and weirs to secure water for their farms. Now it has become a major challenge for the irrigation engineers in controlling and regulating the water in the various canals. WUAs were formed and given responsibility of maintaining the minor canals and water delivery to their farm, however, the situation became worse and it is really a disaster that the flows to the scheme increased, while the cultivated area decreased.

In 1992, the Sudan Government adopted a major economic reform and introduced liberal economy, where all the government irrigated schemes were financed through a consortium of banks (mainly private) which were instructed to finance agriculture in the country. The interest of the Banks’ credits was extremely high

in the beginning (about 70%) in comparison to the facilities offered. This system resulted in a severe setback to the whole agricultural production due to lack of experience in financing agriculture and resources; consequently, this situation resulted in a reduction of cultivated areas and lower productivity.

Due to the new government policy, private sector is getting involved in the irrigated sector. Various forms of finances are introduced varying from sharing the costs and revenue, or securing the finance through bank guarantees and land leasing. Other forms of private sector partnership through agreements with a group of farmers are also being considered.

6.12 CHINESE TAIPEI: Since the early 1980s, Chinese Taipei's irrigation has been facing substantial challenges as agriculture lost its economic importance; the decline of agriculture has come with drastic changes to the country's social-political contours. Several other challenges included vulnerability to the process of industrialization, maintaining the grain reserve for population consumption, the structure of agriculture that is vulnerable to change or diversification, impact of political economy on irrigation management, constraint of the involvement of the farmer on irrigation O&M, constraint of the government to tighten effective irrigation control, challenge of utilization and allocation of water across sectors. As a result, irrigation in Chinese Taipei has taken on new features including a dominance of part-time farming, an increasingly heavy reliance on groundwater, and a growing integration of irrigation into the national water management regime; all these have reduced farmers' incentives to engage in self-governing activities for irrigation management.

However, if the agricultural sector had been able to diversify production, the government's food and agricultural policies would not have affected agriculture too adversely. Unfortunately, the structure of Chinese Taipei's agriculture is not helpful to diversification or change. The political economy of agriculture as described has impact on irrigation management at two levels. Low-incentive mode of agriculture poses serious challenges to Chinese Taipei irrigation management which is grounded upon farmers' participation and farmer-government synergy. At the sectoral level, the change has posed to the government the difficult question of how to restructure its relationship with the irrigation sector. Another dimension of the challenge at the sectoral level is concerned about water resource allocation and utilization across sectors. The challenges at both the operational and sectoral levels have impact on the operation and management of irrigation systems in Chinese Taipei.

6.13 TURKEY: The following issues have been major challenges faced by Turkey:

- Challenges on Land Holding Situation (small farm size resulting in low incomes)
- Degradation of Catchment Areas (excess usage of groundwater in drought years)
- Degradation of Catchments (Floods and Droughts due to global warming and climate change)
- Torrent and drought in relationship with ecological degradation
- Excess or lack of rainfall leading to flood/drought disasters
- Drought may arise from water shortage and from the situation that water amount could not meet the water demand
- Global Climate Change Impact
- Need for Surface Water Irrigation Facilities (irregular river regimes and rainfall patterns resulting in variable average annual precipitation, evaporation, and surface runoff with respect to time and geography)

6.14 UKRAINE: As a result of climate change, the area of dry and very dry zone has increased by 7% and covers more than 29.5% of the territory or 11.6 million hectares (37%) of arable land. The area with excessive and sufficient atmospheric moisture, on the contrary, decreased by 10% and occupies only 22.5% or 7.6 million hectares of arable land. Thus, permanent irrigation in Ukraine requires 18.7 million hectares of arable land, 4.8 million hectares - periodic.

The existing state policy in water management area is ineffective because of the unresolved and unsettled nature of a number of issues, namely: the absence of a single independent authorized body that would be responsible for the development, monitoring and implementation of state water policy; the lack of a delimitation of the functions of water resources management and provision of water services to all

consumers; uncertainty of the status and authority of the basin councils; unregulated participation of water consumers at all levels of water resources management and land reclamation, etc.

In order to meet the existing challenges and implement the existing potential of the country in the field of irrigation and drainage, it was decided to develop a Strategy for the restoration and development of irrigation and drainage systems in Ukraine by 2030 involving experts from World Bank into this project. Reforms are necessary for new market economy and to stop decline of irrigation and drainage sector and to increase its efficiency.

