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2020 FOCUS 13

Understanding the Links between Agriculture and Health

EDITED BY
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AND THE ENVIRONMENT

Introduction

Policymaking initiatives in agriculture and public health are often pursued in a parallel and unconnected fashion. Yet coherent, joint action in agriculture and health could have large potential benefits and substantially reduce risks for the poor. Among development professionals there is growing recognition that agriculture influences health, and health influences agriculture, and that both in turn have profound implications for poverty reduction. This recognition suggests that opportunities exist for agriculture to contribute to better health, and for health to contribute to agricultural productivity. To take advantage of these opportunities, however, it is crucial to understand the precise linkages between the two sectors. How do the linkages work? Where do opportunities for joint action lie, and what are the impediments? How can the agricultural and health sectors work together more closely and thereby contribute to addressing poverty?

To help increase the synergies, IFPRI and its sister centers in the Consultative Group on International Agricultural Research (CGIAR) have begun an initiative on agriculture and health. Part of this initiative is promoting better coordination of health-related research among CGIAR centers and various partners in the health sector. The linkages between agriculture and health are dynamic and complex, and working across sectors presents significant institutional challenges.

The policy briefs presented here draw on a wide body of research conducted within and outside the CGIAR. They provide a historical context to the links between agriculture and health, deal with specific health conditions and agricultural systems, and examine the challenges to linking agriculture and health in policy.

We are grateful to editors Corinna Hawkes and Marie Ruel, as well as to the contributors, for their valuable insights on the multiple, bidirectional linkages between agriculture and health.

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Head, 2020 Vision Initiative

The **International Food Policy Research Institute** (IFPRI) is one of several international research centers supported by the Consultative Group on International Agricultural Research (CGIAR). "**A 2020 Vision for Food, Agriculture, and the Environment**" is an initiative of IFPRI® to develop a shared vision and consensus for action on how to meet future world food needs while reducing poverty and protecting the environment. This set of Focus briefs presents technical research results that encompass a wide range of subjects drawn from research on policy-relevant aspects of agriculture, poverty, nutrition, and the environment. It contains materials that IFPRI believes are of key interest to those involved in addressing emerging food and development problems. The 2020 Vision Initiative gratefully acknowledges support from the following donors: Canadian International Development Agency; Danish International Development Agency (DANIDA); and Swedish International Development Cooperation Agency (SIDA).

UNDERSTANDING THE LINKS BETWEEN AGRICULTURE AND HEALTH

Overview

CORINNA HAWKES AND MARIE T. RUEL

2020 VISION FOR FOOD, AGRICULTURE, AND THE ENVIRONMENT

FOCUS 13 • BRIEF 1 OF 16 • MAY 2006

LINKING AGRICULTURE AND HEALTH FOR POVERTY REDUCTION

Good health and productive agriculture are both essential in the fight against poverty. In a rapidly changing world, agriculture faces many challenges, both old (natural resource constraints, extreme weather conditions, and agricultural pests) and new (globalization, environmental degradation, problems of maintaining production in conflict situations). At the same time, new global health threats emerge, such as HIV/AIDS, SARS, and avian influenza, while old ones persist. Not only do malaria, tuberculosis, diarrheal diseases, respiratory infection, and malnutrition continue to take a heavy toll, but the health sector is faced with increasing problems of chronic disease, drug and insecticide resistance, and a diminishing arsenal of effective interventions. And as the world becomes more integrated, so do the agricultural and health problems the world faces.

The interactions between agriculture and health are two-way: agriculture affects health, and health affects agriculture. The process of agricultural production and the outputs it generates can contribute to both good and poor health, among producers as well as the wider population. Agriculture is fundamental for good health through the production of the world's food, fiber and materials for shelter, and in some systems, medicinal plants. Yet agriculture is associated with many of the world's major health problems, including undernutrition, malaria, HIV/AIDS, foodborne diseases, diet-related chronic diseases, and a range of occupational health hazards. Agriculture can contribute to both the spread and alleviation of these health conditions.

In the other direction, the occurrence of these health conditions has tremendous implications for agriculture. In the general population, the prevalence of malnutrition and disease influences market demand for agricultural products. In the agricultural population, workers in poor health are less able to work, a situation that cuts productivity and income, perpetuates a downward spiral into ill health and poverty, and further jeopardizes food security and economic development for the wider population.

The time is ripe for the agricultural and health sectors to work more closely together to develop innovative solutions to help solve their own problems—and each other's—and contribute to the overarching goal of addressing poverty. The two-way linkages between agriculture and health pose an opportunity for the two sectors to work together to transform the vicious cycle of negative health-agriculture feedbacks into a more virtuous cycle of self-reinforcing primary prevention of health and agricultural problems.

A CONCEPTUAL FRAMEWORK OF THE LINKAGES BETWEEN AGRICULTURE AND HEALTH

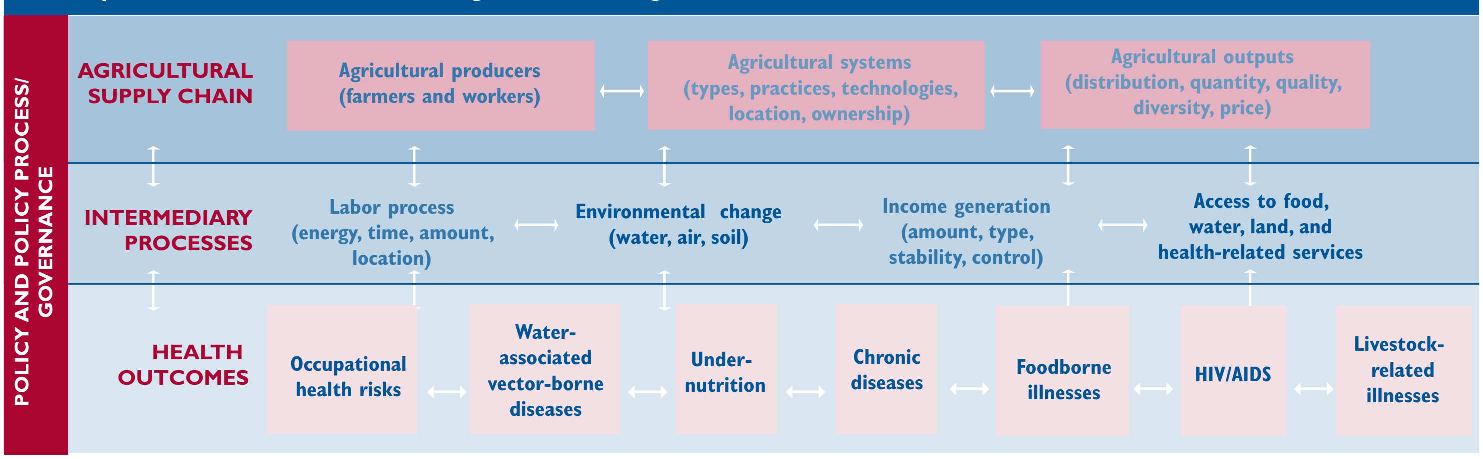
Agriculture and health interact through people, the natural environment, and food and other outputs: poor agricultural producers and their families are particularly vulnerable to malnutrition and disease; agricultural systems interact with the environment, in turn affecting human health; and agriculture produces foods, fibers, and plants with medicinal properties essential for human life, health, and culture. These components—agricultural producers, systems, and outputs—interact with one another and present pivotal "nodes" where greater synergies with good health could be achieved.

The figure shows a framework for linkages between agriculture and health. Across the top are the core nodes in the agricultural supply chain: agricultural producers, agricultural systems, and agricultural outputs. At the bottom are some of the most important health problems affecting the poor in developing countries: undernutrition, malaria and other water-associated vector-borne diseases, HIV/AIDS, foodborne diseases, diet-related chronic diseases, and a range of occupational health hazards. In the middle are the most critical intermediary processes linking agriculture and health in both directions: the labor process, environmental change, income generation, and access to food, water, land, and health-related services. As shown on the left side of the figure, these interactions are all influenced by policies, policy processes, and governance.

Node 1: Agricultural Producers

Agriculture Affects Health. Being an agricultural producer is a determinant of health, in large part through intermediary processes related to income and labor. Agriculture affects the income earned by people who make their living from the land. The amount, type, stability, and control of producers' income influence their ability to purchase and access food, water, land, and health-related services. The labor supplied by agricultural producers affects energy expenditure and time available for child care, food preparation, and other nutri-

Conceptual Framework of the Linkages between Agriculture and Health



tion-related activities. Labor also exposes producers to a range of occupational health hazards, including accidents, diseases, and poisoning. Finally, employment opportunities influence migration and the search for alternative income sources, with implications for the spread of and exposure to disease, such as HIV/AIDS.

Health Affects Agriculture. If malnutrition and poor health are prevalent among agricultural producers, agriculture is negatively affected. Illness among members of households involved with agriculture imposes significant health costs, leads to absenteeism, reduces the ability of households to earn income, and results in losses in the local and national economy. The problem is graphically illustrated by the case of HIV/AIDS. Studies show clearly that communities with the disease experience cash and labor shortages and tend to switch crop types, reducing crop area and livestock use and thus reducing productivity. HIV/AIDS is also associated with loss of farm-specific knowledge and reduced institutional capacity in the agricultural sector.

Node 2: Agricultural Systems

Agriculture Affects Health. Agricultural systems vary enormously in the types of products produced, the methods used, their location, and the system of ownership. Agricultural systems thus affect health in a variety of ways, often through interaction with agricultural producers and outputs.

The influence of agricultural systems is most noteworthy via the intermediary process of environmental changes in water, soil, and air. Examples include the environmental and human health effects of livestock production and aquaculture and the human health impacts of agriculture-related climate change. A notable case is the link between irrigated agricultural systems and water-associated vector-borne diseases (such as malaria). Irrigation alters the environment by creating conditions suitable for parasitic vectors, which then spread disease among producers and the wider population. This example shows the importance of assessing the impacts of the full range of linkages in a coordinated manner. Vector-borne disease among producers has feedback effects on productivity, but the adoption of irrigation can also boost incomes, thus increasing the ability of producers to purchase preventive or curative health-related services. It also boosts agricultural outputs, with subsequent implications for food security and nutrition among the wider population.

Health Affects Agriculture. Health can affect agricultural systems by affecting the health of producers. Poor health reduces producers' ability to innovate, experiment with different farming practices, and capitalize on farm-specific knowledge. Ill health is a major reason why young people leave rural areas, depriving farm activities of needed innovators. Healthier producers, in contrast, are more productive and able to partake in—and drive—the development of agricultural systems.

Node 3: Agricultural Outputs

Agriculture Affects Health. Agricultural outputs affect the health of the population at large. Agriculture produces food in different quantities, at different levels of diversity, of variable quality and price, and subject to differing methods of distribution. These all affect nutrition—undernutrition and overnutrition—along with foodborne illnesses.

With regard to undernutrition, high quantities of agricultural outputs can increase food availability and lower prices, thus affecting access to food. The quality and diversity of food outputs influence access to micronutrients and dietary diversity. Whether food is distributed for household, local, or export consumption affects undernutrition through a combination of the intermediary processes of access to food, income generation, and the labor process. Agricultural outputs are also linked with overnutrition and diet-related chronic diseases. Significant increases in the production of vegetable oils, sweeteners, and other foods have altered quantity and prices, thus influencing access to these foods.

Foodborne illnesses arise in part from microbiological and chemical hazards introduced in agricultural systems. On the positive side, this means that agricultural practices can be adapted to help prevent foodborne illness. Agriculture can also produce medicinal plants that help treat diseases, thereby increasing access to health-related services and products.

Health Affects Agriculture. The prevalence of undernutrition, overnutrition, and disease affects the demand for food quantity, quality, and diversity, and the price people are able or willing to pay. These factors in turn affect agricultural systems and producers positively and negatively. Even if a health condition is not present, the risk of ill health creates or reduces demand for outputs with specific qualities, influencing systems and producers. For example, concerns about foodborne illness in developed countries create demand for foods adhering to strict safety standards, with consequences for agricultural producers.

THE PROMISE OF CLOSER INTEGRATION BETWEEN AGRICULTURE AND HEALTH

The briefs in this series aim to communicate what is known about the linkages between agriculture and health in science and policy, thereby stimulating interest in and dialogue on agriculture and health. With a focus on the poor in developing countries, the briefs deal with the relationship between agricultural producers, systems, and outputs and the world's leading causes of death and disease. They examine the various trade-offs involved and set out some of the approaches needed to create improved synergies between the agricultural and health sectors.

Currently, the health and agricultural sectors remain disjointed: health considerations play little part in decisions farmers make about production, or agricultural ministries make about policy. Likewise, the health sector often fails to reach out to the agricultural sector. The division undermines efforts to improve the livelihoods of agricultural producers and gives short shrift to agriculture's role in solving many of the world's most serious health problems.

Yet, as the briefs show, the linkages between agriculture and health present an opportunity for the two sectors to work together to find solutions to each other's problems. There is real potential for effective agricultural interventions—backed up by good policy—to promote health, and for the health sector to take actions leading to greater agricultural productivity and demand for agricultural outputs, thus increasing national and local capacity to promote good health. ■

For further reading see "Agriculture and Health Linkages: Towards Improved Co-ordination," a workshop held at IFPRI, Washington, DC, June 23–24, 2005, <http://www.ifpri.org/events/seminars/2005/20050623AgHealth.htm>; J. Lebel, *Health: An Ecosystem Approach* (Ottawa: International Development Research Centre, 2003); M. Lipton and E. De Kadt, *Agriculture-Health Linkages* (Geneva: World Health Organization, 1988); and K. Lock, "Integrating Public Health with European Food and Agricultural Policy," *Eurohealth* Special Issue 10, no. 1 (2004).

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Understanding the Links between Agriculture and Health

Agriculture, Food, and Health: Perspectives on a Long Relationship

Tim Lang

2020 VISION FOR FOOD, AGRICULTURE, AND THE ENVIRONMENT

Focus 13 • Brief 2 of 16 • May 2006

Agriculture produces food fundamental for human health. It therefore seems obvious that agriculture, food, and health are related! Agriculture affects whether people have enough food to eat, whether it is of sufficient nutritional value, and whether it is safe, all of which affect human health. But it is not so simple: history has taught that there are different ways of looking at the relationships between agriculture, food, and health. Agricultural connections to food and health are mediated by the natural environment, human culture, and technological change. The challenge today of how to achieve equitable food production that delivers optimum nutrition for health requires an ever better understanding of the interplay between agriculture and environment, culture, and technical capacity, and how it has changed over time.

AGRICULTURE AND FOOD REVOLUTIONS

There have been a number of waves of change in food supply. Arguably, the most significant was the gradual process of developing settled agriculture. Around 10,000 years ago, rather than going out for food and relying on what was there, humans began to produce food near to where they lived. This Neolithic Revolution emerged from a process of experimentation with seed planting, the domestication of livestock, and the development of tools over preceding millennia.

The development of agriculture had a direct impact on food consumption and health. In the region with the first certain evidence of subsistence agriculture—the Fertile Crescent stretching from present-day southern Turkey to Iraq—wheat, barley, peas, lentils, vetch, and flax were developed. These crops altered what people ate and their capacity to override exigencies of climate and circumstance. Other crops developed in Africa, the Americas, Asia, and Europe, changing diets and advancing health.

Subsequent technical advances in farming consolidated the first great transition from hunter-gathering to domestic food production, enabling both a cultural transition from social systems based upon family structures (tribe/clan) to towns and villages and a dietary transition from local food to a different range of foods traded beyond local bioregions. Further revolutions in biology, society, and technology changed what people ate; what was grown; how it was grown, processed, and transported; and where, why, and how it was cooked and consumed. The table maps some of these changes and their impacts on farming and food-related health.

Animals, plants, foods, and culinary tastes were spread around the globe through trade, invasions and wars, and cultural exchange. The pace of change became more rapid over time, particularly once transportation developed, with implications for environment and health. The spread of beans from China to Europe at the end of the first millennium CE, for example, simultaneously improved soil fertility (environment) and allowed humans to store highly nutritious food over the winter, thereby reducing the impact of the hungry months of spring (health).

CHANGING POLICY FRAMEWORKS LINKING AGRICULTURE, FOOD, AND HEALTH

Although landownership has been politically delicate in all societies since time immemorial, systematic and formal policies on agriculture are comparatively recent, often driven by industrialization's need to ensure security of supply. Only in the past two centuries has farming been subject to either local or national government policy frameworks, and only in the 20th century did cross-border policy frameworks emerge. The Food and Agriculture Organization of the United Nations (FAO) and the World Health Organization (WHO) were created mid-century, and in 1994 the first binding agreement on agriculture was created under the auspices of the General Agreement on Tariffs and Trade (GATT), which created the World Trade Organization (WTO).

Since the mid-20th century, agricultural policy has been dominated by a paradigm centered on maximizing production. The FAO and regional and national governments have focused on increasing agricultural production capacity, through agricultural subsidies, for example, as well as through technical and scientific aids to efficiency such as plant breeding. For much of this period, nation-states assumed responsibility for controlling the food supply and the institutions that affect it. But by the mid-1970s, this statist orthodoxy was in decline and market mechanisms were in policy ascendancy. The GATT, the WTO, and regional and bilateral trade agreements created frameworks for market-oriented agricultural policies, such as privatization of domestic agricultural markets and liberalization of international trade, to enable, in theory, agricultural production to become more responsive to market conditions.

What role has food-related heath played in these policy frameworks? In practice, consideration of food and health has been limited in agricultural policy, with macroeconomic concerns in the policy driving seat. Food and health were incorporated only insofar as it was assumed that increased output and greater economic growth would lead to less malnutrition and gains for health. But negotiations and both public and corporate policy generally have not paid nutrition due consideration and are now criticized for failing to resolve food insecurity and exacerbating overnutrition by giving primacy to cheapening food and encouraging a consumerist perspective.

In 1963 the FAO and WHO set up an international standard-setting body for food—the Codex Alimentarius Commission—whose mandate includes the protection of consumer health. But even here the conception of food-related health is rather narrow, focusing more on food safety than on nutrition or health-driven dietary change. The persistence of food safety problems in the developing world and their re-emergence in rich countries, too—despite Codex—brought back some measured recognition that government involvement in setting food standards can be valuable and that a public dimension to markets is desirable.

IMPACT ON FOOD-RELATED HEALTH

The waves of change in agricultural policy and practice have increased the world's capacity to feed its people through increased output, more types of food, and less dependency on seasonality. Food prices have tended to fall with rises in productivity, thereby in theory enhancing food affordability and leaving consumers with surplus income to spend on other improvements in living standards.

