Strengthening Sustainability
in the Irrigation Industry

July 2025

About IFC

IFC—a member of the World Bank Group—is the largest global development institution focused on the private sector in emerging markets. We work in more than 100 countries, using our capital, expertise, and influence to create markets and opportunities in developing countries. In fiscal year 2024, IFC committed a record $56 billion to private companies and financial institutions in developing countries, leveraging private sector solutions and mobilizing private capital to create a world free of poverty on a livable planet.

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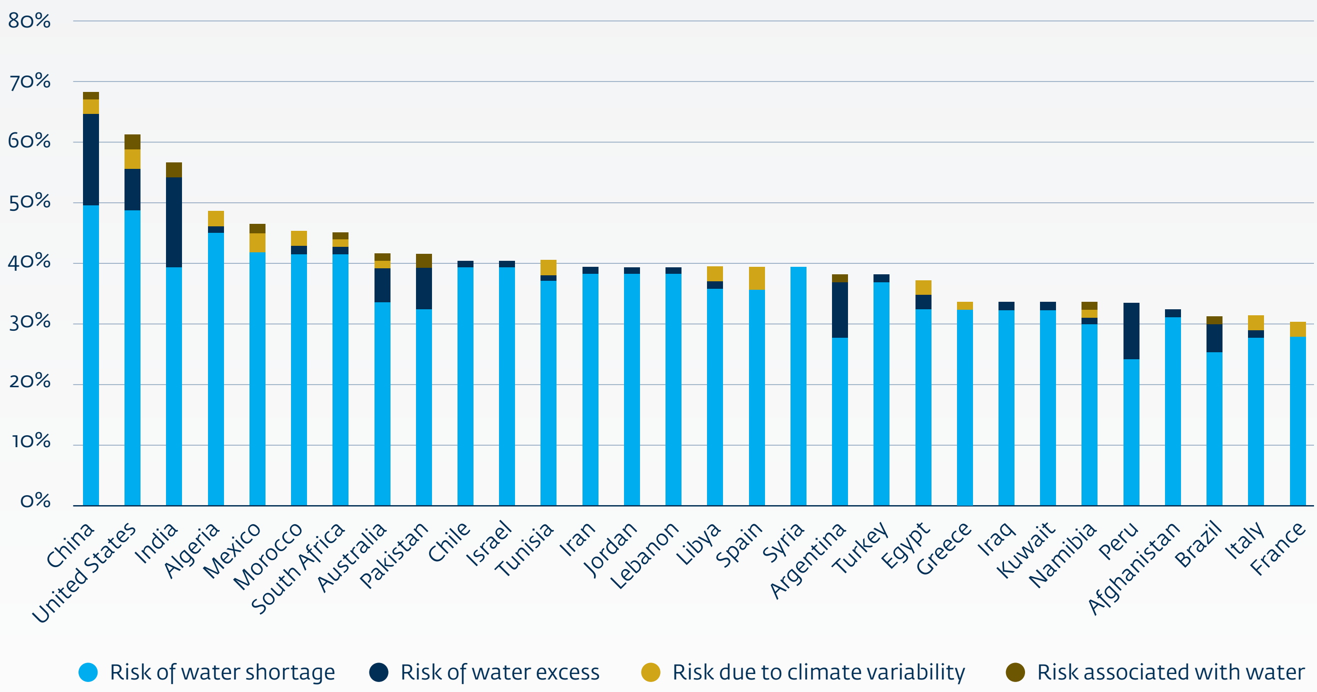
Overview

Agricultural production will need to increase by about 60% by 2050 to meet the growing food demand of a planet that will have 1.5 billion more people than today,[1] with the sharpest growth concentrated in Africa and Asia. Yet even as expectations mount for agricultural systems to deliver not just more calories but better nutrition, increasingly variable rainfall patterns are causing traditional rainfed production methods to become less reliable.

Irrigation, once seen largely as a tool for boosting yields, is emerging as a critical pillar of resilient food systems. By reducing smallholder farmers' dependency on rain alone, irrigation can significantly lower their vulnerability to the adverse effects of changing weather patterns, making food and nutrition security a more attainable goal in the decades ahead.