7.0 WAY-FORWARD AND RECOMMENDATION

7.1 AUSTRALIA: Successful practices in the MDB such as irrigation management transfer (IMT launched at the initiative of irrigators), water trading, water accounting and assessment, modernisation of irrigation management practices, transferring of water right to private sectors, efficiency of volumetric water supply, preparing effective and standardized National Water Management Account, driving water to its highest value, needs to address the issues of long-term environmental sustainability, appropriate institutional arrangements to facilitate the management of surface water on a basin scale, formulation and implementation of effective land and water management plans for the jurisdiction of the entity, volumetric supply of water, cost recovery and command area communication, design and operation of the accounting system should be replicated in other regions as well.

A sustainable irrigation management policy in the MDB, while driving water to its highest value, needs to address the issues of long-term environmental sustainability. The size of WUAs needs to be enlarged along with upscaling of water management into water distribution, works, engineering, environmental services and financial services. Water rights of individuals and the entities need to be clearly defined and enforced effectively; Water reform is a work in progress and will continue to change and refine overtime.

7.2 CHINA: The following thoughts have been put forward to solve the current problems facing rural water cooperation organizations and to promote their innovative development.

- Enhancing the inner strength for development through comprehensive reform **–** The property rights of small irrigation and drainage projects should be transferred to village authorities, and right of use should be transferred to qualified rural water cooperation organizations.
- Developing Socialized Service Agencies Depending on Specialized Co-ops – The development of socialized water service agencies should be supported for the professional maintenance of irrigation and drainage facilities.
- Expanding Channels of Financial Support and Enhancing Regulation of Agricultural Water Consumption – Financial support to rural water cooperation organizations should be strengthened through purchase subsidies.

Future plans include: increasing government investments; standardizing the management of rural water cooperation organizations and exploring development models that suit local conditions; enhancing capacity building and formulating policies of government subsidies; organizing training sessions and encouraging experience exchange to improve management; introducing private capital into the establishment and management of rural water cooperation organizations.

7.3 INDIA: The development and management of irrigation in India is unfortunately compartmentalised which should be dismantled. Further, the irrigation problems can be resolved judiciously only by keeping the stakeholders (mainly farmers) at the forefront. A holistic approach, involving both Structural and Non-structural interventions, can provide a comprehensive and sustainable solution for India's irrigation development. The way forward shall be charted in terms of short-term plan (up to year 2020), medium-term plan (up to year 2025), and the long-term plan (up to year 2035). The **short-term plan** will essentially focus on consolidation of efforts for the successful completion of all irrigation development projects already in hand. The **medium-term plan** will target those projects which have commenced in the past but languishing for numerous reasons, and which are left out from the present prioritization. The **long-term plan** will target new projects starting from scratch, i.e. taking up of pre-feasibility studies, preparation of detailed project reports, impact assessment studies, techno-economic and socio-environmental clearances, followed by construction activities.

Some of the recommendations for strengthening of PIM in India are planned integrated approach for agricultural water management, pricing mechanisms for irrigation water, better demand-supply management and technological upgrades for irrigation. The PIM is being continuously promoted under the Command Area Development & Water Management (CADWM) program of the central government. Some of the recommendations are made in this regard: the CADWM program has been taken up to facilitate the process of creation of WUAs and their taking over of the control and management of irrigation system. (i.e. PIM); in CADWM implementation, optimal standardization can be beneficial in terms of ease of doing, quality control, comparison of cost of construction etc.; WUAs shall be empowered for taking financial decisions on their own; a greater level of coordination and communication needs to established with WUAs for determination and enforcement of warabandi (rotational water supply); market level intervention for farm produce influencing farmer's crop choices.

7.4 INDONESIA: The current presidency has 9 main development goals referred as the '*NAWACITA'* program, in which irrigation plays a large role as already on the island of Java some 50 million persons depend on irrigation as their main source of income. The relevant matters for the irrigated agriculture sector are the goals of food self-sufficiency in 2018; the development of 1 million ha new irrigation, the rehabilitation of 3,000,000 ha, the construction of 49 new storage dams; the adoption of sustainable approaches to farming on rehabilitated upland areas; the development of farm roads; and increased adoption of environmentally friendly technologies for food crops.

The 10 main recommendations for the improvement of the irrigated agriculture in Indonesia are: (1) Water Resources Management; (2) Regional Autonomy; (3) Fiscal Budgeting; (4) Agriculture Extension; (5) SDA Data Gathering; (6) WUA/WAUF and KOMIR Empowerment; (7) Irrigation and Drainage System improvement; (8) Land Consolidation; (9) Single Irrigation Management; (10) Irrigation Management Unit. Other recommendations include development of infrastructure; introduction of real-time irrigation; and increase in routine operation and maintenance funding for irrigation systems.

