Policy Pathway Brief

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Promoting Water Security and Resilience in Water Systems in Agriculture

AGRICULTURE POLICY DIALOGUE

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Just Rural Transition

In brief

Agriculture and food systems are both drivers and victims of escalating climate and nature crises, in turn increasing the risks to healthy diets, livelihoods and economies. Public policies can set incentives for farming and market practices that further exacerbate these trends, but they can also play a role in reversing them. The global Policy Dialogue on Transition to Sustainable Agriculture is a peer-to-peer platform to share experiences, facilitate partnerships and catalyse policy leadership to accelerate the transition to sustainable agriculture and food systems that benefit people, prosperity and the planet.

Policy Pathway Briefs provide an overview of emerging experiences and lessons on policy approaches that contribute to this transition, covering a series of topics requested by Policy Dialogue members, to support peer learning and knowledge exchange. The briefing notes are in no way exhaustive. The options facing governments will be context-specific and look different across and within countries. The notes aim to act as a discussion starter and to facilitate exchanges between countries engaged in the Agriculture Policy Dialogue and with other global initiatives, drawing on the experiences presented by members and examples that are identified through further research.

This Brief focuses on the interactions between water security, resilient freshwater systems and agricultural practices and land use. It identifies policy instruments and actions for governments to provide incentives and support to water users in agriculture to manage the quantity and quality of water sourced, used and discharged in a more sustainable way. This can boost water security and resilience of freshwater systems more broadly while strengthening the resilience of agricultural production and food security.

Key messages

- Increasing water stress and the threat multiplier of climate change mean that governments are faced with increasingly difficult choices about how to allocate water resources among different sectors and activities, including agriculture.
- Agricultural production and land use play a key role in maintaining a water-secure future based on resilient freshwater ecosystems, while agriculture itself is one of the sectors most vulnerable to water stress.
- A diverse portfolio of technical solutions exists for agricultural producers to improve water use, retention, storage and recharging capacity for their own benefit as well as that of broader society.
- Governments need to put in place systematic policy incentives to scale up these solutions, closing the spending gap on water services and repurposing public expenditure, including using targeted subsidies and payments for ecosystem services, and strengthening research and development.
- Appropriate pricing of water can encourage more efficient water use in agriculture, coupled with standards and regulatory tools to promote sustainable water use at the catchment basin level.
- Capacity-building and information provision, underpinned by inclusive, transparent and accountable governance mechanisms across sectors, river basins and watersheds can provide a solid foundation for governments to manage water supply and demand in a sustainable, resilient and fair way.

Background

In 2022, the world surpassed its planetary boundary for fresh water: both "blue water" – humanity's use of lakes, rivers and groundwater – and "green water" – rainfall, evaporation and soil moisture (Wang-Erlandsson et al., 2022). Unsustainable use of existing water sources combined with anthropologically-induced changes to the water cycle at all scales – global, regional and local – mean that this situation is likely to worsen before it improves. The world is faced with a systemic water crisis of having "too little, too much and too dirty water" (Grafton and Fanaian, 2023) moving further away from the goal of water security – adequate availability, quality, access and stability of water for multiple uses (HLPE, 2015). This undermines food security and the availability of water for drinking and sanitation. The issues vary across countries with different hydrologies and different levels of wealth, institutional capacity or socioeconomic development (Grey and Sadoff, 2007).

Climate change will increase the challenges to water security and resilience of freshwater systems as increased temperatures accelerate crop evapotranspiration rates, reduce water availability and quality, and heighten variability and intensity of rainfall patterns (Iglesias and Garrote, 2015; Smith et al., 2019).

Increasing water stress and the threat multiplier of climate change mean that governments are faced with increasingly difficult choices about how to allocate water resources among different sectors and activities across the economy and society: for drinking and sanitation, agriculture, industry, energy and the environment. Such choices will be affected by many significant but uncertain factors that will influence future water demand, water availability and exposure to water-related risks (OECD, 2020).

Agriculture and water security

The agriculture sector plays a key role in maintaining a water-secure future (Grafton and Fanaian, 2023; Joseph et al., 2024) based on a resilient freshwater ecosystem. Globally, agriculture accounts for about 70% of freshwater withdrawals (Siebert et al., 2010; Khokhar, 2017) and blue water withdrawals doubled between 1970 and 2022, reaching 4,000 km^3 per year (GCEW, 2023). This has contributed to the depletion and degradation of both surface and groundwater resources (Scanlon et al., 2023). Groundwater withdrawals for irrigated agriculture account for over 30% of agriculture's freshwater withdrawals and continue to grow at around 2.2% per year, leading to loss of aquifer storage and undermining aquifer function and utility to farmers (FAO, 2021).

