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A Family Health Care Report

# HEALTH IMPACT GUIDELINES FOR THE DESIGN OF DEVELOPMENT PROJECTS IN THE SAHEL

Volume I

Sector-Specific Reviews and Methodology

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# PREFACE

This book is part of a two-volume series commissioned by the Permanent Interstate Committee for Drought Control in the Sahel (CILSS) to familiarize project officers, design teams, and ministry personnel at the national level with the adverse effects on health which might result from the various types of development projects implemented in the region.

The Health Impact Guidelines can be used to anticipate health problems that may result from a project, to predict the extent and seriousness of such problems, and to minimize or prevent these potential threats to health while pursuing the project's objectives. They have been prepared primarily for technicians in sectors other than health. As such, the Guidelines describe practical approaches that design officers can consider for incorporation into their development projects; they also provide a systematic assessment procedure to promote informed decision-making throughout the process of project design. It should be noted at the outset, however, that the Guidelines are a tool intended for use during the initial design of a development project; they do not provide a method of evaluation for use after a project is approved, being implemented or operational.

In pursuing the twin goals of regional food self-sufficiency and sustained economic growth in the Sahel, it is important to be aware of the overlap which often exists among different

portions of the environment. For example, seemingly unrelated projects designed to achieve increased crop production, improved animal production, better transport systems, ecological conservation, improved sanitation, and better quality drinking water are very likely to have a significant impact upon each other. They may complement each other and facilitate the pursuit of mutual goals, or they may undermine each other and compromise their long-term benefits.

Indeed, CILSS views its development efforts in horizontal as well as vertical terms. For example, increased food production is a vertical function of the irrigated and dryland agriculture sector; it is called vertical because it is limited to the sector in which it originates. Its horizontal functions--outcomes manifested in other sectors--might include better nutrition, increased resistance to disease, increased cash flow, improved marketing, and better water retention of the soil. A reservoir built for irrigation may also serve as a watering-hole for cattle, or, if appropriate, a source of drinking water for human beings; these are among its horizontal functions. The complementary aspects of these horizontal functions as they overlap among sectors should be recognized and incorporated into project designs whenever feasible. If this is carried out, time, money and lives may be saved in the future.

The first volume of the document includes chapters on "Dryland and Irrigated Agriculture," "Livestock Development," "Fisheries Development," "Transportation," "Special Issues in

Development," and "The Methodology for Assessing and Avoiding Adverse Health Impacts." Volume II is a reference manual and examines in detail the major diseases prevalent in the Sahel. It also includes a glossary of terms, a bibliography, and a list of organizations from which further information and consultation may be obtained.

# INTRODUCTION

## Health and Development in the Sahel

Because health is associated with vigor, productivity, mental alertness, and motivation, a sick person tends inevitably to be less productive than a healthy person. Health is thus linked on a broader scale with economic and socio-demographic trends: if the population of a region is chronically sick, economic output suffers.[1] And--individually, nationally, and regionally--lowered production and productivity may lead to lowered food availability and consumption, poorer nutrition and in turn increased susceptibility to disease. Thus, a downward spiral of disease and poor nutrition is likely to occur. Demographic trends are also affected since people tend to have large families in areas where disease is prevalent in order to insure that some children survive to adulthood.[2]

In the Sahel, as elsewhere in the world, one of the basic assumptions of development efforts is that this downward spiral can be eventually reversed and the quality of life of the population improved. Despite considerable progress toward this goal, the health status of the people of the Sahel is still far

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1. See Bibliography: 13, 126, 140, 146, 151, 152, 159, 160, 163, 173, 202, 224, 227.

2. See Bibliography: 197, 198, 202, 208, 258, 268.

from satisfactory. As development programs in the region increase in size and number, attention should be given not only to activities of the health sector designed to improve health status, but to all development programs and projects in order to insure the most favorable impact on the population.

Since development frequently results in changes in the environment and since these changes may adversely affect human health, it is vitally important to anticipate the changes which a development activity may cause and the adverse effects it may provoke. Project officers and others who are aware of possible unwanted outcomes will be in a position to evaluate the potential significance of these outcomes and act to minimize them. By thoroughly considering the potential effects their projects may have on human health, development personnel will enhance the overall success of their endeavors and perform a valuable service to the people of the region.

## An Ecological Perspective

In order to assess impacts on health, it is necessary to understand how development can affect health. The relationship is not always direct. Figure 1 portrays the Sahel as a single ecosystem, a community of organisms--human beings, animals, and plants--interacting within the physical environment.[3] The arrows signify dynamic or changeable relationships within the system and the links among its components. Figure 1 indicates

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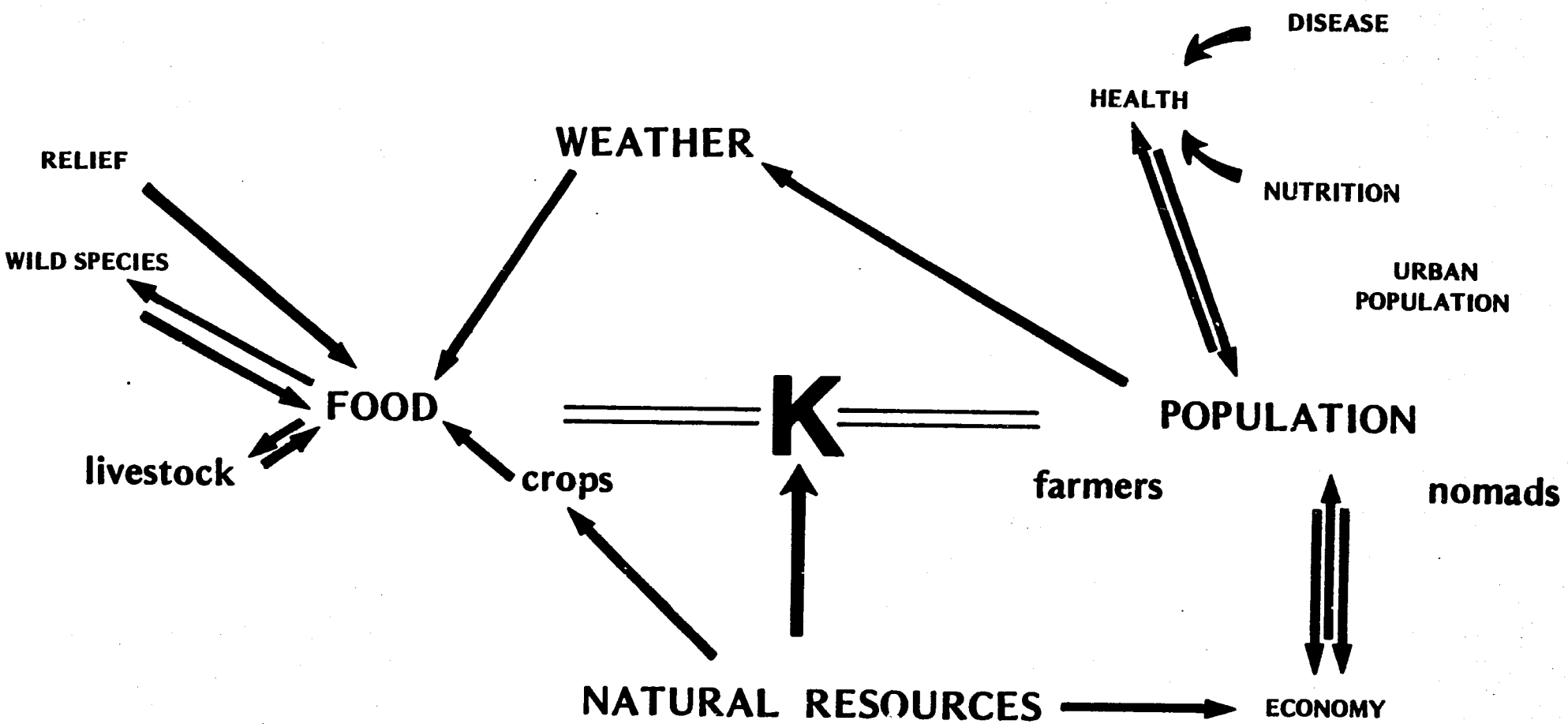
3. See Bibliography: 85, 117, 123, 126

**Figure 1: The Ecological Balance in the Sahel**




*K = carrying capacity

that each component is related to all of the others. It depicts ecological interaction and interdependence. While reading further, keep in mind the ecological principle that any change in one part of the environment ultimately affects other parts of the environment. Development does not occur in a vacuum; thus, one has to be concerned with both intended and unintended results.

In the Sahel, cities have risen where forests once grew; crops are being harvested from fields that at one time were only seasonally grazed; energy is being extracted from the earth, from rivers, and even from the sun; minerals are mined for export and industrial purposes; and diseases are being controlled by means of vaccination, health education, and aerial spraying of insecticides.

However, progress has another side. Cities are polluted by factory and automobile exhausts which can cause heart and lung disease as well as changes in climate. Migration and urban overcrowding break up families, and tension contributes to high suicide rates. The clearing of forests alters climate and eliminates a renewable source of fuel. Continued cropping of fragile semi-arid soils can lead to erosion and desert encroachment. Mining and other activities which destroy the natural plant cover can increase the risk of floods. High-flying aircraft emit gases that reduce the earth's protection from the sun's harmful radioactive energy. Unfavorable food-crop-to-cash-crop ratios may sacrifice nutritional health for economic stability.

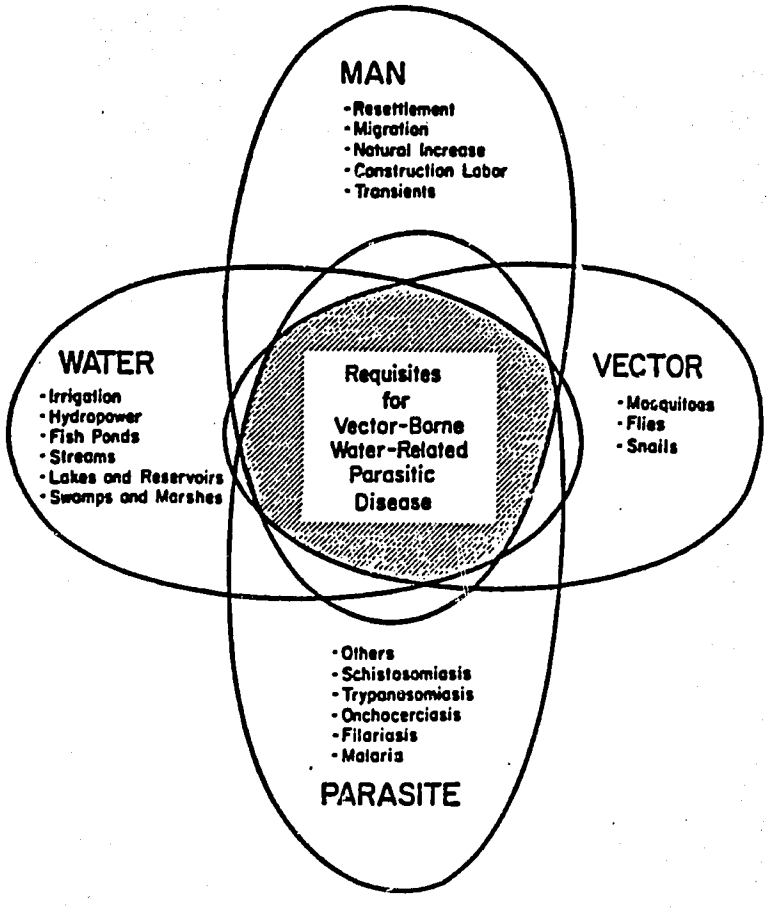
Chemicals may contaminate water supplies, and some types of progress may promote the spread of disease.

Since ecology deals with the study of relationships among living organisms and their natural surroundings, it can help us to examine phenomena ranging in scope from very large to very small. By investigating the interactions among the forces of nature, ecologists can investigate why the Sahel suffered a devastating drought and famine in 1968-1974; or they can explain how several types of bacteria interact to turn milk into yogurt. The subject matter of ecology is virtually limitless, since all living things must interact with each other and within their environment in order to survive.

Like other living things, the organisms which cause disease must eat, excrete wastes, find satisfactory places to live, and reproduce. In the field of public health, such patterns are examined in terms of the ecology of disease (Figure 2). Specific environmental conditions are required for disease organisms to complete their often complex life cycles. Changes in the environment of such an organism that promote its welfare and survival thus tend to maintain and spread the disease it causes. And, as we have mentioned, environmental change is an inevitable result of development. Of course, development is only one factor in a complex set of inter-related factors: climate, geography, flora and fauna, cultural patterns, social structure, political attitudes, ingrained traditions, and socio-economic conditions can all contribute in one way or another to the maintenance and spread of disease agents.

FIGURE 2

THE ECOLOGY OF DISEASE




Source: Owolabi, S., 1976.

## Environmental Change and Its Impact on Health

The major threats to the health of the people of the Sahel may be divided into three categories: endemic diseases (air-borne, water-borne, vector-borne, infectious, zoonotic), poor nutrition, and contamination of food and water by toxic substances. Given the fragile environment in which Sahelians live, it is not unusual for one change in the environment to cause change (or changes) in another part of the environment and subsequently result in an undesired effect on health. For example, let us look at some specific ways in which environmental change can affect the incidence of disease. Vector-borne diseases[4] associated with water, such as malaria, schistosomiasis, onchocerciasis, and dracontiasis (guinea worm) occur primarily in the southern portions of the Sahel. If, however, water-related development projects such as irrigation systems, dams, and reservoirs are implemented in the semiarid north, excellent breeding habitats can be created by which the northward spread of these vector-borne diseases might be facilitated. This can be particularly serious if the exposed population has little or no acquired immunity to a disease such as malaria.

The northern portion of the Sahel differs epidemiologically from the south. Poor general nutrition due to lack of protein and calories is probably the most widespread health problem in the north, particularly common in children under five. Measles

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4. Diseases passed from infected to uninfected individuals through other organisms, or "vectors," such as flies, mosquitos, snails, etc.

and tuberculosis are also prevalent, as are trachoma, and cerebrospinal meningitis. Some zoonotic diseases[5] carried by cattle, such as anthrax and brucellosis, occasionally affect man. Populations resettled from the northern to the southern Sahel will be exposed to certain diseases to which they have developed no immunities. Thus, although the Sahel exhibits widespread spatial distribution of diseases due to its climatic and sociocultural variation, the potential for introducing a particular disease into an area previously free of it is considerable.

As more and more people come to occupy a particular area, it becomes increasingly likely that air-borne, water-borne, and vector-borne diseases will spread. A rise in population density due to a development project tends to bring about closer contact among individuals; it also increases the likelihood that sanitation systems of fixed capacity will prove inadequate. Therefore, consequent rises in the incidence of measles, tuberculosis, amoebic and bacillary dysentery, respiratory infections, intestinal worms, and vector-borne diseases can be expected.

In addition to diseases and nutritional deficiencies, toxic substances introduced into the environment by man or by natural processes can cause serious health problems if they enter the food or water systems. Health can also be affected indirectly by a decline in soil fertility due to the misuse of land. Poor productivity decreases the amount of food available which may adversely affect nutritional status. A decline in nutritional status may increase an individual's susceptibility to disease.

5. Diseases that can be transmitted from animals to man.

The following chapters in this volume deal more specifically with the interactions between development and health. The complementarity of the horizontal aspects among sectors is consistently brought out. A total perspective approach underpins each sector review and, if applied, will be manifested in the optimum application of development resources and consequent successful development activities. This document presents information, methodologies and ideas. It is hoped that it will stimulate the reader to think about alternative project designs, predict adverse impacts and avoid unwanted results through intersectoral cooperation and planning.

# SECTOR-SPECIFIC REVIEWS

# Chapter 1

## Dryland and Irrigated Agriculture

### Introduction

The future prosperity of the entire Sahel region depends on increased food production. In order for the Sahel to achieve an accelerated level of food production by the end of the century, which is part of the stated goal of the CILSS, more land will need to be cultivated (increasing production) and more crops will need to be grown per unit of land (increasing productivity).

However, increased food production and productivity are not the agricultural sector's only objectives. Because the Sahelian countries recognize the importance of economic growth and a sustained and evenly distributed cash flow, their need to increase food-crop production is paralleled by a desire to increase cash-crop production substantially. In more favorable areas, farmers are usually able to produce both. Ideally, the Sahel nations should produce an adequate supply of food for the region, and generate income as well by selling such cash crops as peanuts (groundnuts), cotton, sesame, and rice. Sustaining a nutritionally adequate and economically balanced food-crop-to-cash-crop ratio is vitally important to Sahelian self-sufficiency.

Increased food production is likely to bring about efforts to improve food distribution and the food storage system. In

the long run, the nutritional status of Sahelian rural populations will improve, and as a result, increase their resistance to disease.[1] Thus, increased food production may help to lower infant and child mortality rates, lower morbidity, increase life expectancy and survivorship among the adult population, and possibly contribute to lower birth rates.[2]

## General Activities of Agricultural Projects

The primary goals of agricultural development are clear. Let us now consider what must be done to achieve these goals. In the case of irrigation, an adequate supply of water must be available and canals must be built to deliver the water to farm plots. In the Sahel, water for irrigation can be obtained in a number of ways. River water can be pumped directly to the fields, or rivers can be dammed or diverted to create lakes and/or reservoirs. Barrages (small earthen dams) can be built to trap water on flat lands, and natural catch basins such as marigots can supply water on a seasonal basis.

Dryland agriculture requires a slightly different approach to crop-water delivery. The main accent is placed on increasing the moisture retention capacity of the soil and on soil conservation practices such as contour farming and strip cropping. Water may be delivered to the fields periodically by means of river diversion, which simultaneously irrigates and fertilizes the land (by siltation). Man-made catch basins (polders) may be

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1. See Bibliography: 195, 197, 198, 253.

2. See Bibliography: 197, 253.

built to store water for use during the dry season. Underground reservoirs (aquifers) and streams (wadis) may be tapped by wells.

In addition to their need for water, crops must be planted, weeded, fertilized, protected against pests and diseases, rotated, managed to insure the proper food-crop-to-cash-crop ratio, harvested, marketed, and stored. Local crops may be replaced with improved high-yielding varieties or extensively intercropped. Individual or family farming may be abandoned in favor of communal undertakings. Traditional tools may be replaced by more complex equipment requiring fuel and regular maintenance. Chemical fertilizers and pesticides may be applied to soil and crops respectively. Granaries may be built to protect surplus crops from fungus, bacterial decay and rodents.

## Changes Brought About by Agricultural Development

Development projects produce changes in the physical environment, in the social structure of participating communities, in the demographic profile of resident populations, in the nutritional status of affected individuals and communities, and in the economic structure of families and social groups. Most of the changes resulting from agricultural development will improve the quality of life of the population they are intended to serve. For example, increased food production may lead to improved nutrititional status. However, some changes have the potential to adversely affect human health.

The quickest and most obvious change caused by agricultural projects is change in local demographic profiles. Agricultural projects often involve resettlement, immediately increasing population densities. Furthermore, people often spontaneously immigrate to the neighborhood of a successful project to get a share of the increased food production. The number of farms in the area usually increases, and their size tends to decrease.[3] The demand for food, fuel, and forage may increase. Per capita food availability may decrease as may the adequacy of sanitation and the quality of drinking water.

Changes that occur in the physical environment tend to be less obvious, because they take time to develop. For example, the introduction of irrigated or flood-plain agriculture increases the amount of standing and/or running water. Fertilizers and pesticides increase yields, but once applied may run off into local rivers, streams, or lakes. Soil status might decline because of altered farming practices (shortened fallow periods, overcropping, or overcutting) or the misuse of water (waterlogging and salinization).

New agricultural practices can also produce changes in the economic and social structures of communities. Increased cash-crop production usually enhances the buying power of the local people, enabling them to obtain loans and credit to expand their economic base and enhance economic security. Increased

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3. See Bibliography: 5, 6, 7, 10, 29, 30, 154, 163, 170, 173, 177.

buying power may attract more merchants and increase the number and type of goods and services available. Occupational opportunities may increase, making the community more economically diverse. Family structure may change; traditional roles may be modified. The increased availability of goods and services may alter traditional values and practices. All these changes may result in both positive and negative effects over the long term.

## Effects on Human Health of Changes Produced by Agricultural Development

The most direct adverse effect on health associated with agricultural development is an increase in water-related diseases.[4,5] This increase is primarily due to changes in the physical environment which create favorable breeding habitats for disease vectors. Malaria, schistosomiasis, onchocerciasis and guinea worm are among the most important vector-borne diseases in the Sahel. However, disease transmission does not depend solely on the presence of a vector. A disease organism must also have easy access to a suitable host. This aspect of the disease process may be facilitated by agricultural and other development projects because they tend to raise local population densities and thus increase the likelihood of human-parasite contact.

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4. The term water-related refers to any disease associated with water, i.e. certain vector-borne diseases associated with standing or running waters and water-borne diseases which occur when contaminated water is injested.

5. See Bibliography: 7, 13, 16, 18, 22, 24, 27, 31, 23, 33, 144, 155, 159

Water-Related Diseases. It is important to understand how diseases that require water for their transmission might spread when agricultural projects are undertaken. The diseases most often linked to agricultural development are schistosomiasis and malaria (see Volume II, Reference Manual).

