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INVESTING IN AGRICULTURAL WATER, SUSTAINABLY

RECENT TRENDS IN FINANCING INSTITUTIONS

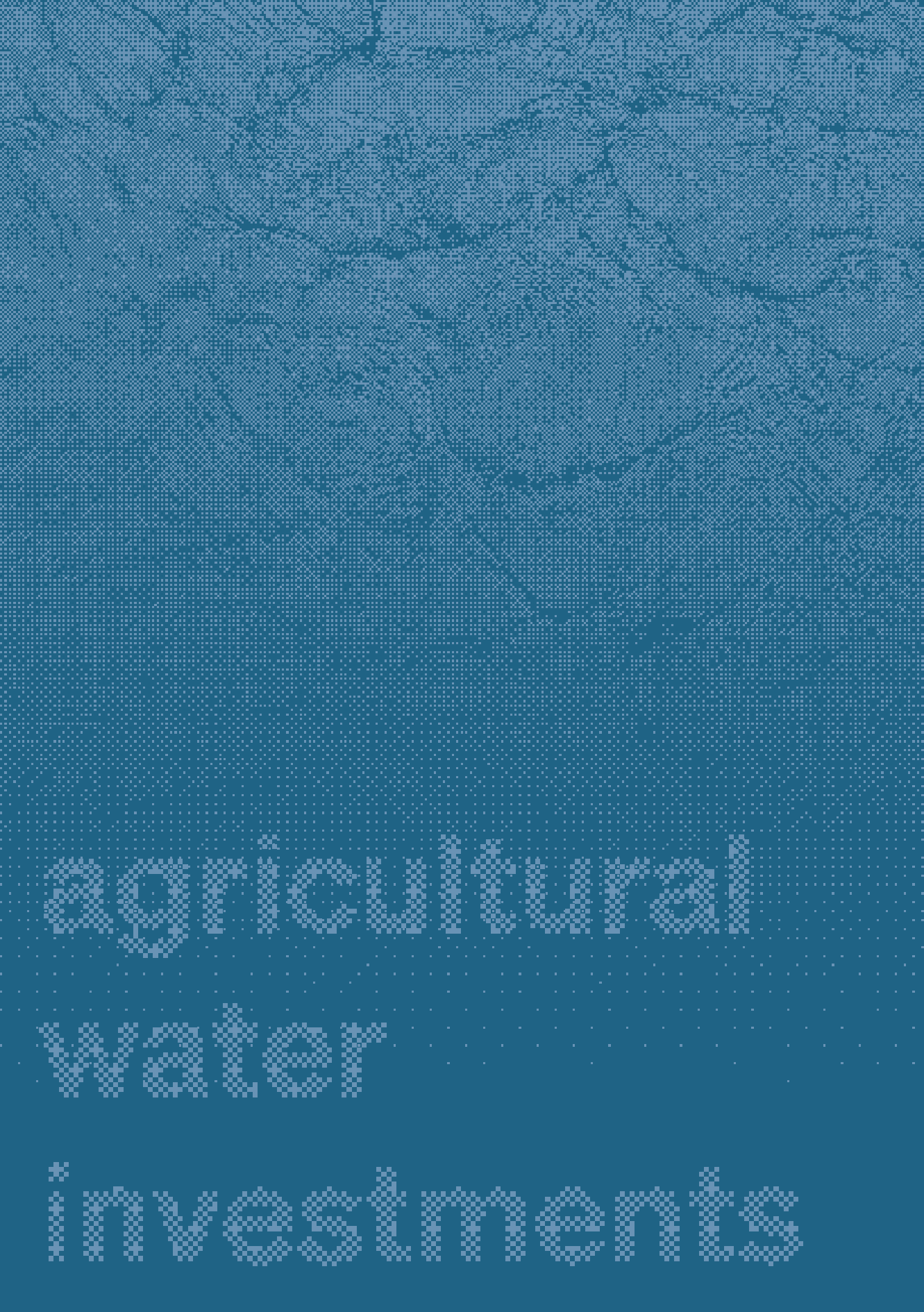


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agricultural water * investments

INVESTING IN AGRICULTURAL WATER, SUSTAINABLY

RECENT TRENDS IN FINANCING INSTITUTIONS

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Abbreviations and acronyms

ADB	Asian Development Bank
AF	Adaptation Fund
AfDB	African Development Bank
AIIB	Asian Infrastructure Investment Bank
AI	artificial intelligence
AFESD	Arab Fund for Economic and Social Development
BAAC	Bank for Agriculture and Agricultural Co-operatives
CFS	Committee on World Food Security
CIAT	International Center for Tropical Agriculture
CIF	Climate Investment Funds
CRS	Creditor Reporting System
DAC	Development Assistance Committee
DBFOM	Design-Build-Finance-Operate-Maintain
DEM	Digital Elevation Model
DPSIR	Driver-Pressure-State-Impact-Response
EBRD	European Bank for Reconstruction and Development
E-PADEE	E-Project for Agricultural Development and Economic Empowerment
EIB	European Investment Bank
FAIR	Findable, Accessible, Interoperable, Reusable
FAO	Food and Agriculture Organization of the United Nations
FDI	foreign direct investment
GCC	Gulf Cooperation Countries
GCF	Green Climate Fund
GDP	gross domestic product
GEF	Global Environment Facility
GGMN	Global Groundwater Monitoring Network
GHG	Greenhouse gas
GNI	gross national income
IBRD	International Bank for Reconstruction and Development
ICRISAT	Crop Research Institute for the Semi-Arid Tropics
ICARDA	International Center for Agricultural Research in the Dry Areas
ICT	information and communication technology
IDA	International Development Association
IDB	Inter-American Development Bank
I&D	irrigation and drainage
IFAD	International Fund for Agricultural Development
IFI	international financing institution
ILO	International Labour Organization
IoT	internet of things
IsDB	Islamic Development Bank

IWMI	International Water Management Institute
IWRM	Integrated Water Resources Management
KPI	key performance indicator
LIDAR	Light Detection and Ranging Instrument
LRI	land resources inventory
NENA	Near East and North Africa
MNC	multinational corporation
MOM	management, operation and maintenance
MPA	Multi-phase programmatic approach
NASDRA	Nigerian National Space Research and Development Agency
NCFF	Natural Capital Financing Facility
NDB	New Development Bank
NENA	Near East and North Africa
NGO	non-governmental organization
O&M	operations and maintenance
ODA	official development assistance
OECD	Organisation for Economic Co-operation and Development
OOF	other official flows
P4R	Program-for-Results
PBL	performance-based lending
PES	payment for ecosystem services
PLC	Programmable Logic Computer
PPP	private-public partnership
R&D	research and development
RBF	results-based financing
SCADA	Supervisory Control and Data Acquisition
SDG	Sustainable Development Goals
SEI	Stockholm Environment Institute
SME	small and medium enterprise
SOLAW	State of Land and Water
UNFCCC	United Nations Framework Convention on Climate Change
UNCTAD	United Nations Conference on Trade and Development
UTNWF	Upper Tana - Nairobi Water Fund
VGGT	Voluntary Guidelines on the Responsible Governance on Tenure of Land, Fisheries and Forests in the Context of National Food Security
WFD	Water Framework Directive
WFPP	Water Financing Partnership Facility
WWAP	World Water Assessment Programme
WUA	Water Users' Association

Executive summary

Investment by international financial institutions (IFIs) in agricultural related water, irrigation and drainage projects is key to tackling food insecurity, poverty, and inequality while at the same time addressing water scarcity and building climate resilience. Many IFIs rely on the Sustainable Development Goals (SDGs) to shape and guide their investments and in this way can be a critical agent for change in promoting food and agricultural water security at country level.

In this report, the authors consider the role of IFIs in agricultural water investments and the types of finance they use, in particular the largest IFIs, the World Bank and the Asian Development Bank. Then using key informant interviews, literature reviews and data analysis they assess those investments in agricultural water over a decade, 2010-19, compared to the previous decade.

The target audience for this report is principally IFIs and international development agencies. Its main goal is to show what has or has not worked in agricultural water investments and how they connect to ecosystems. The paper focuses on water for crop production rather than for livestock and on extractive rather than non-extractive water. It pinpoints several priority innovations offering great potential for future IFI investments in agricultural water.

The report looks at innovations in agricultural water investments to address climate change and harness technologies such as digital communication, to improve productivity and efficiency. And it offers promising new mechanisms and approaches in an analysis focusing largely on public investment by IFIs. The authors acknowledge the dominant role played by governments and private investors, noting that in low- and middle-income countries, private sector and government expenditure in agriculture-related water investments is much higher than IFIs. Investment by individual farmers, such as for land development, machinery, crops, and livestock, exceeds all other sources of funding at 77 percent of total annual agricultural investment (Lowder *et al.*, 2015). Even though IFIs play a small part from a financial perspective compared to other actors, the report finds that they have a critical role in demonstrating responsible agricultural investment in line with the principles identified by the Committee on Food Security (CFS), calling for empowerment, inclusion and respect for farmers' unique knowledge. Furthermore, IFIs can also promote broader societal goals, such as achieving the SDGs, without compromising on cultural and ecological issues.

Financing for climate resilience

In the past climate resilience was not a priority for IFI investments but this has changed radically. The number of climate adaptation projects funded by IFIs during the decade and the amounts committed are high. IFI climate finance commitments in 2020 are about USD 5 billion lower than they were in 2018, most likely as a result of the COVID-19 pandemic. This highlights the need to invest more in resilient agricultural production to achieve SDG goals of universal food security

An indicator of IFI commitment to climate resilience is that in 2020, a group of leading IFIs pledged USD 38 billion towards climate finance in developing and emerging countries, 20 percent of it related to agriculture. Around 7 percent of these commitments go through bilateral agencies and dedicated funds,

such as the Green Climate Fund (GCF), Global Environment Facility (GEF), Adaptation Fund (AF) and Climate Investment Funds (CIF).

Although it has often been overlooked when making earlier IFI investments it is essential to factor in climate resilience in commitments and water management when planning future agricultural water investments. This will ensure these investments are flexible and effective across a wide range of wet and dry conditions, particularly for vulnerable people and ecosystems. IFI investment in agricultural water management must lead to better water productivity, climate resilience and equity among water users.

Main research findings

During the decade, IFI investments have been substantial. They provided between USD 21 billion and USD 68 billion annually to low- and middle-income countries as loans, grants, official disbursements and equity investments. These mainly supported government projects but also benefited the private sector serving as a guarantee for a range of other projects. Output based finance often came with strings attached, such as requiring recipient countries to adopt certain environmental and social policies.

Trends in investment in agricultural water in the decade fluctuated a great deal but were broadly in line with gross domestic product (GDP). Just over a quarter of all IFI agricultural investments were in water resources. The report finds that of 504 IFI-funded projects during the decade, 30 were major recipients and received half the committed funds. All related to agricultural water but with varying goals, such as improving agribusiness, protecting the environment, relieving poverty or community development. In terms of location, sub-Saharan Africa had the highest share of agricultural water projects.

Another recurring theme during the decade is a greater emphasis on projects that increase agricultural productivity to meet the challenges of reduced land and water resources. Investment impact evaluations reveal an unequal distribution of the benefits and costs of irrigation and drainage investments such as unequal land distribution or situations which exclude certain groups from land ownership. Additionally, key performance indicators (KPIs) need to cover water resource management, in particular climate resilience and increasing competition for water amid overall scarcity. The report found that 84 percent of infrastructure and traditional water output projects reviewed registered a satisfactory or improved performance. But the research indicates KPIs were applied to only 20 percent of climate resilience projects and of those a mere 32 percent showed a satisfactory or improved performance.

The report also found there is evidence of insufficient monitoring and evaluation of many water projects which fail to deliver the expected long-term benefits or suffer deterioration due to poor maintenance, climate or hydrology changes or a decline in farm productivity arising from land issues. Many IFIs therefore use water accounting to measure actual water savings achieved from their projects, partly to address the problem that very often water use increases after installation of irrigation schemes.

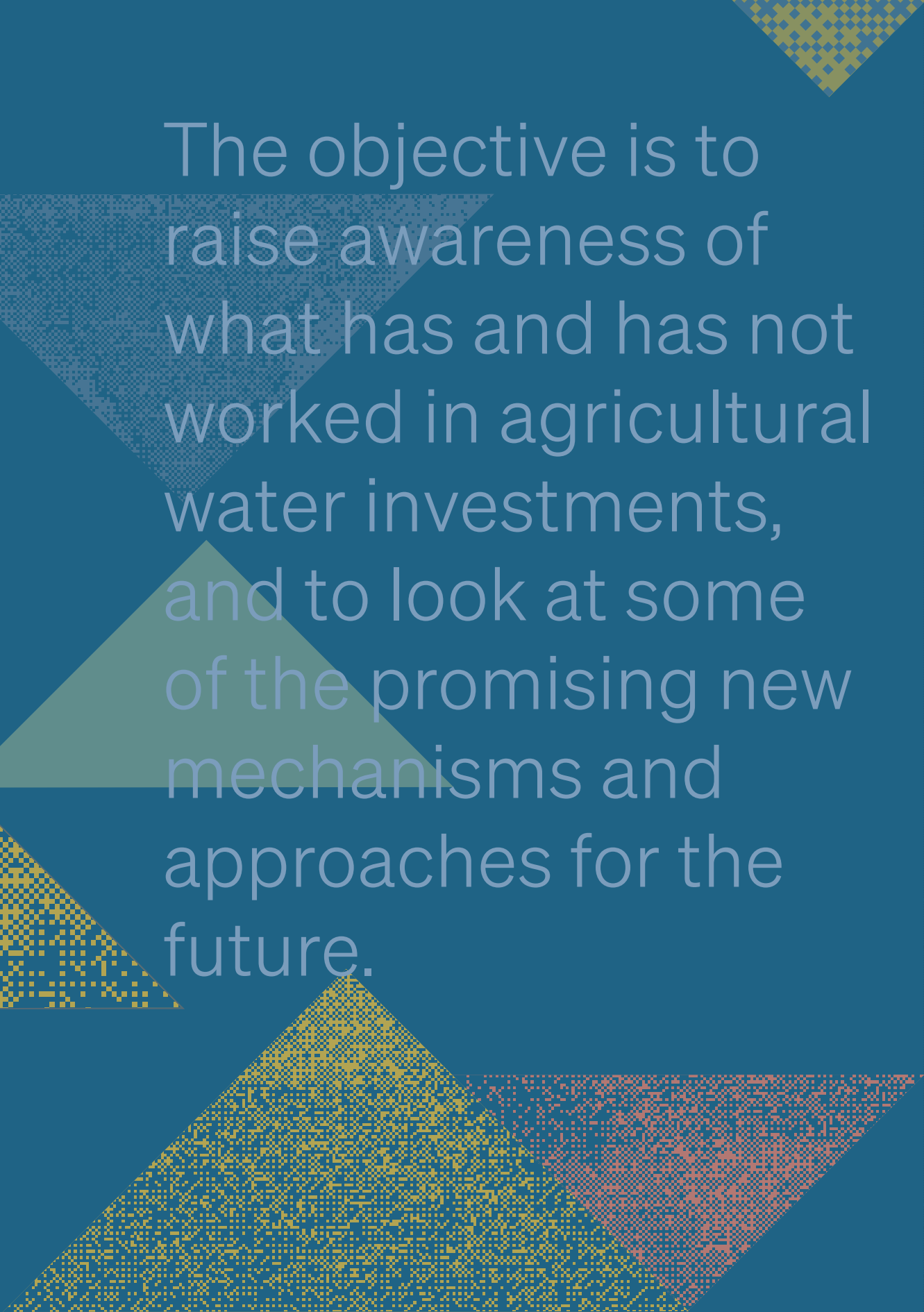
Priorities for future IFI investment

The report also examines emerging areas for investments and innovations, offering new approaches to governance while examining the possible contribution of ground-breaking technologies such as digital communication, biotechnology and new irrigation methods. These, it is argued, can lead to major improvements for farmers in terms of greater productivity, efficiency and access to new markets.

Such innovations require an integrated landscape approach to embrace the needs of other water users and agricultural sub-sectors such as animal production and inland fisheries. The hazards posed by farmland pollution can undermine water quality for other users. To meet this challenge, some IFI instruments require that downstream users contribute to the cost of upstream water conservation, an example of good integrated land and water management governance.

The paper concludes by showing that investments in agricultural water resources have declined while those in agricultural policy and management have increased. This leads on to a focus on supporting existing infrastructure over building new infrastructure. It is clear also that expanded value chains, innovative production methods and stronger connectivity through global communications will deliver massively improved agricultural water productivity with a greater return on any investments made. More reliable irrigation and drainage services require the active engagement of farmers as partners not simply beneficiaries. Building infrastructure alone cannot be a sufficient response to tackle poverty and promote equity and sustainability. Carefully targeted IFI investments in agricultural water can have a major impact in increasing farm yields, improving food security and cutting rural poverty.





The objective is to raise awareness of what has and has not worked in agricultural water investments, and to look at some of the promising new mechanisms and approaches for the future.



Chapter 1

Introduction

This paper examines the investments in agricultural water and related irrigation and drainage infrastructure over the past decade between 2010 and 2019; furthermore, it focuses on the innovations and opportunities that lie on the horizon in the coming decade for climate change, and emerging technologies. Finally, it lends close attention to how agricultural water investments connect to ecosystems.

The intended audience for this paper is a combination of IFIs and international development agencies. The objective is to raise awareness of what has and has not worked in agricultural water investments, and to look at some of the promising new mechanisms and approaches for the future. The analysis focuses heavily on public investment as provided by IFIs. However, public investment nearly always coexists with private investment, even if it has not been formalized in a PPP. This paper therefore also considers the role of private and public-private investment.

Although IFI investments are only one of the tools that can be used to address food and agricultural water security, they can be a critical catalyst for change. Many IFIs rely on the SDGs to provide guidance for future investments. Ensuring food security and meeting food demands is one of the main goals of the agricultural sector. This is mostly found in SDG 2 on Zero Hunger, which directly targets the eradication of hunger and food insecurity. However, at the same time it is equally important to improve farmer livelihoods and reduce related forms of poverty per SDG 1. Historically, the majority of IFI investments have been made for irrigation infrastructure or to increase agricultural productivity to not only improve food production, but also the incomes of farmers.

