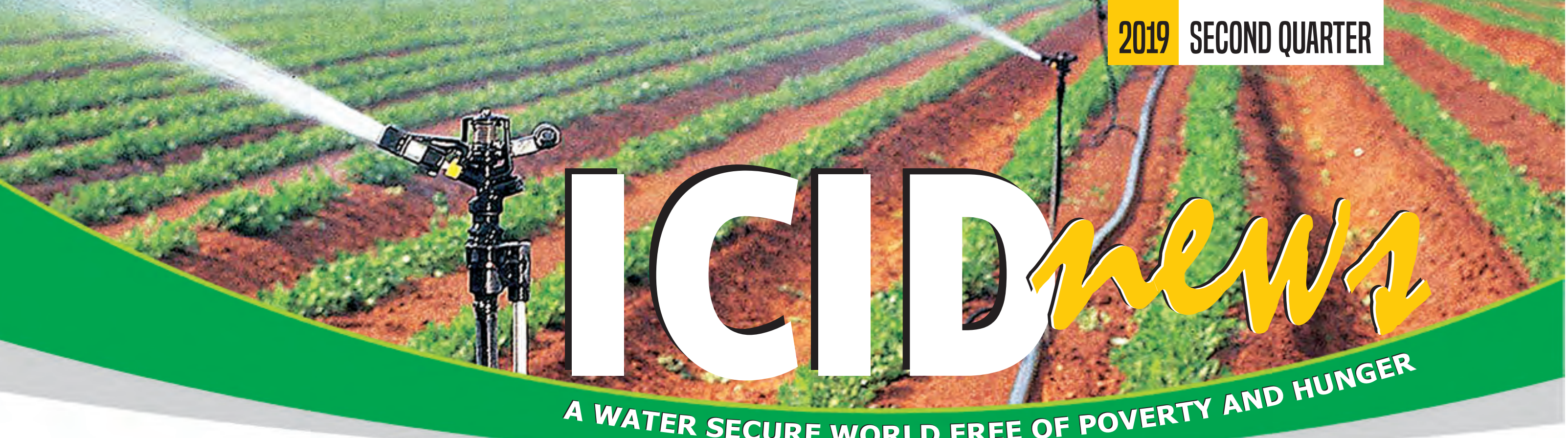


2019 SECOND QUARTER

ICID news

A WATER SECURE WORLD FREE OF POVERTY AND HUNGER

MESSAGE FROM THE PRESIDENT

ICID Celebrates 70th Anniversary of Foundation Day

The International Commission on Irrigation and Drainage (ICID) kick-started the celebration of the 70th anniversary of its foundation day with a seminar on "Leveraging Water Security for Sustainable Agricultural Water Management" at New Delhi India on 24 June 2019. The dignitaries who joined the celebrations include: H.E. Mr. Andre Aranha Correa do Lago, Ambassador of the Federal Republic of Brazil, New Delhi; H.E. Maj. Gen. Chris Sunday Eze (Rtd.), High Commissioner of the Federal Republic of Nigeria; H.E. Farhod Arziev, Ambassador of the Republic of Uzbekistan, New Delhi; Mr. Kenichi Yokoyama, Country Director, India Resident Mission, ADB, New Delhi; Mr. U. P. Singh, Secretary, Ministry of Water (Jal Shakti); and Mr. S Masood Husain, Chairman, Central Water Commission (CWC) and Indian National Committee on Surface Water (INCSW). ICID Central Office was represented by Secretary General, Executive Director, Director (Knowledge Management), Communication Officer, Technical Consultant and the support staff members. Two direct members of ICID were also present. Through a video message, I welcomed all the dignitaries and more than 70 participants from various international and national agencies for the technical seminar.

The seminar started with presentations by the Secretary General and ICID professionals covering a broad range of initiatives that ICID has taken up as a learning organization founded in 1950 and evolved in line with technological advances over the last seven decades. The dignitaries shared their country experiences in the areas of irrigation sector and highlighted their centers of excellence. Hon'ble Ambassador from Brazil reminded the audience that Brazil's central pivot system used in coffee plantations won the ICID WatSave Award in 2007 and the largest pump manufacturer in Brazil collaborates with the Jain Irrigation Systems Limited headquartered in India. Similarly, Hon'ble Ambassadors from Nigeria and Uzbekistan pointed out that ICID can play a much bigger role in addressing agricultural water issues in both Africa and Central Asia by partnering with the national committees and regional associations. ADB's country Director reaffirmed that ADB and ICID have a shared vision for water and food security and are working diligently to ensure sufficient food, nutrition and water for all through sustainable development in the face of uncertainties posed by climate change phenomenon.

CWC Chairman Mr. S. Masood Hussain reminisced that the 70th anniversary of the Foundation Day of ICID marks the 70th anniversary of the Indian National Committee of Surface Water as well. Accentuating the deteriorating state of water resources in the country, he opined that water should be managed in Mission Mode. He also placed on record the fact that the Indian National Committee has always extended cooperation and full support to events organized by ICID.