Schistosomiasis occurs primarily near rivers, lakes, irrigation canals, and permanent man-made reservoirs. A suitable environment, the presence of a vector (a fresh-water snail), an infected population, and a susceptible population are the conditions necessary to foster transmission of this disease. Schistosomiasis is more directly associated with population density than is malaria, because the eggs of the parasite are passed in the urine or feces of infected human beings. If population density increases, it is likely that more human wastes will be deposited in water sources, increasing the spread of the disease.

Malaria is transmitted by anopheline mosquitoes, which breed in standing water. Lakes, slow-moving or blocked irrigation canals, barrages and marigots along flood plains provide ideal breeding habitats. If infected individuals immigrate to an area, or if malaria is already endemic in an area and new susceptible immigrants settle there, the situation is ripe for a malaria epidemic. That this is no mere theoretical statement has been demonstrated by epidemics in Zimbabwe, Ghana, Nigeria, the Sudan, the Middle East, and Southeast Asia.[6]

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6. See Bibliography: 32, 33, 79, 82, 83, 116, 125, 126, 129, 132, 136, 159, 163.

Onchocerciasis or river blindness may also spread as a result of agricultural development. The vector for this parasite (a small blackfly) requires swift-moving water for its development; dam spillways may be good reproductive habitats as well as the area downstream from sluices used to flood flatlands. Thus the spread of onchocerciasis should be considered likely wherever dams are constructed or rivers diverted for dryland flooding.

Dracontiasis or guinea worm infection is found throughout the Sahel. The vector is a small crustacean (Cyclops) which becomes infected when penetrated by the larvae of this parasite after they have escaped from the human host. If standing water sources are created and frequented by infected humans, the transmission of guinea worm is virtually inevitable. Canals, temporary pools, reservoirs, cisterns, virtually any standing water source used for drinking can promote the spread of this disease.

Increased prevalence and incidence of these four diseases have occurred as a result of both large-scale and small-scale agricultural projects. Irrigated and dryland development projects involving dams, lakes, and pumped water have increased the prevalence of one or more of these diseases in Chad, Ghana, Nigeria, Cameroon, Zimbabwe, Egypt, Iran, China, India, Brazil, and other countries throughout the world.[7] The spread of these diseases merits serious consideration because the development and use of surface water are so pervasive in the Sahel. However,

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7. See Bibliography: 6, 7, 13, 16, 22, 24, 32, 33, 79, 82, 83, 92, 111, 112, 116, 118, 119, 125, 126, 129, 136, 144, 145, 153, 155, 159.

they represent only one set of health problems that are associated with agricultural development.

Communicable or Infectious Diseases. Communicable or infectious diseases may also increase with agricultural development. These diseases are spread by air, food, and/or water, and include tuberculosis, measles, poliomyelitis, viral and bacterial pneumonia, influenza, amoebic and bacillary dysentery, intestinal worms, hepatitis, cholera, shigella and others (see Volume 2). Each spreads rapidly if suitable conditions exist or are created. The transmission of communicable disease depends heavily on person-to-person contact, the quality of food and water (and thus the adequacy of sanitation and potable water delivery), and the nutritional status of the exposed population. Its severity depends on the immune status of the victim, the dose received and the amount of medical care available.

It is well documented that agricultural development increases the population density in the surrounding area.[8] In Ghana, for example, more than 78,000 people from approximately 700 villages were resettled in 50 towns because of the 1964 Volta Dam project. When person-to-person contact is increased so markedly, the spread of airborne infections is facilitated. Furthermore, a drastic rise in population density usually decreases hygenic conditions which may lead to increased transmission of food-and water-borne diseases. The more people using a sanitation system of limited capacity or not using one at all, the sooner water

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8. See Bibliography: 7, 21, 29, 30, 116, 147, 159, 164, 170, 177, 184.

and food supplies can become contaminated.[9]

Once food and water supplies are contaminated, a vicious downward spiral begins. The incidence of intestinal infections usually increases, leading to decreased absorption of food due to diarrhea, especially among the young. Thus people not only become sick but often suffer from nutritional stress. Rendered less able to resist other diseases, such as respiratory infections and malaria, they may die. It is important to note that, even if adequate food is available, nutritional stress can and will occur if intestinal diseases are prevalent in the area. Thus, the potential benefits of increased food production can be compromised if avoidance of health problems is not incorporated into the project's design.

Effect of Increased Population Density on Nutritional Status. A rise in population density may not only promote the spread of air-borne, water-borne, and food-borne infections, but may also indirectly affect the nutritional status of the exposed population. A related matter is the relationship between population density and food demand. If too many people immigrate to a project site, they may overextend its food producing capability. Insufficient food makes the new arrivals and the original population more susceptible to disease, and the same downward spiral described above is underway. If production and productivity are increased to meet a growing demand, soil fertility may be irreparably damaged due to nutrient

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9. See Bibliography: 80, 105, 121, 127, 132, 137, 217, 256.

depletion; the final result--decreased food production and nutritional stress--although postponed, will be the same.

Concentration of Chemicals in the Ecosystem. The final health issue associated with agricultural development is the concentration or biomagnification[10] of toxic substances in soil, plants, and human tissue. Modern agriculture increasingly depends on fertilizers and pesticides to promote faster and better growth and to protect crops from pests and disease. However, there is a price to pay, which is the possibility of contaminating food and water supplies with dangerous chemicals. Nitrogenous compounds from fertilizers may run off into the water and kill fish, by poisoning and/or by depleting the dissolved oxygen in the water. The chemicals used in pesticides may not decompose for a long time and can concentrate in the flesh of fish, rodents, domestic animals, and ultimately human beings. Though chemical concentration in the Sahelian ecosystem is not yet widespread, if left unchecked it may cause as much suffering and death as some of the diseases now present in the region.

Table 1.1 catalogues the potential positive and negative effects on health of agricultural development. It should be remembered that it is the change brought about by these activities that causes both the positive and negative results. The table is presented to clarify the concept of tradeoffs - the idea that desirable

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10. The concentration of toxic substances in the food chain caused by natural predator-prey relationships.

Table 1.1

Potential Positive and Negative Effects on Health of Agricultural Development Activities

| ACTIVITY | POSITIVE EFFECTS | NEGATIVE EFFECTS |
|---|---|---|
| Irrigated and Dryland Farming: canal, piped, drip, reservoir/polder and other methods of irrigation; crop rotation, intercropping, flood recession, automated farm machinery | 1. Increased food-crop production, leading to better nutrition<br>2. Increased cash-crop production, enhancing ability to finance medical services and such improvements as better housing and clean water supply<br>3. Increased resistance to disease due to better nutrition<br>a. Improved survivorship of infants, pre-school children and pregnant women<br>b. Increased birth interval and decreased maternal and infant morbidity and mortality<br>c. Increased life expectancy<br>4. Attraction of newcomers to area; increase in availability of non-medical goods and services; increased economic stability<br>a. Eventual decline of population growth rate<br>b. Redistribution of population<br>1. Improved distribution of goods and services<br>2. Decrease in pressure on ecosystem | 1. Increased risk of disease<br>a. Creation of new breeding habitats for vectors of malaria, schistosomiasis, onchocerciasis, and guinea worm<br>b. More person-to-person contact, spreading such infectious diseases as measles, tuberculosis, respiratory infections, polio, and the like<br>c. Increases in population density which exceed local capacity to dispose of wastes, leading to contamination of water and food; increase in dysenteries, intestinal worms, trachoma, typhoid, and the like<br>2. Lowered nutritional status and decreased resistance to disease<br>a. Overutilization of soil, leading to decrease in soil fertility and decreased nutritional status<br>b. Lowered nutritional status due to unfavorable food-crop-to-cash-crop ratio<br>c. Declining agricultural yields due to waterlogging, salinization, or laterization, or shortening of fallow period<br>3. Reduction of water quality<br>a. Chemical contamination from pesticides<br>b. Increased salt or sediment content of runoff from fields unprotected from erosion<br>4. Social tensions and disequilibrium due to immigration, resettlement and increased population density |
| Dams, Lakes, River Diversions | 1. Increased availability of water for irrigation, small gardens, livestock, household use<br>a. Improved nutrition<br>b. Improved domestic water supplies (quantity and quality)<br>2. Improvement in the quality of life due to electric power | 1. Creation of breeding sites for disease vectors (see 1a. under farming)<br>2. Diseases of crowding and mental stress due to resettlement (see 2b)<br>3. Importation of disease due to immigration and resettlement |
| Hybridization (monocultures) | 1. Nutritionally superior crops<br>2. Increased yield<br>a. More drought-resistant<br>b. More disease-resistant<br>c. Shorter growing season<br>d. Improved response to fertilizers | 1. Increased susceptibility to pest damage<br>2. Rejection by populace due to dietary preferences<br>3. Lowered soil fertility due to increased nutrient requirements of high-yielding variety crops<br>4. Introduction of protein-calorie imbalance into diet<br>5. Reduction in supply of usable water<br>a. Lowering of water table<br>b. Nitrates from fertilizers into water supply or contamination from pesticides (see 3 above) |
| Storage | 1. Availability of food during dry season and drought<br>2. Fewer economic losses due to pests and spoilage (see crop protection) | 1. Contamination of surplus due to poorly designed, inadequately maintained storage facilities (Aflatoxins: *Aspergillus* fungus on crops, particularly peanuts) |
| Crop Protection | 1. Increased yield<br>2. Reduction in after-harvest losses to insects and pests | 1. Concentration of pesticides in food, water, soil, and animal and human flesh<br>2. Unpredictable and possibly negative effects of changes in populations of non-target organisms (e.g., loss of pollinating insects may cause decline in yield of Karite, honey, or fruit and garden crops)<br>3. Possible appearance of genetically resistant pests<br>4. Possible outbreaks of disease (plague, endemic typhus, rickettesial disease) if animal reservoir eliminated and disease agent moves to human population |

outcomes may also have undesirable effects - and to reemphasize that development does not occur in a vacuum. However, the table is not meant to imply that negative effects on health are inevitable, nor that all the effects listed always occur and are positive or negative to the same degree.

Measures to Limit Adverse Effects on Health

There are many available methods of limiting the adverse effects on health of agricultural development. The problem is choosing the most effective and feasible method or methods available. If time, money, manpower, and materials were unlimited, solutions would be easier. But this is not the case in the Sahel or anywhere in the world. Thus development personnel need to know WHAT they are able to do within the constraints of their situation, as well as WHAT needs to be done and HOW to do it. For example, it is possible to attack malaria by controlling the mosquitoes that transmit the disease and distributing an antimalarial drug to eliminate the parasite from the human population.[11] However, this method requires a substantial commitment of money and training, as well as cooperation on the national and international levels.

Table 1.2 surveys some available approaches to the health problems associated with agricultural development. Each approach listed has been tried and, depending on fiscal and manpower resources, been proven successful to some degree. Because

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11. See Bibliography: 219, 226, 247, 248, 257, 270, 271.

Table 1.2

Approaches to Health Problems
Arising From Agricultural Development

| DEVELOPMENT PROJECT OR RELATED ACTIVITY | ASSOCIATED HEALTH PROBLEM | OBJECTIVES AND APPROACHES TO THE PROBLEM |
|---|---|---|
| Irrigated and Dryland Farming<br>Canals, Basin Flooding, Dams/Lakes, and River Diversions | Increased risk of diseases due to an increase in the size and number of BREEDING SITES for the vectors | |
| | 1. Malaria | 1. Limit breeding habitats for the malaria vector (Anopheles mosquito).<br>a. Locate the existing breeding sites before the project is designed.<br>b. Evaluate the prevalence of malaria in the surrounding area before the project is implemented; estimate the projected increase.<br>c. Educate adults and children about the transmission of malaria.<br>d. Organize villagers into malaria surveillance teams to:<br>1) identify larval habitats;<br>2) monitor and control larvae in streams using nonresidual chemicals;<br>3) spray the insides of houses and surrounding ground cover to limit the population of adult mosquitoes, using nonresidual chemicals.<br>e. Maintain surveillance of breeding habitats through payment in kind and moderate government subsidies.<br>1) Check canals, lake shores, rivers, and flood pools periodically for larvae.<br>2) Treat water periodically with appropriate nonresidual larvicides.<br>f. Keep water containers covered to prevent growth of larvae; clean up such water-holding materials as gourds, coconut shells, old tires, and the like. |
| | 2. Schistosomiasis | 2. Limit breeding habitats for the schistosomiasis vector (a fresh-water snail).<br>a. Locate the existing breeding sites before the project is designed.<br>b. Evaluate the prevalence of schistosomiasis in the surrounding area before the project is implemented; estimate the projected increase.<br>c. Educate adults and children about the transmission of schistosomiasis.<br>d. Organize villagers into schistosomiasis surveillance teams (possibly same as the malaria teams) to inspect canals periodically and identify aquatic vegetation and snails in canals, on lakeshores and riverbanks, and in reservoirs.<br>e. Incorporate a flow regulator into the canal system. Periodically stop the water flow and dry up the canals completely in order to kill off snails and vegetation. Then open the flow fully to flush out debris (dead snails and vegetation). Repeat this process whenever snails are found in canals by the surveillance teams.<br>f. Line all canals in the area with cement to discourage the growth of vegetation. Clean these canals periodically to avoid accumulation of silt on the canal bed.<br>g. Administer chemicals to water to kill snails (molluscicides). |
| | 3. Onchocerciasis | 3. Limit breeding habitats for the onchocerciasis vector (blackfly).<br>a. Locate the existing breeding sites before the project is designed.<br>b. Evaluate the prevalence of onchocerciasis in the surrounding area before the project is implemented; estimate the projected increase.*<br>c. Determine whether the project will create any fast-moving water (gravity-fed canals, dam spillways, sluices); if so, monitor these areas closely for blackfly larvae. |

Table 1.2
(Continued)

| DEVELOPMENT PROJECT OR RELATED ACTIVITY | ASSOCIATED HEALTH PROBLEM | OBJECTIVES AND APPROACHES TO THE PROBLEM |
|---|---|---|
| | | d. Treat existing and potential breeding sites with a nonresidual blackfly larvicide (abate).<br>e. Educate adults and children about the transmission of onchocerciasis.<br>f. Organize villagers into onchocerciasis surveillance teams (possibly same as the malaria and schistosomiasis teams).<br>g. Clear fast-moving water of rocks, twigs, and other matter that might be inhabited by blackfly larvae.<br>* Ecological impact studies should be performed at the pre-design stage to determine the likelihood of creating favorable breeding habitats. |
| | 4. Guinea Worm | 4. Limit breeding habitats for the guinea worm.<br>a. Educate adults and children about the transmission of guinea worm.<br>b. Discourage people from wading into the project water source for drinking water.<br>1) Help install a preferable alternate source of drinking water.<br>2) Check the water periodically for the intermediate host of guinea worm (the crustacean Cyclops). |
| * * * * | * * * * | * * * * * * * * |
| Canals, Basin Flooding, Dams/Lakes, River Diversions, and Resulting Spontaneous Immigration | Increased risk of disease due to an increase in the number of PARASITES ENTERING THE HUMAN POPULATION in the area | |
| | 1. Malaria | 1. Control of malaria parasites in the human population.<br>a. Oversee the initial organization (if necessary), maintenance, staffing, and supply of an adequately sized health clinic.<br>b. Monitor the prevalence and incidence of malaria in the area (possibly by the vector surveillance team).<br>1) Train teams in the laboratory diagnosis of malaria and other parasitic infections (possibly by the health clinic staff).<br>2) Periodically examine blood samples from the resident population.<br>3) Examine blood samples from all immigrants to the area after the project is in operation.<br>c. Identify immigrant groups that might be nonresistant to malaria (notably those from more arid areas).<br>d. Report all cases and suspected cases of malaria to the local health services; examine and treat them with antimalarial drugs.<br>e. Consider the administration of antimalarial prophylactic drugs to all children under 10 and to women of child-bearing age, especially recent immigrants from nonmalarial areas. (Treatment and prophylaxis should be available at low cost.)<br>f. Promote use of protective clothing to decrease exposure to infected mosquitoes.<br>g. Seek out government support for the activities listed above. |

Table 1.2
(Continued)

| DEVELOPMENT PROJECT OR RELATED ACTIVITY | ASSOCIATED HEALTH PROBLEM | OBJECTIVES AND APPROACHES TO THE PROBLEM |
|---|---|---|
| Canals, Basin Flooding, Dams/ Lakes, River Diversions, and Resulting Spontaneous Immigration (Continued) | Increase in PARASITES (Continued)<br>2. Schistosomiasis | 2. Control of schistosomiasis parasites in the human population.<br>a. Oversee the initial organization (if necessary), maintenance, staffing, and supply of an adequately sized health clinic in the area.<br>b. Monitor the prevalence and incidence of schistosomiasis in the area (possibly by the malaria vector surveillance team).<br>1) Train teams in the laboratory diagnosis of schistosomiasis and other parasitic infections (possibly by the health clinic staff).<br>2) Periodically examine urine and stool samples from the resident population and immigrants to the area.<br>3) Insure that all diagnosed cases are closely watched and, if infection progresses, treated. (Treatment is not entirely effective.)<br>c. Educate adults and children about the role of unsanitary waste disposal in the transmission of schistosomiasis.<br>d. Block or limit the deposition of eggs into water sources by discouraging their use for waste disposal.<br>1) Help install an adequate and well-maintained sanitary waste system and encourage people to use it. This must be done in cooperation with other development sectors.<br>2) Establish regulations governing the disposal of human wastes (subject to the agreement of the populace and enforcement by local officials).<br>3) Erect fences around canals and irrigation networks to prevent people from urinating and defecating in them.<br>e. Limit human contact with water sources to prevent the parasite from entering the population.<br>1) Install lifting devices for drawing water at the river or lake edge, making it unnecessary for people to enter the water to fill containers. (Such devices could be similar to those used in Egypt and other parts of the Middle East.)<br>f. Seek out government support for the activities listed above. |
| | 3. Onchocerciasis | 3. Control onchocerciasis parasites in the human population.<br>a. Oversee the initial organization (if necessary), maintenance, staffing, and supply of an adequately sized health clinic in the project area.<br>b. Monitor the prevalence and incidence of onchocerciasis in the area (possibly by the vector surveillance team).<br>c. Explain to people the role of blackfly feeding behavior and flight range in the transmission of onchocerciasis. Determine when biting rates are highest; advise people to stay away from breeding sites at these times.<br>d. Promote the use of protective clothing to decrease exposure to blackfly bites.<br>e. Monitor infection rates among immigrants to the area, and discourage settlement clos to breeding habitats. |

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Table 1.2
(Continued)

| DEVELOPMENT PROJECT OR RELATED ACTIVITY | ASSOCIATED HEALTH PROBLEM | OBJECTIVES AND APPROACHES TO THE PROBLEM |
|---|---|---|
| Canals, Basin Flooding, Dams/ Lakes, River Diversions and Resulting Spontaneous Immigration (Continued) | Increased transmission of communicable WATER-BORNE DISEASES (amoebic and bacillary dysentery, ascaris, typhoid, and others) | 1. Oversee the initial organization (if necessary, maintenance, staffing, and supply of an adequately sized health clinic.<br>2. Educate people about the transmission of water-borne diseases and ways to prevent them. Explain the importance of personal hygiene practices, especially washing hands before eating and after defecating.<br>3. Discourage the use of crop water for drinking, washing and/or waste disposal.<br>a. Establish regulations governing disposal of human wastes.<br>b. In cooperation with other development sectors, help install an adequate and well-maintained sanitary waste-disposal system and a potable water-delivery system, and encourage people to use both.<br>4. Check water periodically for fecal contamination (perform E.coli bacteria counts) (by health sector personnel)<br>5. Report all cases and suspected cases of these diseases to the clinic for treatment. Periodically examine pre-school children, who are most likely to become infected and are often most seriously affected. |
| | * * * | * * * * * * * * * * * |
| Reclamation of Previously Nonarable Land, Resulting in Spontaneous Immigration and thus INCREASED POPULATION DENSITY | Increased Transmission of Communicable Diseases | 1. Maintain reasonable population distribution in the project area.<br>a. Survey available housing in the project area.<br>b. Monitor spontaneous immigration; regulate immigration into the project area by enforcing a limit on total population or providing incentives to settle elsewhere. The population limit should be based on predictions of the area's carrying capacity. Carrying capacity can be determined by using the resources of the ecology/ forestry team-CILSS staff.<br>2. Try to insure adequate availability and distribution of food in order to promote resistance to infections (see below).<br>3. Install and maintain an adequate water-delivery system (wells, pipes, purification systems) to provide clean drinking water in the project area. Discourage drinking, bathing, and waste disposal in water used for irrigation and floodland crops. Consider establishing separate water sources for agricultural uses.<br>4. Establish and maintain an adequate sanitary waste-disposal system; promote use of these facilities by making them easily accessible to the local population.<br>5. Oversee the initial organization (if necessary), staffing, and supply of an adequately sized health clinic in the area; provide for laboratory examination to identify cases of communicable disease and treatment of serious cases.<br>6. Vaccinate children in the area for measles, polio, diphtheria, tetanus, tuberculosis, yellow fever (if endemic to area), and cholera (if epidemic threatens); keep records on incidence of these diseases; maintain vaccination program. |