It will be expensive to sustainably expand irrigated cropland in emerging markets. Impact financing organizations such as the International Finance Corporation (IFC) play an important role by investing in solutions that increase access to, and use of, sustainable irrigation technologies. Cooperation is needed among these organizations and governments, development institutions, agribusinesses, irrigation technology companies, and farmers to scale up adoption of efficient irrigation solutions that optimize water delivery, improve productivity—and, as a result, strengthen food supply chains, reduce malnutrition, and lift communities.

Water Risk by Country



Source: OECD 2017.

Sector Background

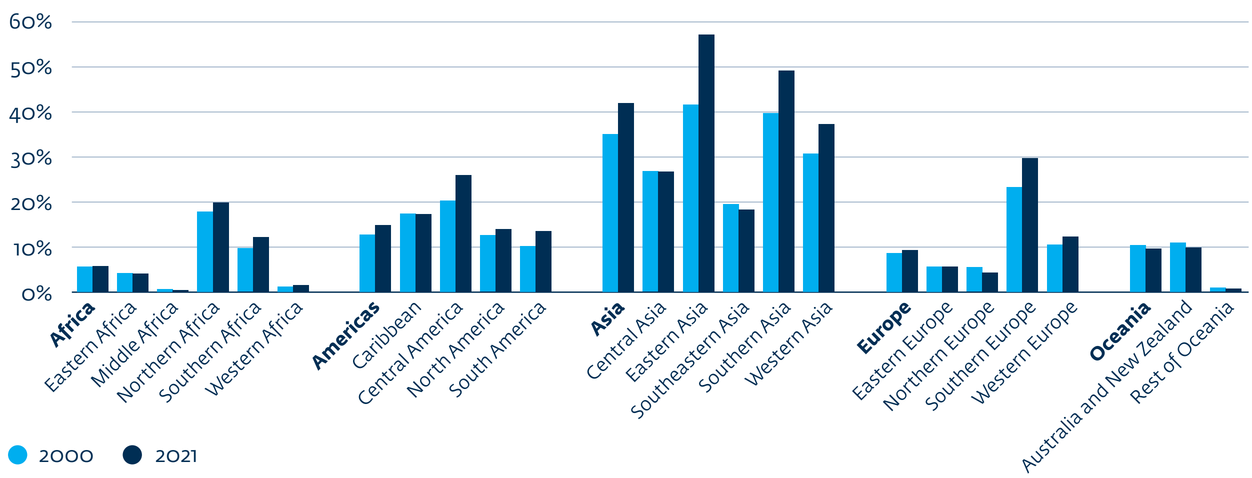
Since the mid-20th century, advances in irrigation, together with high-yield crop varieties, synthetic fertilizers, and pesticides, ushered in the Green Revolution that profoundly increased global food production and spared tens of millions of people from hunger and malnutrition. Field flooding and open-channel distribution, known as surface irrigation, are still among the most common methods to irrigate crops. However, these methods are often inefficient both in terms of water applied and cost. Inefficient irrigation methods contribute to soil degradation and heightened susceptibility to pests, weeds, and diseases that undermine long-term agricultural sustainability. By contrast, efficient methods of irrigation including well-designed and -operated surface irrigation and pressurized irrigation (such as drip, sprinkler, and center pivot) can markedly improve crop productivity and reduce vulnerability to weather variability.

Today, about 70% of the world's freshwater is used for agriculture.[2] A United Nations Development Goals report published in 2023 warned of intensifying "pressure on already scarce water resources."[3] It emphasized that more farmers need to adopt efficient land and water management practices, such as rainwater harvesting, wastewater reuse, and drip systems.

Less than one-fifth of all cropland globally is irrigated, with small-scale farmers in Africa, South America, and Asia largely relying on rainfall.[4] With 500 million small-scale farms around the world supporting the livelihoods of more than 2 billion people, and smallholder farming producing about 80% of the food consumed in Asia and Sub-Saharan Africa, helping this group use water more efficiently and sustainably is critically important.

Many countries have also been slow to incorporate water-use planning into their efforts to develop sustainable food systems.[5] Even on farms that have introduced irrigation, many of the systems are inefficient in their water use or they have negative effects on the environment. Water competition and water disputes—including over drinking water—may increase as some aquifers are depleted faster than they can recharge, and ground water resources diminish.