Agriculture production and land use change to agriculture can also affect water flows and water quality across landscapes. Converting natural landscapes to agricultural land often leads to increased and more accelerated surface run-off due to soil compaction and reduced vegetation cover (Kayitesi et al., 2022). This reduces the ability of soils to absorb and retain water and recharge groundwater sources (as well as undermining yields). This can contribute to unmanageable water flows downstream, aggravating floods in periods of excessive rainfall. Run-off from agricultural fields often contains fertilizer, pesticides and sediment, which degrades water quality, damaging the health of freshwater ecosystems and downstream water users (FAO, 2021). This is not confined to rural areas: water pollution in urban areas is leading to the contamination of irrigated vegetables on urban agriculture plots (Gashaye and Yildiz, 2020; Abdallah and Mourad, 2021).

Agriculture itself is among the sectors most vulnerable to water stress. Fundamental changes to the water cycle, particularly the patterns of rainfall and periods of drought or flooding and higher temperatures are already endangering different crops (FAO, 2021) and about 60% of the world's irrigated crops (by weight) are currently grown in areas facing high or extremely high levels of water stress (Saccocia and Kuzma, 2024; Mazzucato et al., 2024). This is not restricted to low-income countries: water stress affects 30% of the population every year in the 27 countries of the EU and is expected to worsen as the world warms (European Environment Agency, 2024).

There is an urgent need to address these challenges to strengthen water security and the resilience of freshwater ecosystems to ensure food security and buffer against increasing rainfall variability, mediating competing claims across sectors and stakeholders.

Improving water security and resilience of freshwater ecosystems

Technical solutions

Water security and resilience can be enhanced by developing a diverse portfolio of interventions to improve the management and development of water resources, which affect and are affected by agricultural practices and land use. These include increasing water supply, reducing demand, providing nature-based solutions, and strengthening storage and transport of water (Scanlon et al., 2023).

Improving water retention and storage

Improving water retention in landscapes and farmland areas can help mitigate floods, alleviate drought, reduce soil erosion and improve the environmental quality of the system. This can be achieved through a combination of nature-based solutions to retain landscape water retention and "grey" water storage infrastructure (Salman et al., 2016; Iglesias and Garrote, 2015).

Nature-based solutions include soil health improvements,[i] landscape design and innovation to create a sponge effect, improve water drainage and redirect run-off, including (FAO, 2021):

- Increasing levels of organic matter in farmland soil to boost water infiltration and water retention to reduce irrigation needs and expand groundwater retention and storage; and
- Improving vegetation cover and contouring on farmland to slow down water run-off.

Surface storage can be expanded through natural or man-made ponds or tanks, water storage dams and reservoirs, coupled with managed aquifer recharge, source water protection, and watershed and wetland restoration (Smith et al., 2019).

Managing demand for water: improving water use efficiency

Improving the efficiency of last-mile water use for irrigation by individual farmers and companies or communities can also play a key role in reducing freshwater depletion while meeting food production needs. Farmers can use more targeted and water-efficient irrigation approaches, such as sprinkler or drip irrigation instead of flooding fields. Improvements in irrigation infrastructure through modernization and automation can lead to water savings, e.g., in the case of Australia (Koech and Langat, 2018). Farmers may also switch to more water-efficient crops if those are available and suitable for the market (Smith et al., 2019).

[i] See Policy Pathway Brief on Promoting Healthy Soils and Land for further details.

Reducing water use is contingent on the availability of equipment, capacity to manage and maintain irrigation infrastructure, and the cost of irrigation compared to the value of the crops produced. It can also require substantial changes to crop selection and crop husbandry to avoid more efficient irrigation leading to increased water consumption (Perry, 2018; Koech and Langat, 2018).

Other actions to improve the efficiency of water use for agriculture include reducing water loss by plugging leaks in water storage and distribution infrastructure. Indirectly, reducing food waste can help minimize water loss; a quarter of all water used for agriculture grows food that ultimately goes uneaten (Goodwin, 2023; Saccocia and Kuzma, 2024).

Information and digital technologies can be important tools in tracking water use and assessing water risks, including digital twinning of basin water resources (Botai et al., 2023) and community-based monitoring systems, such as communicating flood risk across communities (Saccocia and Kuzma, 2024).

