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The Right to Health in Tropical Agriculture

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About the Lecture Series

The Distinguished African Scientist Lecture Series was initiated by IITA's Board of Trustees in honor of a former Deputy Director General of IITA, Dr. Bede N. Okigbo, whose knowledge of agriculture has been described as encyclopedic. Dr. Okigbo himself delivered the first lecture in the series in April 1989, while Professor O. Abovade, Chairman, Presidential Advisory Committee, Nigeria, delivered the second lecture in April 1990.

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The Right to Health in Tropical Agriculture

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Introduction

I should like to thank IITA's Board of Trustees for inviting me to deliver the Third Lecture in the Distinguished African Scientist Lecture Series. I consider it a singular honor, and I welcome this opportunity to pay tribute to Dr. B.N. Okigbo and to share my thoughts with you on a subject that I consider to be important in our part of the world.

The Board suggested that I speak on an aspect of sustainable agriculture in sub-Saharan Africa. I have given the matter considerable thought and I have decided to address the subject, "The Right to Health in Tropical Agriculture." My emphasis is on people and the health hazards that they face in agriculture in some parts of the tropics.

I believe we are all agreed that agriculture is a complicated activity requiring a complex of inputs, including crops, good soil, water, and fertilizers, but the human being is undoubtedly a key input for its successful operation. Certainly, sustained agriculture cannot be achieved without a maximum involvement of people, sound in body and in mind. The well-being of agricultural workers is of paramount relevance in the practice of agriculture because a healthy farming community is more likely to sustain productive agriculture than one weakened by infections and diseases and preoccupied with ill-health.

It is a matter of grave concern to me that the health of the agricultural practitioner hardly gets half the attention lavished on the health of

1. Formerly Director, Regional Office for Africa, and Regional Representative to Africa, United Nations Environment Programme (UNEP). Presently Director, Environmental Management Services, P.O. Box 49, Achimota, Ghana.

the crops that he cultivates. We owe it to the continued effectiveness of the practice of agriculture that agricultural communities are protected from the avoidable infections to which they are exposed because of their occupation.

I have chosen to focus on this subject because I think that the severity of the infections and diseases that are associated specifically with the practice of agriculture is not sufficiently recognized. Some months ago, I had occasion to address a group of agricultural scientists on the subject of the health hazards of farming inland swamps. Their reaction to that presentation and the usual attitude elsewhere to the broader subject of the health dimension of farming in tropical regions left me convinced that the subject must be more widely discussed.

The issue is this: in parts of the rural tropics, an impressive array of human infections and diseases are endemic and common. They are mostly supported by environmental factors under which agricultural communities live and work. Ecological conditions created by water intensive agriculture support one group of responsible pathogens. Other pathogens are favored by situations where water for the domestic and personal use of agricultural communities is inadequate.

Either way, these infections and diseases constitute a formidable scourge for rural agricultural workers and, most decidedly, deny them their right to good health. It is essential that this problem is given serious attention and some sustained and vigorous preventive action is seen to be taken.

To an extent, it is understandable that the problem tends to be ignored because, in developing countries, the health problems facing all sections of the population are legion. In the normal order of things, some justification is always found why problems of agricultural communities should not be singled out for special attention. But the health hazards faced are enormous and, for the vital service that agricultural communities provide, I believe they deserve a right to be specially considered.

Background and purpose

In the early 1970s, I visited northern Ghana, Burkina Faso, Guinea, and northern Ivory Coast as part of an Onchocerciasis Control Programme (OCP) Technical Advisory Group field mission. From the air, I could see abandoned villages in the valleys of the rivers in the Volta River system. On the ground, in a remote village, the scene which greeted us is vividly etched on my mind. We were faced by a large crowd of seemingly able-bodied men and women, crouching on the ground, totally unaware of our approach. We discovered that they were all blind. The blackfly, *Simulium damnosum*, whose vicious and persistent bites had driven the rural communities away from their villages and farms, had also infected them with river blindness, onchocerciasis, and condemned them to a life of darkness, unable to till their farms in the fertile valleys of their homeland.

For each one of them, there are hundreds more in agricultural communities who, in the course of work, have been infected with filariasis, schistosomiasis, guinea worm, relentless malaria, and a complex of crippling, often fatal, diarrhoeal and dysenteric diseases.

Recently, I listened to groups of workers from a relatively prosperous private farm and a government-owned irrigation scheme elaborate on the various ailments that assail them. It seemed that the regular bouts of malaria which they suffer along with the bites of leeches are nothing compared to the abdominal cramps from diarrhoea, the painful passage of bloody urine, and the persistent mixture of itch and pain from fungal infections between their constantly waterlogged toes.