Share of Cropland Area Equipped for Irrigation by Region



Source: FAO 2023.

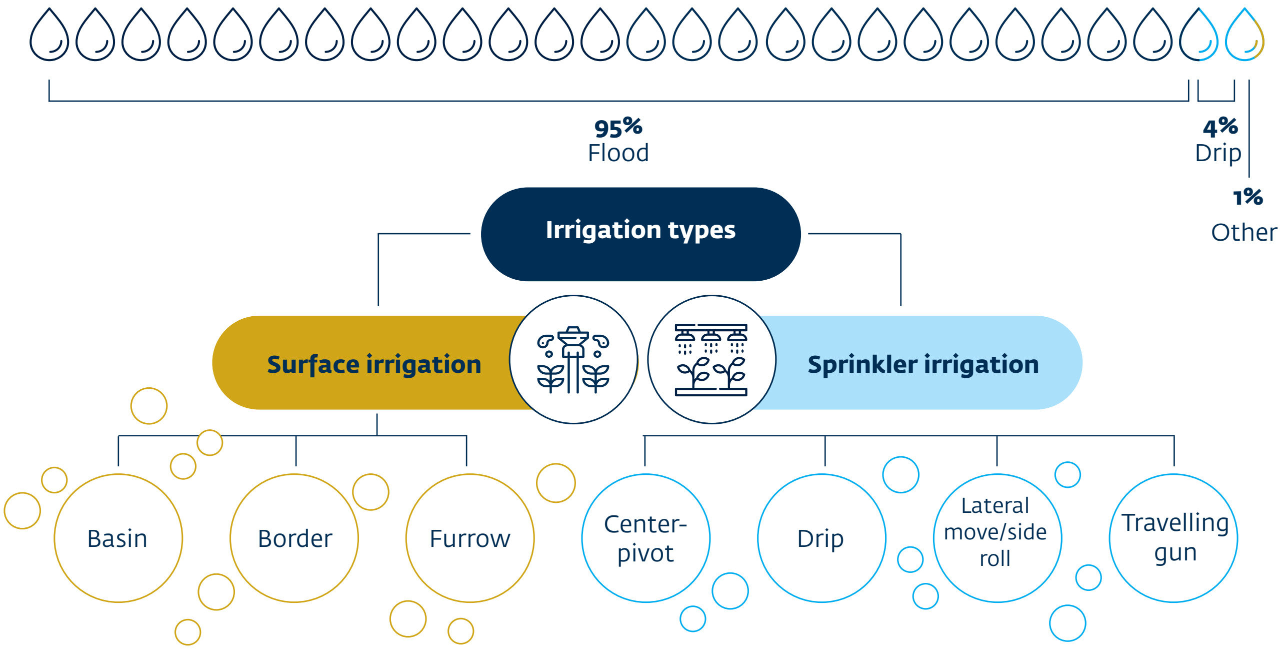
Sustainability

The world's irrigated cropland has expanded rapidly, growing by 20% over the last two decades.[6] Further room for expanding irrigation is mostly found in Africa, where overall, only about 6% of cultivated land is irrigated. In Sub-Saharan Africa, only about 4% of the land is irrigated; in North Africa, 28%. Five countries—Egypt, Sudan, South Africa, Morocco, and Madagascar—hold more than 60% of Africa's water-managed areas.[7]

In upper-income countries, farmers have adopted technological innovations to use water more efficiently and increase their productivity while reducing costs in the long term. In Israel, three-quarters of crops rely on drip irrigation.[8] In the United States, more than 80% of almond growers in the state of California use micro-irrigation, which targets water directly to tree roots; adoption of this method contributed to a one-third reduction in the amount of water needed to grow almonds between the 1990s and 2010s.[9] Today nearly half of all California farms use drip, micro-, or subsurface irrigation, a sharp increase from 16% in 1991.[10]

While countries such as Türkiye, Egypt, and Jordan have started to manufacturer drip irrigation systems and accessories at more affordable prices, cost remains a major barrier to adoption in many low- and middle-income countries (LMICs).[11] IFC's blended financing options can be used to derisk investments in irrigation and make such systems more accessible for farmers of all sizes. Japan International Cooperation Agency (JICA), Multilateral Investment Guarantee Agency (MIGA), International Development Association (IDA), and International Bank for Reconstruction and Development (IBRD) are also funding irrigation projects in areas where access to financing is often limited or difficult.

