WATER-FOOD-ENERGY NEXUS - the FAO Perspective

by

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**FAO’s Vision:** A world free from hunger and malnutrition where food and agriculture contribute to improving the living standards of all, especially the poorest, in an economically, socially and environmentally sustainable manner.

1) Help Eliminate hunger, Food insecurity and malnutrition

2) Make agriculture, forestry and fisheries more productive and sustainable

3) Reduce rural poverty

4) Enable inclusive and efficient agricultural and food systems

5) Increase the resilience of livelihoods to threats and crises

Climate Change, Gender & Governance mainstreamed across all objectives

Global Goals of members

Strategic Objectives
• Understanding and managing often-competing interests while ensuring the integrity of ecosystems
FAO and the Water-Energy-Food Nexus…

• Provide evidence
• Develop scenarios
• Designing and appraising response options
• Supporting multi-stakeholder dialogue
What emerged from this...

• Thinking, talking and implementing the Nexus seems to make most sense when it comes to:
  • Resource use optimization at a technical/practical level: e.g. irrigation modernization; multi-purpose dams; solar irrigation; hydroponics; energy use efficiency measures in cities; crop rotation patterns
  • Conflict resolution and dialogue at a political/higher level: e.g. Amazonas river and forest management

• Need to Focus on the process of thinking, talking and deciding on water, energy and food-related matters – in order to get to any meaningful results.
The FAO approach to the Water-Energy-Food Nexus

- Population growth and mobility
- Diversifying and changing diets
- Cultural and societal beliefs and behaviours
- Technology and innovation
- Urbanisation
- Governance
- Sectoral policies, vested interests
- International and regional trade, markets and prices
- Industrial development
- Agricultural Transformation
- Climate Change

Managing the Nexus

Goals and interests

Different, often competing social, economic and environmental goals and interests related to:

- Food
- Water
- Energy

Resource base

Land
Water
Energy

Capital
Labour
The FAO approach to the Water-Energy-Food Nexus

Drivers
- Population growth and mobility
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- Cultural and societal beliefs and behaviours
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Drivers
- Governance
  - Sectoral policies, vested interests
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Goals and interests
- Different, often competing social, economic and environmental goals and interests related to:
  - Food
  - Water
  - Energy

Managing the Nexus
- Evidence
- Scenario Development
- Stakeholder Dialogue
- Response Options

Resource base
- Land
- Water
- Energy

Capital
- Labour
What are we trying to achieve?

Sustainable Development Goals for people, planet, peace and prosperity
Goal 2 on Agriculture, Food Security & Nutrition

- **Target 2.1**: End hunger and ensure access to nutritious and sufficient food for all
- **Target 2.2**: End all forms of malnutrition
- **Target 2.3**: Double agricultural productivity and incomes of small-scale food producers
- **Target 2.4**: Sustainable food production and resilient agricultural practices
- **Target 2.5**: Maintain genetic diversity and promote sharing and equitable benefits from genetic resources

- **Target 2 overall:**
  a) increase investments in rural infrastructure, agricultural research and extension services,
  b) Correct and prevent trade restrictions and distortions (Doha Round)
  c) Measures towards proper functioning food commodity markets (also to avoid extreme food price volatility)
Goal 6 on Water

- Target 6.1: equitable, affordable and safe access to drinking water for all
- Target 6.2: adequate and equitable access to sanitation & hygiene
- Target 6.3: improve water quality and increase recycling safe reuse
- Target 6.4: increase water use efficiency and reduce number of people suffering from water scarcity

- Target 6.5: integrated water resources management, including transboundary cooperation
- Target 6.6: protect and restore water-related ecosystems
- Target 6. overall: a) expand international cooperation and capacity building, b) support community participation in water & sanitation management
Goal 7 on Energy

- Target 7.1: **Universal access** to affordable, reliable and modern energy services
- Target 7.2: Increase share of **renewable energy** in the global energy mix
- Target 7.3: Double the global rate of improvement in **energy efficiency**
- Target 7 overall: a) **clean energy research and technology** and investments in clean energy infrastructure, b) expand infrastructure and upgrade technology
Small water footprint of a “healthy diet”

- **Diversity** – a wide variety of foods

- **Fresh** food - vegetables, fruits, legumes, whole grains and pulses

- **Resilient** crops that are less prone to spoilage and require less energy for storage

- **Local** production = less energy for transport and local incomes

- Very **limited consumption of processed foods** (which often coincides with foods high in fat, sugar or salt and low in micronutrients e.g. crisps, confectionery, sugary drinks)
Typical values of water and energy consumption per serving during the production of selected food products (from a life-cycle perspective) as well as their caloric value.

- **Water use** is expressed in liters of blue water consumed.
- **Energy use** is expressed in megajoules required to produce the food as well as number of hours for which a 20W bulb should run to consume an equivalent amount of energy.
The Realities

Water-Energy-Food Nexus
Solar Irrigation

- Reliable, clean-energy solution for agricultural water management
- Investment costs for PV-pump systems are coming down → economically viable
- Allows for energy access in rural areas that currently lack reliable access or where diesel / fuel is expensive
- Improve agricultural productivity
- Reduction of GHG emissions
Solar Irrigation & Groundwater Management

How to regulate decentralised Solar Powered Irrigation System (SPIS) to overpumping of groundwater resources in water scarce countries?

- Many countries – where farm power supply is often free or heavily subsidized – already experience groundwater over-pumping.
- Solar pumps, which offer 2,300-2,500 hours a year of uninterrupted, daytime free energy, could just exacerbate the problem by, in essence, encouraging farmers to use water at will.
- Energy subsidies can be used to (a) promote SPIS, (b) regulate water use, but also (c) distort the costs of SPIS and energy prices that ultimately determine how competitive SPIS will be in the long-term.
Solar Irrigation & Groundwater Management

In Morocco, subsidies for SPIS will be linked to water efficient technologies, such as drip irrigation.