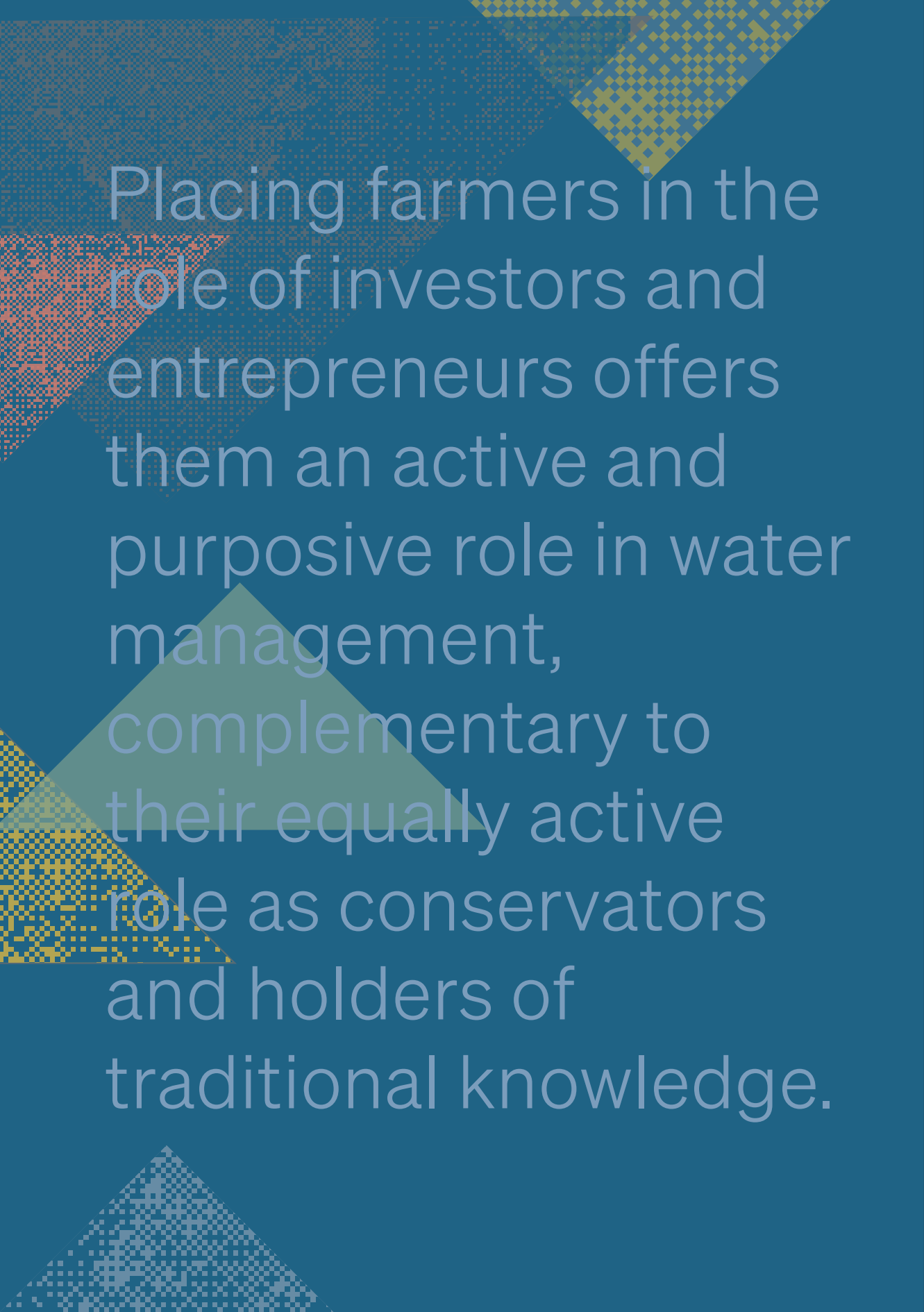
Several other SDGs are directly relevant to the agricultural sector including SDG 6 on Clean Water and Sanitation, SDG 13 on Climate Action and SDG 15 on Life on Land, which require the sustainable use of natural resources, and a reduction in GHGs, while also increasing resilience against climate change impacts and decreasing and restoring land degradation.

New IFI investment approaches focused on results and better governance can potentially lead to improved water productivity, climate resilience and equity. Good agricultural water management means using water in a way that provides crops and animals the amount of water they need, enhances productivity, and conserves natural resources for the benefit of downstream users and ecosystem services. This paper seeks to understand how IFI investments in agricultural water are achieving these objectives, and where future priorities may lie. The focus is on agricultural water for crop production, including water used to produce livestock feed. Water use specifically for livestock was not considered in this study, as the majority of livestock water is used for the production of feed, whereas, at a global level only 2 percent is for drinking and servicing livestock (Mekonnen and Hoekstra, 2012). Additionally, the paper discusses extractive water use, rather than non-extractive water use such as for aquaculture in existing lakes and water bodies. The latest FAO report on the state of world fisheries and aquaculture examines this subject in detail (FAO, 2020b).

Chapter 2 begins with a description of the role that IFIs and other financial actors play in placing agricultural water investments in a broader context, and what types of finance instruments are used. This is followed by an ex-post assessment of some IFI investments in agricultural water over the period of 2010–2019 compared to the prior decade. The assessment is developed through a combination of key informant interviews, review of gray and peer-reviewed literature, and data analysis. Chapter 2 then reviews the performance of investments of the two largest IFIs: the World Bank and the Asian Development Bank.

Chapter 3 outlines emerging areas of investments and innovations. New approaches to governance as well as new technologies and forms of digital communication are presented, which could be game-changing in terms of improved productivity and efficiency, as well as access to markets and forecasts. The chapter concludes with a discussion around priorities for future investments. A summary conclusion is given in Chapter 4.





Placing farmers in the role of investors and entrepreneurs offers them an active and purposive role in water management, complementary to their equally active role as conservators and holders of traditional knowledge.



Chapter 2

Investors and investments in agricultural water between 2010–2019

2.1 ROLE OF IFIs AND OTHER FINANCIAL PLAYERS

In low- and middle-income countries, government expenditure on annual agricultural investment, including research and development (R&D), is 19 percent of the total-agricultural investment, which is approximately six times more than official development assistance (ODA) or foreign direct investment (FDI) combined (Lowder and Carisma, 2011). Private investment by individual farmers, such as for land development, machinery, crops and livestock, exceeds all other sources of funding at 77 percent of the total annual agricultural investment (Lowder *et al.*, 2015); in particular, farmer investment is a much larger source of private finance than FDI. While these figures represent all aspects of agriculture and are not specific to agricultural water, they suggest that IFIs, as contributors to ODA, provide a modest amount of finance. Nevertheless, IFIs have a special role and are under considerable international scrutiny. Their mission is to satisfy both individual governments and private investors while seeking to support global and national development goals through technically, environmentally, equitably and financially viable investments at concessional rates. IFIs also have a key role in promoting best practices when it comes to managing the social and environmental impacts of projects (i.e. ensuring safeguards).

Over the last decade (2010–2019), IFIs disbursed between USD 21 billion and USD 68 billion annually to low- and middle-income countries as ODA loans (25 percent), ODA grants (12 percent), other official flows (OOF)¹ (63 percent) and as equity investments (<1 percent) (Atteridge *et al.*, 2021).

1 According to SEI's Aid Atlas (2021) "OOF refers to transactions by the official (public) sector which do not meet the conditions for eligibility as ODA, either because they are not primarily aimed at development or because they are not sufficiently concessional in character. In Aid Atlas, we include only OOF not related to the promotion of exports from the donor country (referred to as export credits)."

While there are unique aspects to each IFI, they primarily provide loans and grants to governments for specific projects or for policy reforms and technical assistance, as well as investing in the private sector or in provision of guarantees (insurance) for private sector projects. But clearly there are other major investors in both the public and private sectors. Additionally, with pressing concerns around water scarcity and climate change combined with increasing competition over scarce natural resources, there is an urgent need for the increased involvement of other major investors. This chapter describes three such categories of investors: farmers, the private sector, and the multilateral climate funds (GCF, GEF, CIF and the AF).

2.1.1 FARMER-LED INITIATIVES/FARMERS AS INVESTORS

Farmers in high-income countries have long been seen as “investors”, in that they must allocate scarce capital across a portfolio of possible agricultural activities (Hammar, 1941; Blank, 2001). Similar analyses have been applied to developing countries (Raes *et al.*, 2016). Further research into farmer diversification strategies in developing countries argued that farmer strategies go beyond agriculture (Bingen and Simpson, 1997). More precisely, farmers develop “household portfolios” that encompass both agricultural and non-agricultural activities. A related and more recent concept is the “farmer as entrepreneur” (Nordin *et al.*, 2005; McElwee, 2008). Admittedly, in a study of farmer entrepreneurs in the heavily agricultural northeast of Thailand, it was found that many of the entrepreneurial farmers in their study had moved into farming as adults or retirees (Somkaun *et al.*, 2019). They brought with them entrepreneurial skills and motivations and applied them to their new livelihoods. Nevertheless, viewing developing country farmers, regardless of their business experience as entrepreneurs, managers, and craftsmen can shed light on their choice of strategies (Mowo *et al.*, 2006).

Placing farmers in the role of investors and entrepreneurs offers them an active and purposive role in water management, complementary to their equally active role as conservators and holders of traditional knowledge (CFS, 2014). The implication is that farmers should be treated as partners in agricultural investments (CFS, 2014). This idea is central to what the CFS has termed “responsible investment” in agricultural and food systems.² Of the ten principles laid out by the committee (CFS, 2014), half call for empowerment,³ inclusion,⁴ or respect for farmers’ unique knowledge.⁵ The principles are voluntary and can apply either to private investors or to IFIs. Despite being

² There is little guidance in the document on the relationship between smallholder farmers and business. Most of the guidance is offered to states. The document notes that states have the responsibility to foster “transparent and inclusive business models and partnerships, including public private partnerships, to promote sustainable development” (p. 22), while business enterprises “should respect legitimate tenure rights in line with the VGGT [Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests in the Context of National Food Security], and may use a range of inclusive business models.”

³ Principles 2 (Contribute to sustainable and inclusive economic development and the eradication of poverty); 3 (Foster gender equality and women’s empowerment) and 4 (Engage and empower youth).

⁴ Principles 2 (Contribute to sustainable and inclusive economic development and the eradication of poverty) and 9 (Incorporate inclusive and transparent governance structures, processes, and grievance mechanisms).

⁵ Principle 7 (Respect cultural heritage and traditional knowledge, and support diversity and innovation).

voluntary, the principles are anchored in international agreements and statements of principle. Paoloni and Onorati (2014) argue that this is a strength and represents an innovation in the development of “soft” legal frameworks. However, for private investors the CFS principles appear to have weaknesses. Of particular concern is the mismatch between broad principles and the complex reality of agricultural investment and the weak business case for adherence to responsibility principles (Clapp, 2017). A further and more fundamental concern is that by using the language of purely economic actors (such as “investor” and “entrepreneur”) the broader societal goals become submerged (Canfield, 2018). This points to the particular role of IFIs to demonstrate the principles for responsible agricultural investment along the lines identified by the CFS, while ensuring that broader social, cultural, and ecological goals are not compromised.

2.1.2 PRIVATE INVESTORS

The private sector actors relevant to water-related investments are highly diverse. In size, they range from individual farmers drilling boreholes to multinational enterprises purchasing land and importing machinery and equipment. In each landscape there are often multiple private actors with different, and sometimes divergent, goals, who interact with a variety of government entities. This complex agglomeration raises multiple issues around capacities, influence, and equitable access. Yet, the scale of private finance when compared to both ODA and domestic public finance in developing countries is so large that it led to repeated calls to better stimulate commercial investment towards water infrastructure (Bhattacharyay, 2010; Goksu *et al.*, 2017).⁶

Two decades ago, the water resources expert John Briscoe, argued for the rising importance of the private sector in financing water infrastructure (Briscoe, 1999). While dams were increasingly perceived as serving multiple purposes, energy remained an important driver of investment (Grigg, 2019). Examples can be found throughout the world, including planned dams by the electricity supplier Eletrobras and its subsidiary Eletronorte in Brazil (Fearnside, 2006); Lao People's Democratic Republic, where the state provides concessions to private firms (Chowdhury *et al.*, 2020; Delang and Toro, 2011); and Ghana (Obour *et al.*, 2016), where the Bui hydroelectric dam is being built by the Bui Power Authority, a private company created thanks to an act of parliament. China has been supporting its private industry to build hydroelectric dams throughout the world (McDonald *et al.*, 2009). Yet for water infrastructure as a whole, and large-scale irrigation in particular, Briscoe's projection failed to materialize. He pointed out that financing for dam construction, in particular, was becoming closely tied to developments in energy markets, which were already largely deregulated. This trend has persisted whereby private financing specifically for water infrastructure has been low.

There are several reasons for the lack of private investment in large-scale irrigation. Among the most important is the enormous up-front capital cost and investment of time that is required before the project starts. Combined with uncertain revenues, the risks are high. Among other challenges (Goksu *et al.*, 2017; Poulton and Macartney, 2012), these factors contribute to

⁶ See also the World Bank's “Maximizing Finance for Development” initiative [online]. <https://documents1.worldbank.org/curated/en/168331522826993264/pdf/124888-REVISED-BRI-PUBLIC-Maximizing-Finance.pdf>

low investment in large water infrastructure in low-income and middle-income countries. Consequently, much private investment is occurring at smaller scales (Turrall *et al.*, 2010) and small-scale private irrigation has been identified — essentially, amongst farmers or small farmer groups drilling borewells — as a thriving sector (de Fraiture and Giordano, 2014). De Fraiture and Giordano note that in some countries, particularly in South Asia, the use of private irrigation exceeds the public irrigation schemes. Moreover, they point out that small-scale private irrigation is “farmer-driven, and responds to a genuine demand from smallholders and has substantial potential for poverty alleviation and rural development.” Yet, it is uncoordinated and favours those who already have resources to invest. It is therefore both environmentally damaging and socially inequitable.

Despite the challenges, some irrigation PPPs are funded solely by the private sector with limited government involvement. Such is the case with the Olmos Project in Peru, in which the government auctioned 38 000 hectares of previously uncultivated land to private investors (Mandri-Perrott and Bisbey, 2016). The project has pioneered an irrigation PPP scheme known as a “take-or-pay” policy, in which farmers acquire a title to the land from the private investors, as well as the right to the irrigation services. The Olmos Project represents an example of the transfer of investment functions to the private sector on a large-scale.

There are also examples of desalinization plants built for agricultural water purposes through PPPs in Spain, Israel, Oman and elsewhere. In Agadir, Morocco, farmers, the Moroccan government and a private investor (the Spanish company, Abengoa) came together via a Design-Build-Finance-Operate-Maintain (DBFOM) PPP model to build a desalination plant powered through renewable energy to provide water for domestic use and the irrigation of 13 600 ha (Global Infrastructure Hub, 2019). While the number and scale of private investments are still small, recent projects, such as the examples given above are showing some shifts in agricultural water investments towards innovative PPP projects. It appears that more countries are creating the enabling environment for this type of private-sector investments in the future.

A further example of an IFI-supported private investment is the Zambia Irrigation Development Support Project (World Bank, 2020a). While still experimental, this project is pairing subsistence rainfed farmers with commercial farmers in Zambia. The project has an irrigation scheme with three tiers of farmers:

- Tier 1: communal farmer: land is consolidated to allow for more efficient irrigation infrastructure;
- Tier 2: emerging commercial farmer;
- Tier 3: commercial farmer: manage irrigation system for Tier 1 and Tier 2, while also agricultural producer.

The language used in these projects is a focus on “irrigation service provision” rather than irrigation systems *per se* — a concept that helps focus more on performance and benchmarking as is done for urban water utilities. To enable this, rather than have a government body manage the system, a professional service provider is hired to ensure transparency and accountability. Importantly, these are preliminary approaches, and this continues to be a novel area.

Multinational companies may have the resources to invest in large-scale irrigation, but their interests may not align with those of the communities they enter. They may have much closer ties to a host country's investment promotion agency than one focused on rural development. Private investors seek returns, but traditional public irrigation investment has supported a variety of goals. They often include economic efficiency, but also include equity, environmental sustainability, food security, and support for livelihoods (Brelle and Dressayre, 2014; Ward, 2010). While there has been some movement towards full-cost recovery from water investments, particularly for irrigation, subsidies still dominate (Toan, 2016; Ward, 2010). When private actors enter the picture, non-economic goals are at best de-emphasized and at worst disregarded entirely. Some international firms have proven to exert unequal leverage in order to appropriate water from local communities, a process that has been labeled "water grabbing" in the literature. More precisely, "water grabbing [is] a situation where powerful actors are able to take control of, or reallocate to their own benefits, water resources already used by local communities or feeding aquatic ecosystems on which their livelihoods are based" (Mehta *et al.*, 2012, p. 197). The foreign firm brings investment but may utilize existing water infrastructure rather than expand it, as in Oromia in Ethiopia, a case study investigated by Bues and Theesfeld (2012). Otherwise, firms may invest in new irrigation infrastructure, but at the expense of other water users (Dell'Angelo *et al.*, 2018).

IFI commitments can reduce risk for private lenders (Goksu *et al.*, 2017; Rao, 2020). Governments can also reduce private actors' perceived risk by broadening the portfolio within a PPP contract to mix different risk and income profiles (Poulton and Macartney, 2012). Unlike a situation in which the government directly underwrites an investment, for example through a subsidy or by guaranteeing a minimum payment from an otherwise uncertain revenue stream, portfolio diversification is a standard strategy for reducing investor risk. If a private investor simultaneously invests in feeder roads, irrigation systems, and hydropower generation (Poulton and Macartney, 2012), at least some of the fluctuations in revenue in one component of the portfolio will be unrelated to those in another. A drought may threaten both hydropower and irrigation revenue, but not the tax base for the road, while the construction of an alternate route might divert traffic from the road without impacting irrigation or hydropower. Meanwhile, irrigation will largely depend on developments in rural areas, whereas hydropower may be primarily serving urban customers. While multinationals may have other goals, under the right enabling environment private sector investment can be stimulated while ensuring social and environmental safeguards are in place and enforced. IFIs can bridge the needs of different communities and provide social and environmental safeguards, as with the use of "water funds" (Box 1). Water funds are a type of payment for ecosystem services (PES), an approach also used by the Asian Development Bank (ADB) for "eco-compensation" (ADB IED, 2018) and the European Investment Bank (EIB) through its Natural Capital Financing Facility (NCFF). Eco-compensation goes beyond conventional PES schemes in that it encompasses fiscal transfer schemes between regional governments to improve the allocation of funds and benefits, especially if those can flow from one region to another, for example, watershed protection (Zhang and Bennett, 2011).