Types of Irrigation



Source: MIT n.d

As challenges grow regarding availability and use of water amid increasingly variable weather patterns, international development organizations are partnering with governments and private sector companies to promote sustainable water use and irrigation practices globally. Among these efforts, the Food and Agriculture Organization's Water Scarcity Program aims to bring agricultural water use within sustainable limits in the Asia-Pacific region,[12] while the *Handbook for Scaling Irrigation Systems*, authored by IFC and the International Fund for Agricultural Development, offers hands-on guidelines on how to sustainably expand small-scale irrigation.[13]

Advancing Small-Scale Irrigation

Small-scale irrigation (SSI) systems enable year-round cultivation while reducing dependence on unpredictable rainfall. SSI systems can help sustain soil health, increase crop productivity, and enable farmers to diversify into high-value crops, which improves incomes and raise living standards. SSI systems typically yield higher returns than large-scale systems; have lower investment costs, easier maintenance, and more control for end-users; and require less complex operations management. SSI systems also help to ensure more efficient and sustainable water use for small farms.

Small-scale irrigation models generally fall into four categories:

Shared system

Farmers own individual in-field irrigation systems but receive a supply of water from a common source

Collective system

Group of irrigators own and share both the water source and irrigation systems

Individual system

Farmers have ownership and control over irrigation system and own water source

Irrigation as a service

Farmers do not own the irrigation equipment or develop the water source, but pay for water according to time of operation or volume of water supplied

Source: IFC 2024

Systems differ in their management, governance, payment mechanisms, and land-ownership arrangements, but qualities of successful models include participatory management, accountability of leadership, youth involvement, and capacity strengthening of farmers.

Challenges & Opportunities

Changing weather conditions can lead to shortages and excesses of both surface water and groundwater, making proper water management crucial. Groundwater, stored in aquifers which are indispensable for cities, industry, and agriculture, face over-abstraction; its depletion can lead to environmental degradation, land subsidence, and unsustainable reliance on nonrenewable sources like paleowater. Meanwhile, environmental flow—the quantity, quality, and timing of water necessary to sustain the wildlife of a river, wetland, or coastal zone—is being affected by conflicting demands for water, reduced river flows due to irrigation, and impacts on water quality and ecosystems.[14]

Properly designed, installed, and maintained irrigation systems can alleviate some of these challenges by sustainably securing water for crops. Smart water management can complement these systems to protect ecosystems and human health while contributing to agricultural development and job growth.

Availability of surface water[15]

Proper management of surface water is crucial not just for maintaining ecosystems, but also for preventing overuse and water scarcity that could endanger food and nutrition security. Monitoring systems can track changes in water supply and quality and provide essential data for informed policymaking and water governance.[16] Sustainable irrigation can help farmers use surface water more efficiently. Options include precision irrigation technologies, which deliver water directly to plant roots; sensor-based systems, which measure soil moisture and tap weather data; and water storage and management systems, such as on-farm storage tanks or small-scale ponds, which offer low-cost options to capture and store rainwater for use during drought.[17]

Groundwater and aquifer depletion

While groundwater may be harder to access than surface water and require drilling to reach, it tends to be less susceptible to contamination.[18] The African continent has vast areas where water is within seven meters of the surface, thereby easily accessed by solar-powered pumps—offering excellent sites for targeting increased irrigation.

A risk facing many parts of the world today is over-abstraction of groundwater.[19] The rapid depletion of nonrenewable paleowater is of special concern, as billions of people in the world's most arid regions today rely on this source for irrigation and drinking water.[20] Meanwhile, unregistered wells in many areas, such as Algeria, complicate efforts to estimate groundwater availability.

Collaborative governance involving all stakeholders will be critical to resolving potential conflicts and ensuring sustainable use of these water sources, especially as changes in land use, such as deforestation, and in climate intensify shortages. Integrated water resources management can promote coordinated development and management of water, land, and related resources.[21] Water pricing and other market-based mechanisms can incentivize efficient water use and distribution.[22] Prioritization of less water-intensive varieties of crops for semi-arid and arid areas will be critical, too.

