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International Collaborative Initiative

Understanding Water Conversion To Food In Jordan's Food System

FoSTr Jordan Policy Brief No. 3

Key Messages

01 **Jordan faces extreme water stress**; the country currently only has 61 m3 of renewable freshwater available per capita, per year. By 2040, this is projected to decrease to 35 m3, far below the global absolute water scarcity threshold of 500 m3. Significant water losses occur across all stages of Jordan's food system due to inefficient irrigation, outdated processing, and food spoilage, necessitating improved practices. In 2022, agriculture used 537 million m3 of water, which accounted for nearly 50% of the country's total water usage.

02 **Adopting efficient irrigation systems, increasing wastewater utilization (currently 16% of the water supply), expanding rainwater harvesting, and desalination are crucial** to enhance water efficiencies.

03 **Water efficiency varies by crop**. Strategic crops, like tomatoes and olives, should be prioritized for higher returns per water used.

04 **Critical policies are needed to upgrade infrastructure, promote water-efficient technologies, reduce water usage by enforcing strict regulations, and optimize water use** through better data collection. Together, these will help enhance the economic sustainability of Jordan's valuable water resources.

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Introduction

This policy brief is part of a series prepared by the Foresight for Food Systems Transformation (FoSTr) programme[1] to provide decision-makers, politicians, researchers, and practitioners with relevant data, information, policy tools and recommendations that promote a collective understanding of critical issues concerning food system transformation. The need for these notes arose from the workshops conducted by FoSTr in May and November 2023 and other relevant occasions. Stakeholders highlighted the lack of awareness, appreciation and the need to adopt a holistic and comprehensive approach to food system transformation. This policy brief is intended as a diagnostic and issues paper rather than a detailed or analytical document in order to fit the purpose.

Why the need to understand water conversion to food?

Jordan is recognised for its extremely limited water resources, and currently ranks as the second-most water-stressed country in the world (Alverio et al., 2023). The country relies on various sources for water, such as rivers, springs, rainwater, groundwater extraction, and treated wastewater. According to the Ministry of Water and Irrigation's (MWI) water budget report 2022-2023, the total available water from all sources amounted to 1,127.36 million m3, with 58% sourced from groundwater, 26% from surface water, and 16% from treated wastewater (MWI, 2024). This specific allocation reflects the complexity of Jordan's water management strategy, particularly in meeting the increasing demands from domestic consumption, agriculture, and industry. Jordan's total water usage included 517.65 million m^3 for domestic consumption, 575.77 million m^3 for agricultural purposes, and 33.94 million m^3 for industrial activities. Water is allocated by MWI's Planning and Management Unit based on each sector's water demand and consumption.

Currently, Jordan has just 61 m3 of renewable freshwater available per capita, per year, which is far below the internationally-recognized absolute water scarcity threshold of 500 m3. With the country's population projected to grow to 16.8 million by 2040, the renewable freshwater available per capita is expected to decrease further to just 35 m3, excluding desalinated water or new sources. This looming water scarcity highlights the urgent need for sustainable water management practices, including a greater reliance on treated wastewater for agricultural production and improved irrigation efficiency.

Research approach and methods

During a multi-stakeholder workshop in Amman in May 2023, organized by the Foresight for Food Systems Transformation (FoSTr) researchers, stakeholders raised a research question regarding "the extent and key causes of water losses in Jordan's food system." In response, a study was developed, led by FoSTr researchers from various disciplines (see note on authors at the end). The team conducted a comprehensive literature review, with their findings complemented by data analysis and interviews with key experts and stakeholders, including farmers and consumers, who are directly impacted by water use and loss. The Department of Statistics (DOS) also provided crucial data, including a detailed breakdown of water resource allocation across domestic, agricultural, and industrial use, which provided valuable insights into Jordan's water management strategies and associated challenges. By analysing the water footprint of key products in Jordan, the study team was able to determine the extent of water loss associated with Jordan's food system.

Image credit: IFAD/Roger Anis

[1]*The FoSTr programme covers four countries in Africa, Asia and the Middle East. It provides Jordan with a country support facility for food systems foresight and scenario analysis. The country-led and multi-actor foresight process aims to assist stakeholders in their contributions to national food systems transformation. It supports the dialogue, analysis and understanding necessary for co-creating future food systems that are sustainable, healthy, equitable and resilient.*

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Key findings

The research team's activities led to multiple findings, which can be used to enhance understanding of the relationship between water loss and Jordan's food system in a number of key areas.

Water used in the food system

Jordan's food system uses water resources in multiple ways. With reference to the *Policy Brief on Food Loss and Waste in Jordan*, it is important to understand the various water usages – as well as the levels of water loss and waste associated with the food system throughout the agri-food chain. Water use and loss occurs at multiple stages and due to various factors, including:

Production: Significant amounts of water are lost due to inefficient irrigation practices. Additionally, crop loss can occur as a result of poor water management, diseases, pests, or unfavourable weather conditions.

