ENVIRONMENTALLY SOUND SMALL-SCALE LIVESTOCK PROJECTS

GUIDELINES FOR PLANNING

by

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ABOUT CODEL

Coordination in Development (CODEL) is a private, not-for-profit consortium of 43 development agencies working in developing countries. CODEL funds community development activities that are locally initiated and ecumenically implemented. These activities include agriculture, water, forestry health, appropriate technology, and training projects.

The Environment and Development Program of CODEL serves the private and voluntary development community by providing workshops, information, and materials designed to document the urgency, feasibility, and potential of an approach to small-scale development that stresses the interdependence of human and natural resources. This manual is one of several materials developed under the Program to assist development workers in taking the physical environment into account during project planning, implementation, and evaluation.
For more information, contact CODEL Environment and Development Program at 475 Riverside Drive, Room 1842, New York, New York 10115 USA.

ABOUT VITA

Volunteers in Technical Assistance (VITA) is a private non-profit international development organization. It makes available to individuals and groups in developing countries a variety of information and technical resources aimed at fostering self-sufficiency: needs assessment and program development support; by-mail and on-site consulting services; information systems training; and management of field projects. VITA promotes the use of appropriate small-scale technologies, especially in the area of renewable energy. VITA's extensive documentation center and worldwide roster of volunteer technical experts enable it to respond to thousands of technical inquiries each year. It also publishes a quarterly newsletter and a variety of technical manuals and bulletins. For more information, contact VITA at 1600 Wilson Blvd., Suite 500, Arlington, Virginia 22209 USA.

ABOUT WINROCK INTERNATIONAL

Winrock International Institute for Agricultural Development is a private, nonprofit institution founded to help alleviate human hunger and poverty through agricultural development. In partnership with private voluntary organizations, governments, aid agencies, agricultural research centers, and others, Winrock assists people and nations to increase food production and income opportunities. The institute provides both short- and long-term technical assistance to improve farmers, productivity and to strengthen the research and extension systems that support agriculture. Winrock emphasizes human resource development by supporting developing country students in degree training; sponsoring training programs for farmers and people who work with farmers; and producing training and informational materials. Winrock works in Africa, Asia, Latin America and the Caribbean, and the United States. For more information, contact Winrock International at Route 3, Morrilton, AR 72110 USA.

ABOUT HEIFER PROJECT INTERNATIONAL

Heifer Project International is a nonprofit organization founded in 1944 and is supported by donations of individuals, churches, and grants from corporations and governments. HPI has provided assistance to people in more than 100 countries. The purpose of Heifer Project International is to assist small farmers to achieve a better living through more efficient use of human and natural resources. The method is to introduce good quality livestock and to demonstrate and teach proper management.

HPI provides funding, livestock, and materials for livestock development projects. It also provides technical expertise and training, publishes a newsletter on appropriate practical livestock technology and distributes practical educational materials.

HPI assistance is provided without regard to race, creed, or political origin, and in a manner which requires the recipient to share the increase usual]y by passing on the first female offspring to other families. Projects are designed so as to be self-supporting and perpetuating. To accomplish this, plans and agreements are made with indigenous organizations.

GUIDELINES FOR PLANNING SERIES

Environmentally Sound Small-Scale Agricultural Projects, 1979 (Also in Spanish and French)

Environmentally Sound Small-Scale Water Projects, 1981 (Also in Spanish)

Environmentally Sound Small-Scale Forestry Projects, 1983 (Translations in Spanish and French in process)

Environmentally Sound Small-Scale Energy Projects, 1985 (English only)

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PREFACE

This manual is the fifth volume in the Guidelines for Planning series. The series was developed in response to needs of private development agency field and counterpart staff for simplified technical information in order to plan environmentally sound small-scale projects in Third World countries. Titles of the other volumes in the series are listed on the opposite page.

The preparation of this volume has been a collaborative effort of Coordination in Development, Inc. (CODEL), Heifer Project International (HPI), and Winrock International Institute for Agricultural Development. An Advisory Committee composed of representatives of the three agencies guided the preparation of the manual. These include Andres Martinez, Winrock International; the Rev. John Ostdiek, CODEL; Armin Schmidt, Heifer Project International; in addition to the three coordinators listed at the end of this preface.

Initial research was carried out and a basic draft prepared by Dr. Richard Rice, Department of Animal Sciences, University of Arizona and Dr. Milo Cox, School of Renewable Natural Resources, University of Arizona. The coordinators are grateful to Drs. Rice and Cox for their contribution to the final product. The text was further developed and

extensively revised by Linda Jacobs.

Linda Jacobs, the author of this volume, has prepared the illustrations for four of the five volumes in the Guidelines for Planninq series. Ms. Jacobs holds a degree in Biology from Cornell University and served with the Peace Corps in Colombia. For the last eight years she has been living and working with Native Americans in Arizona. She has brought to the project a special interest in, and small-farm experience with livestock. In addition, Ms. Jacobs made good use of her writing and illustrating skills. She is presently teaching at the Navajo Community College, Tsaile, Arizona.

Following the procedure used for the previous volumes, a lengthy review process has involved a number of technical resource persons and potential users in the field. The following have reviewed the manual in addition to the Advisory Committee:

Charles D. Bonham, Colorado State University
Milo Cox, University of Arizona
John Dieterly, Heifer Project International
Peter F. Ffolliott, University of Arizona
Peter J. Grill, Mennonite Central Committee
I.F. Harder, Heifer Project International
Sister Sharee Hurtgen, St. Jude Hospital, St. Lucia
Robert K. Pelant, Heifer Project International
Roald Peterson, UN/FAO (retired)

James O'Rourke, Utah State University
Richard W. Rice, University of Arizona
Sister Mary Ann Smith, CODEL
Ron Tempest, Germantown Academy
Gregg Wiitala, Technoserve, Inc., Kenya
Gerald G. Williams, Heifer Project International

These reviewers offered extensive, substantive, and constructive suggestions for improving the review draft. The suggestions were a significant assistance in preparing the final manuscript. The coordinators greatly appreciate the contributions of these reviewers and the other members of the Advisory Committee.

We welcome comments from readers of the book. A questionnaire is inserted for your convenience. Please share your reactions with us.

James DeVries, Heifer Project International
Will R. Getz, Winrock International
Helen L. Vukasin, CODEL

Chapter I

A DEVELOPMENT PHILOSOPHY

This manual is designed for development assistance workers and others who are planning or managing small-scale livestock projects. Although aimed specifically at those working in less-developed areas of the tropics and subtropics, these environmental guidelines apply to almost any region of the world. They stress:

* ecological principles that relate to livestock production

* the role of livestock in the farming system and local environment

* environmental factors that affect the success of a livestock project

* environmentally sound livestock management practices

A DIFFERENT APPROACH

Most animal science manuals have focused on the care and management of common breeds of domestic animals to achieve greater production. This manual emphasizes the environmental factors that affect livestock and livestock interactions. Standard livestock texts should be consulted for detailed management practices. The bibliography lists some of the more comprehensive of these, especially those that are most appropriate for tropical latitudes.

Traditional livestock texts cover the common domesticated animals, such as the cow, sheep, goat, and chicken. This manual also deals with animals that are unique to certain areas. The intent here is to stimulate thinking about possible options and to stress the uniqueness of local environments in tropical areas. In other words, there may be a local but relatively unknown or overlooked animal that has great potential for development as a livestock project.

Many references are made to the goal of developing a farming system that is compatible with the environment. Just as a tree or wild animal is part of a forest, a livestock project is a part of a farming system. A farming system is an organizational structure that interlinks the various activities of farmers and the distribution of resources. Farming systems may be based on one major activity (for example, the growing of coffee for export), but also may include other activities that do not conflict with respect to labor requirements, use of land area, or use of other resources. An integrated farming system is characterized by strong interconnections among various farming activities that serve to conserve resources and labor and to reduce the need for imported feeds and fertilizers.

One goal of livestock management is to increase production per animal, which at the same time increases total production on a given area of land. Although this may be the goal of a project, a broader view places livestock production in juxtaposition with local environments, local agricultural systems, and community traditions.

Thus this manual emphasizes the following key concepts:

* maintenance of environmental balance through recycling,

regeneration and knowledge of interactions in natural systems

*** active involvement of local people in planning, decision-making, and management**

*** preference for traditional agricultural techniques that have a sound ecological basis**

*** integration of livestock, cropping, and other land-use systems**

WHAT IS A SMALL-SCALE LIVESTOCK PROJECT?

Small-scale livestock projects are developed at the local level and are designed primarily for the benefit of local people. Such projects may involve a few small farmers or herders, or an entire rural community working in a cooperative effort.

A good small-scale livestock project:

*** involves local people in planning, decision-making, and management**

*** respects the organization of the community**

*** encourages regular communication among participants**

* addresses common problems and needs

* uses technology appropriate to the region

* includes practical and relevant training for participants

* enhances personal and community self-reliance

* takes advantage of local production and consumption patterns

* contributes to overall community well-being

ENVIRONMENTALLY SOUND LIVESTOCK PROJECTS

An environmentally sound livestock project works with natural cycles and against environmental degradation. Because all parts of the environment are interrelated, such a project avoids the introduction of substances with unknown properties that might contaminate the soil and water or harm plants and animals. An environmentally sound project uses local resources wisely, works with livestock that are appropriate to the environment, and recycles nutrients back to the soil. Such a project actually may enhance the environment by encouraging beneficial changes that contribute to environmental health. The overall goal is to contribute to a sustainable agricultural system.

Chapter II

IMPORTANCE OF ECOLOGY IN LIVESTOCK-PROJECT PLANNING

The total biotic community and its interaction with livestock and the social system must be considered when making decisions about livestock projects. Planners must be concerned with the amount of pressure that populations, biotic communities, and ecosystems can withstand without drastic alteration. An agricultural system that disturbs the ecological balance least will be more easily sustained on a year-to-year basis.

Small-scale livestock projects can have both positive and negative effects. The impact on the environment may be greater than that viewed within the original scope of the project.

An ecosystem becomes unbalanced if the natural cycles are interrupted. For example, if the cycling of nutrients back to the soil is broken by inadequate handling of wastes and overgrazing, the soil will become less fertile. Crop and grass production may drop from year to year. Maintenance of a healthy soil requires recycling of nutrients.

In an unstable ecosystem, one dominant species may demand so much of a resource that the supply of that resource is threatened. For example, a grassland may have a cattle herd that is too large for the amount of forage available. The cattle overgraze their favorite plants, which are then no

longer able to compete with less desirable plants for moisture and nutrients. The composition of the plant community is changed, the cattle are forced to eat poorer-quality forage, and the cattle grow sick and weak. If cattle die, or are killed and the herd is reduced, the ecosystem may return to its former balance, depending on the extent and duration of environmental stress. If damage has been too great, productive forage land may be replaced by sand dunes and desert scrub.

ECOLOGY DEFINED

Ecology is the study of the relationships between all living things and their surroundings or environment. This environment includes soil, climate, plants and animals. Animals and plants living together under similar conditions form biotic communities, whether on the Arctic tundra or in the depths of the Amazon basin. A community of living things can be found in a field of corn or on an overgrazed mountainside.

Humans are members of the biotic community wherever they live. As farmers, they attempt to change the other members of that community to improve the quantity or quality of food and valued resources. They may plow a field to remove vegetation that competes with crops. They may import a new breed of livestock that provides more benefits than local animals.

Farmers do not operate from outside the biotic community. The forces that work with or against their actions are natural processes -- an intricate network of physical and biological processes that sustain the community. A farmer, as a member of that community, should understand these natural processes and work with them.

Ecosystems

The biotic community in combination with the nonliving parts of the environment -- soil and climate -- form an ecological system or ecosystem. Some major ecosystems are tropical rain forests, grasslands and deserts. Within the ecosystem, each member of the biotic community affects other members. In the grassland ecosystem, cattle or antelope eat the grass. Soil organisms return nutrients to and aerate the soil, and improve soil moisture retention. Rodents eat seeds, leaves and underground stems. Insects feed on and pollinate plants. In various ways, animals carry the seeds of plants to new areas.

Within an ecosystem, plants and animals compete for the available resources. Taller plants provide shade and shelter from the wind, changing the temperature of the air and soil. As plants and animals modify the environment, the members of the biotic community will change. As conditions change, new members will join the community. These in turn may modify the environment even more. A given area of land will support a more or less predictable sequence of communities, a process known as succession.

<FIGURE>

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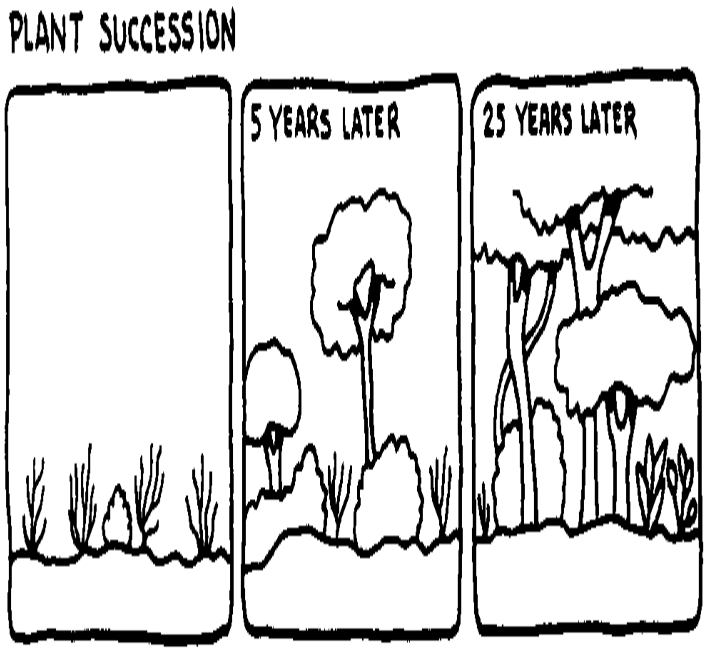

Over time, the community will become relatively stable. Under demanding climatic conditions, certain plants and animals may become dominant. These species will be those that use resources well, and whose reproduction and growth are best suited to the environment. In the humid tropics, however, usually no one species of animal or plant will establish dominance. There are exceptions such as mangrove forests and grasses on deforested land. Because of the warm, moist, stable climate, the tropical rain forest has an incredible diversity of life forms. For example, in the Choco region of Colombia, a one-tenth hectare of tropical forest may contain over 200 different tree species while a similar area of temperate forest might contain 25.