Policy solutions

Without appropriate policy interventions, many of these technical solutions can lie unused or fail to be scaled up. Through redirecting public expenditure and other policy instruments tailored to different contexts, governments can incentivize large-scale adoption of practices to boost resilience of freshwater ecosystems and water security that benefit climate, nature and people.

Financial incentives

Governments spend nearly USD 141 billion annually on water (Joseph et al., 2024) − 76% of this is spent on water supply and sanitation, followed by 16% on water transport and 8% on irrigation. While there remains a significant spending gap to meet Sustainable Development Goal 6 on water, including an annual USD 3.5 billion spending gap for irrigation across 41 countries, there are also serious inefficiencies in how water funds are spent, with more than a quarter of public funds not being spent each year (ibid). Improving budget execution rates by improving financial management and the sector's absorptive capacity, coupled with raising efficiency of service provision, could narrow spending gaps (ibid).

Water use is also driven by broader subsidies, which can indirectly subsidize water use leading to inefficient use and loss of water. These include subsidies to agriculture, particularly those to specific crops (Damania et al., 2023) or energy subsidies, which can affect the cost of abstraction (Rodella et al., 2023). Subsidies to unconstrained use of inputs can also affect the quality of water through run-off of fertilizers and other agro-chemicals (Damania et al., 2023).

Subsidies and grants

A starting point for government action is to understand the impact of broader subsidies on water use, realigning those to consider water availability and access needs, and effects on the resilience of freshwater ecosystems (Rodella et al., 2023). Governments can also provide finance directly to water users in agriculture through subsidies or grants to improve water retention, storage and recharging capacity. For example, in **Pakistan**, the government is re-orienting subsidies to help farmers introduce solar pumps and use more efficient irrigation technologies (Raza et al., 2021).

Governments can also direct funds into research and development, identifying practices and technologies that can benefit a wide range of agricultural water users.

Payments for ecosystem services

Governments can pay agricultural producers for ecosystem services provided by agricultural water control structures or practices, drawing on both public and private funding sources (Okiria et al., 2021):

- In the **USA**, in the Northern Everglades in Florida, the South Florida Water Management District, a state agency, pays cattle ranchers to store storm water on ranch lands in the area, slowing the flow of run-off and nutrients into Lake Okeechobee and the estuary (ibid). The programme has also incentivized ranchers not to sell or convert ranches to urbanized areas so that ecosystems flow could be preserved.
- **Costa Rica** provides a sustained example of using revenue from water bills over several decades to fund watershed management, compensating landowners for conserving forests and improving both water quality and quantity (Solie, 2016).

Water pricing and markets

Water users often benefit from the use of free or underpriced water, the extent of which is unquantified (Mazzucato et al., 2024). Information on the prices charged to farmers for irrigation services is poor overall, and almost non-existent in low-income countries (ibid). However, a survey of 38 countries found that, in 94% of the countries, governments do not recover any operation and maintenance costs; larger and wealthier farmers capture most of the benefits of the low- or zero-cost water (Damania et al., 2023).

Governments can address this by improving the quality of information on water pricing and realigning the price of water to encourage water use efficiency in irrigation, identifying the main targets for this, while considering equity. The impact of the worst effects of price rises for vulnerable water users can be mitigated, e.g., through cash transfers or other social protection mechanisms.

Examples of schemes that use water pricing – or water trading markets – to align demand with supply across different users, including the agricultural sector, include:

- In **Australia**, in locations of particularly acute water scarcity, a system of water trading has emerged, on both a permanent basis and a temporary or annual basis (Rendell et al., 2020). The State and Federal Governments encourage and enforce open trade between users up and down river systems, between rivers and between states, for hydraulically well-connected water supply systems.
- In **Chile**, in the Elqui Valley Water Pricing System, water rights are allocated through a market-based system, where water can be bought and sold (Delorit et al., 2019). Water pricing is based on the volume of water used, and the prices fluctuate based on supply and demand, with farmers able to purchase additional water rights when needed.

Governments will not be able to rely on pricing alone to reduce water use in agriculture. It can result in increased water consumption where farmers have modernized to improve water use efficiency or expanded the area of land under irrigation in response to water savings (Koech and Langat, 2018). It also relies on users being able to specify the volume of water required (often absent in systems serving small farmers) and can imply price levels to balance supply and demand for water that are well beyond the politically acceptable range in most countries (Perry, 2018).

Standards and regulatory tools

Standards and regulations provide guardrails within which financial incentives can operate to avoid the over-extraction of water from rivers and aquifers e.g., through issuing irrigation licences, and to maintain minimum standards on water quality (Koech and Langat, 2018).