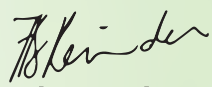
In his keynote address, Mr. U. P. Singh stressed that demand for water is going up in all sectors of the economy. Acknowledging the cooperation between ICID and the Government of India, Mr Singh said that Government of India was always concerned about management of water resources and was instrumental in procuring land for building the Central Office of ICID in the diplomatic enclave of New Delhi. At the end of the inaugural session, a vote of thanks was proposed by Mr. Anuj Kanwal, Director (CWC) and Member Secretary (INCSW).

The above speeches were followed by technical presentations by various experts invited by ICID. The topics and experts included "Agricultural water use and management for efficiency and economic productivity" by Mr. Ajith Radhakrishnan, Country Coordinator, India, 2030 Water Resources Group of World Bank, New Delhi; "Up-scaling the Indo-Israel Agricultural Project (IIAP)" by Mr. Dan Alluf, Counsellor for International Development Cooperation (Mashav), Science & Agriculture, Embassy of Israel; "Policy interventions for effective micro irrigation" by Dr. S. K. Sarkar, Senior Director, Natural Resource & Climate TERI, New Delhi; "Creation of Countrywide Networks of Irrigation and Drainage Infrastructure for Sustainable Development Goals" by Dr. Man Singh, Project Director, Water Technology Center, ICAR-IARI, New Delhi; "Water Resources Development and Management in Africa Mr. Anupam Mishra, Director (Commercial and HRD), WAPCOS Limited, New Delhi; "SDGs for Efficient Water Management in Agriculture" by Dr. Sangita Laddha, Vice President, Jain Irrigation Systems; "How ICID can support its Members and Partners in Alleviating Poverty and Hunger?" by Dr. Teresa Barres of the Embassy of Spain; and "Electrosteel Castings Limited, Kolkatta" by Mr. Sudipto Lahiri, Senior General Manager.

The third and final session comprised of an Open Discussion that was moderated by VP Dr. Yella Reddy and SG Er. Ashwin B Pandya of ICID. Some key learning outcomes of the seminar can be paraphrased as "Water the Engine of Growth", "Water Cooperation", "Water as Heritage", "National Water Authority", and "It's not water crisis, but water management crisis".

Friends, I look forward to meeting you all in the 3rd World Irrigation Forum in about four weeks in Bali, Indonesia, which has received a tremendous global response with more than 500 experts and stakeholders registering for the Forum so far. This issue of ICID News summarizes the three background papers of the three sub-themes of the Forum.

Best Wishes,



Felix Reinders
President, ICID

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Inside

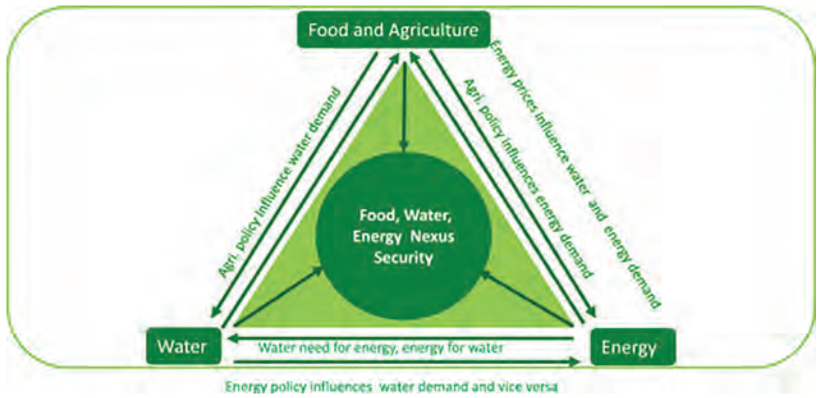
WIF3 Sub-Theme 1: Enabling Policy Environment for Water, Food and Energy Security

Jelle Beekma; Jeremy Bird; Adey Nigatu Mersha; Stijn Reinhard; Sanmugam Ahembaranathan Prathapar; Golam Rasul; Jeffrey Richey; Jouke Van Campen; Raqab Ragab; Chris Perry; Rabi Mohtar; Laurie Tollefson; and Fuqiang Tian

This article analyzes and discusses interrelations among water, food and energy (WFE), also termed as WEF Nexus. The complexity of WEF Nexus is analyzed through modelling mainly from the perspective of (i) water and food and (ii) water and energy and their interconnectivity. Various technology interventions focusing on agricultural water use have the potential to improve nexus outcomes. Stakeholder interaction is essential to contextualise the trade-offs and provide guidance for policy development.

Under competing pressures, the management of natural resources, the basis for human well-being, socio-economic development, peace and political stability; requires tools such as data and information, policies, and institutions that are able to recognize and systematically address various demands. WEF security is widely defined as: everyone, everywhere has enough good quality food, access to sufficient water of acceptable quality for health, livelihoods, production and ecosystems while having uninterrupted availability of energy sources at an affordable price coupled with acceptable level of water risk and energy failures.

