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Towards More Water-Efficient Agriculture for More Resilient Food Security: Water-Energy-Food-Ecosystems (WEFE) Nexus Approach

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Thematic context

Within the European Union, agriculture accounts for 32% of the water withdrawals and for 59% of water consumption. This sector must meet the challenge of food security without compromising water security which is essential to its sustainability. However, the impacts of climate change are reducing the availability of water resources: by 2050, forecasts predict a drop in water flows of between 10 and 40%, and a 30% drop in underground water recharge, meaning a risk of water scarcity.

Developing a resilient and sustainable agriculture therefore means adapting to these disruptions by continuing the efforts to reduce water demands that have been successfully undertaken in this sector (-3% over 10 years, between 2010 and 2020). Effective measures need to be implemented in the river basin management plans (RBMPs): the use of non-conventional resources (rainwater harvesting and storage, reuse of treated wastewater, cf. EU reglementation on minimum requirements for the reuse of water for agriculture irrigation, applicable since 2023), subsidies for efficient irrigation systems complementing progressive and incentive pricing, crop selection and rotation, reinforcement of vegetation cover (reducing evapotranspiration, maintaining soil moisture, limiting erosion...), no-till soil management favoring water infiltration), etc...

The European Union's legislative, political and financing framework supports the implementation of these measures. The Green Pact for Europe and its components (Farms to table strategy, action plan for a circular economy, adaptation strategy) complements the modest quantitative component of the Water Framework Directive (good quantitative status of underground water bodies, river basin management plan covering qualitative and quantitative management, authorization system, control and monitoring withdrawals), and the greening of the Common Agricultural Policy (CAP 2023-2027) finances (up to 25% of direct payments) the adoption of ecological programs including this type of measure.

The Water-Energy-Food-Ecosystem Nexus (WEFE Nexus) approach highlights the interdependence of water, energy and food security and ecosystems – water, soil, and land – that underpin that security. The Nexus approach identifies mutually beneficial responses that are based on understanding the synergies of water, energy, and agricultural policies. It also provides an informed and transparent framework for determining the proper trade-offs and synergies that maintain the integrity and sustainability of ecosystems.

Session Report

Introduction

This session focused on the crucial theme of improving water use efficiency in the agricultural sector in order to build more resilient food security, adopting the integrated Water-Energy-Food-Ecosystems nexus approach. The session brought together experts and decision-makers from various regions, including Austria, the Po Basin in Italy, the Segura Basin in Spain, the FAO, Martinique and China. The aim was to share experiences on the challenges encountered, the solutions implemented and the recommendations suggested for more sustainable water management in agriculture in the face of climate change and increasing pressure on resources.

The topic is particularly relevant given that agriculture is the largest consumer of freshwater globally and that variations in the water cycle due to climate change affect all sectors. An integrated approach and collaboration are needed to consider water as a cross-cutting issue in all relevant policy decisions in order to address future water-related challenges.

Problems encountered

The challenges identified by the various stakeholders are numerous and often

interconnected, exacerbating pressure on freshwater resources for agriculture.

Many regions face severe natural limitations causing structural water stress and scarcity. The Segura Basin in Spain, for example, suffers from one of the highest levels of water stress in Europe, with low annual rainfall (300-400 mm) and high evaporation rates due to a semi-arid climate. Austria enjoys relative water abundance, but its most productive agricultural regions are also those with the lowest rainfall. These conditions are exacerbated by climate change.

Climate change is profoundly altering the hydrological regime. In the Po Basin, there is an increase in interannual variability (alternating dry and wet years) and a change in the temporal distribution of precipitation (fewer but more intense events). Snow cover below 1,300 metres is decreasing, while snow above 2,000 metres is melting earlier and earlier. These changes significantly reduce the availability of resources, particularly during the crucial spring and summer months, which require large volumes for agricultural irrigation. Martinique is also seeing a ‘strong signal of less water’ due to climate change, with a decrease in annual precipitation and an increase in temperatures.

Droughts and floods are becoming more frequent and severe, highlighting the fragility of existing irrigation systems, as demonstrated by the 2022 water crisis in the Po Basin. Projections suggest a 20% reduction in water availability in the Mediterranean region by 2050.