Affordability and accessibility of irrigation technologies

One of the biggest barriers to adopting modern irrigation technologies—especially for smallholder farmers in LMICs—is the upfront cost. Many farmers lack access to affordable credit to invest in these systems or to pay for their maintenance and replacement, even though they can significantly increase crop yields while reducing water and energy use. Expanding irrigation and increasing irrigated cropland productivity in LMICs is estimated to cost between $26 billion and $50 billion per year over the next 20 years.[23] It is also important to consider what type of system is best suited to local conditions, and the effects systems may have on the surrounding environment. In addition to financing, the successful scale up of irrigation use will require farmer training, regulator support, and stakeholder negotiations, including among value chain players such as producers and agribusiness equipment manufacturers.

Runoff and pollution

Inefficient irrigation methods, such as flood irrigation and leakage in aging or poorly maintained irrigation canals and pipes, can waste significant amounts of water and contribute to soil degradation, ecosystem damage, energy overconsumption, and water scarcity. Yet, this challenge can be addressed by modernizing infrastructure, adopting efficient irrigation technologies, and implementing good water management practices.

Many countries face high risk of groundwater contamination from agriculture.[24] Poor irrigation practices contribute to fertilizer, pesticide, and sediment runoff into water bodies and groundwater systems, endangering aquatic ecosystems and human health. Precision irrigation technologies, along with proper fertilizer and pesticide use, can minimize runoff, while the use of buffer zones, groundcover plants, and vegetative filter strips can further minimize water contamination.

Emissions

Irrigation contributes to emissions through both energy use and water management practices. Energy is needed to pump groundwater and to move surface water from rivers or other water sources through canals to fields. Moreover, inefficient irrigation practices can cause waterlogging of crops and trigger the release of methane and nitrous oxide from the soil.[25] Studies suggest that irrigation systems that use solar-powered electric pumps could decrease emissions per unit of energy used for water pumping by 95–97% compared with pumps using grid electricity, and even more compared with diesel pumps.[26] Prices for solar-powered pumps have fallen in recent years, and such systems would offer long-term savings through elimination of fossil fuel purchases and lower maintenance costs than for traditional petrol pumps.

Transboundary water and ecological damage

Transboundary waters—aquifers and lake and river basins shared by two or more countries—account for 60% of the world's freshwater flows, but sharing agreements are rare.[27] Without cross-boundary agreements, irrigation practices could lead to ecological damage, such as by altering or reducing river flows, which in turn could reduce biodiversity or trigger potential conflicts among stakeholders. Transboundary agreements, integrated river basin management frameworks, and international cooperation, data sharing, and joint monitoring can help countries reach agreement on sustainable and equitable water use. And environmental flow assessments, such as South Africa's Building Block Methodology, can help determine the minimum water flow required to sustain ecosystems.[28]

Salinization

Soil salinization can reduce soil health and crop productivity, and harm aquatic ecosystems when salts are released into bodies of water.[29] Human-induced salinization is becoming a widespread problem, causing about 30% of irrigated land to become commercially unproductive.[30] Sustainable irrigation practices such as drip irrigation can reduce water use and minimize salt accumulation. Leaching percolates water through the soil to flush out salts, but the application requires proper drainage systems to prevent waterlogging.[31] On land where salinization has occurred, planting salt-tolerant crops such as rye or licorice, and using soil amendments like straw and microbial inoculations can mitigate the effects of salinization.[32]

Water quality

Poor-quality water used for irrigation can lead to soil degradation, reduced crop productivity, and contamination of water bodies, and contribute to malfunctioning of irrigation equipment and higher maintenance costs.[33] High levels of salts, heavy metals, and other pollutants in irrigation water can accumulate in the soil, causing salinization and toxicity that harm both plants and microorganisms essential for soil health. This contamination can also leach into water bodies, posing risks to aquatic ecosystems and human health. Regular monitoring and testing of water quality is essential to detect and address issues promptly. Similarly to runoff mitigation, introducing buffer zones and vegetative filter strips alongside water bodies can help to trap sediments and pollutants, preventing them from entering aquatic environments.

IFC's Role

Besides promoting economic development and improving people's lives, IFC works with clients to help them strengthen the sustainability of their operations. This means guiding companies to make investments that generate lower carbon emissions or that can help to reduce emissions. It also means helping clients prepare for and adapt to more extreme weather events and identifying business opportunities for transitioning to a low-carbon future.