Since some of the misery and threat to life can be avoided, it bothers me that the subject is not sufficiently acknowledged. Please stay with me so that, together, we may explore this important subject further within the context of productive agriculture.

It is relevant, as a background issue, to emphasize that in our region, agriculture is not easy and establishing food sufficiency through

sustainable agriculture is an even more difficult task. This also accounts partly for the scant attention given to the human health dimension of tropical agriculture.

Generally, many problems directly related to crop cultivation seem to need immediate attention. The erosion of top soils, the loss of soil fertility, and the formation of laterite are only a few of the problems faced in the constant battle to practice agriculture on fragile soils, usually without the benefit of necessary supporting inputs.

Pest infestation, seemingly twice as vicious as elsewhere, has become a hallmark of tropical agriculture. Few places outside tropical regions perhaps experience the violence of swarms of rapacious locusts, capable of completely destroying carefully tended fields of ripe crops just before harvesting. And still fewer may have watched the relentless march of battalions of armyworm devouring and devastating all acceptable plants in their path. The silent ones, the viruses, nematodes, and fungal parasites, contribute to the problem by selecting and destroying major food crops and other plants of economic significance.

As if these are not enough, there is always the crucial issue of water for crops. Africa occupies just under a quarter of the total world land mass, and yet, it has the lowest level of availability of water in millimeters per unit area, with over 70% of the rainfall failing to reach rivers and lakes because of evaporation and seepage. Furthermore, the distribution is such that 75% of the entire continent's surface water resources is in a few rivers and lakes, with the Congo basin alone holding about 50% and the large deserts of the Sahara and the Kalahari characterized by lack of water and prolonged severe droughts.

Seasonal rainfall alternates with harsh dry seasons: streams which provide water for the use of rural communities are subject to the vagaries of drought and they tend to be intermittent in flow. For the most part, food production is dependent on rainy seasons which often fail.

In contrast, temperate regions have an advantage which is generally taken for granted. The heavy precipitation of snow during the winter months soaks into some types of soils and keeps the land moist for the greater part of the spring and summer cropping seasons. When people despair of the failure of food sufficiency in some water-short areas of our region, I wonder if they realize the enormity of the water problem and how lucky temperate zone farming communities are.

Against such a heavy burden of problems seen to be directly related to crop cultivation, it is not surprising that the health problems of agricultural communities tend to be ignored unless they are dramatically demonstrated by disastrous and spectacular mass epidemics.

To briefly reiterate the basis for this presentation:

- **My subject** is the right to health in tropical agriculture.
- **My emphasis** is on people without whom there will be no agriculture.
- **My concern** is the risk to which they are exposed by virtue of working in certain environments in the tropics.
- **My purpose** is to look at the disease-causing organisms, how they operate, the diseases that they cause, and the conditions and factors that support and encourage them, such as freshwater ecosystems, unsafe human waste disposal, and inadequate domestic water supply. If any effective remedial action is to be taken to protect the good health of agricultural communities, there must first be a systematic examination of these relevant factors and a deliberate effort to appreciate how they contribute to the problem.

Freshwater ecosystems

Bear with me, therefore, while we remind ourselves briefly of the nature of freshwater ecosystems, which provide a link between agriculture,

on the one hand, and the parasites which inflict infections on agricultural communites, on the other. I assure you that this is not a diversion from my subject. It is highly relevant to our discussion.

In nature, freshwater is found in lakes, rivers, and streams of different dimensions, in a variety of wetlands, such as mangroves and estuaries, and underground. Man also creates irrigation dams, canals, and water distribution systems. All these forms of surface water bodies, in reality, are living water ecosystems, each consisting of a rich community of interacting flora and fauna in an aquatic environment, itself characterized by a complex of factors, including the intensity and penetration of light, dissolved gases, nutrients, pH range, and even toxic substances.

The plants in the medium are largely synthesizers, but there are also macrophytes, which may be submerged, rooted, floating, or emergent. The faunal biomass, apart from fishes, is dominated by invertebrates represented by free-living single-celled protozoa, mainly flagellates and ciliates, sponges, molluscs, both gastropods and bivalves, freshwater worms, mostly tiny free-living nematodes, some true worms, the Oligochaeta, flatworms of the class Turbellaria, and leeches belonging to the class Hirudinae.

Usually, the largest component of the fauna is arthropods belonging to the major classes of Arachnidae, water-inhabiting mites and spiders, crustaceans, such as copepods, water fleas, shrimps, and crabs, and the Insecta represented by a rich variety of the larval stages of the Ephemeroptera (mayflies), Odonata (dragonflies), Trichoptera (caddis flies), and Diptera (flies), including chironomids, mosquitoes, and the blackfly. These aquatic fauna and flora have an obligatory dependence on freshwater ecosystems.