A major downside has been that modern, intensive agriculture has literally mined the environment (see Brief 14). Moreover, food insecurity and malnutrition persist. The FAO estimates that in 2000–2002, 852 million people were undernourished. From the 1970s, studies showed that even in countries with overall adequate food availability, unequal distribution meant that particular areas and households still experienced food insecurity. Technical gains in food

Agricultural and Food Revolutions and Their Implications for Food-related Health

ERA/REVOLUTION	DATE	CHANGES IN FARMING	IMPLICATIONS FOR FOOD-RELATED HEALTH
Settled agriculture	From 8500 BCE on	Decline of hunter-gathering; greater control over food supply but new skills needed	Risks of crop failures dependent on local conditions and cultivation and storage skills; diet entirely local and subject to self-reliance; food safety subject to herbal skills
Iron age	5000–6000 BCE	Tougher implements (plows, saws)	New techniques for preparing food for domestic consumption (pots and pans); food still overwhelmingly local, but trade in some preservable foods (e.g., oil, spices)
Feudal and peasant agriculture in some regions	Variable, by region/continent	Common land parceled up by private landowners; use of animals as motive power; marginalization of nomadism	Food insecurity subject to climate, wars, location; peasant uprisings against oppression and hunger
Industrial and agricultural revolution in Europe and U.S.	Mid-18th century	Land enclosure; rotation systems; rural labor leaves for towns; emergence of mechanization	Transport and energy revolutions dramatically raise output and spread foods; improved range of foods available to more people; emergence of commodity trading on significant scale; emergence of industrial working-class diets
Chemical revolution	From 19th century on	Fertilizers; pesticides; emergence of fortified foods	Significant increases in food production; beginning of modern nutrition; identification of importance of protein; beginnings of modern food legislation affecting trade; opportunities for systematic adulteration grow; scandals over food safety result
Mendelian genetics	1860s; applied in early 20th century	Plant breeding gives new varieties with "hybrid vigor"	Plant availability extends beyond original "Vavilov" area; increased potential for variety in the diet increases chances of diet providing all essential nutrients for a healthy life
The oil era	Mid-20th century	Animal traction replaced by tractors; spread of intensive farming techniques; emergence of large-scale food processors and supermarkets	Less land used to grow feed for animals as motive power; excess calorie intakes lead to diet-related chronic diseases; discovery of vitamins stresses importance of micronutrients; increase in food trade gives wider food choice
Green Revolution in developing countries	1960s and after	Plant breeding programs on key regional crops to raise yields; more commercialized agriculture	Transition from underproduction to global surplus with continued maldistribution; overconsumption continues to rise
Modern livestock revolution	1980s and after	Growth of meat consumption creates "pull" in agriculture; increased use of cereals to produce meat	Rise in meat consumption; global evidence of simultaneous under-, over-, and malconsumption
Biotechnology	End of 20th century	New generation of industrial crops; emergence of "biological era": crop protection, genetic modification	Uncertain as yet; debates about safety and human health impacts and whether biotechnology will deliver food security gains to whole populations; investment in technical solutions to degenerative diseases (e.g., nutrigenomics)

production clearly do not resolve problems of hunger or food security on their own.

Food safety problems remain, too. According to the WHO, each year 1.8 million people, mostly children, die from diarrheal diseases, mostly transmitted through food and water. Inadequate support has been given to developing countries to control this problem. And in the 1980s changes in agricultural and food systems led to the growth of new food safety problems in both rich and developing economies, such as the rise of *Campylobacter* (see Briefs 5 and 9). Contamination of foods with pesticide residues is another unintended consequence of changes in agricultural practices. Ironically, food for export may achieve higher standards than food for home markets, suggesting that dual frameworks operate.

Technical advances in agriculture have also led to changes in the sources of nutrients, which have some downsides for health (see Brief 4). Improved dairy efficiency can mean raised output of undesirable fats. More calories are now derived from fat, too much of which consists of saturated fats or trans-fatty acids. There are declines in intakes of fiber and whole grain cereals and increases in added sugars, notably from soft drinks. This pattern of dietary and nutrition transition appears to be consistent as classic peasant societies become more urbanized, richer, and more aspirational. Disease patterns alter as a result, with more obesity and chronic diseases such as cardiovascular disease, some types of cancers (bowel, breast), and diabetes.

THE FUTURE

Agricultural policy today operates in a complex world where food insecurity coexists with overconsumption and where a highly technological food supply sits alongside unsafe food, even within the same societies. How will the relationship between agriculture, food, and health develop in the future? Two broad paradigms appear to be emerging. One is based on applying and integrating the life sciences to deliver another round of technical change to improve nutrition and food safety, for example, through biotechnology, proteomics, and nutrigenomics. The other centers on ecological management of food systems, through more local, "sustainable" approaches. These paradigms differ in how they conceive of tackling food-related ill health in relation to environmental and other societal food challenges. It is not certain which view will triumph, but there is growing recognition among all stakeholders that:

- current institutions do not yet adequately link policy demands across levels of governance: global, regional, national, and local;
- the coincidence of over-, under-, and malconsumption within societies is likely to remain and possibly grow, particularly if current global economic trends continue;
- nutrition will have to play a more direct part in framing farm policy and practice;
- agriculture will face renewed pressure to deliver, via sustainable methods, not just more food, but better-quality and health-enhancing foods; and
- market mechanisms need a stronger push to link health, environment, and food systems in ways that are equitable, both within and between nations, while prioritizing public health. ■

For further reading see J. Diamond, *Guns, Germs, and Steel: A Short History of Everybody for the Last 13,000 Years* (London: Chatto and Windus, 1997); FAO, *State of Food Insecurity in the World* (Rome, 2004 [new edition each year: http://www.fao.org/sofi/sofi/index_en.htm]); T. Lang and M. Heasman, *Food Wars: The Global Battle for Mouths, Minds, and Markets* (London: Earthscan, 2004); A. M. McMichael, *Human Frontiers, Environment, and Disease* (Cambridge: Cambridge University Press, 2001); and V. Smil, *Feeding the World: A Challenge for the Twenty-first Century* (Cambridge, MA: MIT Press, 2000).

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Agricultural Technology and Health

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2020 VISION FOR FOOD, AGRICULTURE, AND THE ENVIRONMENT

FOCUS 13 • BRIEF 3 OF 16 • MAY 2006

Agrotechnical progress comprises *research* by farmers and public and private providers; *invention*, discovery or development of a technique; and *adoption*, from innovation by early users to diffusion by learning or extension. It includes everything from the development of basic agricultural tools to biotechnology.

Agrotechnical progress has repeatedly driven revolutions in food production and transformed human development, from the Neolithic settlement, as former hunter-gatherers became farmers, to the Green Revolution in Asia, which brought unprecedented rises in food production (see Brief 2). Only since about 1750, however, has agrotechnical change been a main engine of steady human development, and only since the 1950s has it been deliberately harnessed toward such ends. Indeed, the irrigation and biochemical revolutions of the 1960s and 1970s, with all their imperfections, have led the world's greatest and fastest advance in human development.

THE TWO-WAY LINKS BETWEEN AGROTECHNOLOGY AND HEALTH

Research, invention, and adoption of agrotechnology have played an important role in improving human nutrition and health. Agrotechnology has introduced more effective plant breeds (such as high-yielding varieties), enhanced land management techniques (such as terracing), and improved water management tools (such as irrigation). The adoption of these techniques has benefited nutrition, largely through boosting crop productivity, thereby providing employment and income to rural populations and increasing local and global food supplies.

Pro-poor agrotechnology produces results suitable for low-risk, profitable adoption in conditions faced by many smaller and more asset-deprived farms. Such technology offers long-term benefits to the poor by increasing labor demand, lowering risks, enhancing access to cheap, reliable sources of energy and micronutrients, improving water use efficiency, and helping poor rural communities to acquire key assets. Normally, such economic gains carry clear health benefits. For example, cheaper and less variable micronutrients mean better immune function in times of higher disease incidence or work stress. More assets provide collateral, so poor households can borrow to meet sudden health costs or food price rises. Better water use efficiency reduces the scarcity and distance of essential drinking water. Increased labor demand improves health by raising hungry workers' income and thus their command over food. Policy choices may be needed, however, to minimize harmful side effects on health.

Just as agrotechnology can benefit health, good health can accelerate agrotechnical progress. Research and invention of agrotechnologies cannot benefit health unless farmers adopt them, and healthy farmers are likelier to seek out, afford, find, and try new technology.

AGROTECHNOLOGICAL HEALTH RISKS

Health gains from improved farm production and employment through improved income, nutrition, shelter, and access to water far outweigh negative health effects. But certain agrotechnologies can endanger health by affecting the natural environment, and the type and form of labor needed for agricultural production. These impacts should be anticipated (and health and agriculture policies coordinated) in order to identify effective ways of monitoring them, reducing the hazards, and developing treatments.

Tools and mechanization. Physical injury in farmwork is a threat to agricultural productivity and worker health (see Brief 8). The risks and effects differ depending on the technology used. A study in Bangladesh showed that 80 percent of female users of modern threshing technology suffered pain in their waist and legs for a few hours after threshing, but 20 percent of the farmers said that traditional threshing technologies had caused similar problems. Overall, investment in the new technology was felt to be worthwhile since it made the job easier.

Most physical injury incurred in agriculture is preventable. It is largely ignored, but probably causes more death, pain, and work loss (with much less offsetting output benefit) than agrochemicals and water resources development put together.

Water resources development. For families living near irrigation projects, this more convenient water source may reduce disease through cleaner water or greater availability, facilitating better hygiene. But if the irrigation water is contaminated, drinking it can spread infectious diseases such as cholera and lead to chemical poisoning through surface or groundwater transfer of agricultural and industrial chemicals. Stagnant water is also a breeding ground for disease vectors, especially mosquitoes (see Brief 6).

Use of agrochemicals. Pesticide use in crop cultivation is often higher than optimal for profit maximization, notably in rice cultivation (see Brief 8). Farmers' unawareness of the dangers of agrochemicals, combined with poor regulation and enforcement, often leads to poisoning. In Ecuador, chronic dermatitis was twice as common among potato workers as among controls. Many agrochemical poisonings are due to suicide, but apart from that, agrochemicals cause millions of poisonings each year, the vast majority in developing countries.

Fertilizer use also affects health. Nitrates and nitrites from fertilizer are among the most common contaminants in drinking water; nitrate contact with mouth bacteria causes nitrate poisoning. Yet excess fertilizers are often used inefficiently. In China, only 30 percent of fertilizer applications reach the crop; much of the rest ends up in water courses. In northern China, more than one-half of groundwater monitoring sites had nitrate levels above the allowable limit. Contamination aside, this harms health through inadequate water quantity and increases women's time and labor burden in finding alternative water sources.

More can and should be done to ensure safe and appropriate use of agrochemicals. Reducing pesticide use often improves health and usually cuts production costs. Likewise, when fertilizers get into drinking water instead of crops, both production costs and health suffer. In Indonesia, biological controls (within integrated pest management) have greatly reduced pesticide applications, improved health, and raised farm incomes.

Plant breeding also matters in this context. Plant type improvement on poor people's farms is almost unambiguously good for human development, but must be selected to decelerate inappropriate use of agrochemicals. In China, India, and South Africa, where farmers had been forced to choose between low cotton yields (due mainly to bollworm) and increasingly massive pesticide applications, transgenic Bt cotton has had substantial health benefits *and* raised farm income, including that of poor smallholders.

THE EFFECTS OF HUMAN HEALTH ON AGRICULTURAL TECHNOLOGY

The impacts of human health on agrotechnology are complex and often mediated by the seasonal nature of both illness and labor demand. Temperature and rainfall determine survival and breeding patterns of mosquitoes, and thus incidence of malaria. The rainy season also sees a greater incidence of diarrheal diseases. Nutrition in preharvest seasons tends to be worse, increasing susceptibility to illness. Such threats to human health often coincide with times of high seasonal labor requirements. This situation has implications for the use of agrotechnology because seasonal labor bottlenecks and illness during certain seasons can affect adoption of technology, either positively, as households improve technology out of necessity, or negatively, as households facing labor shortage and lower income due to illness are forced to spend resources on health care and have little left to invest in technologies that ease labor constraints. Where external inputs are used, money might be diverted away from these toward paying health care expenses.

Illness during the slack season is especially likely to deplete farm labor for long-run investments, such as conservation. Households made poorer by illness and needing to save seasonal labor are likely to target activities that give quick returns.

HIV/AIDS illustrates how disease affects agrotechnology (see Brief 7). HIV/AIDS-related expenditures can reduce farm households' spending on productivity-enhancing inputs, especially given that the labor used to apply such inputs might not be available owing to death and time spent caring for the sick and attending funerals. HIV/AIDS also affects the relationship between labor and technology. HIV/AIDS-stricken rural households often invest in labor-substituting technology, which is less likely to be affected by ill health than labor-intensive technology. This situation stimulates labor-saving technology, in particular long-lasting machinery such as tractors. This stimulation is perverse: it worsens poverty by skewing technical progress in ways that reduce demand for labor and hence wage rates; it absorbs savings and capital, which are scarce in poor countries; and in the medium term, it reduces employment for working-age populations, which are growing fast even in HIV/AIDS-affected countries.

MAXIMIZING THE HEALTH BENEFITS OF AGROTECHNOLOGY

Pro-poor agrotechnology can offer long-lasting health benefits to the poor. Since the 1980s, however, agrotechnology has become less pro-poor. Research has moved to the private sector without adequate pro-poor changes in the incentive structure facing this sector or in public-private partnerships. This shift has reduced yield and employment growth in smallholder food production, and concomitantly the impact of agrotechnology on poverty reduction and health.

What policies can enable agrotechnology to accelerate its thrust toward sustainable human development, less poverty, and better nutrition and health? Overall, policies should be based on the recognition of the mutual linkages between agricultural research, discovery, and diffusion on the one hand, and health, education, and empowerment on the other. Investing in health will benefit health not only directly, but also indirectly through the adoption of pro-poor, pro-health agrotechnology. Likewise, investing in appropriate agrotechnology will not only stimulate agricultural progress, but will also benefit health and poverty reduction.

In the health sector, rural health services should be improved and action taken to anticipate and reduce any negative health effects of agrotechnology. As for agrotechnology, if it is to improve its promise of enhancing human nutrition, health, and wealth, it is crucial to expand applied and basic agroscience in the international public sector. An important example is research to increase the micronutrient content of the main food staples, such as provitamin A–rich orange-fleshed sweet potatoes (conventionally bred) and golden rice (transgenic), recently expanded in the HarvestPlus program of the Consultative Group on International Agricultural Research (CGIAR). In addition, for the health needs of small farmers and laborers—as well as poor consumers—to influence research decisions, governments need to develop (1) institutions and incentives to promote such people's participation and communication with the formal research community; (2) competition among private research providers; and (3) public research in activities that respond to farmers' needs but are unlikely to attract formal private research. ■

The brief is an adaptation of Michael Lipton, Saurabh Sinha, and Rachel Blackman, "Reconnecting Agricultural Technology to Human Development," *Journal of Human Development* 3, no. 1 (2002): 123–152.

For further reading see M. Lipton and E. de Kadt, *Agriculture-Health Linkages* (Geneva: World Health Organization, 1988).

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Understanding the Links between Agriculture and Health

Agriculture and Nutrition Linkages: Old Lessons and New Paradigms

Corinna Hawkes and Marie T. Ruel

Focus 13 • Brief 4 of 16 • May 2006

Agriculture is fundamental to achieving nutrition goals: it produces the food, energy, and nutrients essential for human health and well-being. Gains in food production have played a key role in feeding growing and malnourished populations. Yet they have not translated into a hunger-free world nor prevented the development of further nutritional challenges. Micronutrient deficiencies (for example, of vitamin A, iron, iodine, and zinc) are now recognized as being even more limiting for human growth, development, health, and productivity than energy deficits. Hunger among the poor also increasingly manifests itself through excessive consumption of energy-rich but nutrient-poor foods. The result is a double burden of undernutrition (deficiencies of energy, micronutrients, or both) and "overnutrition" (poor diet quality leading to obesity and other diet-related chronic illnesses).

LESSONS FROM THE PAST: HOW CAN AGRICULTURE BEST CONTRIBUTE TO NUTRITIONAL GOALS?

Agriculture is often viewed as a predominantly economic activity. But in the 1960s and 1970s, concerns about food shortages and growing populations led to an increased focus among policymakers, researchers, and donor agencies on maximizing agriculture's nutritional potential. These efforts initially focused on staple food production and the generation of income among agricultural households and, in later decades, took account of the key role of micronutrient-rich foods and women to good nutrition. The experiences provide some key lessons on how the agricultural sector can help address undernutrition:

1. Increasing the availability and affordability of staple foods. In the 1960s and 1970s, governments made major investments in increasing the yields of staple food crops. In this Green Revolution, farmers' adoption of high-yielding varieties increased cereal availability by nearly 30 percent per person in South Asia and reduced the price of wheat and rice globally. But production gains did not automatically translate into equally large nutritional gains, since staples lack several essential micronutrients needed for child nutrition, and households could not necessarily access and afford the increased food supply.

2. Raising incomes in households engaged in agricultural work. Higher incomes increase households' ability to gain access to food, an especially important concern for poor agricultural households at risk from undernutrition. In the 1970s and 1980s, as agriculture became more commercialized in many developing countries, research found that new agricultural strategies, such as cash cropping, led to higher cash incomes and spending on food. Yet these income gains had a relatively small impact on energy intake and little or no impact on childhood malnutrition. In Kenya and the Philippines, for example, the adoption of cash cropping doubled household income, but children's energy intake rose by only 4–7 percent. Rather than buying more of the same foods, households tended to spend extra income on higher-quality foods and other basic needs.

3. Increasing access to micronutrient-rich foods. Early efforts to increase agriculture's contribution to nutrition neglected the role of micronutrients. To help address this gap, the nutrition community began to engage in agricultural strategies to promote household and community production of micronutrient-rich foods, such as fruits, vegetables, fish, meat, and dairy. These interventions have been shown to effectively increase micronutrient intake and status, especially when combined with effective behavioral change and communication interventions. In northeast Thailand, for example, production of green leafy vegetables in home gardens—combined with social marketing—increased vitamin A consumption among the poor. Some efforts have been less successful, highlighting the need for appropriately designed strategies; there are also likely to be trade-offs between income gains from selling home-produced products and dietary gains from own consumption. Currently, a much larger-scale agricultural approach to micronutrient malnutrition is being developed: breeding micronutrients into staple crops through biofortification. The program is beginning to see some positive nutritional outcomes through the development and dissemination of vitamin A–rich, orange-fleshed sweet potatoes.

4. Empowering women. One of the major lessons to emerge from these decades was the critical role women play in providing nutrition to their children. Consequently, efforts were made to increase the participation of women in agricultural development strategies while also recognizing the need to facilitate women's continued involvement in household management and childcare. Such strategies have been found effective. For example, a successful intervention from Kenya showed that support for production of orange-fleshed sweet potatoes among women increased consumption, but the nutritional outcomes were greatly improved when accompanied by strategies to promote appropriate child feeding and caring practices.

There are clearly several pathways through which agriculture can help address undernutrition, but each one has its limitations. To help improve nutrition more effectively, agricultural policies and practices need to foster synergies between the pathways, balancing the contributions of staple foods, micronutrient-rich foods, income, and women, as well as the trade-offs involved. Additional complementary measures are needed to foster links between the agriculture and health sectors to ensure adequate maternal and child care, feeding, and hygiene practices in agricultural households, as well as access to and use of health services.

CHALLENGES AND OPPORTUNITIES FOR THE FUTURE: WHAT IS CHANGING ABOUT THE RELATIONSHIP BETWEEN AGRICULTURE AND NUTRITION?

Over the past 20–30 years, two related processes have had particularly important effects on the linkages between agriculture and nutrition—globalization and urbanization. Processes of globalization have increased the market orientation of the global agrifood system, unleashing new dynamics in food production, trade, and governance. These dynamics have reverberated throughout the food supply chain, affecting not just production, but also the quantity, quality, price, and desirability of food available for consumption. In addition, close to 40 percent of populations in developing countries currently live in urban areas, a figure projected to rise to 60 percent by 2025. In cities, households have different livelihoods: they are less likely to produce their own food, are more dependent on cash income, and have greater access to a wider variety of goods and services. Both women and men work but often become less physically active. Together, globalization and urbanization are altering how agriculture interacts with nutrition in the following ways:

1. Creating environments conducive to obesity and diet-related chronic diseases. Globalization and urbanization are associated with greater supply of and demand for energy-dense, nutrient-poor foods, leading to obesity and related diseases in countries that have yet to overcome childhood undernutrition. In Mexico, for example, overweight and obesity among the poor nearly doubled over 10 years to reach 60 percent in 1998, while stunting still affected almost half of the preschoolers from low-income groups. The emergence of this double nutritional burden calls for policymakers to rethink how to use agricultural policy as an instrument for good nutrition. The lesson from the past—that agriculture can best meet nutritional needs by providing as cheap a source of abundant calories as possible—may no longer be appropriate. For example, Brazil's past policies promoting increases in the production, export, and consumption of soybean oil led to soaring consumption of soybean oil, which today contributes to excessive fat intake in Brazil. Agriculture thus faces a new challenge: ensuring a sufficient supply of staples and micronutrient-rich foods without encouraging excessive consumption of energy-dense, nutrient poor foods.