7.5 IRAN: Based upon experience in the Implementation of IMT in Iran, the followings are concluding remarks: (1) Irrigation Management Transfer - IMT is a part of water resource management reforms in Iran; (2) Three parallel efforts have been conducted for IMT/ PIM in Iran and have more positive impacts on front line of decision-makers' attitude and have more lessons learned for future plan; (3) Past two decade experiences have a few positive impacts on local communities; (4) There are four classified constituents in the PIM process - Participatory Diagnosis, Participatory planning and implementing, Up scaling and out scaling, and Participatory Monitoring and evaluation. Only a part of the second one has been taken into the considerations by the IMT/PIM executive teams in Iran. (5) There is more institutional capacity for IMT in private sectors (OMICs & RPCs & RCCs), but no one was reconstructed for this mission; (6) At the moment, more attention of front line of decision-makers (government & congress) have made several wide channels to flows the IMT/PIM in the GOs body and the private sectors; (7) Current national plan of Irrigation management reform has no providence for IMT.

7.6 JAPAN: The governments will continue supporting the cooperative activities of local communities to maintain and manage agricultural irrigation and drainage facilities. In other parts of the world, efficient water-use to deal with the shortage of water resources is needed along with water management to deal with climate extremities. Further, ICT and other new technologies may allow remote monitoring of the water level of each farmland and irrigation and drainage canals on mobile devices and remotely control valves or other equipment. Such new technologies should be used to further develop energy-saving and efficient water management, and advanced usage of water.

Farmer-participation irrigation management has been tried in many developing countries since the 1990s with the cooperation of international organizations. Introduction of irrigation facilities brings increased food production to each farming household. However, as irrigation facilities can work fully only when the cooperative work of groups in maintenance and management is properly conducted, development of capabilities of farmer organizations in water allocation, as well as in maintenance and management, along with increased appealing capabilities to attract farmers to the organization, is essential when starting farmer-participation irrigation management.

In many of the developing countries, no farmer organization that can manage facilities exists to begin with, or even when such organizations exist, they are hardly functioning. JICA has been fully working on technical transfer in farmer-participation irrigation management since around 2005 to developing countries based on the experience and technologies accumulated by LIDs in Japan.

7.7 SOUTH KOREA: The function of PIM and PPP should be recovered by reorganizing WUGs (Water Users Groups) with decision making rights and water price duty for better water sharing and service. The PPP for enhancing the irrigation water use efficiency in supplying and cultivation processes are very important. The irrigation water efficiency should be the indicator between the amount of water required for irrigation purpose and the amount of water used or delivered for irrigation.

Recently, the smart farming boom using the fully controlled environment with ICT has been created. The smart farming and further smart crop production factory would be alternative solutions for limited land and water problems. The 'smart' cultivation can be an attractive job market by accomplishing one's own little world water-food-energy nexus.

Agricultural water management is so complex because it concerns different spatial and temporal scales and multiple stakeholders with varying goals. The ICT infrastructure in South Korea is now well equipped for irrigation management applications between government and farmers. Thus, as the future irrigation water management of South Korea, it is necessary to build the bi- or multi-directional synchronous linkage of shared information for irrigation management. This is the direction of 4th industrial revolution preparation in agricultural activities.

7.8 MALAYSIA: As the country is rapidly moving towards transformation into a high-income nation, agricultural development specifically paddy production should be the driving force of the National Agriculture Policy by providing sufficient food for the people and provide "new spin off" industry to the farming community. The capacity development no doubt will be complex and demanding task for the authority to pursue nonetheless it is indeed crucial to be carried out for successful transformation.

Knowledge generation, management and dissemination are important to ensure the success of capacity development. This will develop farmers who are aware of the nation's environmental endowments. With the increasing importance of governance in water sector the knowledge acquired will definitely equip the farmers in development of high income rice growers in the country which will be truly inclusive in nation building.

7.9 MEXICO: Not all the challenges of the sector are technical in nature. In parallel, there are a series of challenges to continue with the enhancement of irrigation organizations; they will have to seek integration in order to have a shared vision throughout the hydro-agricultural sector in order to achieve the joint sustainability of irrigation districts, irrigation units, technified rainfed areas and normal rainfed areas. A model of integrated management and an orderly process in view of the necessary conversion of certain areas from rainfed to irrigated areas should be introduced, as well as the introduction of changes in economic activities, crop patterns and the application of clear and equitable rules for water distribution; all this backed by the promotion of technology adoption.

7.10 NEPAL: The irrigators are encouraged to take the responsibility of management of irrigation systems. Since there has been change in the management of state affairs and less importance has been given to state control of management of public enterprises and natural resource management, the community of irrigators have proved that they can manage system through self-management mode. In order to make self-management effective, active participation of the irrigators, polycentric mode of governance, effective water users associations and social capital development have to take place. Hence, DOI is implementing WUA towards self-management.