The point relevant to the issue is that some aquatic organisms serve as intermediate hosts for some human pathogens. Snails of the genera *Lymnea, Bulirus,* and *Biomphalaria* are used by

trematodes, which are parasitic worms, to produce infective larval stages. A number of crustaceans, including cyclops for the guinea worm and crabs for some tapeworms, provide a similar service. Some of the aquatic larval insects become adults which transmit various human parasites. They include *Simulium* species for the worm *Onchocerca volvulus*, which is responsible for river blindness, and mosquitoes, which are actively involved in the spread of malaria and various filarial diseases. Even freshwater plants, such as the water-cress and water chestnut, are involved in the transmission of human parasites.

As regards freshwater sources that are of use to human beings as well as to agriculture, let me underscore two important points:

1. Freshwater ecosystems are the natural habitats of aquatic animals and plants. Unless a water body dries out or is otherwise so drastically changed as to make it uninhabitable for long periods, aquatic plants and animals will always breed in it, irrespective of the use to which the water body is put by the human being.

2. Since some of these aquatic organisms are intermediate hosts for human parasites, as long as parasites and agricultural workers and their families are brought together through the mutual use of a water source or its surroundings, chances of infection will always remain, to put people at risk.

These are simple ecological facts. They will not change.

Pathogens: their role and importance

Let us now consider the pathogens responsible for the infections and diseases that threaten health in rural agricultural communities.

Human beings are affected by various diseases, irrespective of where they live or work. Lack of adequate food and malnutrition, in particular, threaten the maintenance of good health. For the present, I am concentrating only on a

category of diseases which affects rural communities by virtue of their association, directly or indirectly, with environments in which agricultural activity is conducted. Admittedly, these infections are not limited to rural regions of Africa. Some of them strike wherever conditions support them, but they seem to thrive best in the warmth of the humid tropics.

The important point to stress is that human beings are definitive hosts for a number of organisms, including viruses, bacteria, protozoa, and helminths, which are pathogens and parasites. I suggest we remind ourselves of the general nature of pathogens and parasites and examine why they seem to be so successful.

Parasites live in or on other organisms, deriving benefits from them and generally causing harm. They have evolved an arsenal of features, which makes them effective for their nefarious occupation. Parasites are not pleasant creatures and they are nobody's friend. But I do hope that you also will find, in a purely academic way, the amazing characteristics, devious intrigues, and clever machinations of parasites as fascinating as I do.

Because they live in environments where they face reduced competition, compared with their free-living relatives, parasites have become modified structurally and physiologically, discarding some body structures that they do not need and developing or adapting others to suit their parasitic life. For instance, because endoparasites obtain oxygen and nutrients by absorbing them directly from the hosts, who also receive their wastes, they have simplified or reduced digestive and excretory systems. But they have various effective methods and implements for staying safely attached within their hosts.

Since they are so dependent on others, it is to be expected that the survival of the race would be a major objective of parasites. Accordingly, they have evolved outstanding features and clever methods to meet this end.

Parasites have a prodigious capacity for reproduction. Excreted viruses, for instance, are

capable of multiplying into millions. Infected persons have been recorded to shed a million particles per gram of feces. Bacterial and protozoan parasites can multiply rapidly by asexual methods to produce copious "showers" of cysts.

Helminth parasites have been reported to lay many eggs. For instance, paired adult schistosomes can live for 6-40 years, during which time they produce hundreds of eggs a day. The human roundworm produces 200,000 eggs per day. Hookworms live for up to 7 years and continuously lay eggs at the rate of 10,000-20,000 a day. An amazing record is that up to 5,000 of the parasitic worm *Chlonorchis sinensis* can be held in the human bile duct at any time, with each producing 2000-4000 eggs a day. And each mature segment of the tapeworm *Taenia solium* is filled with 30,000-90,000 eggs.

Parasites are not content with their fantastic capacity to produce large numbers of cysts and eggs. The helminths, for example, use various freshwater organisms, as previously indicated, as intermediate hosts to increase the number of infective larvae that they produce. The terminal sporocyst of the liver fluke in the aquatic snail host *Lymnea truncatulatus*, for instance, is a mere sac whose internal cells give undivided attention to the budding of cercariae, to make sure that some, at least, will reach new victims.

Blood parasites are even more clever. They play it safe and take no chances. For instance, the malarial parasite and the worms responsible for river blindness and filariasis stay their entire lives within the definitive and intermediate hosts, multiplying and moving from victim to victim, without ever seeing the light of day.

