2019 FIRST QUARTER

ICID news

A WATER SECURE WORLD FREE OF POVERTY AND HUNGER

MESSAGE FROM THE PRESIDENT

Dear Colleagues,

A critical mass of technological solutions to global water problems, particularly in the agriculture sector, is building up and it is quite re-assuring that key decision makers around the world are taking note of this opportunity. During my work-related travel to various countries over the last couple of years, I have observed a sense of optimism all around despite all the challenges that we face due to erratic climate change phenomenon and its potential adverse impact on our long-term food and water security. Over the course of evolution, humankind has always been busy finding solutions to survival challenges and in our sector, I see the promising role that technology will play to bail us out. Through this brief message, I would like to share some of my thoughts on agricultural water productivity issues and options available to us.

Water productivity in agriculture, a common measure of crop water performance, is largely a function of the technology used in the water application. Other factors may include the crop and soil type, water management practices and local precipitation levels. Flood irrigation has been a traditional method of water application in most situations globally even in water-scarce conditions. However, as the demand for water grows in the other sectors of the economy, agricultural water use attracts the first attention of policymakers and water resources managers for potential savings. The general expectation is that agricultural water use needs drastic improvements so that water can be shared more justly among the various demands.

Irrigation and water resources engineers have been tackling this issue ever since greater diversion of freshwater to other sectors such as industry, services and domestic supplies began at a rapid pace. Disregarding the environmental benefits of flood irrigation, the current thinking in the sector tilts towards improving crop water productivity, meaning more production with less water application, as a way forward. Precision irrigation that matches the crop water requirement with the available supply is an area that has received a significant research interest and as a result, many innovations are now showing commercial viability. The basic principle behind precision irrigation is quite simply that the crop water requirement needs to be measured as accurately as possible using the state-of-the-art technology and this requirement should be met as exactly as physically possible in any given spatial-temporal setting. In this context, it is generally assumed that some other agency or mechanism will take care of environmental flows of water, which, however, deserve a more holistic approach to ecology-based water policy making.

Colleagues, this year the FAO Investment Centre unveiled its new 'Guidelines on irrigation investment projects' during the World Earth Day celebrations. These guidelines introduce innovative approaches, tools and resources to tackle irrigation development challenges such as water scarcity, competition over shared natural resources and the impact of climate change on future water resources.

International Commission on Irrigation and Drainage (ICID), founded in 1950, has food and water security at the core of its mandate. Over the decades ICID has been a constant witness to technological developments in the fields of satellite or sensor-based water measurements such as GIS and tensiometers, efficient water transport and delivery systems such as piped irrigation using surface or sub-surface drips; and scientific management regimes that make precision irrigation possible. To better document and reward such innovations, ICID instituted the Annual WatSave Awards in the year 1997, which promote the judicious use of water in agriculture. I urge to all researchers and innovators to make use of the ICID platform to share benefits of their work that addresses the water productivity improvements in the agriculture sector globally.

The articles in this issue further explain the technological approaches to water measurements, planning and management. And, I hope you will find them useful.

Happy Reading and Best Wishes!

Felix Reinders
President, ICID

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Inside

Solar Powered Irrigation Systems (SPIS)

Recognizing the need and potential for Solar Powered Irrigation Systems (SPIS) in Africa, the Food and Agriculture Organisation, Office for the Near East and North Africa (FAO-RNE), Cairo, Egypt partnered with ICID to learn about the success of SPIS in India through a study tour of high-level delegation from Egypt and Tunisia. This article is the Executive Summary of the learning outcomes of the above study tour activities in three states of India and its capital New Delhi.