2. Elevating the role of agricultural marketing in nutrition linkages. Earlier efforts to improve the links between agriculture and nutrition focused on production. Today, the more market-oriented nature of agricultural policies means agricultural markets play a more important role in determining food availability and access—a shift reinforced by the role of urbanization in increasing the ratio of market consumers to market producers. One example of this shift concerns horticultural products. Production of fruits and vegetables has increased over recent years, yet inadequate consumption remains a problem worldwide. This gap exists partly because of failures of the market supply chain, such as postharvest losses and lack of market access by small producers, which constrain access and availability. To help address micronutrient deficiencies and chronic diseases, the horticultural and health sectors therefore need to focus not only on production, but also on leveraging and adapting aspects of the market supply chain to make fruits and vegetables more available and affordable for poor households, while also ensuring small producers' access to markets. This challenge applies to the global supply chains linking fruit and vegetable producers in Africa and Latin America to consumers in Europe and North America, as well as to smaller local markets throughout the developing world.

3. Increasing the impacts of food and nutritional demands on agriculture. The greater market orientation of food production and consumption has increased the bidirectional links between agriculture and nutrition: agriculture still affects nutrition, but food and nutritional demands increasingly affect agriculture. It is a twofold process. First, the increasing importance of the cash economy arising from globalization and urbanization is increasing the power of consumers in the marketplace. Second, the rise of the food-consuming industries (processors, retailers, restaurants) is subordinating the power of agricultural producers, especially smallholders. In China, for example, rising incomes, urbanization, and population growth have rapidly increased consumer demand for meat. Demand from supermarkets and restaurants is now growing even faster and includes new demands for volume and specific quality attributes. This situation affects traditional backyard producers of pork (the dominant meat), who have trouble responding to such demands, and large-scale industrial producers, whose share of pork production is rising despite associated negative environmental and health impacts. The challenge for the agricultural sector is to respond to the increasing power of consumers and the food-consuming industries without leaving behind smaller, poorer farmers. At the same time, as diets change, the challenge for the health sector is to encourage consumers—and the food-consuming industries—to demand nutritious foods from agriculture. As past experience has shown, more income and greater market orientation is not always associated with good nutrition—a lesson reinforced by the rise of obesity and chronic diseases.

INCREASING THE SYNERGIES BETWEEN AGRICULTURE AND NUTRITION

The changing interaction between agriculture and nutrition in a globalizing and urbanizing world demands new policy responses: old lessons need to be applied and adapted to new realities; emerging challenges and opportunities must be recognized and addressed. To improve the synergies, institutional barriers preventing closer coordination between agrifood and health systems must be broken down. Inflexible governance structures hindered progress in the past and, unless confronted, will continue to do so in the future. At a basic level, capacity building is needed in developing countries to allow more coordinated approaches, while in regional and global institutions, nutritional considerations should become part of multinational agricultural policymaking and agricultural considerations should be built into efforts to improve nutrition and health. ■

For further reading see H. E. Bouis, Special Issue on Improving Nutrition through Agriculture, *Food and Nutrition Bulletin* 21, no. 4 (2000); L. Schäfer Elinder, "Obesity, Hunger, and Agriculture: The Damaging Role of Subsidies," *British Medical Journal* 331 (3 December 2005): 1333–1336; C. Hawkes, "Uneven Dietary Development: Linking the Policies and Processes of Globalization with the Nutrition Transition, Obesity, and Diet-Related Chronic Diseases," *Globalization and Health* 2:4 (28 March 2006); P. Pinstrup-Andersen, A. Berg, and M. Forman, *International Agricultural Research and Human Nutrition* (Washington, DC, and Rome: International Food Policy Research Institute and UN Administrative Committee on Coordination/Sub-Committee on Nutrition, 1984); M.T. Ruel, *Can Food-Based Strategies Help Reduce Vitamin A and Iron Deficiencies? A Review of Recent Evidence,* IFPRI Food Policy Review 5 (Washington, DC: International Food Policy Research Institute, 2001).

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Agriculture, Food Safety, and Foodborne Diseases

EWEN C. D. TODD AND CLARE NARROD

FOCUS 13 • BRIEF 5 OF 16 • MAY 2006

Millions of adults and children suffer from the ill-health effects of foodborne diseases, especially in developing countries. Owing to erratic surveillance systems, estimates of the burden of foodborne diseases are inaccurate and most likely too low. Official reports indicate relatively small numbers of reported cases. The World Health Organization estimates that annually 1.8 million people worldwide (excluding China), most of whom are children, died from diarrheal diseases caused by microbial agents largely attributed to contaminated food and water.

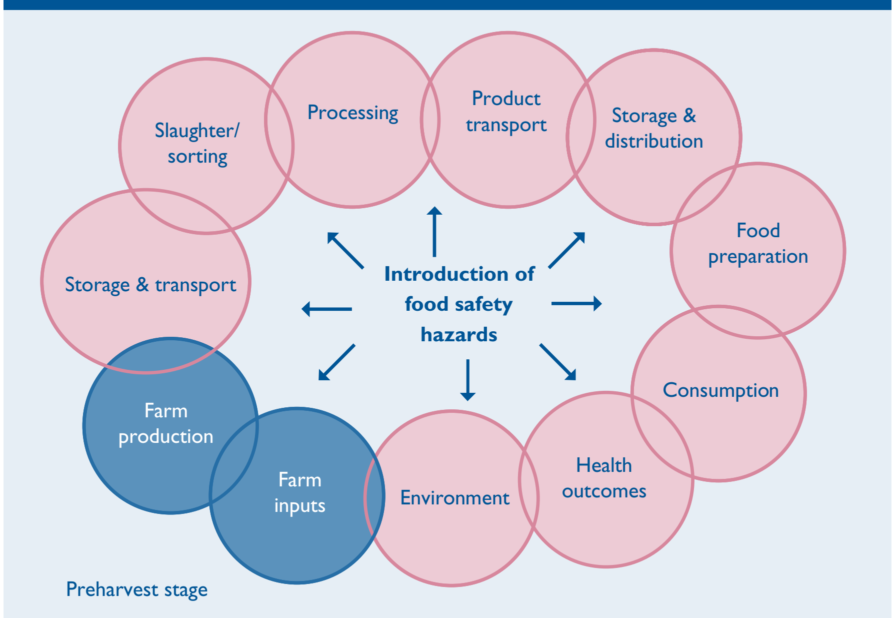
In earlier times, the risks of foodborne illnesses were mitigated by cooking and eating foods immediately or preserving them through fermentation, drying, or cooling. Food supply chains are now more complex, thus increasing the number of potential points of contamination from farm to table (see figure). Agricultural production and the inputs into that production—the preharvest stage—are important potential points of contamination. Owing to globalization, food contaminated on one farm can now cause multiple outbreaks all over the world.

Notable agricultural sources of foodborne disease are zoonotic pathogens, pathogens from contaminated water, and mycotoxins. Zoonotic pathogens—pathogens transmitted from animals to humans—are the most common cause of foodborne diseases. In recent decades several serious zoonotic diseases have emerged—*Salmonella* Enteritidis and *Campylobacter* from poultry; *Salmonella* Newport, *E. coli* O157:H7, and bovine spongiform encephalopathy (BSE) from cattle; the severe acute respiratory syndrome (SARS) virus originating from palm civet cats; and highly pathogenic avian influenza from ducks, geese, and chickens (see Brief 9). All of these risks are linked to animal production practices. Farm animals carry zoonotic pathogens in their gastrointestinal tracts, from where they spread to other animals, crops, and water. Intensified animal production, in which animals are kept at high densities, raises animals' risk of infection and thereby increases the risk that the pathogens will be passed to humans. Zoonotic pathogens can also enter the human food chain on crops treated with inadequately composted animal manure.

Another agricultural source of foodborne pathogens is contaminated water, such as inadequately treated or inappropriately applied wastewater, used in irrigation of horticultural crops. Of major concern are waterborne pathogens such as bacteria (*Shigella, E. coli, and Campylobacter*), viruses (such as hepatitis A and rotavirus), and parasites (such as *Giardia* and *Cryptosporidium*).

In tropical climates, staple crops, such as maize and groundnuts, can be the source of mycotoxins—highly toxic metabolites produced by a number of molds that grow on crops during conditions of drought stress, unseasonably high rains, or high moisture, as well as during and after harvest. One notable example is aflatoxin, which develops in drought-stressed maize and groundnuts and proliferates in crops stored in hot, humid conditions.

Potential Points of Contamination with Food Safety Hazards along the Farm-to-Table Food Supply Chain



CONTROLLING FOODBORNE ILLNESS ON THE FARM

Preventing the transmission of foodborne hazards after the food leaves the farm is becoming more difficult owing to the high potential for cross-contamination during processing. Yet apart from basic hygiene practices, efforts to reduce food safety risks have paid little attention to the preharvest stage. The public and private sectors in many developed countries increasingly require the implementation of coordinated systems such as Hazard Analysis and Critical Control Point (HACCP) or Eurep GAP, but they have traditionally focused on processing. Now, however, more focus is being placed on identifying hazards at the preharvest stage to identify options for preventing hazards from entering the supply chain in the first place.

In some cases simple steps can reduce risks. For example, a recent intervention study in West Africa showed that the use of wooden pallets to store crops significantly reduced exposure among local populations. Other risks require far more complex interventions, particularly for zoonotic pathogens for which it is difficult to trace

RISKS IN AGRICULTURAL PRODUCTION PRACTICES

Foodborne illnesses stem from a wide variety of microbiological and chemical hazards, many of which are introduced during agricultural production. Microbiological contaminants include bacteria, viruses, and parasites, while chemical contaminants include natural toxicants such as mycotoxins and environmental hazards such as mercury. The ingestion of certain pesticides and antibiotics accumulated in food is also thought to pose health risks. The safety of genetically modified foods has been subject to much debate since they may contain allergens or toxins not found in conventional foods, although this has yet to be shown.

the agricultural point of origin. In the United States, the Centers for Disease Control and Prevention use a system called "PulseNet," which allows for molecular comparison of strains and can help identify the source of widely scattered cases. Still, the complexity of the food supply chain makes source identification a challenge.

Antimicrobial resistance is another challenge because efforts on the farm to control one strain may be ineffective against the development of new strains. Over the past decade, *Salmonella* strains with multiple drug resistance have been distributed widely in many countries. In 2000, 40 percent of 27,059 clinical isolates of *Salmonella* tested were resistant to at least one antimicrobial, with 18 percent exhibiting resistance to four or more antimicrobial agents. This is particularly difficult for developing countries where the supply chain is now often based on anonymous transactions in spot markets, implying limited communication and coordination between farmers, traders, and consumers.

RISK ANALYSIS AS A TOOL FOR REDUCING FOODBORNE ILLNESS

To aid in the evaluation of food safety risks and the effectiveness of potential ways to intervene, decisionmakers in some countries are increasingly relying on risk analysis as a tool to help them choose effective management strategies for many types of foodborne disease hazards. Risk analysis is a scientifically based process that identifies the source of the hazard, its characteristics, the health risks it poses, and the impacts of various control strategies.

In many cases, researchers have found that the outcome of risk assessments is driven by the preharvest prevalence of foodborne pathogens. A risk analysis conducted by the U.S. Department of Agriculture on *E. coli* O157:H7 in ground beef in the United States, for example, showed that the overall level of risk was driven by the preharvest load of *E. coli*. The analysis also showed that a combination of intervention procedures would be more effective than any one intervention in reducing contamination.

Likewise, a U.S. risk analysis of *Listeria monocytogenes* showed that a combination of intervention procedures was needed for effective intervention. In response to this analysis, many meat-processing plants made significant improvements to reduce risk, resulting in a gradual decrease in listeriosis.

CAPACITY IN DEVELOPING COUNTRIES

While risk analysis has proved an effective tool in developed countries, very few developing countries have the capacity to conduct such assessments. In general, developing countries lack the capacity to implement and monitor food safety protection systems. PulseNet, for example, is currently used by several other countries, but no developing countries. The supply chain in many developing countries is still often based on anonymous transactions in spot markets, implying limited communication and coordination between farmers, traders, and consumers. Given this lack of coordination, coupled with poor infrastructure and insufficient cold storage systems, market participants have little knowledge or incentive to reduce microbial pathogens and pesticide residues. Though at one time producers in LDCs were direct sellers of products in the market, the supply chain has now become longer, wider, and anonymous; institutions have not been developed to replace what a handshake could once achieve. Developing countries also tend to have weaknesses in their government public health systems, such as outdated food regulations, lack of capacity for compliance, and conflict between public health objectives and facilitation of trade and industry development.

Yet the need to prevent food safety hazards from entering the food chain is particularly important for developing countries since they suffer the greatest burden of foodborne disease. If small producers are to participate in global markets and take advantage of growing demand for highly perishable foods in developed countries, where food safety concerns are high, they will need greater capacity to implement food safety protection systems. Although most food safety research and management practices have been designed for and applied to developed countries, these approaches can be successfully transferred to developing countries provided there is sufficient local data.

MOVING FORWARD

To improve the ability of farmers in developing countries to reduce the burden of foodborne illness, government agencies need to take the following steps:

- ***Implement a farm-to-table approach*** to agricultural health by focusing efforts on the prevention of potential food safety and agricultural health threats at all stages of the supply chain including production, processing, marketing, and retailing.
- ***Raise awareness*** among decisionmakers, public servants, producers, traders, and consumers about the potential sources of food safety problems and ways to protect against such problems. Encourage a multi-stakeholder approach to improving public health.
- ***Strengthen surveillance and diagnostic capacity*** in all countries to improve measurement of prevalence and detection of outbreaks.
- ***Strengthen risk analysis capacity*** to help decisionmakers in all countries to set strategies and priorities, to consider the many needs of the supply chain, and to increase their focus on the preharvest stage.
- ***Switch from command-control policies to performance-based standards*** to meet national and international food safety goals. Command-control policies are often less flexible and have higher fixed costs, which may result in the displacement of poor producers from the market.
- ***Improve infrastructure and access to cold storage facilities*** to ensure the delivery of highly perishable foods to distant markets.
- ***Support efforts to improve supply chain management*** to improve food safety along the whole supply chain. ■

For further reading see D. L. Gallagher, E. D. Ebel, J. R. Kause, *FSIS Risk Assessment for Listeria Monocytogenes in Deli Meats* (Washington, DC: Food Safety and Inspection Service, U.S. Department of Agriculture, 2003); T. Roberts, C. Narrod, S. Malcolm, and M. Modarres, "An Interdisciplinary Approach to Developing a Probabilistic Risk Analysis Model," in *Interdisciplinary Food Safety Research*, ed. N. Hooker and E. Murano (Boca Raton, FL: CRC Press, 2001); L. J. Unnevehr, ed., *Food Safety in Food Security and Food Trade* (Washington, DC: IFPRI, 2004); L. Unnevehr and N. Hirschorn, *Food Safety Issues in the Developing World* (Washington, DC: World Bank, 2000).

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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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Understanding the Links between Agriculture and Health

Agriculture and HIV/AIDS

Stuart Gillespie

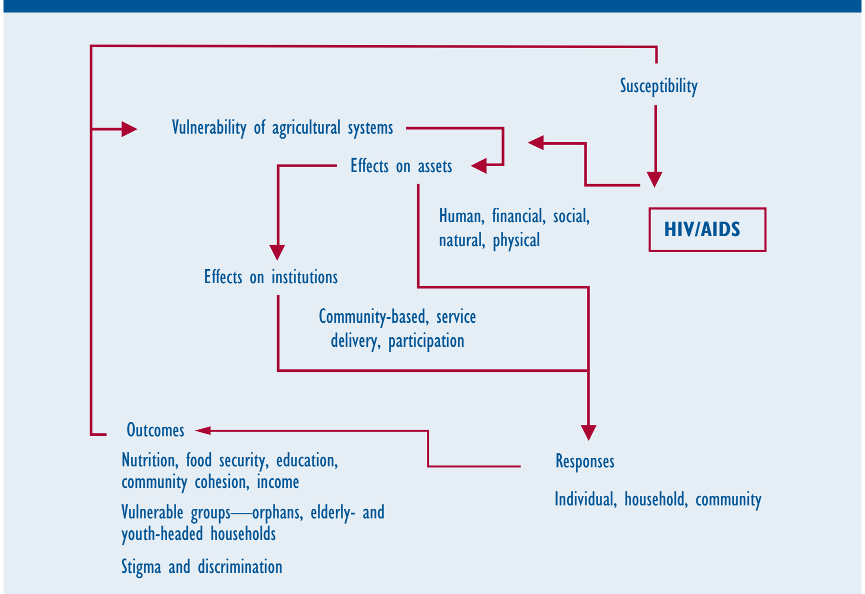
2020 VISION FOR FOOD, AGRICULTURE, AND THE ENVIRONMENT

Focus 13 • Brief 7 of 16 • May 2006

Agriculture is the main source of livelihood of the majority of people affected by HIV and AIDS globally, and it is being progressively undermined by the disease. In Sub-Saharan Africa AIDS is affecting the rural landscape in ways that demand a rethinking of development policy and practice, and parts of South Asia may soon face a similar situation.

Not only does HIV/AIDS affect agriculture, but agriculture also affects HIV/AIDS. The figure shows the dynamics of household and community interactions with HIV/AIDS as an iterative cycle, with HIV/AIDS affecting and being affected by people's livelihoods. The risks people face of contracting HIV will be governed partly by the *susceptibility* of the livelihood system upon which they depend. After HIV has entered a community, the type and severity of its impacts on assets and institutions is then governed by the *vulnerability* of the system. These impacts will in turn determine the responses that households and communities adopt to deal with this threat—responses that lead to certain outcomes (nutrition and food security being among them) that themselves condition future susceptibility and vulnerability. And so the cycle turns.

Understanding HIV/AIDS in the Context of Agricultural Livelihoods



HOW HIV/AIDS INTERACTS WITH AGRICULTURE

First, on the upstream side of infection, it is clear that inequalities of several sorts—gender, socioeconomic, class, caste, and religious—are central to the risks people face. Gender inequity, for instance, shapes power relations, sexual relations, and access to resources, opportunities, and assets, including land. Recent research by the Regional Network on HIV/AIDS, Rural Livelihoods and Food Security (RENEWAL) has shown in Malawi that when agriculture fails to provide a livelihood, poor women may resort to transactional sex that drastically increases their risk of becoming infected.

Mobility is another marker of increased risk. Many of the points of intersection between households and services represent conduits for the spread of infection into or out of communities. Migration, an important consequence of unequal socioeconomic development between urban and rural areas—and one that may be associated with low-productivity agriculture—has been long known to be an important factor in HIV transmission.

On the downstream side of HIV infection, the threat that HIV/AIDS poses for food security was first recognized in the late 1980s. Many studies in Sub-Saharan Africa have since shown that subsistence farmers are vulnerable to the impacts of AIDS because the disease reduces the resources that households can devote to agriculture. Labor loss occurs not only as a result of sickness and premature adult death, but also as a result of its reallocation to nurse the ill, while working capital is siphoned off to pay mounting medical bills.