Ecological Balance

In a stable biotic community, the processes of growth and decomposition maintain a balance. Because of the many interrelationships between the various members of the biotic community, it is a dynamic balance. Populations may vary seasonally, but cyclic patterns in a population can be expected over time. A development project that introduces a new species of livestock or diverts scarce resources may disturb that balance. Sometimes a new balance is quickly achieved. In other cases, the environment may be drastically altered and a new balance will be achieved only after considerable adjustments have been made within the ecosystem.

An ecosystem with a wide variety of plant and animal species has a tendency to be more stable, having a greater capacity to maintain an ecological balance. Changes within this diverse community of plants and animals do not affect the total system significantly, because one change is often compensated by another.

The Web of Life

Animals are involved in the cycles of nutrients and energy that flow through the ecosystem. The nonliving environment consists of carbon, phosphorus, nitrogen, hydrogen, sulphur, many other elements and combinations of elements. Animals need plants to organize these elements into substances that the animals can use in their growth and maintenance.

Through a process known as photosynthesis, green plants use the energy of the sun to make sugar from carbon dioxide and water. Later, plants use the sugars to make starch, fat, proteins and other organic compounds.

Green plants are called producers because they have the ability to make food from raw materials and the energy from the sun. All other life depends upon the food-producing ability of plants.

<FIGURE>

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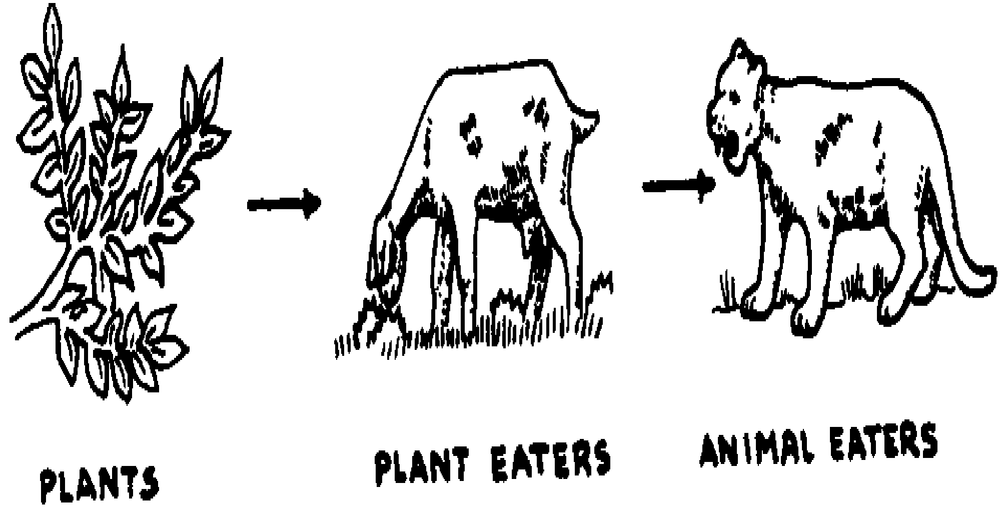

Animals are called consumers because they eat other plants or animals and cannot make food directly from raw materials and sunlight. Primary consumers eat plants; secondary consumers eat other animals. The movement of nutrients from green plants through plant eaters to animal eaters is called a food chain. Because consumers may use more than one food source, food chains interconnect. As the food chains interconnect, a complicated food web is formed.

<FIGURE>

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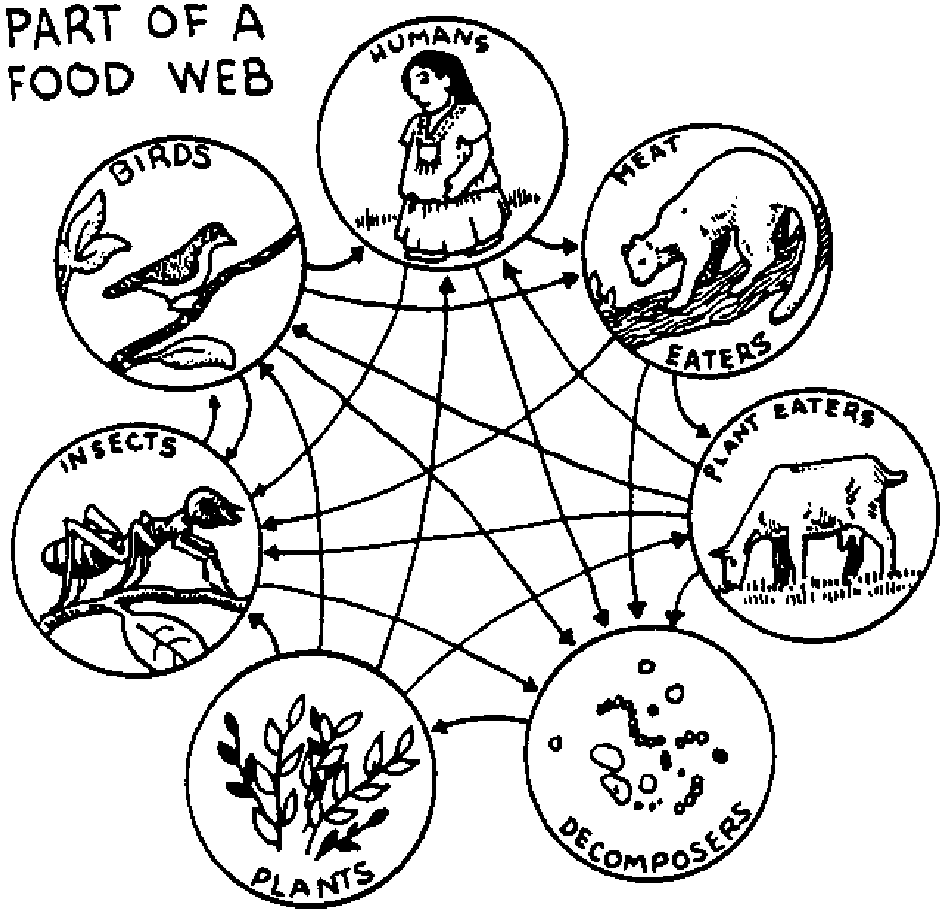

10

The decomposers complete the food web. Decomposers, like fungi and bacteria, produce enzymes that break down dead plant and animal material. The nutrients released by this process can be reused by the producers. Soil humus is formed in this process. Humus, in turn, breaks down to release additional nutrients at a rate dependent on soil temperature, moisture, acidity and aeration. Valuable nutrients are also returned to the soil in animal wastes.

At each step in the food chain, most of the nutrients consumed are used to support daily activities. Only a small portion of the nutrients remain for growth and reproduction. In a given ecosystem, the amount of nutrients available to animal eaters is much less than that available to plant eaters. This concept can be visualized in the form of a food pyramid. At the base of the pyramid is the largest biomass represented by plants, while the second (decreasing) level represents the biomass of the plant eaters, and the top (smallest) level represents that of the animal eaters.

<FIGURE>

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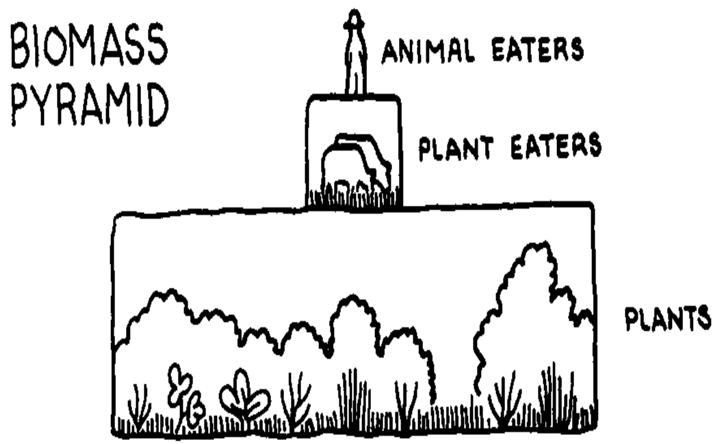

BIOLOGICAL DIVERSITY

Farmers in the temperate zones have often found profitable, at least in the short term, large-scale cultivation of single crops and intensive livestock production. Concentration on one animal or crop, and elimination of all other competing animals or plants, has resulted in high production compared to labor expended.

For whatever reason, planners may decide that a production system based on a single breed of livestock is desirable. The manager of such a project often finds it necessary to isolate animals in one way or another from the surrounding environment. This action itself can result in higher costs of production. Also, the system may strain feed sources and require attention at times that managers find inconvenient or costly for other reasons. Diseases and parasites are major problems for the herds managed by intensive livestock producers, but they are not as devastating to the herds managed by farmers having a more diverse livestock management system. Therefore, the benefits obtained by concentrating on one type of livestock must be compared with the benefits obtained by developing a more diverse agricultural system.

In the humid tropics, the natural environment is composed of a complex network of individual species and the biological forces work to maintain this diversity. Major agricultural activities in some regions are reducing the biological diversity and thus working against biological forces. For example, 70% of the cleared land in Costa Rica is being turned into pasture. In other parts of Central America, rain forests are being cleared at the rate of 4,000 square kilometers per year. Some researchers believe that most of these rain forests will be destroyed by the year 2000.

Little is known about the forests that are being destroyed or about the long-term, and possibly global, effects of such destruction. Over 80% of those disappearing tropical species have not been identified by the scientific community. As older people of uprooted cultures die, knowledge of tropical plants and their uses is being lost. If planners would take time to seek out such knowledge and record it, they would have a better understanding of the importance of these resources both to the local community and to the world. Among the species being destroyed might be sources of new food crops, natural insect controls, and miracle drugs.

An agricultural system that embraces the natural biological diversity of a region may be more appropriate in terms of fulfilling family needs, using local resources, and adjusting to environmental stresses. Creating biological diversity in an agricultural system means incorporating a combination of different animals and plants into the agricultural plan, while at the same time allowing room for wild plants and animals that may not be an immediate or apparent benefit to humans.

CARRYING CAPACITY

The number of animals a given area will support on a yearly basis is sometimes called the carrying capacity. Carrying capacity is based on the amount of forage available to be consumed by livestock. To determine the carrying capacity, we must know the nutrient requirements of individual animals.

Just as each animal is a link in the food chain, it also has a niche. A niche is not something you can see, rather it is the set of relationships that the animal has with the environment. These may include the position in the food chain, the type of environment or habitat in which the animal lives, the place it sleeps at night and its eating habits.

Two animals in a stable community may appear to occupy the same niche and are, therefore, competing for resources. However, minor variations in such things as eating habits and food preferences reduce competition. This creates separate niches so that these two animals can live in the same environment.

Competition will occur between two species that have overlapping niches and are competing for a limited resource. A species will survive if it is a stronger competitor or if it adapts to reduce competition.

A limiting factor is a part of the environment that limits

the number of animals a given area can support. By determining the limiting factors in a specific environment, the livestock planner in a given area is able to focus information gathering. Of course, limiting factors may change from season to season and from year to year, but they are an important concept for planning.

The limiting factor might be the quantity and distribution of food, shelter, or water. These would be affected by the mobility of the animal. Every animal requires a particular kind and quality of food. Animal needs will also vary from season to season. Animals may be able to get food in sufficient quantity, but the quality of that food may be so poor that the animal is in poor condition.

When farmers introduce new breeds of livestock or increase existing herds, they increase demands on local vegetation that has been used by wild species. The amount of vegetation may be the limiting factor that determines total numbers of both wild and domestic species that can be supported in that environment.

Too much, as well as too little, of a particular requirement may affect the numbers of animals. High temperatures may have a debilitating effect on animals that are accustomed to a cooler climate. Each organism has a number of requirements for maximum growth. Any condition that exceeds or fails to reach these requirements is a potential limiting factor.

The removal of one limiting factor results in the population expanding to the point that something else becomes a limiting factor. For example, in an area affected by recurrent droughts, the amount of water available for livestock may be a limiting factor. With the addition of water sources, the livestock population may increase to the point that vegetation is severely overgrazed. Then, vegetation becomes the limiting factor.

Because of seasonal changes, the carrying capacity concept should not be viewed as static. If livestock are stocked at range capacity during good years, vegetation may have no reserve capacity to survive years of severe drought. Therefore, carrying capacity and limiting factors must be continually reassessed through monitoring of range conditions.

Biotic communities and the ecosystem, ecological balance, the food webs, carrying capacity, and limiting factors are all useful concepts in developing a livestock plan.

COMPETITION AMONG ANIMALS

The number of animals a given area can support depends upon the amount of food available to them. Humans as members of the biotic community are part of the food web and compete with other members for food. (See diagram p. 1.) Animals compete with humans when they eat grains and other human food sources.

The graphic representation of a food pyramid (see drawing p.11) supports the argument that more humans could be supported if all became plant eaters. In fact, in some areas of the world, vegetarianism may have evolved not only from religious precepts, but also from environmental and economic factors.

The food pyramid is, however, a simplified representation. Animals can make use of plants that are not suitable for human food. They make use of land that is not suitable for agriculture. By so doing, livestock can extend the range of resources that can be used by humans. Livestock projects that focus on local needs, local people, and the enhancement of the local environment can lessen the conflicts between humans and other animals for resources.

FOOD QUANTITY AND QUALITY

We should not consider food quantity apart from food quality. All animals need protein for maximum growth, activity, and maintenance of life. Proteins are made of amino acids linked together to form a molecule. Green plants can make their own amino acids, but animals depend on plants or other animals to provide some of their amino acid requirements. The amino acids that animals require, but are not able to make within their bodies, are called essential amino acids. Humans need eight essential amino acids: arginine, isoleucine, leucine, lysine, methionine, phenylananine, threonine, tryptophan, and valine.