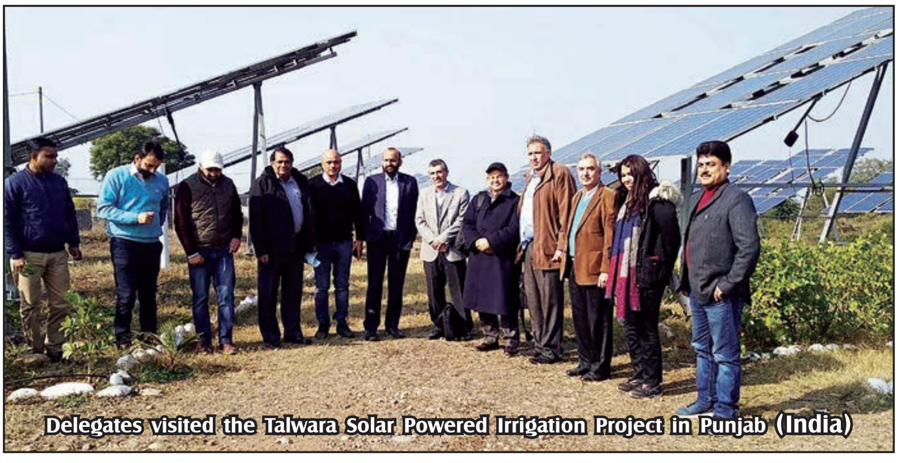
Need for SPIS

With the rapid depletion of fossil fuels and threats of global warming, alternative clean sources of energy are being explored in the energy sector. In recent years, solar energy has emerged as one of the cleanest, environmentally friendly and reliable sources of energy. Energy, one of the main inputs of agriculture especially for irrigation, is becoming a focus in the agricultural water management agenda. In this respect, Solar Powered Irrigation Systems (SPIS) are beginning to gain traction worldwide as the alternative to traditional electric or diesel-run pumps. Such pumps provide an environment-friendly opportunity for irrigation because of the significantly lower emissions of greenhouse gases compared to the higher carbon footprint of the fossil fuel-based electricity options. For sustainable agricultural and rural development, the SPIS' have proven to be a boon for several pilots and near-commercial scale projects. The SPIS' provide a reliable source of clean energy to the farmers to irrigate their lands while reducing their operating cost and providing freedom from fluctuating fuel prices.

Benefits of SPIS

In rural areas, especially in developing countries, agriculture is the main source of livelihood for farmers. Since the opportunity cost of the land in such remote locations is minimal, and the connectivity to the electrical grid is very poor, the farmers are unable to have an on-demand power supply to irrigate their crops timely and hence the resultant agricultural activity in these areas is very low. Moreover, the costs of acquisition and maintenance of diesel engine-based pump sets are also not affordable at all levels.

The SPIS provide the opportunity to the farmers for an additional income in case of surplus power generation, where the excess electricity may be sold to the national electric grid and the farmers may draw the power back from the grid when required.


Delegates visited the Talwara Solar Powered Irrigation Project in Punjab (India)

SPIS replaces the strenuous physical exercise required during the conventional irrigation with the convenient on/off switches which may be operated remotely as well. SPIS, additionally, opens the door for additional income for the family by the means of backyard vegetable farming for women and other local businesses. With SPIS in place, the farmers have a dependable source of electricity for irrigation and if coupled with a sustainable source of water supply, subsequently a sustained source of livelihood.

Costs Associated with SPIS and Government Interventions

One of the biggest disadvantages of solar-powered pumping systems is that they require substantial investments during their initial installation, which constraints the farmers from adopting the SPIS as a viable option for power generation for irrigation. Despite the fact that during their lifetime, the cost for solar energy is cheaper than the diesel-run pumps. Hence, the government interventions are essentially required to support the farmers in the form of subsidies to procure the equipment and during the initial phase of the projects for successful implementation and adoption.

The Federal Government should act as a facilitator and provides broader policy guidelines for sustainable development of the agriculture sector and necessary seed-funds or subsidies for wider adoption of technologies that improve agricultural productivity and natural resource conservation and simultaneously prevent migration of youth to urban areas by creating employment opportunities in the rural sector. Normally, in developing countries, the subsidies are offered to the farmers for the agricultural inputs such as diesel and power, i.e., at a much lower rate than the rate in the free market without government intervention. Overall the farmers receive subsidies for irrigation, power, fertilizers, seeds and so forth. These subsidies should be redirected towards clean sources of energy to promote economic and sustainable development in the agricultural and power sectors. Furthermore, the groundwater laws should be regulated by the Government Natural Resources Policy Framework to reduce over-abstraction.