The specific levels and types of vulnerability depend on the characteristics of livelihoods and farming systems. The most vulnerable farming systems in Rwanda, for example, have been characterized as those with high seasonal labor demand, significant specialization by age and sex, high interdependence of labor inputs, increasing returns to scale of labor, and low substitutability of labor for capital. In one study in Kenya, the death of a male household head was associated with a two-thirds reduction in the value of a household's per capita crop production; adult female mortality caused a greater decline in the cereal area cultivated, whereas cash crops and nonfarm income were most adversely affected in households incurring a prime-age male adult death. In another study in Mozambique, cash constraints were more significant than labor shortages.

HIV/AIDS has also profoundly affected commercial agriculture, and there is increasing evidence that companies are shifting the costs it entails (replacement worker costs, paid sick leave, lost wages, and productivity losses) to employees in a variety of ways. Agricultural extension is being hit hard too, by the sickness and death of extension agents who are at particular risk because of their mobility.

At more aggregate levels, as rural communities with high HIV prevalence face increased labor shortages, widespread reductions in household incomes and increased cash constraints may also depress demand for labor and nontradables. There is some evidence from Malawi that reductions in labor demand may lead to wage declines, posing serious problems even for poor households not directly affected by AIDS.

For poorer smallholder households, the primary constraints on rural productivity and livelihoods may be land and cash rather than labor. A study in western Kenya, for example, found a variety of impacts on rural agricultural households struggling with the illness or death of an adult. Total household expenditure for death-affected households was US$462 per year, compared with US$199 for illness-affected households and just US$21 for non-affected households.

Illness-affected and death-affected households spent 56 percent and 61 percent, respectively, of the amount spent on agricultural inputs by non-affected households.

The impacts of HIV/AIDS on agriculture (and indeed other sources of livelihood) are not one-time events. They are processes, often hidden and slow-burning but potentially very destructive. They are also context-specific, differing by community and by household in type and degree, and they depend on a range of demographic, economic, and sociocultural factors and processes. Impacts may also be revealed in people's responses, and these too differ in effectiveness and sustainability. Some actions may be characterized as coping and demonstrating resilience; others are clearly taken under extreme duress and are not sustainable.

HOW CAN AGRICULTURE RESPOND?

Because agriculture is the fundamental livelihood base of most people affected by HIV/AIDS and because food security is an increasing concern to them as impact waves hit, there is a real need for the agricultural sector to take a proactive stance in the face of the epidemic. If agriculture is to remain an effective source of livelihoods in the face of high HIV prevalences, stakeholders (from farmers to policymakers) need to progressively re-view agricultural situations through an HIV lens in order to respond more effectively.

How does an agricultural policy or program developed using an HIV lens differ from one that was not? An HIV lens would, for example, cause an agricultural commercialization policy to take account of the extra risks posed by evening markets and the need for people to travel far to sell their produce. In another example, in Lesotho, instead of pursuing an add-on activity such as distributing condoms along with agricultural extension messages, the Ministry of Agriculture and CARE are now focusing on improving the food and nutrition security of HIV-affected households and those struggling with other shocks and stresses of poverty.

Another interesting example is Swaziland's Indlunkhulu initiative. Indlunkhulu refers to the tradition of distributing food from the chief's fields to members of the community who are unable to support themselves. In Swazi law and custom, chiefs are responsible for the welfare of orphans within their area. Agricultural policy has built on this practice to provide a sustainable mechanism for delivering food to orphans and vulnerable children, providing initial agricultural inputs for the Indlunkhulu fields, and developing the agricultural skills of older children who work in them.

Agricultural knowledge can also be preserved through the development of HIV-aware and gender-proactive agricultural extension capacity. Farmer life schools, as pioneered in Cambodia and adapted in Kenya and Mozambique, can be developed to bridge gaps in intergenerational knowledge transfer. Capacity constraints may be bypassed through better communications, such as rural radio.

There is clearly tremendous scope for agricultural policy to become more HIV-responsive, both to further AIDS-related objectives and to help achieve agricultural objectives. Yet there are no magic bullets. Land-labor ratios and the relative degree of substitutability between household resources, among other factors, will determine the possible responses to HIV/AIDS. If policy becomes more HIV-responsive, it will stay relevant and effective. By mainstreaming HIV/AIDS into the policy process and carefully monitoring the results, policymakers will help build up evidence of what works in different contexts, enhance learning, and ultimately leave people better equipped to address the multiple threats of the pandemic.■

Research Gaps on HIV/AIDS, Food Security, and Agriculture

Although researchers are learning a great deal about the dynamic interactions between HIV/AIDS, food security, and agriculture, gaps remain in our understanding and in our options for responding. Below are some of the key questions identified by participants at the International Conference on HIV/AIDS and Food and Nutrition Security, organized by IFPRI in April 2005 in Durban, South Africa:

- What is the role of poverty and food insecurity in driving risky behaviors? How prevalent is transactional sex, and how closely is it linked to food poverty? Is food insecurity a major determinant of migration, and are migrants at heightened risk of being exposed to HIV? Can efforts aimed at enhancing the food security and livelihood options of susceptible groups, such as agricultural development programs, make a cost-effective and timely contribution to preventing the spread of HIV?
- How does HIV/AIDS—as a source of vulnerability to food and nutrition insecurity—interact with other sources of vulnerability? Why are certain households vulnerable, and conversely, why are certain households more resilient than others in similar situations?
- Many of the food responses to date have revolved around delivery of food aid. What are other longer-term options for ensuring nutrition security within affected communities? Does nutrition offer an entry point for forging better links between public health and agricultural responses to AIDS?

For further reading see S. R. Gillespie and S. Kadiyala, *HIV/AIDS and Food and Nutrition Security: From Evidence to Action,* Food Policy Review 7 (Washington, DC: IFPRI, 2005); T. S. Jayne, M. Villarreal, P. Pingali, and G. Hemrich, "HIV/AIDS and the Agricultural Sector in Eastern and Southern Africa: Anticipating the Consequences," ESN Discussion Paper (Rome: Food and Agriculture Organization of the United Nations, 2005).

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Understanding the Links between Agriculture and Health

Occupational Health Hazards of Agriculture

Donald Cole

2020 VISION FOR FOOD, AGRICULTURE, AND THE ENVIRONMENT

Focus 13 • Brief 8 of 16 • May 2006

According to the International Labour Organization (ILO), the agricultural sector is one of the most hazardous to health worldwide. Agricultural work possesses several characteristics that are risky for health: exposure to the weather, close contact with animals and plants, extensive use of chemical and biological products, difficult working postures and lengthy hours, and use of hazardous agricultural tools and machinery. This brief outlines the occupational health hazards of agriculture, presents a case study on the trade-offs between their health and economic impacts, and proposes responses.

HEALTH AND INJURY OUTCOMES AMONG AGRICULTURAL WORKERS

The table summarizes the many occupational health hazards of agriculture. Health outcomes associated with these hazards range from relatively simple conditions like heat exhaustion to complex diseases like cancer. Exact data on levels of exposure and associated disease prevalence (or health effects) in the developing world are limited. Pesticide-related illnesses, for example, go largely underreported, though it is estimated that 2 to 5 million people every year suffer acute poisonings and that 40,000 die. Millions of injuries are known to occur, with at least 170,000 of these being fatal for agricultural workers each year. Unsafe equipment and conditions, inadequate training, and limited availability and use of personal protective equipment all contribute.

Health and injury burdens depend on the type of farming activity, the type of worker, and the geographic location. Research in India suggests that agricultural workers using powered machinery are most at risk from fatal accidents, but that injuries are actually more common in less mechanized villages, probably owing to lower adherence to safety standards. Basic hazards like sharp tools and snake bites can also cause debilitating wounds and fatalities.

Different forms of animal husbandry expose workers to different zoonotic diseases. In Malaysia, an outbreak of Nipah virus in 1998 disproportionately affected pig farmers. Workers with dairy cows and sheep in parts of Asia, Africa, and Latin America are at high risk from brucellosis, and animal herdsmen in Africa from Rift Valley Fever. There are also important differences between developed and developing countries: according to the World Health Organization (WHO), although developing countries accounted for only 20 percent of all pesticide use in the early 1990s, they accounted for more than 99 percent of poisonings, because more toxic products were used under more rudimentary conditions.

ECONOMIC IMPACTS OF AGRICULTURE-RELATED ILL HEALTH AND INJURY

Ill health arising from agricultural work has negative implications for agricultural productivity. A study of women farmers in mixed cropping systems, by the University of Benin (Nigeria), found that the vast majority suffered from intense muscular fatigue, heat exhaustion, and skin disorders, forcing them to take days off from attending to crops. In Madhya Pradesh, India, in 2000, the value of human life lost to fatal injuries in agriculture, plus the cost of nonfatal injuries, was estimated at US$27 million.

The economic costs arising from the occupational health hazards of agriculture often arise because of the economic incentives of agricultural work. A study in Carchi, Ecuador—the country's most important potato-growing zone—by a group of international scientists and the International Potato Center found that pesticides bring income gains, but overall they result in lower economic productivity owing to their health costs (see box).

RESPONSES TO HEALTH PROBLEMS IN AGRICULTURE

Rigorous evaluations of the health benefits associated with interventions to improve agricultural practices are few. Still, there are a range of opportunities for technologies and policies to substantially

Occupational Health Hazards of Agricultural Work in Developing Countries

EXPOSURE	HEALTH EFFECT	SPECIFICITY TO AGRICULTURE
Weather, climate	Dehydration, heat cramps, heat exhaustion, heat stroke, skin cancer	Most agricultural operations are performed outdoors
Snakes, insects	Fatal or injurious bites and stings	Close proximity results in high incidence
Sharp tools, farm equipment	Injuries ranging from cuts to fatalities; hearing impairment from loud machinery	Most farm situations require a wide variety of skill levels for which workers have little formal training, and there are few hazard controls on tools and equipment
Physical labor, carrying loads	Numerous types of (largely unreported) musculoskeletal disorders, particularly soft-tissue disorders, e.g., back pain	Agricultural work involves awkward and uncomfortable conditions and sustained carrying of excessive loads
Pesticides	Acute poisonings, chronic effects such as neurotoxicity, reproductive effects, and cancer	More hazardous products are used in developing countries with minimal personal protective equipment (PPE)
Dusts, fumes, gases, particulates	Irritation of the eyes and respiratory tract, allergic reactions, respiratory diseases such as asthma, chronic obstructive pulmonary disease, and hypersensitivity pneumonitis	Agricultural workers are exposed to a wide range of dusts and gases from decomposition of organic materials in environments with few exposure controls and limited use of PPE use in hot climates.
Biological agents and vectors of disease	• Skin diseases such as fungal infections, allergic reactions, and dermatoses	• Workers are in direct contact with environmental pathogens, fungi, infected animals, and allergenic plants
	• Parasitic diseases such as schistosomiasis, malaria, sleeping sickness, leishmaniasis, ascariasis, and hookworm	• Workers have intimate contact with parasites in soil, wastewater/sewage, dirty tools, and rudimentary housing
	• Animal-related diseases or zoonoses such as anthrax, bovine tuberculosis, and rabies (at least 40 of the 250 zoonoses are occupational diseases in agriculture)	• Workers have ongoing, close contact with animals through raising, sheltering, and slaughtering
	• Cancers, such as bladder cancer caused by urinary bilharzia contracted through working in flooded areas in North and Sub-Saharan Africa	• Agricultural workers are exposed to a mix of biological agents, pesticides, and diesel fumes, all linked with cancer

Pesticides, Health, and the Economics of Potato Production in the Highlands of Ecuador

In Carchi, Ecuador, potato growers—mainly smallholders—use hand-pump backpack sprayers to apply high levels of highly toxic pesticides to their crops to fight Andean weevils and late blight fungus. The acute and chronic health effects are severe. In the late 1990s, researchers documented 171 pesticide poisonings per 100,000 people per year in Carchi—among the highest rates reported in the world. Pesticide poisoning was the second largest cause of death for men (19 percent) and fourth for women (13 percent).

Chronic health effects of pesticides were equally severe. The standardized average neurobehavioral score of potato-growing households was nearly 1 standard deviation below the control population. Individual tests indicated that up to two-thirds of these household members showed significant nervous system impairment, enough to cause difficulties in carrying out physical tasks and making farm management decisions.

The problem was traced to incorrect pesticide use: more than 70 percent of men and 80 percent of women did not understand the color coding on pesticide labels indicating toxicity, despite a near 90 percent literacy rate and substantial industry education on "safe use." Farmers made minimal use of protective clothing during pesticide preparation and application, and many failed to shower off pesticide residues or change their clothes immediately after application. Farm families stored pesticides in their homes and washed their application equipment and clothing nearby. As a result, their homes were widely contaminated with toxic pesticides.

In economic terms, the farmers' heavy use of pesticides offered a positive marginal benefit: an additional dollar spent on pesticides generated more than one additional dollar of income. The severe health impacts, however, reduced farmers' work capacity and production. The immediate cost of a typical poisoning (related to medical care, medicines, travel, and days of recuperation) was valued at about 11 days of lost wages. Econometric analysis also showed that farmers who had suffered significant neurobehavioral impairment were less productive than those not affected. So the economic benefits from using the pesticides were outweighed by the economic losses created by negative health impacts.

In Carchi, several policy options have been examined to reduce the health effects of pesticides, each with their benefits and problems. One option, education for safe use, focuses heavily on the use of costly or ineffective personal protective equipment, but has not prevented even the most literate and educated farmers from using pesticides in an unsafe way. Econometric analysis has shown that taxing highly toxic pesticides would improve both farmer health and profitability in Carchi, but the option lacks political feasibility. Stakeholders attending provincial and national-level meetings in Carchi suggested banning highly toxic pesticides—the most effective solution from a health perspective but one opposed on economic grounds. Overall, the best option appeared to be integrated pest management (IPM). In farmer field school experimental plots, farmers tested simple IPM technologies that substantially reduced costs while maintaining yields, leading to increased profitability. The returns on investment ranged from 120 to 145 percent. Farmer networks are now slowly spreading this option through highland communities.

Source: Adapted from Yanggen et al. 2003.

reduce the health-related burdens of working in agriculture. Different hazards require different solutions. In general, if occupational health hazards are to be addressed, greater organization and empowerment of the agricultural workforce and small farmers is needed. The International Federation of Plantation and Agricultural Workers advocates for better working and living conditions for agricultural wage workers, while numerous nongovernmental organizations and some national governments work with small farmers to reduce risks.

Giving workers a voice in determining working conditions can make a difference. For example, community monitoring convinced donors to stop providing toxic pesticides to World Bank–funded projects in the Philippines. Regulations and codes of conduct that do exist also need to be enforced, such as the ILO and WHO guidelines for reducing hazards in agricultural work and providing occupational health services to agricultural workers.

To effect change, the agriculture and health sectors should work together more closely. The agricultural sector should develop and build on ways of working with farmers to grow crops that promote healthier cultivation practices and reduce exposure to hazards. Health-sector staff, meanwhile, should document health problems and identify the greatest hazards, help explain the health reasons for such changes, and monitor changes in health with improved production methods. ■

For further reading see R. K. Egharevba and F. A. Iweze, "Sustainable Agriculture and Rural Women: Crop Production and Accompanied Health Hazards on Women Farmers in Six Rural Communities in Edo State Nigeria," *Journal of Sustainable Agriculture* 24, no. 1 (2004): 39–51; M. A. El Batawi, *Health of Workers in Agriculture* (Cairo: WHO Regional Office for the Eastern Mediterranean, 2004); International Labour Organization, *Safety and Health in Agriculture*, Report VI (1) (Geneva, 1999); F. Konradsen, W. van der Hoek, D. C. Cole, G. Hutchinson, H. Daisley, S. Singh, and M. Eddleston, "Reducing Acute Poisoning in Developing Countries: Options for Restricting the Availability of Pesticides," *Toxicology* 192, nos. 2–3 (2003): 249–61; D. Yanggen, D. Cole, C. Crissman, and S. Sherwood, "Human Health, Environmental, and Economic Effects of Pesticide Use in Potato Production in Ecuador," Research Brief (Lima, Peru: International Potato Center, 2003); and P. S. Tiwari, L. P. Gite, A. K. Dubey, and L. S. Kot, "Agricultural Injuries in Central India: Nature, Magnitude, and Economic Impact," *Journal of Agricultural Saftey and Health* 8, no. 1 (2002): 95–111.

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2020 VISION FOR FOOD, AGRICULTURE, AND THE ENVIRONMENT

Livestock and Health

MARIA ANGELES O. CATELO

FOCUS 13 • BRIEF 9 OF 16 • MAY 2006

The linkages between livestock and health are significant, particularly for the poor, whether as livestock raisers or as consumers of meat and milk, or even as users of the environment. The processes of livestock production and consumption bring both benefits and problems for human health.

BENEFITS OF LIVESTOCK FOR HUMAN HEALTH AND NUTRITION

Animal source foods (ASFs) such as meat, milk, and eggs are guaranteed sources of high-quality protein and essential structural fats. They are also a major source of highly bioavailable (that is, easily absorbed and used by the body) essential micronutrients, such as iron, zinc, vitamin A, and calcium, that are either lacking or not as bioavailable in many developing-country diets that are predominantly composed of cereals. These nutrients are essential to maintain adequate growth and development. For example, a Kenyan study of more than 500 children in 12 schools revealed that increased intake of ASFs is strongly associated with significantly improved health, growth, and cognitive function. Micronutrients also protect against infectious diseases and mortality: zinc, for instance, reduces the incidence, duration, and severity of infections, and vitamin A reduces child mortality. Deficiency of some micronutrients is also associated with increased risk of or vulnerability to some chronic diseases.

The distribution of ASFs to people across the globe is highly uneven. Vulnerable segments of the population with particularly high micronutrient requirements, such as young children, pregnant and lactating women, and HIV/AIDS-affected people, often receive less than their share of ASFs because of lack of access or inadequate allocation within the household. At the same time, other groups are consuming large amounts of ASFs and thus excessive amounts of saturated fats, which pose risks for health. The challenge now lies in making ASFs more available to poor people while not promoting excessive consumption.

Livestock production can also have positive health effects by improving the livelihoods of the poor. Mixed crop and livestock production systems provide a critical source of income to 84 percent of the world's rural poor. In India more than 70 million farm families rely directly on microlevel dairying for employment and income, and in Viet Nam 60–70 percent of all rural households raise chickens and pigs. Many of these mixed-farm households have little access to other assets or resources, and therefore the animals they keep provide them with a pathway out of poverty. Dairy products, eggs, wool, leather goods, and even manure can be traded for cereals. The prevailing trend of industrial livestock production in recent years may therefore threaten the positive impact of livestock on the livelihoods of many of the world's poor.

RISKS OF LIVESTOCK FOR HUMAN HEALTH

Livestock production and consumption can lead to four main types of human health risks: (1) diseases transmitted from livestock to humans; (2) environmental pollution; (3) foodborne diseases and risks; and (4) diet-related chronic diseases.

Diseases transmitted from livestock to humans. Zoonoses are diseases that can be transmitted from animals to humans via bacteria, parasites, viruses, and unconventional agents. The more common and serious zoonoses caused by infectious agents include salmonellosis, swineherds' disease caused by *Leptospira* species, brucellosis, the hepatitis E virus (HEV), bovine spongiform encephalopathy (BSE) and the variant Creutzfeldt-Jakob disease (vCJD), Rift Valley fever (RVF), adult meningitis caused by *Streptococcus suis*, and the influenza virus.

Zoonoses pose a significant human health risk. Take, for example, the influenza virus. The Spanish flu outbreak in 1918–19 was, together with HIV/AIDS, one of the most important infectious disease outbreaks of the 20th century, claiming the lives of at least 50 million people. Now, at the onset of the 21st century, the gravest among the viral zoonoses is the highly pathogenic "bird flu," caused by the H5N1 virus. It was first detected in humans in Hong Kong in 1997, and between 2003 and February 2006 it caused 173 outbreaks and 93 deaths, mainly in Southeast Asia. In February 2006 the virus was detected in wild and domestic birds in India, the African countries of Niger and Nigeria, and in a dozen European countries. Scientists believe mutations of H5N1 have striking similarities to those found in the Spanish flu strain.