The demand for water, food and energy is continually increasing due to rapid population and economic growth in combination with accelerated urbanization and changing lifestyles. It is estimated that by 2030 the global population will need at least 40% more water, 35% more food and 50% more energy. By 2050, an increase in global food demand of 70% is predicted. Meeting the demand for food in a sufficient quantity and acceptable nutritious quality underlines the importance of greater efficiencies in agricultural production systems globally. It is projected that by 2025, 40% of the global population will be prone to severe water stress and by 2050, the global freshwater demand will grow by about 55%. According to the UN SDG report 2018, water insecurity remains high and accelerated progress is needed to meet the SDG targets for Goal 6 for clean water and sanitation. In the future variability in water supply and risks of drought and floods are expected to increase while at the same time overall competition for water will increase. Global energy demand is projected to rise by 25% until 2040. Although considerable progress has been made in electrification, still just under 1 billion people are without electricity. Energy insecurity is likely to continue to constrain human development and local economic development in many locations. The complex WEF Nexus can be seen as:



- **Water for food –** Over 70% of global freshwater withdrawal is used for food production
- **Water for energy –** Water is needed for energy extraction, electricity generation, refining and processing in the energy sector
- **Water for energy and food –** Hydropower generation exhibits energy-water-food-environment connectivity
- **Agriculture and land for energy and water –** Agriculture has a dual role as an energy user and supplier in the form of bioenergy. Agriculture production impacts the water sector through its effects on land condition, runoff, groundwater discharge, water quality, and land/water availability for other purposes.
- **Agriculture, water and the environment –** Over-abstraction from surface water affects the minimum environmental/ecological flow that is required to maintain ecosystem services, water quality, fish communities and leisure.
- **Energy is required for food and water** directly or indirectly, for transportation, processing, packaging, and for water supply, including extraction (surface or groundwater), purification, and distribution of water.
- **Energy for water supply and sanitation services** for activities such as pumping of water, water distribution networks, water and wastewater treatment, desalinising seawater etc.

Meeting each of the sectoral SDG goals for water, food and energy is already a major challenge in many countries. Lack of an integrating resource management framework, exacerbates this challenge through the risk of inefficient use of resources. For years, sector analysts have emphasized the need to increase productivity, boost production and reduce waste as solutions to meet pressing global challenges of increased demand. However, it is increasingly recognized that the challenges are far more complex than simply producing more food or energy because of increasing resource constraints and interconnectivity of sectors, the levels of stress on environment and ecosystems, and the consequences of carbon emissions. Institutional, regulatory and physical systems take time to develop and respond to increased scarcity. Water governance and water pricing are ideally deployed to ensure productive and efficient water use and equitable water distribution.

Development for Water, Food and Nutrition Security in a Competitive Environment is the main theme of 3rd World Irrigation Forum (WIF3), Bali, 1-7 Sept. 2019.

The nexus approach is based on a system-wide thinking for the sustainable use and management of interlinking resources and processes within water, food and energy systems. It is aimed at providing tools to assess the use of a broader set of resources than conventionally has been the case as well as managing the inevitable trade-offs and exploring synergies for planning of sustainable adaptation responses. In agricultural water management it places the challenge on improving (crop) water productivity across levels from field level to river basin incorporating energy implications and exploring the multi functionality of irrigation systems by enhancing policy coherence, promoting natural infrastructure and increasing stakeholder participation.

Competition for water as a scarce good: Scarcity by definition refers to conditions when demand for water is higher than that of supply. Globally, water scarcity is distinguished between physical scarcity, economic scarcity and institutional scarcity in its comprehensive assessment of water management in agriculture. The impacts from land-water-energy (LWE) bottlenecks vary significantly spatially and temporally. Therefore, the main issue is having the resources at the right time in the right place, which is a major component of water security.

Call for a framework within which alternative development decisions can be evaluated: The Nexus approach to decision-making encourages decisions in one sector to take into account other sectors or internalize the externalities to the extent possible. Decisions on water would then require the inclusion of effects on food and energy – are they positive, negative or neutral? The decision-space would then expand depending on the level of cross-sectoral influence and the search for trade-offs. The task of finding win-win solutions is complicated though by quite different and separate institutional frameworks and planning processes in the main water, food and energy sectors. Monetary measure or efficiency of resource use can serve as possible 'nexus indicator'. Current research is based on availability or scarcity of resources and projected costs and benefits in related sectors, but a reality test is also needed taking into account the practicalities of implementing potential solutions within prevailing institutional and governance systems. Integration across sectors is required at the policy level as well as during implementation.

Using models to provide a window on the consequences and benefits of alternative actions: Despite the progress in recent years, there remain many challenges in scientific research on the WEF nexus, while implementation as a management tool is just beginning. The scientific challenges are primarily related to data, information and knowledge gaps in our understanding of the WEF inter-linkages. Robust analytical tools harnessing existing data, can advance scientific understanding in WFE systems and make analytical resources accessible to a range of end-users, particularly in regions with limited data availability and computing resources. Communication and collaboration are key components for successfully managing shocks in the WFE nexus space by bridging the disconnect between knowledge producers and users as well as the disconnect between communication of uncertainty and the risk at local, national, and international scales. There is a need for new computational tools that can translate between the complex space-based resource management problems and the physical boundary spanning nature of human decision-making on resource problems. A cloud-based cyber infrastructure comprised of "modules" linking the WFE systems would provide such a decision-support toolset. The overall Nexus toolset is then represented by the coupling between the models.