Viable Business Models

Some of the most successful business models entail participation of the private sector, sufficient government support and the active involvement of the community. Each actor plays a specific role in the adoptions of SPIS beneficially at the ground level, for e.g., the government through its policies may provide capital support to the farmers in the form of subsidies, whereas the private sector may actively conduct capacity building programmes and provide after-sale technical support to the farmers.

Business models involving the coupling of SPIS with the micro-irrigation systems

Delegates discussing with farmers on the benefits of SPIS in Alwar, Rajasthan (India)

to grow commercial vegetables and crops locally have yielded highly positive results in the arid and semi-arid regions of India. Contract farming is proving to be another successful model where the farmers receive support from the private sector for the entire production value chain. Other models include the working of the private sector in tandem with the progressive farmers for local technical support. In almost all the success stories, the catalytic role is played by the private sector working on the manufacturing of solar-based equipment. The private sector is working closely with the farmers, local extension and irrigation officials, and promotes capacity building of farmers.

Capacity Building

Long-term capacity building efforts have been key to the entire success where comprehensive assistance was always available to the pilot beneficiaries. The capacity development programmes are needed to support farmers, extension workers, local agri-businesses and other stakeholders. A continued adaptive model for modifying the implementation strategies and products is needed to ensure success in greenfield projects. Stakeholders in the water sector need scientifically validated climate change information and its potential impact on human life and natural resources including water. To further develop the technical capacity at the farm and community level, sustained interventions from the governments and the private sector are required. The main agenda of these programmes should be to generate awareness amongst the farmers to use water judiciously with an objective to improve productivity and reduce input costs. Also, at the government level, the policies and regulations should be enforced to monitor and curb the over-abstraction of ground or surface water.

Conclusions and Recommendations

The government aims to reduce the subsidies and reduction of natural resources footprint of the operations while the farmers' objectives are to improve the production and increase the income with reduced labour to achieve economic prosperity and meet growing demands of his/her family. Hence, while implementing SPIS, these mutually exclusive objectives that of the government and the individual farmers must be addressed. With the careful implementation of the technology and complementary government policies, SPIS provide an excellent alternative to the diesel or electric-run pumps to withdraw water for irrigation. Introduction of solar power coupled with the adoption of micro-irrigation systems has shown promising results in many regions around the world, especially India.

A much-neglected aspect of solar energy application in agriculture is its other applications in agricultural operations at the farm besides water application. Energy availability at the farm level would also be useful in chaff-cutting, dairying, connectivity to mass media and knowledge resources, post-harvest activities such as thrashing, cleaning, heating/cooling and a general sense of energy security in the farm family.Energy availability also enhances drinking water filtration capacity for family members.

Successful implementation of SPIS' is not just a technology-driven activity; it also requires an enabling policy environment, locally-adaptable business models, and adequate capacity of farmers, extension workers and water management professionals, among others. The key to success lies in continued adoption and sustained operations through local skilled and unskilled manpower available and continued operational and financial benefits above the traditional means of energy supply and continued replacement of the parts of the system through owners' resources and not through subsidy route.

Delegates discussing the SPIS systems benefits and challenges with the Water Users' Association in Talwara, Punjab (India)

Crop Water Productivity in Afghanistan

Er. Najumuddin*

Ensuring water security remains critical in Afghanistan for future agricultural production and to satisfy other livelihood needs. The contribution of agriculture is roughly a third of the national economy and over two-thirds of employment, especially in rural areas. Agricultural growth remains a key component of national growth and employment, and it also provides a foundation for successful structural transformation of the national economy. Because of arid to semi-arid climate of the country, agriculture is dependent on the availability of irrigation water to a large extent. Hence, Afghanistan's economy is essentially water dependent.