In the past, attempts at eradicating zoonoses associated with livestock included quarantine, vaccination, depopulation, cleaning and disinfection of farms, and mass culling of animals. Today, unconventional measures are being suggested, such as Hazard Analysis and Critical Control Point Program (HACCP) controls by food processors, bans on imports of live animals, and early warning systems. Bird flu is a real concern because there is no tried and tested vaccine, and while the experimental licensed drug oseltamivir phosphate appears to work, the world does not have enough for widespread use.

The death of livestock from disease epidemics severely impoverishes poor households, as does the ill health or death of the breadwinner from disease. Thus, for small livestock-keeping households in developing countries to ascend from poverty, the provision of human and animal health care is crucial.

Environmental pollution. Livestock production systems are intensifying worldwide, particularly in urban and peri-urban areas. As a result, livestock waste is emerging as a serious environmental and public health concern. Livestock waste can lead to huge nutrient surpluses concentrated in areas close to humans and has even been implicated in climate change. Untreated and ill-disposed hog waste can become airborne and waterborne, leading to health effects such as gastrointestinal diseases; respiratory ailments primarily caused by inhalation of noxious gases like hydrogen sulfide, methane, and ammonia; and skin irritation, "blue baby syndrome," and cognitive impairments due to the growth of *Pfiesteria* in the air and water at high nitrate concentrations.

The Philippines is noteworthy for the rapid increase in its hog production, both in backyards and in large commercial lots. A study of 82 pig-producing households and 94 families residing near industrial pig farms in a periuban area in 2000 revealed that both groups suffered from respiratory and gastrointestinal ailments, conjunctivitis, influenza, and skin allergies. The study also measured the health costs paid by livestock raisers and households residing near pig farms. It found that the annual costs (including medical expenses, forgone income, and cost of discomfort) paid by commercial livestock raisers' households averaged US$601 for pneumonia, US$47 for diarrhea, and US$49 for influenza. Households near commercial or industrial pig farms spent relatively more money to mitigate health effects—an average of US$8,239 for pneumonia, US$176 for diarrhea, and US$77 for conjunctivitis. For the majority of the rural poor, who are either producers or neighboring consumers, the costs just to keep themselves healthy seriously erode their meager earnings.

Foodborne diseases and risks. Several deadly bacteria are associated with the consumption of ill-prepared livestock products, notably *Campylobacter, Salmonella, E. coli* O157:H7, and *Enterococcus* (see Brief 5).

Antibiotics are used widely in developed countries in intensive livestock operations and are used increasingly in developing countries as growth promoters and to prevent the spread of infection. Though they have the potential benefit of increasing the availability of ASFs to poor families in developing countries, a recent study estimated that the benefit was negligible. Antiobiotics are also a foodborne public health risk: there are concerns that the use of antibiotics in animals could lead to the emergence of strains of resistant pathogens that also cause diseases in humans, thus reducing the ability to treat human disease. The United States and European Union banned the use of certain antibiotics as growth promoters in the late 1990s; by 2006 all antibiotic growth promoters will be banned in the United Kingdom.

Concern about livestock-related foodborne diseases has led industrialized countries to develop strict food safety standards, but compliance with high-technology, process-based food safety standards, like HACCP, is prohibitively costly for many small, developing-country producers. Unless addressed, this situation could lead to negative feedback effects on income and poverty reduction.

Diet-related chronic diseases. Although consumption of livestock products can bring nutritional benefits, ASFs are energy-dense and contain high levels of saturated fats. Excess saturated fat and calorie consumption are associated with the development of obesity and diet-related chronic diseases such as cardiovascular disease, diabetes, and some cancers (see Brief 4). Societies in developing countries are now en route to adopting the typical Western diets high in saturated fats—largely contributed by increasing intakes of animal source foods—and in consequence are experiencing rapid rises in obesity and chronic disease.

CONCLUSION

The key to managing the linkages between livestock and health is to promote the benefits and mitigate the problems as they affect poor and vulnerable groups.

One problem that must be mitigated is the spread of zoonoses. Effective surveillance, prevention, and control of zoonoses are indispensable and require improved coordination among farmers, public health agencies, and animal disease control officials, as well as organizations involved in food and water safety. International organizations and affluent countries must strengthen the capacities of resource-poor countries and other partners to detect, control, and prevent zoonoses. There must also be systematic integration between public health infrastructure and policy, as well as between human and animal health surveillance and control. To enhance global surveillance and response to zoonotic diseases, the Food and Agriculture Organization of the United Nations, the World Organisation for Animal Health, and the World Health Organization have jointly initiated a Global Early Warning System (GLEWS) for transboundary animal diseases. Sharing the information generated from this initiative is crucial.

In developing countries, smallholders have only rudimentary methods of protecting themselves from diseases and preventing their spread to neighboring farms and communities. There may be a need to rethink the trends toward wholesale privatization of animal health services and public disinvestment in these services and to look more deeply into public and private partnerships.

Although the developed countries have put in place extensive regulatory and market-based measures to mitigate environmental damage from intensive livestock production in urban and peri-urban centers, in developing countries both monitoring and compliance costs are prohibitive. It may be necessary to rethink concentrated livestock feeding operations to better handle waste disposal problems linked to the ill health of livestock keepers and the community at large. Less intensive livestock operations could also potentially reduce animals' susceptibility to infection and disease and reduce the indiscriminate use of antibiotics.

Overall, there should be no need for conflict among the goals of health, environmental safety, and wealth creation; rather they should be viewed as ideal complements.■

For further reading, see M. A. Catelo, M. Dorado, and E. Agbisit, Jr., *Backyard and Commercial Piggeries in the Philippines: Environmental Consequences and Pollution Control Options*, EEPSEA Research Report No. 2001-RR6 (Ottawa, Canada: International Development Research Centre, 2001); M. W. Demment, and L. H. Allen, eds., *Animal Source Foods to Improve Micronutrient Nutrition and Human Function in Developing Countries*, Supplement to the *Journal of Nutrition* 133 (11S-II; 2003): 3875S–4061S; World Health Organization, Food and Agriculture Organization of the United Nations, and World Organisation for Animal Health, *Report of the WHO/FAO/OIE Joint Consultation on Emerging Zoonotic Diseases* (Geneva: 2004), available at whqlibdoc.who.int/hq/2004/WHO_CDS_CPE_ZFK_2004.9.pdf; and P. Walker, P. Rhubart-Berg, S. McKenzie, K. Kelling, and R. S. Lawrence, "Public Health Implications of Meat Production and Consumption," *Public Health Nutrition* 8 (2005): 348–356.

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Understanding the Links between Agriculture and Health

Fish and Health

Nanna Roos, Md. Abdul Wahab, Chhoun Chamnan, and Shakuntala Haraksingh Thilsted

Focus 13 • Brief 10 of 16 • May 2006

Fish production is an important source of livelihoods among the world's poor, and fish consumption has long been known to have nutritional benefits. The dynamics of the world's fisheries—and fish consumption—are changing, bringing health-related challenges. This brief describes the various links and the challenges they present.

FISH AND NUTRITION

Fish are a rich source of protein, fatty acids, and essential vitamins and minerals such as vitamin A, calcium, iron, zinc, and iodine. The vitamin A, calcium and iron found in small fish species are particularly bioavailable—that is, easily absorbed by the body. Rising incomes and high consumer preferences for fish, especially in Asia, have caused global fish consumption to double in the past 30 years to 15 kilograms per person per year, according to the Food and Agriculture Organization of the United Nations (FAO). This trend is mainly attributable to demand from growing urban populations in China and other Asian countries.

Official data on fish production and consumption tend to exclude the fish caught, consumed, and traded within the communities for whom the nutritional benefits of fish are most striking: rural populations living in riparian and coastal areas in some of the poorest countries in the world. These communities not only consume fish, but also depend on it for their income and livelihoods. Fish caught by household members or bought in local markets are eaten daily by all members of all households, especially in the fish production season. Small fish species are particularly important for these groups. Studies in rural Bangladesh and Cambodia show that small fish make up between 50 and 80 percent of all fish eaten during the production season. Although consumed in small quantities, these small fish, which are consumed whole, are particularly rich in micronutrients (see table). Their bones are an excellent source of calcium, and in some species, vitamin A accumulates in their eyes and intestines. A study of poor, rural households in Bangladesh in 1997 revealed that small fish intake provided about 40 percent of the vitamin A and 32 percent of the calcium recommendations of an average household in the peak fish production season.

The long-chained omega-3 polyunsaturated fatty acids found in marine fish have a range of health benefits. Epidemiological studies have shown that the prevalence of cardiovascular diseases is low in North Atlantic regions with high fish intake, and it is well accepted that some fatty acids ameliorate the risks of cardiovascular failures, stroke, and development of dementia in adults. In young children, omega-3 fatty acids are important for the development of membranes of the brain and the retina.

THE DYNAMICS OF FISHERIES DEVELOPMENT, NUTRITION, AND HEALTH

Traditional, small-scale fish production has become increasingly commercialized in certain regions. For example, fisheries in Lake Victoria in East Africa were transformed through the introduction of the Nile perch (*Lates niloticus*) in the 1960s. In the following three decades, fish production increased fivefold. The incomes of fishermen rose as they joined the crews of large fishing vessels that supplied the Nile perch to processing factories. But traditional trading and fish processing disappeared, and thousands of women lost their incomes, with negative consequences for the nutrition and health of their children. In the 1990s, greatly reduced fish intakes were recorded among the poor, as the commonly consumed, low-value, small fish species dagaa (*Ratenebola agentum*) and skeletons from the processing factories were used for fish meal production instead of local consumption.

Freshwater capture fisheries in Asia are under great pressure, and the result has been decreased fish intakes. This situation is due to human population growth, reduced access to common water resources, environmental changes related to rice production, embankment construction for flood control, the filling up of open water areas, and the use of irrigation, pesticides, and fertilizers. Agricultural systems that remove small fish from the diet or replace small fish with large fish, such as silver carp (*Hypophthamichthys molitrix*), of which the edible parts are mainly the muscles, have a detrimental effect on the micronutrient intakes of the rural poor (see table).

As fish stocks—both marine and freshwater—decline globally, there is a steady increase in aquaculture, based largely on intensive fish farming and the use of fish meal and fish oil. Asia accounts for 90 percent of the world's aquaculture, most of which targets the fast-growing demand of urban populations. Growth in aquaculture has thus far

Nutrient Contents of Small Indigenous and Cultured Fish Species in Bangladesh

TYPE OF FISH	VITAMIN A (RAE/100 G RAW, CLEANED PARTS)	CALCIUM (MG/100 G RAW, CLEANED PARTS[a])	IRON (MG/100 G RAW, CLEANED PARTS)	FAT (G/100 G RAW, CLEANED PARTS[b])
Small indigenous fish species				
Chanda (Parambassis baculis)	1,680	348	1.8	5.1
Darkina (Esomus danricus)	880	775	12.0	4.5
Mola (Amblypharyngodon mola)	2,680	776	5.7	4.4
Puti (Puntius sophore)	60	784	3.0	7.1
Cultured fish species				
Mrigal (Cirrhinus cirrhosus)	< 30	< 10	2.5	2.9
Rui (Labeo rohita)	< 30	86	NA	NA
Silver carp (Hypophthamichthys molitrix)	< 30	36	4.4	2.7
Tilapia (Oreochromis niloticus)	< 30	NA	5.0	NA

[a] Corrected for plate waste.

[b] Sampled in peak growth season (October–November).

Note: RAE = retinol activity equivalents. Vitamin A is found as retinoids and dehydroretinoids. Dehydroretinoids are given a value of 40 percent of all-*trans*-retinol in calculating RAE, based on their functional bioefficacy. NA = not available.

Source: N. Roos, Md. M. Islam, and S. H. Thilsted, "Small Indigenous Fish Species in Aquaculture in Bangladesh: Contribution to Vitamin A, Calcium, and Iron Intakes," Journal of Nutrition 133 (2003): 4021S–4026S.

had limited health benefits for the rural poor. In Bangladesh, pond aquaculture using carp species and tilapia has grown tremendously in the past 20 years and is highly profitable. For small-scale farmers, however, semi-intensive pond aquaculture is one of many farming activities, contributing only a 10 percent increase in annual household income. Research in rural Bangladesh showed that in Gazipur District from 1990 to 1999, aquaculture greatly raised the production and availability of silver carp, and its price in the local markets fell, making it 20 percent cheaper than small fish. At the same time, because of increased pressure on the fisheries environment, rural households fished less frequently, fish intake was halved, and the proportion of nutrient-dense small fish species consumed was reduced substantially.

Yet aquaculture can be reoriented toward helping the poor. In Bangladesh the government and nongovernmental organizations (NGOs) have begun to promote semi-intensive polyculture in small, seasonal ponds, using the nutrient-dense small fish mola (*Amblypharyngodon mola*) together with carp species. Mola greatly improves the nutritional value of the output of the pond, has no negative economic consequences, and adds about 10 percent to the total productivity of the pond. In Malawi, semi-intensive pond aquaculture is being introduced in HIV/AIDS-affected households, especially those headed by women and orphans, to improve income as well as health.

FISH-RELATED HEALTH RISKS

The health benefits of habitual consumption of fish are threatened by environmental contaminants and fishborne zoonotic parasites. The accumulation of mercury in fatty fish, like tuna, is a potential global health risk, as canned tuna is widely exported and consumed. Some developed countries have issued guidelines for restricted intakes of fatty fish by pregnant women and children, to avoid toxic exposure to mercury. Accumulation of arsenic, lead, and cadmium in fish stocks in specific environments may also pose a health hazard. In the Nordic countries, there are recommended limits to fish intake from the Baltic Sea owing to the accumulation of dioxin. Also, accumulation of polychlorinated biphenyls (PCBs), caused by industrial pollution, in fish from coastal and inland waters is identified as a health risk factor.

Consumption of raw or inadequately cooked fish infected with fishborne zoonotic parasites also poses threats to health. In Southeast Asia, diseases such as bile duct cancer, gallstones, diarrhea, and peptic ulcers caused by these parasites are emerging as public health issues. Fishborne zoonotic parasites affect more than 60 percent of the workforce in northeast Thailand and 15 to 20 percent of the population in certain areas in Vietnam. Inadequate cooking of fish in poor households is primarily due to fuel shortages. Moreover, population pressure, water pollution, and dams create favorable environments for the snails and fish that transmit parasites.

IMPACT OF POOR HEALTH ON FISHING COMMUNITIES

High prevalence of and vulnerability to HIV/AIDS in fisherfolk in many developing countries have been reported by the FAO. In the Lake Victoria region in Kenya, fishermen are five times more at risk of dying from HIV-related illnesses than farmers are (the prevalence rates in women involved in fisheries are unknown). The increased vulnerability of fishing communities stems from many social, cultural, and economic factors, such as traditional gender roles, mobility, time spent away from home, prostitution, alcohol and drug abuse, and daily cash income. Because of the poverty, insecurity, and marginalization of fishing communities, they are neglected in terms of basic services like education and health care, and thus HIV/AIDS prevention, care, and mitigation efforts do not reach them. The consequences are devastating for the health and livelihoods of fishing communities, as well as of other groups in the fisheries sector (see also Brief 7).

CONCLUSION

The importance of fish for the health of consumers and producers demands policy attention. For poor riparian and coastal populations, national and local fisheries management policies need to incorporate the need for access to fish, especially nutrient-dense small fish species, and fisheries by these groups. Thus, it is critical to develop and disseminate sustainable aquaculture technologies that are suitable for adoption by the rural poor, such as making use of rice paddies, irrigation canals, and seasonal ponds to produce fish both for sale and for consumption. In addition, aquaculture in these water bodies can promote human health by controlling mosquitoes, and thereby malaria, as well as snails that bear schistosomiasis parasites.

For growing urban populations, measures are needed to increase fish intake as a means of curbing the rise of chronic diseases. To cope with urban demand, intensification of aquaculture is thought to be the way forward. This entails the use of technologies (breeding, management, and biotechnology) to raise productivity and requires large private and public sector investments. There are challenges, however: competition with other users for land and water, environmental problems (like effluent pollution), and the spread of fish diseases. Moreover, it is not certain that fish availability can keep pace with demand, even with the rapid expansion of aquaculture.

It is now apparent that the overexploitation of fish and fisheries to satisfy demand for fish consumption, fish meal, and fish oil and to generate economic and income growth has resulted in serious risks to the health and well-being of the poor, the environment, wild fish stocks, the quality of fish, and the viability and sustainability of the fisheries sector. Striking a balance between these developments is an enormous challenge, but there seem to be concerted efforts at all levels to meet this challenge through adoption and implementation of various components of the Code of Conduct for Responsible Fisheries, launched by the FAO in 1995.■

For further reading see P. Edwards, D. C. Little, and H. Demaine, eds., *Rural Aquaculture* (Wallingford, UK: CAB International, 2002); Food and Agriculture Organization of the United Nations (FAO), *Impact of HIV/AIDS on Fishing Communities: Policies to Support Livelihoods, Rural Development, and Public Health*, New Direction in Fisheries (Rome: FAO, 2005); G. Kent, "Fisheries, Food Security, and the Poor," *Food Policy* 22 (1997): 393–404; J. S. Narriman and M. C. Öhman, "Marine Fisheries in Tanzania," *Ambio* 31 (2002): 518–527; and P. Thompson, N. Roos, P. Sultana, and S. H. Thilsted, "Changing Significance of Inland Fisheries for Livelihoods and Nutrition in Bangladesh," *Journal of Crop Production* 6 (2002): 249–318 (also a chapter in P. Kataki and S. Babu, eds., *Food Systems and Human Nutrition* [New York: Howard Press, 2002]).

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Agroforestry, Nutrition, and Health

Brent Swallow and Sophie Ochola

2020 VISION FOR FOOD, AGRICULTURE, AND THE ENVIRONMENT

Focus 13 • Brief 11 of 16 • May 2006

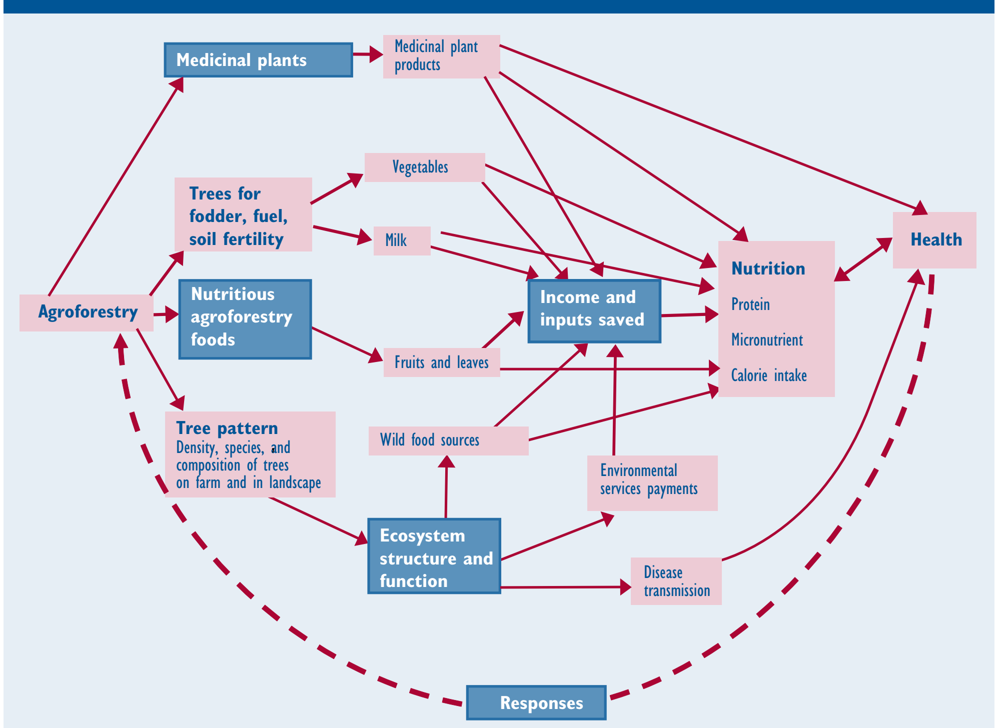
Agroforestry is an ancient land use practice and modern science involving the deliberate management of trees on farms and in surrounding landscapes. Agroforestry systems vary greatly in tree species mix, complexity, configuration, and input requirements, producing a wide range of products and services. With appropriate technical and institutional support, the practice of agroforestry can contribute to rural food and health systems and help buffer households against health and nutrition shocks. As a science, agroforestry integrates perspectives from agriculture, ecology, and rural development.