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Table 1.2
(Continued)

| DEVELOPMENT PROJECT OR RELATED ACTIVITY | ASSOCIATED HEALTH PROBLEMS | OBJECTIVES AND APPROACHES TO THE PROBLEM |
|---|---|---|
| (*) See also "erosion guidelines" | Lowered Nutritional Status due to GRADUAL EXHAUSTION OF SOIL from overuse (*) | 1. Monitor soil status and use of cropland by means of soil surveys and production information.<br>2. Develop a plan to manage soil fertility.<br>a. Determine the minimum necessary fallow period.<br>b. Apply fertilizer as needed.<br>c. Maintain organic matter content of soil by mulching, composting, green manuring, covercropping, etc.<br>d. Have project engineers design adequate soil-drainage systems to prevent water-logging and salinization. (A hydrological and soil survey may be necessary at the pre-design stage.)<br>e. Plan crop rotation and appropriate ratio of cultivated land to fallow land.<br>f. By controlling population density, discourage overgrazing of fallow land and overcutting of uncultivated land.<br>g. Take steps to minimize erosion (i.e., cover crops, fallow fields, tree planting, etc.). |
| | Lowered Nutritional Status due to UNBALANCED FOOD-CROP-TO-CASH-CROP RATIO | 1. Formulate a nutritionally balanced food-crop-cash-crop ratio.<br>a. Identify preferred foods, weaning foods, and cash crops; identify the sources and soil requirements of each.<br>b. Before the project becomes operational, discuss the cash-cropping aspects of the project with the Ministry for Economic Development; emphasize the need for an adequate food supply, and the limited amount of arable land.<br>c. In the project design, provide for an annuall adjustable food-crop-to-cash-crop ratio. Avoid long-term economic commitments, since food-crop failures may lead to nutritional stress and thus to a need for more food-crop production in subsequent years. |
| Cultivation of New Food Crops and High-Yielding Varieties (HYVs) | Lowered Nutritional Status due to RELUCTANCE TO EAT UNFAMILIAR FOODS | 1. Identify locally-preferred foods.<br>a. Conduct a nutritional survey (via health sector) before the project is designed.<br>b. Test acceptance of new foods and HYVs by introducing them to resident populations; base introduction of new foods into the project area on the observed reactions.<br>c. Find out whether preparation of traditional foods differs from that of new foods; demonstrate (especially to women) preparation of the new foods.<br>2. Identify the traditional weaning foods of each ethnic group expected to immigrate to the project area; determine their availability locally and identify appropriate substitutes. |
| * * * * | * * * * | * * * * * * * * |
| Storage | Contamination of stored grain by fungus (Aspergillus) | 1. Identify quantity of storage needed, i.e., storage capacity.<br>2. Promote use of better storage, i.e., elevated structures, reinforced bricks, plastic (if available).<br>3. Maintain storage facilities when implemented.<br>4. Rotate stored material periodically to prevent fungal growth.<br>5. Inform people of health hazards associated with improperly stored material. |
| * * * * | * * * * | * * * * * * * * |

Table 1.2
(Continued)

| DEVELOPMENT PROJECT OR RELATED ACTIVITY | ASSOCIATED HEALTH PROBLEMS | OBJECTIVES AND APPROACHES TO THE PROBLEM |
|---|---|---|
| Crop Protection | Chemical Contamination of Food and Water From Pesticides and Fungicides | 1. Determine what chemicals must be used and where.<br>a. Determine the amounts (concentrations, number of applications per year) to be used.<br>b. Find out the chemical properties of the pesticides and fungicdes to be used. (Are they biodegradable, or do they persist in soil and living tissue?)<br>c. For each chemical, determine its potential toxicity and the concentration in living tissue which produces toxic effects.<br>d. Investigate methods of application and storage; determine the optimum number of personnel needed to minimize risk of accidents during application and storage.<br>e. Establish training programs for those who will administer these chemicals.<br>2. In the project design, provide for the safe application of chemicals.<br>a. Provide for adequate storage and distribution of chemicals.<br>b. Insure that chemicals do not enter the drinking-water supply.<br>1. With the assistance of a sanitary engineer, design safe runoff ditches and adequate drainage of fields.<br>3. Inform local people about the dangers of chemically contaminated water.<br>4. Prevent water contaminated with chemicals from being used by local people.<br>5. Provide for periodic checks of sanitation and water supply systems to ensure their adequate functioning and to monitor the quality of drinking water. |

irrigated and dryland agriculture raise a number of the same problems, certain approaches overlap. Table 1.2 can be used to identify potential health problems your project may encounter and approaches that can be incorporated into its design to avoid or minimize these problems.

Combatting Schistosomiasis. Schistosomiasis is the best-known health problem resulting from irrigated agriculture. Its effect on human vigor and productivity and economy should not be underestimated.[12] If a project involves the use of canals, design alternatives to limit the spread of schistosomiasis merit consideration. The reservoir(s) from which canals originate may also be a source of infection. One should also consider the effect of increased population density on transmission.

The snail vectors live in canals and along the banks of lakes and slow-moving rivers. Transmission can be reduced by decreasing the snail population and/or limiting human-snail contact. Preventing the snail from infesting a canal, lake, or river is almost impossible. Cement-lined canals are very effective but prohibitively costly. By constructing a number of large cement-lined irrigation systems, Egypt, Iran and China have partially limited the transmission of schistosomiasis in certain areas;[13] however, given the financial constraints and scope of the problem in the Sahel, this approach is not feasible on a large scale.

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12. See Bibliography: 13, 16, 24, 151, 158, 159, 160, 173, 198, 210, 237.

13. See Bibliography: 79, 107, 112, 126.

More feasible methods of decreasing transmission are available. Local people need to be informed about transmission and convinced that it is a serious hazard to their health. Health education can help to achieve this goal and should be considered whenever implementing any large-scale projects; mass health education campaigns in China are reported to have achieved great success.[14]

Informed communities can organize themselves to clear the canals periodically of aquatic vegetation (the snail's food). Surveillance teams of villagers can be formed to check canals and natural waterways for snails (and mosquito larvae). Canals can be equipped with waterflow regulators allowing them to be dried out periodically, which kills off the aquatic vegetation and the snails that feed on it.

Another way of combatting transmission is to minimize the probability that the snail is infected with parasites. With this method health education and the provision of an adequate sanitary system are particularly important. People--especially children--often urinate and defecate in nearby rivers and irrigation canals. If they are already infected, they are thus promoting the spread of infection by depositing the parasite's eggs in the water. In theory, if children and adults can be convinced to build and use sanitary facilities and to obtain water with a mechanical lifting device rather than wade into the water to fill a container, transmission can be effectively limited; and in time,

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14. See Bibliography: 87, 88.

the parasite can be eliminated.[15] Fences around ponds and other small watering places, and sanitary codes for waste disposal can also help to decrease transmission. Each of these options should be thoroughly considered before the project design is finalized.

Combatting Malaria. Malaria is often described as the most serious health hazard in the tropics because it can spread and kill so quickly. It is directly related to agricultural development because such development usually increases the amount of standing water in an area. The combination of more mosquitoes, more people, and importation of the parasite from elsewhere is a dangerous formula for an epidemic.

What can be done to avoid spreading malaria? After being informed about how the disease is transmitted, villagers can organize themselves into surveillance teams, identify breeding sites and monitor local water sources for mosquito larvae. This should be done before the project begins. Malaria prevalence should be determined among both the people indigenous to the project area and those who immigrate. An acceptable prevalence should be agreed upon by local health authorities and those responsible for the implementation of the project. If by periodic monitoring (surveillance) one finds the incidence to be increasing to unacceptable levels, one has a number of options to control the spread of the disease.

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15. See Bibliography: 88, 93, 105, 106, 108, 113.

Particularly vulnerable groups (i.e. children under five and pregnant or lactating women)[16] may be treated prophylactically with an antimalarial drug such as Nivaquine. This will both prevent the serious effects of the disease among those treated and lower the incidence of the disease in the community.

At the same time, mosquito breeding sites previously identified should be treated periodically with larvicides to reduce the number of viable mosquito larvae and thus decrease the number of potential adults. Additionally, adult mosquitoes may be killed by applying insecticides to the walls of houses in the project area. However, the use of these chemicals is expensive and must be supervised by qualified personnel if contamination of the environment is to be avoided.

Combatting Communicable Diseases. Since water is one of the main sources of infection an adequate supply of clean drinking water coupled with a flexible sanitation system designed to meet present and future needs can help limit the spread of communicable

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16. Children under five and lactating (breastfeeding) women are particularly vulnerable to malaria. Young children may not be resistant to the parasite and therefore they may be completely overwhelmed. Furthermore, these children may be nutritionally stressed and thereby be more susceptible. The prevalence of infection in this age group is also high and may thus render these children at greater risk to serious malaria infection. Lactating women are at particular risk due to their lowered nutritional status caused by breastfeeding. This makes them more susceptible to other infections and thus increases the severity of an otherwise benign infection such as malaria, even though they may have a good deal of acquired immunity.

diseases. For this reason, it is important to think about potable water delivery and sanitary waste disposal when planning large agricultural projects. Infections such as measles, polio, diphtheria, pertussis, tetanus, and smallpox spread if population density is increased, but with proper planning can be controlled by immunization. Health education in disease transmission and personal hygiene can be effective as can regulating the population distribution to avoid crowded and often unsanitary living conditions. Estimates of population influx would be valuable in planning the type and extent of disease-preventive facilities such as adequate housing, waste disposal systems, portable water delivery and social services such as schools and health care facilities.

Combatting Nutritional Problems. Although agricultural development should increase crop production, cash crops may take precedence over food crops. Nutritional problems can result in two ways: food may become scarce because of the increased demand created by more people immigrating to the area, or the area's production potential may decline because of soil nutrient depletion due to overcultivation. These problems might be avoided by regulating the number of people who settle in the area, adopting a nutritionally adequate food-crop-to-cash-crop ratio, rotating crops annually, limiting overcropping, establishing food storage and distribution systems and providing food subsidy in times of shortage.

Combatting the Effects of Toxic Chemicals. The potentially toxic effects of fertilizer and pesticide runoff deserve serious

attention. The health hazards associated with chemical contamination of the environment are slow to develop and very difficult to resolve. Toxic chemicals concentrate readily in the food chain and can cause serious nervous disorders, cancer, and genetic defects. Adequate drainage is essential when pesticides or fertilizers are being used. Drinking water sources should be protected from contamination, and the storage and application of fertilizers should be managed by trained personnel.[17] Adequate drainage, runoff canals, and the monitoring of soil and water should be considered whenever such chemicals are applied in an area.

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17. See Bibliography: 6, 11, 24, 25, 105, 106, 136, 137.

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# Chapter 2

## Livestock Development

### Introduction

The goals of livestock development in the Sahel are to preserve the region's remaining pastures and to establish optimal herd size at the individual and national levels and--ultimately--for the entire region. The preservation of existing pastures is doubly beneficial for the entire region: improved and well-maintained pastures will provide an adequate supply of forage for livestock and will simultaneously protect the topsoil from wind and water erosion. Adequate forage will foster improved animal nutrition, health and survivorship, and increase the cash value of marketed livestock.

The activities associated with livestock development include management of pastures (i.e. promoting ecologically sound ratios between animals and forage), monitoring and regulating the movements of herds in the northern, marginally productive ranges, establishing marketing/distribution/meat processing centers (having their own slaughterhouses), improving animal health (via disease and pest control), relocating cattle to the southern areas (to be used for traction), creating new pastures (based on water delivery and irrigation) and improving human nutrition (via increased availability of high quality protein). Directly related as it is to the ecological stability of the region, and thus to the overall regional goals of food

self-sufficiency and sustained economic growth, livestock development is genuinely multipurpose in its aims.

Changes Brought About by Livestock Development

In order to control the number of cattle grazing on the land, some nomadic herders and transhumants in the northern Sahel may be urged to move farther south and encouraged to settle and farm. Population redistribution and the possible alteration of social and cultural patterns are prominent changes associated with livestock development. Changes in occupation, social structure, housing, diet, and income are not uncommon.[1] Unfamiliarity with a new lifestyle often fosters fear and stress. Thus, these people require a good deal of support. Food subsidies, training in agricultural methods, medical care, housing, and fuel should be available throughout the resettlement process, especially during the first two to three years.[2]

Changes in the physical environment also result from livestock development. Improved pastures do more than supply increased forage to livestock; they also provide a rain-break for the topsoil and prevent excessive erosion and soil runoff.[3] Thus, proper range management promotes continued soil fertility. Livestock personnel should also be concerned with the environmental change induced in the resettlement areas. The

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1. See Bibliography: 39, 41, 47, 55, 143, 159, 163, 170, 176.
2. See Bibliography: 7, 29, 30, 39, 85, 116, 126.
3. See Bibliography: 35, 37, 49, 52.

establishment of markets, slaughterhouses and distribution centers will likely increase the occupational and economic opportunities in project areas and tend to attract immigrants. Thus, population density may drastically increase with the growth of new livestock distribution sites. Higher population density in turn can increase the demand for food, fuel, water, and sanitation facilities, and create significant health problems.

Livestock development may also affect the concentration of inorganic chemicals in local food and water supplies. Furthermore, the amount of standing water may be increased to provide water for livestock. The amount of human-animal contact is likely to increase with the establishment of a livestock-processing center. All of the above have potentially serious repercussions on human health and need to be considered both individually and collectively before a project becomes operational.

Effects on Human Health of Livestock Development Projects

Zoonotic Diseases. Livestock development's most direct effect on human health is its potential to spread zoonotic diseases.[4] The three most important zoonoses in the Sahel are anthrax, brucellosis, and bovine tuberculosis (see Volume II, Reference Manual). All three are carried primarily by cattle, and can spread to human beings through close contact with animals. Livestock projects can set the stage for the spread of these diseases by inducing close contact with animals. This is

4. Diseases that can be transmitted from animal to man (see Glossary, Vol. II).

especially true when slaughterhouses and processing centers are established.[5]

Other Human Diseases. Other human diseases are indirectly related to livestock development. Because livestock need a continuous supply of water, a number of watering holes may be dug in the project area. Standing water may thus contribute to the spread of such diseases as malaria, schistosomiasis, and dracontiasis by creating ideal breeding habitats for the vectors of these diseases (mosquitoes and snails and crustaceans). Cattle may also carry leptospirosis, which infects humans who bathe or swim in water contaminated by the urine or feces of an infected cow.

Diseases That Affect Cattle. Human health is also indirectly threatened by three diseases that infect only cattle: rinderpest, cowpox, and cattle trypanosomiasis. If different herds are brought together in one place, such as when they are sold, these diseases can spread and kill cattle quickly. Rinderpest is particularly severe. Human health is adversely affected by these diseases in that cattle fatalities represent a loss of security, wealth, and food. People may suffer nutritional stress (especially children) and/or economic hardship due to the loss of their animals.[6]

Relocation and Resettlement. When people move from their homes, they tend to feel homesick and anxious. Traditional tools, foods,

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5. See Bibliography: 42, 53, 56.

6. See Bibliography: 36, 39, 46, 55, 85, 86, 116, 126, 183.

and sometimes beliefs may have to be abandoned. People may become very tense, leading to personal and social conflicts. Frustration may ensue if new occupations lead to failure rather than success. Infantile malnutrition may occur if traditional weaning foods are unavailable and/or mothers are unfamiliar with those of the new area.[7] Communicable diseases may spread due to overcrowding and overuse of waste disposal systems. Coupled with an overextended supply of potable water and a scarcity of food, serious health problems can ensue, as was the case in Zimbabwe in the early 1970s.[8]

Concentration of Chemicals in the Ecosystem. Pesticides used in slaughterhouses and pasture protection may become concentrated in the flesh of the animals being dipped; even more dangerous is the contamination of food and water supplies by these pesticides. If safe application, storage and supervised disposal of these chemicals are not planned and incorporated into the overall project design, they may enter the human food chain and water systems and cause serious damage to livestock and to humans.[9]

Table 2.1 catalogues the potential positive and negative effects livestock development may have on the environment, health, and other aspects of human and animal life. It is also meant to clarify the concept of tradeoffs--the idea that desirable outcomes may also have undesirable effects--and to emphasize

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7. See Bibliography: 195, 197, 202, 223, 224, 236, 253.

8. See Bibliography: 29, 126, 129, 159.

9. See Bibliography: 25, 136.

Table 2.1

**Potential Positive and Negative Effects on Health of Livestock Development Activities**

| ACTIVITY | POSITIVE EFFECTS | NEGATIVE EFFECTS |
|---|---|---|
| Animal health: vaccination programs dipping tanks, disease control activities | 1. Increased availability of high quality protein in market area<br>a. Improved human nutrition<br>b. Improved animal health, increased marketability | 1. Increased pressure on range resources, potential overgrazing, loss of ground cover.<br>2. Improper use of chemicals, concentration of toxic substances in water, soil, food. |
| Livestock Water Supply | 1. Increased herd size and number as water supply constraints ease, increased livestock survivorship.<br>2. Improved animal health | 1. Increased pressure on range resources (expanded potential for overgrazing and subsequent decline of soil fertility). |
| Pasture rehabilitation, restoration of vegetative cover | 1. Increased carrying capacity of pastures.<br>a. Increased ecological stability (i.e., resistance to environmental stress)<br>b. Improved soil fertility (water retention, nutrient content, decreased erosion) | 1. Secondary effects of agricultural techniques employed to reseed, plow, etc. (i.e., increased cultivation) and increases in animal and human populations (exploitation of recovered land). |
| Relocation and Resettlement of Nomadic Herders; Herd Management | 1. Decrease in the number of herders and animals, protecting northern pastures from overgrazing<br>a. Fewer herds<br>b. Fewer animals per herd<br>c. Improved animal nutrition, increased market value<br>d. Ecological stability of pasture, better water retention of soil, decreased erosion<br>2. More marketable livestock, leading to improved cash flow<br>a. Increased livestock sales<br>b. Improved human nutrition | 1. Increase in population density in southern (resettled) areas<br>a. Increase in communicable diseases, due to crowding and overuse of sanitation facilities<br>b. Increased prevalence of serious diseases (e.g., TB and malaria)<br>c. Increased personal and ethnic conflict<br>2. Lowered nutritional status<br>a. Poor crop yields due to resettled people's unfamiliarity with farming methods<br>b. Initial hunger due to impossibility of planting crops if resettled too late in growing season<br>c. Unavailability of traditional foods, rejection of new foods due to unfamiliarity and ignorance of cooking methods<br>d. Infantile malnutrition due to unfamiliarity with weaning foods<br>3. Decreased farmland per capita in resettled areas |
| Establishment of Markets, Slaughterhouses, Storage and Shipping Facilities | 1. Increased availability of high-quality protein in market area<br>a. Improved nutrition<br>b. Increased resistance to disease<br>2. Attraction of merchants<br>a. More available cash<br>b. Increased availability of commercial goods and services<br>3. Improved efficiency of livestock marketing<br>4. Decrease in livestock disease due to dipping in disinfectant | 1. Increase in zoonotic diseases due to meat processing<br>a. Anthrax<br>b. Brucellosis<br>c. Bovine tuberculosis<br>d. Cattle trypanosomiasis<br>2. Possible contamination of food and water supply<br>3. Overuse of sanitation facilities due to increased immigration<br>a. Increase in food and water-borne diseases (dysenteries, typhoid, cholera, intestinal worms)<br>b. Increase in vector-borne diseases (malaria, schistosomiasis, trypanosomiasis) |

that development does not occur in a vacuum. The table is not meant to imply that negative effects on health are inevitable, nor that all the effects listed always occur and are positive or negative to the same degree.

Measures to Limit Adverse Effects on Health

There are many methods available to limit the adverse effects on health from livestock development. The problem is choosing the most effective and feasible method or methods available. If time, money, manpower, and materials were unlimited, solutions would be easier. But this is not the case in the Sahel, or anywhere in the world. Thus development personnel need to know WHAT they are able to do within the constraints of their situation, as well as WHAT needs to be done and HOW to do it. For example, it is easy to say that the number of cattle grazing the northern pastures of the Sahel should be decreased. But one cannot simply solve the problem by dictating that a certain number of herders will be moved to the southern areas to take up new lives as sedentary agriculturalists. Decreasing the number of cattle in the region and achieving optimal herd size involve a substantial commitment of money, time, education, and cooperation locally, nationally, regionally, and internationally. Even if people understand why they are being resettled and the advantages to be gained by relocating, the process is extremely disturbing and fraught with problems, not the least of which involve health.

Table 2.2 surveys available approaches to the health problems associated with livestock development. Each approach listed has been tried and, depending on fiscal and manpower resources, been proven successful to some degree. Because different activities raise similar problems, certain of the approaches overlap. The table can be used to identify some of the problems a project may encounter and possible approaches that can be incorporated into its design to avoid or minimize them.

Combatting the Effects of Resettlement. High concentrations of people can both overtax a fixed-capacity sanitary system (if one exists) and increase demand for food. Thus, resettlement and sedentarization of nomadic peoples can contribute to the spread of infectious and communicable diseases, and to undernutrition if increased food needs are not met.[10] Psychological stress associated with resettlement may become a problem. But how can one prevent such adverse outcomes if a project requires relocation and sedentarization?

The number of people to be relocated should be accurately calculated before the relocation process begins to enable development planners to provide for the housing, sanitation and health needs of the resettled people. Adequate sanitation helps prevent the spread of diseases such as amoebic dysentery, bacillary dysentery, cholera, and intestinal worms. Furthermore,

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10. See Bibliography: 29, 30, 35, 36, 39, 41, 47, 53, 55, 116, 126.