Where a parasite spends a part of its life history in the outside environment, it is usually well protected and assisted in its task to carry on the race. For example, although adult flukes and schistosomes are not ciliated, the free-living stage, the miracidium, is well provided with cilia to help it swim to the intermediate snail host. Bacteria and protozoa form cysts for life in the outside environment. The egg of the roundworm has an effective protective coat and the

developing larvae of the hookworm, under suitable external conditions, can stay viable for long periods.

Parasites leave nothing to chance. They have evolved several routes to assure reentry into their victims. Their cysts and eggs may be passively ingested, the infective larval stage may actively penetrate the skin, or it may be passively introduced into a victim by a transmitting agent.

Trade union rules are strictly observed by parasites through a host-specificity system, which requires that a species be restricted to one host. For example, should the human roundworm infect a pig, it will not reproduce in it and the human malarial parasite does not infect other animals. To cap it all, parasites maintain their stocks through reservoirs established in various animals including crustaceans, fish, some mammals, and human carriers.

There is no doubt at all that parasites are well equipped for their terrible trade and this makes them a formidable adversary to human health. They need to be tackled with a determined and well-planned control strategy. With so many particles of viruses, bacterial and protozoan cysts, nematode eggs, cercariae, and transmitting flies around in the environment, it is surprising that many more people are not infected by these pathogens. I like to believe that this is an indication of the human being's superior capability to deal with them.

After that general consideration of pathogens and parasites, please come with me to look at some real pathogens that threaten rural agricultural communities.

Types of infections/diseases

For convenience, I distinguish three types of infections and diseases.

1. Pathogen-based infections and diseases, acquired through prolonged contact with infected surface waters.
2. Pathogen-based infections that occur in situations where water supply for domestic and personal hygiene is inadequate.

3. Nonpathogen-based diseases, due to contaminating chemical substances.

Of the pathogen-based infections and diseases associated with freshwater ecosystems, schistosomiasis, in endemic areas, is the most common. Infection is acquired as a result of prolonged contact with transmission sites, which are associated with standing or slow-moving waters. The damming of rivers and streams to create large reservoirs, farm and irrigation ponds and the extension of irrigation canals and water distribution systems have contributed to ecological conditions that spread schistosomiasis.

Africa has both urinary schistosomiasis caused by *Schistosoma haematobium* and intestinal schistosomiasis due to *S. mansoni*. When the parasite's egg enters the freshwater medium because of contamination with the excreta of an infected person, it hatches into a free-living larva, the miracidium, which then seeks out and enters a suitable aquatic snail host, *Bulinus*, or *Biomphalaria* spp., and develops into cercariae, after some time.

Cercariae initiate infection by actively penetrating the skin of the victim. People are infected with schistosomiasis only because they come into physical contact with surface waters containing cercariae. Schistosomiasis is not a water-borne infection. People do not normally become infected through drinking water. It is important to stress that infection is through physical contact with infected waters. People can avoid infection if they use safer alternative water supply sources, which keep them away from contact with infected ponds, rivers, and canals.

Let me take a minute to look at what happens after the cercariae penetrate the skin, because I think you will find it interesting. Using special glandular secretions, the cercariae wriggle their way through the skin, eventually into blood vessels associated with the intestinal or urinary circulation. They develop, in a few weeks, into mature male or female schistosomes. The sexes pair up and the male, which has a deep ventral groove, holds and keeps the female

permanently attached in it for a life time of up to 40 years. The adult female starts laying spined eggs. Bloody urine and stool indicate damage to the blood vessels of the intestines and the urinary tract by the passage of the eggs. Disease is caused by eggs that become lodged in tissues. With *S. mansoni* infections, the liver and spleen become enlarged and cancer of the bladder is a feature of advanced cases of urinary schistosomiasis.

The current massive schistosomiasis problem in the Sudan began with the construction of the Sennar Dam and the extensive Gezira irrigation scheme some decades ago. In Egypt, the schistosomiasis problem worsened with the practice of perennial irrigation after the Aswan High Dam was built. On both the Volta Dam in Ghana and Lake Kainji in Nigeria, with the establishment of *Bulinus* populations after the rivers slowed down and the association of infected people with the lakes, the incidence o schistosomiasis rose alarmingly in places wher the disease was previously unknown.

Schistosomiasis is an ugly disease that in fected persons suffer in silence, since rarely i there immediate violent death to register th disease. Indeed, I have been told that infecte people often look on the disease as a way of lif and, therefore, that it should be so accepted.

However, the fact remains that schis tosomiasis is an insidious, debilitating oc cupational disease which affects people engage in water-intensive agriculture and fishing. It i a chronic, long-drawn-out disease of publi health importance, which continues to clain new victims. Most children in constant contac with infected waters are heavily infected by th age of 14 and many adults have diseased bladders by the time they are 40 years old.