<FIGURE>

A diet that includes meat, milk, or eggs at each meal is high in protein. A diet consisting only of starchy cereals, roots, or tubers is low in protein, calcium, and vitamins. A child on such a diet may be able to eat until full, but may be starving for protein. A small addition of meat, cheese, eggs, or milk would balance such a diet.

Meat, milk, and eggs also are called complete protein foods, indicating that the protein in such food sources has the proper balance of essential amino acids to satisfy human needs. Many traditional vegetarian diets use beans, lentils, peas, nuts, and grains as sources of protein. Although these are good protein sources, the protein does not always have the proper balance of essential amino acids to satisfy human needs. The most difficult amino acids to obtain from vegetable sources are lysine, tryptophan, and methionine. Grains are deficient in lysine, and legumes are deficient in methionine and tryptophan. Nuts and seeds are low in lysine and tryptophan.

Although legumes and grains have a lower quality protein than does meat, in combination they may complement each other, each making up for the amino acid deficiencies in the other. Therefore, an adequate diet is possible without the addition of meat or animal products. Although protein

balance is more difficult to achieve without the use of complete protein sources, traditional diets may use vegetable protein sources in combinations that effectively complement each other. Therefore, studies of local diets and traditional methods of food preparation are useful in determining how effectively livestock projects focused on food production can be in improving nutrition.

<FIGURE>

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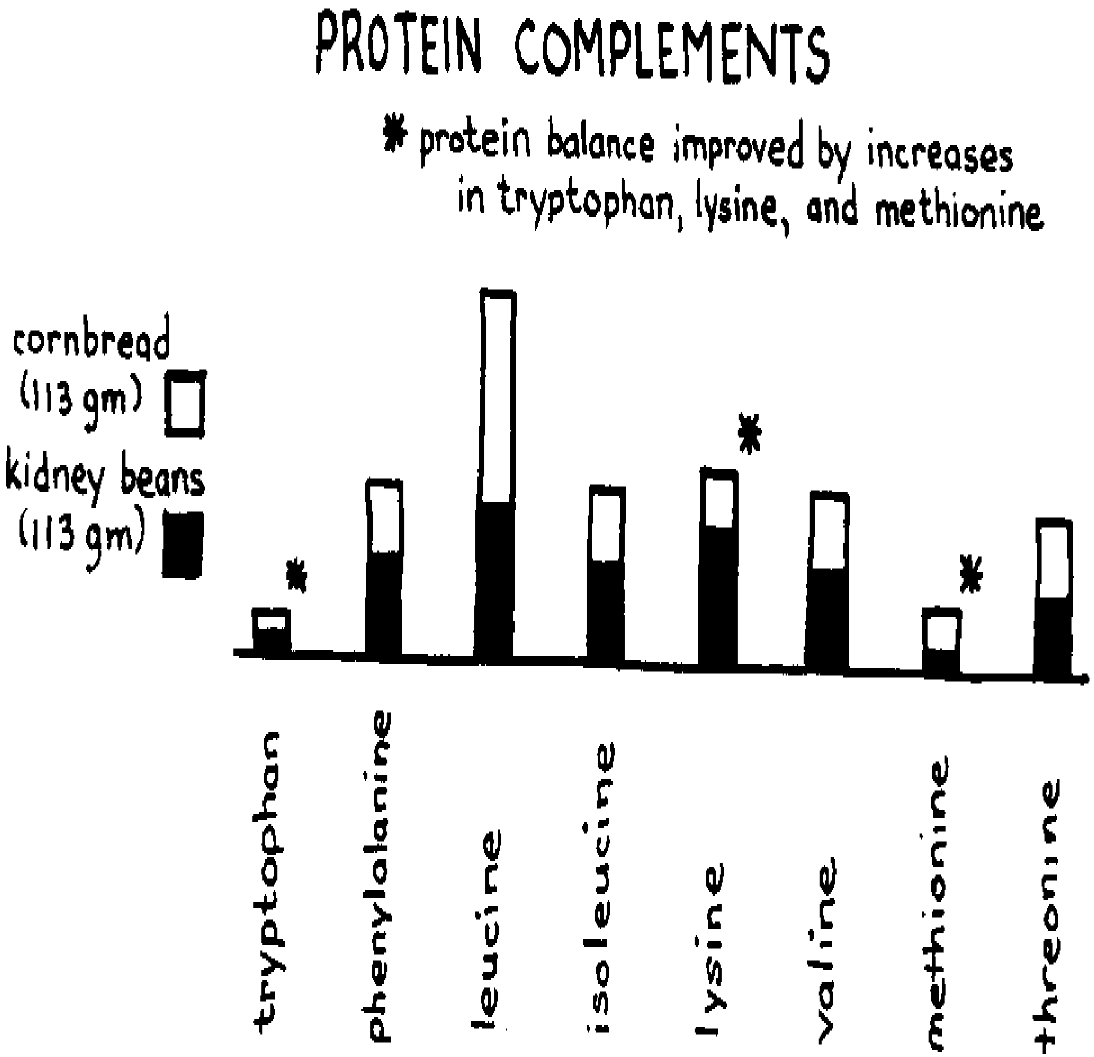

VALUE OF ANIMALS IN A FARMING SYSTEM

Livestock supply power, fiber, clothing, fertilizer, fuel, and social status. In fact, in many parts of the world, animals are valued most for such nonfood contributions. In addition, livestock convert foods indigestible by humans into nutrient-rich, digestible foods. Livestock can graze on land that is unsuitable for cultivation or of little agricultural value. They can eat surplus human foods that would otherwise spoil and can provide a reserve food supply when crops fail.

Animals that eat plants have digestive systems that can use the fibrous portion of feedstuffs such as cellulose. Cellulose is one of the substances that forms the cell walls of plants and gives them structure. As the plant matures, the amount of cellulose increases. Cellulose is resistant to digestion, but some animal digestive tracts contain bacteria that break cellulose down into organic acids. The cell wall breaks, releasing nutrients that then become available for digestion.

Goats, cattle, and sheep are called ruminants. Ruminants have an efficient digestive mechanism to use feeds that are high in cellulose. When they eat, food is passed first into a section of the compound stomach called the rumen. Here, bacteria break down the fibrous materials. This mass of partially digested material is forced back up into the mouth where it is chewed more thoroughly before being swallowed again. The mass then passes through the rumen and into another section of the stomach.

<FIGURE>

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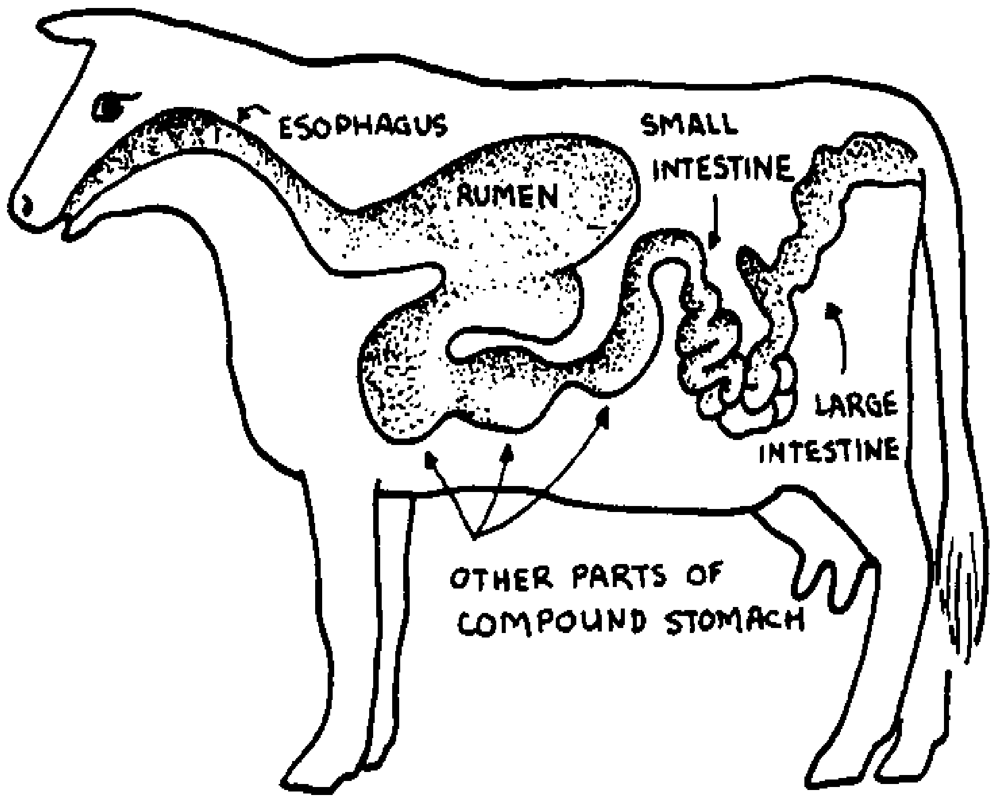

The bacteria in the rumen break down some of the protein. These simpler compounds are used by the bacteria to build other amino acids. Bacteria also can build protein from simple nitrogen compounds. These bacteria eventually are moved into another section of the stomach where they are digested, providing nutrients for the animal.

The bacteria in the rumen require sufficient amounts of protein or nitrogen compounds for growth and cellulose digestion. With poor roughage, ruminants need additional sources of nitrogen. That is why urea, a simple nitrogen compound, is sometimes added to a feed supplement.

MANAGEMENT BY ISOLATION FROM THE ENVIRONMENT

Attempts to manage animals by isolation from the environment may have a short-term benefit, but in the long run may cause harm to the environment, or will cease to be effective. In trying to isolate animals from the environment, humans have increasingly used compounds, such as insecticides, that kill other organisms. Many of these compounds are persistent; that is, they remain in the environment, accumulate in animal tissue, and may be eventually consumed by animals that are higher in the food chain.

Antibiotics also are used routinely to isolate an animal from potential disease-producing organisms. Antibiotics are effective medicines that kill organisms on or in an animal with relatively few side effects to that animal. Broad-spectrum antibiotics kill a wide range of these organisms and, increasingly, they are being added to feeds to prevent low-level infections that interfere with growth. Unfortunately, the extensive use of these antibiotics may be linked to the development of resistant strains of bacteria and new medicines will be needed to treat diseases caused by such resistant bacteria.

Chemicals used in agriculture to interrupt natural cycles also can cause a change in the regular balancing mechanisms of the local ecosystem. For example, an insecticide applied to kill a certain insect may be so effective that it is used regularly, sometimes when the insect problem is only mild. Natural consumers of the insect also may be killed by the insecticide, thus reducing natural controls that keep insect populations down. With natural controls weakened, the farmer or livestock manager becomes increasingly dependent on the insecticide for control of pests.

Also, insecticides are often sold to people who cannot read the cautions on the containers and who are totally untrained in their use. Although an insecticide may be safe as long as it is used properly, there is a high probability of improper use.

THE ENVIRONMENT AND LOCAL CULTURE

Studies of current resource-use patterns are needed to determine how a livestock project may fit into a farming system. Consideration also must be given to local values, traditions, and taboos regarding animals. The beliefs and traditions of a culture may be based on religious social, and economic considerations, as well as biological events experienced through centuries of development. Such traditions or beliefs can affect movements toward balance in an ecosystem.

The cultural traditions of a group also can help document the group's interaction with the environment. Cultural beliefs, handed down by oral tradition, may reflect the established method of adaptation to the environment. For example, the Navajo Indians of North America are proud of their skill as shepherds and herdsmen, but their lands are overgrazed. When asked why this is so, the traditional Navajo's answer is that the young people have abandoned the "old ways." Traditional Navajos had relied on their cultural heritage to maintain a balance with nature. Before suggesting changes in an agricultural system, planners must thoroughly investigate and understand the local culture and its conception of balance with the natural environment.

TRENDS IN LIVESTOCK MANAGEMENT

Many options are available when planning livestock projects for a local community.

* The availability of feed can be increased by improving the productivity of grazing lands or by using waste products from other agricultural activities.

* Breeding practices can be improved or new types or breeds of animals can be introduced.

* Water sources can be developed.

* Supplemental feeds can be added.

* New uses for animal power can be found.

* Disease can be reduced.

These are traditional methods for improving livestock management.

Because of the diversity of ecosystems, livestock improvement methodology varies widely. New information and new ideas for livestock management will develop from a renewed awareness and appreciation of natural systems. Successful application of these ideas to livestock systems will depend largely on local conditions.

Currently, farming systems involving agroforestry are receiving wide attention. Agroforestry or forest farming is a farming system that integrates trees and other plants that survive more than one season into the agricultural system. An agroforestry system might consist of a variety of trees and shrubs simulating the original vegetative cover. Alternatively, the trees and shrubs might be used as borders, windbreaks or fences around pastures and annually cultivated fields. The trees might be intercropped with other crops such as grains. The trees are selected for their yield of food and non-food products, such as fruit, nuts, fibers, animal forage, and fuel. Animals can harvest the food directly from the trees, or the tree clippings and fruit can be brought to the animals in adjacent pastures or lots.

Wild or semi-domesticated animals also are being considered as potential members of a farming system. Recent research indicates that native wild species often use local plants more efficiently with less negative environmental impact than do domestic animals. The cropping of wild animals by hunting can be more productive than cattle ranching; for example, the eland in Africa and the capybara, a large rodent in South America, are species that have been considered for inclusion in a game-farming system.

Domestic animals in tropical areas also may be better suited to their environment than animals that might be introduced from other regions. For example, a recent experiment in Ecuador showed that the guinea pig, a long-domesticated animal of the Andean region, was more profitable to raise than swine or milk cows. Yet, in the past, planners in this region had often considered the introduction of rabbits or chickens, rather than concentrating upon improvement of guinea pig production.

Trends in livestock management are influenced by local needs as well as by national goals. If national goals do not coincide with local needs and do not consider environmental effects, imbalance will result. Makers of national policy cannot ignore the environment. As the world communities become more interdependent, agricultural policy planners must become global in their awareness, and at the same time, must be able to adapt policy to the requirements of local ecosystems.