Table 2.2

Approaches to Health Problems
Arising From Livestock Development

| DEVELOPMENT PROJECT OR RELATED ACTIVITY | ASSOCIATED HEALTH PROBLEM | OBJECTIVES AND APPROACHES TO THE PROBLEM |
|---|---|---|
| Relocation/Sedentarization (Settlement of people and livestock from the northern Sahel in the South) | Spread and increase in seriousness of vector-borne, and communicable diseases | |
| | 1. Vector-borne diseases (malaria, schistosomiasis, trypanosomiasis) | 1. Decrease risk of transmission of vector-borne diseases.<br>a. Locate existing breeding sites before the project is designed.<br>b. Evaluate the prevalence of these diseases in the project area before the project is implemented; estimate the projected increase.<br>c. Make provisions for adequate sanitary waste disposal to prevent contamination of water with human waste (primarily for prevention of water-borne disease, but also to combat schistosomiasis).<br>d. Oversee the initial organization (if necessary) maintenance, staffing, and supply of an adequately sized health clinic.<br>e. Educate adults and children about the transmission of these diseases.<br>f. Consider administration of antimalarial prophylactic drugs to all children under 10 and women of childbearing age recently arrived from arid or semiarid areas.<br>g. Encourage newly arriving unexposed population groups to live initially at a distance from the indigenous exposed population in order to limit transmission and identify sources of outbreaks.<br>1. Monitor the disease status of the non-exposed group (by the health clinic staff).<br>2. Treat suspected cases of malaria with antimalarial drugs.<br>h. Inform people about the biology of vectors (i.e., habitat, feeding behavior, longevity) and how to avoid coming in contact with the vector. |
| | 2. Water-borne diseases (amoebic and bacillary dysentery, intestinal worms, others) | 2. Decrease risk of water-borne diseases.<br>a. Monitor spontaneous immigration; regulate immigration into the project area by enforcing a limit on total population. (This limit must be determined by residents of the project area, based on predictions of the area's carrying capacity. Carrying capacity can be determined by using the resources of of the CILSS ecology/forestry team.)<br>b. Consider the feasibility of installing and maintaining a sanitary system to provide clean drinking water to the local population, and ensure that wastes will be adequately disposed of, without threat to the water supply.<br>1. Encourage use of these facilities by making them readily available to the local population.<br>2. Hire or motivate local individuals to maintain the facilities; make sure they are well supplied and officially supported.<br>3. Check water purity periodically including E. coli bacteria counts as an indicator (by health sector personnel).<br>c. Oversee the initial organization (if necessary), maintenance, staffing, and supply of an adequately sized health clinic.<br>d. Educate adults (particularly mothers and young women) and children about the dangers of contaminated water and ways to decrease transmission of water-borne diseases (i.e., boiling water, personal hygiene). |

Table 2.2
(Continued)

| DEVELOPMENT PROJECT OR RELATED ACTIVITY | ASSOCIATED HEALTH PROBLEMS | OBJECTIVES AND APPROACHES TO THE PROBLEM |
|---|---|---|
| Relocation/Sedentarization (Settlement of people and livestock from the northern Sahel in the South) cont'd | 3. Other communicable diseases (measles, tuberculosis, poliomyelitis, viral and bacterial pneumonia, others) | 3. Decrease risk of transmission of communicable diseases.<br>a. Encourage newly arriving unexposed population groups to live initially at a distance from the indigenous exposed population in order to limit transmission and identify source of outbreaks.<br>b. When resettling people, arrange for a food subsidy adequate to supply food for at least 2 years after relocation (see Nutritional Stress below).<br>c. Help local residents procure adequate shelter to discourage overcrowding.<br>d. Vaccinate as many people as possible, particularly preschool children, against measles, typhoid, diphtheria, tetanus, and poliomyelitis. |
| | * * * * | * * * * * * * * |
| | 4. Psychosocial stress due to massive changes in lifestyle, living conditions, and occupation | 4. Provide adequate emotional and material support to resettled people.<br>a. Provide good transportation to the new area.<br>b. Before and after resettlement, inform settlers thoroughly about occupation, farming methods, growing seasons, sources of water, endemic diseases, storage facilities, etc., in the new area.<br>c. In case of crop failure, have available sufficient food for the first 2 years after resettlement.<br>d. Make available to relocated people enough land to work, to prevent tension and conflict associated with overcrowding.<br>e. Consider in advance of resettlement the probable social and cultural changes that will be imposed on settlers and how impacts can be minimized through culturally sensitive project design and implementation. |
| | * * * * | * * * * * * * * |
| | Nutritional stress due to unfamiliar diet, new weaning foods, and possibly decreased soil fertility | 1. Oversee the initial organization (if necessary), maintenance, staffing, and supply of an adequately sized health clinic.<br>a. Organize nutritional surveillance teams of villagers to help identify preferred foods, availability of traditional foods, acceptance of unfamiliar foods. Estimate and project amounts of food required at the project site.<br>b. Identify traditional weaning foods. If possible, make them available; if not, inform people (especially mothers and young women) about preparation of alternative native weaning foods (threshing methods, amount of water, boiling times, and such.)<br>2. Train new settlers in farming methods; make food subsidies available to them for at least the first 2 years after resettlement.<br>3. Cooperate actively with agriculture personnel to maintain soil fertility.<br>a. Teach new settlers to rotate crops and observe adequate fallow periods.<br>b. Monitor and regulate spontaneous immigration into the resettlement area to discourage overuse of the land and a consequent decrease in soil productivity.<br>c. Before the project is designed, conduct or oversee a soil survey to determine the soil's long-term carrying capacity and need for fertilizer. |
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Table 2.2
(Continued)

| DEVELOPMENT PROJECT OR RELATED ACTIVITY | ASSOCIATED HEALTH PROBLEM | OBJECTIVES AND APPROACHES TO THE PROBLEM |
|---|---|---|
| Livestock Marketing/ Processing Centers (markets, slaughterhouses, dipping stations) | Increase in zoonotic diseases (anthrax, brucellosis, bovine tuberculosis, leptospirosis) | 1. Decrease risk of transmission of zoonotic diseases.<br>a. Separate human beings and animals by corralling herds; separate different herds to reduce the spread of zoonoses.<br>b. Inform livestock workers about the transmission of zoonotic diseases, ways to avoid infection, and identification of human and animal symptons.<br>c. Oversee the initial organization (if necessary), maintenance, staffing, and supply of an adequately sized health clinic in the marketing area to treat zoonotic and other diseases.<br>d. Encourage local residents to boil cows' milk to decrease risk of bovine tuberculosis. |
| | * * * * | * * * * * * * * |
| | Contamination of food and water supply with toxic chemicals | 1. Limit the risk of toxic chemicals (disinfectant, herbicide, and pesticide by-products) entering the environment.<br>a. Determine the types and volumes of chemicals to be used in the project area pasture or marketing site annually.<br>b. Design engineering safeguards to prevent these chemicals from reaching water and food sources.<br>1. Provide for adequate drainage ditches for chemical runoff from pastures.<br>2. Provide for adequate storage and disposal of chemical disenfectants used in dipping stations.<br>3. Evaluate potential for contaminating water supply when designing and siting a dipping tank; monitor leakage from dipping tanks.<br>c. Oversee the initial organization (if necessary), maintenance, staffing, and supply of an adequately sized health clinic.<br>1. Help health personnel familiarize themselves with the symptoms of chemical toxicity.<br>2. Design a program to inform people about the dangers of chemical-waste contamination.<br>d. Cooperate actively with sanitary engineers, health personnel, and agricultural personnel to monitor annually the concentration of chemicals in the water supply and in blood samples. |
| * * * * | * * * * | * * * * * * * * |

an adequate supply of food should also be on hand before the resettled people arrive to avoid food shortages during the initial adjustment period. If these precautions are not taken, relocation may be expected to increase local population density, facilitate the transmission of communicable and infectious diseases, create food shortages (lowering nutritional status), and cause psychological stress (due to unfamiliar surroundings, occupations, and living conditions).

Combatting Zoonotic Diseases. An important health problem associated with livestock development is the spread of zoonotic diseases, notably anthrax, brucellosis, leptospirosis and bovine tuberculosis.[11] A good way to control the spread of these diseases is by means of health education. The transmission of these diseases should be explained to residents and the occupational risks clearly defined. The proper handling of hides, meat and offal and boiling of milk can help prevent anthrax, brucellosis and bovine tuberculosis. Advising workers in slaughterhouses to be wary of these risks can also decrease transmission. Although this is primarily a responsibility of health sector personnel, livestock personnel should be aware of the role health education can play in the control of these diseases, and should encourage local residents to participate.

However, educating people alone will not totally prevent the transmission of zoonotic diseases. People who work in and around slaughterhouses should be supplied with protective

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11. See Bibliography: 53, 227, 252.

clothing such as gloves, boots, aprons, and the like to prevent disease organisms from entering their bodies. They should also be supplied with workclothes if possible, to be worn only during working hours and cleaned periodically to prevent disease organisms from being carried home. The common use by humans and animals of water for drinking and bathing should also be discouraged to decrease the risk of exposure to leptospira. Furthermore, different herds should be segregated into different corrals at the marketing-distribution center to impede the spread of zoonotic diseases from herd to herd. The spread can be monitored and controlled if cattle are inspected before and after slaughter by a veterinarian or a qualified technician.[12] Samples of hides, meat and organs can be checked by clinical and laboratory investigators to determine the prevalence of zoonotic (and animal) disease and the distribution of the diseases in incoming herds.

Combatting the Effects of Toxic Chemicals. Another potential problem created by livestock development is contamination of water and food supplies with chemicals. Livestock personnel might confer and cooperate with development personnel from other sectors which use chemicals (such as agriculture) to design facilities for the proper drainage and storage of potentially dangerous chemicals.[13] Hydrological and soil surveys ought to be conducted to evaluate the potential of these chemicals to seep into drinking water supplies when stored, applied or discarded.

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12. See Bibliography: 252.

13. See Bibliography: 25.

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# Chapter 3

## Fisheries Development

### Introduction

A limited food supply is the highest priority problem in the Sahel and fish production appears likely to play an important role in the development of the region. Fish is a renewable source of high-quality protein which the Sahel badly needs.[1] Furthermore, fisheries which produce more than is consumed locally can create income when the surplus is sold. The resulting benefits from increased fish production include improved nutrition and human survivorship, greater resistance to disease, increased income and better distribution of goods and services.

Because new fisheries are often located in areas where other development projects are already underway, it is necessary to consider them in combination with these projects in order to understand their potential effects on the local ecology and on health. Natural fisheries such as coastal waters, lakes, and rivers are large (several thousand hectares) and often located near farmland. These fisheries rely on the capture of fish by fishermen and receive little or no management or control. Man-made fisheries are smaller (0.1-15 hectares) and are commonly established in ponds, reservoirs, rice paddies and irrigation canals. This type of fishery relies on the intensive production

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1. See Bibliography: 58, 59, 60, 62, 63, 66.

of fish achieved by careful management of nutrients, fish densities and harvesting to obtain sustained optimum yields. They are geared to make the fullest and most profitable use of a project area's physical resources. Thus, fisheries may be distinguished as being either capture oriented (i.e. natural fisheries) or culture oriented (i.e. smaller, man-made fisheries).

Effects on Human Health of Fisheries Development

Vector-Borne Diseases. Probably the most serious and direct effect of fisheries on human health is their contribution to the spread and maintenance of water-related diseases.[2] The development of new inland fisheries can often increase the amount of standing water in a locality and generally increases human contact with standing water. Man-made fisheries are suitable breeding habitats for mosquitoes, snails and crustaceans, the vectors of malaria, schistosomiasis and dracontiasis respectively.

Water-Borne and Food-Borne Diseases. If a new fishery is established near a village without another convenient and reliable water supply, it is likely that people will use the fishery water for drinking, bathing, livestock watering, and waste disposal. These practices tend inevitably to promote the spread of water-borne and food-borne diseases (see pages 5 - 9 in Chapter 1). In addition to malaria and schistosomiasis, therefore, the introduction of a fishery into an area can inadvertently cause increases in the prevalence of guinea worm,

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2. See Bibliography: 64

enteric infections (including cholera), leptospirosis, infectious hepatitis and intestinal worms.[3] The storage of fish may tend to spread trachoma and dysenteries, since inadequately stored fish tends to attract filth flies (mechanical vectors for these diseases).

Chemical Biomagnification. Both natural and man-made fisheries can become contaminated with chemicals.[4] According to the principle of biomagnification, certain chemicals tend to concentrate additively in the more complex organisms in the food chain--the order in which organisms in an ecosystem prey on other organisms as food. Pesticides used in agriculture, forestry and livestock development can run off into fish ponds. Humans who continuously ingest contaminated fish may eventually accumulate enough toxic material in their tissues to cause disease. Although the effects of chemical toxicity can take several years to manifest themselves, they are severe and often irreversible. Changes induced by livestock and forestry projects, as well as agriculture, may affect human beings through the medium of fisheries. Though chemical toxicity is not directly caused by fisheries, the presence of a fishery can magnify the problem and cause its effects on health to occur more quickly.

Increased Population Density. In combination with nearby development projects, new fisheries may also tend to attract people who lack immunity to a vector-borne disease such as malaria. This usually occurs only when large impoundments are

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3. See Bibliography: 64

4. See Bibliography: 61, 68.

being implemented. For example, if a new fishery were established on an inland delta of the Niger River in conjunction with river-basin development, people from the drier northern regions might migrate south. Since they have little or no acquired resistance to the diseases endemic in wetter areas, the northern immigrants may be particularly susceptible to malaria and other vector-borne diseases, and their mortality rate is likely to be much higher than that of the indigenous population. Thus not only the incidence but the seriousness of disease can increase markedly.[5]

Table 3.1 catalogues the potential positive and negative effects of fish production.[6] It should be remembered that it is the change brought about by development activities that causes both the positive and negative results. The table is also presented to clarify the concept of trade offs--the idea that desirable outcomes also have undesirable effects--and to re-emphasize that development does not occur in a vacuum. However, the table is not meant to imply that negative effects on health are inevitable, nor that all the effects listed always occur and are positive or negative to the same degree.

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5. See Bibliography: 32, 79, 82, 83, 126, 159.

6. The potential positive effects of fisheries development in the Sahel varies widely within the region depending on the availability of water and dietary preferences: approximate annual consumption of fish varies from 1.5 kilograms per person in Upper Volta to 50 kilograms in Senegal.

Table 3.A

Positive and Negative Effects on Health of Fisheries Development Projects

| PROJECT | POSITIVE EFFECTS | NEGATIVE EFFECTS |
|---|---|---|
| Increased Fish Production (stocking of ponds, reservoirs, irrigation canals, rivers, deltas, and/or paddies) and Marketing (locally, regionally, and for export) Capture and Culture oriented fisheries | 1. Improved nutrition<br>a. Increased survivorship of children and adults<br>b. Better physical and mental growth<br>c. Increased resistance to disease<br>d. Increased productivity and individual vigor<br>2. Increased cash income<br>a. Increased buying power<br>b. Attraction of merchants and other businessmen leading to eventual increased availability of goods and services<br>3. Attraction of newcomers due to increased cash income and economic stability<br>a. Increased availability of goods and services<br>b. Well-established supply routes<br>4. Example of integrated rural development (cooperation and complementarity among development sectors) | 1. Creation of new breeding habitats for vectors of malaria, schistosomiasis, and guinea worm<br>2. Increased transmission of amoebic and bacillary dysentery, intestinal worms, possibly cholera, and other water-borne and food-borne diseases due to contamination of water with human waste<br>3. Toxic effects from eating fish contaminated by pesticides in runoff water from agricultural/livestock development projects<br>a. Biomagnification/concentration in animal flesh<br>b. Human organ malfunction<br>4. Conflict with livestock projects (shared water resources; incursion into dry season pastures along stream channels)<br>5. Conflict with ecology/forestry projects: destruction of vegetative cover for smoking, processing fish. |

Measures to Limit Adverse Effects on Health

Fisheries development officers must choose the most effective and feasible methods of minimizing fisheries' adverse effects on health, given the limitations of time, money, manpower, and physical resources. Table 3.2 lists several such methods, each of which has proven successful to some degree, depending on the fiscal and manpower resources available. Table 3.2 identifies some of the problems a fishery project may encounter and some possible approaches that can be incorporated into its design to avoid or minimize such problems. Choice of an approach or approaches will depend on many factors, i.e. financial resources, socio-cultural patterns, time, manpower, etc.

Because the major health problems associated with fisheries are similar to those associated with agricultural development--and because fisheries are often located near or within agricultural project areas--it is highly recommended, after reviewing Table 3.2, to read or reread Chapter 1. The sections of particular pertinance to fisheries are those concerning the creation of standing water and the spread of water-related diseases (pages 5 - 17).

Gambusia. Particularly noteworthy is an effective method of controlling malaria that is easily accommodated by most fisheries: stocking at high densities with fish that feed on mosquito larvae. Gambusia ops. are often used for this method of biological control and are found in the Sahel. Because these fish grow well in inland water courses such as ponds, pools and reservoirs,

Table 3.2

Approaches to Health Problems
Arising From Fisheries Development

| DEVELOPMENT PROJECT OR RELATED ACTIVITY | ASSOCIATED HEALTH PROBLEM | OBJECTIVES AND APPROACHES TO THE PROBLEM |
|---|---|---|
| Implementation of Fisheries: Both capture and culture orientated (in lakes, ponds, reservoirs, rivers, irrigation canals, and/or paddies) | Increased risk of disease due to an increase in size and number of BREEDING SITES for the vectors | |
| | 1. Malaria | 1. Limit breeding habitats for the malaria vector (Anopheles mosquito).<br>a. Locate the existing breeding sites before the project is designed.<br>b. Evaluate the prevalence of malaria in the surrounding area before the project is implemented; estimate the projected increase.<br>c. Educate adults and children about the transmission of malaria.<br>d. Organize villagers into malaria surveillance teams to:<br>1. identify larval habitats;<br>2. monitor and control larvae in the fishery;<br>3. spray the insides of houses and surrounding ground cover to limit the population of adult mosquitoes, using nonresidual chemicals.<br>e. Maintain surveillance of breeding habitats through payment in kind and moderate government subsidies.<br>f. Stock fisheries with larvae-eating fish (Gambusia) at high densities.<br><br>* It is not advisable to spray fishery water with nonbiodegradable chemicals, because concentration of these chemicals in the fish may have adverse effects on health over time. If chemicals are added to enhance production and administered in proper concentrations by qualified personnel, the risk of contamination and permanent damage can be minimized. |
| | 2. Schistosomiasis | 2. Limit breeding habitats for the schistosomiasis vector (a fresh-water snail).<br>a. Locate the existing breeding sites before the project is designed.<br>b. Evaluate the prevalence of schistosomiasis in the surrounding area before the project is implemented; estimate the projected increase.<br>c. Educate adults and children about the transmission of schistosomiasis.<br>d. Organize villagers into schistosomiasis surveillance teams (possibly same as the malaria teams) to inspect the fishery thoroughly for snails.<br>e. Periodically clear the fishery of vegetation if it exists.<br>f. Organize villagers to periodically clear the fishery of snails by hand.<br>g. Drain fishery annually to limit vegetation and restore organic material for continued fertility. |
| | 3. Guinea Worm | 3. Limit breeding habitats for the guinea worm.<br>a. Educate adults and children about the transmission of guinea worm.<br>b. Discourage people from wading into the fishery for drinking water.<br>1. Help install a preferable alternate source of drinking water.<br>2. Check the water periodically for the intermediate host of guinea worm (the crustacean Cyclops).<br>c. Drain fishery periodically to limit spread of Cyclops. |

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Table 3.2
(Continued)

| DEVELOPMENT PROJECT OR RELATED ACTIVITY | ASSOCIATED HEALTH PROBLEM | OBJECTIVES AND APPROACHES TO THE PROBLEM |
|---|---|---|
| Implementation of Fisheries (Continued) | Increased risk of disease due to an increase in the number of PARASITES ENTERING THE HUMAN POPULATION in the area. | |
| | 1. Malaria | 1. Control of malaria parasites in the human population.<br>a. Oversee the initial organization (if necessary), maintenance, staffing, and supply of an adequately sized health clinic.<br>b. Monitor the prevalence and incidence of malaria in the area (possibly by the vector surveillance team).<br>1. Train teams in the laboratory diagnosis of malaria and other parasitic infections (possibly by the health clinic staff).<br>2. Periodically examine blood samples from the resident population (especially those living near the fishery).<br>3. Examine blood samples from all immigrants to the area after the project is in operation.<br>c. Identify immigrant groups that might be nonresistant to malaria (notably those from more arid areas).<br>d. Report all cases and suspected cases of malaria to the local health service; examine and treat them with antimalarial drugs.<br>e. Consider the administration of antimalarial prophylatic drugs to all children under 10 and to women of childbearing age, especially recent immigrants from nonmalarial areas. (Treatment and prophylaxis should be available at low cost.)<br>f. Promote use of protective clothing to decrease exposure to infected mosquitoes.<br>g. Seek out government support for the activities listed above. |
| | 2. Schistosomiasis | 2. Control of schistosomiasis parasites in the human population.<br>a. Oversee the initial organization (if necessary), maintenance, staffing, and supply of an adequately sized health clinic in the area.<br>b. Monitor the prevalence and incidence of schistosomiasis in the area (possibly by the malaria vector surveillance teams).<br>1. Train teams in the laboratory diagnosis of schistosomiasis and other parasitic infections (possibly by the health clinic staff).<br>2. Periodically examine urine and stool samples from the resident population and immigrants to the area (especially fishery workers and those living close to the fishery).<br>3. Insure that all diagnosed cases are closely watched and, if infection progresses, treated. (Treatment is not entirely effective.)<br>c. Educate adults and children about the role of unsanitary waste disposal in the transmission of schistosomiasis.<br>d. Block or limit the deposition of eggs into the fishery by discouraging use of the fishery for drinking water and/or waste disposal.<br>1. Help install an adequate and well-maintained sanitary waste system and a pure water-delivery system, and encourage people to use both. This must be done in cooperation with other development sectors. |