Water productivity: Irrigation efficiency has long been used to help gauge the effectiveness and performance of irrigation using various definitions at various levels of the system. However, water productivity, depending on the prevailing development objective and degree of water scarcity, is preferred as this links the production (or benefits) to the water consumption. This is an indicator for the efficiency of actual water use as it links the consumption of water to the crop production or the economic returns. Irrigation water productivity increases with the adoption of precision technologies such as variable rate irrigation, lower energy irrigation, drip irrigation, irrigation scheduling, fertigation, and chemigation. Research should focus along the entire agri-food chain to help save energy and water and motivate farmers to invest in their systems to ensure optimal returns from their investment, while also addressing environmental impacts of greenhouse gas emissions. Institutional approaches include the participatory approach, water pricing, training and educational opportunities.

Innovative technological applications for addressing WFE Nexus challenges: Technical and management interventions characterized as 'sustainable water management' include practices that are well-established and are available to transfer elsewhere or have shown promising results in pilot testing. For example, improving water use productivity by using suitable and efficient irrigation systems (subsurface drip, low level sprayer sprinkler), using renewable energy for the required pressure. On average, obtaining a better understanding of the actual crop water requirement based on the modern technologies could save at least 50% of irrigation water for this region. However, in ideal circumstances (e.g. rootzone nutrition, aeration and absence of pests), water consumption and productivity are almost linearly related and higher production leads to higher consumption. Limiting water supply to the exact crop need, or even below it will, in the absence of sufficient precipitation, lead to salinization of the rootzone. The basin or (sub)-catchment water balance needs to be considered in any move towards efficiency and productivity gains.

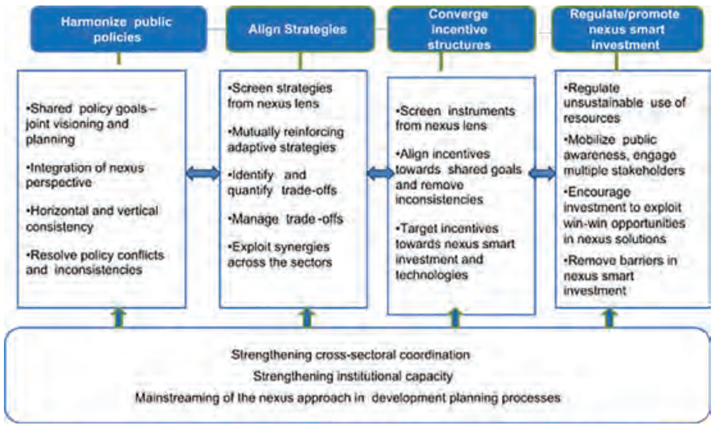
Greenhouse cultivation and optimizing circular use of inputs: The emerging technology of greenhouse horticulture completely rethinks irrigated agriculture systems and has the potential to radically reduce crop water demand, particularly in arid countries. The reduction of water (irrigation) and energy (pumping) inputs to produce food is a clear nexus case, but potentially comes at a threat to water quality in drainage water released into surface water bodies or groundwater. There are several examples of further improving productivity of water, recycling water and nutrients in greenhouses, desalinizing water using solar energy and using potential energy of water in much wider range than reservoirs for generating power, are all elements of a more circular economy. Circular economy and its underlying principles form a new paradigm in our strive for development and sustainability, get rapidly more attention and provide new positive challenges for further development.

Policy Instruments for managing WFE Nexus challenges: Using the nexus approach to improve trade-offs requires a major shift in the decision-making process towards taking a holistic view and integrated approach, as well as developing institutional mechanisms to coordinate the actions of diverse actors and strengthen complementarities and synergies among the three sectors. Both regulatory and market-based instruments need to be aligned to incentivize nexus-positive activities (Figure 2).

Regulatory measures: Especially regarding monitoring groundwater use, using remote sensing chips, or implementing policies where farmers have to pay for groundwater extracted by the unit, would be helpful in managing ground water over extraction.

Market based instrument: Given the limitation of regulatory measures, many market-based innovations are introduced to manage water-agriculture-energy nexus such as water buybacks, electricity pricing and metering, solar pumping program.

Policy interventions- incentives to address the competing environment: Best results in the complex food water energy trade-offs require us to abandon silo thinking and vested interests, instead adopt better coordination and integration institutional mechanisms with other sectors' activities and plans, including the agriculture, energy, urban and trade sectors, each of which depends on and/or affects water resources. Below some suggestions are given for using a nexus perspective to inform policy development.



- Strategic investments for managing water, food and energy security
- Internalise external effects, quantify and make them transparent; and develop policies such as water pricing
- Create incentives to substitute resources and induce innovation
- Promote a circular economy
- Stimulate development of an overarching research framework

Summary

1. Concerted effort is required within each sector to address the intensifying challenges of water, food and energy security through policy reforms and sustainable practices.
2. There is a growing body of promising innovations to address insecurity which needs to be complimented with required technological and financial support for large scale implementation.
3. There is growing awareness of the inter-connectivity between sector interventions and trade-offs for management of the constrained resources.
4. New modelling approaches are being developed to simulate cross-sectoral consequences of alternative development choices in support of decision-making.
5. Moving from academic research frameworks to improving policy directions and providing incentives to implement change.