- In **England**, this includes setting limits on water withdrawals and setting legally binding targets to significantly reduce pollution from farming, enforcing this with large penalties for non-compliance (DEFRA, 2023).
- In **Australia**, regulations around water use efficiency (e.g., in irrigation) are applied in response to scarcity and climate concerns, encouraging farmers to adopt more efficient methods (Rendell et al., 2020).

Governments need to monitor standards and regulations on a regular basis to ensure that they keep up to date with emerging technologies or practices, e.g., new chemicals used in manufacturing that find their way into the water system.

Beyond national borders, several initiatives operate:

- **Water Stewardship Standards** are being revised to require a collective, catchment basin approach, incorporate climate change and strengthen the water elements of other commodity standards, such as the Rainforest Alliance, Fair Trade and Good Agricultural Practices. These can use procurement and disclosure tools to drive change through supply chains and trade arrangements.
- The **Fair Water Footprints**[ii] initiative aims to bring together stakeholders from government, private sector and civil society to ensure that water embedded in consumer goods and international trade is managed in a sustainable, resilient and fair way.

Capacity-building and information provision

Using new practices or technologies to improve water management in agriculture requires strengthened capacity, of both water users and the government officials providing support, e.g., understanding groundwater systems and the role of climate change and other factors in affecting groundwater depletion.

Key to this is the availability of data and information that is accessible at all levels with the capacity of people to apply it to manage dynamically changing risks (Smith et al., 2019) such as tracking climate shifts to ensure that governments can plan infrastructure, water use, etc., and economic shifts that will affect water use and allocation across different user groups. Real-time digital information can enable policymakers to employ quality, accessible, timely and reliable disaggregated data, smart technologies and robust monitoring mechanisms to develop effective and equitable cross-sectoral policies (FAO, 2021).

Innovations that help to get this information into the hands of decision-makers include (Smith et al., 2019):

- **Water accounting**, a technique that assesses the balance among water flows, storage and consumption in a basin (e.g., Water Accounting-plus, developed by the International Water Management Institute and IHE Delft Institute for Water Education).

[ii] The Glasgow Declaration for Fair Water Footprints for Climate-Resilient, Inclusive, and Sustainable Development, 2021.

- The World Resources Institute's **Aqueduct**, which provides global water-related risk data available.

Governance mechanisms

Achieving water security incurs social and environmental costs, and there are inevitable trade-offs; in some countries, these are "significant, often unforeseen and even unacceptable" (Grey and Sadoff, 2007: 545). Managing these trade-offs across sectors and stakeholders requires inclusive, transparent and accountable governance mechanisms.

Governance of water resources and their multiple uses across different stakeholders is particularly complex and can require coordination across countries, river basins and watersheds. At the state level, governments can achieve this by addressing policy and budget coherence across multiple sectors – agriculture, water, energy and environment (George et al., 2024; Chaudhary and Srivastava, 2020) – ensuring that all national policies consider, and are reviewed, for their impact on water. Adopting a water–food–energy nexus approach can help to optimize resource-use efficiency and address important synergies and trade-offs between sectors (FAO, 2021).

Examples of coordination at national level include (Martin et al., 2023):

- **South Africa's** National Water Act (1998) promotes integrated water resources management, which coordinates water use across various sectors and geographic regions.
- **Australia's** Murray–Darling Basin Plan manages water resources across the basin's multiple states, aiming to ensure that water is allocated fairly and sustainably across all sectors – agriculture, urban use and environmental needs – among specific states via a Murray–Darling Basin Authority.

The governance of water resources also relies on inclusive water management, creating spaces for water managers and users to solve their own catchment problems and provide them with the information, funding and agency to do so. This requires high levels of coordination between different governance levels, to ensure sustainable and harmonized spatial planning of the whole region, and a basin-wide "shared vision" of what resilient water systems can and should look like in practice (Dominique et al., 2021).

- In **Burundi** and **Tanzania**, watershed management groups were established to prioritize and oversee implementation, resulting in improvements in food security and resolution of resource conflicts (FAO, 2021).
- **France** has progressively devolved allocation decisions over irrigation water to agricultural water user groups since 2006. This has led to greater awareness amongst irrigators of their water resources, and allocation rules balancing local economic and social priorities for local surface and groundwater (Rouillard and Rinaudo, 2020).

Process considerations

As with other Policy Dialogue topics, discussions acknowledge that a transition to low emission, climate resilient agriculture practices must centre on people and engage stakeholders at all stages – rather than imposing policy on them – to ensure that proposals are feasible, incorporate equity and efficiency issues, and reflect local conditions.

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