WATER RESOURCES IMPACT

WATER/ENERGY/FOOD NEXUS: SUSTAINING AGRICULTURAL PRODUCTION

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INTRODUCTION

During the first decade of the 21st Century, the price of oil rose substantially worldwide, inhibiting the ability of energy-importing countries to grow their economies. At the same time, many communities were experiencing water shortages, which increased pressure on a shrinking agricultural community to produce more food on less land with less water and higher input costs. Financial resources that were previously used to invest or reinvest in equipment and on-farm improvements were suddenly diverted to pay for higher fuel costs. Food and energy security are directly related to water security. Food cannot be produced without water, and water cannot be effectively distributed for large scale food production without using energy for pumping and distribution.

The 5th World Water Forum (5th WWF) held in Istanbul, Turkey, in March 2009 concluded that energy prices, food prices, global economic turbulence, and water-related disasters are critically interlinked. This article discusses how energy prices, food prices, and economic security are related to, impact on, and are affected by water. These issues are inextricably linked and their linkage must be sustainable throughout the food production and food consumption chain. This linkage is generally only understood in rural agricultural communities and decision makers from more urban regions must be educated that water resources are among the most important factors that drive the current changes in food security, affecting nations as well as local communities.

FOOD PRODUCTION: COMPETING DEMANDS

People all over the world want everyday access to inexpensive, high quality food. Farmers and other food producers want to support their families, make a living, maintain the productivity of their farm lands, and maintain a sustainable water supply. In addition to these demands, our future as a global community also requires that both food consumers and food producers prioritize the efficient and sustainable use of available energy and water resources.

Americans, like the rest of the world, want to purchase high quality food at a low price. What does this mean for energy and water considerations? Other than smaller specialty-type food from small local farmers' markets, most food consumed in the United States is produced on large-scale domestic and foreign farms. Large scale food production requires significant quantities of fertilizer and significant amounts of energy in order to pump, lift, and distribute water to crops. Large scale food production also means that food is likely transported hundreds or thousands of miles/km from farm to market, requiring significant amounts of fuel for transportation.

WHAT DOES THE FUTURE HOLD?

The population of the planet is estimated to increase by 50% by 2050. If this increase occurs, it means that we will have to produce food for 3 billion additional inhabitants in the next 40 years. More than half of the world's population now lives in cities, and increasing urbanization will likely continue. It is reasonable to project that the demand and prices of natural resources and energy will increase as the planet's inhabitants grow in number, and as food, energy, and water consumption increases.

THE RELATIONSHIP AMONG FOOD/WATER/ENERGY FROM THE FARM PRODUCER'S PERSPECTIVE

Fresh water supplies are critical for food security and for sustaining agricultural communities that are needed to provide food to growng larger and larger cities, and to the continually expanding urban populations.

Water is used to irrigate food and livestock feed crops. Ground water supplies significant amounts of water for crop production, especially in arid regions that do not have access to surface water supplies or in regions that use ground water to supplement surface water sources. Many large-scale farms use center pivot irrigation systems that generally irrigate 122 acres (49 ha) under each pivot (the infamous crop circles). For optimum efficiency these center pivots require a supply of approximately eight gallons per minute (gpm) per acre (30 liters/min) or approximately 1,000 gpm (3,785 liters/min). Center pivot systems need to be operated with a constant water pressure throughout their quarter-mile (402 m) length. Flood irrigation, which is less efficient than center pivot or other irrigation methods, generally requires 25% more water to irrigate the same acreage.

Agricultural producers need inexpensive power to operate well pumps and to distribute irrigation water. Yet, as ground water levels decline and aquifers are mined, pumping costs increase proportional to ground water head declines. In addition, water also is used in energy production, as described below, and add to the competition for water rights.

As national economics become more intertwined in the global marketplace, prices for many fixed products are driven by global supply and demand, and the average farmer has no opportunity to influence market prices

Water also is used to process food. Whether one is cleaning up milking cows or removing soil particles from spinach leaves, our sanitation expectations and laws require significant washing. Depending on the circumstances, water that has been used in washing may no longer be clean enough to discharge into surface waters,

and this water must then be properly treated and managed.

Emerging from the 5th WWF was a recommendation that discussions on food, water, and energy security should include diverse stakeholder interests. Water resource development is not easy, not inexpensive, and not politically facile. To sustain our food, energy, and water security, governments, water users, and the private sector will need to partner together to assume and share the costs, risks, results, and impacts of investment in water. Yet, as the current trend towards large-scale more efficient food production grows, one can expect to see a shrinking agricultural producer population, which will strain stakeholder relationships as there are fewer and fewer people who understand the needs of the agricultural community.

THE COMPETITION FOR WATER BY ENERGY PRODUCERS

Nearly all types of energy production requires water. Coal, natural gas, and nuclear plants all require large quantities of water for cooling. Different types of energy production require less or more water (e.g., water for keeping solar panels clean vs. water used to cool steam turbines that generate electricity).

Food production requires energy. Electricity is needed to manufacture fertilizer. Large irrigation pumps (>800 gpm; 3,785 liters/min) require significant amounts of energy to operate. These pumps can be powered by electric, natural gas/propane, or diesel engines. Water is required in energy production. Also, food transportation from farm to market is not without impact on water (e.g., water is a by-product of oil production).