WIF3 Sub-Theme 2: Role of Civil Society and Non-state Actors in Farm Extension and Facilities

Olcay Unver; Melvyn Kay; Konda Chavva; and Amali Abraham Amali

This article examines the changing nature of farmer support services, particularly the increasing importance of agricultural water management and irrigation as water becomes the limiting resource for food production, how food markets are growing and can incentivise smallholders to produce more, and critically, how farmers are finding new ways of acquiring the knowledge and expertise they need to do this. Non-Governmental and Civil-Society Organizations are reshaping traditional farmer irrigation advisory services.

Agricultural extension is widely recognised as an essential mechanism for capacity building millions of smallholders who still subsist on farms less than 1ha and struggle to produce enough food for their families. They do not always have access to improved seeds, fertilisers, irrigation, and finance and have little resilience to the natural elements such as floods, droughts, pests, and diseases, and to volatile market prices. Low motivation, poor literacy levels, a lack of technological know-how, and the high risks of failure, all conspire to constrain smallholders from entering the cash economy. The demand for extension continues but governments, looking for ways to reduce public spending, can often find themselves unable to afford to fund. Let alone services that farmers have come to rely on. Many developed country governments have found it attractive to pass on the responsibility to farmers and to the private and voluntary sectors. Commercial farmers, profiting from advice are increasingly expected to pay for it. These trends are beginning to take hold to some extent in the developing world as well. Poor rural infrastructure, weak institutions, poor research and access to innovative technologies, low productivity, reduced government investment and official development assistance, as well as limited engagement with the private sector, all hinder the process of commercialising agriculture in developing countries.

Irrigation Advisory Services have grown alongside the traditional agricultural extension services as water resources can limit production. These are wide ranging services from specialist crop water scheduling to planning and design, advisory services for on-farm irrigation practices, irrigation performance analysis, design and installation, environment and water quality and irrigation management support for both large schemes involving many smallholders and individual smallholder farms. Some of the constraints that have limited the effectiveness of services:

- Irrigation scheduling developed by research institutes are not user-friendly.
- Irrigation management advice defined by irrigation experts who do not always respond to the needs and priorities of farmers, thus low acceptance rates.
- Complexities of good irrigation management not easily translated into simple operational guidelines for farmers.
- Irrigation advisory services linked to development projects with limited time duration and thus not sustainable beyond the project life.
- State training and advisory services have low priority and limited funding.
- Services have limited reach because of a lack of staff and communication facilities.

Overall, water managers tend to use measures of efficiency, while farmers are more interested in productivity. As a result, irrigation management advice does not always respond to the real interests and priorities of farmers, and results in low acceptance rates.

Civil society organisations (CSOs): As water resources management shifts from "water government" to water governance, CSOs are closing the gaps left by inadequate 'formal' state services. They are playing integrative roles by bridging the current stream of ideas on the importance of good water governance with sustainable growth and the common interest of citizens. CSOs encompasses a wide range of informal networks within communities that collectively provide benefits to their communities. International organizations promoting integrated water resources management (IWRM), rely on CSOs in member countries to provide effective two-way communications that ensures the needs of the public are made known to government and vice-versa.

Community based organisations (CBOs) are a form of CSO that work specifically within and for the benefit of a community. In the more fragile states CSOs are usually the only institutional structures within communities, whereas in states with declining state services, CSOs usually complement or replace them.

Farmer-based organisations (FBOs) are another form of CSO and have grown out of a desire among smallholder farmers to work together for their mutual benefit. Examples of FBOs include Water User Associations (WUAs), farmers' credit unions, and producer groups. Such groups are becoming increasingly important as they provide a mechanism for smallholder farmers to engage with the private sector.

Non-Governmental Organizations (NGOs) support farmer groups and have two main roles: service delivery and advocacy. They operate in most countries and range from small, local grass-roots organisations to large organisations that are almost indistinguishable from state and international institutions. International development donors often see NGOs as an effective means of interacting directly with civil society and working in the interests of the poor. They provide a range of support services to farmers such as advice on finance and credit, marketing, insurance, and legal matters, and can act as brokers to establish links between rural populations and other support services from the state and the private sector. They can help to communicate farmer problems to governments through advocacy and hold governments to account for their rural strategies and activities.

Social Capital: Sustainable development requires us all to look beyond technology transfer and human capital development to increasing social capital which is about building community processes for collectively managing scarce resources. CSOs form part of a community's 'social capital' – broadly meaning the trust that grows as people, work together for a common cause. This plays an important part in the lives of poor people who tend to invest heavily in social cohesion for their survival. When communities are cohesive, they are better positioned to attract government and NGO resources. International NGOs also rely on social capital to influence development. Thus, external support from donor aid or NGOs to strengthen CSOs can be beneficial but there is always the risk that imposing new rules can overwhelm local CSOs rather than enhance them. An appropriate and productive balance is needed between formal and informal service delivery, water governance mechanisms, and appropriate investments.