Most river basins experience issues of water stress and populations live with an inadequate level of water security, thereby, affecting the food security, energy production and ecological health of the basin. It also adversely affects the health and livelihoods of its populations. Afghan river systems are already among the most stressed river systems in Asia (with Helmand river at the top) and probably in the world. As in the rest of the world, climate variability, as well as other global and regional changes such as declining groundwater tables, are expected to exacerbate water issues. Afghanistan is particularly vulnerable given its mountainous environment and snow-based hydrology.

Lack of available irrigation water is an important impediment in improving agriculture productivity in Afghanistan. World Bank (WB) has been a long-term partner of the Ministry of Agriculture, Irrigation & Livestock (MAIL) in supporting construction and rehabilitation of Irrigation Schemes to increase farmers' access to water. As part of the efforts, On-Farm Water Management Project (OFWMP) has been conceptualized with an objective to improve the agricultural productivity in the project areas by enhancing the efficiency of water used. The Project started its operation in March 2011 with a 41.0 million USD financial support from the Afghanistan Reconstruction Trust Fund (ARTF) under the management of World Bank (WB). It requested Additional Finance (AF) of 45 million USD in 2016 to support scaling up of activities and restructure the original project to match with the growing needs and demands of the communities based on the lessons learned. Currently, the project is working in five regions (Central, Bamyan/Baghlan, Herat, North, and East) covering 23 provinces of the country in service to provide effective and efficient irrigation systems to improve the conveyance & application efficiency and increase water productivity.

OFWM Project and Crop Water Productivity

As stipulated in the present OFWMP documents, the overall Project Development Objective (PDO) is to improve crop water productivity in project areas by enhancing the efficiency of water use. Increase in Water Productivity is one of the key indicators proposed to measure the success of the Project in terms of the degree of achievement of the overall PDO, and its best assessment would be of great importance for the decision-makers in the Government and other stakeholders involved in the planning and prioritizing investment in the development of the Agriculture sector. The project mainly aimed at improving water use efficiency to increase agricultural production, building the capacity of local staff to implement similar projects in the country and educating farmers to adopt high-efficiency irrigation systems (HEIS) and other modern agricultural practices. The project comprises the following components:

i. **Irrigation Rehabilitation and Management in the five Regions:** This component would have the following two sub-components:
   (a) Establishment and strengthening of irrigation associations (IAs), and
   (b) Improvement of Irrigation infrastructure for the existing irrigation schemes typically less than 1,000 hectares.

ii. **Support for Enhancing Productivity:** Support for enhancing agriculture and water productivity through demonstration of Modern Irrigation (HEIS), Agronomic practices activities and technical assistance.

iii. **Institutional Strengthening and Capacity Building of the MAIL:** Institutional strengthening and, technical and administrative capacity building of the MAIL including developing a legal framework for the irrigation and drainage subsector.

iv. **Project Management, Coordination, Monitoring and Evaluation:** This component directly supports the incremental operating cost, project staff cost, logistics (vehicles), and critical office equipment pertaining to project implementation so as to ensure sound management of the project.

The concept of Crop Water Productivity (CWP), in general, is taken as a robust measure of the ability of the agricultural systems to convert water into food and fibre production. While it has been used principally to evaluate the function of irrigation systems as the amount of 'crop per drop', usually expressed

Table. River Basins of Afghanistan

River basin	Area (%)	Water (%)	Rivers
Amu Darya	14	57	Amu Darya, Panj, Wakhan, Kunduz, Kokcha
Hari Rod-Murghab	12	4	Hari Rod, Murghab, Koshk
Helmand	41	11	Helmand, Arghandab, Tarnak, Ghazni, Farah, Khash
Kabul (Indus)	11	26	Kabul, Kunar, Panjshir, Ghorband, Alinigar, Logar
Northern	11	2	Balkh, Sar-i-Pul, Khulm
Non-drainage area	10		