Collection, harvesting, sorting, and packing: Water is often utilized in different ways to facilitate the collection of agri-food products from fields, the aggregation process, and packaging for transport.

Processing and distribution: Water is heavily used during food processing and manufacturing in activities such as cleaning, cooking, and other processing needs. Inefficient processes or outdated equipment can also lead to water waste. Furthermore, if food products are damaged or spoiled during processing or transportation, the water used in these early stages is wasted.

Wholesale, retail, and services: Water use in these three stages, though less-documented, also contributes to the overall water footprint of food products.

Consumption: Significant water waste occurs when edible food is discarded due to spoilage from improper storage, excessive purchasing, or expiration. This waste represents 15% of water used in Jordan's agricultural production (based on figures obtained from DOS, 2022; Mekonnen and Hoekstra, 2012; Mourad et al., 2010).

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Challenges and projections of water use

A scenario-development exercise on the state of water and water usage in 2050, supported by the Embassy of the Kingdom of the Netherlands in Jordan, highlighted critical dilemmas (Hellegers et al., 2022). Notably, it emphasized that to achieve sustainable and resilient agricultural production in Jordan, there must be a greater reliance on treated wastewater. As Jordan's population is projected to grow to 16.8 million by 2040, the renewable freshwater available per capita, per year, is expected to decrease to just 35 m3, significantly below current availability of 61 m3. The National Water Strategy 2023-2040 further projects that the water required for irrigation in Jordan's agricultural activities will rise to 950 million m3, placing additional pressure on already-scarce freshwater resources.

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Water-efficient practices and innovations

Water use can be optimized if farming techniques such as precision irrigation, soil moisture sensors, and soilless culture are implemented, as these can significantly reduce water loss through evaporation, runoff, and percolation.

Enhancing greywater (domestic waste water) recycling and improving wastewater treatment processes, to produce higher-quality water for irrigation and industrial use, would help conserve valuable freshwater for essential purposes.

Another approach to conserve water, particularly for use during dry periods, involves installing rainwater harvesting systems. These collect rainwater from rooftops, surfaces, and catchment areas and store it in tanks or reservoirs for use later on. For example, a 100 m2 rooftop can harvest approximately 32 m3 of water annually (Al-Kharabsheh, 2020).

A crucial source of freshwater can be created by desalinating seawater and brackish groundwater. This approach is being realized by projects such as the Jordan National Water Carrier, which aims to produce 300 million m3 of freshwater by 2027. This project will transport desalinated water from the Red Sea to areas of high demand in northern Jordan, including Amman and other major urban areas.

Finally, effective management of non-revenue water (water produced and supplied by a water utility but not billed to customers) can significantly reduce water losses during distribution, addressing issues such as leaks, pipe bursts, unauthorized consumption, and inaccurate metering. Currently, total network water leakage is estimated to account for 52% of water supplies (MWI, 2022).

Water conversion ratios and agri-food insights

The research examined water conversion ratios (which measure the amount of water required to produce 1 kg of a product) for key agricultural commodities in Jordan, including grains, fruits, vegetables, animal products, and processed goods. Jordan has achieved moderate to high levels of self-sufficiency in key products like vegetables, fruits, and animal meats, with a food self-sufficiency ratio of 55.7% in 2022 (DOS, 2022).

There is significant variation among the water conversion ratios. For example, cereals have a global water footprint of 1,644 l/kg, while vegetables have a lower footprint at 322 l/kg. In Jordan, cereals and vegetables are produced with relatively efficient water use, at 1,100 and 158.7 l/kg, respectively. Beef production in Jordan has a local water footprint of 622 l/kg, compared to a global average of 15,415 l/kg.

The revenue per m3 of water used varies widely among agricultural products. While milk and meat are water-intensive, they generate substantial revenue, partly because much of the water used goes in to producing animal feed – which Jordan mostly imports. Potatoes and tomatoes, which demonstrate high water-use efficiency and market value, could be considered strategic crops. Additionally, olive production, primarily dependent on rainfall, offers a higher return per m3 of water than typically calculated for other agricultural products and should be recognized as a strategic product for Jordan.

There is a notable scarcity of published data on water conversion ratios specific to Jordanian agricultural products. This lack of detailed information presents a challenge to fully understanding water usage patterns and optimizing water use across different agricultural activities.

Policy recommendations

To effectively reduce water use in Jordan and enhance the efficiency and sustainability of its water resources, several key policy measures should be implemented:

Strategic investments in infrastructure:

Public and private investments are critical to upgrade and expand water infrastructure. Reducing losses from leaks, pipe bursts, and inefficient distribution systems, along with expanding water treatment and desalination facilities, are crucial to secure and diversify Jordan's water sources. Moreover, both public and private stakeholders could invest in improving greywater recycling initiatives and wastewater treatment processes. Doing so would produce more higher-quality water suitable for irrigation and industrial use and conserve freshwater for essential needs. These investments would lay the groundwork for a resilient food system capable of meeting future demands.