Chapter III

BEGINNING THE PLANNING PROCESS

This chapter and those that follow can assist the development worker to include consideration of the ecological system discussed in Chapter II in working with a community to plan a livestock project.

Ideally, planners follow a logical sequence when planning a livestock project. First, information is gathered in partnership with community members. As community needs and problems are identified, possible project options are considered. Together, community members and planners prioritize options and define project goals and objectives. Taking into account anticipated problems, a variety of means are considered to attain these goals. The best choice of these alternatives will bring the most benefits with the least negative impact on the community and the environment.

It is impossible to anticipate all environmental effects of a given project. Therefore, planners should monitor all activities to determine additional problems that might need to be addressed. When the project is in operation, planners and community members should continuously evaluate the results to see if objectives are being attained and if any undesired effects have occurred. Evaluation also will aid in the planning of future projects in the region.

<FIGURE>

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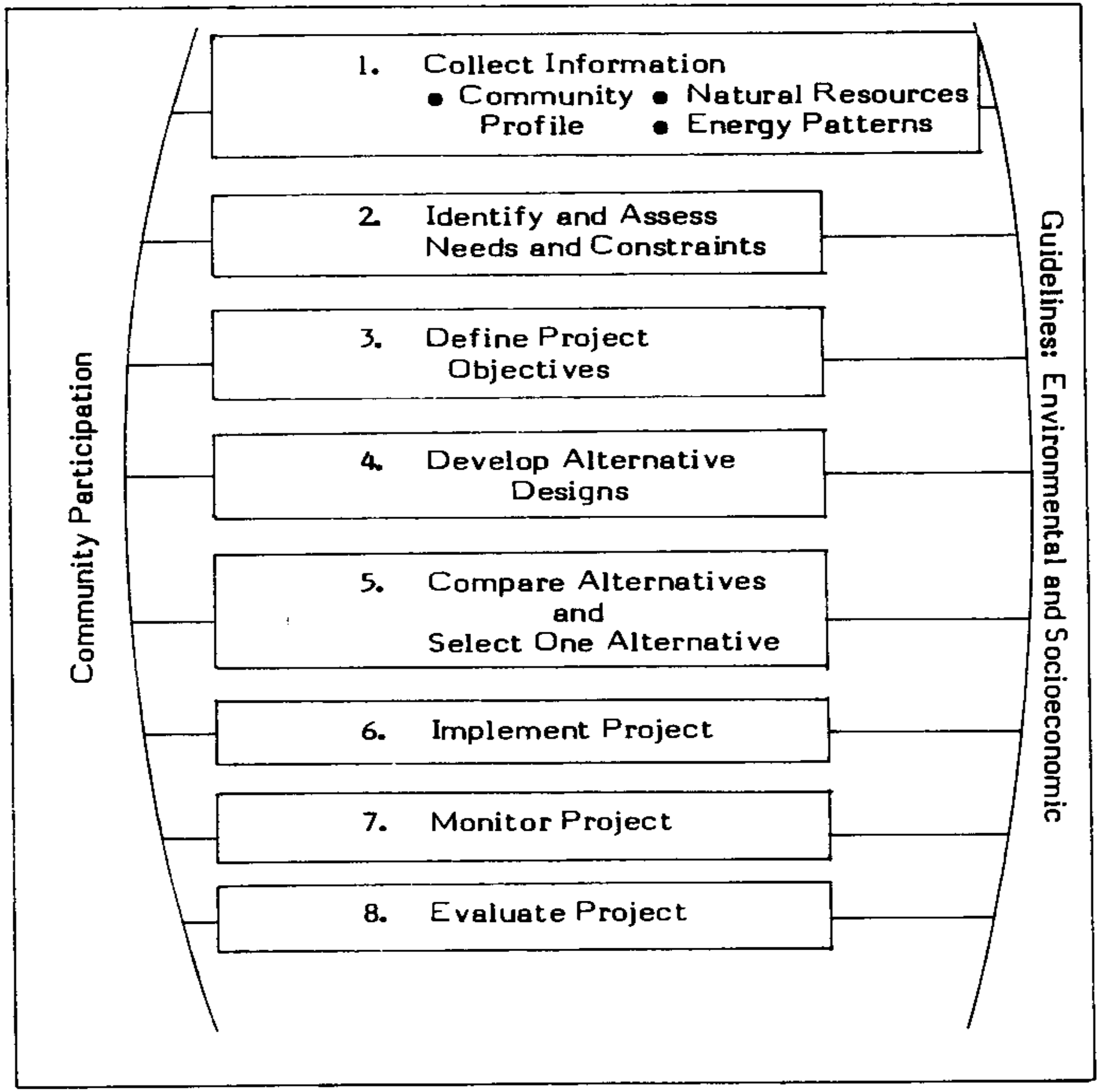
A PLANNING PROCESS



The first step in planning is the gathering of information. All planning should be based on a sound understanding of

local community and environmental conditions. Community participation in information collection and identifying and assessing needs and constraints cannot be overemphasized.

From a socioeconomic perspective, a "community" usually consists of a mixed group of individuals with different resource endowments, unequal access to inputs and markets, and different production objectives. Thus, individuals living in a "community" may not readily agree on what should be included as community interests. Before the project is designed, the specific targeted population should be identified.

This chapter presents some useful environmental and community guidelines for planning, with later chapters focusing on specific relationships of the environment and agricultural systems. Chapter IX outlines the remaining steps in the planning process.

THE FIRST STEP...INFORMATION GATHERING

Gather information on the social structure, the economic base, land use, livestock practices, and the environment. Conduct surveys and gather information in cooperation with local people. Emphasize the importance of relating a project to a specific community. Do not draw premature conclusions. Take special notice of the social structure in regards to sex roles, the division of labor, responsibilities and decision-making.

The planner and community members can jointly decide which data are most essential as community needs are identified. However, general survey data should be gathered first. Further information needs may then become apparent. Understanding the social structure of the community is extremely important. Failure to determine who makes the decisions, and what motivates them, can lead to the collapse of even the best-planned projects.

COMMUNITY PARTICIPATION

When community members participate in all phases of project planning, execution, and evaluation, they will be more committed to the project and have a sense of ownership. Arousing and maintaining community participation is a challenging task. It is not difficult to communicate with one or two leaders or a small group. However, involving the whole community and helping them to realize what can be achieved is more difficult. Some references on the subject are included in the bibliography.

Planners and community members may not always agree on the priority needs of a community. Each is looking at the problem from their own point of view. If planners begin a project that addresses needs that are not identified by the community, there will be insufficient support from the community. With the participation of local people, planners can learn which issues are critical in the eyes of the community.

Communities are groups of individuals that may have conflicting goals. If the project satisfies only the goals of certain members of the community, planners should make sure that the project does no harm to those who are not participating. A project that satisfies the needs of several different groups within the community will be more sustainable.

Where commercial sales of livestock or livestock products are involved, wholesalers, retailers and transporters should be included in planning. These groups are experienced with marketing problems and with past successes and failures. If all related groups are included in the development process, they can explore the reasons why projects have failed, so that mistakes are not repeated.

ENVIRONMENTAL AND COMMUNITY GUIDELINES

The following guidelines should be considered when gathering information, and while designing, implementing, monitoring, and evaluating a project. The guidelines are designed to help the planner avoid pitfalls and maximize potential.

Guidelines differ from objectives in that objectives are specific ends to be accomplished, whereas guidelines are suggested means to reach these objectives. For example, an objective might be to provide six eggs per day to each participating household to supplement the local diet. A guideline would suggest how to use locally available chicken feeds that were not being used efficiently.

The brief list of environmental and community guidelines below offers a general framework for the kinds of guidelines to be considered. Planners should add guidelines that fit the region in which they are working.

Environmental Guidelines

* IDENTIFY the competing uses for natural resources and possible results of diverting these resources for livestock production.

* CHOOSE livestock that are suited to the local environment with respect to needs, habits, and special characteristics.

* USE an integrated plan that emphasizes the interrelationship of all members of the biotic community and the physical environment. Livestock should be an interlinking part of a total farm system.

* MAINTAIN or enhance the ecological productivity of the ecosystem.

* PRESERVE the ecological balance for long-term benefits.

* INTEGRATE livestock production plans with crop production and soil management plans.

*** IMPROVE soils by reducing erosion and increasing soil fertility.**

*** DETERMINE seasonal availability and demand for water and crop residues so that demand does not exceed supply.**

*** PROTECT water quality and supply by improving and protecting wells and springs, and planning for recycling of wastes.**

*** INVESTIGATE plant growth potential and resistance to heavy grazing to avoid overgrazing rangeland.**

*** ENCOURAGE traditional practices that conform with sound environmental management by incorporating them into the plan.**

Community Guidelines

*** INVOLVE all people who will be affected in all phases of the livestock project development.**

*** DETERMINE if resources to be used are not presently needed by the landless and the very poor.**

*** BUILD upon the existing social organization and customs.**

*** DETERMINE what problems may occur when a new system of management is placed on an older system.**

* DEVELOP land-use strategies that integrate livestock with established agricultural systems.

* CHOOSE livestock which in terms of methods of control, labor required, technical knowledge required, and type of product are best adapted to the local community.

* CONSIDER possible health problems such as contamination of the ground and water supply by animal droppings.

* DESIGN projects which can be controlled by the target population.

PLANNING QUESTIONS

The questions below are designed to help the planner gather information and organize the data into a usable form. Additional questions follow other chapters, as ecological concepts are introduced that may apply to a particular situation.

* What is the population of the community and what is the rate of growth?

* What is the structure of the population of the community?

* How are decisions made in the community?

* Who are the local leaders?

* What is the traditional method of determining leadership in the community? Age, sex, religion, wealth, herd numbers?

* What groups are involved in assessing needs and addressing them?

* Who controls the use of land and other resources? How are the controls administered?

* What are the indicators of wealth in the community?

* What are the local sources of employment?

* What local industries and crafts production exist in the region?

* To whom and for what is credit locally available? Is it easily available to all groups? To women?

* What local traditions and ideas may affect the acceptance of a livestock project?

* What local, regional, and national policies such as laws, taxes, and subsidies affect local resource management?

* What are the local, regional, and national markets for

livestock products?

* What marketing and transportation facilities are available? Are they adequate to handle increased production?

* What public health problems are the most critical in the region? Will new livestock projects add to or help prevent the conditions that are causing these problems?

* Have recent changes in the community affected livestock? How does the community view these changes? How are they responding to these changes?

Chapter IV

LIVESTOCK CHARACTERISTICS: BACKGROUND FOR PLANNING

Livestock project planners should analyze the characteristics of different species and how each fits into the farming system and local traditions. Animals are often valued most for characteristics other than for the production of meat, milk, and eggs; they also provide power, fiber, and manure for fuel and fertilizer. They devour insect pests and thorny brush and can be sold or traded in the market place.

<FIGURE>

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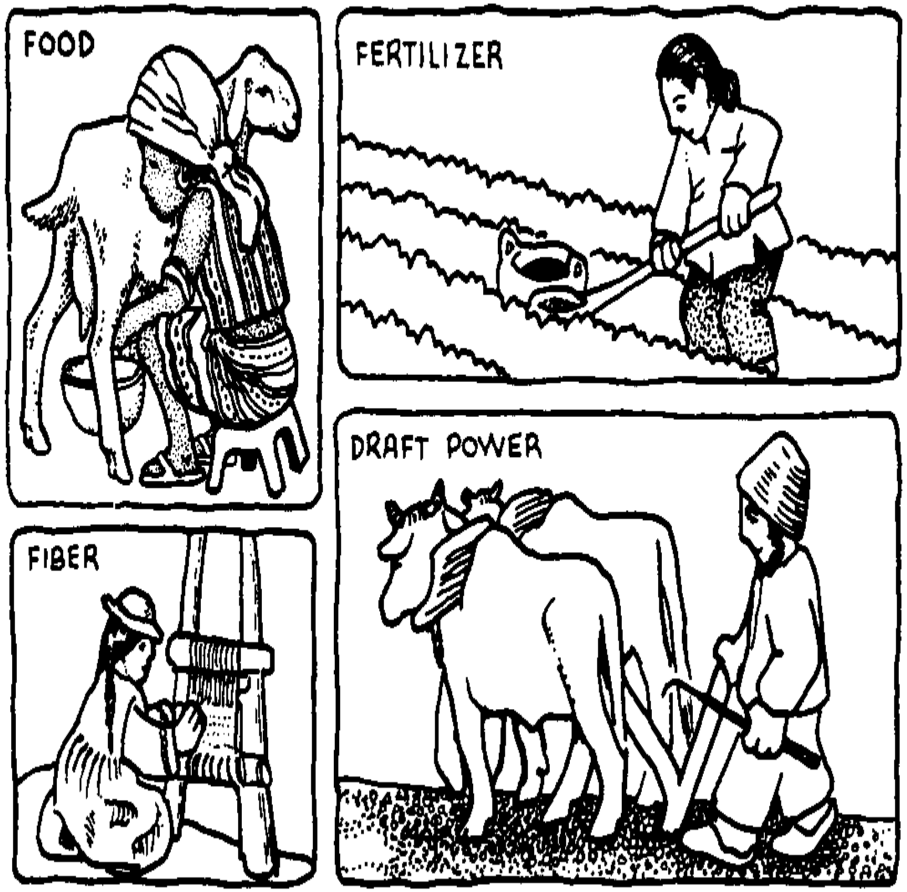

Within various social systems, animals are used as indications of wealth, gifts to resolve conflicts, exchanges to establish marriage alliances, offerings to promote friendship with others, and symbols of harmony and good health.
The provision of meat or gift of an animal to relatives, friends or strangers at traditional gatherings is seen as an expression of goodwill that enhances a family's position in the community.

As a negative influence, livestock may overgraze the land, destroy useful vegetation as they invade cropland, strip the bark from trees, and kill young trees. Overgrazed pastures may erode, and water sources may be polluted. Improper manure management may cause insect, odor, and pollution problems, which are especially annoying in populated areas.

Planners must consider the positive and negative effects of livestock projects in terms of the total environment.

