Understanding the Links between Agriculture and Health

Agriculture, Malaria, and Water-Associated Diseases

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2020 VISION FOR FOOD, AGRICULTURE, AND THE ENVIRONMENT

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Malaria, schistosomiasis (bilharzia), and Japanese encephalitis are the major vector-borne diseases whose increase or decrease can be attributed to agricultural water development (see table). Others include dengue fever, yellow fever, and filariasis. Young children in poor communities are particularly affected: malaria is among the top five causes of death among under-fives in Sub-Saharan Africa; schistosomiasis among children affects growth, nutritional status, and cognitive development; and encephalitis occurs mainly in young children.

LINKAGES BETWEEN AGRICULTURAL WATER RESOURCE DEVELOPMENT AND DISEASE

The development of agricultural water resources affects the environment, which in turn affects human health. Agricultural water projects can create the conditions suitable for parasitic vectors and thus facilitate the spread of water-associated, vector-borne diseases (see table). Data on changes in disease prevalence due to agricultural and water development in the South is far from comprehensive, but there are some concrete examples.

Malaria. Following irrigation, the number of mosquitoes usually increases, and this increase sometimes leads to a rise in malaria prevalence. In Burundi malaria parasite prevalence was estimated at between 24 and 69 percent in irrigated rice fields compared with 5–30 percent in nearby nonirrigated cotton-growing areas. Similarly, the prevalence of malaria in the Hola cotton and vegetable irrigation scheme in Kenya has been reported to be 54 percent higher than in surrounding, nonirrigated areas, resulting from an increased number of mosquito breeding sites.

Yet, paradoxically, increased mosquito numbers do not necessarily result in increased prevalence of malaria. In Tanzania improved socioeconomic status due to rice growing has been found to lead to reduced malaria prevalence, in spite of increased mosquito populations among villages adjacent to flooded rice fields. Unlike farmers in nearby nonirrigated settings, farmers in the irrigated villages can afford self-protection measures such as insecticide-treated nets, and they also seek treatment. Studies in a rice-irrigation scheme in Kenya have also shown that malaria prevalence is lower in irrigated villages, in this case apparently because the predominant mosquito species preferred to feed on cattle rather than on people.

Schistosomiasis. Through dam building, this disease has been introduced into populations previously completely unexposed. For example, in the Hola settlement scheme in Kenya, there were no snail vectors of schistosomiasis before irrigation began in 1956. A decade later, the prevalence of urinary schistosomiasis among Pokomo schoolchildren was 70 percent, rising to 90 percent by 1982. After the building of Senegal's Diama Dam in 1986 and expansion of the population without accompanying sanitation, virtually the whole population upstream of the dam along the Senegal River had become infected by 1994. Before the dam was built, the area had never experienced the intestinal form of the disease.

Japanese encephalitis. Agricultural development projects in Sri Lanka illustrate the agricultural links to this disease. For example, the Mahaweli rice development project provided breeding sites for the mosquito vector, while a separate development project nearby encouraged pig production (pigs are the reservoir hosts of the Japanese encephalitis virus). The resultant epidemics seriously disrupted the newly settled communities. The 2005 outbreak of Japanese encephalitis in north India affected more than 1,000 people—mostly children—living close to rice fields and piggeries.

Concurrently, the presence of malaria and other water-associated, vector-borne diseases in agricultural communities has negative impacts on agricultural productivity. For example, a study of intensive vegetable farming in Côte d'Ivoire between 1999 and 2002 found that malaria led to increases in work absenteeism, which resulted in lower yields and family income.

AGRICULTURAL CONTROL MEASURES

Agricultural interventions are available to control the spread of water-associated, vector-borne diseases. Available techniques include filling and draining small water bodies, environmental modifications, and alternate wetting and drying of rice fields (see table). Intermittent irrigation in African rice fields has been shown to significantly reduce the density of malaria vectors by curtailing their larval development, while still maintaining yields, saving water, and reducing methane emissions. Similar results have also been found in China.

Control measures are context specific. For example, where cattle are present, they can naturally divert malaria mosquitoes away from

Major Water-Related, Vector-Borne Diseases and Their Links to Agricultural Development

DISEASE/PREVALENCE	LINK WITH AGRICULTURAL WATER RESOURCES
Malaria World's most important parasitic infectious disease; over 2 billion people at risk; between 300 and 500 million episodes and over 1 million deaths annually; over 90% of malaria burden in Sub-Saharan Africa; also a major problem in Brazil, Colombia, India, Solomon Islands, Sri Lanka, and Viet Nam.	Transmitted by Anopheles mosquitoes that breed in fresh or occasionally brackish water; transmission intensity and disease distribution are exacerbated by water resources development; agricultural control measures include filling and draining small water bodies to reduce mosquito breeding sites.
Schistosomiasis Second most important water-related parasitic infection for public health and economic impact; at least 779 million people are at risk; 207 million are infected; between 50,00 and 100,000 deaths annually; 80% of the infected people live in Sub-Saharan Africa.	Transmitted by free-swimming larvae of *Schistosoma* (flatworm); disease transmission and outbreaks significantly increased by water resources development; agricultural control measures include environmental modifications (e.g., lining of canals) that prevent snail vectors and limit human-water contact.
Japanese encephalitis Viral disease; 1.9 billion people are at risk and 50,000 clinically infected; case fatality as high as 60%, but deaths vary significantly between years (15,000 deaths in 2001); occurs mainly in Asia and the islands of Western Pacific.	Transmitted to humans and animals by *Culex* mosquitoes, which often breed in flooded rice fields; the disease circulates in birds, and pigs are amplifying hosts; disease distribution significantly linked to irrigated rice production combined with pig rearing; agricultural water management measures include alternate wetting and drying of rice fields to reduce vector populations.

people (since cattle do not become infected). If cattle are topically treated with an appropriate insecticide such as those used to control tsetse flies, they could also serve as lethal blood-meal baits for hungry mosquitoes, thereby reducing the malaria problem.