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Table 3.2
(Continued)

| DEVELOPMENT PROJECT OR RELATED ACTIVITY | ASSOCIATED HEALTH PROBLEM | OBJECTIVES AND APPROACHES TO THE PROBLEM |
|---|---|---|
| Implementation of Fisheries (Continued) | Increase in NUMBER OF PARASITES (Continued) | |
| | 2. Schistosomiasis (Continued) | d. (Continued)<br>2. Establish regulations governing the disposal of human wastes (subject to the agreement of the populace and enforcement by local officials).<br>3. Erect fences around the fishery to prevent people (especially children) from urinating and defecating in them, or wading into the water to fill containers.<br>e. Seek out government support for the activities listed above. |
| | 3. Guinea Worm | 3. Control of guinea worm parasites in the human population<br>a. Oversee the initial organization (if necessary) maintenance, staffing, and supply of an adequately sized health clinic.<br>b. Monitor the prevalence and incidence of guinea worm in the area by diagnosis of the symptoms at the health clinic.<br>1. Examine water samples for the intermediate host (Cyclops).<br>c. Educate people about the transmission of guinea worm.<br>1. Discourage the use of fishery water for drinking (see d below).<br>2. Discourage the practice of wading into the water to obtain it or excrete wastes. Make available easily accessible sanitary waste disposal and potable water supply systems.<br>d. In cooperation with other development sectors, help install an adequate and well-maintained pure water delivery system and encourage people to use it.<br>e. Refer all cases and suspected cases of guinea worm to the health clinic for treatment. |
| | * * * * | * * * * * * * * |
| | Increased transmission of communicable WATER-BORNE DISEASES (amoebic and bacillary dysentery, ascaris, typhoid, and others) | 1. Oversee the initial organization (if necessary), maintenance, staffing, and supply of an adequately sized health clinic.<br>2. Educate people about the transmission of water-borne diseases and ways to prevent them. Explain the importance of personal hygiene practices, especially washing hands before eating and after defecating.<br>3. Discourage the use of fisheries for drinking water and/or waste disposal.<br>a. Erect fences around the fishery.<br>b. Establish regulations governing disposal of human wastes.<br>c. In cooperation with other development sectors, help install an adequate and well-maintained sanitary waste-disposal system and a pure water-delivery system, and encourage people to use both.<br>4. Check water periodically for fecal contamination (perform E. coli bacteria counts) (by health sector personnel).<br>5. Report all cases and suspected cases of these diseases to the clinic for treatment. Periodically examine preschool children, who are most likely to become infected and are often most seriously affected. |
| | * * * * | * * * * * * * * |

Table 3.2
(Continued)

| DEVELOPMENT PROJECT OR RELATED ACTIVITY | ASSOCIATED HEALTH PROBLEM | OBJECTIVES AND APPROACHES TO THE PROBLEM |
|---|---|---|
| Implementation of Fisheries (Continued) | Increased transmission of communicable AIR-BORNE DISEASES (measles, tuberculosis, polio, viral and bacterial pneumonia) due to INCREASED POPULATION DENSITY at the fishery site (for large impoundments) | 1. In cooperation with other development sectors, monitor population growth in the project area.<br>a. Take steps to regulate spontaneous immigration.<br>b. Provide adequate housing for people so that crowded conditions do not occur.<br>c. Identify ethnic groups in the area to determine whether future outbreaks are caused by a particular group of people from any given area.<br>2. Oversee the initial organization (if necessary), maintenance, staffing, and supply of an adequately sized health clinic; keep records on incidence of these diseases; maintain vaccination program; refer all cases and suspected cases of these diseases to the clinic.<br>3. Educate people (especially mothers and pregnant women) about the transmission of air-borne diseases and ways to avoid infection. This must be done in cooperation with other development sectors.<br>4. Vaccinate children in the area against measles, polio, diptheria, tetanus, yellow fever (if endemic to area) and cholera (if epidemic threatens); keep records on incidence of those diseases; maintain vaccination program.<br>5. Try to insure adequate availability and distribution of food in order to promote resistance to infections. |
| | * * * * | * * * * * * * * |
| | Lowered nutritional status due to DECREASED PER CAPITA FOOD SUPPLY | 1. In cooperation with other development sectors, monitor population growth in the area. Encourage local officials to regulate population influx into the project area, based on projections of the area's carrying capacity.<br>2. With the help of the economic development sector, encourage widespread distribution of fish in the area.<br>3. Construct storage facilities for the surplus fish harvest to guard against food storages. |
| | * * * * | * * * * * * * * |
| | Chemical contamination of fish due to CHEMICAL RUNOFF from agricultural and livestock activities (farm plots, dipping stations) | 1. Prevent contamination of the fishery by pesticides.<br>a. Identify risks of chemical contamination.<br>b. Bring potential problems to the attention of agricultural and livestock personnel; include a water engineer in the discussions.<br>c. Design safe drainage around dipping stations and agricultural plots to prevent water containing chemicals from contaminating the fishery.<br>d. Test soil permeability before the project is designed to estimate rate of seepage and predict the likelihood of underground runoff and subsequent contamination. |

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they can be effective in controlling the spread of malaria due to agricultural and fishery development.

Cooperation With Other Sectors. If the fish pond is the most convenient and reliable local water source, people will use it to supply all their needs for water. This practice inevitably leads to contamination of the water, and thus to the spread of disease.[7] For this reason, a source of potable water and a soundly designed basic sanitation system are highly beneficial both to the local population and to the fishery. The problem, of course, is that the cost of installing these systems where none exist is ordinarily prohibitive. The same is true of engineering safeguards to protect fisheries from pesticide runoff. However, fishery personnel might consult with local administrators, other sector officials and technicians to investigate the feasibility of sharing the cost of such undertakings. If the provision of an extensive water supply and sanitary system is not feasible, then fishery personnel might encourage residents in the project area to build and use sanitation and water delivery systems of simpler design, i.e. pit latrines and covered wells.

Such activities as health education, establishment and enforcement of rules, construction of fences, and periodic deployment of village squads to clean ponds would be strengthened by intersectoral cooperation of personnel. Because fisheries are highly vulnerable to undesirable effects passed on by other

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7. See Bibliography: 64, 82, 83, 93, 116, 127, 132, 133, 136, 137, 256.

sectors, fisheries personnel are likely to be especially sensitive to the interdependence, interaction and complementarity of development projects. Thus, fisheries development officers can often be particularly persuasive in soliciting mutual cooperation and investment from other development sectors in the prevention of many adverse health impacts.

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# Chapter 4

## Transportation

### Introduction

The capacity to transport equipment and supplies, and in turn, products, is a crucial precondition of economic development. Restricted mobility often limits the scope and success of individual economic projects in developing countries. And, as the Sahel's recent past has tragically demonstrated, adequate transportation is essential to the efficient distribution of food in times of scarcity. The construction of transport facilities sufficient to the Sahel's future needs will in the long run also enhance interregional communication and improve the health and nutritional status of the region.[1]

The effect of a new road on the localities it touches can be dramatic. The local economy is likely to be both stimulated and stabilized by improved mobility and communication. Merchants may be attracted to the area; markets may spring up in roadside villages, which may shortly grow into towns, and population increases. Markets become more accessible, and cash-cropping may become possible for the first time. A wider range of consumer products will probably appear, and the unit price of goods produced elsewhere may decrease as transport costs are reduced.

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1. See Bibliography: 24, 74.

The occupational structure also tends to change: for example, farmers may become merchants, and those previously unemployed may find work as drivers, loaders, or stockers. As health services and supplies become more available locally, and as acutely ill persons are more able to reach clinics and hospitals, the rate of illness may decline and infant survivorship may increase. Mobility and wider communication also seem to enhance people's desire for a higher standard of living by increasing their knowledge and expectations.

## Characteristics of Transportation Projects

Because the main activity of the transportation sector in the Sahel is the planning and construction of roads, this chapter will focus on roadbuilding. Most of the topics it addresses are, however, also pertinent to the building and operation of railroads and airstrips. Roadbuilding eventually affects not just points A and B, the localities at the two ends of the road, but all the towns and villages in between. Over time it can become a large-scale, continuous endeavor employing massive amounts of money, equipment, manpower, technical skills, and effort.

The first step in roadbuilding is usually to survey the land and plan the route the road will take. Decisions made at this point can have serious and virtually irreversible impact, both positive and negative, on the road's ultimate consequences for health and safety.

The next step, clearing the land, tends to cause significant changes in the surrounding environment. Alteration in the previous drainage pattern can create new water points, and inundate the vegetative cover, which may have serious ramifications for agricultural productivity. The creation of pools of standing water promotes transmission of such vector-borne diseases as malaria, schistosomiasis, and guinea worm.

The most highly visible activity associated with roadbuilding in the Sahel is the mining of laterite soil, huge quantities of which are required for the construction of all-weather roadbeds. Large borrow pits, one or two hectares in area and one to three meters deep, are dug along the routes of roadways throughout the Sahel. Borrow pits that fill up with rainwater may be used by the local population as a source of drinking water, and, if unattended, may facilitate the spread of a number of vector-borne and water-borne infections. Well-managed borrow pits, on the other hand, can greatly improve health status by serving as a source of clean drinking water for humans, as watering-holes for livestock and/or sources of irrigation water for nearby fields.

Because laterite must be wetted to facilitate the compaction and hardening process, the construction of a road requires a convenient and reliable source of water. Roadbuilders may be forced to dig wells to tap underground water supplies; more often, temporary earthen dikes (retenues d'eau) and/or more permanent dams (barrages) are built to collect runoff water

during the rainy season for later use. All three methods of water collection have considerable potential to spread water-borne and vector-borne diseases. Properly managed, however, they can serve as a safe source of water for the nearby population.

The ultimate activity associated with roadbuilding is, of course, use of the completed road to transport equipment, goods and supplies, and to enhance human mobility. Let us examine in detail the effects of these changes, and ways that adverse effects on health can be combatted.

## Effects on Health of Roadbuilding and Road Use

Traffic Accidents. Roadbuilding's most direct effect on health is an increase in the number of traffic-related deaths and injuries. A new road is not just used by motor vehicles; since it is the easiest way to travel, it becomes the preferred route for pedestrians, herded animals, beasts of burden, and animal-powered vehicles as well. As a result, traffic accidents are one of the fastest-growing health problems in the developing world.[2] For towns along the roadside, improved accessibility brings with it the tradeoff of increased deaths and injuries due to accidents.

Urbanization. New transportation routes also promote urbanization, or migration to centers of population from more isolated areas. All-weather roads make travel much easier, and people respond by travelling--and by moving permanently. People from neighboring villages are drawn to roadside towns, and town residents in turn

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2. See Bibliography: 70, 72, 73, 75.

to bigger towns, by the availability of more goods, services, markets, and employment opportunities. The terminals and roadside towns that attract newcomers tend to experience markedly increased population densities, contributing to the spread of communicable diseases.[3] The surrounding environment is likely to be subjected to overcropping, overcutting, and overgrazing. Waste disposal can become a problem if the area's capacity to absorb wastes is overloaded. If demand for food, pure water, fuel and building materials exceeds available supplies, health status will decline.

Crowding in turn leads to an increase in the transmission of communicable diseases, particularly air-borne infections spread by close human contact, such as respiratory infections, measles, polio and until recently, smallpox.[4] Indigenous and newly arrived ethnic groups may mutually transmit diseases to which they have developed no natural immunities. Chapter 1, pages 5 -10, and Table 1.1 discuss in detail the effects on health of changes in population density.

Environmental Damage. If rainwater runoff from a raised roadbed is not channelled, it can cause erosion in adjacent fields and/or damage the roadbed during the rainy season. If runoff is slowed, sedimentation can occur. The local population may suffer serious nutritional hardship as a result of diminished crop yields.

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3. See Bibliography: 70.

4. See Bibliography: 7, 29, 177, 184, 190.

Vector-Borne and Water-Borne Diseases. Standing water in borrow pits, dikes, dams, and pools created from runoff rainwater is a favorable breeding habitat for the mosquitoes, fresh-water snails, and crustaceans that serve respectively as vectors for malaria, schistosomiasis, and guinea worm. Schistosomiasis and guinea worm are directly increased when the parasite is deposited in the water by specific human behaviors; malaria is spread more indirectly, by exposure to infected mosquitoes. Road crews often import diseases into the area where the road is being built. They may inadvertently contaminate water supplies and facilitate disease transmission among themselves and to those residing near the roadway. Vector and water-borne diseases are likely to spread if precautions (such as health education, pit latrines and provision of clean drinking water) are not taken.

If contaminated water is used for washing of food, drinking, and bathing as well as for excretion, the spread of water-borne infections like dysenteries, intestinal worms, and leptospirosis is virtually inevitable.

## Measures to Limit Adverse Effects on Health

Both the development of an adequate transportation system and the prevention of resulting threats to health require long-term planning and sustained effort.[5] The more the initial planning process takes matters of health and safety into account, the less severe will be the unintended ill effects. This is by no means merely a platitude: avoidable mistakes made in the planning of a road can be serious and virtually impossible to correct.

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5. See Bibliography: 70, 72, 73, 75, 88, 95, 96.

Because other development sectors benefit immeasurably from the construction of roads that connect them with markets and sources of supplies, it is in their clear interest to cooperate in the process of planning a new road. (Consultation with other project officers might lead, for example, to the placement of a borrow pit where it could be used for livestock watering or irrigation; in exchange, the other sector could organize surveillance squads to monitor the borrow pit for disease vectors.) The planning process ought not to end with the design of the road; a long-term plan, undertaken jointly with other sectors, ought also to include cost-effective and feasible approaches to road maintenance, regulation, population increase, and threats to health.

Before considering specific ways to prevent or combat risks to health, it may be of value to review transportation projects' positive and negative effects on the environment and human health by looking at Table 4.1. It is important to note that it is the <u>change</u> brought about by any development project that causes both its positive and its negative outcomes.

It is the responsibility of transportation development officers to choose the most effective and feasible methods of combatting the potential ill effects of roadbuilding on health, given inevitable constraints on time, money, manpower, and physical resources. Table 4.2 summarizes several approaches, each of which has proven successful to some degree, depending on available resources. Table 4.2 can be used to identify problems your project may face, and approaches that can be incorporated into its design to avoid or neutralize them.

Table 4.1

Positive and Negative Effects on Health of Transportation Development Projects

| PROJECT | POSITIVE EFFECTS | NEGATIVE EFFECTS |
|---|---|---|
| Road Construction | 1. Improved access to remote areas<br>a. Decreased unit prices for transported goods<br>b. Improved distribution of goods due to lowered cost<br>c. Attraction of people to roadside and terminal towns<br>1. Improved economic opportunities<br>2. Economic stability.<br>d. Improved potential to administer medical care and relief in case of food crisis<br>1. Decreased illness<br>2. Improved infant survivorship.<br><br>2. Adequate transportation capacity for the Sahel's future needs<br>a. Better population distribution<br>b. Improved interregional communication. | 1. Increased vehicular and pedestrian traffic, leading to rise in traffic-related deaths and injuries.<br>a. Increased environmental pollution from vehicle exhausts<br>b. Increased demand for fuel and vehicles, requiring increased maintenance and expenditures<br><br>2. Increased risk of disease<br>a. Spread of vector-borne diseases (malaria, schistosomiasis, guinea worm) due to creation of new breeding habitats in dikes, dams, borrow pits and roadside pools.<br>b. Spread of water-borne diseases (dysenteries, viral and bacterial infections) due to human ingestion of waste-bearing water.<br>c. Spread of air-borne infections (measles, tuberculosis, pneumonia and the like) due to increased population density.<br><br>3. Increased population density<br>a. Increased spread of disease<br>b. Overuse of sanitation system<br>c. Overuse of water supply<br>d. Ecological damage<br>1. Decreased soil fertility due to overcropping<br>2. Damage to ground cover and erosion due to overcutting for fuel and building supplies<br>e. Decreased nutrition due to increased food demand.<br><br>4. Increased urbanization<br>a. Urban poverty<br>b. Increased spread of disease<br>c. Poor distribution of wealth. |

Table 4.2

Approaches to Health Problems
Arising From Transportation Development

| DEVELOPMENT PROJECT OR RELATED ACTIVITY | ASSOCIATED HEALTH PROBLEM | OBJECTIVES AND APPROACHES TO THE PROBLEM |
|---|---|---|
| Road Use | Increase in Traffic-Related Accidents | 1. Minimize traffic-related deaths and injuries.<br>a. Design roadways with shoulders or extra width for pedestrian and animal traffic.<br>b. Grade the road away from inclines.<br>c. Construct gentle ridges across the road at the outskirts of villages to remind fast-moving through traffic to slow down.<br>d. Design roadside drainage canals to prevent rain water runoff from causing erosion.<br>e. Consider guardrails at dangerous curves or inclines.<br>f. Consider traffic lights and road signs at crossroads and in towns.<br>g. Consider streetlights along the road in towns to insure adequate visibility for drivers and pedestrians at night.<br>h. Help local officials establish and enforce traffic laws and speed limits, vehicle inspection, and licensing of drivers.<br>i. Encourage proper maintenance of roadways. |
| * * * * | * * * * | * * * * * * * * |
| Dikes, Dams, and Borrow Pits | Increased prevalence of malaria, schistosomiasis, and guinea worm due to the creation of BREEDING SITES for the vectors | |
| | 1. Malaria | 1. Limit breeding habitats for the malaria vector (Anopheline mosquito).<br>a. Locate the existing breeding sites before the project is designed.<br>b. Evaluate the prevalence of malaria in the surrounding area before the project is implemented; estimate the projected increase.<br>c. Educate adults and children in schools about the transmission of malaria.<br>d. Organize villagers into malaria surveillance teams to:<br>1. identify larval habitats;<br>2. monitor and control larvae in streams using non-residual chemicals;<br>3. spray the insides of houses and surrounding ground cover to limit the population of adult mosquitoes, using non-residual chemicals.<br>e. Maintain surveillance of breeding habitats through payment in kind and moderate government subsidies.<br>1. Check dikes, dams, and borrow pits periodically for larvae.<br>2. Treat water periodically with appropriate non-residual larvicides (only if water is not used for human consumption). |
| | 2. Schistosomiasis | 2. Limit breeding habitats for the schistosomiasis vector (a fresh-water snail).<br>a. Locate the existing breeding sites before the project is designed.<br>b. Evaluate the prevalence of schistosomiasis in the surrounding area before the project is implemented; estimate the projected increase.<br>c. Educate adults and children in schools about the transmission of schistosomiasis. |

Table 4.2
(Continued)

| DEVELOPMENT PROJECT OR RELATED ACTIVITY | ASSOCIATED HEALTH PROBLEM | OBJECTIVES AND APPROACHES TO THE PROBLEM |
|---|---|---|
| Dikes, Dams, and Borrow Pits (Continued) | Increase in VECTOR BREEDING SITES (Continued) | |
| | 2. Schistosomiasis (Continued) | 2. (Continued)<br>d. Organize villagers into schistosomiasis surveillance teams (possibly same as the malaria teams) to inspect dikes, dams, and borrow pits periodically to identify aquatic vegetation and snails.<br>e. Encourage local residents to remove aquatic vegetation and snails periodically, with the assistance of health sector personnel and vector surveillance teams.<br>f. Apply a molluscicide to the water periodically to kill the snail host (only if the water is not used for human consumption). |
| | 3. Guinea Worm | 3. Limit breeding habitats for the guinea worm vector (the crustacean Cyclops).<br>a. Educate adults and children in schools about the transmission of guinea worm.<br>b. Test standing water for the guinea worm vector; help health sector personnel evaluate the prevalence of the parasite in the human population.<br>c. Install water-lifting devices to discourage people from wading into water to fill containers (thus preventing the vector from becoming infected. |

Preventing Traffic Accidents. It is of the utmost importance to design roads with shoulders or sufficient extra width to accommodate pedestrian and animal traffic. It may prove worthwhile to think about building a wider but shorter road than was originally intended, or building a wide road in stages as funds become available, rather than constructing a longer, narrower, and more dangerous road.

Grading of the road away from inclines and roadside borrow pits can prevent many accidents at very little cost, as can safety-conscious decisions about the placement of borrow pits. Runoff from rainwater can be kept from causing erosion by the proper design of roadside drainage canals. Gentle curves are preferable to knifelike straightness in a long road because they promote alertness; long-haul drivers tend to fall asleep at the wheel more often on monotonously straight roads.

In many countries, fast-moving through traffic is reminded to slow down in populated areas by the construction of two or three gentle ridges across the road at the outskirts of villages. Road signs should also be considered as a means of traffic regulation and as an important method for accident prevention. Guardrails at inclines and traffic lights or stop signs at crossroads and in towns, though initially expensive, may prove worth the cost.

Of course, everything cannot be done at the design stage; a long-term commitment to regulation and maintenance must also be made. Roadbuilding project officers are in an excellent

position to stimulate a coordinated intersectoral commitment to such matters as vehicle maintenance, driver education, and avoidance of erosion. Once the road is underway, transportation planning officers can provide valuable expertise to local officials in a concerted effort to establish and enforce speed limits and traffic laws, vehicle inspection, and licensing of drivers.[6] Overloading of buses and trucks, which is the cause of many accidents in developing countries, can be discouraged by revoking the licenses of drivers who exceed load limits.

