Water: A Resource Critical to Food Production and Survival**

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Summary
Fresh water is a limited and valuable natural resource that is crucial to human health and survival. Poor quality water continues to result in human illness and disease despite microbial and chemical quality standards for water used for both drinking and in food production. These standards are both inconsistently formulated and irregularly enforced. Factors limiting water availability and impacting water quality include an expanding global population, climate change, aging infrastructure, and industrial uses. Expanding populations, in particular, will continue to drive an increasing strain on fresh water resources. Water and food production-related problems are complex, long-term, and affect everyone, so solutions will require collaboration across diverse disciplines, in addition to public funding. Currently, water protection and conservation are not priority issues among citizens or policy makers in the United States. Although some scientific research is available to support policy development, there continue to be members of the public, in addition to policy makers, who view scientists and scientific data with suspicion. The lack of science-based policies to protect water combined with changing water availability may negatively impact human health and survival, and food production and safety.

Current realities

Food and water are two of the most essential human needs. For this reason, water availability, water quality, food production, and food safety are global concerns. Although the overall U.S. population and water consumption rates seem fairly steady, fresh water consumption in specific U.S. regions and in other regions of the world is predicted to continue to increase for many reasons, including population shifts and expansion, uncontrolled usage, and climate change. Water quantity is not the only issue: fresh water demand also includes quality requirements to meet intended uses and to avoid human illness and disease.

Although no organization has authority to enforce global water quality standards, the World Health Organization (WHO) provides international leadership in defining parameters and criteria to help achieve water quality goals. In the case of drinking water, WHO guidance states that *"The judgment of safety, or what is an acceptable level of risk in particular circumstances, is a matter in which society as a whole has a role to play. The final judgment as to whether the benefit resulting from the adoption of any of the guidelines and guideline values as national or local standards justifies the cost is for each country to decide."* U.S. drinking water standards, set by the U.S. Environmental Protection Agency (EPA), are comprised of lists of contaminants and their maximum contaminant levels and are designed, in general, to result in lower than a 1 in 10,000 likelihood of adverse effect to those who consume the water.

The need for and use of water are very complex issues. There are human needs for drinking water and food, but also for energy. A current example of water and energy overlap is the U.S. natural-gas boom, driven by controversial high volume hydraulic fracturing (HVHF). These practices in gas exploration involve the use and contamination of large volumes of fresh water such that water quality is degraded. The gas companies support the current costs associated with extraction and disposal but will likely not shoulder long-term costs for necessary regulatory enforcement or impact to the environment. Monitoring and determining the overall impacts to health and the environment are difficult because gas companies do not disclose the chemicals and amounts used in the extraction process, however initial scientific studies outline several reasons for concern and

caution. HVHF gas exploration highlights how water issues can compete with other important issues such as energy resource development.

Water quality and availability issues converge during fresh produce production. The use of water for cropland irrigation has a significant impact on stream flow and resulting water availability. The quality of water used in the production of fresh produce is currently the focus of many research programs throughout the world because contaminated water is believed to be the cause of many produce-associated foodborne illnesses and deaths. In the U.S., fresh produce commodity organizations were the first to establish microbial quality criteria for water used in fruit and vegetable production. The Food Safety Modernization Act (FSMA)-proposed Produce Safety Rule has also outlined microbial water standards used in the production of fresh produce. The basis for the irrigation water component of these criteria was a set of EPA recreational water quality standards for activities that result in full body contact with water, such as swimming. Although understandable with regard to intent, the adoption of these criteria to limit health risks in food production lacks a solid scientific foundation for the following reason: the ultimate dose received by a consumer from irrigated produce is fundamentally different from the ultimate dose from full-body exposure to swimming water. Water quality requirements are also a concern because if farmers cannot meet the water quality standards, they may decide to grow crops other than fruits and vegetables. This could result in less consumer access to fresh produce and likely increased prices. In a nation facing heart disease and obesity epidemics, the focus should be on encouraging the production and consumption of fresh produce, especially if there is not sufficient science to prove a human health risk from use of the water.

Water issues are also impacted by the ability of the public and policy makers to understand scientific research results and support science-based policies. As demonstrated by the perceived controversy over the reality of global warming, the public and policy makers in the U.S. often have difficulty evaluating the significance and credibility of scientific reports. The global climate change controversy is a clear example of small groups of individuals ignoring science-based research and effectively using uncertainty to derail effective policy development. A general lack of science literacy in the U.S. public hinders science-based policy development and communication between scientists, the public, and policy makers.

Scientific opportunities and challenges

Fresh water availability, quality, and use need to be intensively studied to determine how current resources can be managed to sustain human populations in the long term. To effectively address opportunities and challenges related to water quality and availability and its involvement in food production, teams should be assembled that include experts from natural and social science disciplines. Current practices and policies should support infrastructure improvements to conserve water during distribution to benefit public citizens, food production facilities, and other businesses dependent on water.

A significant challenge that must be overcome if science-based policies are to be developed is the lack of effective communication between scientists, policy makers, and the public. Trust in scientific research is very low among the public. This is caused by many things, including communication with the public being a very low priority for scientists and research institutions such as universities, as well as a lack of scientific literacy among the public and policy makers.

Policy Issues

- Recognize that clean, potable water is a limited and valuable natural resource critical to human health and survival. Support public funding and coordination of a team of experts with diverse scientific and technical expertise to study key issues and suggest both research priorities and

action plans related to water availability (both quantity and quality of water). This policy goal should interface with the policy goal outlined next.

- Create a national outreach and communication effort to improve the public's scientific literacy related to the issues of water, food production, and water-relevant aspects of climate change. Presentation of complex ideas through simple, clear messaging requires a dedicated, funded, and focused effort. This could be achieved through public service announcements designed for the general public as well as through the development of curriculum modules that can be incorporated in K-12 classrooms. These modules could incorporate core curriculum concepts so they meet state educational requirements while using water, food production, and climate change as the subject. Public universities should enhance their efforts to transparently share how research is conducted and published to improve public understanding and trust. All researchers who receive federal funding should be asked to interface with the public about their research either through a written document or a public webinar. These resources could be catalogued and distributed through public libraries, universities, cooperative extension, public television, or other accessible media outlets. Public scientific literacy *must* be enhanced so that, as a nation, we are better able to utilize the historic U.S. investment in science resources and excellence to address problems related to water and food production through unbiased science rather than economic and political motivations.

- Bolster regulations and enforcement to ensure that use of large volumes of water that result in chemical contamination can either be effectively remediated or that alternative strategies be developed to minimize water use. Companies that use large volumes of water should have to register in a manner similar to the 2002 Bioterrorism Act for food production facilities. This may require personnel in the appropriate government agencies to oversee the process including monitoring and enforcement. Penalties should be severe enough to encourage following developed regulations.

- Develop and support conservation steps that lead to sustainable water use. In the U.S., an easy conservation step is the replacement of aging water distribution systems. Funding water infrastructure improvement through state grants or federal matching grants to municipalities should be considered to distribute and use water resources effectively.

- Establish water quality standards for the production of fresh fruits and vegetables based on science generated in-field production environments. To do this, the government would need to establish an acceptable public health risk standard as a benchmark so that researchers could have a standard for risk comparison. In establishing the standard, the impact it would have on fresh produce production should be considered, since production will impact availability and cost, which in turn impacts consumption and human health.

References

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