Box 1

Innovations in agriculture water investment financing: PES and water funds

The protection of watersheds through integrated water resource management is an increasingly important aspect of irrigation projects. A “water fund” is one mechanism being used in many irrigation projects to ensure downstream beneficiaries of water resources pay for upstream water conservation and preservation. This provides the continued benefit of ecosystem services to the community that lives near the water source and to the downstream communities that utilize the water resource.

For example, the Qiandao Lake and Xin'an River Basin Water Resources and Ecological Environment Protection Project initiated in 2018 by the World Bank (IBRD) has a water fund component to finance long-term sustainable pollution reduction (World Bank, 2020). The fund would help with activities to reduce non-point source pollution to water bodies from agricultural activities through better soil nutrient management including improved fertilizer application, run-off control, and the use of integrated pest management techniques to reduce pesticide use.

Between 2010 and 2019, IFAD has been setting up water funds using a PES approach. A pilot water fund project in Kenya during the early 1990s (IFAD, 2017), is now a full-fledged project serving as a template for other water fund projects by IFAD. In the Upper Tana - Nairobi Water Fund (UTNWF) project, Nairobi-based private companies that acquire water 300 km away from the Upper Tana watershed are paying into the water fund. The water fund is helping small-holder farmers in the Upper Tana to implement climate-smart agricultural techniques to increase resilience while also restoring the ecosystem.

The employment of PES has increased significantly in recent years to contribute in a limited but positive way towards long-term conservation goals (Chen *et al.*, 2020). As of 2018, there were more than 550 active PES programmes around the world, valued at USD 40 billion in annual transactions (Salzman *et al.*, 2018). Watershed PES is one of the most well-established applications of PES, as the threat to water quality and supply upstream is readily understood by downstream water users (Salzman *et al.*, 2018).

SOURCE: Authors' own elaboration.

Between the individual farmer and the multinational are found the SMEs, which are at a disadvantage compared to smaller firms as they are large enough to regulate, but compared to multinationals they are too small to attract low-cost financing or take substantial risks. The European Bank for Reconstruction and Development (EBRD) has been focusing its efforts on ways to give SMEs greater leverage. In Serbia, the EBRD is working to engage a wide range of actors, including farmers, international firms, and SMEs, in “the strategic and data-based improvement and modernization of [Serbia’s] irrigation system” (FAO, 2022a). Much of the private-sector support has been in agri-business, that is, food processing and retail. Irrigation investment has been channeled in more conventional ways through the government. However, the investments are focused on rehabilitation rather than new infrastructure, and at farm scale the upgraded infrastructure is meant to enable investments in high-efficiency irrigation systems (EBRD, 2019).

As noted in a recent ADB report (ADB, 2017a), while multilateral funders have historically leaned towards spending on new infrastructure, land is becoming scarce and degraded (Flora, 2010; Foley *et al.*, 2011; Stocking, 2003) and the poorly-maintained existing infrastructure is becoming dilapidated. This trend is the most prominent in Asia and North Africa, where surface irrigation systems that were built over many decades must be adapted to the new reality of scarcity and increasing competition for water resources. Along with the EBRD’s project in Serbia, some of the most recent commitments reported in the Organisation for Economic Co-operation and Development (OECD)’s Creditor Reporting System database are for rehabilitation in Indonesia (a 2018 IBRD commitment of USD 0.2 billion), in Kazakhstan (IsDB commitments in 2015 totaling USD 0.3 billion and a 2017 ADB commitment of USD 1.5 million), and in Viet Nam (a 2015 International Development Association (IDA) commitment of USD 0.3 billion). Additionally, many countries in the Near East and North Africa (NENA) region benefited from modernization projects funded by the World Bank, including in Morocco, Egypt, Tunisia, Iraq, to name a few.

These recent IFI commitments, together with that of EBRD, suggest a possible shift in priorities away from new irrigation infrastructure investment and towards rehabilitation and modernization, but they still leave the question of operation and maintenance costs, which must be covered by tariffs, transfers (e.g. remittances), or taxes (Goksu *et al.*, 2017, Fig. 2.3). These are uncertain and risky sources of repayment, even under PPPs. IFI commitments can help to reduce the risk and thereby “crowd in” private finance (Goksu *et al.*, 2017; Rao, 2020). A further option is for public agencies to “bundle” PPP contracts with different risk and income profiles, e.g. by combining irrigation with roads and power generation (Poulton and Macartney, 2012). However, for private investors this approach should not be used to cross-subsidize an inherently unprofitable component of the portfolio. For example, revenues should, under normal circumstances, cover costs. Governments might choose to subsidize unprofitable activities in order to meet social goals. In such a case, a positive externality justifies foregone income. The diversified PPP portfolio strategy applies when risk-adjusted returns for each separate portfolio component is unattractive, but they become attractive once the risk is diversified across the portfolio.

2.1.3 DEDICATED CLIMATE FINANCE FUNDS

According to the 2015 Paris Climate Agreement (UNFCCC, 2015), developed countries must provide USD 100 billion per year towards climate mitigation and adaptation in developing countries in order to limit global warming to well below 2°C above pre-industrial levels and pursue efforts to limit global temperature change to 1.5°C.

Since 2011, major IFIs started using a common tracking framework for climate finance commitments and have been reporting commitments in the annual report "Joint Report on Multilateral Development Banks' Climate Finance" (EBRD *et al.*, 2021). According to the latest report, in 2020,⁷ USD 38 billion was committed by major IFIs towards climate finance in low- and middle-income countries. A breakdown of climate finance by IFI is found in Figure 1.

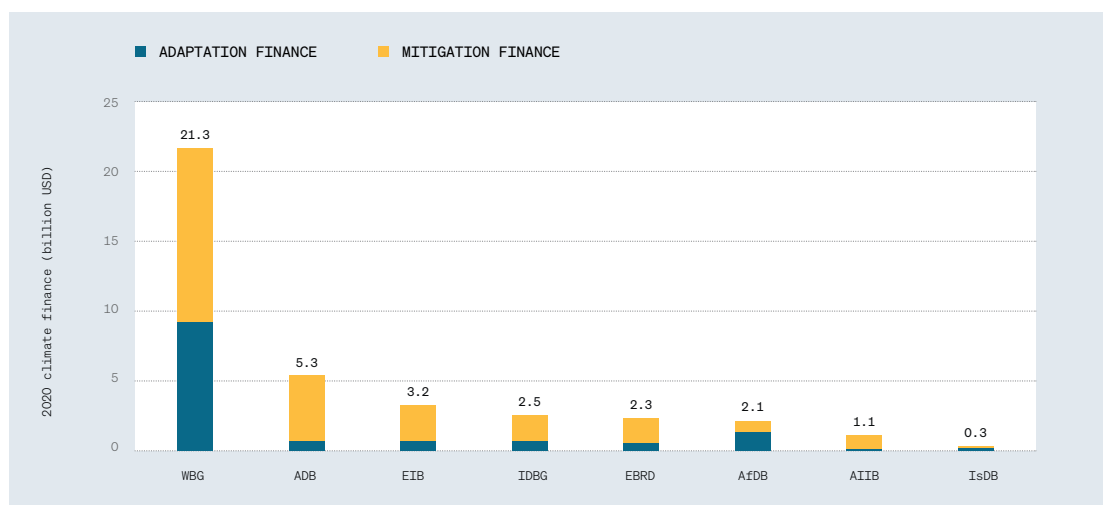


Figure 1
2020 climate finance from major IFIs to low- and middle-income economies

SOURCE: Data taken from EBRD. 2020. 2020 Joint Report on Multilateral Development Banks' Climate Finance. See Table 3, p. 12.

⁷ The 2020 climate finance commitments by IFIs are around USD 5 billion less than 2018. This is likely due to a diversion of funds towards the COVID-19 pandemic.

Most of these commitments are through investment loans (69 percent), followed by policy-based financing (12 percent) and grants (9 percent). The remaining funds are distributed through results-based financing (RBF), guarantees, lines of credit, equity and other miscellaneous financial instruments. Finance for crop and food production and other agricultural and ecological resources makes up 12 percent (or USD 1547 billion) of the total commitments for adaptation in 2020. On the mitigation side, finance for agriculture, aquaculture, forestry and land-use makes up 6 percent (or USD 1533 billion) of the total commitments for mitigation in 2020.

Approximately 7 percent of the reported IFI climate finance commitments to low- and middle-income countries are channeled through bilateral agencies and dedicated climate finance funds, such as the GCF, GEF, AF and CIF.

The GCF, created by the UNFCCC in 2010, directs finance towards climate mitigation and adaptation projects in developing countries. Developing country governments can request direct access to funds without going through an intermediary party. Approximately 7 percent of 2020's total funds of USD 10.18 billion went towards projects related to health and well-being, and food and water security (GCF, 2021).

Similar to the GCF, funds for the GEF, established in 1992, are replenished every four years by donors, and serves to provide developing countries with funds to meet international environmental conventions and agreements.

The AF, established in 2001 and launched in 2007, was created to finance adaptation projects in developing countries that are parties to the Kyoto Protocol. Initially, a portion of proceeds from the clean development mechanism was added to the AF, but other funding sources such as donations from high-income countries make up the majority of funding now. Developing countries can receive funding from the AF through an intermediary. Only national, regional or multilateral financial institutions (i.e. IFIs) accredited by the AF may receive funding for adaptation projects. Many IFIs have signed accreditation agreements with the GCF and AF to carry out approved projects.

Launched in 2008, the CIF is a multilateral climate finance mechanism for developing countries which provides competitive financing to reduce risk for investors in clean technologies, energy access, climate resilience and sustainable forests. In 2020, the number of projects in agriculture and water resources was only 4 percent of the total (CIF, 2021).

2.2 FINANCING INSTRUMENTS FOR AGRICULTURAL WATER INVESTMENTS

The impact and effectiveness of finance depends both on the type of funding — such as loans, grants, equity or guarantees — and the ways, or “modalities” in which they are provided. The combination of type and modality is characterized as a “financing instrument” (ADB, 2005). Whatever instrument is selected, if the financing is even agreed upon depends on the needs and capacities of both borrowers and lenders. As all finance is risky, any agreement must accommodate both borrower and lender risk. Thus, instruments evolve over time in light of experience and the evolving perceptions of risk. An example of seeking to balance lender and borrower risk is the ADB's Water Financing Partnership Facility (WFPF) (ADB, 2006), which implements a multiphase programmatic approach (MPA) to lending. Multi-phase projects

can be attractive to IFIs because they offer significant efficiencies. However, countries may be reluctant to sign on because of the overhead in negotiating and implementing the projects and the potential for political change over the course of the project. The WFPF was created after a review of the ADB's water policy implementation recommended that the bank focus on long-term partnerships, and think innovatively about how best to reach poor communities, including innovations in financing. Following a generally positive but still critical review by the ADB's Independent Evaluation Department (ADB, 2010), the facility provided additional funds for capacity development and opened a window for programme quality support in addition to the project support window. By 2013, ADB had ramped down programme quality support, and WFPF continues to be a major mechanism for the bank to achieve its water policy goals (WFPF, 2020).

Different funders target different recipients, as shown in Table 1. The IFIs form a special category of lender: their motives are mixed, aiming for both economic development and often times for financial return. The risk profile is similarly mixed, encompassing both conventional sources of risk, such as the risk of default, and unconventional ones, such as the achievement of development goals or loss of engagement by recipient countries. The mixture of motives has led to an evolution over time from input-based, to output-based, to results-based finance.

Private corporate investment might take the form of either direct or portfolio investment. Direct investment is money invested by firms in the firm's own operations or those of one of the firm's affiliates. FDI, where a multinational corporation (MNC) makes an investment outside of its home country, is of particular interest for land and water investment in developing countries. The role of multinational corporations in large-scale transfers of land and water rights ("land-grabbing" and "water-grabbing") are discussed elsewhere in this report.

Domestic banks often provide finance to firms and sometimes also provide farmer loans. In some countries a bank may specialize in farm loans or loans targeting agricultural value chains, such as the Agricultural Development Bank⁸ of Ghana or the Bank for Agriculture and Agricultural Co-operatives⁹ in Thailand. IFIs may also provide loans and grants to both public and private sector entities to finance single investment projects or investment programmes. Loans are typically larger than grants, however the minimum loan size varies between IFIs. IFIs do not directly finance farmers but give funds to local financial institutions to be disbursed as credit to farmers based on eligibility requirements. However, it should be noted that eligibility requirements then rely on local financial institutions, and they may not have the capacity to implement them.

Otherwise, farmers may rely on their own savings or those within their social network to finance investments in land and water. Despite the volatility of this source at the level of individual farmers and furthermore the low volume because smallholders have poor access to formal credit, it is an important source of finance. They may also draw upon microfinance from a variety of sources. However, a study in Bangladesh found that bank and informal financing of farming activity were much more common than microfinance (Dalla Pellegrina, 2011). While the reasons were not entirely clear from the

8 ADB Agribusiness Division [online]. www.agricbank.com/products-services/agric-finance/

9 BAAC (Bank for Agriculture and Agricultural Co-operatives) [online]. www.baac.or.th/baac_en/

dataset used for the study, the author suggested both a bias on the part of microfinance lenders towards non-agricultural investment and the use of standardized contracts with short repayment periods. Harper (2005) draws similar conclusions, noting that microfinance contracts aim for a low “lumpiness” of return that arrives with little delay, low seasonality and centrality to household income, and high predictability. Microfinance lenders also preferentially target women as borrowers. Those features do not align well with on-farm investments, where the activities typically overseen by women may satisfy some of the criteria, but not predictability, whereas the more predictable activities typically overseen by men are seasonal and feature lumpy and delayed return. Both men’s and women’s agricultural activities are often central for household income. Marr (2012) points to risks, both for rural borrowers and their potential microfinance lenders, that create barriers for microfinance.

Table 1
Categories of financing instruments

Instrument	Main sources of finance	Main recipients
Input-based finance	IFIs	Governments
Output-based finance	IFIs	Governments
Results-based finance	IFIs	Governments
Direct investment	Domestic and international firms	Firm affiliates
Portfolio investment	Institutional and individual investors	Domestic firms
Bank finance	Domestic banks	Firms, farmers
Informal finance	Farmers’ social networks	Farmers
Microfinance	Private firms, NGOs, UN agencies	Farmers

SOURCE: Authors’ summary based on material cited in the text.

Development finance has evolved considerably over time, both in its goals and its modalities. Early models focused on filling the “financing gap.” The presumption was that productive investment would naturally occur, but was constricted by the lack of domestic savings. International investment would fill the gap, allowing investment to proceed. In this approach, the basis of financial support is the cost of inputs. This is not to say that the lenders had no influence over how the funds might be spent. Indeed, they provided expert advice and training on economic planning. Nevertheless, by the 1980s the strategy was widely seen to have failed, whether because non-economic factors were neglected (Seers, 1979), or economic (that is, market) factors were neglected (Lal, 1985) or incentives were absent or misaligned (Easterly, 1999). This led to strategies to disburse funds based on outputs rather than inputs; for example, the successful construction and operation of a dam.

Output-based finance was often combined with conditionalities, such as the adoption of specific policies by recipient countries (Paul, 2006). For land and water investment, IFIs undertake different levels of technical and economic reviews of potential projects and programmes and many ensure a certain level of social and environmental safeguards as a condition of funding. As discussed in the previous section, safeguards are important to protect the livelihoods of farmers and local communities, ensure equity and protect environmental resources, however these safeguards also vary between IFIs.

For example, since the EIB is owned by the European Union Member States, it must follow EU legislation both within and outside the European Union (or at least its core principles). The EU Water Framework Directive (WFD) requires irrigation projects to have an Integrated Water Resources Management (IWRM) plan at the country-level and to regularly update the plan. The IWRM is conducted to ensure that water is available for downstream users and that environmental impacts are minimized. The IWRM process starts with assigning each water basin a status according to its baseline quality and quantity and developing a plan to improve its status if there are concerns. Any mitigation measures are screened to evaluate potential impacts on the environment. However, some countries are unable to comply with the EU WFD, due to a lack of capacity. In those cases, to satisfy the essence of the regulation, they complete an IWRM at the basin or sub-basin scale. Completing an IWRM does not guarantee financing for an irrigation scheme, but it makes the potential recipient eligible. In other cases, governments are increasing their capacity to implement IWRM; a case in point is the 'Lower Usuthu Smallholder Irrigation Project' in Eswatini¹⁰ (IFAD, 2016), where the government has been moving forward in the legislative framework and adaption their administration to implement the IWRM concept.

Much IFI finance involves a certain amount of output-based financing. However, the outcomes — that is, actual changes in the development landscape — were seen as not being met, leading to a further search for alternatives. At present, a prominent orientation is RBF (or performance-based lending, payment-by-results, outcomes-based finance, or cash-on-delivery) (Birdsall et al., 2010). One example of this is the World Bank's Performance for Results (P4R), but other schemes exist.

While most of the RBFs are outside of agriculture, there are some examples, such as Rwanda's "Transformation of Agriculture Sector Program Phase 3", which took into account the uncertain nature of agricultural production (Gelb and Postel, 2016) or an irrigation project for the North China Plain (Rodriguez et al., 2014). Much of the evidence of RBFs effectiveness is from outside land and water, and results to date are mixed. The success depends heavily on the indicators chosen to measure progress (Gelb and Hashmi, 2014), and there are incentives for both lenders and borrowers to "game the system" (Sabbi and Stroh, 2020). Clist (2019) points out that there have been success stories, but they tend to be on a small-scale scheme, whether for a small project or as a small component in a large project. To the extent that it has failed, it is in the realm of what Clist calls "big" payments by results projects, which required excellent indicators for their success and envisaged revolutionary results.