IFC works with a range of stakeholders to drive sustainable transformation in the agriculture sector in LMICs, investing in solutions that support a transition from low-efficiency irrigation or fully rain-dependent systems, toward sustainable irrigation technologies. We partner with agribusiness companies and other international development organizations to scale up adoption of irrigation technologies that optimize water delivery, increase crop productivity, and mitigate risks associated with variable weather conditions—and make sure that the technology reaches those in most need of it. Beyond financing, IFC's advisory services help clients optimize water use, enhance supply chains, and integrate sustainability into their operations. Our investment and advisory services aim to strengthen food supply chains, increase resilience and sustainability of agricultural production, help reduce malnutrition, create jobs, and improve community well-being.

Public-private partnerships (PPPs) remain complex to implement but are increasingly seen as a way to unlock large-scale irrigation projects that make irrigation available to a wider community of producers. For example, IFC contributed to structuring Morocco's Guerdane PPP, a landmark 30-year concession that has improved water access for citrus farmers.[34]

Irrigation investments often face significant hurdles—high costs, fragmented market ecosystem, and regulatory bottlenecks. IFC works with development partners and governments to address these barriers and ensure that both small-scale farmers and agribusiness giants can access technology and expertise needed to transition toward sustainable, high-efficiency irrigation.

IFC has invested in several companies at the forefront of irrigation innovations. The drip pioneer Netafim[35] is developing smarter drip and micro-irrigation systems for large-, medium-, and small-scale farmers. IFC invested with Netafim in the Africa region, enabling projects such as the Gabiro Agribusiness hub which combines commercial and smallholder farming within a community irrigated farm system.[36] These projects are models for irrigation investments worldwide, demonstrating how smart policies can attract private capital to critical infrastructure.

Another IFC client, Jain Irrigation Systems Ltd.,[37] one of the world's largest irrigation companies,[38] promotes a closed-loop model, where wastewater recycling and solar-powered drip irrigation converge to create sustainable farming ecosystems.[39] Rivulis Irrigation—yet another beneficiary of IFC's investment and advisory services—focuses on micro-irrigation solutions tailored to smallholder farmers.[40] The company recently launched an AI-powered product that helps farmers optimize water use, reduce chemical inputs, and enhance soil health.[41]

IFC Irrigation Investment: Niger Rice Sector

Farmers are facing more stress in Niger, as rainfall has become more variable, temperatures have risen, and the frequency of droughts has increased.

These factors are causing the Niger River flow to decrease, which makes it a challenge to grow crops in areas that depend on the river. To help the country's farmers—especially women farmers—IFC partnered with the Climate Investment Funds (CIF) and Netafim, a global leader in micro-irrigation technology, to set up the Niger Irrigation Program (NIP).

The initiative provided small- and medium-scale farmers with solar-powered drip irrigation, reducing reliance on rainfed farming and enabling more crop production with less water and energy.

A COMMERCIALLY SUSTAINABLE APPROACH WAS DEVELOPED TO:

Design → Supply → Install → Maintain

drip kit systems for Niger's smallholder farmers

95% of the farmers saw improvements in crop productivity.

>70% started growing crops in two or more cycles.

THE VAST MAJORITY OF PARTICIPATING FARMERS ALSO REPORTED:

a significant increase in personal safety related to better access to water on farm and more free time—factors particularly important for women farmers

A better irrigation market ecosystem with several local small and medium-sized enterprises emerging to provide installation, training, and maintenance services

A decrease in import taxes on irrigation equipment, creating a more enabling fiscal policy environment for scaling up irrigation use

PROJECT FUNDING BY CIF:

$ 1.3 MILLION

PROJECT PERIOD:

3 YEARS

x 6

To overcome technical capacity barriers to sustainable irrigation, the program set up a motorcycle cadre of six Community Field Assistants to train farmers on how to use their irrigation kits, to assist them with maintenance, and to help them create crop calendars to rotate and optimize seasonal produce.

900
>50% WOMEN

farmers were trained directly by Netafim on how to use the irrigation technology. The training also covered other topics, including high-value crop agronomy.