Source: Favre and Kamal, Watershed Atlas of Afghanistan (A topology of Irrigation System in Afghanistan, Bob Rout 2008)

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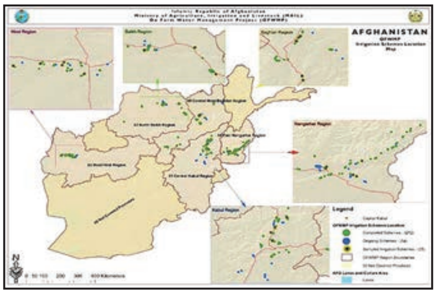


Figure 1. Irrigation scheme location and coverage map of OFWMP

in terms of kg/m³ or tons/m³, being the most meaningful indicator where water resources become increasingly scarce. The basic purpose of CWP is to enable comparisons between water use systems in space and time i.e. 'before and after' or 'without and with" project implementation of irrigation related agricultural projects. The Crop Water Productivity (CWP) in such projects is determined through the following steps:

Assessment of Crop Water Productivity (CWP): The time period for the assessment of CWP would cover at least one complete crop cycle, extended over a complete year (winter and summer crop seasons) to account for productive and non-productive water use.However, the assessment may be extended over several years to derive estimates of average, minimum or maximum crop water productivity within each season.

Measuring Crop Water Productivity: For measuring water productivity, the amount of water directly consumed by the cropping system (evaporation and transpiration) as well as the amount of water supplied from different sources. As we move upscale from field to farm to basin, we wish to know how much water has been depleted in agricultural production, which accounts for actual evapotranspiration (Et) and water use by different crops. At the field, farm and system (command area) scale, the denominator of water use is potentially made up following dominant constituents:

Water Used = SI + GI + Rainfall (m³)

where SI = Surface irrigation water (canal) supply and GI = Groundwater irrigation (tube-well) supply

CWP can be measured/calculated, in irrigation schemes of OFWM Project, as yield per unit of water used (depleted) by the crop at a farm, i.e. average crop product per unit of water consumed as:

$$\text{Crop Water Productivity (CWP)} = \frac{\text{Crop Produce (kg)}}{\text{Water Used (m}^3\text{)}}$$

Estimating CWP becomes more complex for large and heterogeneous areas containing complex land uses and diversified cropping patterns. Measurements by different users (farmers) may also lead to discrepancy creating conflicts between different water users within a single area. To simplify this, the method of water accounting may help track different water depletion flow paths.

Approach: For assessment of CWP in Afghanistan, a representative sample of 5 completed rehabilitated irrigation schemes are considered within each of the five regions (Nangarhar, Kabul, Bamyan, Herat and Mazar-e-Sharif). The selection of representative Irrigation Schemes and farms was carried out jointly by the Irrigation Agronomist and Water Management Specialist of the respective Area teams in consultation with the Core team counterparts (Fig. 1). The irrigation data was collected during each irrigation rotation (turn) as well as crop yield data (at harvest) for major crops grown at selected farms of the Irrigation Scheme. The rainfall data was taken from the rain gauge at the farm and from nearby Weather Station/ DAIL Observatory.

Methodology: The steps involved in the determination of the crop water productivity of irrigated crops include following steps:

1. Preparation of Farm Map clearing showing the details, including irrigated fields (plots), irrigation channels (watercourses or ditches), farm structures and location of tube-well, etc. and record the size of each field (dimensions), in particular.
2. Taking soil samples from each field and get analyzed for soil type and other characteristics, if possible, such as water holding capacity, organic matter, pH and NPK.