For the practice of agroforestry to yield its full potential, it needs to bring health and nutrition to the fore. The figure presents a simple conceptual framework of agroforestry, health, and nutrition linkages that focuses on five pathways between agroforestry and health, dubbed the MINER pathways: M—medicinal plant conservation, domestication, and propagation; I—income earned and inputs saved through improvements in the farm resource base and products for sale; N—nutritious agroforestry foods, including fruits and leaves; E—changes in ecosystem structure and function that affect disease risk and transmission; and R—responses of agroforestry priorities and program design to changes in farmers' circumstances resulting from health and nutrition problems. The rest of this brief briefly discusses the five MINER pathways.

MEDICINAL PLANT PATHWAY

Across much of Africa and Asia, people use traditional medicines—based largely on products from trees, shrubs, and herbs—to help meet their primary health care needs. The World Health Organization (WHO) estimates that about two-thirds of the world's population, and 80 percent of Africa's population, sometimes use herbal or traditional medicines. WHO also estimates that the global market for herbal medicines is worth more than US$60 billion per year. Despite its huge monetary value, the herbal medicine industry still relies largely on plant products collected from the wild. Those wild areas are decreasing in area, and remaining wild areas are often overharvested. A case in point is *Prunus africana* (variously called bitter almond, iron wood, or red stinkwood in English), a slow-growing African hardwood tree.[1] Bark from *Prunus africana* trees is used in a treatment for prostrate disorders, especially in Europe and North America. While it is technically possible to harvest bark from *Prunus africana* sustainably, bark poachers tend to either cut down mature trees or strip live trees entirely of their bark, killing the tree. As a result, the tree is now in Appendix II of the Convention on the International Trade in Endangered Species (CITES). One potential solution is to incorporate *Prunus africana* into agroforestry systems (an approach currently being studied by the World Agroforesty Center): vegetative propagation methods have been found effective in propagating high-quality trees growing in the wild and making that material available to smallholder farmers. This approach is also being extended to two tree species whose products are used to treat malaria, *Artemisia annua* (sweet wormwood), indigenous to China, and *Warburgia ugandensis* (East African greenwood, East African greenheart, or pepper-bark tree), indigenous to Africa.

Linkages between Agroforestry, Health, and Nutrition



INPUT AND INCOME PATHWAY

Agroforestry systems offer farmers opportunities to diversify their income and to increase farm production, allowing them to increase the resources they devote to purchasing food and countering disease. Agroforestry can improve soil fertility, provide animal fodder, produce tree fruits, expand fuel wood supplies, and produce a variety of wood products for farmers' home use and sale. Research results from around the developing world show that financial returns generated from agroforestry systems vary greatly but are generally much higher than returns from continuous unfertilized food crops (see table). The higher returns associated with agroforestry can translate into improved household nutrition and health, particularly when the income is controlled by women. Unfortunately, however, there is scant empirical evidence that agroforestry income produces these health benefits. Monitoring and impact assessment studies need to give more attention to how agroforestry affects household resource allocation, consumption patterns, nutrition status of household members, and health.

[1] Botanic names and English names of trees are taken from the World Agroforestry Centre agroforestry database, located on the Internet at http://www.worldagroforestry.org/Sites/TreeDBS/Treedatabases.asp.

Income Benefits of Agroforestry Systems

COUNTRY	AGROFORESTRY SYSTEM	DISCOUNTED PRESENT VALUE IN US$/HECTARE	COMPARISON WITH RETURNS FROM NONAGROFORESTRY LAND USE
Tanzania	Rotational woodlots	US$500 over 5 years	Agroforestry return is 6.3 times higher than unfertilized maize
Uganda (southwest)	Tree fallows on scoured terrace benches	US$155-917 over 4 years	Net loss of US$4 over 4 years from continuous maize
Nepal	Rotational woodlots	Mean annual return of US$1,582 or US$2,796 for 2 agroforestry systems	Mean annual return of US$804 for continuous maize
Viet Nam	*Tephrosia candida* as fallow, hedgerow, or mulch on upland rice	Net loss of US$59 to net gain of US$123 over 4 years	Net loss of US$33 over 4 years for continuous monocrop upland rice
India	Biodiesel using *Jatropha curcas*	US$853 over 30 years	Wastelands assumed to have 0 opportunity costs

NUTRITIOUS FOOD PATHWAY

Agroforestry has the potential to contribute to human nutrition through increased production and availability of particularly nutritious fruits and leaves and through general diversification of farmers' diets. Agroforestry research and development organizations in Africa are promoting a number of tree products with particularly nutritious fruits and leaves, including indigenous trees such as *Adonsonia digitata* (baobab) and *Uapaca kirkiana* (wild loquat) and exotic trees such as *Moringa oleifera* (drumstick tree) and *Psidium guajaya* (guava). The nutritional profile of some of these products is impressive. For example, the leaves and fruits of the baobab tree contain beta-carotenes and vitamin C, while the leaves of *Moringa oleifera* are rich in vitamin C and beta-carotene and contain significant amounts of protein, phosphorus, lipids, and calcium. A study in Zimbabwe by the World Agroforestry Centre and Hanover University showed that many households consumed large amounts of fruit and generated considerable income from indigenous fruits. Within households, children were the main consumers of fruit. Research and development are therefore now focused on on-farm production of indigenous trees, production of new products from indigenous fruits, and expanded production of selected exotic species.

ECOSYSTEM SYSTEM STRUCTURE AND FUNCTION PATHWAY

It is now recognized that one of the critically important services that ecosystems play is controlling the emergence and spread of infectious and vector-borne diseases by maintaining equilibria among predators and prey, and among hosts, vectors, and parasites in plants, animals, and humans. As a land use that is intermediate between undisturbed forests and annual cropping, agroforestry has the potential to have positive and negative impacts on disease risks. Depending upon whether agroforestry systems replace annual crops or primary forests, agroforestry can change (1) the risk of malaria (by changing ambient temperatures and pools of standing water); (2) the risk of African animal and human trypanosomiasis (by changing the habitat for tsetse flies and animals that provide blood meals for tsetse); and (3) the quality of water in natural ecosystems. Agroforestry products can also be used for environmental benefits. The seeds of *Moringa oleifera* (drumstick tree), for example, have the potential to clarify and reduce bacteria loads in drinking water, and *Dendrocalamus giganteus* (giant bamboo) can absorb large quantities of nutrients from human or animal waste. The particular relationships between agroforestry, alternative land uses, and health tend to be context specific, so more studies across a range of contexts are needed.

FEEDBACK EFFECTS FROM HEALTH TO AGROFORESTRY

Just as agroforestry has the potential to improve health, the health status of communities also affects agroforestry. Health and nutrition status affect how people use trees and other natural resources, the amounts and types of resources they apply to their farming operations, and how they perceive the attractiveness of various agroforestry systems. Households suffering the effects of chronic illness or death tend to increase their reliance on woodland resources for food and income. Such households are likely to reduce their use of purchased inputs for farming and to become discouraged from adopting agroforestry systems owing to their delayed payoffs and high management demands. HIV/AIDS is one disease with particularly large impacts on these feedbacks (see also Brief 7). Yet agroforestry systems can also respond to the HIV/AIDS epidemic through the first four pathways, as follows:

- Agroforestry systems can produce medicinal products to help treat symptoms and opportunistic infections. For example, the African tree *Melaleuca alternifolia* (tea tree) contains an anti-fungal substance that combats *Candida albicans*, the bacteria responsible for fungal skin problems and mycosis (a condition that commonly affects the eyes of AIDS patients).
- They can produce nutritious foodstuffs (fruits and berries).
- They can generate income through woodlots and improved fallow methods that require relatively low intensities of labor and purchased inputs.
- They can mark ownership of land for widows and orphans.

CONCLUSIONS

This brief suggests the large potential, but also the complexity, of the possible links between agroforestry, health, and nutrition. Across the developing world, farmers and other rural residents use products from hundreds of tree species, often in many different ways, to meet their subsistence food needs, diversify their diets, generate income, and treat a wide range of ailments. At the landscape level, agroforestry contributes to the complexity of vegetation profiles and landscape mosaics, in the process changing the epidemiology of infectious and vector-borne diseases. It is not surprising, therefore, that there is relatively little conclusive evidence of direct links between agroforestry and health. Nonetheless, there is an urgent need to generate and synthesize such evidence. Health and nutrition interventions will be made more effective when they are able to incorporate tree components in full confidence of the likely impacts. ■

For further reading see B. Swallow, P. Thangata, S. Rao, and F. Kwesiga, eds., "Agroforestry Responses to HIV/AIDS in East and Southern Africa," Occasional Paper No. 1 (Nairobi: World Agroforestry Centre, 2005).

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Understanding the Links between Agriculture and Health

Agrobiodiversty, Nutrition, and Health

Timothy Johns, Ifeyironwa Francisca Smith, and Pablo B. Eyzaguirre

2020 Vision for Food, Agriculture, and the Environment

Focus 13 • Brief 12 of 16 • May 2006

Biodiversity provides essential components of healthy environments and sustainable livelihoods. One key component of biodiversity is agrobiodiversity—that is, the cultivated plants and animals that form the raw material of agriculture, the wild foods and other products gathered by rural populations within traditional subsistence systems, and organisms such as pollinators and soil biota.

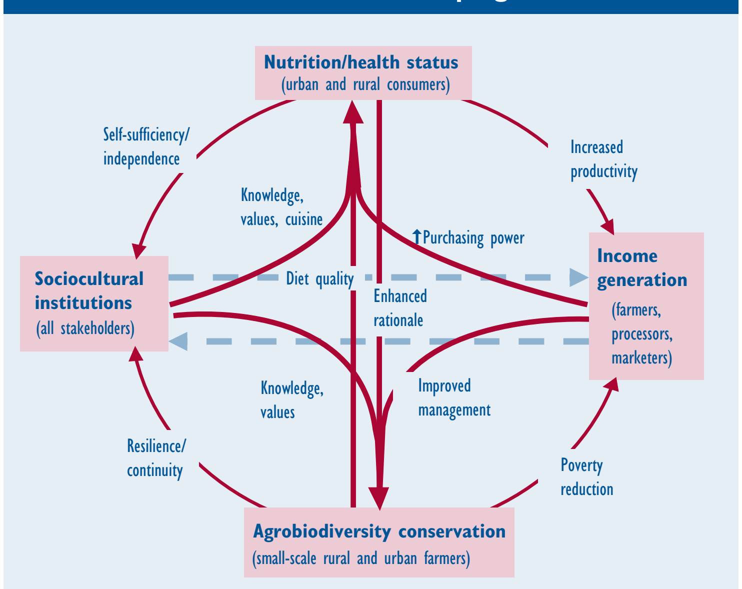
Farming systems rich in agrobiodiversity are characterized by a range of crops, many of which may be represented by numerous traditional varieties even in the same field. Agrobiodiverse systems tend to comprise smaller quantities of multiple species for culinary, medicinal, and cultural uses. They often tolerate or encourage valuable wild plants within fields, on field margins, and in adjacent natural areas.

Before the emergence of modern industrial agriculture, farms everywhere were richer in biodiversity than they are today. Agrobiodiverse systems now tend to be found more in developing countries, among indigenous communities and small-scale farmers, and in extreme or marginal environments. Economic and social development often leads people to abandon these valuable assets, thus preventing agrobiodiversity from contributing to improving the health and livelihoods of disadvantaged populations.

CONCEPTUAL LINKS BETWEEN AGROBIODIVERSITY AND HEALTH

The figure shows how biodiversity, nutrition, and health can support each other in a synergistic fashion. Agrobiodiversity used and conserved in a livelihood context can directly contribute to nutrition, health, and income generation. Health and prosperity linked to robust sociocultural institutions, in turn, help individuals and populations make healthy behavioral choices, and help institutions develop public policies that maintain the diversity and health of ecosystems. Utilizing and encouraging agrobiodiversity requires viable markets, which depend on demand from consumers, which in turn translates into opportunities for income generation and improved livelihoods for rural farmers. Scientific research and entrepreneurial initiative can provide new products and markets from and for agrobiodiversity.

Population-level synergies linking biodiversity conservation and human nutrition in developing countries



Source: Johns and Sthapit 2004.

THE POTENTIAL FOR AGROBIODIVERSITY TO PROVIDE THE NUTRIENTS ESSENTIAL FOR A HEALTHY LIFE

Agrobiodiversity could be more effectively utilized to improve diets and nutrition. Eight hundred million people in the world have diets insufficient in energy, and some 2 billion suffer from micronutrient deficiencies. Improving accessibility to a range of crops would offer nutritional benefits to the rural and urban poor. Farming systems that maintain and use agrobiodiversity have strong potential for improving this accessibility and thus improving nutrition, because they often produce indigenous, neglected, and underutilized food crops and gathered foods rich in nutrient quality.

In different parts of the world this potential has been recognized, and efforts made to build on it. For example:

- In Brazil, buriti (*Mauritia vinifera*) and some other indigenous palm fruits are noted sources of beta-carotene (provitamin A). The Brazilian Ministry of Health promotes the consumption of these foods through national and local activities directed at sustainable small-scale production, product development, and marketing.
- In Sub-Saharan Africa, indigenous leafy vegetables are potentially rich sources of micronutrients and antioxidants. To promote production and consumption of African leafy vegetables, the International Plant Genetic Resources Institute (IPGRI), in collaboration with the World Vegetable Center (AVRDC) and national partners in eight countries, has combined research, public education, dissemination of information, support to small-scale producers, and facilitation of links to retail markets. Consequently, in Nairobi, Kenya, supermarket sales of leafy vegetables have increased 10-fold over a period of one to two years, and the informal market sector has grown.
- *Moringa oleifera* (drumstick tree) is a fast-growing, multipurpose tree whose leaves contain high levels of vitamins A and C, calcium, iron, and protein. There are now multiple efforts underway to incorporate *Moringa* into agricultural systems and the diets of people at risk of malnutrition in India, Sub-Saharan Africa, and other regions (see Brief 11).

In addition, agrobiodiversity is a potential source of genetic resources that plant breeders and scientists can use to add nutrients like beta-carotene and zinc to staple crops.

LINKING AGROBIODIVERSITY TO DIETARY DIVERSITY

Dietary diversity increases the chances that individuals will meet their dietary requirements. Fruits, minor vegetables, and leaves used as condiments, spices, or sauce ingredients can be grown in small quantities and add variety and essential nutrients to diets otherwise dominated by carbohydrates. Agrobiodiversity is an underexplored avenue for giving both food producers and consumers access to greater dietary diversity. A recent study in a subsistence-oriented mixed farming system in an upland region of the Philippines showed that the diversity of agricultural production—comprising cultivated and gathered products such as fruits, vegetables, and multiple varieties of rice—was important to ensuring food security and reducing the risk of temporary food shortages.

Increasing biodiversity in home gardens is another way to promote dietary diversity among producers. In Bangladesh, Helen Keller International projects show that homestead food production focused on a wide variety of fruits and vegetables and integrated with animal husbandry enables households to diversify and increase the quality of their diet. A recent project promoting home gardens and income generation in the Terai area of Nepal through training, technical assistance, and seed distribution significantly improved nutritional knowledge and consumption of 16 types of micronutrient-rich vegetables and fruits.

Food consumers more broadly could also benefit. Information on the contribution of indigenous food species to people's diet and nutrient intake, however, is almost non-existent. Most food consumption surveys either underestimate or ignore indigenous and wild foods, as do the food balance sheets of the Food and Agriculture Organization of the United Nations, which are widely used to estimate global food supply.

AGROBIODIVERSITY AND THE EMERGING EPIDEMIC OF CHRONIC DISEASES

There is growing evidence from the epidemiological literature that optimal health requires more than just essential nutrients. Specific plant foods also have so-called functional properties that are associated with reduced risks of chronic diseases and improved health overall.

Important examples of crops underutilized in modern farming systems are buckwheat and finger millet, which have blood glucose–lowering effects. Particular animal-source foods, such as many fish and marine species, as well as seeds such as flax, pumpkin, and walnuts, contain high levels of omega-3 fatty acids, which are highly protective against chronic diseases (see Brief 10). Leafy vegetables and other plant foods contain carotenoids such as lycopene and lutein, which, in spite of having no provitamin A activity, appear to reduce the risk of certain types of cancers. These carotenoids, as well as other widespread compounds called phenolics, act as antioxidants and prevent damage to the body's cells and tissues.

All these resources could be more effectively mobilized in farming systems to help control the rapidly emerging problem of chronic diseases. Although many of these foods, or supplements containing specific food constituents, can be purchased, local sources can be more accessible and affordable for people with limited resources. Moreover, these widely distributed species are components of nutritious food systems for which other potential benefits remain to be investigated. Considering the difficulty in precisely identifying optimal diets, a diverse and balanced diet provides an intrinsic buffer against the uncertainties of change and remains the preferred choice for human health.

BIODIVERSITY AND THE RECONSTRUCTION OF HEALTHY FOOD SYSTEMS

Unfortunately, commercialization of markets potentially limits the opportunities of small-scale farmers to produce and sell minor crops or to compete against the produce of local or foreign commercial farms. Supermarket conglomerates prefer to sell commodities with greater volume, longer shelf life, and guaranteed delivery, while often dictating prices and terms of supply and payment that small farmers cannot operate with. Moreover, with cultural influences such as media and advertisement, novel processed foods often displace native foods and traditional cuisine, which become perceived as inferior or unfashionable.

Efforts to encourage farmers to grow a greater range of agrobiodiversity have had success when they simultaneously increase demand through promotion to consumers, provide technical and management support to farmers, and help create market opportunities. To build on these positive lessons and realize the full potential of agrobiodiversity for nutrition, research is needed on key questions:

- What is the nutrient composition of underutilized species and landraces?
- What is the contribution of native foods from agrobiodiverse food systems to food security, micronutrient nutrition, and health? How can these linkages be enhanced?
- What are the constraints and potential opportunities for greater use of agrobiodiversity in markets?
- What relevance do sociocultural factors in traditional food systems have to agrobiodiversity promotion?

Policy actions are also needed. Policymakers should incorporate agricultural biodiversity into existing global policy tools on nutrition and health. Legislators should introduce measures to use land and other natural production resources to enhance the ability of all to make use of agrobiodiversity. Policymakers should promote local markets and facilitate access to international markets for the products of agrobiodiversity. Finally, they should strengthen the links between human and ecosystem health for the conservation of agrobiodiversity. ■

For further reading see M. Frei and K. Becker, "Agro-Biodiversity in Subsistence-oriented Farming Systems in a Philippine Upland Region: Nutritional Considerations," *Biodiversity and Conservation* 13 (2004): 1591–1610; E. Frison, O. Smith, and M. S. Swaminathan, *UN Millennium Development Goals Five Years Later: Agricultural Biodiversity and the Elimination of Hunger and Poverty*, The Chennai Platform for Action (Rome: International Plant Genetic Resources Institute [IPGRI], 2005), http://www.ipgri.cgiar.org/publications/pubfile.asp?ID_PUB=1062; and T. Johns and B. R. Sthapit, "Biocultural Diversity in the Sustainability of Developing Country Food Systems," *Food and Nutrition Bulletin* 25 (2004): 143–155.