'Commercialising' advisory services: Smallholder farmers are the bedrock of agri-food supply in most developing countries, but they are facing immense change. Most have only known subsistence farming and government support services, they now face the uncertainties and unprecedented growth in domestic markets, and a wave of investments by local and international food manufacturers and retailers that want to supply food to domestic consumers and for export. Modern food markets are driven by increasing urbanisation, economic growth, and consumer preferences. The traditional public sector-led agro-industries are giving way to the private sector, businesses and food retailing have grown and are adapting to these changes. Modern markets offer the 'pull' that encourages smallholders to produce more and increase farm income. Markets can incentivise smallholders to adapt to these changes, but they must also learn that markets bring risks of over-production and low prices which can threaten the inexperienced. Irrigation offers more farmer-control over timeliness of supply, and produce quantity and quality which are essential components in producing food for increasingly sophisticated urban customers.

Smallholder business models: Some agro-industries have established large farms to ensure supplies, but many realise that resilience depends on sustainable development and working with smallholders who own and farm the land. Argo-industries have searched for business models that are sensitive to emerging markets, include smallholder producers and address the needs of processors and retailers to manage costs and risks. Three workable models have emerged that link smallholder farmers to agribusiness and changing markets (Table). Complementing the models is the growth in support services for smallholders, often provided by the link companies in the value chain, rather than by the state. They tend to be

Table. Typical business models for smallholder producers.

Model	Driver	Motivation
Producer driven	Smallholder groups, Farmer-Based Organisations (FBOs), associations, cooperatives	Access to new markets, increased bargaining power, access to inputs, technical assistance, secure market, position, farmer empowerment
Buyer driven	Processors, retailers, exporters, traders, wholesalers	Access to land, supplies, increase volumes, supply niche markets
Intermediary driven	NGOs, development agencies, governments	Local and national economic development, farmer empowerment

integrated services focused on producing the crop, rather than the 'siloed' public services with specialists focused on soil management, pest and disease control, water management and irrigation.

Developing capacity: While funds are generously allocated for developing infrastructure, the need for comprehensive capacity-development programmes to create a cadre of specialists and technicians is often neglected. There are serious deficiencies in human capacity among rainfed and irrigating farmers and institutional capacity among state organisations that traditionally provide support to farmers. Smallholders require finance, infrastructure, and technology, but they do not substitute knowledge and skills needed to take advantage of them. Embedded in capacity development is participation and empowering people to take responsibility for their own livelihoods. This includes developing individual capacity through education and training for farmers and professionals; organisational capacity, through water user associations, extension agencies, and private sector companies; and the capacity of states to create a socio-economic environment in which organisations and private companies can function and prosper. Some examples are as follows:

- Participatory approaches have proved to be an effective way of engaging with smallholders to adopt good water management practices and technologies such as On-farm Water Management training and Farmer Field Schools (FFSs) of FAO. FFSs have helped increase production, productivity, and income in rural households. Effective communication strategies used in advisory services include farmer field days, farmer meetings, and in more recent times web-based information, mobile phones, radio and television.
- More direct links between smallholder groups and research will become important rather than the 'top down' approach of promoting research through extension agents. While researchers must learn to engage with smallholders, smallholders must also learn how to work with researchers if they are to benefit from their expertise and speed up farmer adoption of new technologies.
- Rural electrification using solar energy and cell phones can strengthen extension, advice, and expertise, and provide real-time information on irrigation, on-farm processing, and market advice. Other opportunities may also exist such as biotechnologies and producing bio-fuels for imports and generating off-farm income.

Most efforts to establish extension support services start with financial and logistic seed inputs from the government or multilateral funded projects. The efforts run well as long as the necessary inputs, like funds for day-to-day operations are available. However, once communities are approached to pay for the running and operations costs, the problems of sustainability take over. Many times, corpus is provided which can generate adequate returns for maintaining the core services of the CSO/ NGO which is unsustainable due to inflation and other effects. Hence a business model should be designed which makes economic sense to all levels of beneficiaries from the grassroot level to a corporate manager. Entities involved in water management should be long-lasting and self-supporting. Water being part of the common pool resource, community participation and adjustments of concerns at inter-community level extending up to inter-regional level is necessary otherwise, the local policies adopted in a micro-context may harm the overall allocation and equity regime in downstream regions. In such cases, long-surviving CSO networks can help to resolve conflicts at regional level.

Summary

1. Smallholders are the bedrock of food production in most developing countries and governments continue to look to them to 'produce more with less'.
2. Smallholders will inevitably need to take more personal responsibility for developing their capacity. They will increasingly need to rely on their own resources, on the private sector, and on support from CSOs (includes NGOs) to acquire knowledge and skills.
3. CSOs are beginning to close the gap left by inadequate 'formal' state services by helping farmers to help themselves by forming producer groups to tackle issues collectively rather than on their own.
4. New business models are emerging that 'commercialise' advisory services driven largely by 'market pull' which encourages smallholders to produce more.
5. CSOs are helping to build the valuable links between business and smallholders and the links between agricultural research and smallholders that overcome the inadequacies of traditional extension services.
6. In the absence of strong national institutions, CSOs are also stepping into governance roles to help communities create sustainable solutions for landscape level problems like sustaining aquatic ecosystems on which farmers depend for ecosystem services.
7. There are wide-ranging services for irrigators from specialist crop water scheduling to planning and design, and advisory services for on-farm irrigation practices for both large schemes involving many smallholders and individual smallholder farms. Support needs to respond more to the real interests and priorities of farmers rather than the desires of water resources managers and researchers.
8. All CSOs form part of a community's 'social capital' – broadly meaning the trust that grows as people, come together for a common cause. When communities are cohesive, they are better positioned to attract government and NGO resources.
9. Capacity is still the main constraint as support has always been for infrastructure rather than on capacity development. However, there are signs that this is changing as the private sector and others focus on production and are beginning to support smallholders with the wherewithal to produce the goods.
10. Technology is helping with rural electrification, solar energy and cell phone which strengthen extension and empower farmers with market knowledge.