Over-exploitation of water resources, particularly groundwater, is a major risk. In Austria, although average irrigation demand is low, the high concentration of this demand in certain regions could lead to overexploitation of groundwater by 2050, with a local risk of shortages. In the Segura, surface and groundwater resources are being depleted faster than they are being replenished.

Agriculture, as in the Segura Basin, is heavily dependent on water-intensive crops (citrus fruits, lettuce, tomatoes). In Martinique, the agricultural model inherited from colonisation is dominated by water-intensive export monocultures (bananas and sugar cane), which are poorly adapted to current environmental requirements, to the detriment of food crops necessary for local food security.

The way in which water data is collected and used is a governance issue. SDG indicator 6.4.2 (water stress level), which measures the pressure on a country's water resources, is often calculated and presented as aggregate values at the global, regional or national level. This aggregation masks significant disparities at the sectoral level (who uses the most water), spatial level (which regions and basins are most affected) and temporal level (when stress is most critical during the year). This makes it difficult for policymakers and managers to target interventions effectively and ensure integrated and sustainable management.

Beyond the technical challenges, there are deeper structural, political and economic constraints. In Martinique, the predominance of export crops is strongly linked to the European subsidies allocated to them. The economic model remains marked by a colonial trading economy. Smallholders following the Creole model receive little support. Other obstacles exist. Social acceptance of certain promising solutions (reuse of wastewater) is low, as traumatic events such as chlordecone contamination have made the population distrustful of the authorities. The cost of organic products is high for the local population. There is a

lack of technical references for alternative agriculture and diversification in a tropical context, as technical institutes have historically worked for intensive agriculture. Insularity makes territories more vulnerable to disease and complicates the regulation of local markets.

The historical Austrian model of landscape management aimed to drain water quickly (drainage of wetlands, canals), which is the opposite of current needs for water retention in the face of prolonged droughts.

Solutions Implemented

Faced with these challenges, various solutions are being implemented by stakeholders in different basins and organisations.

A key strategy is the modernisation of irrigation systems towards more water-efficient methods. The Segura River Basin Hydrographic Confederation is implementing advanced irrigation systems such as drip irrigation, which can reduce water use by 30-60% and achieve yields of 90-95%. The use of digital tools, sensors to monitor soil moisture and integrated farm management systems is also being promoted for more accurate water demand management. Austria supports investment in irrigation, including requirements for water permits, meters, water savings during renovations, and the switch from fossil fuel pumps to electric pumps. China is transforming its irrigation methods, moving from flood irrigation to pipe or sprinkler irrigation, particularly in 'high-quality agricultural land', enabling significant savings in water and fertiliser. Innovations such as the use of drones to monitor water conditions in fields are also being deployed.

In structurally deficit regions, diversification of sources is vital. The Segura Basin is an example, with over 94% of its treated wastewater reused for irrigation, and an ambitious plan to produce 404 hm^3/year of desalinated water by 2027 via 12 plants along the coast. The use of a 'water mix' from different sources also makes it possible to achieve the appropriate salinity for plants and prevent soil degradation.

In the face of prolonged droughts, the aim is to move away from historical management practices that focus on rapid drainage towards methods that retain water in the landscape. Austria is developing methods and pilot sites for water retention, adapting simulation models to optimise practical implementation. The cross-border AT-CZ Interreg SaveWater project, for example, aims to identify, evaluate and promote water retention measures. The Po Basin is seeking to recover land management practices that promote deep infiltration and aquifer recharge, particularly in rice-growing areas that are important wetlands.

Beyond irrigation, changes in farming practices are essential. This includes crop diversification and soil management such as crop rotation, cover crops, adding organic matter and balanced fertilisation in the Segura. Austria promotes agro-photovoltaics, agroforestry, sustainable use of biomass, promotion of efficient water use and retention. Martinique is developing agronomic expertise for practices such as the use of cover crops, the reintroduction of tree hedges, agroforestry (coffee, cocoa, vanilla) and tree-covered crops. The recent development of organic farming is also being supported. China, for its part, is focusing on optimising water use patterns.