IFC Irrigation Investment in India's Rice Sector

IFC has committed a $600,000 advisory engagement with Olam India, a leading agribusiness firm, to promote sustainable irrigation practices across its rice supply chain.

The project is deploying advanced, climate-smart irrigation technologies—such as drip systems and laser land-leveling—to increase water-use efficiency.

WITH IFC'S SUPPORT:

10,000

SMALLHOLDER RICE FARMERS

will be trained by Olam on efficient irrigation use and climate-smart agriculture practices...

...making on-farm water management more resilient to increased climate variability while improving crop productivity.

IFC is also helping Olam strengthen its environmental, social, and governance practices to bolster food and nutrition security.

Conclusion

Expanding access to efficient irrigation is essential for strengthening global food and nutrition security, improving agricultural resilience, and safeguarding water resources. As weather variability and water scarcity intensify, investing in efficient irrigation technologies will help farmers increase productivity, reduce adverse environmental impacts, and sustain livelihoods in water-stressed regions.

IFC remains committed to supporting this transition by financing scalable solutions, derisking investments in irrigation infrastructure, linking small-scale farmers with technology and credit, and fostering innovation through partnerships with agribusinesses, technology providers, financiers, and other development institutions. By enabling farmers to adopt modern efficient irrigation systems, we not only enhance agricultural productivity and self-sufficiency, but also promote climate adaptation and long-term economic stability.

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Endnotes

1. INED 2024.
2. UNESCO 2024b.
3. United Nations 2023.
4. Colback and Kolb 2022.
5. Dubler n.d.
6. FAO 2023.
7. Malabo Montpellier Panel 2018.
8. Kaplan-Zantopp 2023.
9. California Almonds n.d.
10. Cultivate California n.d.
11. Russu 2021.
12. FAO 2021.
13. Colback and Kolb 2022.
14. Texas Living Waters n.d.
15. Surface water is freshwater found aboveground and includes lakes, rivers, streams, and glaciers. It accounts for nearly 70% of global freshwater and constitutes a critical source of water for the agriculture sector.
16. Examples include the U.S. Geological Survey's network of 1.9 million sites and the European Space Agency's Sentinel-2 satellite. Sources: USGS (U.S. Geological Survey). n.d. "USGS Water Data for the Nation." https://waterdata.usgs.gov/nwis?; ESA (The European Space Agency). n.d. "Water Bodies." https://www.esa.int/Applications/Observing_the_Earth/Copernicus/Sentinel-2/Water_bodies#:~:text=By%20providing%20measurements%20of%20water,%2C%20or%20unsafe%2C%20to%20swim.
17. Van Meter et al. 2016. Other technologies that help reduce water overuse and energy consumption include irrigation systems that integrate weather-monitoring technology, and automated pivot irrigation, which allows farmers to remotely control water distribution.
18. Groundwater resources refer to water stored underground in aquifers.
19. This trend has affected places as diverse as California's Central Valley, which has seen falling water tables and drying wells, and India, where competition between agriculture and urban water use has contributed to water tables declining by 1–2 meters annually in some regions. See: Khan, Sarah, Kewal Gupta, Kaushal Kumar, and Reeta Routela. 2022. "A Review of Groundwater Status and Problems due to Industrial Pollution: Case Study of Ghaziabad City." *Materials Proceedings* Volume 69, Part 2: 261–5. https://www.sciencedirect.com/science/article/pii/S2214785322057030.
20. Mora 2022.
21. UNEP n.d.
22. One example of this is Cape Town's decision in 2018 to raise water prices to reduce demand as it faced a "Day Zero" water shortage. See: Zetland, David. 2021. "The Role of Prices in Managing Water Scarcity." *Water Security* Volume 12 (April 2021): 100081. https://www.sciencedirect.com/science/article/pii/S2468312420300237.
23. Colback and Kolb 2022.
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26. Siepman n.d.
27. United Nations n.d.
28. King and Louw 1998.
29. Soil salinization occurs when soluble salts accumulate in the soil. It can occur naturally in arid regions with high evaporation rates, or it can result from agricultural practices such as irrigating with salt-rich water or overwatering, which raises the water table and brings salts to the surface.

[30] European Commission Joint Research Centre n.d.
[31] University of California 2015.
[32] Tarolli et al. 2024.
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[34] IFC 2010.
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[38] World Bank 2017.
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