WIF3 Sub-Theme 3: Improving Water Productivity with Focus on Rural Transformation

IJsbrand H. de Jong; Narges Zohrabi; Klaus Roettcher; Neelam Patel; Eman Ragab; Paavan Kumar Reddy Gollapalli; Sigit Supadmo Arif; Iwan Hadihardaja; and Kaluvai Yella Reddy

This article reviews the technologies, institutions, policies and incentives to improve agricultural water productivity. The paper argues that increasing water productivity requires no less than a rural transformation and "Business as usual" is no longer a viable response. Improvements in water productivity (SDG 6.4) involve complex and comprehensive rural transformation that goes beyond mere adoption of water saving technologies. Rural-urban migration, improved living standards and changes in diets, and access to internet, mobile phones, energy and affordable technologies all play a role. Many of the measures to improve water productivity require significant changes in the production systems of farmers and in the support that is provided by public and private service providers – extension services, input suppliers, agricultural off-takers, and others. The paper uses Molden's four pathways for increasing water productivity at the irrigation system or at basin level, and provides concrete cases that are located on each of these pathways, showcasing the diverse experience in the use of technologies, institutions, policies, and incentives.

Competition for water is likely to occur between agriculture, potable water use, industrial uses and the environment. The challenges will be even worse in semi-arid and arid areas. Some 7% of the world's population live in areas suffering from water scarcity; the figure has been forecasted to increase to more than 67% by 2050. Feeding the world and providing water security for all will require important changes in the technologies, institutions, policies and incentives that drive present-day water management. Irrigation is the largest and most inefficient water user, and there is an expectation that even small improvements in agricultural water use could have significant implications for local and global water budgets, and therefore for the water security of other water users. While feeding more people, agriculture will need to use less water to produce more. The associated water savings should be allocated to other parts of the economy so that overall each drop of water contributes most to achieving agreed societal objectives. Irrigated agriculture will need to invest in water savings so that these savings can be allocated towards sectors that produce more value for society. The productivity of water use, however defined, is increasingly becoming an important metric to benchmark the performance of irrigation. Advances in the use of remote sensing technologies will make it increasingly possible to cost-effectively estimate crop evapotranspiration from farmers' fields.

Agricultural productivity depends on a number of inputs, and each farmer will strive to use the proper mix of these inputs to obtain optimal results within the particular context that farmer operates. Water productivity is often not the driver of investment decisions; the ratio between the costs and benefits of investing in more productive water use is a more appropriate yardstick.

Water efficiency and water productivity are sometimes used interchangeably. Yet, they refer to very different concepts and apply to very different contexts. Water use efficiency often relates to the amount of water used to meet crop ET. Any excess over and above the amount of water required to meet ET is counted towards inefficiency. Water productivity relates to the value produced with a given volume of water. Water productivity can increase even if water use efficiency does not, e.g., by growing higher value crops with the same amount of water and the same amount of return flow. In open river basins, the emphasis is often on capturing more water for productive uses whereas in closed basins, increasing water productivity and allocation water to those users that add most value to the economy becomes increasingly important. The schema prepared by Molden is helpful in better understanding water availability and efficiency as it identifies the following four pathways for increasing water productivity at the irrigation system or at basin level: (i) increase yield per unit of water consumed, (ii) reduce non-beneficial depletion, (iii) tap uncommitted flows, and (iv) re-allocate water among uses.

- Efficiency at scheme level is often confused with efficiency at river basin level. While there is a general recognition that irrigation efficiency at scheme level is often low, when excess water from inefficient irrigation is returned to the river and used for irrigation in downstream irrigation systems, overall efficiency at basin level can actually be high.
- Investments in more efficient irrigation do not necessarily unlock water for use for alternative purposes, it rather leads to an expansion of the irrigated area and to more and not less water consumption. This is particularly true when farmers do not save money when saving water. In these cases, the only rational reason for a farmer to invest in water savings is to expand his irrigated area using the saved water. Where farmers do pay per unit of water, they use it more efficiently.