This section suggests that small-scale investments by farmers will continue to be financed largely through informal and bank channels. Informal finance can be expensive (Dalla Pellegrina, 2011), therefore efforts to improve access to and alignment with other forms of small-scale finance, particularly microfinance, could encourage farmer investment in land and water. Development finance is by nature challenging, as it features multiple actors with diverse and sometimes conflicting motivations (Paul, 2006). The complex relationships between those actors creates challenges for performance-based aid (Paul, 2015). Nevertheless, RBFs such as output-based finance, is a

10 Swaziland – Lower Usuthu smallholder irrigation project. www.ifad.org/documents/38714170/39150184/Swaziland+-+Lower+Usuthu+smallholder+irrigation+project.pdf

modality that can work at the small scale and with the certain partners, particularly non-governmental organizations (NGOs) (Clist, 2019). For very large infrastructure investments, the ADB's Water Financing Partnership Facility is a model for capacity development with long-term national partners.

2.3 TRENDS IN IFI INVESTMENTS IN AGRICULTURAL WATER

This section provides an analysis of trends in agricultural water investments over the 2010–2019 period. The focus of this analysis is on capital financing rather than the operation and maintenance costs needed to sustain investments over time (Goksu *et al.*, 2017). Within the broad category of capital financing, financial commitments are distinguished from financial disbursements. Each of these provides complementary information: commitments show funders' current priorities; disbursements show resources actually available to countries. Commitments also show funds available to countries, although they consistently exceed disbursements (Bulř and Hamann, 2003). The consistent gap suggests problems with investment implementation (such as project delays) or cost estimation at project appraisals. Because we wish to focus on funding priorities, this paper focuses on commitments.

Trends in investment financing commitments in agricultural water resources in the 2002–2010 period are compared with the 2010–2019 period in Figure 2. The commitments fluctuated greatly, but as shown by the trend line (the dotted line in the graph), they tended to broadly parallel the growth in the gross domestic product (GDP) of countries eligible to receive funding from the International Development Association (IDA) and International Bank for Reconstruction and Development (IBRD) (the dashed line in the graph).¹¹ There is a clear increase in the funding of agricultural water investments following the 2007–2008 food crisis. This period also overlapped with the 2005–2015 UN International Decade for Action on Water for Life, which may have influenced the funding priorities towards water. The years 2016–2025 are the International Decade for Action on Nutrition.¹²

11 IDA funding is available to all countries with a gross national income (GNI) per capita of USD 1925 or less. That lies in the middle of the World Bank's range for "lower middle income" countries. IBRD funding is available to credit-worthy countries whose GNI per capita is 6975 or less (the IBRD graduation threshold). That lies in the middle of the World Bank's "upper middle income" country range. So-called "blend" countries are IDA-eligible and also eligible for some IBRD funding.

12 "The UN Decade of Action on Nutrition is a commitment by United Nations Member States to undertake 10 years of sustained and coherent implementation of policies, programmes and increased investments to eliminate malnutrition in all its forms, everywhere, leaving no one behind." (www.un.org/nutrition/).

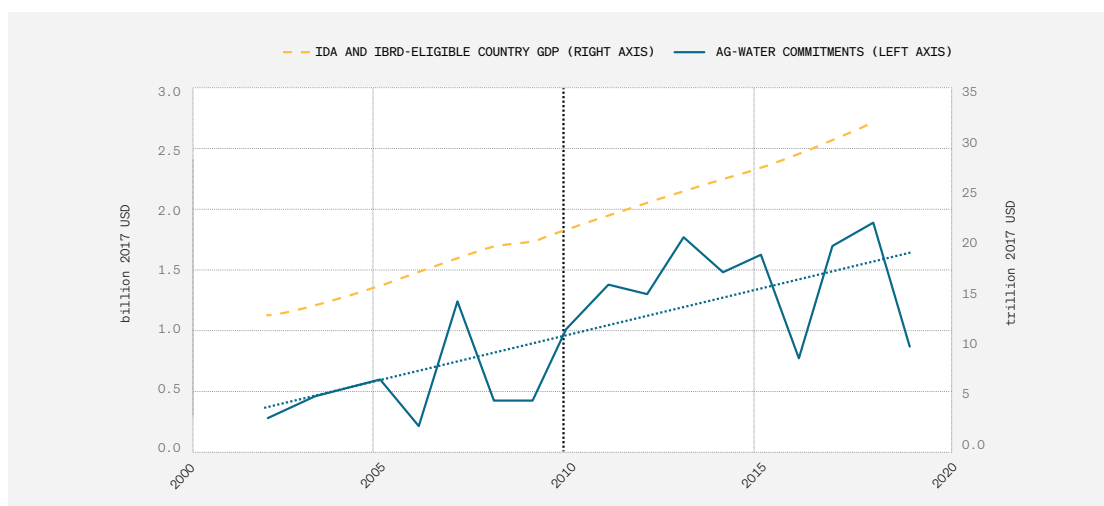


Figure 2

Volume of commitments in agricultural water resources from all IFIs, 2002–2019 (left axis), with GDP of likely recipient countries (right axis): IDA and IBRD-eligible countries

NOTE: The sector categories used in this paper are those of the OECD Development Assistance Committee (DAC)’s Common Reporting Standard. Data are from the Creditor Reporting System (CRS), either directly (<https://stats.oecd.org/Index.aspx?DataSetCode=crs1>) or as used in the Aid Atlas (<https://aid-atlas.org>). The data in the Aid Atlas are taken directly from the OECD CRS. Within the CRS, finance towards agricultural water management is categorized as “agricultural water resources” and defined as including irrigation, reservoirs, hydraulic structures, and groundwater exploitation for agricultural use.

SOURCE: Data from the World Bank World Development Indicators [accessed 26 May 2020].

Funding commitments can change abruptly around specific events. For example, over the three years prior to the 2005 Paris Declaration on Aid Effectiveness, Agricultural development made up 33 percent of commitments in agriculture, forestry, and fishing, while the agricultural policy and administrative management received 14 percent. It should be noted that according to the OECD’s Common Reporting Standard classification system, agricultural policy and administrative management is defined as “agricultural sector policy, planning and programmes, aid to agricultural ministries, institution capacity building and advice and other [forms of] unspecified agriculture” (OECD, 2018). In the three years after the declaration, commitments for these categories swapped places, with 22 percent going to agricultural policy and administrative management, and 12 percent to agricultural development. A similar, although less dramatic, shift in investments occurred after the 2015 donor conference in Addis Ababa, with financing commitments to agricultural water resources shrinking and those to agricultural policy and administrative management growing.

Total financing commitments in the agricultural sector over the 2010–2019 period are shown in Figure 3. The categories in the figure are defined by the OECD Common Reporting Standard classification system. The commitments are in the form of ODA including grants (5.4 percent) and loans (48.4 percent), other financial flows such as non-export credits (46.1 percent), private development finance and equity investment (0.03 percent). Just over a quarter of all agricultural investments by IFIs are in agricultural water resources.

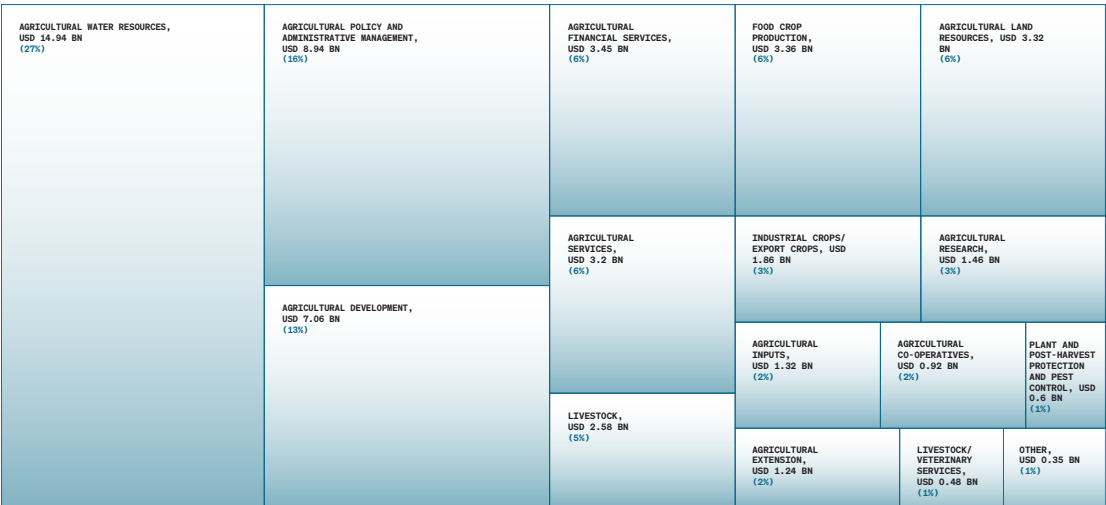


Figure 3
Volume and share of agricultural investment commitments from IFIs, 2010–2019.
Units in 2019 USD

SOURCE: OECD. 2021. Creditor Reporting System (CRS) [online]. <https://stats.oecd.org/Index.aspx?DataSetCode=CRS1>

Figure 4 shows the financing commitments for agricultural water resources in greater detail. The top donors are the World Bank (IBRD and IDA), the ADB, and the Islamic Development Bank (IsDB).¹³ India, Pakistan, and Indonesia are among the main recipients of agricultural water resource financing.

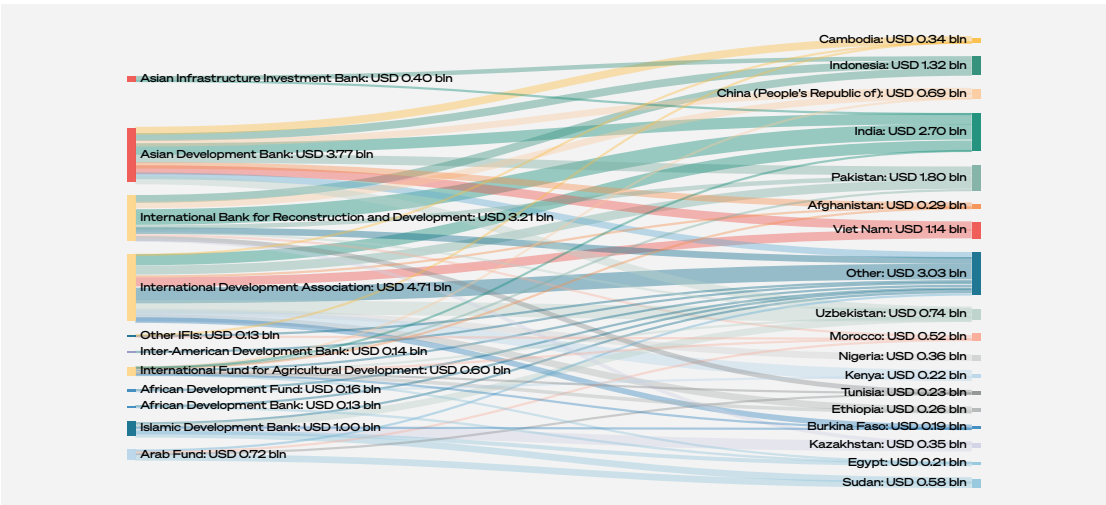


Figure 4
Donor commitment flows to agricultural water resources between 2010–2019 for the World Bank (IDA, IBRD), ADB, IsDB, IDB, AfDB and others. Units in 2019 USD

SOURCE: Donor commitment flows to agricultural water resources between 2010–2019 for the World Bank (IDA, IBRD), ADB, IsDB, IDB, AfDB and others.

¹³ Bilateral flows exceed multilateral flows. In very recent years, private funding has grown considerably, roughly doubling in one year, from USD 400 million in 2016 to USD 800 million in 2017.



Figure 5 shows the volume of investment financing commitments in agricultural water projects during the 2010–2019 period. The top three donors represent almost 80 percent of the commitments and the top five donors almost 95 percent of the committed investments.

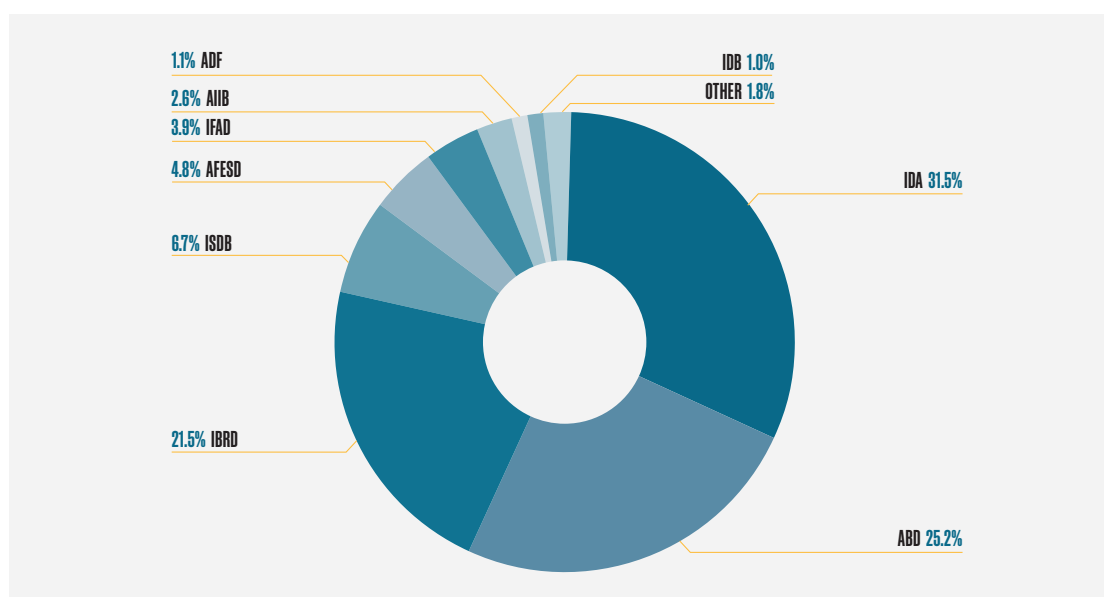


Figure 5
Total commitments for agricultural water investments by IFI, 2010–2019

SOURCE: OECD. 2021. Creditor Reporting System (CRS) [online]. <https://stats.oecd.org/Index.aspx?DataSetCode=CRS1>



Tables 2 and 3 provide an overview of the number of projects between 2010 and 2019 by investment category and region, using a system developed by the authors.¹⁴ Among the 504 projects, 30 projects (6 percent of the total projects) received half of the committed funds while the top ten received around 25 percent of committed funds. While all these projects were classified under the agricultural water resources category, the project titles show that many of these projects have varying scopes. For example, they may seek to improve agribusiness, have an ecological or environmental focus, or focus on poverty alleviation and community development more generally.

Geographically, sub-Saharan Africa had the highest share of agricultural water projects at 39 percent of the global total, with the majority of projects in agricultural development. South Asia had the highest level of financial commitments, at 34 percent of the global total, with the majority of commitments in irrigation projects. The full breakdown of projects by region and category are provided in Appendix A.

¹⁴ A text-based search was carried out using three project databases: the OECD CRS database via the Aid Atlas (2021)—limiting the search to World Bank, ADB, IsDB, and IFAD—and the World Bank and ADB web-based databases (World Bank Group, 2021; ADB, 2021). In the OECD CRS database, different tranches of a given project were combined into a single project, including supplemental funding. Supported by text mining tools, projects were combined that appeared to be identical but with different spelling. For example, we combined “CORE ENV PROG & BIODVRSTY CNSRVTN CORRIDORS INTIATIVE IN GMS PH 2”, “Core Environment Program and Biodiversity Conservation Corridors Initiative in the Greater Mekong Sub-region”, and “CORE ENVT PRGM & BIODIVERSITY CONSERVATION CORRIDORS INITIATIVE IN GMS”. That left 263 projects that had received commitments from the selected list of donors. Next, the project list was manually categorized using a devised categorization scheme. The scheme identified 10 categories and 48 sub-categories based on the frequency of specific words in the project titles. The number of projects and volume of commitments in each category were then counted and each category was assigned to typical policy responses and objectives for addressing agricultural water issues, as outlined in FAO’s Driver-Pressure-State-Impact-Response (DPSIR) Framework for the 2021 State of Land and Water Report (Bhaduri et al., 2020). A complete summary of the categorization is provided in Appendix A.

Table 2**Overview of projects by agricultural water investment category**

Investment category	No. of projects	Value of commitment (2019 million USD)
Soil preparation cooperatives		
Irrigation systems	129	6910
Agricultural development	109	3096
Water sector	75	1934
Climate change	72	1268
General development	50	549
Market access/agribusiness development	35	381
Emergency relief	13	340
Land management	9	69
Unsure	7	362
Ecological/environmental	5	34
Grand total	504	14 944

NOTE: Data covers 2010–2019 for the World Bank (IDA and IBRD), ADB, IsDB, IFAD and other major IFIs.

SOURCE: Categorization developed by SEI, based on data from OECD. 2021. Creditor Reporting System (CRS) [online]. <https://stats.oecd.org/Index.aspx?DataSetCode=CRS1>

Table 3**Overview of agricultural water projects by region**

Investment category	No. of projects	Value of commitment (2019 million USD)
Soil preparation cooperatives		
sub-Saharan Africa	199	3087
East Asia and Pacific	93	3745
South Asia	91	5085
Europe and Central Asia	50	1525
Near East and North Africa	35	1187
Latin America and Caribbean	27	308
Unspecified	9	8
Grand total	504	14 944

NOTE: Data covers 2010–2019 for the World Bank (IDA and IBRD), ADB, IsDB, IFAD and other major IFIs.

SOURCE: Categorization developed by SEI, based on data from OECD. 2021. Creditor Reporting System (CRS) [online]. <https://stats.oecd.org/Index.aspx?DataSetCode=CRS1>

The top ten investment sub-categories were ranked by number of projects (Figure 6) and amount committed (Figure 7), using the categories shown in Table 2. New irrigation schemes systems topped the number of projects, whereby the rehabilitation and modernization of existing irrigation systems received the highest amount of funding. Water resources management and development also rank high. Generally, the rankings in both tables align with a few exceptions. For example, the construction of dams and barrages ranks high in total commitments, however it has only 15 projects because each individual project is very large. Interestingly, the number of climate adaptation projects is high, which demonstrates the growing importance for IFIs to address climate change risks, including floods.