Schistosomiasis causes an estimated mortality of about 200,000 people a year in 76 countries. The number of cases is believed to be 20 million, with 500-600 million more considered at risk.

Essentially, schistosomiasis is a disease of poverty. Communities which cannot afford

water supply away from infected sites are the most infected. Ignorance is a major contributory element in the spread of schistosomiasis, but better management of human waste, reliable domestic water supply, and limited contact with transmission sites are basic measures in any control program.

Where a pathogen is transmitted by a water-dependent fly, a victim does not need physical contact with a water source to be infected. Anopheles mosquitoes, for instance, breed in reasonably clean waters of irrigation systems, and they bite victims, sometimes away from the site, to transmit the protozoan parasite, *Plasmodium* sp., to man to cause malaria.

It has been estimated that 267 million people are infected with malaria in 103 countries, and there are 107 million clinical cases a year, with a mortality rate of 1-2 million, and a further 2,100 million at risk. It is a weakening and killer disease, which takes a heavy toll in illness and death among children. Prophylactic drugs and methods that discourage mosquito bites are the most common preventive measures in use.

The larvae of *Mansoni* sp. mosquitoes are found in weedy standing waters. Some adult species are involved in the transmission of *Brugia* filariasis which, though not fatal, is quite disabling. Worldwide, there are an estimated 90 million people infected in 76 countries, with 905 million more threatened.

The tse tse fly transmits the flagellate parasite *Trypanosoma brucei rhodesiense*, which causes African sleeping sickness. The fly uses the moist humid areas bordering swamps and water bodies for breeding. The number of cases has been estimated at 25,000 per year in 36 countries, but 50 million more are believed to be at risk.

As regards the blackfly, *Simulium damnosum*, the aquatic stages develop where streams and rivers have a required speed and turbulence. It is capable of flight over long distances to find a victim. It transmits *Onchocerca volvulus*, the worm parasite responsible for river blindness. Like mosquitoes, the female blackfly requires a

blood feed before oviposition, and it uses the bites to transmit parasites from person to person. Microfilaria subsequently produced by adult worms in the victim cause disease during migrations through the body. They cause disfiguring dermatitis, ocular damage, and blindness. Some 17.6 million people are infected, including 326,000 already blind, and 905 million people are estimated to be at risk in 34 countries.

Prior to the construction of the Volta Dam in Ghana, the blackfly used to breed profusely in the rapids of the river as well as in the Volta River system, spanning 7 countries in West Africa. The Onchocerciasis Control Programme has reduced the problem to some extent but, with ecologically suitable breeding places still in existence, it would be too much to expect that the problem will be completely solved soon. These fly-transmitted parasites persist mainly because the association of rural communities with the vicinities of surface waters maintains active contact between people, the transmitting flies, and the pathogens.

Diseases related to shortage of water

The second group of pathogen-based health problems which threaten agricultural communities result mainly from conditions in the living environment. Most of the diseases are caused by fecal-related pathogens. Environmental diseases are serious, because many of them are infectious and they constitute a hazard to whole communities.

In contrast to the first group, these diseases occur wherever there is a shortage of water, especially for domestic and personal hygiene, and human waste disposal is unsatisfactory. In many rural farming communities in tropical Africa, unfortunately, such conditions seem to be the norm, not by design or choice, but by circumstance.

I should emphasize again that environmental diseases are not limited to rural agricultural communities in the tropics. They occur worldwide, wherever unsafe disposal of human waste and insanitary conditions prevail.

In some industrialized countries, before the improvement of human waste disposal and hygienic practices, fecal-related environmental diseases were equally serious. Previously, typhoid used to be a common killer and there were serious outbreaks of cholera. And until the widespread immunization against poliomyelitis was introduced, it was common for children to be disabled by the disease. Even now, in the poorer regions of industrialized countries, diarrhoeal diseases, infectious hepatitis, and worm infections continue to be periodically reported.

The essential point about this group of infections and diseases is that a variety of organisms live normally in the human intestinal tract. Some of them are pathogenic and they cause diseases, often characterized by diarrhoeas and dysenteries.

So much has been spoken and written about diarrhoeal diseases that the misery and agony of infection have become overshadowed by statistics and slogans and left only to the sufferers to experience and bear in silence. In some tropical developing countries in Asia, Latin America, and Africa, village after village is without satisfactory public health standards. Sometimes babies are born healthy only to be riddled at an early age with disease-causing viruses, bacteria, protozoa, and helminths. They die young or face a lifetime of periodic painful attacks of diarrhoea, which herald or accompany more sinister, insidious, and debilitating diseases. Their living conditions deprive them of a right to good health, even as they are born.

This is a common pattern of life in many parts of our region, and it demonstrates graphically the end result of a common legacy characterized by a lack of basic facilities, diseases, and overall poverty.