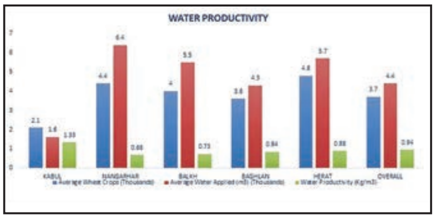


Figure 2. Graphical representation of Water Productivity data of Wheat crop from five regions

3. Prior to coming crop season (winter or summer), preparation of Crop Calendar or Plan clearly indicating the schedule of different activities like land preparation/tillage, sowing/planting, fertilization, irrigation, and harvesting.
4. Installation of flow measuring device (preferably a cut-throat flume) permanently at the farm gate for recording the inflow (discharge) for different crops at the farm during each irrigation rotation (turn).
5. Installation of Rain Gauge at the farm. The concerned farmers shall be trained in recording rainfall data immediately after rain.Alternatively, it shall be obtained from nearby Weather Station /DAIL Observatory.
6. Estimation of actual evapotranspiration (Eta) using reference potential evapotranspiration (Eto) and crop factor for the area.
7. Recording irrigation data (time/duration of inflow and discharge) for different crop fields (plots) during each irrigation rotation (turn).
8. Calculation of water inflow from both irrigation and rainfall during crop period in terms of cubic. meter/ha (Denominator).
9. At the harvest of each crop, obtain crop yield data as well as data on straw and green fodder production in terms of kg/ha (Enumerator).
10. Calculation of water productivity (CWP), with respect to both total water supply (inflow) and Eta, using the formula:

$$\text{CMP} = \frac{\text{Enumerator, Step-9}}{\text{Denominator, Step-8}} \text{ kg/m}^3$$

Result and Discussion: On average, the crop water productivity for wheat crop in different IDSs of five regions (Fig. 2) where the data was collected is, 0.94 KG/m³ while the maximum water productivity is 1.40 kg/m³ in GulBafa irrigation Demonstration Site, Herat region and the minimum water productivity is 0.65 kg/m³ in Mir Roza Dar Irrigation Demonstration Site, Balkh region. In general, the CWP figures compared well with the international potential CWP values of the wheat crop and CWP values from five regions lie in accepted range for the wheat crop (0.60-1.7 kg/m³).

*The author delivered a webinar on these research findings through ICID Young Professionals e-Forum in February 2019. The recording is available at **http://www.icid.org/icid_webinar_15.html**

Basin Futures*: supporting a water secure world

Basin Futures released its Beta testing version in 2018 and as a part of MoU between ICID and CSIRO-Australia, Basin Futures development team conducted training session of the Beta Version at ICID Central Office in New Delhi, India from 8 April 2019 to 12 April 2019. A total of 6 river basins from India, Cambodia and Somalia were tested and assessed through the cloud-based Basin Futures model.

Water scarcity affects every continent, and two-thirds of the world's population currently live in areas that lack water security. Water scarcity is manifested through physical shortages, failure of institutions or lack of infrastructure. Climate change is expected to amplify the complex relationship between development and water demands. Shortages in water impact on people's health, livelihoods, ecosystems and the ability to produce food. It also impacts a nation's ability to achieve Sustainable Development Goals.

Combating water security challenges

To alleviate water security challenges, basic information on water resources is needed. This includes knowing how much water is available, where it is distributed and how it will change under scenarios of development and climate change. Data and models are often used to address these questions. However, data is typically distributed, difficult to access and process and models require significant expense, time to develop, and advanced capability and capacity to use. As a result, it can be difficult and expensive to support the basic information needs to overcome water scarcity.

Basin Futures Solution

To answer some of the first-order questions needed to combat water security challenges, a new tool, Basin Futures has been developed. Basin Futures is a web application that is an entry-level modelling tool that aims to support rapid and exploratory basin planning globally. As a cloud-based tool, it brings together high-performance computing and large-scale global data sets to make data analysis accessible and efficient. The system is designed to bring together global and local datasets to empower decision-makers to understand their opportunities and constraints in managing their water resources. Basin Futures offers users results in an efficient and timely manner.

Key Features of Basin Futures

- User-friendly system.
- Preloaded global data and defaults.
- Ability to integrate global and local data.
- Integrated hydrological and agricultural models.
- Links to population and industrial demands and environmental flows.
- Visualization and reporting tools.
- Scenario development and exploration.
- Global climate scenarios.
- A rapid turnaround for initial water resource snapshots.
- Decision-focused outputs

How does this support water planning?