In Gujarat, India, the first solar irrigation cooperative was founded in 2013, where farmers have a choice between using the energy the produce to irrigate or to feed-back into the grid as a cash crop for which they receive an income.
## Selected FAO Approaches and Frameworks

### Sectoral Approaches

<table>
<thead>
<tr>
<th>Sector</th>
<th>Approach</th>
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</thead>
<tbody>
<tr>
<td>Crops</td>
<td>Save and Grow: <strong>Sustainable</strong> Crop Production Intensification</td>
</tr>
<tr>
<td>Livestock</td>
<td>Global Agenda for <strong>Sustainable</strong> Livestock</td>
</tr>
<tr>
<td>Forestry</td>
<td><strong>Sustainable</strong> Forest Management (SFM)</td>
</tr>
<tr>
<td>Fisheries</td>
<td>Code of Conduct for Responsible Fisheries (CCRF)</td>
</tr>
<tr>
<td>Aquaculture</td>
<td><strong>Ecosystem</strong> Approach to Fisheries (EAF)</td>
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</tbody>
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### Cross-Sectoral and Thematic Approaches

- Conservation and **Sustainable** Use of Biodiversity and Genetic Resources
- Energy-Smart Food for People and Climate (ESF)
- **Sustainable** diets
- **Resilient** livelihoods
- Climate Smart Agriculture (CSA) and FAO-Adapt
- Coping with water scarcity
- Global Soil Partnership (GSP)
- **Sustainable** Land Management (SLM)
- Landscape initiative *(in development)*
Building on ongoing initiatives

Regional Water Scarcity Initiative in the Near East and North Africa

• Strategic planning and policies
• Improving water management efficiency and productivity in major agricultural systems and in the food chain
• Managing the water supply through reuse and recycling of unconventional waters
# The Nexus in a specific context

Entry-point for analysis and discussions

<table>
<thead>
<tr>
<th>Topic</th>
<th>Nexus Dimension</th>
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<tr>
<td>Groundwater management</td>
<td>Overextraction of groundwater resources for irrigation, using diesel/ electricity/ solar-powered pumps</td>
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<tr>
<td>Irrigation modernization</td>
<td>Water and energy use efficiency vis-à-vis economic viability of large-scale irrigation systems</td>
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<tr>
<td>Intensification of livestock production</td>
<td>On-farm waste management for bioenergy production (“closed-loop”)</td>
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# The Nexus in a specific context

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<tr>
<th>Topic</th>
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<th>Nexus Indicators</th>
<th>Context</th>
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<tr>
<td>Groundwater management</td>
<td>Overextraction of groundwater resources for irrigation, using diesel/ electricity/solar-powered pumps</td>
<td><strong>Groundwater withdrawal</strong>&lt;br&gt;• Renewable groundwater resources per capita&lt;br&gt;• Groundwater withdrawal rate&lt;br&gt;• Percentage of groundwater allocated to agriculture/ other uses Area under groundwater irrigation&lt;br&gt;• Number of groundwater structures for agriculture</td>
<td><strong>Energy consumption</strong>&lt;br&gt;• Agricultural fossil fuel/ electricity consumption (GkWh)&lt;br&gt;• Diesel/ solar/ electricity operated groundwater pumps compared to total mechanised groundwater structures&lt;br&gt;• Diesel/ electricity price index</td>
<td><strong>Change in groundwater levels and groundwater quality</strong>&lt;br&gt;• Change in groundwater levels in both shallow and deep aquifers over time&lt;br&gt;Change in salinity levels and selected water quality indicators over time</td>
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<td></td>
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<td><strong>Energy pricing</strong>&lt;br&gt;• Electricity subsidy ($/ha) of groundwater irrigated area and per consumer over time&lt;br&gt;• Capital, O&amp;M and disposal costs for solar pumping system</td>
<td></td>
<td><strong>Importance of groundwater to agricultural production</strong>&lt;br&gt;• Contribution of groundwater irrigation to agricultural GDP compared to surface water&lt;br&gt;• Net agricultural profit after electricity subsidy (farm/ national level)&lt;br&gt;• Working hours saved due to access to irrigation/ cost of operating pumps</td>
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Rationale and added value of a nexus approach

• Increasing pressure on resources for socio-economic development:
  • Growing and competing demand for energy, food, water
  • Increasingly complex interactions between water, food and energy
  • Stressed natural resources
  • Climate change

• Policies and development strategies very much sector-driven
  • Incoherence
  • Conflicts
  • Missed opportunities for enhanced synergies
  • Sub-optimal investments

• Limitations of integrated approaches → cross-sectoral dialogue becomes key
IMPORTANT NEXUS TOPICS IN THE AGRICULTURE SECTOR

**Bioenergy**: How can we make the best use of our resources to support both energy and food security?

**Irrigation modernisation**: How can we make irrigation systems more water and energy efficient while better meeting the needs of its users?

**Wastewater reuse**: Can we find synergies between wastewater treatment, energy production and food safety standards?

**Intensive livestock production/ aquaculture**: What means do we have to reduce pollution from intensive production on water, energy and land resources (feed and manure)?

**Hydropower**: How can we seek synergies between multiple uses and how can we mitigate trade-offs between different interest groups?

**Food waste and losses**: How can we reduce losses along the supply chain and waste by the consumer, avoiding wasteful use of resources in the first place?
In conclusion...

- Integrate Nexus thinking in broader processes about sustainable development and natural resources management - *international, regional, national and sub-national*

- Focused interventions on specific technological, managerial or operational issues
  - Documentation and dissemination of scientific evidence