Encouraging water efficiency:

The government should consider implementing a tiered pricing structure that reflects the true cost of water to encourage more-efficient use among farmers, industries, and households. This approach will make water conservation economically advantageous. Simultaneously, the government could provide financial incentives, such as subsidies or tax breaks, to encourage adoption of water-saving technologies in agriculture – including efficient irrigation systems, drought-resistant crop varieties, and advanced soil management practices. Such measures will not only enhance water efficiency but also support the transformation of agricultural practices toward sustainability.

Regulation and enforcement:

Existing regulations on water use should be enforced by the government, including restrictions on groundwater pumping and limits on irrigation water withdrawals. Regulations should also mandate water recycling and re-use in industrial processes. Strong enforcement mechanisms, supported by significant penalties for non-compliance, are essential. This regulatory framework will help ensure that water resources are managed effectively, paving the way for a more sustainable food system.

Enhanced data collection and research:

overnment-mandated research could create a real-time, accurate agricultural production database that enables farmers to better understand market demand, forecast supply, and determine optimal cultivation areas – thus leading to more informed crop choices. Such information can also help reduce market bottlenecks and increase farmers' revenue by optimizing water use. Government and development donors should increase funding for research and development programs focused on implementing water-saving technologies, improving irrigation efficiency, and creating drought-resistant crops. In addition, private sector actors should promote the cultivation of less water-intensive, high-value crops, and instead encourage value-addition through processing locally-produced agricultural products – thereby reducing waste and maximizing the economic benefits of scarce water resources. This focus on data-driven decision-making will facilitate the transformation of Jordan's food system into a more adaptive and efficient model.

Water loss and waste:

It is crucial to implement comprehensive strategies aimed at reducing water loss and waste throughout the entire supply chain. This includes investing in modern irrigation techniques, promoting efficient water use practices, and raising public awareness about the importance of water conservation. Establishing benchmarks and monitoring systems for water use in agriculture will help identify areas for improvement and ensure that water resources are utilized effectively, ultimately contributing to a more sustainable and resilient water management system in Jordan.

Conclusions

Understanding how water is utilized in food production is vital to address the critical challenges of water scarcity in Jordan. Accurately quantifying the water footprint of various food production activities and value chains allows stakeholders to identify where improvements can be made to optimize water use, reduce waste, and enhance overall efficiency.

Research and cross-sector collaboration are fundamental to developing solutions that mitigate water-related risks and build resilience within Jordan's food system. Targeted interventions, such as adopting water-saving technologies, optimizing crop selection, and implementing effective policy measures, are essential to reducing water use while sustaining agricultural productivity and livelihoods. These interventions will serve as catalysts for transforming the food system into a more sustainable and efficient entity.

Enhanced research and monitoring, along with a shift in how stakeholders in Jordan's food systems perceive and utilize water, will be essential for promoting sustainable water and food conservation. Through comprehensive and coordinated efforts, Jordan can secure its water future while ensuring food security and fostering sustainable agriculture, ultimately leading to a more resilient food system.

Note about authors of this policy brief

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References

- Al-Kharabsheh, A. (2020). Challenges to Sustainable Water Management in Jordan. Jordan Journal of Earth & Environmental Sciences, 11(1).
- Alverio, G.N., Sowers, J., & Weinthal, E. (2023). Displaced to Cities.
- Hellegers, P. J. G. J., van Halsema, G. E., Seijger, C. J. L., Borghuis, G. J., Christoforidou, M., & Vervelde, B. J. (2022). Confronting the challenges of water scarcity in Jordan; Seeking viable, sustainable, and prosperous options for Agriculture & Water in 2050: Technical Background Report. Wageningen University & Research. https://edepot.wur.nl/581568
- Mekonnen, M. & Hoekstra, A.Y. (2012). A Global Assessment of the Water Footprint of Farm Animal Products. Ecosystems, 15(3), 401–415. https://doi.org/10.1007/s10021-012-9525-1
- Mourad, K.A., Gaese, H., & Jabarin, A.S. (2010). Economic Value of Tree Fruit Production in the Jordan Valley from a Virtual Water Perspective. Water Resources Management, 24(9), 2021–2034. https://doi.org/10.1007/s11269-009-9536-9
- Ministry of Water and Irrigation (MWI). (2022). National Water Strategy 2023–2040. https://faolex.fao.org/docs/pdf/jor218684.pdf
- Ministry of Water and Irrigation (MWI). (2023). Jordan Water Sector Facts and Figures 2022. Amman, Jordan.
- Ministry of Water and Irrigation (MWI). Annual Water Budget 2022–2023. Amman, Jordan.

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