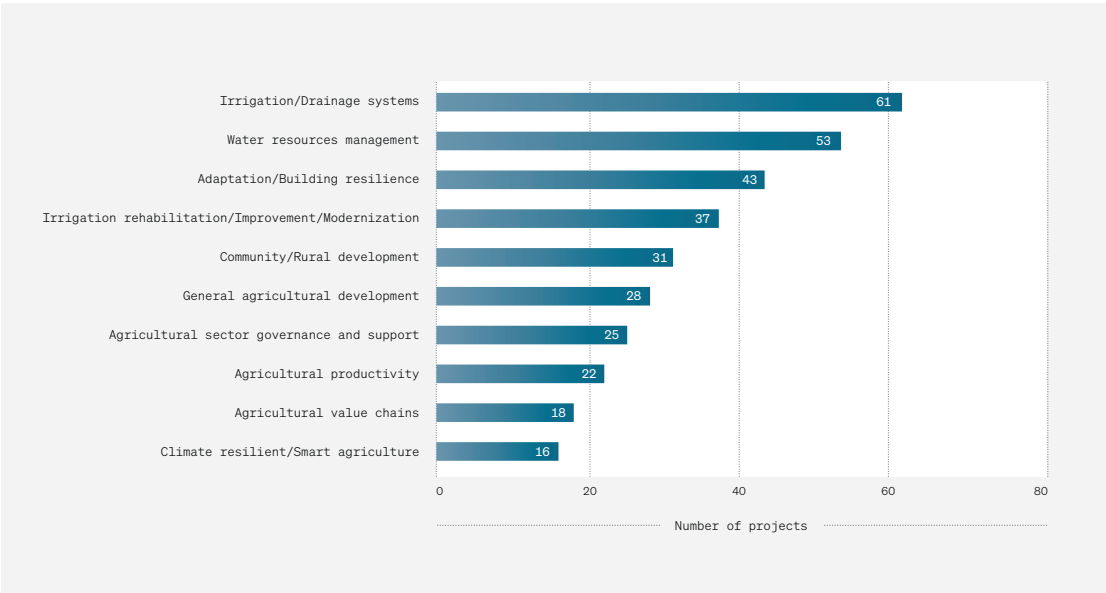


Figure 6
Top ten agricultural water investment areas by number of projects

NOTE: Data covers 2010–2019 for the World Bank (IDA, IBRD), ADB, IsDB, IFAD and other major IFIs.

SOURCE: Categorization developed by SEI, based on data from OECD. 2021. Creditor Reporting System (CRS) [online]. <https://stats.oecd.org/Index.aspx?DataSetCode=CRS1>

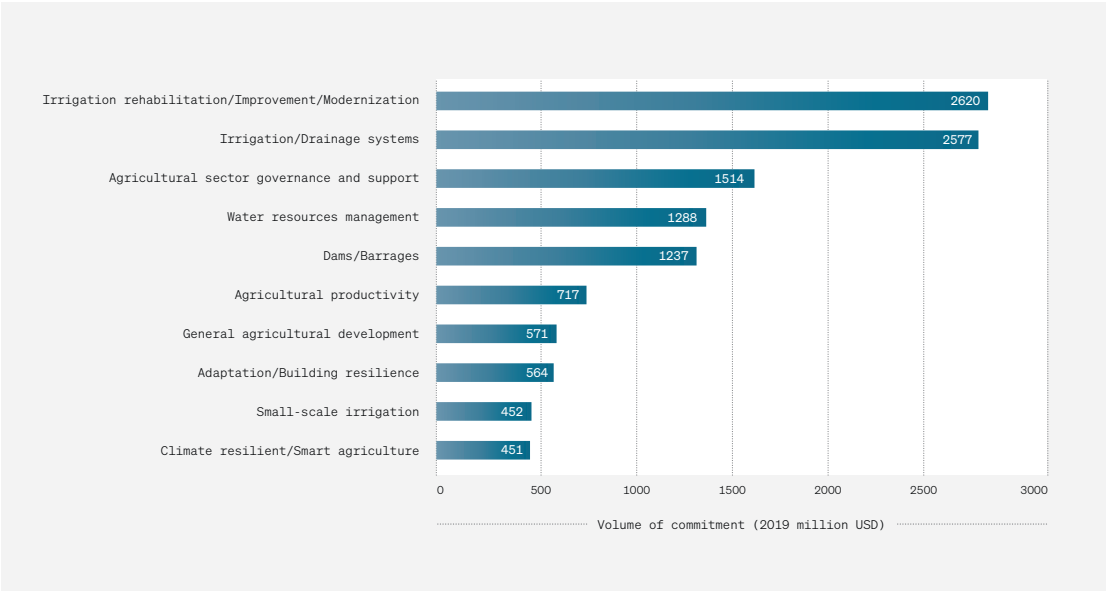


Figure 7
Top ten agricultural water investment areas by size of commitments

NOTE: Data cover 2010–2019 for the World Bank (IDA, IBRD), ADB, IsDB, IFAD and other major IFIs.

SOURCE: Categorization developed by SEI, based on data from OECD. 2021. Creditor Reporting System (CRS) [online]. <https://stats.oecd.org/Index.aspx?DataSetCode=CRS1>

The categories from Table 2 motivated a choice of keywords that were used to scan project titles in the World Bank and ADB web-based project databases. Figure 8 shows the number of projects among chosen keywords. The results broadly reflect the findings shown in Figure 6. The number of projects that mention both irrigation (and related terms) in either the title or the abstract remains quite high, despite a general decline and a sharp increase in recent years. Ecosystem-, climate- and governance-related terms are of comparable magnitudes prior to 2018. The funding for projects mentioning climate began to rising in 2010, after the 2009 Copenhagen climate conference, and rose again after the 2015 Paris conference.

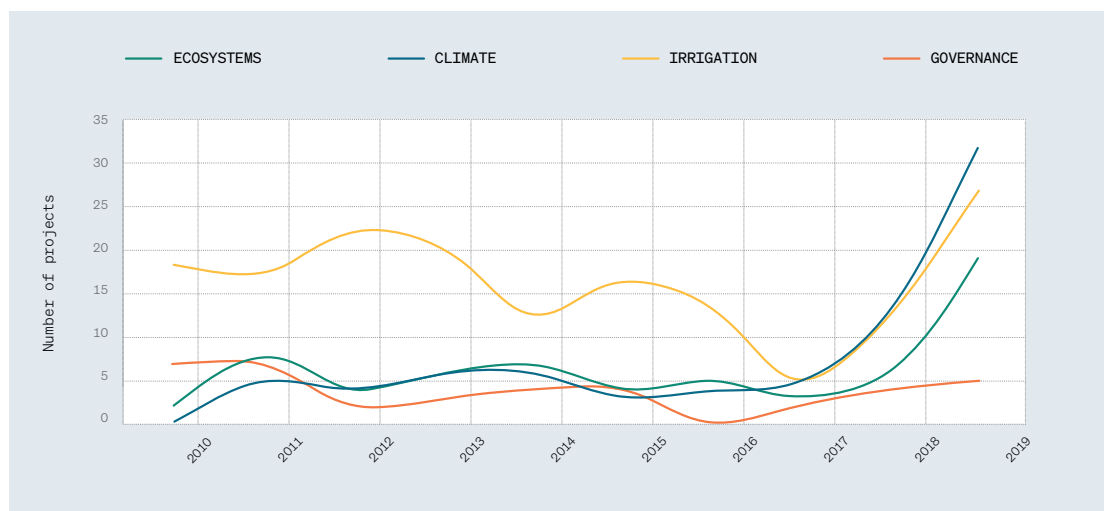


Figure 8

Number of new projects in which related keywords appear in the title or abstract of World Bank or ADB agricultural projects (trendlines have been smoothed for clarity)

SOURCE: Categorization developed by SEI. Data for the World Bank (IDA, IBRD) and ADB taken from OECD. 2021. Creditor Reporting System (CRS) [online]. <https://stats.oecd.org/Index.aspx?DataSetCode=CRS1>

When reviewing the projects in the OECD CRS Database against FAO’s 2021 State of Land and Water Report’s (SOLAW) Driver-Pressure-State-Impact-Response (DPSIR) framework (Bhaduri et al., 2020), the majority of investment responses fall under the “technical” category of response (Figure 9). In terms of the objective linked with these responses (Figure 10), “Increasing productivity and efficiency” is the top ranked objective and with the highest value of commitments due to the size of each project. This objective typically corresponds to a rehabilitation/modernization investment and not necessarily to an expansion (i.e. a new scheme). Many of the projects fulfil the FAO DPSIR objective of conservation of natural resources, highlighting the increased awareness of ecosystems and their services in promoting food security and sustaining agricultural production.

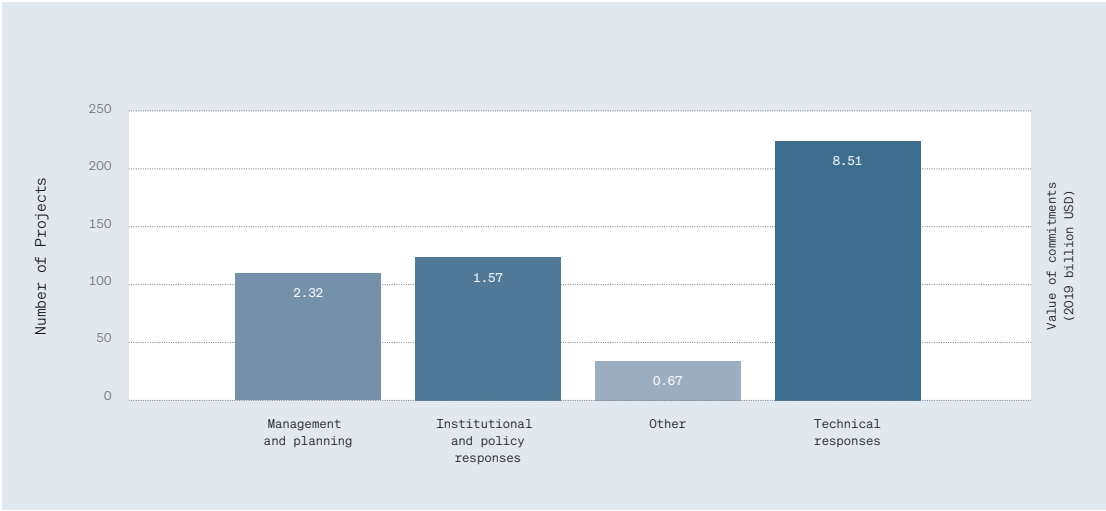


Figure 9
Number of projects and value of commitments by DPSIR response category

NOTE: Data covers 2010–2019 for the World Bank (IDA, IBRD), ADB, IsDB, IFAD and other major IFIs.

SOURCE: Categorization developed by SEI, based on data from OECD. 2021. Creditor Reporting System (CRS) [online]. <https://stats.oecd.org/Index.aspx?DataSetCode=CRS1>

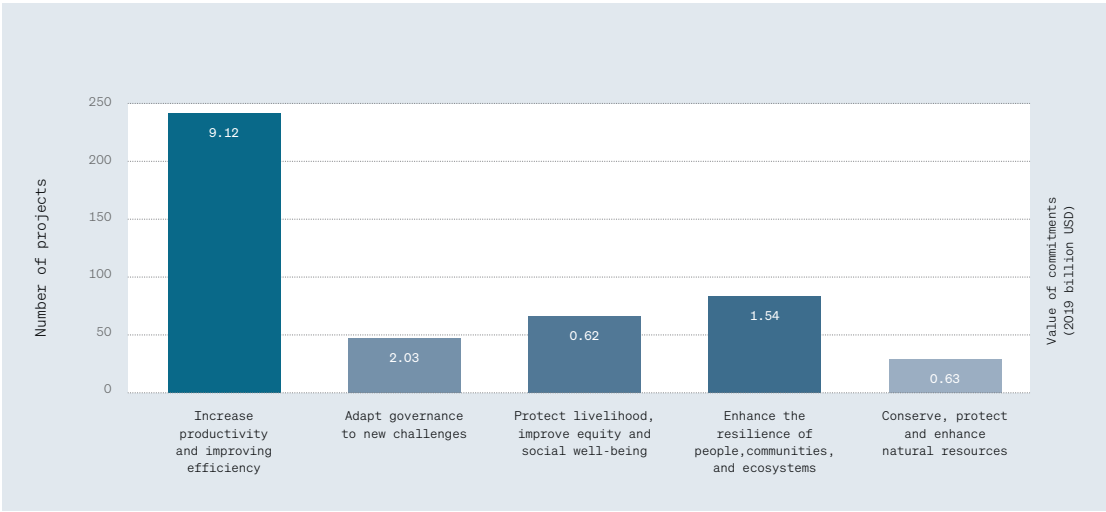


Figure 10
Number of projects and value of commitments by DPSIR objectives (some investments fulfill multiple objectives)

NOTE: Data covers 2010–2019 for the World Bank (IDA, IBRD), ADB, IsDB, IFAD and other major IFIs.

SOURCE: Categorization developed by SEI, based on data from OECD. 2021. Creditor Reporting System (CRS) [online]. <https://stats.oecd.org/Index.aspx?DataSetCode=CRS1>

In sum, during the decades prior to 2010, investments went towards the use of water resources for developing and growing the agricultural sector, while environmental pressures and land constraints due to urbanization were important, but secondary (Koochafkan *et al.*, 2010). The strategies from the last decade put a larger emphasis on increasing agricultural productivity to adapt to the decreasing availability of land and water resources due to societal and environmental pressures (Koochafkan *et al.*, 2010). Climate change adaptation and water resources management both ranked high in terms of the investment dollars committed between 2010 and 2019.

2.4 PERFORMANCE EVALUATION OF AGRICULTURAL-WATER INVESTMENTS BY IFIs

All IFIs have mechanisms for a regular review of their performance through impact evaluations, conducted internally and externally. These can be at the level of individual projects, sectors, and themes, such as gender and inclusion or poverty alleviation. This section reviews the impact evaluations of the leading IFIs with a focus on the World Bank (Giordano *et al.*, 2019; World Bank, 2019a), IDB (IDB, 2015) and ADB (ADB IED, 2018).

Environmental benefits and natural resource protection are emphasized to varying degrees by different IFIs in their impact evaluations. The ADB review notes positive contributions to natural resource protection and climate resilience, both through its eco-compensation instrument and by supporting the development and maintenance of rural infrastructure and flood protection. Nevertheless, both the IDB and World Bank reviews provide evidence that more attention needs to be given to the negative impacts on the environment, particularly associated with irrigation projects. The World Bank's Independent Evaluation Group review on the impacts of irrigation (World Bank, 2019a) found that the majority of projects had limited focus on addressing environmental issues from irrigation and drainage infrastructure, including flooding, reduced river flows and groundwater, salinization, and contamination. The review also points out, however, that bank projects have protected natural resources by enhancing the productivity of agricultural land and reducing the pressure to expand production to land of marginal quality. The report notes that the positive impacts of the bank's irrigation projects on natural resources are rarely identified in project evaluation reports and academic literature and deserve greater emphasis.

A consistent message from the evaluations is around the unequal distribution of benefits and costs of irrigation and drainage investments. The World Bank Impacts of Irrigation Review (Giordano *et al.*, 2019), which reviewed more than 500 articles, found that in almost every study both the positive and negative impacts of irrigation projects were unequal socially, spatially, and temporally. This happens, for example, when irrigation systems have an unequal land distribution or when some groups are excluded from land ownership. In many societies, women have a marginal role in the decision-making processes of irrigation as well as in the profits derived from irrigation. In contrast, the 2018 evaluation of ADB projects finds that ADB has supported inclusive growth and enhanced gender equality. Many of the projects assessed by the report target beneficiaries directly, helping with the reduction of poverty and inequality on a community level. This focus on community-based projects provides improved small-scale infrastructure, access to microcredit, and enhanced capacity, all of which serves to reduce poverty. The ADB's focus on

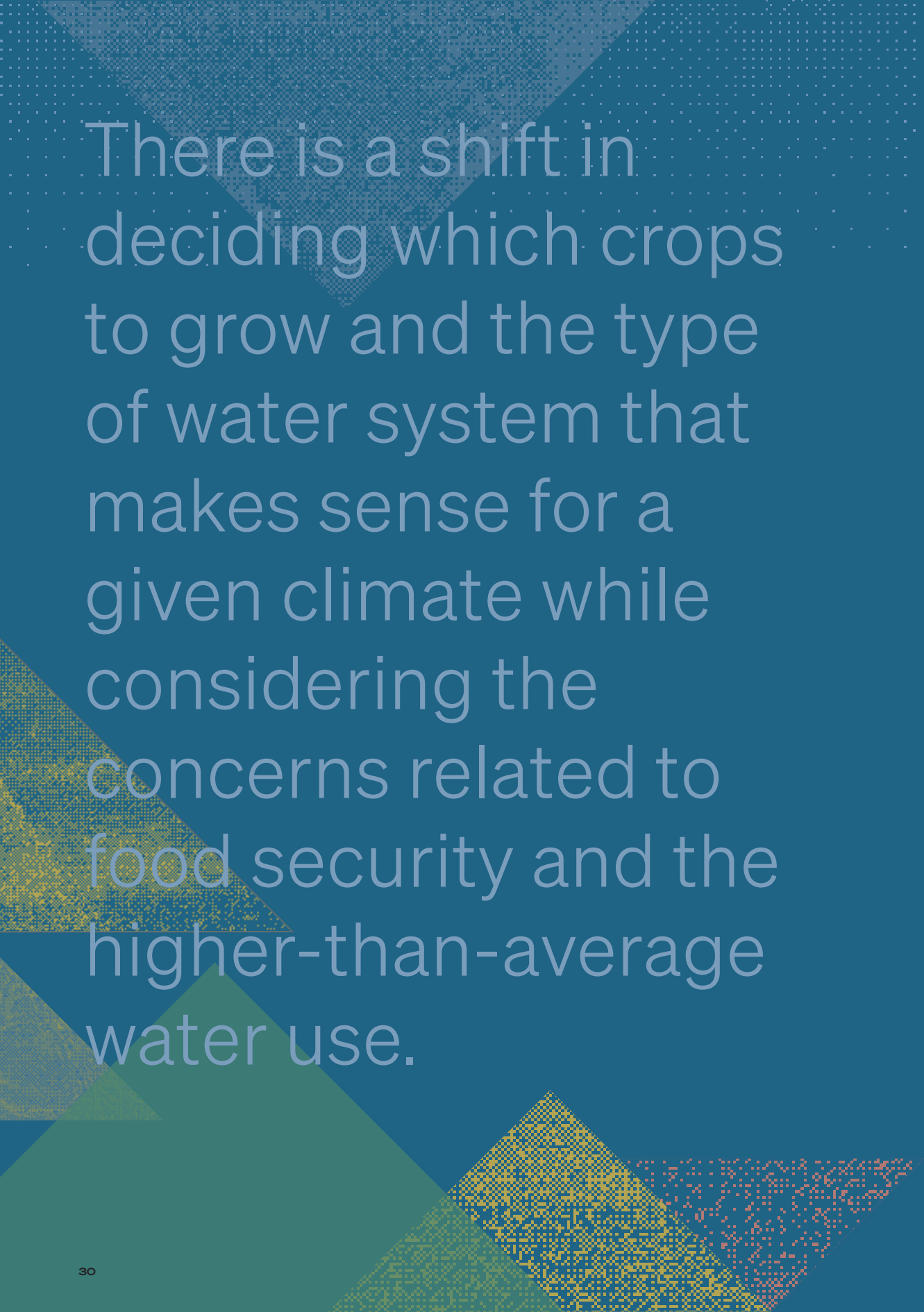
gender equality can be seen in the widespread inclusion of gender action plans, which were found in 76 percent of all 114 approved projects examined by the report. Yet the evaluation points out that even with gender action plans in place, there is scope for improving gendered outcomes in agricultural investments.