Once a road is in use, it requires regular maintenance and repair. Washouts and potholes must be filled in order to prevent accidents, damage to costly vehicles, and obstructed passage. Other sectors can be encouraged to help maintain a road they use, since it is in their interest to keep it usable and safe. Extension agents involved in cash-crop production are particularly well-suited to recruiting maintenance workers and coordinating and supervising their work; their efforts insure that the crops can reach their markets. Extension agents can also organize surveillance for disease vectors and maintain the cleanliness of the water in borrow pits, dikes, and dams.

Combatting Vector-Borne Diseases. Roadbuilding shares with nearly every other type of development project pursued in the Sahel the capacity of spread vector-borne diseases. In fact, vector-borne disease is probably the most widespread and universal health problem associated with development. By increasing human

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6. See Bibliography: 73, 75.

contact with standing water, projects involving transport, agriculture, livestock, and fisheries all tend to contribute to the transmission of such diseases as malaria, schistosomiasis, and guinea worm.

Because human behavior patterns are a central factor in the transmission of vector-borne diseases,[7] education is a directly effective way of limiting the spread of disease. Adults and children can be educated in schools and training facilities about the daily practices that spread disease; transportation officers can participate in the educational process in cooperation with health, and other social services.

If malaria, schistosomiasis, and/or guinea worm are already present in areas a projected road will pass through, it is worthwhile--in cooperation with the health sector--to evaluate their prevalence, estimate potential increases, and monitor outbreaks. Once the road is in use, teams of villagers can be organized by agriculture extension agents and health personnel to monitor and exterminate disease vectors in standing water. Borrow pits can also be stocked with Gambusia, a fish that feeds on the larvae of the malaria-bearing mosquito (genus Gambusia); the use of these fish is discussed in Chapter 3, pages 47-52.Chapter 1, pages 20-23, and Table 1.2 outline in detail alternative methods of combatting vector-borne and water-borne diseases.

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7. See Bibliography: 152, 156, 164, 170, 173, 176, 183, 196.

Environmental damage and an increase in standing water caused by changes in the drainage pattern can be avoided by designing drainage canals for road runoff.

Responding to Urbanization. The health problems brought about by urbanization are large-scale and often severe, and cannot usually be directly prevented without sizeable expenditures. For these reasons, cooperation with other sectors and local officials is indispensable. Joint planning and cost-sharing may make possible a potable water-supply system and other measures outlined in detail in Chapter 1, page 4, and in Table 1.2.

In conclusion, a new road tends to have both acute and far-reaching consequences for health in the areas it passes through. The problems it can cause, however, are particularly amenable to prevention through long-term planning and intersectoral problem-solving. Actively soliciting other sectors' cooperation from the outset can have a profound positive outcome for those who use the road and those who live near it.

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## Chapter 5

## Special Issues in Sahelian Development: Technology Transfer, Village Water Supply and Ecology/Forestry

The availability of suitable technology is an enabling condition of development. This is true both historically and in terms of the outcome of individual development projects undertaken presently and in the future. Technology directly affects all the ways a development project's success can be measured: operational efficiency, productivity, scale, savings in human labor, creation of new opportunity, safety, acceptability, and effects on health and well-being.

When we speak of technology, we are talking not just about equipment, products, and machines but also about the application of ideas, information, procedures, systems, and the valuable lessons of past experience.

Making the best possible use of technology does not always mean using the greatest number or most advanced tools; the crucial matter is to use what is most appropriate.[1] Deciding on appropriate technology involves making choices among the available options. The heart of technology transfer, therefore, is the process of decision-making. The specific technological requirements of different sectors differ, but the process of arriving at sound choices is shared by all.

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1. See Bibliography: 88, 123.

## Appropriateness: The Key to Technology Transfer

Appropriate technology, on any scale, is technology that can be understood, implemented, used and maintained by local people using locally available supplies. It may involve a sophisticated idea, thoughtfully developed and applied by means of simple procedures and readily available materials. Though perhaps technical in the sense that it has been designed by skilled specialists, it is appropriate in that it uses local materials and is readily understood and maintained by its users. This is not to suggest that "grass-roots technology" is the only type of technology appropriate for developing countries. Appropriateness is determined by taking into account a mix of factors, including needs, projected energy expenditures, social and political constraints, available resources of money and labor, possible benefits and drawbacks, unintended consequences, and often the unique circumstances of the particular situation. Appropriate technology is feasible, affordable, maintainable, understandable, effective, and suited to the needs and resources of its users. If possible, it uses local resources and is in keeping with traditional practices. Thus, appropriateness is a direct reflection of the social, economic, environmental, and political realities of the nation or region in question.

The applications of technology vary from sector to sector. For example, agricultural projects may involve building dams, creating irrigation systems, applying fertilizers and pesticides, and adopting new tools and/or new varieties of seeds. The livestock projects may involve building slaughterhouses and

marketing centers, and also using chemicals to protect animals from pests and diseases; fisheries are similar. Transportation projects often utilize surveying equipment and large machines to clear land and construct roads.

Even if there were space in this book to review, for example, the relative merits of different kinds of fertilizer or road equipment, it would be virtually useless to do so, since technologies are consistently changing, and appropriateness will vary with each situation.

## The Decision-Making Process

It is far more useful to examine the decision-making process itself--the process by which project officers can make sound decisions about the kinds of technology they employ. This is a process applicable not just to the initial choice of equipment or approach but also to its location, installation, and maintenance, and, in fact, the design of the entire project.

The process varies, of course, from situation to situation; a step that proves difficult and time-consuming in one instance may be self-apparent and almost instantaneous in another situation. Perhaps one or more of the steps can be pursued simultaneously, skipped, or combined; sometimes there may be no options. Decision-making is always necessary; done well, it requires information, problem solving skill, and thorough familiarity with the nature of the project. The process, which has proven very valuable in pursuits of all sorts throughout the world, consists of the following steps:

1. Recognizing a need, problem or opportunity.

2. Identifying alternative ways of approaching it, technological or otherwise.
3. Foreseeing the possible consequences of each approach with regard to such matters as cost, threats to health and safety, manpower requirements, maintenance needs, acceptability, and cultural constraints.
4. Weighing the options in light of their possible consequences.
5. Making an informed choice, particularly with the help of input from the community involved.
6. Integrating the choice with other plans in the most effective possible way.
7. Providing for operation, maintenance, repair, management, and combatting of ill effects.
8. Implementing the choice.
9. Checking to be certain it is working as it should.
10. Making any necessary further decisions and adjustments.

Even with such thorough preparation, it may prove necessary to repeat the process in response to an unforeseen circumstance.

## Decision-Making and Health

We are concerned here with the application of this process to matters of health. This is by no means a narrow focus, since human health is inextricably intertwined with ecological concerns, economic viability, and such specific matters as choice of crops and animal health.

All too often, ill effects on health result from failure to consider all the consequences of an undertaking--due sometimes to lack of full information, sometimes to insufficiently thorough decision-making, sometimes to inexperience, and sometimes to neglect. During the devastating drought and famine of the early 1970s, cattle in the northern Sahel were dying of thirst. Engineers and ecologists decided to try to save some of the animals by delivering water to them, and numerous borehole wells were dug to tap subterranean water. The initial problem was solved: cattle could drink their fill. When word spread, however, herders from all over the region brought their animals to the wells. What followed was an ecological disaster.[2] The hungry herds consumed the ground cover and then began to die of starvation. New borehole wells were dug approximately 30 kilometers from the first ones; herds migrated to the new water sources and the same thing happened again. This process was repeated over and over again, and when the drought finally ended huge portions of the northern Sahel had been left denuded and highly susceptible to wind and water erosion. Soil fertility was thus severly decreased, leading to desertification and permanent ecological damage. The water table had been lowered and land was lost to the desert, all to virtually no gain.

Well-handled technology transfer involves rigorous and thorough assessment, decision-making, and planning. Chapter 6 presents a method for applying these processes in particular development sectors; this method corresponds roughly to the first five steps in the decision-making process outlined on

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2. See Bibliography: 40, 51, 98, 159, 160, 183.

pages 72-73. The remainder of this chapter will examine the role of technology transfer, using as models two pursuits that cut across all other development sectors: village water supply and ecology/forestry.

Like technology transfer itself, village water supply and ecology/forestry are both processes whose shared purpose is to improve the quality of life in general. They differ from the product-oriented segments of the economy in that problems arise less from unintended side-effects or necessary tradeoffs than from inappropriate initial choices of method.

Earlier chapters have stressed the unity of the ecosystem and the interrelatedness of the various development sectors. That interrelatedness is clear in processes like the borehole well effect, in which a negative outcome is brought about by the combined effect of the interests and actions of various sectors. The remainder of the chapter will illustrate the applicability of this point to the process of technology transfer.

## Village Water Supply

A reliable and adequate source of potable water is crucial to a community's well-being and prosperity. Earlier chapters have described the dangers of contaminated water; the drawbacks of an intermittent water supply are self-evident.[3] A well-

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3. See Bibliography: 105, 106, 127, 132, 137, 198.

functioning village water supply system[4] reduces the risk of water-borne and vector-borne diseases and can enhance crop production and animal growth and reproduction, both of which promote improved human nutrition. Installation of a water supply system also tends to create a sense of permanence and shared responsibility, making the village a more cohesive community. The village may grow and become an autonomous town; medical, social, and agricultural services and economic development, may appear.

If the sole purpose of a village water supply project is to benefit the local population, how can it do harm? Generally speaking, the problems related to village water projects arise from misapplications of technology in terms of type or scope.

Each component of a water supply system needs to be thought through at the predesign stage in light of information about projected supply, projected use, and serviceability. It often proves highly worthwhile to consult experts from other sectors for help in addressing these questions. In fact, village water supply projects probably involve more people from more diverse sectors than any other kind of development. Participants in the project itself might include hydrologists, engineers, public health officers, agriculturalists, ecologists, economists, and transport personnel.

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4. Village water supply is a general term encompassing animal water, crop water, domestic water (for bathing, cooking, and laundry) and drinking water. We will focus here on the delivery of potable water for domestic use and drinking; other types of water supply have been discussed in earlier chapters.

In the community, the benefits of a reliable water supply are universal; there are particular benefits for women (who are the traditional waterbearers), children, farmers, and herders.[5]

When designing a water supply system, it is essential to think clearly about who its primary users will be--and to take into account any potential conflicts among uses or users. It is also crucial to incorporate maximum flexibility into the design of a water supply project. During the initial planning process, the village's future water needs should be estimated by seasonal availability and demographic projection, taking into account the possibility of spontaneous immigration from nearby villages that lack water. This projection of future needs will serve as insurance to the village that the system will not be overtaxed and the water supply thus inadequate. In turn, the system itself should be expandable to meet future demands. Decisions about the source of water, the system's initial and projected size and physical character, and the type and projected lifespan of materials used, should all be made in such a way as to provide for sustained long-term use.[6]

For example, a gravity-fed, single- or multiple-spout system might be adequate for a small village; at the other extreme, a large village with an extensive irrigated perimeter may be able to support a system with conduits for each house, supported by a fuel-powered pumping station.

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5. See Bibliography: 105, 121, 137.

6. See Bibliography: 121, 133, 137.

In selecting among alternative methods of water delivery, it is crucial to keep in mind too that the technique chosen must be capable of being built, maintained, and repaired by the local population, using locally available materials. The cost of the materials needed to deliver the water and to maintain its quality has to be considered as well.

Decision-Making and the Delivery of Village Water

There are two categories of water sources: surface water (rivers, lakes, springs, temporary and permanent reservoirs), and underground water (aquifers) tapped by open or closed wells. In selecting the type of water system employed, it is essential to consider the abundance of water available--annual rainfall and recharge rate for a surface water source, and the size and recharge rate of the aquifer in the case of underground water. The type of storage facilities used, such as rainbarrels, tanks, cisterns, or hand-carried containers, should also to be taken into account.

The vulnerability to contamination of surface water is a strong argument for providing a safe means of waste disposal. Deep pit latrines located at a considerable distance from the surface water source might serve to prevent contamination. In general, it is of the utmost importance to plan and locate a water supply system in full knowledge of prevalent waste-disposal habits; it may prove possible to plan and install a sanitary system in conjunction with the water supply system.

If gravity-fed surface water is the primary source of village water, a treatment unit ought to be considered, since such water is easily contaminated. A simple filtration unit employing sand is one alternative; chlorination using hypochlorite or a similar product is another.

Related issues of pertinence to underground water are poor drainage around wells, seepage of contaminated matter into the aquifer, and shoddy well construction. All three problems can harm the water supply. Poor drainage creates mud and puddles around the well that serve as breeding grounds for mosquitoes and facilitate transmission of hookworm.

If a well is dug without a preliminary hydrological survey, the volume of underground water and/or the rate of recharge may be overestimated. The water supply may soon prove inadequate, especially if demand rises due to spontaneous immigration. Seasonal maintenance of quantity is a prime consideration, since wells dug during the rainy season when the water table is high may run dry when the water table drops.

Village residents must be trained to maintain and repair the water supply system, and a supply of spare parts for equipment must be readily available. The system will be more likely to thrive, and a sense of community and permanence to flourish in the village, if villagers are encouraged to participate actively in planning, operating and maintaining their water supply system. Before the project becomes operational, responsibility for maintenance of machinery, potability, distribution,

and conservation of water should be clearly assigned to those local residents best suited to each task.

Villagers may not automatically make use of a newly installed water supply system in preference to their traditional sources of water. Cultural taboos and preferences may intervene; if a well is located on sacred ground, people may refuse to use it. And people sometimes prefer the taste of water gathered from traditional sources to that of well water.

Education can be an effective way of promoting use of a water supply system and disease prevention. The village residents who are trained to maintain the system can also be trained to teach their fellow villagers how to use the water system and how to maintain water potability. They should be informed about proper waste disposal and the use of sanitary containers to carry and store water. If necessary (and feasible), people should be instructed to boil drinking water. Every effort should be made to prevent contamination of water once it is drawn from the well, pipe, or spigot.

In sum, a clean and reliable village water supply has a generalized but incalculably positive effect on health, in terms of nutrition, disease transmission, and the overall quality of life. For this and other reasons, a new water supply system tends to enhance a village's sense of permanence and coherence; villagers tend to greet the advent of the water supply system enthusiastically. Thus it should not prove arduous to provide for the smooth operation of the system by local residents,

provided appropriate initial choices are made about the design and technology of the system.

## Ecology/Forestry

It is clear that the most severe problems facing the Sahel today are ecological: poor soil, erratic and inadequate rainfall, a serious imbalance between people and resources, growing human and animal populations, and uneven population distribution. Overuse of the land resulting from the rapid population growth over the last fifty years, coupled with a fluctuating climate, have rendered the Sahelian ecosystem extremely fragile. Under such circumstances a relatively mild environmental assault could have extreme consequences.[7]

In response to these pressing problems, ecologists and foresters are pursuing three interrelated goals: preventing further deterioration of the ecosystem, maintaining the quality and increasing the quantity of renewable resources (forests and water), and enhancing the region's carrying capacity--the number of people and animals it can support without incurring damage. Successful efforts to protect the environment in turn have pervasively beneficial effects on human health, life expectancy, and general well-being. The word that best sums up the goals of the ecology/forestry sector is conservation; fuel, soil, water, food, and energy must be conserved in the future.

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7. See Bibliography: 35, 40, 51, 85, 98.

Decision-Making and Ecology/Forestry

Large-scale efforts are being made in the arid and semi-arid areas of the Sahel to combat the encroachment of the desert by means of reforestation. Consideration is currently being given to a Sahelian greenbelt--a swath of trees across the southern edge of the desert to contain its southward expansion. Trees hold the soil firmly and prevent erosion caused by wind and/or water, thus forming a barrier to the desert. Because vegetation holds water, the planting of trees can also eventually influence local climate by releasing more water into the atmosphere and increasing rainfall. This approach to antidesertification has proven successful in other parts of the world.

Tree plantations also serve the crucial function of increasing the Sahel's reserves of renewable fuel (firewood), which in turn means that less damage will be done to natural vegetation during an urgent search for fuel. When firewood becomes scarce, for example, people cut down karite trees, which yield nutritious fruits during the rainy season and nuts that are processed for oil. Also vulnerable to use as emergency firewood is the *Acacia albida*, a valuable farm tree which contributes nitrogen-rich organic matter to the soil, improving yields of millet. It also drops a seedpod that is eaten by livestock.

Plantation adjoining farmland can also have a beneficial effect on the soil by acting as windbreaks. All these processes can indirectly but decisively affect nutrition by contributing to

higher agricultural yields. (Such subsidiary benefits as the availability of wood to preserve fish should also be noted.)

In its efforts to protect soil fertility, ecology/forestry overlaps with the agricultural sector. Ecologists have an interest in maintaining adequate fallow periods, rotating crops, and growing crops whose nutrient requirements put minimal pressure on the soil. Reforestation projects and the planting and maintaining of ground cover prevent erosion and increase the water-holding capacity of the soil.

Ecologists are also involved in efforts to conserve pastureland. The northern Sahel has been heavily overgrazed by livestock, denuding the land of ground cover, and large portions have been lost to the desert. Range management--limiting herds and replanting forage material--allows the range to recover enough to support the herds that remain. Chapter 2 describes in fuller detail the various ramifications for health of herd reduction and resettlement. Well-managed ecology/forestry projects may also serve as examples of multi-faceted projects and intersectoral compatibility.

Because of the nature of the ecosystem itself and the interrelated goals of the ecology/forestry sector, it is ecologically counterproductive to concentrate, for example, on growing trees at the cost of exhausting the soil, or preserving ground cover at the expense of food production. Ecology projects thus tend in general to have multiple uses and multiple goals. Problems tend to arise less from inappropriate choices of method *per se*,

as in the case of village water supply, than from excessive single-mindedness, overmanipulation of the natural environment, and extreme changes in land use, which can cause severe and avoidable damage in pursuit of a large-scale benefit.

For example, the introduction of monocultures, or single-crop plantations, of fast-growing exotic species that produce just wood tends to be in direct competition with food production, both natural and agricultural. Such intensively-managed high-yield plantations can also exhaust the soil by stripping it of nutrients.

The wholesale clearing of brush and natural forest to make way for a plantation may eliminate dozens of indigenous plants that had previously served as valuable sources of vitamins and calcium. The vitamin-rich condiments traditionally used in sauces are becoming scarcer in many parts of the region, as are honey, medicinal plants and edible fruits, flowers and leaves. The net result is unnecessary nutritional hardship.

If bulldozers are used to clear land for a plantation, it is not uncommon for erosion and compaction of the soil to result; bulldozers can also uncover deposits of laterite, rendering the area permanently infertile.

These kinds of ill effects arise from flawed understanding of the locality's ecological profile and inadequate application of the principles of conservation and multiple use, and are largely preventible during the project's predesign stage.

It is highly desirable, for example, to undertake a nutritional survey of the surrounding bushland before deciding to convert it entirely to the plantation of trees. If such a survey reveals the presence of useful plants, it is worth thinking about either conserving them or propagating them in conjunction with other varieties. It is desirable--for economic and nutritional as well as ecological reasons--to design ecology/forestation projects to be maximally compatible with food production. The concept of multiple use is not prescriptive; there are no rules about how to apply it to a given situation. It is the situation itself, thoroughly examined, that determines how to do so.

Multiple use is also a principle with wide applicability to other sectors, suggesting a way to actively and pragmatically approach intersectoral complementarity. The mutual benefits of, for example, agriculture and forestry, or agriculture and fisheries, make it foolhardy not to consider the possible benefits of cooperation.

It is crucial--in order to learn from experience--to monitor the effects of a plantation or other ecology/forestry project on local climate, soil status, and human health. Ecologists and foresters are also well-suited to help introduce into village schools information about the dangers of overcropping, overgrazing, overcultivation of land, and overcutting of trees for fuel.

Earlier chapters have treated specific threats to human health posed by various forms of development. A less localizable and more pervasive threat is posed by the Sahel's ecological vulnerability. The ecosystem is precariously balanced and prone to upset, and people suffer the full severity of the results. Ecology projects themselves rarely contribute to health-threatening processes, such as disease transmission, in a major way. But, as we have seen over and over again, the health of the environment has consequential direct and indirect effects on human health.

## The Role of Ecology in Economic Development

Because they are especially well-equipped to foresee and interpret the effects of particular environmental changes, ecologists are uniquely qualified to serve as "watchdogs" over the environment, alerting others to potential dangers, preferably before they arise. In particular, ecologists can share information and insights with other sectors' planning officers during the predesign stage of their projects.

Ecologists in the Sahel should consider it imperative to alert others to potential health-threatening and/or environment-threatening problems, and to bring together all those involved to discuss ways to prevent or minimize them. Ecology's total-perspective approach equips the ecologist particularly well to promote intersectoral complementarity and cooperation in the interests of integrated rural development.

The means for avoidance of major negative impacts lie in sectors other than that of ecology. Ecologists cannot, for example, build sanitation systems or adequate housing, provide food, undertake health surveillance, or supply clinics. Nor are there any standard procedures for bringing about these kinds of efforts or avoiding negative outcomes. It is largely a matter of stressing to others that problems will inevitably arise and explaining how, where, and why they are likely to occur. In order to do this effectively, ecologists must be thoroughly familiar with the other sectors of the economy and their activities.