APPROPRIATE LIVESTOCK FOR FARMING SYSTEMS

The development of a new farming system or the improvement of an existing system should be based on identified community needs. Because many breeds and types of animals are now domesticated, it is usually possible to find one that is adapted to the local environment, available at reasonable cost, and socially acceptable. Thus, the planner seeks to identify livestock with food, water, and labor requirements that fit the local environment. Livestock that can be easily controlled and are within the financial reach of participants can best serve the needs of the community.

Large Animals Versus Small Animals

One major consideration is the suitability of large animals as compared with small animals. Large animals, including the horse, cow, buffalo, llama, elephant, and camel are important as draft animals. Draft animals greatly increase the ability of the small farmer to prepare land and plant crops at the proper time. By using draft animals, the farmer can increase the amount of land farmed and the total food production of the family unit.

Large animals cover extensive areas in search of food. They require large amounts of feed and water per animal, but most breeds can use low-quality forage to a large extent. Many are adaptable to nomadic herding systems, but may require protection from predators.

Generally, large animals require a greater financial investment, can be more difficult to control, and have lower reproductive potential than small animals. Butchering for meat in areas without refrigeration requires cooperative agreements between families or other meat-processing techniques.

Smaller animals such as sheep, chickens, rabbits, guinea pigs and pigs require smaller amounts of feed per animal. They are generally more efficient in converting feed to animal protein. Many, such as chickens, rabbits and pigs, are not suitable for a nomadic farming system. They are valuable where land is limited and when production must be concentrated in a small area. Many require housing for control and protection from predators.

Small animals require a smaller financial investment. They are easier to control and have higher reproductive potential. They can be butchered on a daily basis for family meals and are a suitable animal husbandry educational project for children.

Browsers and Grazers

Animals that are browsers, such as the goat or camel, prefer the leafy tops of brush. Because they are browsers, they are less susceptible to infection from parasites found on grasslands that have been heavily grazed and that are infected by parasite eggs and cysts. Pasture management for browsers requires planning for forage from brush and tree species. Because the browser prefers leafy, young growth, it will avoid the tougher and more mature pasture grasses. As grasslands are taken over by older growth, productivity slows.

Grazers crop the grasses and leafy plants that are at ground level. Although grazers also prefer leafy growth and certain plants, on poor pastureland they unwillingly graze the mature stands while browsers nibble the buds and new growth on shrubs. Knowledge of these different eating habits can be advantageous; for example, a livestock manager can adjust the balance of browsers and grazers on a range to coincide with the kind of forage that is available.

Knowledge of food habits also can help the livestock manager find ways to influence beneficial forage changes. For example, to prevent a woody plant from establishing dominance and crowding out other beneficial species, the manager can stock the range with browsers that will eat the plant. Herds of browsers can be brought in and held in areas where the plant is concentrated. The proper mixture of browsers and grazers can have desirable effects on the overall plant species composition and total productivity of the range.

SOME COMMON LIVESTOCK AND THEIR CHARACTERISTICS

Cattle

As ruminants, cattle can make use of large quantities of low-grade forage and agricultural by-products and thus do not compete with humans for grain resources. They are able to range over large areas in search of food and are therefore useful in extensive forage areas where crop production is limited by low rainfall. They require less labor than many other types of livestock, as well as a limited investment in buildings and equipment.

The major environmental stresses for cattle in the tropics are high temperatures, sometimes combined with high humidity and diseases. For example, breeds originated in European countries and noted for milk or meat production are strongly affected by heat stress and disease problems when exported to tropical regions. Zebu cattle, on the other hand, are resistant to heat stress and tropical diseases. European-Zebu crosses retain some of the hardiness of the Zebu and at the same time show increased ability for milk or meat production. Superior milk yields in the tropical regions require feed of high quality, obtained through the use of supplements or improved pastures.

Cattle herd numbers build slowly, so the return on the investment in animals is gradual. This slowness also makes it difficult to adjust herds to range conditions. Some benefits may be gained by grazing cattle with other animals, such as sheep and goats, which will help promote more productive conditions on the range by distributing grazing pressure more evenly.

Cattle are valued as draft animals and for their manure, which can be used as a fertilizer and as fuel for cooking or curing pottery. Although sheep or goats may give greater meat or milk production (per unit of feed consumed), cattle may be preferred to provide cow manure, animal power, or social status.

Water Buffalo

The water buffalo is an important draft animal for the small farmer. Where cattle may produce poorly, water buffalo provide meat, milk, and hides. Their milk has a high butterfat content and one animal may produce from one to sixteen liters per day.

The water buffalo can digest low quality roughages and also aquatic plants. As compared with other livestock, the water buffalo is one of the most efficient in using feeds with a

high content of fiber. Food passes slowly through its large digestive tract and is exposed to intensive microbial fermentation. Because of this slow digestive rate, water buffalo are less efficient than cattle in using high-quality pasture. Water buffalo seldom are raised in a pasture system, but can take advantage of roadside vegetation, crop residues, and aquatic weeds.

Two main types of water buffalo are named for their choice of habitat -- the swamp and river. The swamp buffalo prefers a mudhole for wallowing and works well in rice fields. It produces some milk and is a good source of meat. The river buffalo prefers running water for its habitat and is primarily a milk producer, although it is of some value for meat.

Water buffalo are docile and long-lived, sometimes working until 20 years old. They have few foot problems, and apparently have some resistance to ticks. Water buffalo need water and shade during hot weather, and prefer to graze at night.
Water buffalo have an excellent potential for improvement through selective breeding. Artificial insemination has been difficult, however, perhaps because of low fertility.

Because of a slow rate of maturity, long intervals between births, high death rate of the newborn, and its digestive physiology, the buffalo does not compete with cattle for better forage. It is best used in wet areas such as in

marshes or rice fields with high-fiber forage or crop residues.

Horses, Mules and Donkeys

Horses, mules, and donkeys have been used for centuries for transportation and as draft animals. The larger animals are preferred when farm work is heavy and the fields are level, whereas smaller animals are adequate for hill farms or where feed is scanty. Mules and donkeys can tolerate poorer feed and are better adjusted to hot weather than are horses. Donkey milk is said to be highly nutritious, with more sugars than cow milk.

Sheep

Sheep provide meat, milk, and fiber and sheep breeds have adapted to regions from the moist tropics to the sub-Arctic. However, a taste for mutton and lamb meat may have to be developed among people unaccustomed to their flavor. The two major types are wool sheep and hair sheep, the latter not markedly different in appearance from the short-haired goat. Sheep do well in dry climates. Some breeds store fat when feed is plentiful to be used later when drought reduces the amount of food available. Some breeds are prolific and lamb more than once per year.

As ruminants, they are able to use a wide variety of forage. However, they are very susceptible to diseases.

Sheep need more protection from predators than do cattle, as well as more attention at lambing time. Labor demands also are high if animals must be sheared. When children serve as herders of sheep in settled areas, such work often deprive them of the opportunity to attend schools that may be available.

Sheep production is best on rangelands with medium to low rainfall. They can take advantage of cereal grain stubble, and their flocking instinct makes them relatively easy to manage around crop areas.

Goats

Goats are also ruminants. Goats are hardy, adaptable to many climates, consume a wide variety of feeds, and produce meat, milk, fiber and leather. Goat milk can greatly improve the diet of rural families. With well-managed breeding practices, a herd of three or four goats can provide milk through an entire year. Excess milk is often used as a supplement feed for young pigs or chickens or is made into cheese for market or home consumption.

Goats are browsers, preferring the new growth of shrubs and the seed heads of grasses to the lower-quality older growth in a pasture. Because they are able to select the most nutritious parts of plants and can use a wide range of forage, they are able to survive in areas where other livestock production would not be feasible.

As browsers, they are useful in brush clearing when grazed in high concentration on a restricted area. Because they strip the leaves and bark of young trees, they should be used in settled farm areas only if good fences can be provided. Even when goats are well fenced, constant vigilance is necessary; they will continually try to get through fences to wander the farm yard. One or two animals can be controlled with a tether, but this method also requires vigilance. Frightened goats will run to the end of the tether and be jerked to the ground; they will knock over carelessly placed water containers, get tangled in the brush, or wind themselves around a small tree.

Goats have a herd instinct, but are more independent than sheep, and are thus more difficult to herd. This may cause problems in settled areas, as they may lead the sheep flock onto cropland.

Goats are suited for dry areas with little high-quality forage and areas with dense brush that other livestock cannot penetrate. They are at a disadvantage when crop residues are the main feed source, because of the low selection of food sources in most crop lands.

Camels, Alpacas, and Llamas

Camels provide meat, milk, and draft power and transport men

and goods across the desert. Llamas carry loads to market in the high Andes. Alpaca wool is spun and used for valuable textiles.

These members of the camel family are more efficient at digesting poor-quality foliage than are sheep or cattle. They are ruminants that chew their cud, but their stomachs have only three main parts. The first stomach contains specialized pouches that increase the absorption of nutrients.

Camels require relatively little water, can survive almost indefinitely on browse, and can eat plants with a high salt content. However, they feed slowly, mature late, produce low-quality meat, have long intervals between births, and do not like muddy conditions. They serve best in providing transport and animal power in dry regions where high-quality feed is lacking.

<FIGURE>

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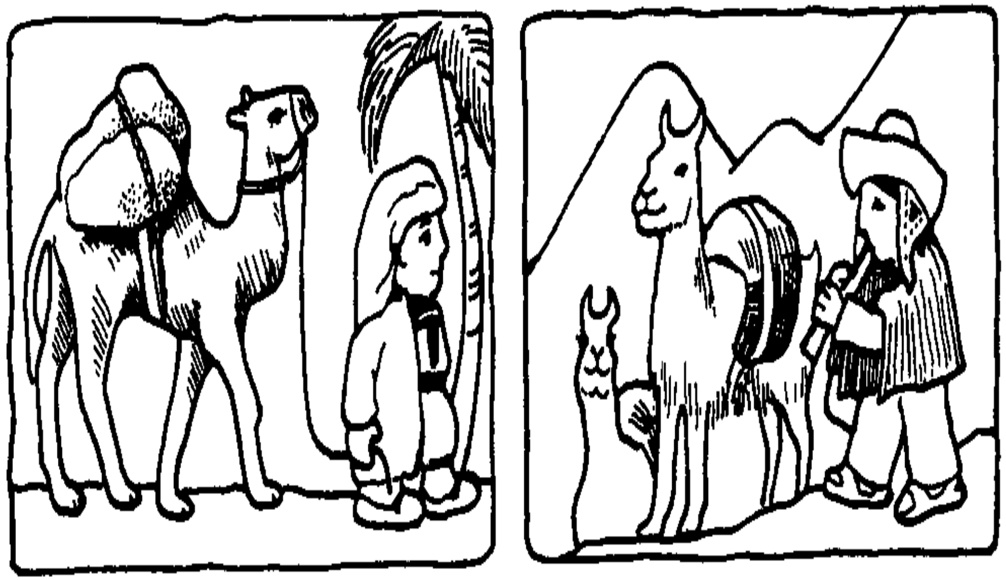

Alpacas are adapted to high altitudes, having small red blood cells with concentrated hemoglobin that may improve the cell's ability to exchange oxygen. Compared on the basis of body weight, they consume less feed per day than sheep or cattle.

As yet, the Andean breeds are of major importance only in a limited region of South America. Llamas are currently in vogue, however, in the mountain regions of North America where they are used for carrying supplies on extended hiking expeditions. In the Andes, benefits will be gained by a more complete understanding of disease, fertility and nutritional problems and by improvements in herd management and breeding programs for wool production.

Pigs

Pigs are efficient converters of feed to meat, but they are not able to consume large quantities of coarse forage. However, they eat a wide variety of feeds when fed a limited amount of grain, swine can be raised on waste materials such as vegetable scraps, corn husks, sweet potato vines, and water hyacinths. They also will eat acorns, roots, fruit, insects, lizard eggs, mice, and birds.

Pigs are prolific and can have up to 12 young per litter and two pregnancies per year. Under intensive production, the young can reach market weight of 100 kilograms within six to nine months. However, high growth rates require considerable attention to feed rations.

The dressed meat portion of the swine carcass may amount to 60% to 80% of live weight, as compared to 50% or 60% for cattle and 45% to 55% for sheep. Pork fat is highly valued and mature sows are acceptable for slaughter.

Some cultures, however, have taboos against raising and eating pork products. Pigs are highly susceptible to disease. Although pigs require only a small investment for buildings and equipment, any fencing for hogs must be strong. Enclosures must be tight enough to keep the young pigs out of crop land. Pigs kept in pastures will be healthier and cleaner, but by rooting up soil on steep slopes pigs can encourage erosion.

Pigs are best adapted to diverse and intense agriculture. Because they are prolific, returns on an investment multiply quickly. They are most efficiently produced in areas where grain by-products are available.

Poultry

The term "poultry" includes several different species of birds raised for meat and eggs, including chickens, turkeys, ducks, geese, guinea fowl, and pigeons.

Small-scale livestock projects have most commonly focused on chickens, which are efficient converters of feeds to meat protein and eggs. Eggs are one of the most complete foods, with a good balance of proteins, fats, carbohydrates, minerals, and vitamins. However, chickens do require high-quality feeds and thus may directly compete with humans for food grain.

To reduce competition for scarce and expensive feed, chickens often are allowed to forage for their own food, eating insects, food scraps, and weed seeds. In this way they can survive with minimal supplemental feeding. Because they are unprotected, however, they may be eaten by wild animals. Poor nutrition also results in fewer eggs, which may be well hidden and difficult to find.

The introduction of more productive breeds is often recommended, with improved breeds of chickens put in cages raised above the ground for good ventilation and for ease of manure collection. An enclosure system requires more attention to feed requirements and possibly the purchase of some grains or food supplements to insure higher production. It also requires more attention to sanitation and disease prevention.

Other poultry have potential as a livestock project; for example, the Japanese have found raising quail to be profitable. Geese are good foragers and can be raised on good quality pastures. They can be used with certain crops to help remove weeds and insects. Ducks also are good foragers, requiring less management and labor than do other poultry. They are especially suited for wet regions; they glean grain from croplands, they help control weeds and insects, and their manure is high in nitrogen and phosphorus.