Finally, climate resilience emerges as a theme that was often overlooked in IFI investment priorities in the past. The World Bank evaluations, and to a lesser extent the ADB's evaluations, have found that insufficient attention has been given to climate change and, more broadly, to the increased complexity of agricultural investments, such as greater competition for water with an increasing urbanization and global market demand and variability. The evaluations of the World Bank find that its projects are oriented towards traditional elements of irrigation infrastructure and institutional capacity building at the government agency level. The emergent areas of water resource management, such as climate resilience, increased water competition and scarcity in both surface and groundwater systems, need to be more explicitly included in key performance indicators (KPIs). KPIs are measured for infrastructure and traditional institutional outputs in 68 percent of the projects reviewed, with 84 percent showing satisfactory or better performance, which is clearly important. In contrast, KPIs for climate resilience were measured in less than 20 percent of projects, with only 32 percent showing satisfactory or better performance. The 2019 World Bank Support for Irrigation Service Delivery states that only two World Bank projects have addressed climate resilience to a significant extent. ADB finds that the bank's projects have pursued climate resilience, but that there remains room for improvement. ADB projects have positively contributed to climate resilience through conservation farming and reforestation and the development of stronger institutional capacities. The ADB has financed climate adaptation erratically, with an average of about USD 857 million per year and a total of USD 1.8 billion from 2012 to 2017. The evaluation finds that the ADB often interweaves aspects of resilience and responses to natural disasters into projects supporting rural infrastructure.

There is evidence that the desired project outcomes are often times not met due to insufficient monitoring and evaluation of projects. A review of 79 large-scale irrigation systems in sub-Saharan Africa installed prior to 2010 revealed that only 25 percent of the schemes delivered long-term benefits, while the rest deteriorated due to poor maintenance, changes in local hydrology and climate, and farm productivity constraints due to land tenure issues or other factors (Higginbottom *et al.*, 2021). Most of these schemes were financed by IFIs such as the World Bank and the African Development Bank (AfDB). Along similar lines, many IFI investments in irrigation efficiency such as with sprinklers or drip irrigation systems fail to measure metrics like water use efficiency, therefore making it unclear if investments lead to genuine water savings (Perry and Steduto, 2017). According to the "paradox" of irrigation efficiency, very often water use actually increases after irrigation technologies are installed at the irrigation scheme level or basin level, despite decreases in water use in a per hectare basis (Grafton *et al.*, 2018). IFIs are now starting to use water accounting to actually measure water savings arising from their projects (Perry and Steduto, 2017). Many IFIs are using these past experiences to implement RBF on projects to ensure disbursements occur only after strong evidence that project outcomes meet initial objectives. A discussion on RBF and other related financing instruments are discussed in chapter 2.2.







There is a shift in deciding which crops to grow and the type of water system that makes sense for a given climate while considering the concerns related to food security and the higher-than-average water use.



Chapter 3

Looking into future agricultural water investment priorities

This chapter reviews priority agricultural water investment areas for future IFI financing to respond to growing and new opportunities and challenges. The chapter begins with an overview of key drivers for agricultural water investments including tackling food insecurity, tackling poverty and inequality, and building climate resiliency. The accompanying responses range from technological improvements, improved knowledge dissemination on sustainable and resilient agricultural production methods to the need for greater institutional capacity and governance in managing agricultural water resources. The aspects linked to innovations in IFI financing mechanisms and instruments are also a priority for future investments in agricultural water management, as reviewed in detail in chapter 2.2.

3.1 FUTURE DRIVERS FOR CHANGE

3.1.1 Addressing food insecurity

According to FAO's report, *The future of food and agriculture – Alternative pathways to 2050* (FAO, 2018a), by 2050 agricultural production needs is expected to increase by 50 percent compared to 2013 in order to meet growing global agricultural demands. Despite significant increases in food production, it has been estimated that under the best FAO scenario 344 million people will still be undernourished in 2050, while under the worst-case scenario the numbers would rise to 1.2 billion people.

Growing social inequalities, conflicts, climate shocks and economic instabilities are contributing to insufficiencies in food supply and distribution, and in particular to food access. Further to the existing risks, the scale of impacts from the 2019 novel coronavirus (COVID-19) on food security and hunger are significant. Food supply chain inefficiencies and a deepening gap *vis-à-vis* affordability for nutritious food caused by trade disruptions and economic shocks are just a few of the impacts of the pandemic, according to FAO's State of Food Security and Nutrition in the World 2021 report. The COVID-19 pandemic resulted in 161 million more people suffering from chronic hunger — the largest increase to occur in a single year in decades — and it is estimated that 155 million more people will become acutely food insecure (FAO *et al.*, 2021).

Agricultural water resources are key to meeting global food security goals. Increasing crop yields through adequate irrigation systems and improving resiliency against climate change are areas of priority. While irrigation infrastructure has played and continues to play a large role, issues of water scarcity and poor water management make this a challenge.

3.1.2 Tackling poverty and inequality

While the production of food is necessary for combatting hunger and providing food security, for many, participating in the agricultural sector itself is the best way to alleviate poverty, hunger and food insecurity. Officially, 26.8 percent of the labour force is employed in agriculture, forestry and fishing worldwide (ILO, 2020). Among the 608 million farms in the world, around 84 percent are small farms with land plots less than 2 hectares, and producing 36 percent of world's food in terms of value (Lowder *et al.*, 2019). Poverty and food insecurity are common among small farmers in low- and middle-income countries (Rapsomanikis, 2015).

Many agricultural water investments are driven by the need to ensure sufficient food production, and to a lesser degree by the needs and priorities of smallholder farmers (Santini *et al.*, 2012). Access to water and related technologies is necessary to bolster smallholders' livelihoods, particularly the poorest ones. For agricultural water investments this means, "a fundamental shift beyond considering water as a resource for food production to focusing on people and the role water plays in their livelihood strategies" (UNESCO-WWAP, 2006). Taking a livelihoods approach focuses on peoples' need for a secure, stable and diversified source of income as opposed to just concentrating on increasing yield (FAO and IFAD, 2008). However, in practice, it is important to recognize that farmers have different needs depending on their circumstances, therefore one-size-fits-all solutions can be inappropriate (Santini *et al.*, 2012). As described in chapter 2.1.1, a shift towards farmer-led initiatives dictating investments can help to ensure context-specific strategies are implemented.

In addition to taking a socio-economic perspective to investment decisions, it is important to consider other aspects of inequity, such as gender. Agricultural water management projects often overlook women farmers in training programmes and decision-making roles and processes, although the scale of gender-related agricultural water issues are unknown due to poor documentation and data collection (FAO, 2021). Within the household, women are often responsible for balancing the use of water for household consumption with agricultural water needs, which can be challenging during seasonal peaks of water scarcity (Parker *et al.*, 2016). The associated labour and time burdens on women and girls to secure other sources of water can limit the time available

for other productive activities, including their employment and education. Projects on integrated water management examining gender-based roles, responsibilities and impacts need to be considered when making investment decisions. Furthermore, gender analysis, as part of project design, can greatly improve women's empowerment, including their participation in the planning and implementation of economic activities.

3.1.3 Climate change mitigation and adaptation

Climate change has significant implications on water resources and agricultural productivity, especially in regions with existing water scarcity issues. Climate change is already increasing variability in temperatures, from heat waves to cold snaps, and creating irregularities in rainfall patterns, including longer and more intense periods of drought or extreme flood events. For instance, projections show that drought frequency will increase by more than 20-60 percent by 2100 (FAO and IWMI, 2019).

According to a World Bank study, a 20 percent reduction in water availability in the Near East can decrease the GDP between 5 percent and 10 percent compared to 2016 values (World Bank, 2020b). The study assumes that, in order to cope with water scarcity, farmers will transition away from irrigation systems towards rainfed agriculture and will expand cropland to compensate, such as through deforestation and conversion of pastures. Many farmers are turning to groundwater to meet agricultural water needs. To ensure the sustainability of groundwater resources and prevent exploitation of groundwater at unsustainable rates, it is important to limit water extraction to natural recharge levels (Perry and Steduto, 2017). Water management policies, including but not limited to water accounting (i.e. standardized records of water resources) and water monitoring, are recommended to secure water for the region. Additionally, to reduce pressures on freshwater resources there is growing interest in the desalination of seawater and wastewater reuse for agricultural water uses. Desalination of seawater for agricultural purposes will likely receive support from IFIs if done with renewable energy sources in order to be aligned with the 2015 Paris Agreement. Currently, 39 percent of treated wastewater is reused within the Gulf Cooperation Countries (GCC) with the rest discharged to water bodies (Qureshi, 2020).

Another example is Viet Nam, one of the most vulnerable countries to extreme weather events, including recurring tropical cyclones that cause severe damage to buildings and agricultural systems, alongside longer droughts during the dry season. A World Bank-funded study showed that implementing climate change adaptation measures in Viet Nam's agricultural sector has the potential to increase their agricultural value-added by 10 percent (World Bank, 2010). Potential adaptation measures reviewed include modifying sowing schedules, planting drought-, flood-, and/or salinity-tolerant crops, increased research and development related to climate adaptation in the agricultural sector, improved agricultural extension services, or increasing the share of irrigated land.

Generally, significant variability in climate stresses crops both directly, through crop loss, and indirectly, through the rise of pests and diseases or insufficient water supply. These changes are already being seen around the globe. As a result of droughts, increasing rates of groundwater abstraction are not only depleting groundwater levels beyond sustainable levels, but are also creating GHGs from the fossil fuel burned from pumping groundwater. Addressing variability thus requires new and innovative technological solutions to reduce stress and improve resiliency. Plant breeding has been used to increase yields, improve nutritional value of crops (such as cereals),

improve taste and quality, increase tolerance against pests and diseases, and decrease the use of harmful inputs (i.e. chemical fertilizers and pesticides) that have environmental and health concerns (Huang *et al.*, 2002). New climate change-resistant crop varieties against drought, floods, salinity and other issues can help create climate resiliency and reduce livelihood risks for smallholder farmers. Creating resiliency also requires farmers to make use of every drop of water that is available, particularly in water scarce areas through water-efficient technologies, the optimization of existing water use through monitoring processes and enhancing water retention in soils.

To meet the climate targets set out in the 2015 Paris Agreement, in 2018, major IFIs made a joint declaration on their commitment to climate finance activities (EBRD, 2018). The EIB, for example, published a climate roadmap in 2020 with a fairly detailed list of investments that would no longer be considered compatible with the Paris Agreement, including carbon-intensive activities in the agricultural sector (EIB, 2020). While some progress has been made by IFIs to address climate change, actual progress towards ensuring climate resiliency is insufficient and there is profound uncertainty about making assumptions regarding climate and irrigation benefits or losses. Climate uncertainty means that investments in agricultural water need to be planned differently, to ensure that investments are flexible and capable of ensuring acceptable performance across a wide range of wet and dry conditions. To factor in climate change, countries need evidence-based approaches that rely on data collection and climate research and development, as well as more on capacity development of governmental agencies on climate issues.

The past decade has seen greater global recognition of the risks caused by global warming to food, energy (via hydropower and cooling) and water security, as well as to related infrastructures, due to the increased frequency and severity of extreme events. Investments in climate change resilience, climate-smart agriculture and adaptation have increased this past decade across all IFIs, as noted in chapter 2. Based on a review of IFI projects by agriculture water investments by category, investments in projects that reference climate have almost doubled, despite remaining below 10 percent of the total number of projects. Climate change is a development priority that remains an important gap that needs to be filled.

3.2 PRIORITIES FOR FUTURE INVESTMENTS

With increasing food demands, decreasing land and water availability alongside issues of environmental degradation, much of the next generation of investments will need to focus on intensifying agricultural production in a sustainable manner through improved management and governance. IFI's are already looking into how they can invest in modern technologies and processes for the next generation of investments to meet land- and water-related SDG targets at a faster and greater scale.

To ensure reliable harvests and respond to climate change and agricultural land expansion constraints, researchers are continually finding new and innovative methods to improve agricultural yields and crop quality to ensure food security. Expanding and integrating information and communications systems for farmers can provide timely information to better inform optimal water management given the climate and market conditions. New and modern technologies, including biotechnology, can increase yields

and improve resiliency. IFIs should also support these interventions through investments in R&D and education. Often the main bottleneck is not the low adoption of technologies, but the lack of data and lack of capacities to obtain and interpret information at the country level.

3.2.1 Technical and technological innovations

Information and communication systems in agriculture

Access to the Internet with faster computers and mobile platforms has changed the way the world communicates. While investment in ICT may not fall into the realm of typical agricultural investments, there is strong interest across all major development banks to invest in ICT for agricultural and rural development, or e-agriculture (FAO, 2016). E-agriculture has demonstrated to improve the livelihoods of smallholder farmers by empowering them with the knowledge and services needed to increase productivity and incomes (World Bank, 2017a). There are many different ways that ICT could be utilized by farmers throughout the farming cycle, including, for water management, information systems and sensors (World Bank, 2012).

The use of mobile apps across the agricultural sector is expanding across the agricultural sector. For example, the Nigerian National Space Research and Development Agency (NASDRA) recently created a solar-powered irrigation system that works with a mobile app. This system is fitted with soil sensors that are monitored via navigation satellites and reported to the mobile app, which then turns the solar-powered water pump on or off when soil moisture levels fall below or above a specified range.¹⁵

Complementary to pump control apps, the Global Groundwater Monitoring Network (GGMN) launched the groundwater monitoring app that enables users to geo-reference and register groundwater monitoring stations and monitor data for sustainable groundwater management.¹⁶ Water scarcity exacerbated by climate change is driving the overexploitation of groundwater resources. This kind of groundwater monitoring app not only helps farmers track groundwater use and availability, but also enables users to share information more widely to inform policies and investment decisions.

In addition to mobile apps, an e-platform project was developed through IFAD's E-Project for Agricultural Development and Economic Empowerment (E-PADEE) project in Cambodia in 2015 to send technical advice through video or text to farmers (IFAD, 2019). The e-platform, including hardware and software, was distributed to 1649 households across 14 districts, and the result of this initiative was a 72 percent increased uptake of improved rice seed varieties, a 32 percent increase in yields through optimized fertilizer use and a 49 percent increase in income compared to those not receiving advice (IFAD, 2019).

¹⁵ The Guardian. 2018. NASDRA says Automated Irrigation System will make farmers cultivate more. The Guardian Nigeria News - Nigeria and World News, 11 June 2018. Technology. <https://guardian.ng/technology/nasrda-says-automated-irrigation-system-will-make-farmers-cultivate-more/>

¹⁶ UN-IGRAC. 2019. IGRAC relaunches mobile groundwater monitoring app. www.un-igrac.org/news/igrac-relaunches-mobile-groundwater-monitoring-app

Other ICT examples include mobile apps for soil testing and mapping of soil characteristics, nitrogen sensors to determine the correct fertilizer dose, mobile and ICT based advisory on agronomic practices based on weather, soil, pest outbreaks and other conditions, satellite or drone-based monitoring of fields, water resources, livestock and more (World Bank, 2017a). Accessible, affordable and reliable ICT can provide farmers with the technical information they need to improve agricultural productivity, such as through mobile apps, short messaging service (SMS) or through internet-based courses, which has direct effects on managing agricultural water resources (World Bank, 2017a). This type of information can be particularly useful for making agricultural decisions in the age of climate change where historical rainfall patterns are less reliable. Since the COVID-19 outbreak, IBM and Yara, accelerated the development of a global digital farming platform for smallholder farmers to obtain hyperlocal weather forecasts, gain advice through AI insights and share data with other farmers (IBM, 2021).

Poor smallholder farmers are more connected than ever through growing mobile and internet subscriptions thanks to wireless networks and satellite systems. Even with expanding coverage, the majority of the 1.2 billion people that do not have broadband-capable networks live in rural areas (GSMA, 2018). Digital adoption challenges in rural areas include high infrastructure costs (especially for the “last mile” of connectivity), capacity constraints, limited access to electricity, and the need to create relevant, localized and actionable content for farmers (AfDB, 2020). There is a need for more software developers to design platforms that are easy to access and help farmers with what they need. Furthermore, rural users would like to move from basic phones to feature phones including digital cameras, flashlight, radio, Bluetooth and internet connectivity (World Bank, 2017a). This will help to develop the information channels required to digitize the agricultural sector. Lastly, there are concerns about equity whereby some farmers may benefit more than others, and smallholder farmers, especially women smallholder farmers, will be left behind due to a “digital divide” (GSMA, 2020). Promoting greater uptake of ICTs and digital agriculture are also important for youth involvement to driving agricultural innovation and entrepreneurship and creating attractive job opportunities for young people along value chains. In addition to infrastructure, ICT skills development and digital literacy is also needed (World Bank, 2012).

There are several recent projects underway to improve connectivity for agriculture. For example, a USD 100 million Digital Rural Transformation Project was initiated by the World Bank (IDA) in Benin to increase broadband access for smallholder farmers to easily obtain information on crops, financial services and markets (World Bank, 2019b). A USD 70 million E-Agriculture project is currently underway in Côte d'Ivoire to increase digital access for 6.1 million smallholder farmers and to “strengthening the capacity of farmers in climate smart production management and marketing and facilitating the formation or consolidation of farmer groups into more formal structures” (World Bank, 2018). Both projects have a focus on empowering female smallholder farmers to reduce the gender-related digital divide.