Basin Futures can be used to explore and plan water-related development and climate scenarios. Scenarios to explore for water secure basins include:

- Planning for climate resilient basins: assessing the potential changes in the quantity and timing of runoff, precipitation and streamflow based on global climate change scenarios.
- Planning for changing population demands: assessing the demands for food, energy and water security based on a changing population scenario.
- Planning for reliable agriculture and infrastructure: assessing the temporal reliability and production values of various infrastructure and cropping scenarios.

*ICID members and partners can write to **icid@icid.org** for more information about the access to Basin Futures Beta Version.

Collaboration between ICID Asia Regional Working Group, PAWEES and INWEPF in the "PAWEES-INWEPF" International Conference, Nara 2018

Japanese National Committee, ICID (JNC-ICID)

The "PAWEES-INWEPF International Conference Nara 2018" (Nara Conference) was held from 20-22 November 2018 in Nara city, Nara prefecture, Japan. The Nara Conference was jointly held by the International Society of Paddy and Water Environment Engineering (PAWEES) and the International Network for Water and Ecosystem in Paddy Fields (INWEPF) in collaboration with the ICID Asia Regional Working Group (ASRWG).

Under a common purpose of sustainable development of paddy farming, the PAWEES organizes activities with an academic approach, and the INWEPF mainly with policy and engineering approaches. During the conference, a total of 552 participants including researchers, policy makers, engineers and private sectors from 21 countries and regions and 4 international organizations (ICID, FAO, IWMI and MRC) discussed the issues on paddy farming including water use, water management and water environment under the joint theme "Promoting sustainable paddy farming to achieve the SDGs".

The "ICID-PAWEES-INWEPF Collaborative Workshop" was held in the Nara Conference by the Japanese National Committee, ICID (JNC-ICID) in close cooperation with the ASRWG in order to strengthen partnership with the PAWEES and the INWEPF, and contribute further development of sustainable agriculture in Asia. The participants discussed on irrigation and drainage in Asia to achieve the SDGs. Expert speakers stressed the significance of strengthening collaboration and cooperation among the international organizations. Innovations to solve the issues that Asia will face in the medium to long term such as reduction of farming population, increase of paddy productivity, and promotion of crop diversity and high profit crops, gathered a lot of interests from participants.

The PAWEES and the INWEPF re-acknowledged the significance of ensuring the multi-functionality of paddy farming as well as sustainable and stable food production. Toward achieving the SDGs, both parties expressed their contribution with mutual cooperation to further development of sustainable paddy farming in harmony with the environment, strengthening the partnership among countries and related organizations such as ICID and FAO.

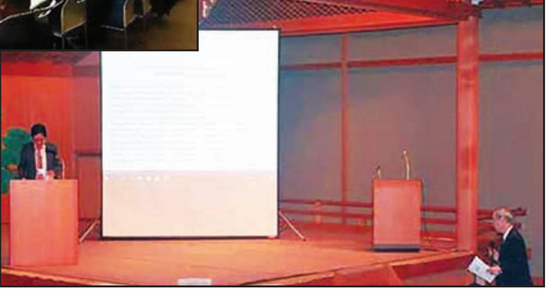
Venue: (Nara Kasugano International Forum - I RA KA-)

Welcome Speech: Mr. Shogo Arai, Governor of Nara Prefecture

Presentation: (Dr. Charlotte de Fraiture, VPH of ICID)

ICID-PAWEES-INWEPF Collaborative Workshop

The 15th INWEPF Steering Meeting



Wrap-up Meeting

The 15th INWEPF Steering Meeting was held under the sub-theme of "More Resilient and Productive Paddy Farming" by the participation of 14 member countries, 4 international organizations (ICID, FAO, MRC, IWMI) and JICA. At the Steering Meeting, member countries were divided into three working groups* and discussed with each other. Then, each leader of three Working Groups reported the output of discussion to all participants.