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Understanding the Links between Agriculture and Health

Urban Agriculture and Health

Diana Lee-Smith and Gordon Prain

2020 Vision for Food, Agriculture, and the Environment

Focus 13 • Brief 13 of 16 • May 2006

With half the world's population living in cities and towns, many poor urban dwellers face problems gaining access to adequate supplies of nutritionally balanced food. For many urban populations, an important source of food is urban and peri-urban agriculture (UPA). Production and processing of crops—particularly horticultural crops—and livestock is frequently part of urban and peri-urban livelihood strategies, and the food produced forms a large part of informal sector economic activity. This brief examines the benefits and problems of UPA for the nutrition and health of poor urban and peri-urban populations.

NUTRITIONAL BENEFITS OF UPA

UPA is probably most significant as a livelihood strategy and as a food source in Sub-Saharan Africa. In the cities and towns in East Africa where data are available, on average around a third of urban dwellers are engaged in agriculture, whereas in West Africa, reported figures vary from more than 50 percent in Dakar, Senegal, to 14 percent in Accra, Ghana. As much as 90 percent of leafy vegetables and 60 percent of milk sold in Dar es Salaam, Tanzania, is produced in and around the city. Similarly high levels of urban and peri-urban milk production are cited for Nairobi, Kenya, and Addis Ababa, Ethiopia.

In Asia the picture is more mixed, with China providing evidence of the highest levels of urban and peri-urban vegetable supply. Seventy-six percent of the vegetables supplying Shanghai is produced within 10 kilometers of the point of sale, and in Beijing, the figure is estimated at 85 percent, with 79 percent of fruits coming from peri-urban areas. Intensive vegetable and fruit production is also a widespread livelihood option for urban populations, estimated at 31 percent in urban Beijing and 64 percent in the peri-urban areas. In lowland Southeast Asia, where most of the large metropolises are located, UPA is a smaller supplier of food or source of livelihoods. In Metro Manila about 6 percent of land is allocated for agricultural use, including 2 percent for fishponds; fish production by local people involved in aquaculture and off-shore fishing meets two-thirds of fish demand.

In Latin America, the special conditions created by the U.S. blockade of Cuba led to a massive increase in urban agriculture in Havana and other cities. Currently, agriculture covers about 12 percent of the city area, provides work for 117,000 people, and is the major supplier of vegetables to Havana. Research in Lima, Peru, indicates that between 15 and 20 percent of households are engaged in UPA, mostly landless families raising poultry and other small animals. The three irrigated valleys in the city make major contributions to the vegetables consumed—up to 70 percent for some species.

The production of food in urban and peri-urban areas brings nutrition and health benefits to poor producer households. Studies in Kampala and Kigali, Rwanda, have shown positive correlations between food production and improved nutrition, owing to higher and more stable access to food virtually throughout the year. Urban mothers who were farmers gave a higher level of care to children than did mothers in other types of work.

UPA can also offer nutritional benefits to urban consumers. Poor consumers in Yaoundé, Cameroon, depend on indigenous leafy vegetables, produced almost exclusively in the urban inland valleys, for a major part of their micronutrients. Urban agriculture in Havana has had a significant, direct effect on urban nutritional status, providing a per capita supply of between 150 and 300 grams daily of fresh vegetables and herbs.

THE HEALTH CHALLENGE OF UPA

Although UPA helps secure urban livelihoods and combats hunger and poverty, there are widespread concerns that accompanying health hazards may undermine nutritional and social development benefits. The major health hazards associated with urban agriculture and its products are (1) chemical, involving direct or indirect contact with chemicals; (2) physical, such as injury from tools or equipment; (3) biological, involving direct or indirect transmission of harmful organisms; and (4) psycho-social, related to anxiety and stress.

The dilemma surrounding urban waste and agriculture illustrates the opportunities and risks UPA poses for health. Urban wastewater and solid wastes contain high levels of plant nutrients that could improve soil fertility in areas beset by poor soil quality, like Sub-Saharan Africa. Urban producers have in fact used these nutrients since the days of the earliest human settlements. Yet urban areas discharge large amounts of these nutrients haphazardly, creating high health risks, an unpleasant environment, and environmental damage. Animal manure and human excreta are today rarely used effectively as soil nutrients in urban areas of poor countries. Extensive research and development are needed to find low-cost infrastructure and policy solutions that make better use of urban wastes for higher food production.

HEALTH RISK ANALYSIS OF UPA

Clearly a balance must be sought between the health benefits and risks of urban and peri-urban agriculture. One tool for evaluating this balance in development projects is a health-impact assessment (HIA). Through risk analysis, project developers can better ensure that projects are suited to the unique reality of the community, that the health risks and benefits are identified and addressed, and that the project will be evaluated and accountable to stakeholders.

The steps in an HIA are as follows:

1. Identify and prioritize the most important health hazards and benefits for the city and its population through discussion with multiple stakeholders;
2. Examine hazard exposures for particular populations to think through how to reduce and mitigate these health hazards;
3. Identify who benefits most and how from a specific UPA-derived health benefit and how to promote this benefit; and
4. Formalize outputs from steps 2 and 3 into health hazard mitigation strategies or health benefit promotion strategies.

An example of this HIA process comes from Kampala, Uganda, where HIA showed the existence of real risks, but also uncovered different perceptions of risk by different stakeholders. In the complex policy and stakeholder environment of cities, these different perceptions need to be discussed and negotiated to arrive at common responses (see box).

Case Study: The Kampala Study of the Health Impacts of UPA

Between 2001 and 2005, Urban Harvest, a systemwide initiative of the Consultative Group on International Agricultural Research (CGIAR), documented the nature of urban farming in Kampala, Uganda, where half the land is farmed, mainly in the wetlands of Lake Victoria and its channels. The study involved a stakeholder analysis of the benefits and problems of UPA, followed by a scientific health-impact assessment. Key stakeholders included national and city government agencies, research and environmental organizations, and several local nongovernmental organizations (NGOs). The results of the stakeholder and scientific analysis were consistent in some respects but inconsistent in others.

Stakeholders perceived the main benefit of UPA as nutrition and the main problems as bacteriological and toxic contamination of soils and crops, air pollution also affecting crops, and the transmission of disease from livestock to humans (for more on zoonotic diseases, see Briefs 5 and 9). Indeed, earlier studies from the 1990s had shown that urban households involved in food production in Kampala had better nutritional status than other households. In terms of risk, farmers in Kampala believed that poor sanitation and uncontrolled discharges from a variety of urban economic activities were leading to toxicity in crops. The scientific assessment partly bore out this belief: heavy metals like lead, cadmium, and zinc do accumulate in crops, particularly leafy vegetables, growing within 30 meters of main roads. Yet measurements of heavy metals in various urban crops suggested a limited risk from consumption of tubers grown in wetlands. The level of contaminants in fish, a common source of protein near Lake Victoria, requires more investigation, as does the potential risk for children of consuming raw fruit in areas with high levels of emissions from several sources at once (traffic as well as wood smoke).

Bacterial contamination was not found to be transmitted to crops through their roots or to tubers grown in contaminated wetlands. Clear public health and policy guidelines are needed, however, to inform farmers and consumers about how to reduce health risks from contaminated wastewater. The limited level of risk identified under current circumstances would be further reduced if these measures were implemented.

Studies of animal-to-human disease transmission found that brucellosis appears widespread in livestock in both urban and peri-urban areas of Kampala, but that human infection is low in both producer and nonproducer households. This is probably because of awareness of the dangers associated with consumption of raw milk. But milk samples were found with high levels of antimicrobial residues, which can result in health disorders such as allergies and drug resistance. There is a need for intervention from urban extension services and public information campaigns about the dangers of using these antimicrobials. These results show significant potential health risks from livestock raising for both producers and nonproducers, even if current health problems are still limited. This situation points to the importance of improved policy guidelines and the need for public information campaigns about safe livestock raising.

The overall results of the study fed into a multilevel participatory review of Kampala's health ordinances, which helped raise awareness of the risks from urban livestock raising and other agricultural practices while highlighting its importance as an income source for large numbers of Kampala households. The process concluded with City Council approval of a set of simplified, coherent ordinances, which have been pilot-tested with local residents as part of a sensitization campaign. This campaign needs to deal with another finding of the HIA: even if poor urban farmers and residents understood the health risks posed by UPA, they felt powerless to do anything about them because of their limited options—daily survival and feeding the family are the priorities, especially for women. Thus, implementation of the new ordinances will need to go hand in hand with efforts to improve basic services like water and sanitation as well as to enhance the capacity of UPA to address food security and income needs.

CONCLUSIONS

An adequate health-impact assessment of urban agriculture is still incomplete. Research questions remain concerning the level of chronic disease risk posed by contamination of urban food from air pollution, as well from industrial effluents. Further assessment is needed of the health risks of using biological wastes as fertilizer. Research questions also remain regarding the infectious disease risks posed by urban livestock keeping. Although cooking destroys most pathogens in food, farmers may be exposed to higher risks of infectious disease than consumers through their handling of organic wastes. Adequate waste treatment systems and sanitation need to be provided to poor countries' urban areas, but the technologies should be designed to capture the nutrients in waste for increased food production. Control of discharges into soil, air, and water by industries, whether large factories or small kiosks, is likewise essential. Existing environmental legislation needs to be made effective by proper implementation through both community action and government support in urban neighborhoods. ■

For further reading see *Feeding Cities in Anglophone Africa with Urban Agriculture: Concepts, Tools, and Case Studies for Practitioners, Planners, and Policy Makers*, CD-ROM available from Urban Harvest (CIP-Lima) as part of a web-based course at http://etraining.cip.cgiar.org; and Smallholder Dairy Project, *Public Health Issues in Kenyan Milk Markets*, Policy Brief 4 (Nairobi, 2004).

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Agriculture, Environment, and Health: Toward Sustainable Solutions

RACHEL NUGENT AND AXEL DRESCHER

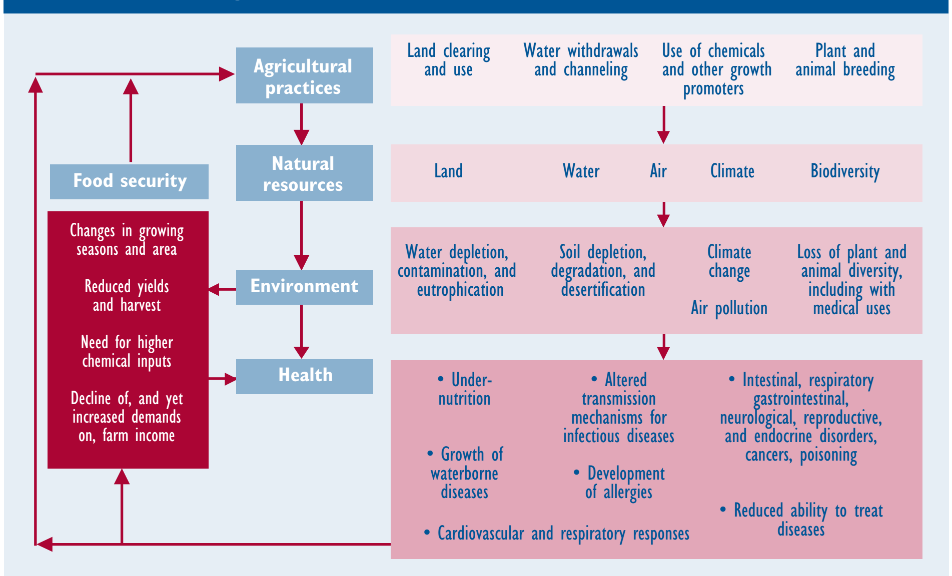
FOCUS 13 • BRIEF 14 OF 16 • MAY 2006

Agricultural production relies on environmental services to transform raw inputs into the nutritious and diverse food that humans rely on for survival. Although the practice of agriculture is essential for human health, careless and inappropriate agricultural practices can degrade and contaminate natural resources and in so doing, harm human health. Modified agricultural practices can help mitigate these problems. This brief provides an overview of the linkages between agriculture, environment, and health, some of which are dealt with in more detail in other briefs in this series.

IMPACTS OF INPUTS TO AGRICULTURAL SYSTEMS ON ENVIRONMENTAL AND HUMAN HEALTH

Agriculture is the oldest form of environmental management by humans. As shown in the figure, some agricultural practices can have negative environmental impacts. These impacts can affect human health directly or, via reduced food security, indirectly. In a bidirectional link, these food security and health outcomes feed back to affect agricultural practices.

Links between Agriculture, Environment, Food Security, and Health



Agricultural practices of particular relevance for health include land clearing and use, water withdrawals and channeling, plant and animal breeding, and the use of chemicals and other growth promoters. Many of these practices are associated with conventional, intensive farming in contrast to traditional, subsistence-oriented farming.

Land clearing and use. Clearance and use of land for crop and animal production contributes greatly to soil problems like salinization, sodification, depletion, and, in the extreme, desertification. The United Nations Environment Programme and others have estimated that, owing to poor farming practices, 38 percent of active farmland suffers from soil loss. The subsequent declines in production capacity have implications for food security. In Mali, for example, between 40 and 60 percent of harvest relies on fragile and low-fertility soils that cannot produce adequate food to meet food security needs.

Land clearance, arable farming, and animal production have been identified as factors contributing to climate change since they can lead to increased concentrations of carbon dioxide and methane in the atmosphere. Many studies now suggest that climate change has important implications for human health, notably cardiovascular and respiratory responses to changing temperature and altered transmission mechanisms of infectious disease. The World Health Organization (WHO) estimates that climate-change-induced temperature change leads to an estimated 10 percent higher risk of diarrhea in some regions. One key large-scale effect is the increased strength of hurricanes associated with global warming. In 1998 Hurricane Mitch in Central America caused almost 10,000 immediate deaths and resulted in widespread water- and vector-borne diseases.

In the other direction, models predict that climate change will adversely affect food production through its impact on agriculture. Of concern for developing countries is the potential for a decrease in grain yields that is expected to hit particularly hard in food-insecure regions. A recent study of the impacts of increased El Niño events shows declining yields of sorghum, millet, groundnuts, and maize in Southern Africa associated with these events. In extreme El Niño years, crop productivity dropped by 20–50 percent. The WHO estimates significant to small changes in malnutrition as a result of climate change. Recent studies challenge conclusions about declining yields globally and attempt to incorporate more realistic scenarios of adaptation, but they do not negate the possibility of significant pest and disease effects.

Land clearance is also associated with the loss of medicinal plants (see Brief 11) and declining biodiversity of plants, animals, and microbes that have the potential to advance medical research. Declining biodiversity—compounded by water withdrawals, agricultural chemicals, and plant and animal breeding and selection—also alters the balance of organisms in the ecosystem, which, like climate change, alters the transmission pathways of infectious diseases.

Water withdrawals and channeling. Agriculture is the largest user of water in the world and alters, depletes, contaminates, and eutrophies water bodies—all of which have implications for human health. Water-associated infectious disease kill approximately 3.2 million people per year, and a significant fraction can be traced back to agriculture-imposed changes in vector habitat and water quality. In the tropics, irrigation has led to increased habitat and breeding sites for vectors that transmit malaria and schistosomiasis (see Brief 6). Throughout the developing world, the use of polluted water in agriculture leads to the spread of viruses and parasites and consequently, diarrheal diseases. From a nutritional standpoint, water development for rice production compromises access to fish by local populations (see Brief 10).

Use of chemicals. Modern agriculture relies increasingly on chemical inputs, notably fertilizers and pesticides, to meet increasing global demand for food and feed. The health impacts of agricultural chemicals are a function of their degree of accumulation in environmental sinks—soil, air, water, plants—and the degree to and form in which humans are exposed to them. It has been estimated, for example, that only 0.1 percent of pesticides actually reaches pests, while the remainder stays in the environment or on food. Overuse of pesticides is also related to declining biodiversity, such as of pollinating bees. Though difficult to measure, both processes have health implications. Much more measurable are the acute effects on agricultural workers using pesticides: millions suffer ill-health effects of pesticides every year, especially in developing countries (see Brief 8). Direct and indirect exposure to agricultural chemicals has been linked to intestinal, respiratory, gastrointestinal, neurological, reproductive, and endocrine disorders, as well as cancers and poisoning.

Plant and animal breeding and selection. Plant breeding and selection are associated with the disappearance of the vast majority of traditional seed varieties from commercial sale over the past 25 years. The reduction of landrace seed varieties in favor of cross-bred modern varieties may threaten food security. Given the concentration of industrial farming on a small number of crops and the increasing use of patented seeds, farmers have few incentives to maintain seed banks of lesser-used food crops. This situation can leave poor farmers vulnerable in the event of higher prices for seeds, as well as exposing all farmers to systemic shocks from natural or market events that adversely affect the dominant crops. Plant breeding and selection also contribute to declining biodiversity.

IMPROVING THE ENVIRONMENT AND HEALTH THROUGH AGRICULTURE

Although some agricultural practices have negative environmental and health implications, they can also be adapted to reduce such outcomes. Greater use of agricultural methods with positive environmental and health implications could promote positive agriculture-environment-health synergies.

"Sustainable agriculture" refers to agricultural systems that aim to reduce or eliminate environmental harms while maintaining adequate food and feed production. Sustainable agricultural practices include:

- reducing fertilizer inputs and replacing them with organic fertilizers or other methods of fixing nitrogen for soil enrichment;
- combining plant varieties, mixed cropping, or increased rotations to avoid monocropping; and
- employing biodiversity-friendly methods such as wildlife corridors or mixed farming areas, and using more indigenous species.

As a philosophy, sustainable agriculture did not incorporate a human health dimension until recently. Sustainable agricultural approaches have been developed to mitigate environmental impacts, but they also reduce human health risks through reduced degradation and contamination of soil and surface water, reduced CO_2 emissions into the atmosphere, and increased biodiversity. Particular forms of sustainable agriculture with potential health benefits include organic agriculture (land husbandry techniques and biological and manual methods instead of chemical inputs), integrated pest management (IPM—biological, cultural, and other less chemically intensive approaches to pest management), conservation agriculture (improved soil management), and plant breeding that promotes biodiversity.

The opportunities in agriculture to apply these techniques are many. In West Africa, for example, where a new breed of rice increases yields without fertilizer, rice farmers are using sustainable growing methods that reduce chemical use and exposure. In Asia, several varieties of rice grown together appear to reduce the need for pesticides and increase disease resistance. West African farmers are working with researchers to grow a wild species of bush mango that fruits sooner than cultivated species—and in the process restores some of the natural biodiversity of the region. More work is needed to heighten awareness of the health benefits of such approaches.

CONCLUSION

To implement sustainable solutions, more specific knowledge of the linkages between agriculture, environment and health is needed, particularly on the human health effects of specific agricultural activities and the cumulative and interactive impacts of multiple environmental changes. And while acute health impacts are relatively identifiable, better knowledge of the chronic health problems that arise from unhealthy agricultural practices is required.