Creating data value chains for water management and planning

Investment is driven by evidence and data, however there is a lack of data on water resource conditions and related issues. Due to ever-growing land and water resource restraints, there is a need to shift from resource-intensive to knowledge-intensive agriculture, which can be enabled through ICT (ADB, 2018). New technologies and digitization could support improved water

accounting and water measurement to track the performance of agricultural water investments and provide early warning on emerging issues in water quality and availability. This technological transition in agriculture should be supplemented with investment in education and engagement, especially of women and youth, to adequately face the challenges of the coming decades.

Mobile solutions can help farmers make more informed decisions that can help with agricultural productivity. There are other innovative ways for farmers to send and receive data. For example, an ADB project in 2016 investigated ways for farmers and farmer organizations to participate in an “Internet Plus rural economy” in China to see how internet technologies (e.g. mobile internet, Internet of things (IoT), cloud computing, and big data) can be applied to the agricultural sector and rural livelihoods (ADB, 2018). IoT, in particular, has significant potential in the agricultural sector for real-time monitoring and decision making through the use of sensor technologies for monitoring air, temperature, humidity, soil, pest or water followed by the control and automation of farming techniques (i.e. water or fertilizer addition), such as those used for precision agriculture, based on the monitoring data (Farooq et al., 2020).

In addition to agricultural productivity, investments have been made in digitalization of agricultural value chains to improve coordination between value chain actors. This type of digitalization has been put under enhanced priority in light of the COVID-19 pandemic by the AfDB, FAO and other major institutions to keep the flow of information between actors going when face-to-face interactions are challenging (AfDB, 2020).

Beyond data for farmers, there is a need to collect and analyse data in new ways, and to make data more accessible in the public domain in order for the public and government agencies to deepen their ability to make decisions on land and water resources. Data collection also allows for better service delivery and verifies project results needed for projects financed through performance-based lending techniques. Traditional data collection through official statistics and surveys can be complemented with new technologies and methods such as sensors, smart meters, crowdsourcing methods, mobile phone data, apps and more. Projects are using remote sensing more than before for collecting large amounts of data. Remote sensing, such as Light Detection and Ranging (LIDAR) equipment, is used depending on the size of the investment and if accurate high-resolution images are needed. For planning purposes, free Digital Elevation Models (DEMs), created using existing remote sensing data, are publicly available for use.

There are many ICT-based systems and tools used for water resource management, including hydrological mapping for water accounting and auditing, evapotranspiration monitoring and management systems, Supervisory Control and Data Acquisition (SCADA) systems for irrigation modernization, ICT for early warning and extension services and more. Water accounting and auditing, for instance, is a way to support evidence-based decision-making on water-related matters, including provisioning water allocations and preparing for floods and droughts. The *Water Accounting in the Niger River Basin* study (FAO and IHE Delft, 2020), led by FAO and the IHE Delft Institute for Water Education, used remotely sensed derived data stored in FAO’s online WaPORv2.0 database¹⁷ along with other open access datasets on water storage and land cover classifications data to create a baseline assessment of water resources in the basin. This comparatively low-cost, rapid

¹⁷ WaPOR, remote sensing for water productivity. [online]. www.fao.org/in-action/remote-sensing-for-water-productivity/resources/publications/wapor-publications/en/

water accounting exercise was then used to evaluate the water availability for irrigation projects and flood potential of a proposed irrigation scheme in the basin. Despite minor uncertainties around precipitation and evapotranspiration rates, the low-resolution open-source data was useful in estimating water availability for irrigation and identifying the need for water use efficiency measures.

Another example is the World Bank's Second Karnataka Watershed Development Project (World Bank, 2019c) in India, whose core objective was to develop a comprehensive land resources inventory (LRI) for improved land and water management. A failure of many projects is that the resource information is gathered at a high level, which may not account for the reality for many farmers on the ground. The LRI database was developed with site-specific resolution on a geo-referenced cadastral map and includes site-specific information on land use, soils, weather, climate, water resources and socio-economic circumstances. This level of detail enables the development of detailed watershed developed plans by government agencies.

SCADA uses sensors to collect data and transmits the data through ICT infrastructure (radio, satellite, Wi-Fi, etc.) for remote monitoring. SCADA can also be used to control devices, such as pumps, valves, gates and more through remote computers known as Programmable Logic Computers (PLCs) (Burt and Piao, 2005). Automatic control of water and irrigation infrastructure, such as through SCADA systems, can reduce over/under-irrigation, increase crop yields, improve efficiency, conserve money and resources (such as from pumping-related energy and water needs), reduce equipment wear and tear, and provide flexibility to farmers (Burt and Piao, 2005). However, there are many important considerations that need to go into designing and implementing a proper SCADA system. For example, a project performance assessment report on the World Bank Water Resources Assistance Project in Vietnam indicated the need to make time for training and calibration of SCADA systems (World Bank, 2019d). Furthermore, it specified that SCADA was discontinued in many cases due to poor quality sensors or because of O&M costs, however the schemes with working SCADA systems were successful, and in some cases, expanded.

With the large volumes of "Big Data" being collected, analysing and making sense of it all can be done by using machine-learning or artificial intelligence (AI), both offline and in real time. Provided that data is collected using Findable, Accessible, Interoperable, and Reusable (FAIR) principles¹⁸ with rich metadata, data can be easily processed using computational systems. While big data can help target interventions and measure progress on SDGs, there are risks involved in ensuring the privacy of individuals and guaranteeing that the data reflects all people and does not exclude certain groups (UN, 2016). An example of big data use is found in the USD 250 million Kenya Climate Smart Agriculture Project led by the World Bank (IDA) initiated in 2017 (World Bank, 2017b). This project has a component that uses big data to develop a "climate-smart, agro-weather and market information system" to help farmers determine when, what, where, and how to plant crops. While the exact strategy for implementation has yet to be determined, the project document references an International Center for Tropical Agriculture (CIAT) initiative in Colombia that used machine learning to process large datasets of

¹⁸ FAIR Guiding Principles for scientific data management and stewardship: www.go-fair.org/fair-principles/

historical rice production yields and farming practices, alongside climate and soils data to identify climatic factors affecting yield (CGIAR, 2014). This information provided rice farmers with site specific recommendations to help improve rice yields.

Irrigation priorities

In addition to biotechnology, there are many examples of new technologies that can open up opportunities to mobilize new sources of water and green the agricultural water management sector, for example with wastewater reuse, desalination, solar irrigation, managed aquifer recharge. Alongside new infrastructure, the modernization of existing irrigation systems is gaining traction, as shown in chapter 2. Water data acquisition, water accounting, real-time water infrastructure operation and management, water harvesting as a supplemental, and many more improvements to existing irrigation infrastructure can close the performance gap to higher service delivery standards.

There is a shift in deciding which crops to grow and the type of water system that makes sense for a given climate while considering the concerns related to food security and the higher-than-average water use. For example, Burkina Faso is moving towards growing staple crops using a “Californian-style” water system (i.e. canals and pipelines for conveying low pressure water) in preference over crops with high value addition. This impacts water-use and irrigation investments.

Compared to flood irrigation, under certain conditions drip irrigation can save on water in water scarce regions and allow farmers to better control water and fertilizer inputs to improve crop yields. However, drip irrigation systems have higher capital and energy costs than flood irrigation systems due to the need for a pressurized pipe network (Sokol *et al.*, 2019). Furthermore, MIT’s Media Lab and the International Center for Agricultural Research in the Dry Areas (ICARDA) are piloting the use of ultra-low pressure drip irrigation systems for smallholder farmers in the NENA region (Jordan and Morocco) with plot sizes ranging from 0.09 ha to 0.76 ha. The project involves creating valves that provide drip irrigation at very low pressures of 0.15 Bar versus the 0.50 to 1.00 Bar needed for a conventional system (Sokol *et al.*, 2019). This way, a smaller capacity pump could be used to pressurize water, or, depending on site characteristics, farmers could use a tank of water on the roof of their house to provide water by gravity to irrigate a field. This is a very efficient way to use water in a water-deprived region and can reduce pumping energy by 50 percent.¹⁹

Renewable energy is emerging as an innovative way to expand irrigation access, keep costs affordable, and minimize carbon footprint. This can directly benefit farmer incomes and agricultural productivity. For instance, there are examples of solar covered canals in India that provide energy for pumping water for the purpose of irrigation. Other technologies can include solar-powered drip irrigation systems, floating solar systems on water bodies, solar-driven irrigation machines, to name a few. It is important to ensure that renewable energy for irrigation is expanded, to consider loans or subsidies especially for small-scale farmers, ensure proper training on day-to-day operations and maintenance, choose a system based on local site conditions, and reduce potential pressures on water resources from over abstraction of water (Hartung and Pluschke, 2018).

¹⁹ ICARDA project “Ultra-low energy drip irrigation for MENA countries”
<https://mel.cgiar.org/projects/322>

Other advances in nanotechnologies, such as graphene-based membranes, could also disrupt the desalination market potentially making desalination for agricultural applications feasible in the next decade. Wastewater reuse is also emerging as an option to recycle wasted water.

Water efficient irrigation technologies, such as sprinklers and drip systems, can help combat climate change impacts to water availability (World Bank, 2020). However, while subsidizing water-efficient irrigation infrastructure can help farmers adopt more water-efficient irrigation methods (Grafton *et al.*, 2018), it can also lead to farmers expanding the area under irrigation, thus resulting in a net increase in water usage (Ward and Pulido-Velazquez 2008; Giordano *et al.*, 2017). The level of subsidization, alongside water monitoring and regulations, are needed to ensure water abstraction rates remain at sustainable levels.

Rainfed agriculture

Around 70-80 percent of cropland is not irrigated,²⁰ thus investment in rainfed agriculture is crucial to increasing food production (Rosegrant and Cline, 2003). The pressing question is the extent to which yield gaps can be closed. Two gaps are of interest: between biophysical potential and the yield attained at research stations; and between researchers' yields and farmers' yields (Kemp-Benedict *et al.*, 2013). Closing the first gap shows what can be achieved despite naturally poor soils and variable rainfall; closing the second shows what profitable farm practices can accomplish. Evidence that the first gap (between potential and attainable yields) can be closed is provided by long-term experiments in dry environments, such as those carried out by the International Crop Research Institute for the Semi-Arid Tropics (ICRISAT) since 1976 (Wani *et al.*, 2009) and agronomically-based arguments that there is scope to improve rainwater retention and shift from non-productive water loss (evaporation and run-off) to productive water loss (transpiration) (Rockström and Falkenmark, 2000).

If the second gap (between attainable and farmer yields) were closed, the impact could be substantial: in an "optimistic" scenario in which 80 percent of the second gap is closed, experts found (de Fraiture *et al.*, 2009) that 85 percent of the projected increase in crop demand from the early 2000s to 2050 could be met from rainfed agriculture. This can be accomplished partly by transferring techniques from research stations to the field through training, physical investment, and demonstration. However, the techniques must offer farmers both profits and an acceptable level of risk (de Fraiture *et al.*, 2009).

Thus, techniques to close rainfed yield gaps include improving access to markets and credit and supporting farmer associations (Rosegrant and Cline, 2003; Rockström *et al.*, 2010; Shideed, 2017). This implies a systemic approach at the watershed level (Wani *et al.*, 2009), including broader actions both technically and managerially through managing rainwater and soils. Complementary actions include the conservation of water in soils, efficient water use and water scarcity management, tech-enabled irrigation systems, and runoff and rainwater collection and storage systems, to name a few. A pilot study of small- to medium-sized farms demonstrated the potential for converting a rainfed system to an irrigated system through the capture and storage of rainwater and runoff. It showed multiple benefits, including increasing yield, greater control over water availability, and potential for

²⁰ From FAOSTAT: Global total land area equipped for irrigation in 2017 was 21 percent of total cropland [accessed August 10, 2020].

expanding and diversifying crops (Jaramillo *et al.*, 2020). Improving water productivity, yields and incomes on rainfed land is complex because of the many causes of yield gaps, yet investment costs in rainfed agriculture are relatively low (de Fraiture *et al.*, 2009). IFAD is among one of the IFIs specializing in this sector. Consistent with the previous observations, they take an IWRM approach. Their investment portfolio targets a mix of rainwater management, land productivity improvements, capacity building, conservation agriculture, and market access. They have long included supplementary irrigation and community rainwater harvesting, and are increasing their funding for household-level rainwater harvesting and full irrigation. The IsDB, which focuses on dryland areas, also makes its investment decisions in line with these recommendations. The IsDB's inclusive growth strategy (IsDB, 2020) targets inclusive value chain development and “de-risking” smallholder investments in variable climates.

3.2.2 Governance innovations

The irrigation governance discourse in the early 1990s through the late 2000s was dominated by principles of local participation (to promote transparency) and cost recovery (to ensure economic efficiency and financial sustainability), which are key. However, typical investments in governance appeared too procedural and lacked the flexibility to adapt to specific political and social contexts (FAO, 2018b). Furthermore, the evidence for a link between participation, cost recovery and broader effectiveness is not definitive (Senanayake *et al.*, 2015), deterring governments from investing in governance programs without clear benefits (FAO, 2018b).

Large investments in irrigation systems were made as early as the 1960's–1980's, with governance structures that in many cases have proven ineffective or wrong. This phenomenon leads to the “well-recognized downward spiral of build-neglect-rehabilitate” (Waalewijn *et al.*, 2019). More specifically, the focus has long been and often continues to be on initial construction, rather than on ensuring ongoing management, operation and maintenance (MOM) of infrastructure, in spite of efforts to break this cycle. As a result, a process of deterioration occurs (neglect) that would lead to another “build” cycle of rehabilitation of the physical infrastructure. Because governance is not adequately addressed in the process of rehabilitation, this cycle continues to plague investments.

This “governance gap” has plagued past IFI investments in irrigation and drainage (I&D) systems. In the Second High Level Forum on Aid Effectiveness in Paris in 2005 (OECD, 2005), and in the following Third High Level Forum on Aid Effectiveness in Accra in 2008, two declarations were made that culminated in four areas of focus,²¹ including: ownership; inclusive partnerships; measurable positive impacts; and capacity development. Considerable emphasis is placed on the governance and institutions in these declarations.

21 Water Scarcity in Agriculture (WASAG) has been designed to bring together key players across the globe and from different sectors to tackle the collective challenge of using water better in agriculture [online]. www.fao.org/wasag/en/

While governance and institutional reform have long been recognized as a key part of the success of IFI loans and grants around irrigation, the tendency has been to engage with governance in piecemeal and short-term ways, such as project-funded project management units, that are defunded once projects end (World Bank, 2019d). In the past, foreign direct investment has been primarily channeled towards short-term productivity improvements — such as those that can be made in manufacturing — rather than longer-term investments in natural resources management and sustainability. As governments have increasingly privatized the provision of infrastructure services, however, new investments in this sector from abroad are growing (Kirkpatrick *et al.*, 2006; UNCTAD, 2015).

Over the past decade it has become clearer that irrigation governance is highly contextual, influenced by physical factors, levels of economic development, social cohesion and—last but not least—political and cultural norms. Governance interventions require a deep understanding of context and a problem-driven approach in order to overcome dynamic and persistent challenges (Waalewijn *et al.*, 2019). For example, FAO’s Guidelines on irrigation investment projects (2018b), prescribes a problem-driven governance approach emphasizing context-based solutions through a governance analysis that identifies local governance challenges, analyses historical governance patterns (and related problems) and prioritizes context-specific actions. There are also alternative governance approaches, such as those described by Ostrom, (1993), whereby water users develop the rules and institutions that allow for the sustainable and equitable management of shared water resources.

Governance interventions for I&D are considered high priority due to their critical role in ensuring infrastructure maintenance. It is significantly cheaper to govern effectively than the infrastructure costs necessary in their absence. However, good governance is less visible than constructing physical assets and building effective governance systems can take a much longer time. Governance interventions also present an opportunity for improved water-service delivery. These schemes have proven effective, but meaningful outcomes require an iterative process of changing attitudes and rigid institutional norms.

Notable innovations are both at the level of stakeholder engagement, as well as at the level of central government institutions, with a focus on strengthening capacity, planning tools and accountability. For instance, sensing and monitoring platforms are unlocking water data at multiple scales to improve water governance and planning by authorities at several levels. These technologies are described in chapter 3.2.1.

Stakeholder engagement

Stakeholder engagement assists in proactively considering the needs of affected communities and individuals in decision-making processes, while also empowering stakeholders, building trust and obtaining buy-in into potential initiatives. Since the 2000s, the broader water governance debate has shifted, as demonstrated by work from the OECD on a set of water governance principles (Akhmouch and Clavreul, 2016). The report notes three primary trends within the larger stakeholder engagement debate. First, its calls for “participation” are increasingly being replaced by those for “engagement,” a shift that implies a more inclusive decision-making process. Second, while stakeholder engagement has tended to be largely a “one-off”

exercise, it is increasingly moving towards more structural forms of stakeholder engagement with the support of new legislation and guidelines. Third, stakeholder engagement has been more institutionalized for water resources management than service delivery, with most legislation targeted at the management of water resources. The World Bank suggests that effective governance needs to focus more on water service delivery (reliability, equity and flexibility), organizational resources (financing, technical and strategic), and governance (transparency, accountability and inclusion).

It is clear that while stakeholder participation is decidedly important, the process must carefully balance the intended objectives with the resources they require in order to be successful. Participation needs to be set in a governance context in order for the system to be effective and equitable. Since water is a common good, the interest of a community or group may not be aligned with the national one. Interviews with stakeholders highlight the importance of linking and aligning top-down planning with bottom-up participation and increasing attention to the private sector. Part of the needed change involves how IFIs view farmers – from beneficiaries who are receiving services to partners who invest. Beneficiaries always contribute in-kind, but often struggle to contribute even 10-15 percent. There is an emerging spectrum of ways to engage smallholders with the private sector using different forms of governance: from small-holder rainfed farmers to large scale commercial farms.