In particular, ecologists should be fully acquainted with the major diseases that occur in the region. Since disease transmission is an ecological phenomenon, ecologists can play a valuable role in disease prevention and control.

If it is convincingly presented, the ecological perspective can rally people from different development sectors to work together to formulate a coordinated long-term plan designed to prevent and/or combat threats to environmental and human health while promoting sustained economic growth.

## SUGGESTED READINGS/SPECIAL ISSUES IN DEVELOPMENT

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# Chapter 6

## A Method of Assessment and Planning to Minimize Adverse Impacts on Health

### Introduction

Let us now consider a systematic way to determine how your project's activities and the environmental changes it causes might affect the health of the people in the project area. This method of assessment has two parts, each of which requires your active involvement. It is by no means a set of rigid rules; it is a suggested procedure to rationalize and streamline the decision-making process and promote informed planning. The first part is a general assessment of a particular project's possible effects on health; it consists of a predesign checklist requiring short answers (pages 90-92). The questions elicit your judgments and in some cases predictions.

The second part is a detailed assessment of the health-related outcomes associated with a project. It is presented in framework form as a blank fill-in table or matrix (see pocket on back cover). The matrix asks a number of sector-specific questions that require short but well-considered answers. The questions are designed to help weigh alternative methods of minimizing threats to health and the relative feasibility of each. Once the blank matrix has been filled out, you and your colleagues can use it as a tool to facilitate decision-making.

Figure 6.1

Pre-Design Checklist

1. Project Officer: _____ Date: _____

2. Type of Project: _____

3. Location: _____

_____

4. Primary goal(s) of the project (vertical functions*)?

_____

_____

5. Are there any secondary goals (horizontal functions*) you wish to achieve? Yes ☐ No ☐ If so, explain _____

_____

6. Will the project be:

a. Large (involving more than 2,000 people)? ☐
b. Moderate (500-2,000 people)? ☐
c. Small (fewer than 500 people)? ☐

7. Do you expect that the project will cause any changes in:

a. Population density (number of people/$km^2$)? ☐
b. Income/availability of cash and credit? ☐
c. Farming practices? ☐
d. Nutritional status? ☐
e. Prevalence of disease? ☐

Explain: _____

_____

8. Would you expect more water than usual to be available during any particular season? Yes ☐ No ☐ Explain: _____

_____

9. Draw a map of the project area including all buildings and prominent physical features. (Make the map as accurate as possible.)

* see page of Introduction

Pre-Design Checklist (Continued)

10. Are any kinds of health services available at or near project site? E.g. village health workers, health clinic, mobile health teams. Yes ☐ No ☐ Don't Know ☐

    If not located at the project site, what is the distance to the services? _____

    If services provided by mobile team, how often does team come to the project site? _____

    a. Do you think they are adequately and regularly supplied with common medications and equipment? Yes ☐ No ☐ Don't Know ☐

    b. Are midwifery services available for routine? Pre/post natal care and normal deliveries? Yes ☐ No ☐ Don't Know ☐

11. Are there now or do you forsee other forms of development at the project site? Yes ☐ No ☐ If yes, explain: _____

    _____

12. Is there an adequate supply of pure drinking water in the project area? Yes ☐ No ☐ Don't Know ☐

    a. What is the source of water supply?

    | | | | |
    |---|---|---|---|
    | Rivers | ☐ | Cisterns | ☐ |
    | Lakes | ☐ | Pipes | ☐ |
    | Protected wells | ☐ | | |
    | Unprotected wells | ☐ | | |
    | Canals | ☐ | | |

    b. If the water source is a river or canal, does the water flow rapidly? Yes ☐ No ☐ If yes, do you think onchocerciasis could become a problem? Yes ☐ No ☐ Don't Know ☐

    c. If the water source is a river, lake or canal, does the water stand still? Yes ☐ No ☐ If yes, do you think malaria and/or schistosomiasis could become a problem? Yes ☐ No ☐ Don't Know ☐

    d. Do animals get their water from the same source as humans? Yes ☐ No ☐ Don't Know ☐

    e. Is the water treated in any way before use? Yes ☐ No ☐ Don't Know ☐ If yes, explain: _____

    _____

    f. How is water stored? Community tank ☐ Household tanks ☐ Small containers (clay pots, gourds, and the like) ☐

    g. Do you think the stored water becomes contaminated? Yes ☐ No ☐ Don't Know ☐

Pre-Design Checklist (Continued)

h. Will the water supply become contaminated because of your project? Yes ☐ No ☐ Don't Know ☐

13. Having read the preceding parts of this volume relating to your sector, and on your own knowledge and experience, which of the following health problems do you anticipate?

| | | | |
|---|---|---|---|
| Malaria | ☐ | Venereal Disease | ☐ |
| Schistosomiasis | ☐ | Dysentery | ☐ |
| Onchocerciasis | ☐ | Respiratory infections | ☐ |
| Measles | ☐ | Tuberculosis | ☐ |
| Trachoma | ☐ | Alcoholism | ☐ |
| Malnutrition | ☐ | Traffic accidents | ☐ |

14. Do you think availability of food could become a problem at the site? Yes ☐ No ☐ Don't Know ☐

15. Do you think disease could become a problem at the site? Yes ☐ No ☐ Don't Know ☐

16. Do you think that pesticides could contaminate food and water supplies in the future? Yes ☐ No ☐ Don't Know ☐

17. What can be done from a design standpoint to avoid or minimize the risk of disease, poor nutrition, and chemical toxicity in the project area?

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

All the factual information necessary to complete the matrix for your sector's project can be found in corresponding chapters of this volume. It may also prove useful to refer to Table 6.1 (pages 94-96), which outlines in condensed form associations between types of projects and vulnerable parts of the physical and human environment, called parameters of impact. As a guide to filling out the matrix, an example of a completed matrix appears on page (103)and is explained in detail on pages (102-112).

The Pre-Design Checklist

Turn to the pre-design checklist on page 90. Your answers to the questions it asks should prove pertinent to your thinking about the project's planning, design, and implementation. After you have reviewed the checklist, continue reading.

The Matrix

Let us now review the matrix in detail. We will "walk through" its various parts discussing what each means, how it relates to development, and how to interpret it once the matrix is completed. As you can see, the matrix has two dimensions: it is divided vertically into response categories and horizontally into parameters of impact. The response categories are essentially questions for you to ask and answer about your project's potential effects. Parameters of impact are, as we have said, aspects of the physical and human environment that may change as a result of development; in other words, they are subjects that ought to be considered in order to answer each

Table 6.1

Characteristic Associations Between
Types of Development and Parameters of Impact

| PARAMETER OF IMPACT | DEVELOPMENT PROJECT | ASSOCIATION BETWEEN PROJECT AND IMPACT |
|---|---|---|
| 1. Water Supply | Irrigated Agriculture (dams, canals, river diversion) | a. Change in the source of water, making it closer or farther away.<br>b. Decrease in water purity, possible contamination and chemical runoff. |
| | Dryland Agriculture (flood-plain development) | a. Increased contamination of water with human wastes due to population increase.<br>b. Pesticide runoff and water contamination. |
| | Livestock (herd management, slaughterhouses) | a. Decrease in potable water for humans due to competition from livestock.<br>b. Contamination of local water supply by animal wastes.<br>c. Runoff of pesticides from dipping station into human food chain. |
| | Forestry/Ecology (land conservation, reforestation) | a. Increased forest cover leading to decreased water runoff, increased water retention of soil, better water conservation, and increased availability.<br>b. Exposure of laterite layer, increasing water runoff. |
| | Transportation (roads) | a. Increased water availability due to wells, retinues d'eau, and borrow pits constructed to build roads.<br>b. Overuse of water supply system due to ease of transport and increased population density at the project site. |
| | Village Water Supply | a. Increased availability and improved quality of water. |
| * * * * | * * * * | * * * * * * * * |
| 2. Soil Status | Irrigated and Dryland Agriculture | a. Improved soil fertility due to increased use of fertilizers; more crop rotation; more cover crops, reducing danger of erosion and improving water retention capacity; change in cultivation practices to improve soil fertility.<br>b. Decreased soil fertility due to shortened fallow period (continuous cropping) and monocultures.<br>c. Decreased yield due to waterlogging and salinization caused by poor or nonexistent drainage. |
| | Livestock (herd management) | Decreased soil fertility due to compaction of soil by herd leading to increased water runoff. |
| | Forestry/Ecology (reforestation) | Decreased soil fertility due to laterization resulting from clearing of land for trees and exposure of laterite layer. |
| * * * * | * * * * | * * * * * * * * |
| 3. Natural Vegetation | Irrigated and Dryland Agriculture | Decrease in natural vegetation due to clearing and flooding for agricultural plots (possibly leading to loss of traditional medicinal plants and supplementary food sources). |
| | Livestock (herd management) | a. Increased vegetative stability due to improved herding practices and smaller herd size.<br>b. Decreased natural vegetation because of overgrazing due to improved water supply and animal health projects which result in increased herd size. |
| | Transportation | Decreased vegetative cover due to increased demand for fuel and building supplies because of increased population density or marketing activity due to ease of transportation. |
| | Forestry/Ecology (reforestation) | Change in natural vegetation due to tree plantations and fire control. |
| * * * * | * * * * | * * * * * * * * |

Table 6.1
(Continued)

| PARAMETER OR IMPACT | DEVELOPMENT PROJECT | ASSOCIATION BETWEEN PROJECT AND IMPACT |
|---|---|---|
| 4. Housing | Transportation (roads) | Increased demand for fuel (wood) supplies due to increase in population density therefore shortage of wood for fuel and building supplies. |
| | Forestry | a. Increase in supply of wood.<br>b. Decrease in availability of cropland (due to competition with tree plantations). |
| | Irrigated and Dryland Agriculture | a. Increased resettlement, increased demand for housing supplies.<br>b. Changes in landuse patterns and pressure on arable land. |
| * * * * | * * * * | * * * * * * * * |
| 5. Introduction of Chemicals | Dryland Agriculture (cash crops) | a. Increased use of pesticides.<br>b. Use of insecticides and fungicides to protect stored crops.<br>c. Increased use of fertilizers.<br>d. Use of herbicides to control weeds. |
| | Irrigated Agriculture | Increased use of insecticides to control disease vectors. |
| | Forestry | Use of pesticides to protect plantation from termites. |
| | Livestock | a. Fertilizer application on pastures.<br>b. Pesticide use at dipping stations. |
| * * * * | * * * * | * * * * * * * * |
| 6. Creation of Breeding Sites for Disease Vectors | Irrigated Agriculture | Dams, polders, canals, lakes, barrages, marigots, saturated soils. |
| | Dryland Agriculture | Dams, river diversions, reservoir pools, wells. |
| | Livestock | Hoofprints, watering holes. |
| | Fisheries | Accumulation of standing water (ponds, canals, reservoirs). |
| | Transportation | Borrow pits, retinues d'eau, barrages, wells, poor drainage. |
| * * * * | * * * * | * * * * * * * * |
| 7. Pattern of Movement<br>8. Density/ Distribution<br>9. Birth Rate/ Death Rate<br>10. Food Demand | Irrigated and Dryland Agriculture (resettlement) | a. Increased population density, increased ethnic conflict.<br>b. Possible stabilization of population growth due to improved survivorship. |
| | Transportation (roads) | a. Attraction of people, ease of transport leading to increased population density and/or change in population distributions. |
| * * * * | * * * * | * * * * * * * * |
| 11. Traditional Land-Use Patterns<br>12. Farming Practices<br>13. Ethnic Confrontations<br>14. Value System<br>15. Division of Labor | Irrigated and Dryland Agriculture | Change in land-use and farming practices (initially may lead to poorer crop yields and eventual malnutrition, especially among young). |
| | Forestry | Introduction of soil conservation practices, changes in availability of crop residues. |
| | Livestock | a. Changes in land-use patters, grazing patterns, occupation (from herding to farming) (associated with resettlement primarily).<br>b. Conflict between herders and farmers or herders and fishermen. |
| 16. Weaning Practices<br>17. Waste-Disposal Practices | Land Reclamation (relocation, resettlement) | a. Changes in the prevailing value system and in living conditions (cash crops, increased accessibility to markets).<br>b. Changes in nutritional patterns (weaning periods, weaning foods) and nutritional status.<br>c. Overuse or misuse of existing sanitary systems. |
| * * * * | * * * * | * * * * * * * * |

Table 6.1
(Continued)

| PARAMETER OF IMPACT | DEVELOPMENT PROJECT | ASSOCIATION BETWEEN PROJECT AND IMPACT |
|---|---|---|
| 18. Cash-Crop-To-Food-Crop Ratio<br>19. Availability of Cash (Buying Power)<br>20. Local Market Prices (staple goods)<br>21. National Export Market<br>22. Distribution of Goods and Services | Irrigated and Dryland Agriculture<br>Livestock<br>Forestry<br>Fisheries<br>Integrated Rural Development<br>Transportation<br>Resettlement<br>Technology | a. Cash flow may increase or decrease depending on the type and amount of sellable goods produced (i.e., crops, livestock, wood, fish, transport, etc.).<br>b. Prices may fluctuate with demand created by changes in population density, demand, availability, season, accessibility of market, etc.<br>c. Increased production of food or cash crops may increase national export volume and stimulate increase in distribution of goods and services. |
| * * * * | * * * * | * * * * * * * * |

question. Of course, no project will affect all the parameters of impact, and some outcomes will be minimal or remote. Thus the matrix is not intended to focus unduly on remote associations; its primary purpose is to draw attention to potentially major adverse effects on health.

Matrix Response Categories

Let us now discuss the relationship between the response categories and the impact parameters. The first column, Applicability, asks a simple question: Does the project you are considering cause change in any of the impact parameters? An irrigation network, for example, might change the availability of water (parameter 1c) by creating a lake or several reservoirs. Dryland development might alter soil status (parameter 2) by making previously uncultivated land fertile. Livestock development will change natural vegetation (parameter 3) if cattle consume previously ungrazed pastures. Most development projects attract people, and thus change local population density (parameter 8). Once you have decided whether a given kind of change is caused by the activity you are considering, check yes or no.

The next column, Description of Impact, asks for a very brief description of the kind and magnitude of change that might occur. The description may or may not include a reason for the impact to occur. If you are considering a village water supply project, for example, your description of impact on water supply (parameter 1) might be "increased availability of pure drinking

water; change of source due to construction of wells and/or piped delivery." A dryland project may have to use fertilizer to enrich the soil; the general type to be used might be noted. An increase in standing water (parameter 6) may be unavoidably brought about by the digging of borrow pits for a transportation project. Similarly, an increase in buying power (parameter 19) may be brought about by the increased cash-crop production made possible by an irrigation network, or by improved soil fertility due to a reforestation project. The description should be brief but make note of any changes that might occur.

The next column, Effect on Health, directly addresses the basic goal of the Health Impact Guidelines. Both positive and negative health effects should be recorded; most projects are characterized by both. For a village water supply project, for example, you might write in "lowered incidence in intestinal parasites, less infantile diarrhea, improved child survivorship, possible water contamination due to overuse." For a fisheries project, you might write "improved nutrition, increase in malaria and schistosomiasis (due to an increase in standing water and thus in breeding habitats for the vectors)." Again, you may want to consult the "Positive and Negative Effects" tables presented in the foregoing chapters in addition to Table 6.1.

The next three response categories call for more considered judgment on your part. The first, Outcome of Effect, allows for you to indicate whether each effect is good or bad. If, on completing

the tables, you find far more marks in the negative column, significant changes may need to be made in the design of the project. However, only a few negative marks may indicate a minor change in the project design if the effect is sufficiently severe (see below).

The next column, Onset of Effect, asks you to estimate how long it might take for each effect to come about. Disease spread may take 1 to 5 years, and changes in soil status even longer; improved nutritional status and increased production may be apparent within one year. Changes in population density and cultural practices may also occur rapidly. While chemical contamination of food and water may occur quickly, the effect on health may not be felt for more than five years. Estimating the onset of effect as accurately as possible requires consideration of the project's long-term as well as short-term impact.

The Seriousness of Effect category calls for another value judgment on your part. Since effects of health vary in severity, the matrix calls for you to characterize each as low, moderate, or high. The spread of such life-threatening conditions as malaria, infantile diarrhea, nutritional stress, and measles is of high severity. Schistosomiasis, onchocerciasis, and changes in cultural and economic practices are less directly threatening to survival and may take years to develop; these effects might be termed moderately serious. Evaluating seriousness of effect involves weighing both the threat to life it poses and the time it takes for adverse impact(s) to develop.

The next response category, Ways to Minimize Adverse Effects on Health, draws on material from the foregoing chapters and the tables they contain. Though you are undoubtedly familiar with the chapter pertinent to your project, you may find helpful a quick review of the "Approaches to Problem" table while filling out this part of the matrix. List the approaches you think most likely to succeed. Doing so does not mean that you are committing yourself to these approaches, but simply that you have systematically determined potential health hazards and understand what can be done to minimize them. Let us assume, for example, that you are planning the development of a river basin for agricultural production. You may have identified as adverse health impacts contamination of water supplies with pesticides and human waste due to intensive cropping practices and spontaneous immigration. You may have also predicted an increase in malaria and schistosomiasis due to changes in the habitat. You may in turn recommend that an adequate drainage system be incorporated into the project so that water runoff will not introduce dangerous chemicals into the water supply; you might also recommend a sanitary waste disposal system. You might choose to urge local officials to seek ways to limit spontaneous immigration. Finally, you might recommend that local residents be diagnosed and treated for malaria, and that breeding, feeding and resting habitats be identified and sprayed to limit the number of mosquitoes. You and your colleagues may ultimately choose to undertake all or some of these measures; for example, after weighing all the

information, you may decide to concentrate available resources on combatting malaria, and ignore schistosomiasis because it is not life-threatening. Resources are never unlimited, and such choices among realistic alternatives must be made in the Sahel as in the rest of the world. The crucial issue is that the choice be informed, and that long-term costs due to epidemics, malnutrition, and social disruption, are not incurred in the interest of short-term savings.

The next category, Feasibility of Ways to Minimize Adverse Effects, asks: how feasible are the approaches you have recommended, given the realities of your particular situation? In making recommendations about project design, one must consider the cost of various alternatives; the amounts of technical expertise, unskilled labor, time required, social constraints, and how much administrative support is available to push the recommended changes through the design stage and into implementation. Issues of feasibility are very important in developing countries. A realistic assessment of feasibility is critical to successful project implementation.

The final category, Probability of Successfully Minimizing Adverse Effects, requires another judgment on your part. That is, if ideally X, Y, and Z should be done, but practically, you can only do X, is it enough? Will it have beneficial effect? Will it work? What will be left undone? These are difficult questions, requiring thorough analysis, but clearly they are worth asking and answering, for the sake both of your project's future success and that of the local population.

## A Model Matrix

Now that we have "walked through" the matrix, let us look in detail at an example of a filled-in or model matrix. Doing so will clarify how the matrix is to be filled out, and what use can be made of it after it is completed. A well-done matrix will indicate what can happen to health when the project is implemented, and how risks to health can be minimized at the pre-design stage by selecting feasible alternatives or later by amending the project design. The next step is to pursue all the ways open to you of achieving your goals, including soliciting the assistance of ministry officials, personnel of national and regional organizations, and international donor groups.

The knowledge you gain from completing the matrix will help you to present your case persuasively to those who are in decision-making positions, particularly if supported by cost-effective considerations.

Examining the model matrix will demonstrate how it can be useful and the type of responses expected. Let us use an irrigated agriculture project as an example, since it is such an important aspect of Sahelian development. Suppose we are planning a 2,500-hectare irrigated farming project in the 100-200mm rainfall zone of North Central Mali. Place the blank matrix and the model matrix on a table in front of you, alone or with colleagues. Review the Response Categories and the Impact Parameters. Begin with the first impact parameter (water supply).