The guinea fowl is a native poultry bird of Africa and has a tendency to lose domestic characteristics. Because each male bird chooses one mate, many male birds are required for each flock. Their eggs are thick-shelled and keep longer than do chicken's eggs.

Rabbits and Guinea Pigs

Domestic rabbits produce meat, fur, and skins. Does should be bred at six months of age and can average four litters a year, with seven or eight per litter. One doe can therefore produce 70 to 80 pounds of dressed meat per year if well managed. Rabbits will eat farm scraps, such as leafy plants, root crops, shrubs and kitchen scraps. Rabbits need clean but simple housing and a little daily care. They need extra feed during pregnancy and when nursing young.

Guinea pigs were a major meat source for Andean Indians long before the arrival of the Spaniards in the 1500s. They are gentle, prolific, and easy to care for and when fed kitchen scraps and alfalfa, are efficient meat producers. Twenty females and two males can provide adequate meat for a family of six. Females begin breeding at two to three months of age and produce up to four litters a year, with six in a litter. Traditionally, guinea pigs are raised in the farm home. Sometimes kept in a pit on the floor, they are fed kitchen scraps, wild grasses, barley and alfalfa. They are cared for by women and children.

In Peru, a guinea pig breeding program reported average weights had increased from .7 to 2 kilograms, along with accelerated growth rate.

CHOOSING LIVESTOCK THAT FIT THE ENVIRONMENT

Improved livestock production should take advantage of local animals and local situations. Objective study of a specific environment can be more rewarding than taking the ideas of another location and(or) another culture and trying to force them to work.

To decide which livestock can be most suitable for a project:

*** Make a thorough assessment of environmental conditions and local resources. How are these resources being used?**

*** Identify the overall needs and goals of the project.**

*** Describe tentatively the characteristics of the animal that would fulfill those needs.**

*** Compare local livestock breeds. How do they use resources? Could they satisfy the needs of the project? What are management practices and how could they be improved?**

*** Identify new livestock types. Would they satisfy needs? How would they fit into local farming systems? Would they adjust easily to new environmental conditions?**

Often, the value of local breeding stock and its adaptation to local environmental conditions is underestimated. They may be resistant to local diseases, have developed ways of coping with droughts or extreme heat, or may have unusual characteristics that are of value to local people. In contrast, a new breed of cattle may adjust poorly to environmental stresses, or may not have the type of hump on its neck that fits the local draft harness.

INTRODUCTION OF NEW BREEDS OR SPECIES

In the less developed parts of the world, livestock managers often have not assigned production capability a high priority in their breeding programs. As a result, improvement of production is one area in which a change in livestock breeding practices can show dramatic results. Partly because of this, a considerable emphasis is now being put on the importation of superior breeding stock from other areas or countries.

The introduction of new animals into an environment must be approached with caution. Large-scale introductions should be attempted only after the proposed animals are tested under local conditions for performance and resistance to local disease.

Introduction of livestock brings with it the possibility of introducing diseases that may decimate local domestic and wild species. For example, the superior water buffalo wanted for breeding purposes live in areas having many severe diseases; importation of these animals would increase the risk of spreading these diseases.

Animal introductions have sometimes caused dramatic changes in local environments. On an island, such effects are more visible, and, therefore, have been more easily studied. In the last 200 years, more species have become extinct in

Hawaii than on the entire continent of North America, mainly because of the introduction of new plants and animals.

<FIGURE>

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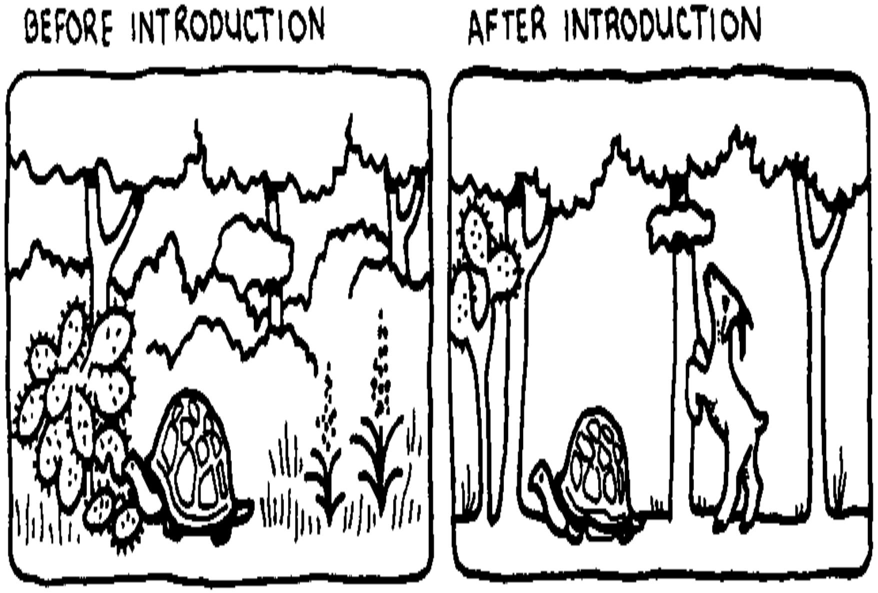

Island flora and fauna have evolved over thousands of years of isolation and have developed defenses only against native animals. A study of an island environment leads to an understanding of what occurs on a modified scale in ecosystems that have had more interactions with surrounding systems. On an island, introduced animals that escape captivity may survive without human care. A domesticated

animal that becomes wild is called a feral animal. Within ten years, a pair of feral goats can multiply to a herd of one thousand. Feral animals can completely destroy the unique flora of an island, and at the same time introduce new plants, insects and disease organisms. Feral animals that have been blamed for the destruction of island environments include rabbits, pigs, dogs, cats, cattle, sheep, and goats.

Once introduced, feral animals are difficult to remove. No matter how many animals are hunted or slaughtered, if there is a breeding pair left, the island will soon be repopulated.

In Hawaii, to save the remaining vestiges of native forest and shrubland communities, miles and miles of expensive fences over hilly terrain must be erected to keep out feral pigs and goats. Feral sheep prevent native forests from regenerating, also.

The coypu or nutria, a native rodent of Central and South America was introduced into England as a fur bearing animal. When the experiment failed, the animals were released. They settled in rivers and marshes, where they chewed and trampled reeds used for thatching. Later, as they grew in numbers, they began attacking crops. Fortunately, hard winters and a campaign against them reduced the population to a manageable size.

Weeds may be introduced by seeds in the hair or manure of an

imported animal. These plants interfere with the growth of native vegetation. In Hawaii, an introduced vine, the banana poka, grows so thickly it kills groves of native trees.

The mongoose was imported to Hawaii in 1883 to attempt to reduce populations of roof rats that were feasting on the sugar cane. The mongoose, however, was equally fond of native birds.

When considering the introduction of livestock, assess the danger of importation, the possibility of animals becoming feral, and the introduction of weeds, insects and diseases. Local livestock and native plants and animals may be threatened, especially when animals are brought from other continents or when local animals have lived in isolation for a long period of time.

PLANNING QUESTIONS

* What type of livestock can be raised under local climatic conditions?

* What wild and domestic animals are already present and in what numbers? Have domestic or wild populations changed significantly lately? Why?

* What are present livestock practices that control the size and the composition of herds or animal groups

managed by the family or community?

* Are livestock in danger of attack by wild animals?

* What are the feeding preferences of existing animals? Do they compete for the same food and water sources?

* Is there demand for livestock products locally or in surrounding areas?

* If new types of animals are to be introduced, what are the characteristics that would best fill local needs?

* What dangers and therefore accompanying precautions will be involved in the introduction of new animals?

* How much time do livestock managers currently spend on animal care?

* Are livestock managers interested in learning new methods or do they prefer current methods?

* Are livestock managers willing to increase time spent on daily care for animals?

* Will new technologies for preparing livestock products reduce demands on the environment, while opening additional markets, increasing income or increasing health and nutrition?

Chapter V

THE SOIL AND NUTRIENT CYCLES

Soil is a living community overlying a rock base. It is made of inorganic and organic materials, microorganisms, water, and air. A gram of soil may contain a million bacteria, a kilometer of fungal threads and thousands of cells of algae and protozoa.

THE CARBON CYCLE

When studying the environment, we cannot look simply at such variables as soil types, vegetation types, and rainfall. This is a static view of the environment and does not reflect the relationships between each member of the living and nonliving community. Materials such as water, carbon dioxide, and oxygen constantly flow from the soil and air to plants, from plants to animals, and eventually from animals back to the air and soil. The flow of materials can be thought of as following a circular path. One of the processes central to life and growth is the carbon cycle. The following diagram shows the cycle of carbon through an ecosystem.

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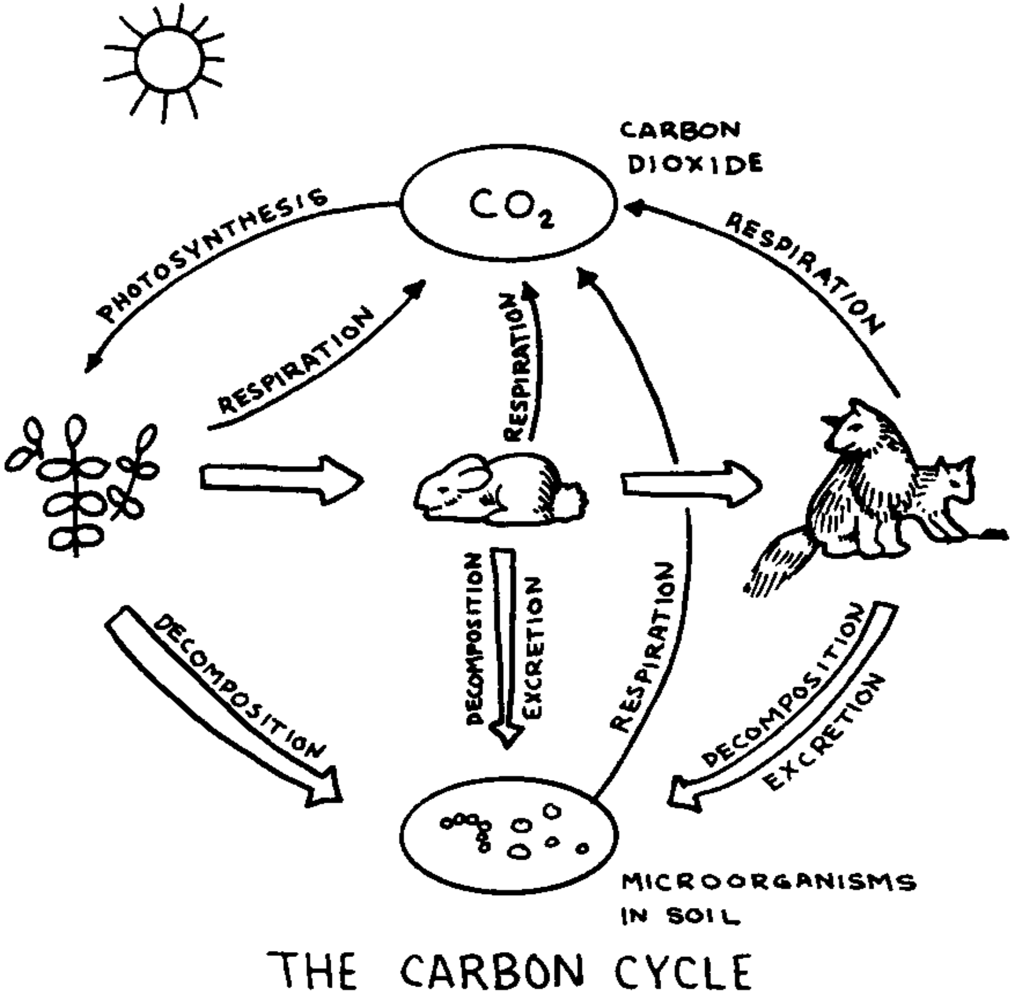

THE WATER CYCLE

Another important ecological cycle is the water cycle. As sunlight warms the surface of the soil, plants and lakes, water rises up into the air. Water collects in clouds and returns to the earth as rain. Vegetation helps to slow the return of water to lakes and rivers, preventing flooding and

soil erosion.

<FIGURE>

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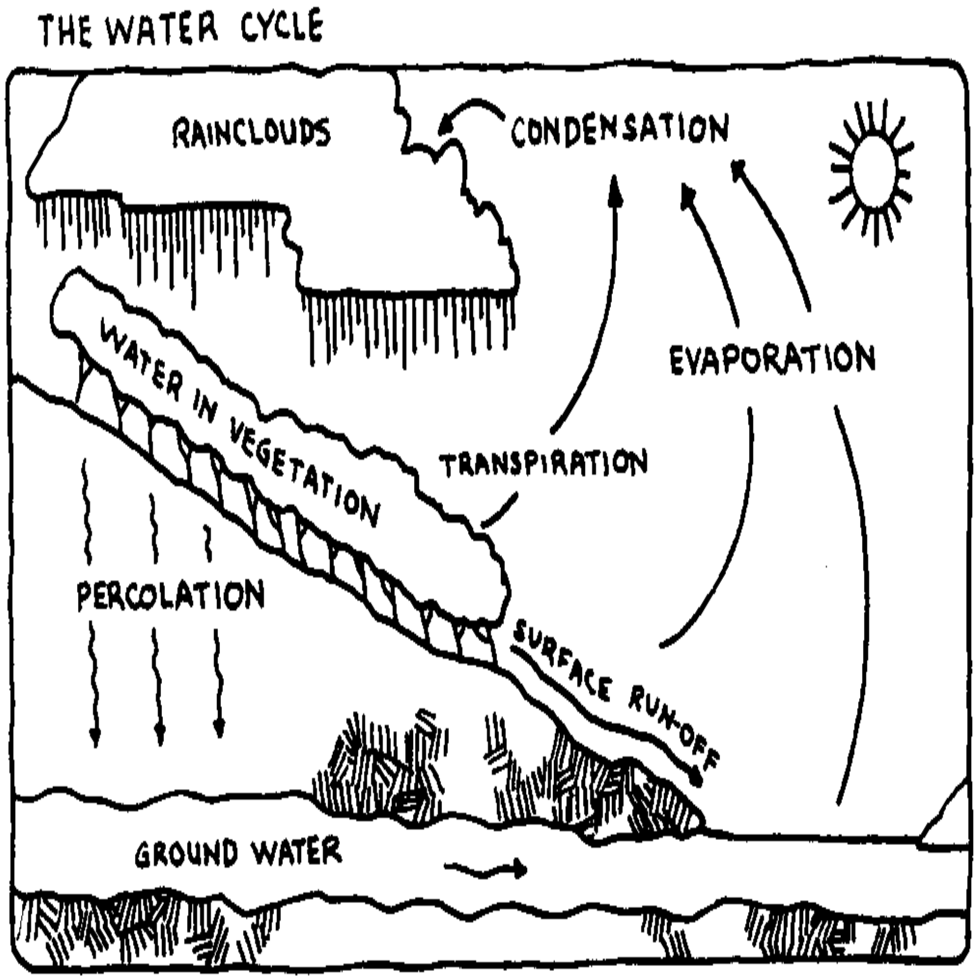

THE NITROGEN CYCLE

Nitrogen is an important nutrient. The following diagram shows the valuable role of soil bacteria in the nitrogen cycle. Interruption of the nitrogen cycle may occur when bare soils are exposed to heavy rainfall and when animal wastes are not returned to the land. Accumulation of nitrates (a form of nitrogen) can also occur, especially in areas with little rainfall or during drought. High nitrate levels in feed can poison sensitive animals, such as cattle or pigs.