For the intestinal pathogens, human waste is a major evacuation vehicle. The pathogens are readily transmitted to new victims from fecal-contaminated backyards of houses, playgrounds, farms and fields where sewage is used as fertilizer, and even from the vegetables

produced from such fields. Where personal hygiene is unsatisfactory, pathogens on fecal-contaminated hands, fingers, nails, food, clothes, or flies are readily ingested. The fecal/oral entry is the route most effectively used by fecal-related pathogens. Safe human waste disposal and adequate water supply at home are key factors in the fight against these pathogens.

Most of these fecal-related environmental diseases are due to viruses, bacteria, protozoa, and helminths. Let me give some examples.

Excreted viruses are found in the human digestive tract. The Hepatitis Virus A, responsible for infectious hepatitis, and the polio virus, which has a crippling effect on the central nervous system, are examples. The Rotavirus group, in particular, is significant in diarrhoeal diseases.

Bacterial infections due to the *Salmonella* group are often characterized by acute diarrhoeas and abdominal cramps. Typhoid fever, which can be fatal, is due to *Salmonella* spp. Another group of parasitic bacteria, *Shigella* spp., is responsible for bacillary dysentery, and *Vibrio cholerae* is the agent responsible for the dreaded cholera epidemics, which kill hundreds of people.

Protozoan pathogens include *Entamoeba histolytica*, which causes amoebic dysentery. Some 350 million persons are reported infected with amoebiasis. A ciliate protozoan parasite, *Balantidium coli*, and a flagellate, *Giardia lamblia*, are also common dysentery-causing protozoa.

Helminth infections rate high among rural diseases. The parasites belong to a number of genera. They include the human roundworm (*Ascaris lumbricoides*), hookworm (*Ancylostoma duodenale* and *Necator americanus*), the pinworm (*Enterobius vermicularis*), threadworm (*Strongyloides stercoralis*), whipworm (*Trichuris trichiura*), and parasitic flatworms (*Schistosoma* spp.).

A 1976 global study estimated that 650 million people were infected with *Ascaris*, 350 million with whipworm, and 200 million with schistosomiasis. Hookworm disease has been shown to have vigorous transmission near

water bodies associated with agricultural fields. Like threadworm, hookworm infection is effected through the active penetration of unprotected skin of the victim by the worm. It is believed to infect some 700 million people. Blood sucking leeches are a terrible threat on irrigation schemes, though they are hardly recognized as such.

Let me sum up on these environmental infections and diseases by saying that diarrhoeal and dysenteric diseases are poverty ailments, resulting mainly from lack of basic facilities and education. Tackled systematically, they can be overcome. They are perpetuated by inadequacy of domestic water, insanitary conditions, and ignorance of the need for frequent washing and hygiene to keep pathogens at bay.

It is important to repeat that these infections and diseases are not limited to rural Africa. They occur also in Europe, Asia, Latin America, and in fact worldwide, wherever insanitary conditions encourage them. They are most potent where people have been weakened by malnutrition. The recorded estimates of infections underline the dangers posed by these pathogens.

The safe management of human waste keeps pathogens away from people. Adequate water supply at home makes it feasible to practice domestic and personal hygiene; it prevents pathogens from completing the fecal/oral transmission cycle. Some simple practices contribute to the prevention of infection. For instance, avoiding contact with transmission sites breaks the infection cycle of schistosomiasis; wearing shoes provides some protection against hookworm and threadworm infections. Water and its sensible use are crucial to health security in rural communities.

Unfortunately, in some rural areas, domestic water supply has to be hauled laboriously, by women and children, from surface and groundwater sources long distances away. And they can never carry enough. The current rural water supply problem is largely that there is never enough water at home for domestic chores as

well as personal hygiene. What agricultural communities need is reliable and adequate supply of water at home.

This fact must be fully appreciated as relevant to decisions on the improvement of rural water supply in developing countries, especially where some developers shy away from the use of surface waters, already safely and amply supplying rural communities. They tend to see surface waters as "impure," unless they are given the full treatment applied to municipal water supply. Even where surface water is readily accessible, they tend to prefer groundwater bore holes and wells as the water supply source, without much concern about water quality or recharge capability.

In this connection, it is relevant to note that the presence of *Escherichia coli*, usually taken to be indicative of fecal contamination, does not necessarily imply the presence of fecal-related pathogens capable of causing infection through drinking water. In reality, only a few fecal-related pathogens use drinking water from surface sources as a normal route for infection. A study of the fecal-related pathogens which we are now considering shows that most of them can neither survive nor complete their development and life cycles in surface waters.