# FRAMEWORK FOR ASSESSI

2500 ha. IRRIGATION
PROJECT: 100-200 mm
RAINFALL ZONE, MALI

| PARAMETERS OF IMPACT | | | APPLICABILITY YES | APPLICABILITY NO | DESCRIPTION OF IMPACT | EFFECT ON HEALTH DISEASE, NUTRITIONAL STATUS, TOXICITY |
|---|---|---|---|---|---|---|
| | PHYSICAL ENVIRONMENT | 1. Water Supply | ✓ | | New source of water for drinking, washing, etc. | Increase in water-borne and Vector-borne diseases particularly diarrheal diseases |
| | | a. Source | | | Contamination of water in canals due to waste disposal | |
| | | b. Purity/Contamination | | | Decreased underground water supply | |
| | | c. Availability | | | | |
| | | d. Conservation | | | | |
| | | 2. Soil Status | ✓ | | Waterlogging, salinization | Decreased food production and availability with subsequent decline in nutritional status (children and aged first to be affected) |
| | | a. Nutrients/Topsoil/Erosion | | | Shift in farming practices | |
| | | b. Cropping Patterns/Practices | | | Decreased soil fertility | |
| | | c. Waterlogging/Salinization | | | | |
| | | d. Laterization | | | | |
| | | 3. Natural Vegetation (Ground Cover) | ✓ | | Population increase in project area, therefore more land cut and cultivated. Traditional resident species of plants may be removed which had medicinal and/or food value | Could decrease nutritional status by decreasing soil nutrient content. (However, relationship not direct) |
| | | a. Medicinal plants | | | | |
| | | b. Supplementary foods | | | | |
| | | c. Overgrazing | | | | |
| | | d. Overcutting | | | | |
| | | e. Use of fire | | | | |
| | | 4. Housing (Demand) | ✓ | | Increased demand for housing, fuel, building supplies; overcrowding and decrease in safe waste disposal may result. | Increase in air-borne and water-borne disease, possibly decrease in nutritional status |
| | | a. Overcrowing | | | | |
| | | b. Decreased sanitation | | | | |
| | | c. Construction | | | | |
| | | 5. Chemical Input (Fertilizers/Pesticides) | ✓ | | Application of pesticides and fertilizers | Increased food production and increased nutritional status |
| | | a. Contamination/Toxicity | | | | Toxic effect - biomagnification in human and animal tissue |
| | | b. Effect on food supply | | | | |
| | | 6. Creation of Breeding Habitat for Disease Vectors | | | | |
| | | a. Aquatic vegetation (Snails/Schistosomiasis) | ✓ | | Increase amount of aquatic vegetation | Increase in water-borne and vector-borne diseases (enteric infections, malaria, schistosomiasis, Onchocerciasis, dracontiasis) |
| | | b. Standing water (Mosquitos/Malaria) | ✓ | | Increase amount of standing water | |
| | | c. Fast-moving water (Blackflies/Onchocerciasis) | ✓ | | Change water flow, increase amount of fast-moving water | |
| | | d. River banks (TseTse/Trypanosomiasis) | | | | |
| | | e. Savannah Development (TseTse/Trypanosomiasis) | | | | |
| | POPULATION | 7. Pattern of Movements | ✓ | | Attraction of people to project area - also livestock. Increase in local population density, crude birth rates | Spread of air-borne infections (measles, TB, etc.) |
| | | a. Human | ✓ | | | Increase in water-borne disease due to over use of water system and excreta disposal system |
| | | b. Livestock | ✓ | | | Increase vector-borne disease due to increased host-vector-host contact |
| | | 8. Density/Distribution | ✓ | | | |
| | | 9. Birth Rate/Death Rate | ✓ | | Increased food demand due to more people in one place | |
| | | 10. Food Demand | ✓ | | | |
| | CULTURE | 11. Traditional Land Use Patterns (Crops) | ✓ | | Dryland farmers changed to irrigation farming | Possible psychosocial stress |
| | | 12. Farming Practices | ✓ | | Crops and cropping patterns will change | Decreased nutritional status due to change in crop production, available food, yields etc. |
| | | 13. Ethnic Confrontations | | | | |
| | | 14. Value System Change | | | Increased emphasis on cash crops and currency | |
| | | 15. Division of Labor | | | | Increase in enteric infections caused by change in excreta disposal. |
| | | 16. Weaning Practices | | | Food intake patterns changed and excreta disposal | |
| | | 17. Waste Disposal Practices | ✓ | | | |
| | ECONOMY | 18. Cash-Crop-to-Food-Crop Ratio | ✓ | | Increase in amount of cash crops produced | Generally little adverse effect |
| | | 19. Availability of Cash (Buying power) | ✓ | | | Improved medical services and nutrition due to increased buying power, general improvement in quality of life |
| | | 20. Local Market Prices (Staple goods) | ✓ | | Increase in buying power | |
| | | 21. National Export Market | ✓? | | Stabilization of market prices | |
| | | 22. Distribution of Goods and Services | ✓? | | | |

# SSING THE IMPACTS ON HEALTH FROM NONHEALTH DEVELOPMENT AC

| JS, | OUTCOME OF EFFECT | | ONSET OF EFFECT (IN YEARS) | | | SERIOUSNESS OF EFFECT | | | WAYS TO MINIMIZE ADVERSE EFFECTS ON HEALTH | FEASIBILITY OF WAYS TO MINIM | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | COST (MONETARY) | | | TECHNICAL REQUIREMENTS | MANPOWER REQUIREMENTS |
| | + | - | <1 | 1-5 | >5 | LOW | MOD | HIGH | | L | M | H | | |
| and cularly | | ✓ | ✓ | ✓ | | | | ✓ | Treatment plant, liquid waste disposal system | | | ✓ | engineers, micro-biologists, equipment | much skilled and unskilled labor |
| | | | | | | | | | Health education, fence around irrigated area, pit latrines | ✓ | | | a few health personnel, tools for setting fence, water engineer for latrines | mostly unskilled labor, villagers |
| n quent s | | ✓ | | ✓ | | | | ✓ | Monitor soil status before and after scheme operational<br>Determine nutritionally adequate food crop to cash crop ratios<br>Conduct nutritional survey to identify groups at risk and determine food requirements<br>Incorporate adequate drainage for system | | ✓ | | soil engineers, hydrologists, agronomists, agricultural economists, nutrition personnel, survey personnel | skilled personnel supported by local people to formulate teams and maintain monitoring system |
| e | | ✓ | | ✓ | | | ✓(?) | | | | | | | |
| | | | | | | | | | Monitor population influx<br>Identify supplementary food sources and medicinal plants | ✓ | | | botanist, local healers | few skilled workers, census workers would be useful |
| L reas | | ✓ | (?) ✓ | ✓ | | | | ✓ | Control immigration to project site (via local sanction and cooperation)<br>Supply safe water supply and solid waste disposal system<br>Monitor and intervene overcutting to limit soil erosion<br>Attempt to define area's carrying capacity | | ✓ | | water engineer, microbiologist, ecologist/forester | few skilled non unskilled labor |
| n tatus | ✓ | | | ✓ | | | | | Positive effect | | | | | |
| a in | | ✓ | | ✓ | | | | | Adequate drainage around agricultural plots, proper storage and application of chemicals | ✓ | | | few skilled technicians - hydrologist to design drainage system | Local people can be taught and help build drainage system and administer chemicals |
| | | ✓ | | ✓ | | | ✓ | ✓ | Monitor creation of standing and fast moving water, hand clear aquatic vegetation from canals, flush canals periodically via sluices incorporated into design of canal system, Organize surveillance teams at village level, treat cases, report suspected cases to health clinic, pit latrines | | ✓ | | Some skilled health and engineering personnel, health educators | Villagers needed to monitor vectors in water and explain routes of transmission to local population |
| s isease ystem due to stact | | ✓ | ✓ | ✓ | | | ✓ | ✓ | Regulate numbers of immigrants<br>Locate immigrants in different areas to avoid overcrowding<br>Health education<br>Provision of supplemental food if required | ✓ | ✓ | | Demographic planners, Health educators, Sanitary engineers, Nutritionists, Public Health technicians | Substantial, since many people need to be located and looked after. Local manpower should be utilized |
| due tion, ms ta | | | | ✓ | | | ✓ | | Insure adequate supplemental food supplies<br>Inform farmers about proper farming methods associated with irrigation<br>Provide adequate waste disposal (i.e. pit latrines) and encourage its use | | ✓ | | Agronomist, economic planner, Agricultural Extension Workers, Sanitary engineers | Skilled and unskilled manpower required. All farmers should be informed personally or in a class, thus extension personnel essential |
| r ging | ✓ | | | ✓ | | | | | Maintain nutritionally adequate cash-crop-to-food-crop ratio | ✓ | | | Agricultural economist, Nutritionist | |

# PMENT ACTIVITIES

| OF WAYS TO MINIMIZE ADVERSE EFFECTS ON HEALTH | | | | PROBABILITY OF SUCCESSFULLY MINIMIZING ADVERSE EFFECTS |
|---|---|---|---|---|
| MANPOWER REQUIREMENTS | TIME REQUIREMENTS | CULTURAL CONSTRAINTS | ADMINISTRATIVE SUPPORT | |
| much skilled and unskilled labor | 1-2 years for planning and implementation | taste may be affected; traditional sources might be preferred | cost and time may be prohibitive and not be approved | Low probability of success due to constraints of cost, time, manpower, etc. |
| mostly unskilled labor, villagers | 6 mo. to a year | must convince people to use latrines in preference to traditional waste disposal practices | good support expected since low cost and relatively effective | good probability of success if implemented and used - few serious constraints. |
| skilled personnel, supported by local people to formulate teams and maintain monitoring system | 6 mo. to a year | few if any cultural problems would be expected | expect firm support since maintenance and increase of irrigation systems essential | good probability of avoiding nutritional stress due to soil deterioration IF project planned with these dangers in mind. |
| few skilled workers, census workers would be useful | 6 mo. to a year | preservation of natural resources may be difficult if food/fuel in short supply | good if stimulated by ecologist, forester, public health personnel | fair probability since issue not directly life threatening may therefore little action may result. Largest obstacle is changing traditional patterns. |
| few skilled nor unskilled labor | 1-10 yrs if choosing to monitor population's ecological consequence | People don't like to change. Immigrants, if turned away, may cause economic problems and social problems | Support may be difficult since large projects are prestigious and dangers due to increased population density remote | Difficult to regulate influx of people and therefore hard to prevent high demand for food and supplies. Growth of area essential, however, rate must be controlled. Thus probability of success at best fair. |
| Local people can be taught and help build drainage system and administer chemicals | 1-2 years for design and building of drainage system, storage system and training of local personnel | Little or none expected | Support good - cost-effective - locally conducted | good probability of avoiding chemical contamination of water and food supplies |
| Villagers needed to monitor vectors in water and explain routes of transmission to Local population | disease spread should be monitored on a continuous basis, therefore Long time period required | Few if any cultural constraints, Local habits may need to change such as water gathering and excreta disposal | Support should be expected due to good cost-benefit ratio. | fair to good: depending on availability of materials for proper design strategies, technical, administrative and local interest and support |
| Substantial, since many people need to be located and looked after. Local manpower should be utilized | Long-term process. Health and nutrition as well as demographic trends will have to be monitored continuously | Expect considerable cultural reaction to relocation process. Local support essential | Expect good support in theory but little in active stages - Problem-solving lies with field personnel | Fair - many logistic problems, however, not insurmountable. Pre-implementation planning and solicitation of local cooperation will improve chances of success. |
| Skilled and unskilled manpower required. All farmers should be informed personally or in a class, thus extension personnel essential | 1-2 years depending on the number of farmers and number of extension personnel available | Few cultural constraints expected. Need to prevent ethnic conflict | Expect good administrative support. National ministries expected to help with extension personnel | fair to moderate: depends on number and quality of extension workers, receptivity of local people, number of people in project area, type of agro-economic system planned in project development |
| | | | | |

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1. Water Supply. Your first consideration should be: Does irrigation, as exemplified in a project like ours, affect the source, purity, availability, and/or conservation of water in any way? Under Applicability, check yes. If a lake or small reservoirs are to be created, the source of water might change. Local use of the irrigation canals for drinking is also a change of source. If people deposit wastes in the canals, the purity of water will be affected. If the canals receive water from an underground aquifer that is constantly being tapped, conservation will be affected. As for Description of Impact and the other response categories, the changes associated with irrigation may affect health by (1) increasing food availability (a positive effect with short onset time), and (2) increasing diarrheal and other water-borne infections due to contamination (a negative effect with moderate onset time and high seriousness). The spread of water-borne infections due to irrigation might be minimized by building a sophisticated sanitary system, including a water purification system and a sanitary waste disposal system. Both would be expensive, require substantial technical expertise, local manpower, and time, and might encounter misunderstanding and lack of popular acceptance. These matters should be noted in the appropriate response categories on the matrix. Alternatively, health education can be provided to inform people about the dangers of contaminated water, and the means to avoid it, canals can be fenced off to prevent entry and low-cost latrines can be dug for human waste disposal. These approaches

are less costly, require less manpower, time and money and would probably be supported by governmental administrative bodies. The latter approach is thus probably the most feasible, which may be noted under Feasibility.

2. Soil Status. Irrigation might affect soil status by changing cropping patterns and increasing the risk of soil waterlogging and salinization; check yes under Applicability. The Impacts of both processes are a change in local crops and decreased soil fertility due to high water or salt content. Health might be influenced by a change in cropping patterns that affects nutritional status (this outcome would be negative, the onset 1 to 5 years, the seriousness moderate). If salinization were to occur, severe nutritional stress would follow (outcome negative, onset moderate, seriousness high). These two nutrition-related effects could be avoided by devoting some of the project's fields to traditional food crops. Planning crop types and amounts would probably require a comprehensive local nutritional survey, which would be moderately costly and require few trained personnel, some local cooperation, little time, and routine official approval. To be effective, such a survey would have to be completed before the project is initiated, and its findings taken into account when the project is operational. A hydrological survey should be conducted at the same stage to determine the soil's water-holding capacity and the likelihood of salinization. This would require a moderate amount of money, some skilled personnel, little or no local manpower, little

time, and routine governmental consent. Thus, the feasibility and the probability of minimizing adverse health effects are both good.

3. Natural Vegetation. Does irrigation affect ground cover, supplementary foods, overgrazing, overcutting, or the use of fire? The effect of irrigation on these impact parameters is difficult to predict in this instance. Therefore, write yes under Applicability, but in the other response categories indicate that more information is needed (evaluation of existing land use, potential for dry season grazing, removal of existing ground cover when a new irrigation project is implemented).

4. Housing. Agricultural projects may affect housing (including demand for fuel and building supplies) by attracting people to the project site. Therefore write yes under applicability. Population densities will increase, as will demand for housing construction materials. The waste disposal system is also likely to be overused, resulting in generally worse sanitation in the project area. Effects on health would be increases in communicable and water-borne diseases, due to increased human contact, contamination of the water and food supplies, and possibly lowered nutritional status due to overcutting of ground cover for fuel and building supplies. (Overcutting indirectly influences nutritional status by decreasing the amount of ground cover, increasing wind and water erosion, and in the long run lowering soil fertility.) Generally speaking, the outcome would be negative, the onset 1 to 5 years, and the seriousness could be very high.

Ways to minimize these adverse effects on health include monitoring and control of immigration, a firm commitment to construct and maintain an adequate sanitation system (including pit latrines and potable water delivery), and control over the cutting of ground cover for fuel and building supplies.

These methods are difficult, and their feasibility is untested. A complete sanitation system is costly, and demands a certain amount of technical expertise and local manpower. Monitoring of population movement and conservation of ground cover are both long-term endeavors. Cultural constraints involving the use of sanitation facilities, demand for fuel and building supplies, and spontaneous immigration may intervene. If the potential benefits of such safeguards are sufficiently desirable, their total cost is not exceedingly high. Administrative support should be strong.

5. Chemical Input. Pesticides are often used in irrigated agricultural projects. The nature of their impact is that they can enter the water and food systems in runoff from agricultural plots. The consequent effect on health is danger of chemical poisoning from contaminated food and water. The outcome of this effect is clearly negative, the onset moderate (1 to 5 years), and the seriousness high. Methods of minimizing this effect are (1) construction of adequate drainage around agricultural plots to prevent chemical runoff from contaminating food and water supplies, and (2) adequate storage and disposal facilities for these dangerous chemicals. Generally speaking,

the feasibility of preventing chemical toxicity is good. The cost is low, as are the manpower requirements, whereas removing chemicals from water and food is generally difficult. Little time is needed since the drainage canals can be built at the pre-design stage and the storage facilities need only be built once. Cultural constraints are inconsequential, and administrative support should be readily available. The probability of success is thus very good.

6. Creation of Breeding Habitats. Irrigation projects can increase aquatic vegetation, increase standing water, enlarge river or lake banks, and increase human exposure to lake and river banks. The consequent effect on health is an increase in water-borne and vector-borne diseases due to contamination of water with human and animal wastes or increased human-vector contact respectively. This outcome is obviously negative, the onset moderate (1 to 5 years), and the seriousness moderate to high, depending on the disease spread.

The adverse consequences can be controlled by monitoring standing water and aquatic vegetation, hand-clearing aquatic vegetation around irrigation canals, and examining standing water for snails and mosquito larvae and providing adequate sanitation facilities. Cases of schistosomiasis, guinea worm and malaria can be reported by a surveillance team of local personnel organized at the time the project is implemented, and trained in the basic identification of various diseases. If a satisfactory treatment exists, such as for malaria, drugs can be administered with the help of the surveillance team. Thus the

spread of vector-borne diseases can be minimized if breeding habitats are made unsuitable and cases of disease are treated.

The total cost of these measures would be moderate, the technical requirements moderate, the manpower requirements moderate to high, the time requirements long (monitoring must continue indefinitely), and administrative support hopefully easy to procure. Cultural constraints would probably pose no major problem. Thus the probability of success in decreasing transmission of tropical diseases would be fair to good.

7-10. Population Parameters. Development projects tend to attract people (and thus livestock) from nondeveloped areas, directly affecting population density and population distribution throughout the region. Local birth and death rates and demand for food are also likely to be affected. Potential impacts include attraction of people, increased density at the project site, and greater demand for food. The effect on health is straightforward: Increased person-to-person contact increases the chance of spreading communicable or air-borne diseases such as measles, tuberculosis, other respiratory infections, and venereal disease. Such parasitic diseases as malaria and schistosomiasis might also increase due to increased contact among infected people, the organisms that transmit the disease, and noninfected people. Water-borne diseases such as amoebic and bacillary dysentery and intestinal worms can also increase due to the overtaxing of sanitary facilities. Finally, nutritional status might be adversely affected if the per capita food-producing capability of the area drastically decreases.

Generally speaking, the outcome would be negative, the onset approximately one year, and the seriousness moderate to high depending on the type of diseases anticipated. As is true of the effects on housing discussed above, ways to minimize this effect are difficult to implement. Development officials might seek to limit the number of people immigrating into the project area and the number of livestock they own. An effort should be made to encourage people to settle throughout the project area rather than in one place. These are very difficult goals, involving as they do the changing of traditional social patterns. Although cost might be low to moderate and the technical requirements few, a great deal of manpower will be needed and the process will take a long time. Severe cultural constraints and lack of administrative support might be encountered. Therefore, the probability of successfully limiting in-migration in the project area might be considered only fair. However, evidence from Ghana, Rhodesia, and the Sudan supports the value of such endeavors.[1]

11-17. Cultural Parameters. Depending on the nature of an agricultural project, it can bring about changes in land-use patterns, farming practices, value systems, weaning practices, the division of labor, and waste disposal practices. An irrigation project in the northern Sahel might obligate local farmers to change their land-use patterns; former dryland farmers

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1. See Bibliography: 159.

attracted from the south will likewise confront the need to change their farming practices. If many people come together in the area, tension and ethnic confrontations might ensue. Changes in the food-crop-to-cash-crop ratio may produce changes in the local population's prevailing value system (i.e., increase orientation towards a cash flow economy), as well as in the division of responsibility within the family and throughout the community. Dietary practices may also change. And, again, high concentrations of people may overuse the sanitation facilities, spreading food-borne and water-borne diseases.

These conditions affect health by causing psychological stress and lowering nutritional status. The onset (1 to 5 years) and the seriousness would both be moderate. Cultural and nutritional stress can be minimized by insuring adequate supplies of food and building supplies, and by arranging for new farming practices to be appropriately introduced to local residents and/or newcomers.

Again, installation of a waste disposal system would be advantageous. As for feasibility, these undertakings would be moderately costly and require a significant amount of technical and local manpower. The time frame would be moderate, and few cultural constraints would be encountered if the process were carried out in an appropriate way. The probability of success would be fair to moderate, depending on the extent of community participation in the project and the amount of government support this participation receives.

18-22. Economic Parameters. Agricultural projects often change the food-crop-to-cash-crop ratio locally, and thus the availability of cash (buying power). Local market prices may change or stabilize. Increased agricultural production may affect national export markets. A large agricultural project may also stimulate distribution of nonagricultural goods and services. Predictable impacts are more cash crops and food crops, increased availability of cash, stabilization, increase, or lowering of market prices, and better distribution of goods and services.

Nutritional problems may arise if more cash crops than food crops are produced. Nevertheless, effects on health would, for the most part, be positive, onset would be between 1 and 5 years, and seriousness would be low.

The only way to minimize the adverse effects would be to incorporate into the project design a well-maintained balance between food crops and cash crops. The feasibility is quite good since cost, technical requirements, manpower requirements, and time requirements would be low, few cultural constraints would be encountered, and administrative support would probably be strong.

Summary of Associations Between Types of Projects and the Environment (Table 6.1)

When you are ready to begin filling out the blank matrix with data and judgments about your particular project, you may find it useful to refer to Table 6.1, on pages 94-96, which

demonstrates the associations between types of development and resulting impacts. Table 6.1 provides much of the information needed to fill out the first three columns of the matrix.

For each impact parameter listed in the first column of the table, look to see if the type of project you are pursuing is listed in the second column; if so, consider whether the associations listed in the third column are realistic in the case of your project. If they are, list them on the blank matrix under Description of Impact and explain them under Effect on Health.

If you are considering a livestock development project, for example, look first to see whether livestock development has an effect on water supply. Column three lists three ways livestock projects affect water supply. Note them on the matrix and go on to consider the next impact parameter, soil status. And so on.

Review the table carefully and choose only those associations applicable to the real-world situation in which you work. Finally, do not assume that the table includes every possible asociation. Only you and your colleagues know all the specific characteristics and circumstances of the project you envision. Thus, do not hesitate to add to the matrix any further associations you may foresee.

This volume has supplied the tools you will need to make both informed choices and accurate appraisals of impact, and to help you understand how your project might affect other development sectors. But this book is just a beginning. The responsibility

burden now lies with you and your colleagues. The future health status of the people in your project area will be affected by your wisdom, commitment, determination, and perseverance.

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