7.11 SUDAN: The Memorandum of Agreement signed by a group of Farmers and a private company from South Africa is planned to be implemented next season. It will be a good example to change the agricultural practices in Sudan. The World Bank is also offering a salvation program: Rehabilitation and Modernization to the irrigated sector starting with the Gezira Scheme. This program is under preparation. If the said practices are successful, these will be replicated and scaled up spatially on a larger area.

Sudan is endowed with vast agricultural lands and has good experience with irrigation. In view of meagre financial resources, it is recommended that the government should make the proper polices and adopt the PPP concept and introduce it gradually in the irrigation sector. For the irrigation schemes, it is recommended to start with small areas and gradually expand. Private sectors should also be encouraged to invest more in agriculture with the government support in the form of tax holidays. The water should be charged by volume instead of flat rate. Awareness campaigns designed to farms' needs should be put in place.

7.12 CHINESE TAIPEI: The worsening of climate change in recent years has brought the hydrological conditions into more extremes, and threatens the water sectors. Especially for irrigated agriculture, the irrigation land is always forced to conduct fallow in order to transfer the water to other sectors, which may introduce the deficit risk shift to irrigation sector and food security problem. That is, traditional irrigation practices are no longer capable for the normal operation of water resources distribution, and hence new ideas are needed.

The Irrigation Associations should not confine themselves on the single service of irrigation. Instead, through diversification of the businesses by making better use of the facilities, land assets, and human resources, the financial situation of the Irrigation Associations should be significantly improved. The example of Chia-Nan Irrigation Association in southern Chinese Taipei is a successful case. Besides traditional irrigation and drainage, Chia-Nan Irrigation Association also engages in: (1) power generation by setting up a power plant, yet under the condition that water conveyance is not affected, (2) renting the canal network to other sectors for water conveyance, (3) constructing business buildings for commercial use, and (4) establishing water-friendly parks or entertainment parks beside the waterways. The management of sustainable diversification without selling properties by the Chia-Nan Irrigation Association is definitely a model example in Chinese Taipei.

7.13 TURKEY: Operation and Management (O&M) of DSI General Directorate is in the process of developing a new Irrigation Management Information System (MIS) called SUTEM. O&M Department has implemented questionnaire for WUAs based on 84 indicators in 2016. The results indicate that 78% of WUAs are operating successfully, 13% are satisfactory and 9% are not satisfactory.

Generally, a WUO would manage irrigation cooperation, if the WUO has 5,000 ha or more agricultural area . Generally, WUOs having agricultural area less than 5,000 ha and WUOs having pumping irrigation facility face difficulty in paying energy and maintenance cost. Solar panels have been installed to overcome this situation. Further, it is absolutely necessary to have storage facilities to ensure irrigation and domestic and industrial supply, and to generate hydroelectric energy.

There are also some WUOs not managed well. Alternative operation models are being studied for the irrigations which were not able to be transferred to any organizations or which are unsuccessful in their operations. One option is Transfer of Operational Rights to Municipalities. Another one is procurement of the operational services. In addition to existing projects, by 2023 Turkey aims to attain 200 BCM (existing capacity is 165 BCM).

7.14 UKRAINE: Reforms are necessary for new market economy and to stop decline of irrigation and drainage sector and to increase its efficiency. Management and operation of local irrigation and agricultural drainage systems will be transferred to WUOs, under a new WUO Law. These will be non-profit bodies of public law set up and managed by their members to provide specified services in irrigation and drainage. They will employ professional management and must have sufficient scale to employ specialist staff, equipment and systems. The creation of WUOs should precede the legislative settlement of issues such as legal form of WUOs (public organization, not private law); the task of their activities, rights and responsibilities; the procedure for the elaboration and adoption of the Statute; the order of management and decision-making; organizational structure and principles of activity, including budget formation.

The two functions of managing water resources and operating infrastructure should be separated because the roles are very different and there is a potential conflict of interest given the competing demands of other water uses and the impact of agricultural run-off on water quality. Phase I would strengthen the Water Resources & Operations Divisions within the State Water Agency, and begin a functional review of ancillary

functions and reorganize the resource-management staff in the current region and district water management units. Phase II would see the canals and drainage infrastructure moved out of State Water Agency into new regional bodies. Water Agency ancillary services, such as design bureaux and training institutions, would be retained, restructured, relocated or privatised. Inter-ministerial coordination would continue under the Inter-Agency Commission for Water Resources during Phase I, though with an independent chairman from outside SAWR. In Phase II, it would be succeeded by a National Water Resources Committee to coordinate the activity of different ministries in the management and use of water resources.

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