Chemical contamination

The third set of health hazards is posed by nonpathogen-based diseases, resulting mainly from chemically contaminated waters. For agricultural communities living under conditions where safe domestic water is inadequate, the consumption of chemically contaminated waters can pose serious problems.

In recent years, various forms of chemical compounds have increasingly found their way into the environment. A wide range of synthetic fertilizers, herbicides, and pesticides are used in agriculture. In one country in this region, it has been estimated that in one year, 300 tonnes of DDT and 120 tonnes of active lindane were used, with other organophosphates, to protect the cocoa crop in 1976.

In the OCP, an organophosphate, abate was used to spray *Simulium* larvae in the Volta River system for about 10 years. The molluscicides, bayluscide and frescon, have been widely employed against aquatic snails in bilharzia control programs. Excesses of these chemical compounds and their component parts, as well as of others, discharged through industrial wastes, eventually leach into surface and ground waters. There have been records of DDT and dieldrin in rain as well as in surface and ground waters.

For most of these chemicals which contaminate surface and ground waters, the human safety limit is low. High nitrate levels have been linked to infantile cyanosis. Other chemicals from industrial and mining waste releases likely to contaminate surface and ground waters include cyanamides, fluorides, and mercury.

Many of the contaminating chemicals are carried in water, soil, some fish, vegetables, and other materials in common use. They can affect communities irrespective of their location or occupation. I draw attention to them in this presentation mainly as potential health hazards in situations where they are likely to be consumed in large quantities from unsafe water sources.

Summary and implications

I have deliberately emphasized the key place of people in agriculture, elaborated on freshwater ecosystems and their biota, described some relevant pathogens and the human diseases that they cause, and indicated the crucial role of water and waste management in any strategy to protect the health of agricultural communities.

I am particularly concerned at this time about people because, in this region, where feasible in the near future, we shall have to extend irrigated agriculture, with both small-scale and large-scale schemes, to produce food and other crops and, consequently, there may be an escalation in the spread of some diseases.

In the early 1970s, the irrigated area of Africa was estimated to be only around 8 million

hectares out of a total cultivated area of about 150 million hectares. What bothers me is that despite the known impact of irrigated agriculture on the spread of some diseases, and especially schistosomiasis, much more thought still goes into the planning of large irrigation schemes for plants than to the provision of domestic water supply for workers and their families, who invariably end up drawing water from irrigation ponds and canals supplying the schemes.

Human waste management also tends to be ad hoc and unsafe. And, judging from the Gezira experience, should irrigation become widespread in this region, populations associated with the schemes may become widely infected with schistosomiasis and other fecal and water-related diseases. The tragedy is that, in the midst of so much water in irrigation schemes, agricultural communities will continue to be denied safe domestic water supply, and the situation will continue, unless, of course, we insist that, in the matter of water, the people should be given a similar privilege as the crops.

Another point that worries me is that although the health issue is large enough to be visible, generally it tends to be overlooked. In the several decades that I have been associated with national agricultural research and within the last couple of decades that I have had the opportunity to observe international agricultural research closely, I have been impressed and fascinated by the ingenuity of agricultural scientists as they have worked relentlessly on the diseases of their crops—bacterial leaf blight, fungal blast, rice tungro virus, and helminth parasites—to sustain plant health and contribute to higher yields and production.

At the same time, there seems to be an indifference to the human health dimension of agriculture. Until relatively recently, the direct impact of some agricultural technologies on the health of the people who practice agriculture was given only cursory recognition. Organizations such as the World Bank can be singled out

for having supported extensive programs on the control of tropical diseases, water supply, and human waste management which benefit agricultural communities, but their efforts have had only a limited impact because of the size and complexity of the problem.

Recently, there has been a surge of interest to emphasize women in agriculture, with the lead, I am pleased to note, taken by women. However, even here, I am yet to see an acknowledgment of the impact of agricultural technologies and practices on the health of women and children.

While selecting my theme for this presentation, I examined a number of recent pronouncements and statements on problems of agriculture in the Third World and looked at some recommended actions. I was disappointed to note that not one of them made even a glancing reference to human health issues. Not a word of concern is spared by any of them for the physical and mental well-being of the people who, presumably, would be expected to implement their fine suggestions. Even here, the plants once again score over the people.

Perhaps vigorous action is lacking because not many of those who can take action have a direct experience of the threats to health faced by rural agricultural communities. There is a Ghanaian proverb which translates literally, "when a sharp thorn is sticking into somebody's foot, as far as you are concerned, it might as well be sticking into wood. When it is sticking into your foot, that is when you feel it and try to remove it." Maybe a few decision-makers and donors should be accidentally infected with a couple of diseases!!