The integration of the various dimensions of water management is essential. The FAO is promoting the disaggregation of SDG indicator 6.4.2 (level of water stress) at the river basin level for a more detailed analysis of the tensions between water demand and resource availability. To this end, the FAO, in collaboration with the Stockholm Environment Institute (SEI), has developed a new plugin for the Water Evaluation and Planning System (WEAP) tool that calculates water stress by sub-basin and season, simulating different management and climate scenarios. This disaggregation is considered essential for better understanding the causes and impacts of water stress and enabling decision-makers to target interventions more effectively.

Public policies play a crucial supporting role. The Common Agricultural Policy (CAP) 2023-2027 supports investment in irrigation under certain conditions. Austria's agricultural vision for 2028+ incorporates soil protection, an effective water strategy and the promotion of renewable energies. China promotes government/market synergy: the government provides budget subsidies, special funds and tax incentives (around ¥200 billion over a decade, or around €1.3 billion), and the market uses tiered agricultural water pricing to encourage efficiency.

More structural changes are also needed. The Po Basin aims to improve the efficiency of collection and distribution systems by creating small reservoirs and reducing losses. The Segura Basin has an interconnection network for desalination plants. China is building a National Water Network and has improved its irrigation infrastructure over millions of hectares. In Martinique, a programme supported by the Water Office aims to structurally transform the agricultural system, moving from export crops to crops for local consumption, for greater food autonomy and resilience. Regional cooperation is highlighted, such as the AT-CZ cross-border project in Austria and the FAO's promotion of inter-agency cooperation to improve governance. China is establishing coordinated governance between upstream and downstream areas, tributaries and main branches, and riverbanks.

Suggested recommendations

It is imperative to accept that the current situation requires a change of era and that we must be prepared to readjust land management systems and agricultural models. This implies a technical, economic and cultural structural transformation, requiring the participation of all stakeholders (professionals, experts, communities). Martinique is thus aiming for a long-term transformation in the face of multiple constraints.

A key recommendation is the disaggregation of the SDG 6.4.2 water stress indicator by sector, area and season. This provides a better understanding of the causes and impacts and helps decision-makers to target interventions more effectively in regions and sectors with high consumption or high stress. This disaggregation improves water governance by promoting cooperation between agencies and experts and supports national integrated management policies.

An integrated approach is needed, considering water as a cross-cutting issue in all relevant policy decisions. This includes integrated water resource management, coordinated river basin management, and strengthening regional cooperation, which is vital for managing shared resources and mitigating conflicts.

Developing and applying methods to retain and store water in landscapes is crucial in the face of droughts. This involves adapting simulation models and creating pilot sites to test these measures.

Recognising the value of the ecosystem services that agriculture can provide could encourage farmers to adopt practices that are beneficial to water and the environment.

Incentives such as subsidies and appropriate water pricing are important.

Continue to diversify water sources (reuse, desalination) and encourage crop diversification, agroecology and soil management techniques.

The Martinique Water Agency is working at all levels to support the transition, but the predominance of heavily subsidised banana cultivation remains a major obstacle. Sufficient financial and technical support is needed to accompany the change in the agricultural model. It is crucial to improve the distribution of European funds so that they provide greater support for diversification and subsistence farming. The development of technical references for alternative agriculture in tropical areas is also a necessity.

Conclusion

This session highlighted that agriculture is both vulnerable and a major player in managing the water challenges posed by climate change and increasing demand. The issues are complex, ranging from physical water stress and direct climate impacts to structural, political and governance barriers. The solutions presented by the speakers show a range of actions from technological modernisation and diversification of water sources to more profound changes in landscape management and agricultural practices. A holistic approach to achieving sustainable water use seems essential. This means that the agricultural sector must fulfil its productive functions while preserving and improving the state of water, air and biodiversity. Recommendations converge on the need for a vision of structural change, improved water governance based on disaggregated data, integrated basin-wide approaches, appropriate incentives and adequate support to enable a long-term shift towards more water-efficient and resilient agriculture. The experience of different regions and the FAO highlights that cooperation, innovation (both technical and in practices) and political will are essential to achieve sustainable food security within the constraints of the water-energy-food-ecosystem nexus.