For example, while the World Bank has supported the establishment of many water user associations around the world, the Malawi Shire Valley Transformation Program (SVTP-I), funded by the World Bank, AfDB, and other partners, is taking a different approach. The project area has a large number of farmers working small plots of land. The land is communal, traditionally allocated by the chief, so there is no individual ownership. The project is establishing groups of farmers to create “blocks” of 500 ha to establish commercial cultivation with center pivots. The farmers have ownership in a cooperative or association that owns that land, and farmers receive a dividend at the end of year. There is a large sugar estate in the valley that works with several farmer blocks to bring sugar to the mill. While still in the early stages, this partnership has improved livelihoods for many farmers. There may be opportunities to scale up to other parts of Africa (AfDB, 2018). A similar approach was taken in the Lower Usuthu Smallholder Irrigation Project (LUSIP) in Eswatini (IFAD, 2016), originally designed in 2001, but with mixed success due to substantial areas of land that were unsuitable for growing sugarcane, lack of gender mainstreaming and resistance to resettlement away from traditional lands. Despite many households being lifted from poverty, it is imperative that every project go through an inclusive stakeholder engagement process whereby affected communities and farmers have agreed upon the terms, as well as governance structures, well in advance of implementation.

In the Upper Tana-Nairobi Water Fund project (IFAD, 2017), IFAD has put in efforts to make sure beneficiaries understand the value of the project and how much to maintain it. This effort seeks to engage and incentivize all inhabitants in the watershed to invest in their landscape. IFAD is working with FAO's WASAG Financing Working Group (FAO, 2022b) on a financing model to promote more investment in watershed development. This aligns with the recommendation of experts (Wani et al., 2009) to create a watershed-scale public-private “business model” that dissolves the artificial separation between irrigated and rainfed agriculture and encompasses a set of mutually reinforcing livelihood activities.

Strengthening the capacity and accountability of central government institutions

Another key category of innovations lies around investments that aim to strengthen capacity, transparency and accountability of central government institutions. Large-scale, centrally run irrigation systems have historically been plagued with problems, as noted above. But there are ways to invest in governance to address these shortcomings, including:

- empowering farmers at the point where they interact with service provision, and enabling communication among farmers to increase their collective ability to raise concerns;
- creating accountable service delivery contracts of both the government and private sectors;
- aligning job responsibilities with service delivery across scales;
- increasing the regulatory and capacity building capabilities in training farmer and water user associations.

There are examples of success stories, but they have largely been driven through visionary internal leadership for example, in India, Mali, and Nigeria (Waalewijn *et al.*, 2019).

Capacity building objectives suffer from projects' relatively short timelines. There is a need for governments to expand applied research within educational and research institutions and create strong linkages to agricultural extension services to disseminate key knowledge and information to farmers. However, building the capacity of central government institutions is a time-consuming endeavour that requires an ongoing and iterative process of shifting social and institutional norms at the local level. The time needed to change this form tends to be far longer than project timelines allow, a limitation that significantly undermines progress towards this goal.

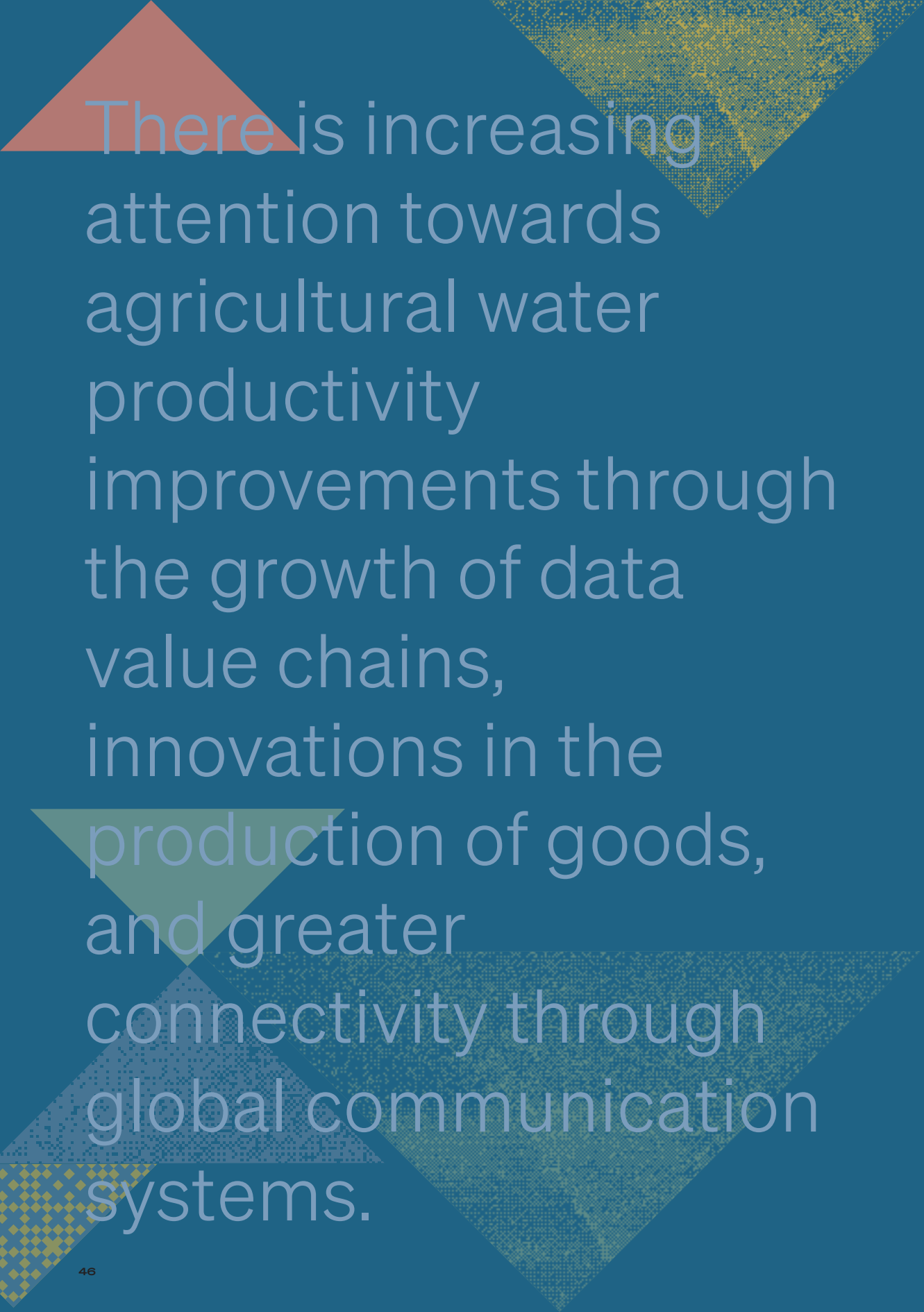
Government irrigation departments have typically been viewed as policy instruments to implement reform and favour irrigation management transfer. However, projects have overlooked the fact that irrigation bureaucracies' attitudes toward reform are influenced by factors beyond the objective of improved systems performance. More could be achieved by making irrigation departments agents of change rather than just project implementers (Suhardiman and Giordano, 2014).

Governance through water user associations

ADB's Sector-wide Evaluation report (ADB IED, 2018) highlighted "inadequate institutional arrangements for delivery" as one of three areas that needed strengthening. While a number of IFIs have supported Water Users' Associations (WUAs) in the past, their initial promise did not measure up. This is largely because implementation of WUAs has had difficulties both internally with collecting user fees, creating appropriate incentives for farmers, and perpetuating gender and social inequality, in addition to external challenges impacted by politics, policies and bureaucracies (Aarnoudse *et al.*, 2018). They had been viewed as organizations focused on user fee collection rather than providing services. This is largely because capacity building of staff in WUAs has been unsatisfactory. There is also a need to lay out more clearly the legal status and authority of WUAs (Garces-Restrepo *et al.*, 2007). An example of an alternative approach is investment in starting peer-to-peer learning for organic farming in Thailand, which while small, is proving to be successful (ADB, 2017b).

IFAD has long promoted WUAs, with similar performance issues. Part of the issue is that the WUAs are not aware of the value of their irrigation assets. IFAD is putting new emphasis on getting WUAs to recognize the value of assets by making deliberate efforts for beneficiaries to appreciate the value of water not just for irrigation investments, but for watershed itself. This has already started in Eastern Europe, where assets that are transferred by IFAD appear on the municipality's balance sheet.





There is increasing
attention towards
agricultural water
productivity
improvements through
the growth of data
value chains,
innovations in the
production of goods,
and greater
connectivity through
global communication
systems.

Chapter 4

Summary conclusion

IFI investments in agricultural water over the past decade have fluctuated, but they have tended to parallel the growth in GDP of IDA and IBRD-eligible countries. The exception was shortly after the 2015 Addis Ababa Conference on Financing for Development, when the volume of finance expanded rapidly, by 47 percent between 2016 and 2017, before returning close to earlier trends. However, the emphasis within these investments have shown significant shifts in a number of ways. Within the agricultural sector, commitments to agricultural water resources shrank and those to agricultural policy and administrative management, grew demonstrating increased focus on governance and maintenance of existing infrastructure over building new infrastructure. Agricultural research and extension make up only 4 percent of overall investments at the moment.

With respect to new players there are two aspects to note:

- A recurrent theme is the need to mobilize private funding for water infrastructure; this is particularly true for management, operation and maintenance (MOM) costs. PPPs can combine up-front (public) finance with later (private) fee collection to cover O&M.
- Historically, IFIs have focused on funding new agricultural water infrastructure investments rather than rehabilitating or optimizing existing ones. "Impact investors" and increasing interest in sustainability-linked investments (e.g. green bonds) is of increasing importance, as is the need for the agricultural sector to engage with these investors.
- Some ADB Institute and World Bank authors argue that IFIs can work to "crowd in" investment by lowering those risks, such as through blended finance mechanisms. By facilitating access to credit among small farmers, it lowers their need to use their livelihood assets (e.g. land) as collateral.

Also, while there has been some movement towards full-cost recovery from water investments, irrigation access is largely subsidized for farmers. This impacts the ability to maintain infrastructure investments resulting in their decline. In addition to the economic and financial viability of irrigation schemes, investors are also considering the potential social impacts of projects. When examining evaluation of performance of IFIs relative to their own objectives, several key aspects emerge:

- More funds could be invested in the agricultural sector relative to the non-agricultural water sector and there is a need to understand the inter-dependence of urban and rural water needs in order to achieve resilient water, food and land security.
- More importance should be given to the potential of agricultural productivity improvements.
- Environmental benefits and natural resource protection need to be considered from the beginning of planning investments. This includes establishing a baseline for future comparison as typically, receiving countries have limited understanding and availability of data on existing water availability and quality.
- There is a continuing problem around the unequal distribution of benefits and costs of irrigation and drainage investments.

Climate resilience emerges as a theme often overlooked in past IFI investments. While more attention and investments are climate change relevant, the World Bank evaluations and, to a lesser extent the ADB's evaluations, find that insufficient attention has been given to climate change and the increased complexity of agricultural investments more broadly, such as greater competition for water with increasing urbanization.

Looking forward, there are a number of innovations with respect to financial instruments, the importance of emerging technologies and the role of governance relative to investments in physical structure.

For financial instruments, two instruments have gained momentum among IFIs:

- Multi-phase programmatic approach (MPA), which is also called “multi-tranche,” seeks to reduce the complexity of implementing large, complex, and long-duration projects by splitting the projects into multiple phases.
- Performance-based lending (PBL). Under this approach, funds are held back until performance criteria are met.

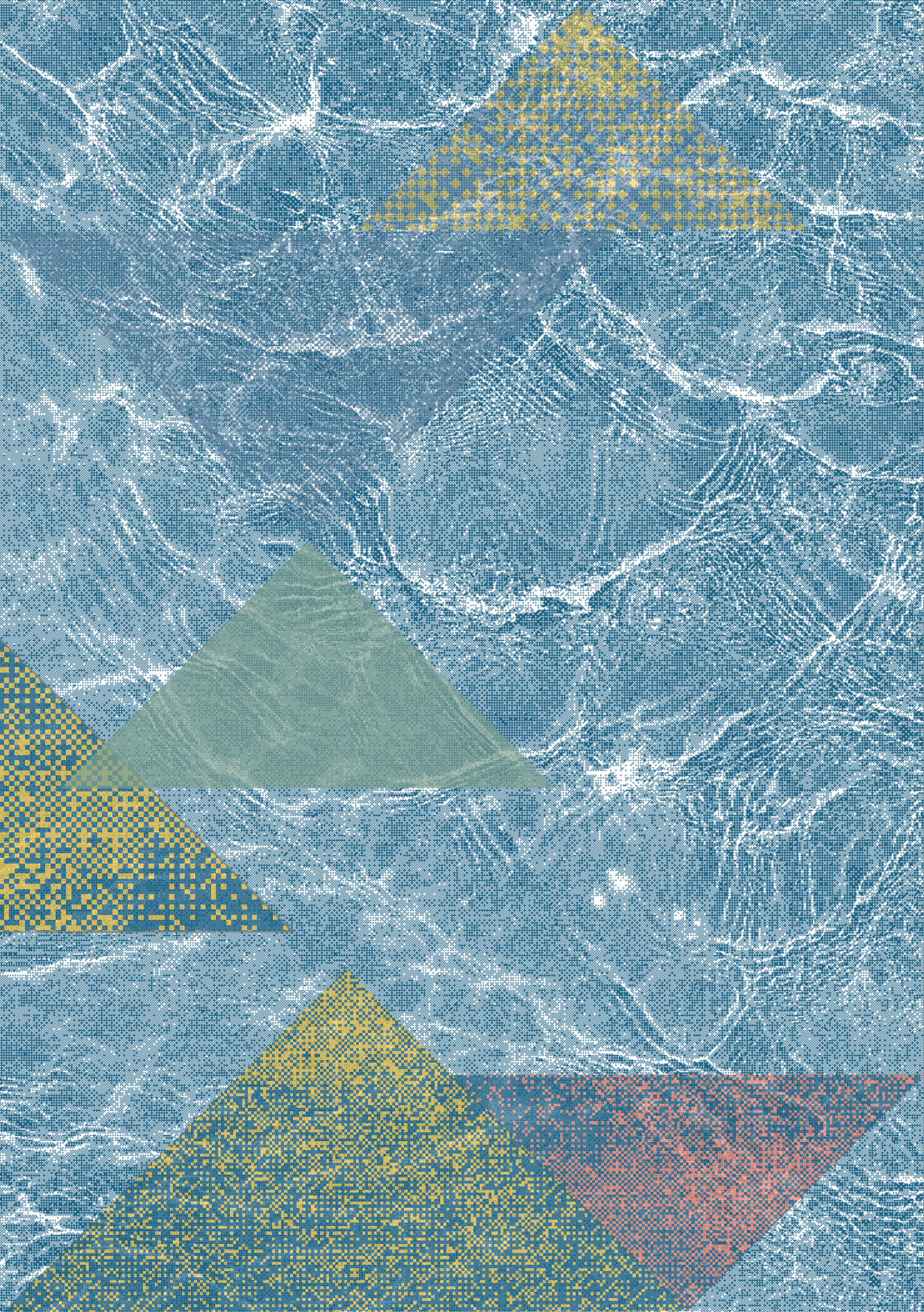
IFIs are looking into how they can invest in modern technologies and processes. There are two key “buckets” of opportunities in this realm: improved climate resiliency and agricultural productivity, and innovations in governance. There is a stronger focus on agricultural water productivity improvements through the growth of data value chains, innovations in the production of goods, and greater connectivity through global communication systems. Governance is also receiving increased attention — a recognition that infrastructure alone is not enough to succeed in addressing poverty, equity and sustainability.

Finally, it is clear that the 2020 pandemic related to COVID-19 has demonstrated that there is a need to invest much more in creating more resilient agricultural production globally to ensure food security.









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An aerial photograph of a dry, cracked landscape. A winding road or path cuts through the parched, fissured earth. The cracks in the ground form a complex, web-like pattern, indicating severe drought or arid conditions. The overall tone is somber and highlights the impact of water scarcity on the environment.

agricultural water * investments



Appendix A

Table A-1

Overview of projects by region and investment category

Region	Investment category	No of projects	Value of commitment (2019 million USD)
Sub-Saharan Africa	Agricultural development	60	904
	Irrigation systems	38	1043
	Climate change	26	422
	Water sector	24	144
	Market access/agribusiness development	18	188
	General development	13	78
	Emergency relief	8	128
	Land management	6	66
	Unsure	4	81
	Ecological/environmental	2	32
East Asia and Pacific	Climate change	17	280
	General development	17	249
	Agricultural development	16	1148
	Irrigation systems	16	1347
	Water sector	13	489
	Market access/agribusiness development	8	87
	Emergency relief	2	142
	Ecological/environmental	2	1
	Land management	2	2
South Asia	Irrigation systems	35	2768
	Water sector	23	826
	Agricultural development	9	678
	General development	9	76
	Climate change	7	367
	Unsure	3	281
	Emergency relief	2	54
	Market access/agribusiness development	2	34
	Ecological/environmental	1	1

Region	Investment category	No of projects	Value of commitment (2019 million USD)
Europe and Central Asia	Irrigation systems	20	895
	Water sector	12	469
	Climate change	6	17
	Market access/agribusiness development	4	65
	Agricultural development	4	62
	General development	2	1
	Land management	1	1
	Emergency relief	1	15
Near East and North Africa	Irrigation systems	14	840
	Agricultural development	10	260
	Climate change	4	61
	General development	4	23
	Water sector	2	0
	Market access/agribusiness development	1	2
Latin America and Caribbean	Climate change	9	114
	Agricultural development	6	44
	Irrigation systems	5	15
	General development	5	122
	Water sector	1	7
	Market access/agribusiness development	1	5
Unspecified	Agricultural development	4	1
	Climate change	3	5
	Market access/agribusiness development	1	0
	Irrigation systems	1	0
Grand total		504	14 944

NOTE: Data covers 2010–2019 for the World Bank (IDA and IBRD), ADB, IsDB, IFAD and other major IFIs.

SOURCE: Categorization developed by SEI based on data from OECD (2021).

Climate change, poverty, inequality, and other disruptive factors are changing the way water is used for agriculture. Although IFI investments are only one of the tools that can be used to address food and agricultural water security, they can be a critical catalyst for change. A research study carried out by the Stockholm Environment Institute, under the direction of the FAO Investment Centre, examines IFI investments and financing mechanisms in agricultural water over the last decade (2010–2019) and identifies emerging goals, areas of investments and innovations. The study aims to provide IFIs and international development agencies insight into what has and has not worked in agricultural water investments, while offering promising new mechanisms and investment priorities for the future. The analysis focuses heavily on public investment as provided by IFIs, but also considers the role of private and public-private investment, and farmers as private investors and entrepreneurs. This publication is part of the Directions in Investment series under the FAO Investment Centre’s Knowledge for Investment (K4I) programme.

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