Towards an integrated control strategy

What then should be done? And who should do it? It is possible, on the basis of the life histories of the pathogens and the conditions that support them, to formulate an effective, integrated control strategy. It will not be the first strategy, but it could be realistic and down-to-earth if it is based on a background of related factors, such

as the principles of parasitology relevant to the pathogens, the life histories of intermediate hosts, domestic water supply, human waste disposal, and a liberal dose of education. It would help to visualize and, where possible, actually see the picture of disease and ill-health in irrigated and other forms of water-intensive agriculture in the tropics.

In China, where there is a long-standing experience of "snail fever" due to *Schistosoma japonicum*, which is a killer disease, a few decades ago, such an approach was taken by the government to put together a major multidisciplinary national control strategy. It required a thorough understanding of the biology of the snail hosts, *Oncomelania* spp., as a basis for effective control.

As regards the implementation of such a strategy, it would be a demonstration of responsible interest for agricultural research institutions to champion the good health of agricultural communities. However, it would also be unrealistic to expect such institutions to undertake the activities necessary to manage the infections and environmental problems. What is needed is a pooling of various expertise in multidisciplinary cooperation to assist organizations that have the necessary mandate to interpret and implement control strategies effectively.

Actually, but for the lack of requisite resources, there is no reason why agricultural communities should not take the initiative to help themselves. Worldwide, human communities could provide their own services if they felt a real need and had the resources, manpower, and know-how. Unfortunately, in developing regions, resources never seem to be readily available to local people even if they understand and know how they would want to solve a problem.

Whether it is to build a toilet, protect a spring, dig a well, or install a stand pipe in a developing country, it seems that donors prefer supporting foreign nongovernmental organizations (NGOs) for decision and leadership

roles in projects. In Africa we have a plethora of private NGOs. While some of them are providing useful service, there are others of dubious qualification, competence, and experience.

If indeed donors want to help Africa through the NGOs, then I strongly urge those who support foreign NGOs to work in Africa also to sponsor qualified, competent, and experienced African NGOs to work on African problems. On this continent, we do have some well qualified, competent, experienced, but generally underestimated and underutilized, manpower. We even have experienced men and women farmers who, though illiterate, can provide competent guidance on specific problems to some of the NGOs.

Should donors accept the challenge, we may perhaps begin to have some realistic and sensible down-to-earth strategies implemented to justify some of the huge resources spent, and, what is even more important, we may begin to find effective and permanent solutions to some of Africa's rural community problems.

In the three decades that have passed since the international community's Declaration on the Human Environment, which emphasized the judicious management of natural resources and ecological systems, a revised perspective has gradually crept into thinking on the development process. Against that background and considering present circumstances, I strongly suggest that irrigation and other forms of water-intensive agriculture should be no longer regarded merely as crop production processes. I submit that such forms of water-intensive agriculture should increasingly be seen as part of an integrated management of essential natural resources—water, soil, plant, nutrients, other inputs, and the human being. I strongly urge that the health dimensions of the processes should be recognized as an integral part of agriculture. I firmly believe that we must insist that new irrigation schemes in particular, being man-made, must be designed to be free of human health hazards, to guarantee the good health of workers, if, indeed, the schemes are to qualify

as contributors to sustainable agriculture in tropical areas.

Farmers everywhere are necessary for agriculture. Without healthy agricultural communities, it will be difficult to assure sustainable agriculture. In fact, I would say that farmers are essential to justify agricultural research and, healthy farmers, as implementers of research results, are definitely an asset to the improvement of agriculture, even through research.

Should we not make it our responsibility to see that agricultural communities are protected, especially against preventable infections and diseases? I believe that for the vital service that they render, farming communities especially deserve a right to sustainable good health.

About IITA

The goal of the International Institute of Tropical Agriculture (IITA) is to increase the productivity of key food crops and to develop sustainable agricultural systems that can replace bush fallow, or slash-and-burn, cultivation in the humid and subhumid tropics. Crop improvement programs focus on cassava, maize, plantain, cowpea, soybean, and yam. Research findings are shared through international cooperation programs, which include training, information, and germplasm exchange activities.

IITA was founded in 1967. The Federal Government of Nigeria provided a land grant of 1,000 hectares at Ibadan, for a headquarters and experimental farm site, and the Rockefeller and Ford foundations provided financial support. IITA is governed by an international Board of Trustees. The staff includes around 180 scientists and professionals from about 40 countries, who work at the Ibadan campus and at selected locations in many countries of sub-Saharan Africa.

IITA is a member of a system of international agricultural research centers supported by the Consultative Group on International Agricultural Research (CGIAR). Established in 1971, CGIAR is an association of about 50 countries, international and regional organizations, and private foundations. The World Bank, the Food and Agriculture Organization of the United Nations (FAO), and the United Nations Development Programme (UNDP) are cosponsors of this effort.

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