<FIGURE>

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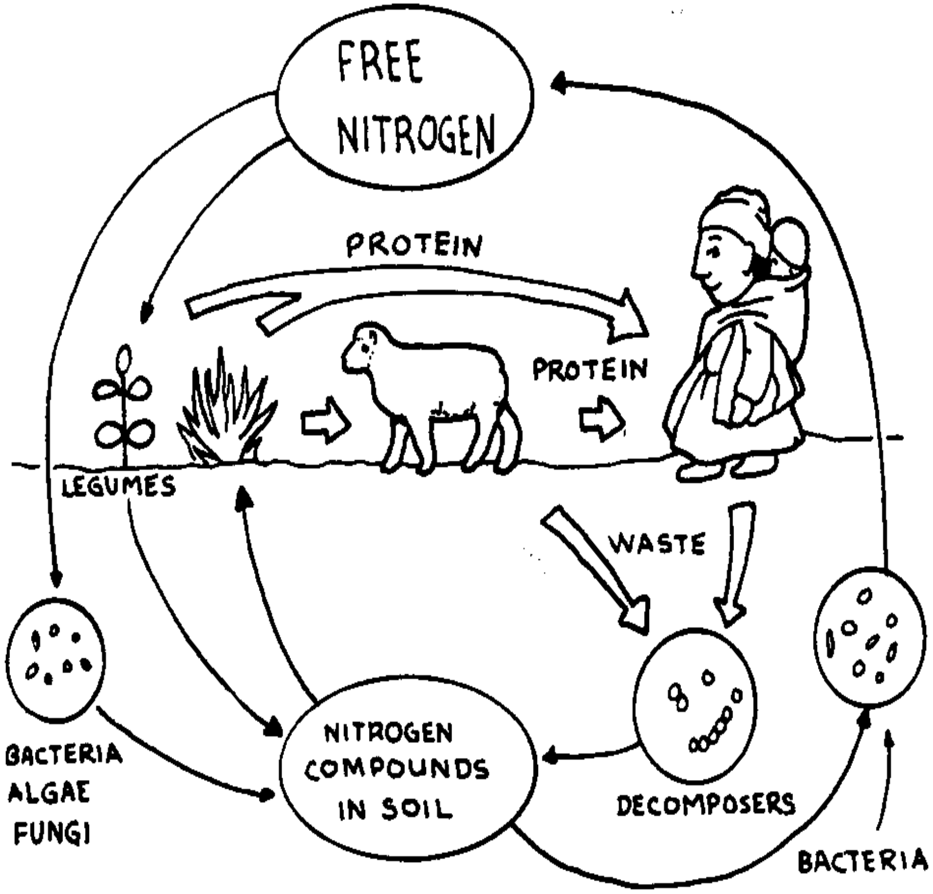

THE NITROGEN CYCLE

Knowledge of the various cycles of nutrients helps us to realize the importance of soils in the total ecosystem and the effect that interruption of these cycles might have. It emphasizes the interrelationships of water, soils, bacteria, plants, and animals.

SOIL STRUCTURE AND COMPOSITION

About 51% of tropical soils are highly leached. Leaching is a process in which water moving through soil carries away substances that can be dissolved. Often these nutrients later show up in rivers, streams, and ground water.

In areas where rainfall is heavy, abundant vegetation reduces the amount of leaching that occurs and consequently the amount of nutrients lost. Under conditions of high heat and humidity, plant litter such as leaves and rotted branches decompose rapidly. The vegetative cover quickly recycles the nutrients released to prevent loss. Therefore, in the humid tropics, most of the nutrients will be found in this vegetative cover, not in the soil surface as is common in temperate regions. Without a vegetative cover, these nutrients are washed from the soil during heavy rainfall, resulting in a yearly decrease in productivity.

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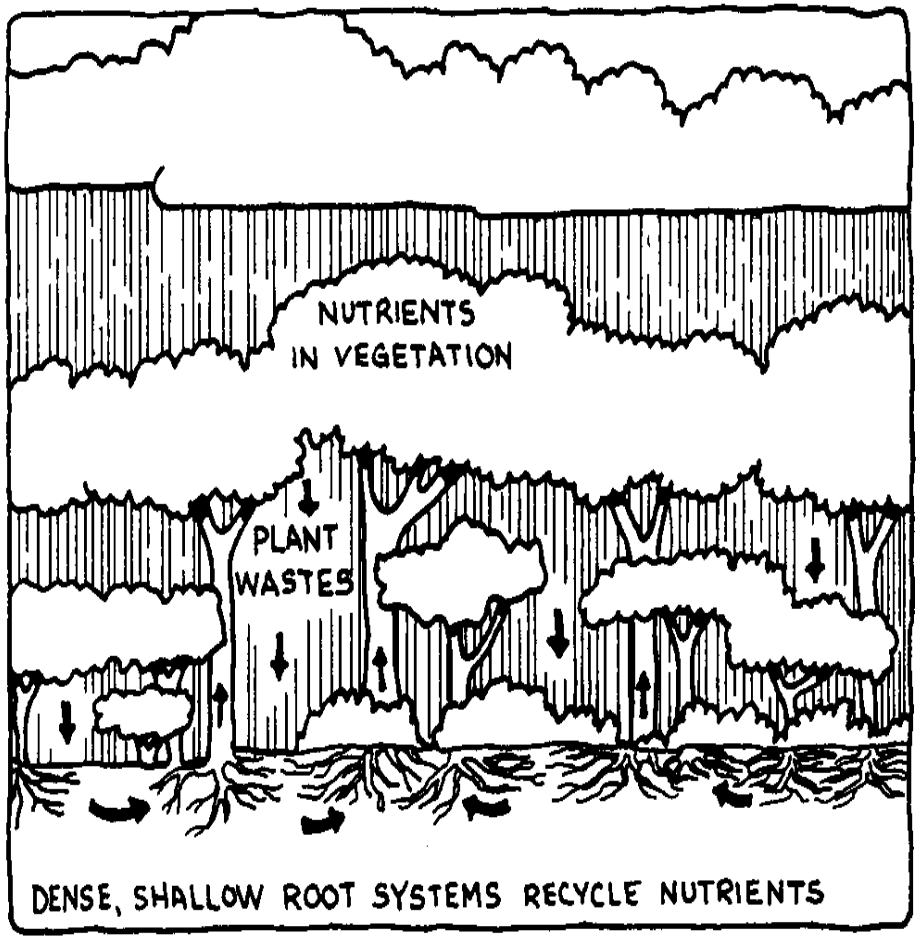

The fertility of the rain forest is, therefore, tied to the vegetative canopy. Slash and burn agriculture has been able to continue in this environment because the rain forest was allowed to quickly regenerate and such agriculture was not practiced over extensive regions. Recent failures in this system are blamed on shortening periods between reuse of forest areas as a result of population pressures. The ecosystem

is unable to return to its former balance when the ability of the forest to regenerate is threatened by decreases in fertility, extensive changes in plant species composition, and changes in soil structure.

In dry soils, a process almost the opposite of leaching occurs. Water is drawn-up through the layers of the soil by evaporation at the surface. As a result, calcium carbonate and other minerals are deposited at the soil surface and the soil becomes alkaline. Plant growth is limited to those plants that can tolerate high concentrations of various minerals and salts. The plant growth is further limited by the lack of water, not nutrients.

<FIGURE>

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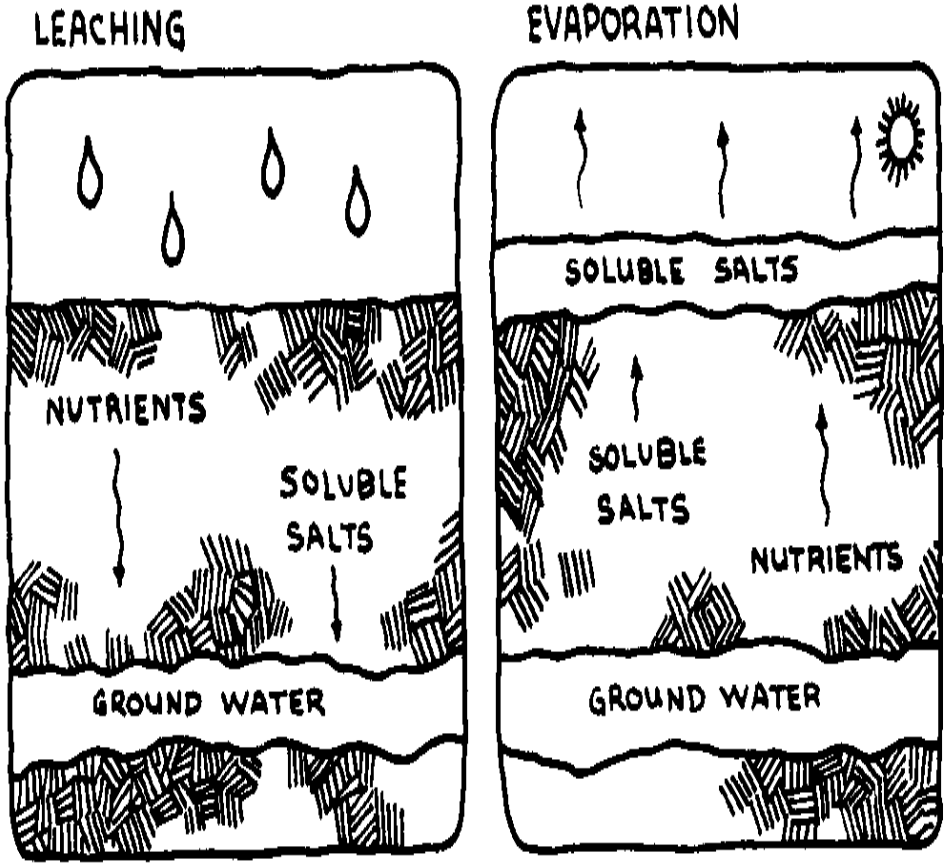

Laterization is a process that occurs in some tropical soils in parts of Asia and Central and South America, where heat and heavy rainfall can turn soil to a hard bricklike surface. Soils that are susceptible to laterization are high in iron and aluminum. The rains wash silica out of the soil and the soil surface becomes compacted. This condition is accelerated when forest canopies are removed and can result in an irreversible reduction in the total growth potential of the ecosystem.

Because soils are formed from the rocks in the surrounding areas, the mineral content of soils is affected by the mineral content of the rock. In some tropical areas, soils are low in minerals such as calcium and phosphate. As a result, the vegetation in these regions is also low in these compounds. Animals eating feeds deficient in certain minerals will develop disease symptoms that can be alleviated only by supplementation of the needed minerals.

Animals that do not have enough phosphorus in their diet will chew bones, wood, soil, and rotten flesh. They will lose their appetite and have weak bones, stiff joints, and reproductive problems. Animals with low amounts of calcium in their ration break their bones easily and give less milk.

Iron, cobalt, and copper are related in the functions they perform in the body, and feed deficiencies in these substances produce similar symptoms. Animals become anemic and grow thin. When sheep diets are deficient in copper, newly born lambs are unable to stand up and nurse.

ANIMAL FEED REQUIREMENTS

As illustrated in the nutrient cycles, animals are dependent on plants and the soil for the compounds they need for growth, maintenance, and reproduction. Animals need carbohydrates, protein, fat, vitamins, minerals, and water. The quantities needed may vary, for example:

* An animal may be able to make certain compounds within its own body.

* A young animal needs additional nutrients because it is growing and building bone and tissue.

* A pregnant animal needs additional nutrients for her growing young.

* Milking animals need more calcium and water.

* Different daily habits may create a difference in feed requirements. The active or nervous animal will use more food energy in daily activities.

When resources become scarce, the ability of an animal to grow and reproduce with the least amount of feed intake becomes important. An animal that eats a kilogram of grain will not produce a kilogram of meat, because not all of the feed will be digested. About one half of the nutrients digested are used for maintenance. The food is used to maintain body temperature, repair tissue, and replace water and minerals lost through excretion.

In one study in a temperate environment, calorie and protein production of various farm animals were compared with the amount of feed consumed. Pigs and dairy animals, such as milk cows and goats, were shown to be the most efficient. Next came chickens and turkeys and last were beef cattle and sheep. This estimate did not take into account various byproducts such as wool. The results of such studies would, of course, vary with local conditions.

FEED MANAGEMENT

Animals may range for their own food or have their food brought to them. When grazing, given abundant and varied forage, animals are able to select the food they need. If fencing of pastures is feasible, the daily work of herding can be reduced.