Working Group1 : Strengthening Multi-functionality and Food Value Chain

Lead Country: Malaysia

Objectives: WG1 will discuss how to strengthen multi-functionality and food value chain (FVC) related to paddy and share/disseminate the outputs of the discussion with members and in international fora.

Working Group2: Modernization Irrigation and Drainage System in response to Climate Change

Lead Country: Korea

Objectives: WG2 will discuss how to modernize irrigation and drainage system in paddy responding to climate change and share/ disseminate the outputs of the discussion with members and in international fora.

Working Group3: Improving Water Use Efficiency and Water Productivity

Lead Country: Japan

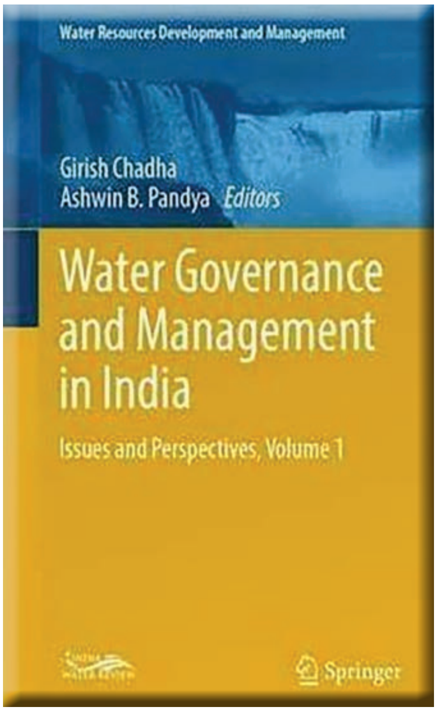
Objectives: WG3 will discuss how to improve water use efficiency and water productivity in paddy and share/disseminate the outputs of the discussion with members and in international fora. The WG3 will also strengthen partnership and collaboration with FAO for the WG discussion on improvement of water use efficiency and water productivity.

After that, the Fifth Phase Strategy and the Annual Action Plan 2018-2019 which included activity plans for the next three years were agreed by the member countries.

At the end, the PAWEES and the INWEPF summarized each discussion for two days at the Wrap-up Meeting. Then, "PAWEES-INWEPF Nara Joint Statement" was accepted. It was decided that the next PAWEES and INWEPF joint international conference will be held in South Korea in November, 2019. The ASRWG will further strengthen partnership with the PAWEES and the INWEPF including through cooperation for the next conference.

Water Governance and Management in India

India has been facing severe water stress in recent years. The water management in the country needs a serious scientific understanding coupled with the cooperative approach rather than a competitive one. This book provides an insight into the current water regulations and highlights the need for effective water management and governance in India. The book also underlines the need for water policy reforms to ensure higher water usage efficiency in all the sectors, to capture the groundwater depletion and to manage the available resources in a disciplined manner. The book also discusses the role of stakeholder engagement and water pricing as means to manage increasing water demand across all sectors owing to rapid population growth and industrialization.



About the Authors:

Girish Chadha is a New Delhi-based business journalist-cum-entrepreneur. His engagement with water sector runs across several dimensions. He has written extensively on global water issues in leading foreign publications and is the Editor of India Water Review, a multi-media news platform on water in India. Girish also overlooks efficient water usage practice for a fast-growing global organic foods company with projects across several geographies.

Ashwin B Pandya is the Secretary-General of International Commission on Irrigation & Drainage (ICID). An M Tech in Structural Engineering from IIT-Delhi, Pandya has been a former Chairman of Central Water Commission. In his long-distinguished career encompassing all aspects of water resources sector, Pandya has provided mentorship and led the large water resources engineering community towards a sustainable and rational development regime. Pandya has been engaged with several state governments, many countries and the World Bank in various capacities and is an advisor to the Indian Government on several flagship projects.

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International Commission on Irrigation and Drainage (ICID) established in 1950 as a scientific, technical and voluntary not-for-profit professional international organization.

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