Recently, corn ethanol and other types of biofuels have been developed for energy generation. With the rise in demand for biofuels there is increased competition for water to grow crops for food and for fuel. While burning ethanol rather than fossil fuels may reduce air pollution, energy production from corn diverts water from food crops and increases demand for corn that then drives up livestock feed prices. The dichotomy facing us is how to balance food, energy, and water self-sufficiency. We need to consider both the "big picture" perspective and the individual farmer's perspective. For example, the costs associated with ground water pumping could decrease with increased efficiencies in the national electric grid.

A PERFECT STORM: FUEL, FEED, AND FERTILIZER

Many agricultural producers, whether crop producers or livestock producers, are market takers, not market makers. That is, food products are priced by markets that the producer does not control. This means that when producer input costs increase, the producer generally cannot increase the cost for his/her product ... unlike other product markets where a producer can adjust a price to cover costs.

In this era of large-scale farms producing the bulk of food in the United States and other food-exporting countries, food is transported at greater and greater distances from farm to market. The cost of long-haul shipping of food, especially produce and other perishables, such as milk, dramatically increased during 2008. In 2008 the price of a barrel of oil reached a then-record high of $140.00/barrel. For farmers, this meant that transportation costs skyrocketed, and at the same time they had no choice but to pay high prices to get their products to market, or face the choice of having to plow under their product. It also meant that prices for fuel to run machinery and irrigation pumps skyrocketed. In addition, farmer paid higher prices for fertilizers.

For livestock producers in particular, the 2008 energy prices created a perfect storm in three sectors: fuel, livestock feed, and fertilizer. Not only were fuel prices and fertilizer prices up, but the costs of producing and hauling feed, such as hay or corn for their livestock, skyrocketed. Livestock producers could not increase their sales price for milk, beef, chicken, or pork to help them absorb the increased input costs because they were stuck with the prices set by markets far from the farms. Dairy producers, especially, were hit hard and many went out of business and tens of thousands of dairy cows were slaughtered.

As national economies become more intertwined in the global marketplace, prices for many food products are driven by global supply and demand, and the average farmer has no opportunity to influence market prices. If input costs for farming exceed output costs, smaller farmers have no option but to shut down. The loss of American farmers and food producers decreases our food security, reduces our available food and livestock feed, and sends additional members of the agricultural community off the farm.

CONCLUSION AND RECOMMENDATIONS

Water is a cross-cutting issue throughout developed and developing countries. Water resources must be developed concurrently for agricultural, municipal, industrial, and other uses as their economic survival is intertwined. In more arid regions there is often fierce competition for water between cities and the agricultural communities that supply food to urban dwellers. Many private entities own or control vast quantities of water rights and water supplies. Recently, local water users in states like New Mexico have developed water banks that allow owners of agricultural water rights to lease water to municipalities and other entities without losing their water or their right to the water. This type of cooperation is necessary for the water/food nexus to be successful. The cross-cutting nature of the water sector must help inform these decision makers in order for them to make more sound choices about how they utilize water in their activities.

Recommendations for Achieving the Goals Established at the 5th WWF

Enhance the Coordination of Water and Energy Policies. Water and energy policies are rarely well coordinated. Increasingly, agencies are taking a boarder approach to the impacts of water on energy policy and vice-a-versa. Far better coordination is required to establish markets and investment conditions and regulatory

mechanisms, which optimize water and energy use and reuse. These water and energy investments by necessity require partnerships between private interests and governmental entities.

Conduct National Water/Energy/Food Sustainability Assessments. Not enough is known about how water, energy, and food are interrelated, and even less is known about how new trends and climate change will impact the use of both resources. It is important to conduct national water and energy resource sustainability assessments, which must consider agriculture and poverty aspects, and to define sustainable water and energy resources at regional, national, and subnational levels.

Create Sustainable Management Approaches Through Stakeholder Input. To sustain the water/energy/food nexus for future generations, discussions need to include private and public producers and consumers, professional associations, business and the private sector, regulators, governments, NGOs, scientists, the academic community, farmers' organizations, and society at large. These competing interests are often at odds over water supplies. Sustainability through conjunctive management of multiple resources is the only way we can keep farms in production and provide water to our cities.

Develop Proper Pricing. Creating the proper pricing structure for food, energy, and water will encourage sustainable use of water and energy. Adaptive governmental policies and a creative and flexible regulatory environment are critical to ensure that the use of both water and energy is sustainable. Adequate pricing promotes the full inclusion of upstream and downstream uses and users. Water and energy sector reform, including cost recovery and improved electrical transmission infrastructure, also fosters private sector investment in the building and maintenance of infrastructure. Stronger regulatory and policy frameworks promote rational allocation of resources and help protect water supplies.

Enable, Incentivize, and Encourage Reuse. Through reuse, we can improve the reliability of water and energy services, reduce the need for wasteful practices, encourage supply and demand-side management approaches for conservation, and promote cleaner and more efficient production practices. Water reuse for food production and energy production should be a priority for governments and their water agencies.

Improve Education About the Water/Energy/Food Nexus. There is too little thought about and planning for the water/energy/food nexus in most parts of the world, especially in rapidly developing regions. With rapidly fluctuating energy costs, instantaneous decisions have to be made about how to distribute power, and operations of the water and energy sectors must be interconnected. It is therefore important to develop a comprehensive understanding of the water/energy nexus at the local, national, regional, and international levels. Water and energy actions take place at the global level all the way down to individual communities where water and energy choices take place on the ground. Wide participation from water/energy/food producing entities and consumers of these commodities is necessary from all sectors. We need to create analytical systems that integrate water resource planning at the basin scale, and energy resources at the grid scale that include special consideration of the cross-cutting implications of various resource management choices on the food/water/energy nexus.

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