In the meantime, action is needed at the policy level. Policies aimed at environmental protection or resource conservation already exist in many countries. These policies should be enforced and also examined and possibly retooled to ensure that they are maximizing human health benefits. Although any positive health outcomes would be revealed only over the long term, such approaches are needed as human health becomes a higher priority in agricultural decisionmaking. After all, agriculture relies on the productivity of the environment for its survival, and humans rely on agricultural productivity for their survival. ■

For further reading see E. Chivian, ed., B*iodiversity: Its Importance to Human Health* (Cambridge, MA: Harvard Medical School, 2002); L. Cohen, S. Larijani, M. Aboelata, and L. Mikkelsen, *Cultivating Common Ground: Linking Health and Sustainable Agriculture* (Oakland, CA: Prevention Institute, 2004); *Millennium Ecosystem Assessment, Ecosystems and Human Well-Being: Synthesis* (Washington, DC: World Resources Institute and Island Press, 2005); V. Ruttan, "The Transition to Agricultural Sustainability," *PNAS* 96, no. 11 (1999): 5960–5967; World Health Organization (WHO), *Climate Change and Human Health: Risks and Responses* (Geneva, 2003).

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UNDERSTANDING THE LINKS BETWEEN AGRICULTURE AND HEALTH

Agriculture and Health in the Policymaking Process

TODD BENSON

FOCUS 13 • BRIEF 15 OF 16 • MAY 2006

Earlier briefs in this series make the case that there is added value for the agricultural and health sectors in working more closely together to address problems of human well-being that fall at the intersection of the two sectors. Yet the divisions between the two sectors are wide and difficult to bridge. Building the space and providing sufficient incentives and resources for collaborative activities between them will require changes in government policy—itself not a straightforward endeavor. Moreover, the sharp human and financial resource constraints in developing countries compound the challenge.

This brief describes some of the important barriers to effective collaboration between the two sectors and suggests ways to overcome them. First, though, why does policy matter in this context? Policy states how government intends to prioritize the allocation of resources under its control for what is perceived to be the best interest of society. Poor health and stagnant or declining agricultural productivity are among the most fundamental challenges to improved human welfare and economic growth. Government has the responsibility for providing many of the institutions, infrastructure, and resources—key public goods—without which many farmers, in particular, will remain unhealthy, unproductive, and mired in poverty. Thus the policies and actions of government are a critical component in enabling individuals, particularly in rural areas, to live healthier and more productive lives.

CHALLENGES TO LINKING AGRICULTURE AND HEALTH IN POLICY PROCESSES

The seeming inability of members of the agricultural and health sectors to work together effectively and regularly is not surprising given divisions in institutional organizations and their different worldviews and functions. A recent institutional study of how the health and agriculture sectors in four African countries address malnutrition elucidates some of these divisions (see text box).

The Agriculture-Nutrition Advantage (TANA) Project

As an activity of the Agriculture-Nutrition Advantage project, an institutional study was conducted in Ghana, Mozambique, Nigeria, and Uganda between 2002 and 2004. This study examined the opportunities for and barriers to expanding linkages between the agriculture and health communities in order to more effectively address the problem of malnutrition in these countries, with a particular focus on gender. The larger project sought to improve food security and reduce poverty and malnutrition by bringing these two communities closer together so that they combine their scarce resources to utilize them more effectively. The analysis and examples in this brief draw in part on the results of this project.

Institutional divisions. The TANA project found that the sectoral organization of government, with separate agriculture and health ministries and associated institutions, reflects a relatively rational ordering of government tasks. Each sector sees itself as self-contained, with its own individual and usually non-duplicative mandates. This organization has generally proven adequate in enabling governments to manage many of the development challenges they face. This organization of government has the perverse effect, however, of setting the sectors up as competitors in many contexts, particularly over budget allocations to each. This competition renders collaborative efforts more difficult to undertake. In the belief that any such work will result in a net loss in resources for their own institutions, sectors may be unwilling to share resources, even when cross-sectoral approaches are optimal, such as those needed to address linked problems of agriculture and health. As a nutrition officer in Nigeria noted, "Funding is at the core of why there is little interaction between agriculture and health. Everyone wants to be in charge. If [the Ministry of] Health writes . . . proposals that include some agricultural components, Agriculture is unhappy with Health, as Agriculture feels that Health is trying to take resources that should be theirs." The possession by government sectors of distinct and relatively unique areas of expertise is one way in which they are able to make justifiable claims on resource allocations from government. Under conditions of limited resources, conflicts over allocations of those resources actually may result in less collaborative activity, rather than more collaboration to maximize the use of what is available.

Selective worldviews. Agriculture and health professionals have their own selective worldviews in which certain features are prioritized and addressed, while much of the world beyond these areas of expertise is viewed as irrelevant to sectoral objectives. Within the public sector at least, the prime objective of agriculturalists tends to be maximizing agricultural productivity, while for health professionals it is providing health services and preventing ill health. Although attaining these two objectives could be mutually reinforcing, there is little immediate obvious overlap. Moreover, different training paths and institutional backgrounds hinder the development of any common focus. These backgrounds determine how professionals in each sector define the public policy problems they face, the language they use to assess the problems, and the tools that they will bring to bear on them. And each sector has its own performance indicators for judging its own success and that of individuals working within it. As a Ugandan researcher noted, "Even if agriculture and health officers sought greater collaboration at the district level, each would be responsible for reporting on an individual set of indicators—thus there is an inherent disincentive built into this reporting structure against collaboration."

Differing functions. Finally, there are substantive differences in the contributions each sector makes to the well-being of society. Agriculture is a productive activity, creating economic value and sustaining livelihoods. In contrast, the health sector is not a directly productive sector, but is concerned with reproduction of labor in households and in society. If a key objective of a government is to foster economic growth, then, particularly for the predominantly agrarian societies common in the developing world, agriculture will play a central role in development strategies. In contrast, when broad human development objectives guide government action, the health sector receives prominence and agriculture plays a secondary role. These fundamentally different functions in a society's economy contribute to keeping the sectors apart.

OVERCOMING THE CHALLENGES TO LINKING AGRICULTURE AND HEALTH

The two sectors most commonly work independently or even at cross-purposes rather than in harmony. Yet both the agriculture and the health sectors are ultimately working to improve the material well-being of the population. Moreover, as highlighted in this series of briefs, many of the most pressing problems constraining human welfare lie at the intersection of their classic sectoral concerns. Consequently, mechanisms need to be put in place that respect the existing worldviews and functions of each, while also bringing about improvements in general well-being. A win-win outcome should be possible for both as they work to meet their primary objectives—increasing agricultural productivity, while at the same time sustainably improving the health status of the population. Several steps should be explored.

First, opportunities for agriculture and health professionals to undertake joint action should be encouraged to establish a pattern of such activities. Two areas—malnutrition programs and community development—are of immediate interest. The underlying causes of malnutrition include food insecurity in all its dimensions, including agricultural production; poor access to health care; and improper care for the nutritionally vulnerable. For substantial and sustainable reductions in malnutrition in most agrarian developing countries, the health and agriculture sectors need to undertake coordinated action to address its underlying causes. Successes in jointly reducing malnutrition can lay the groundwork for coordinated action on other health and agriculture issues.

In the classic model of community development, community leaders work as mobilizers to guide residents' actions to address local development challenges. Where community mobilizers require technical or broader public support, they can draw upon extension staff, primarily from the health and agriculture sectors, as facilitators. At the community level, development problems often are not neatly categorized into sectors and typically require attention from facilitators in both sectors. Lessons learned in undertaking cross-sectoral action at the community level have the potential to inform how sectoral managers interact at higher levels.

Another area to explore is advocacy to change government policy toward food and health issues and to transform current sectoral patterns of action. A compelling, evidence-grounded narrative must be developed on why health and agriculture issues require a joint public policy response. This narrative should be presented at all levels of public debate, from the grass-roots level, where political demands are made clear to local leaders, to the central government level, where individual policy champions can affect the content of government policy. Advocates must make clear how closer collaboration between agriculture and health will explicitly contribute to the objectives of developing countries' poverty reduction strategies or other dominant development strategy. In Uganda, for example, nutrition advocates participated in the 2003 revision of Uganda's Poverty Eradication Action Plan, ensuring that the plan highlighted improved nutrition as a desired development outcome requiring attention from across the sectors and, in particular, agriculture and health.

Finally, policymakers need to strengthen incentives to encourage health and agriculture professionals to work collaboratively. Community-led development processes place demands on local professionals to work together and, as such, constitute such an incentive. More formal incentive systems also have a role to play. For governments with policies that address development problems at the intersection of agriculture and health, government budgetary and expenditure oversight bodies can justifiably hold the sectors to account in this regard, seeking compliance with these priorities. Nigeria and Uganda are putting in place such oversight bodies both to oversee sectoral efforts to address malnutrition and to build accountability among the sectors in this regard. Similarly, at the individual or sectoral departmental level, annual performance appraisals can require documentation of joint sectoral activities. Joint activities should become part of what is expected of agriculture and health professionals, rather than being exceptional.

MOVING FORWARD

It is not easy to build a consensus within government that cross-sectoral action is needed to effectively address many of the key development challenges facing a society. Such a consensus, however, is needed. This brief suggests some initial steps to put in place the necessary policies and intersectoral relationships. These will not emerge from the normal operation of existing policy processes. Advocates for joint action must engage in the policy processes of governments if these health-agriculture issues are to be addressed in a substantive and sustainable way. ■

For further reading see T. Benson, *Improving Nutrition as a Development Priority: Addressing Undernutrition within National Policy Processes in Sub-Saharan Africa* (IFPRI, Washington, DC, 2005), unpublished manuscript; and C. Johnson-Welch, K. MacQuarrie, and S. Bunch, *A Leadership Strategy for Reducing Hunger and Malnutrition in Africa: The Agriculture-Nutrition Advantage* (Washington, DC: International Center for Research on Women, 2005).

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2020 VISION FOR FOOD, AGRICULTURE, AND THE ENVIRONMENT

Understanding the Links between Agriculture and Health

Opportunities for Improving the Synergies between Agriculture and Health

Robert Bos

Focus 13 • Brief 16 of 16 • May 2006

In principle, all national agricultural, public health, and environmental policies fit within the macroeconomic development policy frameworks that governments regularly adjust to maximize and distribute economic benefits. In practice, however, policies in these three sectors are not sufficiently harmonized to achieve optimal synergies or to prevent them from actually counteracting each other.

This failure to integrate and coordinate sectoral policies stems from the nature of sectors themselves, which are reflections of vested societal interests with sufficient critical mass to claim, in the political process, specific territory and resources in the governance structure (see Brief 15). This system encourages competition—sometimes fierce—between sectors over limited resources and different goals. It leaves little room for collaboration, for integration, and for coordination between them, unless there are clear incentives that supersede the advantages of competition.

INTEGRATION AND COORDINATION BETWEEN THE AGRICULTURE AND HEALTH SECTORS

At the moment, a lack of integration and coordination characterizes the relationship between the agriculture and health sectors. Traditionally, agricultural and health policies address specific goals within those sectors. Agricultural policies address conservation of the natural resource base, protection of farmers' livelihoods, basic needs of the poor including food security, and the context for regulations on, among other things, food safety and the sound use of pesticides. National public health policies are also sectorally driven and reflect the dichotomy in the health sector between preventive action and curative care.

Yet it has long been recognized that development policies, including agricultural policies, are a determining factor for the health status of communities. It was articulated in the 1991 World Health Organization (WHO) publication *The Impact of Development Policies on Health*. The focus was, however, on a one-directional process: to what extent do policies and programs of the agriculture, energy, transport, and other sectors affect health, positively and negatively? Only through the HIV/AIDS crisis in Sub-Saharan Africa was this focus broadened to a bidirectional perspective incorporating the effects of health on agriculture. This perspective shows that the policies that guide decisionmaking in the health sector implicitly underpin the results in the "productive" sectors.

The comprehensive framework (see Brief 1) that underlies the briefs in this series stresses this bidirectional linkage and shows how agricultural producers, agricultural systems, and agricultural outputs are associated with a range of health conditions, through their interaction with the environmental and social determinants of health. The global public health significance of malnutrition and of the diseases linked with agriculture indicate the importance of improving the synergies between the sectors internationally and nationally.

INTERNATIONAL POLICY FRAMEWORKS PROMOTING INTERSECTORAL ACTION

The concept of intersectoral action for health has been on the agenda since the WHO/United Nations Children's Fund (UNICEF) Alma Ata Declaration of 1978. This declaration established the policy goal of "health for all" and proclaimed primary health care as the key vehicle to achieve it. The intersectoral perspective of this goal has remained elusive, however, and often has met with the strongest resistance from within the health sector itself.

The importance of intersectoral action has been historically promoted by the sustainable development movement. The 1987 publication of *Our Common Future* (the Report of the World Commission on Environment and Development) marked the first comprehensive recognition of interdependencies between different sectors at all levels (including at the level of international organizations). It made intersectoral policies and intersectoral action a cornerstone of sustainability. Regrettably, four years later, the seminal global policy document for sustainable development, *Agenda 21*, inadequately incorporated health as a central component of sustainable development.

The new hope for intersectoral collaboration is the Millennium Development Declaration, adopted by 170 heads of state in 2000 and crystallized into the Millennium Development Goals (MDGs). The MDGs represent the first global policy framework for poverty reduction adopted at a level where sectoral divides can be overcome and opportunities for collaborative approaches enforced. The MDGs are therefore a useful framework for identifying the areas where joint policy formulation between agriculture and health can be of significant benefit in reducing poverty. Some areas where greater synergies between agriculture and health could help achieve the MDGs are identified in the table.

Even following the adoption of the MDG policy framework, it continues to be difficult to put critical development issues in an intersectoral context. For example, efforts by the World Bank to help countries reduce international debt and strengthen their socioeconomic situation by preparing and agreeing on poverty reduction strategy papers (PRSPs) could have been a context for improved intersectoral policy formulation. A WHO analysis of a number of PRSPs revealed, however, that they had led to little investment in health-relevant cross-cutting areas (such as the provision of safe drinking water and adequate sanitation). Most of the investments in health remained within the confines of the health sector and focused on strengthening health services.

NATIONAL POLICY FRAMEWORKS TO ENHANCE THE SYNERGIES BETWEEN AGRICULTURE AND HEALTH

There are several ways through which national policy frameworks could be enhanced to promote synergies between agriculture and health. A first option is not specific to the agriculture and health framework: governments can formulate policies that create incentives for any type of intersectoral collaboration that benefits the national good over and above strict sectoral division. Such policies would have to emanate from the highest policymaking level, such as the prime minister's office. They would need to be able to count on the active support of the ministry of finance (which would have to allocate financial resources for proposed intersectoral actions), and they would need to contain clear-cut definitions and criteria to maintain a focus on truly intersectoral issues. Only policies with budget appropriations attached have a chance to overcome the routine competition between sectors.

Agriculture and Health Linkages in the MDGs

MDG	SYNERGIES BETWEEN AGRICULTURE AND HEALTH
Goal 1. Eradicate extreme poverty and hunger.	• Better health is linked to a reduction in poverty, and in turn helps sustain the natural resource base for agriculture. • The security of agricultural livelihoods depends on the health of its members; adults who are ill themselves or must care for sick children are less productive. • Ill-health conditions that may be related to agricultural production systems generate high health costs relative to the income of the rural and peri-urban poor. • Different agricultural production systems have different impacts on health, nutrition, and well-being. • Households can use income from agricultural production for improved access to health products and services. • Some agriculture-associated infections affect nutrient absorption and people's nutritional status.
Goal 2. Achieve universal primary education.	• In rural communities that are healthy there is less demand on children to participate in agricultural production, and school absenteeism is reduced.
Goal 3. Promote gender equality and empower women.	• Promotion of gender equality in agricultural production systems can help focus attention on gender-specific vulnerability to health risks related to specific agricultural tasks.
Goal 4. Reduce child mortality.	• Improved environmental management, fewer episodes of illness associated with agroecosystems, and better nutrition lead to healthy physical and mental growth of children and an important decline in childhood illness and under-five mortality.
Goal 5. Improve maternal health.	• Better maternal health and nutrition increase the chances of a healthy pregnancy and the ability to engage in agricultural activities. • Occupational health policies can target pregnant women working in agriculture for additional protection.
Goal 6. Combat HIV/AIDS, malaria, and other diseases.	• Environmental management practices in agriculture and the combination of integrated pest management and integrated vector management contribute to a reduction in malaria transmission risk. • Ensuring rural communities a proper livelihood from agriculture reduces risky sexual behavior as a source of additional income and thus reduces risk of HIV/AIDS and other sexually transmitted diseases. • Less pressure by infections on the immune system of HIV/AIDS sufferers enhances their potential in agricultural production.
Goal 7. Ensure environmental sustainability.	• Sustainable use of water resources, balanced for domestic and agricultural use, supports healthy communities. • Using wastewater, excreta, and graywater as valuable resources addresses issues of health protection and of water scarcity in agriculture. • Careful use of chemical inputs in agriculture contributes to health protection by avoiding contamination of surface and groundwater.
Goal 8. Develop a global partnership for development.	• Intersectoral partnerships between agriculture and health can act on rationales for synergistic policy development. • Impact assessment procedures by national governments and bilateral and multilateral agencies will enhance the health potential of agricultural development projects.

Source: Adapted from the Water Supply and Sanitation Collaborative Council, 2004.

A second option is to carry out bisectoral or multisectoral policy reviews aimed at harmonizing existing policies, identifying opportunities for reciprocal action to address each other's concerns, and formulating new policies that support the concept of intersectoral collaboration. This option, though cumbersome, may result in a sustainable process that could have a long-lasting impact. Such policy reviews will be most productive if they are conducted for issues that require policy review for other reasons, thus avoiding the impression that the initiative is a special plea for the health sector's interests. For example, countries with increasing water scarcity may identify wastewater as an important resource in agriculture and formulate policies for its optimal use. This policy change would provide a good occasion to ensure that this new resource is used not only productively, but also in ways that protect the health of agricultural producers, their families, and the consumers of products cultivated with wastewater.

Another objective of such reviews would be to identify perverse policies—that is, sectoral policies that contradict and counteract each other. For example, in some countries the agriculture sector has policies in place to subsidize tobacco growers while the health sector has policies to prevent smoking-related illness.

A third policy area is impact assessment. Over the past 25 years, most countries have developed a policy framework for environmental impact assessment, or EIA (often under pressure from multilateral and bilateral donor agencies). Health continues to be a weak element in this framework. EIAs categorize health as determined by environmental factors only, ignoring the social determinants. They formulate recommendations that put the onus mainly back on the health sector, thus transferring to the health sector the hidden costs of development. And they do not sufficiently recognize the health ministries as the final authorities in matters of health. At the same time, the health ministries often do not have the capacities, capabilities, and jurisdiction needed to participate effectively in such assessments.

A policy that promotes a distinct health-impact assessment procedure, or HIA (implemented in parallel and in consultation with the EIA procedure) will ensure that the health impacts of any new agricultural development project or new agricultural policy are considered in a timely fashion and that a public health management plan that ensures intersectoral action can be prepared (see Brief 13).

This policy area needs to be addressed not only at the national level, but also within bilateral and multilateral development agencies that provide financial support for agricultural development. These agencies themselves must review their decisionmaking criteria for projects and adopt policies that ensure that health safeguards are incorporated where relevant.

Finally, the health sector may need to formulate and adjust its policies to strengthen its capacity to deal with other sectors in general, and the agriculture sector in particular, on issues of joint interest. Admittedly, for a number of issues (food safety, nutrition, livestock, and veterinary public health) such policies may already exist. Yet the health sector remains deficient in its capacity to effectively deal with the agriculture sector across the board. The parts of the health sector that would need to work directly with the agriculture sector are frequently underfunded, have no formal arrangements for intersectoral roles and responsibilities, and have staff with inadequate skills for intersectoral negotiation and decisionmaking.

In conclusion, a conducive policy framework is essential for effective agriculture-health collaboration. This framework should be comprehensive, focus on strategic issues, be periodically reviewed and updated, and maintain criteria that recognize the bidirectional nature of the links. Not only are these policies important at the national level, but they should also be introduced at the level of international organizations and bilateral and multilateral development agencies. ■

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2020 FOCUS 13

May 2006

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