Rural Transformation

- Active, positive procedure of change and development in rural communities in terms of social and economic national and international changes.
- Growing urban influence on rural livelihoods and changes in the systems and processes, which often significantly affect the lives of those living in villages.
- Traditionally focused on utilization of natural resources including agriculture and forests rather than improving people's livelihoods in rural areas.
- Process of comprehensive societal change whereby rural societies diversify their economies and reduce their reliance on agriculture; become dependent on distant places to trade and to acquire goods, services, and ideas; move from dispersed villages to towns and small and medium cities; and become culturally more similar to large urban agglomerations.
- Adequate policy decisions along with intervention from the private and public sectors so that the rural space turns into a more sustainable, society-based ecologic entity.

Technology: With the emergence of remote sensing technologies, monitoring of water productivity and evaluation of the effectiveness of efforts to improve it have come within reach. Similarly, the use of drones in irrigation management, e.g., to detect non-beneficial ET and leakages is being scaled up throughout the world. Innovative ICT products and services include Irrigation Analyst, GIS and IrriSat system, and numerous mobile apps that have been developed. Advanced hydrological models such as Groundwater Flow Modelling for Managed Aquifer Recharge also help in monitoring, forecasting and evaluating water productivity.

Agronomic Innovations: To improve water productivity, include zero tillage, systeme rizicole intensif (SRI) in combination with rice ratooning, laser land levelling, use of "happy seeder", mulching, changing crop planting dates to match periods of less evaporative demand, and intercropping. Improvements in the access to agricultural markets, reduction of post-harvest losses, and grading and standardization all have a demonstrated impact on water productivity. Greenhouse agriculture represents another approach to optimal use of water for crop productivity. Irrigation with magnetized water adds to crop yields and quality of the final product. Magnetized water can be used to enhance water productivity and germination rate. Important improvements in water productivity can also be achieved through better linkages between farmers and markets. In many cases, farmers don't adopt higher value crops because the markets for higher value products either don't exist, or are too demanding in terms of the harvest date, the quality and the uniformity of the produce. Higher value crops are often perishables and require well performing markets with adequate critical mass of buyers and sellers. In view of these challenges, farmers often prefer to continue growing lower value cereals, thereby foregoing the benefits of higher water productivity. Successful technologies include a broad set of pressurized micro- or precision irrigation systems, sub-surface drainage systems, desalination and wastewater treatment. Better water management and improving the quality of irrigation service delivery can help make water supply more predictable so that farmers can invest in more and better inputs. "Tail to head" supply, such as practiced in Telangana (India), can help reduce wastage and improve water efficiency and productivity, as well as supplemental and deficit irrigation, and alternate wet and dry irrigation of rice. Increased water storage can help transfer excess water from the wet season to the dry season, while ensuring a more productive use of water at basin level throughout the year. Agricultural mechanization often serves as a fundamental and effective factor in enhancing the production and productivity of water. Among others, through the utilization of agricultural machinery (for land preparation, planting, cultivation, and harvesting) contributes to enhanced production and water productivity.

Incentives: Incentivizing farmers to adopt micro-irrigation for on-farm water saving Institutions: Improving water productivity requires 'institutions of innovation' that involve a range of actors, from public and private actors, academia and research institutions, producers, and water management agencies. Local level management and control of groundwater can improve both productivity and sustainability.

Policies: Regulation, policies and demand management are indispensable as part of a comprehensive package of water productivity reform measures such as introduction of volumetric water fees or water withdrawal rights and adoption of water withdrawal caps. Efforts to reallocate water among users, e.g., through establishment of water markets or the introduction of river basin organizations also need mention. Adjustments in cropping patterns also lead to water savings while increasing crop yield.

Conventional flood irrigation systems need to be retrofitted to accommodate the more frequent supply of smaller amounts of water that are required by higher value horticulture crops. This often requires installation of sub-surface pressurized pipe systems and/or development of on-farm storage. The quality and reliability of irrigation services require a quantum leap; in many cases, on-demand delivery of water will be expected by farmers to meet the demands of markets. Converting to higher value production requires rural transformation at the tertiary unit level. Support is required in the early days of this conversion to address market failures, and care should be taken that this support does not provide perverse incentives and crowds out private sector initiatives. It is important to take great care in the design and implementation of the rural transformation process. Increasing agricultural water productivity through rural transformation must strive to achieve the highest societal value of water which requires institutional support, multi-sector capacity strengthening and empowerment of rural communities to provide incentives to adopt the changes. In that regard, taking particular account of the inhabitants' domestic, local knowledge is imperative.

Summary

1. Significant shifts of inter-sectoral water allocations will be required to support continued economic growth.
2. Due to population growth, urbanization, industrialization and climate change, improved water use efficiency will need to be matched by reallocation of as much as 25-40% of water in water stressed regions, from lower to higher productivity and employment activities.
3. Technological innovations combined with changes in the policy environment will need to play an increasingly important role in agricultural water management such as use of remote sensing technologies to improve water accounting and management at the regional and basin-wide levels.
4. Institutions need to be strengthened, including Associations of Water Users and councels and agencies for River Basin Management, and institutional and policy reforms need to be pursued and scaled up to underpin the improved capacities.
5. Incentives need to be provided to farmers to use water more efficiently and productively, including through adequate demand management measures.
6. Adoption of appropriate technologies needs to be scaled up and support needs to be provided to accompanying the rural transformation to take the quantum leap in the improvement of water productivity that is required to ensure sustainable use and water security for all.

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