CHALLENGES

Addressing the adverse impact of agricultural water projects on both health and the environment is a challenge. Communities as well as the agricultural and water sectors tend to focus on economic benefits, paying inadequate attention to assessing public health and environmental impact. Water projects tend to be planned and managed in isolation from other aspects of development at the local, district, and even national level. Moreover, the successful implementation of measures to minimize such impacts is constrained by paucity of information, technical reasons, and limitations in human, financial, and institutional capacity.

An intersectoral approach is clearly needed. Yet bringing together researchers or practitioners from different sectors remains a daunting task. For example, the International Water Management Institute has brought together experts from the agricultural and health sectors to work on malaria, but its experience has shown that researchers are often conditioned to work in a compartmentalized manner based on the academic disciplines that formed their early university education. Innovative ways of facilitating interdisciplinary approaches to environment and health are needed. In many developing countries, however, the requisite professionals are unavailable or not effective in promoting the intersectoral collaboration and coordination necessary for successful environmental and health planning and management.

RECOMMENDATIONS

The following recommendations are a pragmatic attempt to address these challenges. Given the association between health and environmental impacts, they should be considered together in agricultural water-development planning and management.

Assessment. Strategic environmental assessments (SEAs) should be used as a planning tool for agricultural water development both at the national level and for major international river basins. These SEAs should integrate environmental, health, and social concerns and attempt to reconcile development, environmental protection, and community rights. Health-impact assessments (HIAs) are another potential tool. Capacity must be built to conduct such assessments. Drawing on lessons from countries with practical experience of implementation, all countries without compulsory health and environmental impact assessment processes should enact laws that make these mandatory for large infrastructure projects, including large irrigation projects. Institutional arrangements should be strengthened, such as by establishing environmental health units within government ministries responsible for irrigation.

Compliance. Many irrigation project operators fail to fulfill voluntary and mandatory obligations, and civil society and governments fail to enforce compliance. Therefore, once rules and regulations are in place, innovative approaches are needed to ensure compliance with health and environmental requirements. Improving compliance requires incentives as well as sanctions.

Awareness. Governments and donor agencies should develop strategic approaches that build local-level awareness of the environmental health issues associated with agricultural water development. Specifically, they should support health-awareness campaigns carried out by community health teams and training programs that increase awareness by working in collaboration with community groups (such as farmers' associations, agricultural water user associations, and women's groups). Information on maximizing health benefits, understanding potential hazards, and ameliorating potential negative impacts should be provided.

INITIATIVES TO ADDRESS THE LINKAGES

Initiatives to increase the technical know-how, capacity, and research necessary to adopt these recommendations have been developed. The WHO has a program to assist countries in building capacity to include health considerations in water development projects. The Consultative Group on International Agricultural Research (CGIAR) is building research and capacity through its Systemwide Initiative on Malaria and Agriculture (SIMA), a network of partners studying the relationship between malaria and a range of farming systems in seven African countries. The initiative is also building capacity into curricula at selected African universities.

CONCLUSION

Water development projects bring important benefits locally and globally. Yet it is often assumed that irrigation will bring health benefits to all, regardless of their socioeconomic standing within a community. In reality, the economic and social impacts of irrigation are diverse and widespread, and neither costs nor benefits are evenly distributed among community members. In Sub-Saharan Africa, as elsewhere in the world, there is increasing recognition of the need to reduce the negative impacts of agricultural development on ecosystems and peoples' health. Unless well-targeted interventions are made, the most vulnerable—notably poor children and their mothers—will continue to benefit least from the promise of irrigation and suffer most from the adverse health impacts. ■

For further reading see "Malaria and Agriculture" (special issue), *Acta Tropica* 89 (2004): 95–259; J. N. Ijumba and S. W. Lindsay, "Impact of Irrigation on Malaria in Africa: Paddies Paradox," *Medical and Veterinary Entomology* 15 (2001): 1–11; J. Keiser, J. Utzinger, and B. Singer, "The Potential of Intermittent Irrigation for Increasing Rice Yields, Lowering Water Consumption, Reducing Methane Emissions, and Controlling Malaria in African Rice Fields," *Journal of the American Mosquito Control Association* 18 (2002): 329–340; C. M. Mutero, F. Amerasinghe, E. Boelee, F. Konradsen, W. van der Hoek, T. Nevondo, and F. Rijsberman, "Systemwide Initiative on Malaria and Agriculture: An Innovative Framework for Research and Capacity Building," *EcoHealth* 2 (2005): 11–16; WHO, Water Sanitation and Health (WSH), <http://www.who.int/water_sanitation_health/en/>, 2005.

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