Where herding or fenced pastures are not satisfactory, animals can be kept in pens and will have their food brought to them. Such a management system, called zero grazing, has proved to be economically rewarding for dairy farmers close to markets in Africa. The manager of a confinement system can make use of crop wastes that could not be grazed, can reduce fencing needs, and can gather manure more easily. In addition, the farmer can locate animals close to crops to ease feeding and fertilizing chores.

A feed management system also can be adapted to seasonal growth. For example, hay and other crop residues can be cut and stored as hay or silage and used during periods of severe drought.

Livestock nutrition is affected by the timing of use of forage. Grasses and other forage crops have different growth cycles, depending on their reaction to temperature, moisture, and sunlight. The nutrient value of forage changes as it grows and matures. Green, rapidly-growing vegetation is high in nutritive value, especially protein. As grasses mature, protein and phosphorus content decreases as the amount of carbohydrates increase. Older plants also have more fiber and are less digestible. They also will have less vitamins. Thus, animals will benefit most if plants are grazed or harvested when their nutrient content is high.

KINDS OF FEED AND FORAGE

Soils that lack nitrogen produce vegetation that is slow-growing and also lacking in nitrogen. To improve the soil and provide additional forage that is high in nutrients, the planting of legumes is recommended. Legume plants are members of the pea family and have nodules on their roots that contain bacteria. These bacteria use energy obtained from carbohydrates of the host plant to fix nitrogen from the air and form ammonia. This process is known as nitrogen fixation. The bacteria use the ammonia to make protein. Any excess ammonia produced is used by the the host plant. Death of these bacteria also frees the nitrogen compounds to be used by plants.

<FIGURE>

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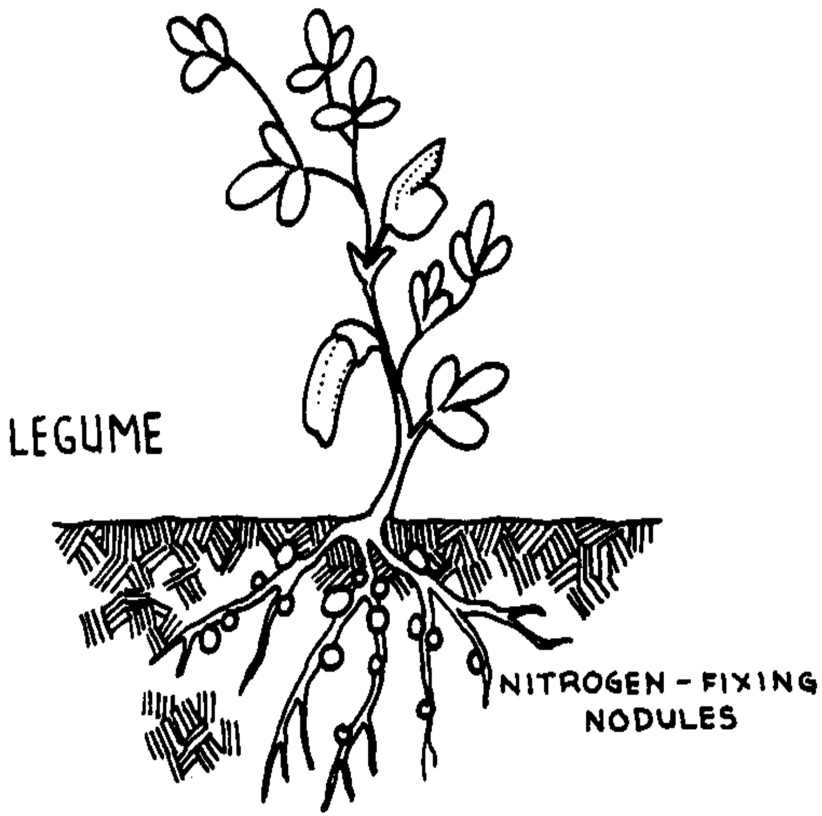

Many legumes are now being used in farming systems. For example, pigeon pea is a short-lived perennial that grows well in subhumid regions with long dry seasons; the cluster bean, or guar, is a bushy annual that does well in sandy soils at high temperatures; and the hyacinth bean, or lablab, requires good drainage, but tolerates poor soils.

Other legumes used for forage include the jack bean, rice bean, velvet bean, and winged bean. Peanut leaves and stems are an excellent protein feed for horses and ruminants.

Because of the nitrogen-fixing bacteria, legumes are not dependent on soil or fertilizer to meet their high nitrogen requirements. Legumes also have a high requirement for minerals, phosphorus, and various trace elements. Adding manures to correct these deficiencies is often recommended.

The value of the manure in this case is not in supplying nitrogen, but in supplying the phosphorus and other trace elements such as calcium, magnesium, and sulfur. If chemical fertilizers are to be used, additional analysis of crop needs is recommended, because of the absence of trace elements in most standard fertilizer formulas.

Legumes are excellent feeds for ruminants and often are used in swine and poultry rations as a protein source. Certain legumes, such as peas and beans, are suitable human foods, and their vines can provide feed for livestock, while the roots improve the soil.

Shrubs and trees can also provide food for livestock. The leaves and fruit of woody plants are especially important food sources during the dry season when other plants are dormant.

Crop residues that may be fed to livestock include cereal grain, straw, sugarcane stalks, and excess garden produce. Most of these are considered roughages, because they are low in protein and usually high in fiber. They will maintain mature animals, but usually are not adequate as the only feed for growing or working animals. Such feeds should be supplemented with foods rich in carbohydrates, protein, and phosphorus.

Feeds that are low in fiber and high in nutrients include grains, roots, tubers, and fruits. Roots are high in carbohydrates. Grains are high in protein. Soybeans, peanuts, beans, and peas also contain digestible fats, as well as protein. Other supplements that may improve nutrition are calcium and vitamins, especially B vitamins.

To keep costs low, the livestock manager should use locally available supplemental feeds. In addition to the feeds with high nutritive content mentioned above, other possibilities include dried citrus pulp, dried seaweed, and the byproducts of sugar manufacturing.

Some problems are the result of mineral deficiencies in feed. In Colombia, 50% or more of cattle loss in the plains region may be due to mineral deficiencies. Commercially available mineral mixes lack important minor elements. Furthermore, the commercial mill could not produce economically the variety of mineral mixes that would be necessary to adjust to the variable nature of the local soils. In experiments that provided minerals in separate boxes on a free-choice basis, the findings showed wide variation in amounts of minerals consumed from the dry to the wet season. Assuming that livestock are able to recognize their own mineral needs, such experiments could be used to determine feed deficiencies and mineral needs at specific locations.

FEED CONTAMINATION

If feed must be purchased from a mill, livestock managers should get reliable information about or visit the mill to find out how the feed is mixed and what safety precautions are taken.

The importance of such precautions is illustrated by a disastrous event in the United States of America, where, in 1973, a feed mill in Michigan accidentally mixed into animal rations several hundred pounds of polybrominated biphenyls (PBBs), a highly toxic chemical normally used as a flame retardant. Tons of this contaminated feed were distributed and as a result 30,000 cattle, 2 million chickens, and thousands of sheep and pigs died or had to be destroyed. The PBBs also contaminated the animal manure which polluted soils, rivers, and lakes. According to studies reported in 1977, all Michigan residents tested had excessive levels of PBBs in their body tissue. This catastrophe underlines the effect that one mistake at a feed mill can have on an entire region.

In a rural environment, introduced compounds, such as chlorinated hydrocarbons, stay in the farming system or may be washed into adjoining lakes and rivers. These compounds can be passed from one organism to another through all the links in the food chain. For example, if a crop is dusted with such an insecticide, and grain from that crop is fed to chickens, the eggs laid by these chickens may contain that chemical. In the body, the compound may be stored in fat tissue and also in the liver and kidneys where it may become concentrated. Thus, ingestion of small amounts of chlorinated hydrocarbons can build up to lethal quantities in living tissue. Such compounds in the body freely cross the placenta to the fetus, which has less resistance to the poisons. Chlorinated hydrocarbons can become concentrated at the highest levels in animals that are at the end of the food chain.

<FIGURE>

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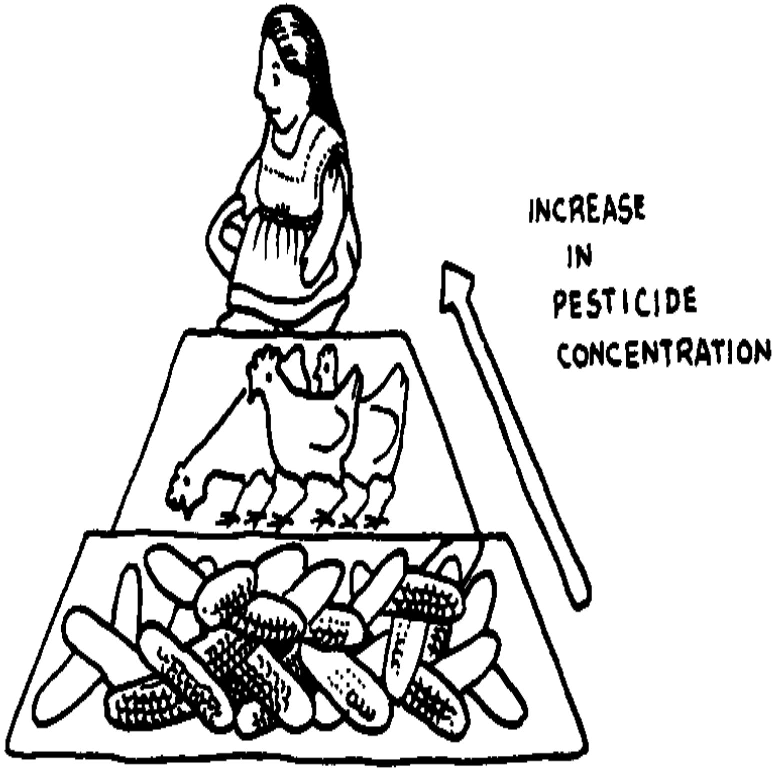

Potential for contamination of feed for animals and animal products has become greater as the use of pesticides expands. Public awareness of these potential effects can be developed through sophisticated testing and methods of communication. All agriculturalists and others who might inadvertently cause food or soil contamination must depend on each other to practice safe methods of handling potentially dangerous substances.

When examples of food contamination are made public, evidence from recent incidents suggests that:

* All producers in the area may be immediately suspected of having contaminated products.

* The market for all related products may drop. Crops must be left in the field to rot and(or) milk must be poured out upon the ground.
* If producers have used contaminated feeds, yet claim to have used a substance properly, their honesty and ability as farmers may be questioned.
* Governmental agencies responsible for notifying producers and consumers may not release information to protect the agricultural sector.
* The public may become concerned about a cover-up and will lose faith in both farmers and government officials.

All farmers should be concerned that others engaged in agriculture or that have the potential to affect agriculture in the region are conscious of how their actions may affect the environment, including the people in the area.

PASTURE AND RANGE MANAGEMENT

Pastures usually are located in areas of medium to high rainfall where conditions for grass growth are favorable. If pasture areas are not extensive, practices such as the planting of improved grasses and hand removal of brush may be useful.

Ranges include a wide variety of habitats, such as desert scrub, savannahs, and woodlands. These various habitats are the result of differing amounts of rainfall and other weather and soil factors. In extensive rangelands, mechanical ways of managing forage are less practical. Therefore, when livestock managers study rangeland ecosystems, they must concentrate more on environmental interactions to find ways to manage forage.

Grasses and other plants that make up the forage floor of pastures and rangelands can be perennial or annual. That is, they may survive from season to season or they may grow from seed each year. Grasses that dominate many types of climax vegetation are perennial. Annuals are common in areas where the climax vegetation has been removed.

Where rainfall supports the growth of shrubs and trees, grasslands can be developed by removing the forest canopy and planting grasses. Because shrubs and trees will quickly reinvade these man-made grasslands, management must focus on the prevention of shrub and tree regrowth. If brush removal is difficult in such areas, animals that can make use of browse are often included in the livestock system.

Desertification is a term used to describe a process through which lands in many parts of the world are becoming deserts. In this process the long-term productivity of the land is degraded by natural events or human abuse. There is a major debate about the extent to which desertification is caused by natural events or human abuse.

Weather experts have pointed out the cyclical nature of droughts; that is, that droughts come and go, and, in drought-prone lands, one can alway expect a reoccurrence of the cycle. The problem is that no one has been able to predict accurately the time of arrival of a drought, nor has anyone been able to predict when a drought will be over. Therefore, one argument is that the present trend of desertification may be reversed at any time as climatic conditions change.

On the other hand, the United Nations Conference on Desertification cited mismanagement of the land as the cause of the environmental deterioration known as desertification. The consensus was that abuse renders the land more vulnerable to a drought and the drought precipitates more abuse of the land.

Accordingly, proponents of this view say that the process of desertification has been hastened by human activities and overgrazing. First, the land is cleared of trees. As the vegetation disappears, there is less water loss from leaves and the humidity drops. The land is invaded by grasses. Then these grasslands are grazed to the roots. The last scrub trees are cut for firewood. Topsoil is blown away, and rain and cloud patterns are altered. Organic litter no longer accumulates; topsoil is washed away. The land becomes part of the expanding desert.

No matter what is the outcome of these arguments, planners in areas endangered by desertification should focus on practices that:

* Increase the amount of plants and plant residues left each grazing season.
* Increase soil moisture levels.

* Encourage preservation of brush and tree species.

ENVIRONMENTAL GUIDELINES

Because of the complex biological interactions in a pasture or range system and the difficulty of generalizing from one ecosystem to another, the environmental guidelines suggested here are outlined broadly, with brief explanations of why these guidelines should be considered.

* Combine livestock species to maximize forage productivity. Animals tend to overgraze favored areas and plants and to neglect others. Those plants that are not grazed will continue to be avoided in subsequent years. As these plants mature, they lose vigor and the dead material reduces their nutritional value. If various livestock breeds are combined or alternated on a range, their differing food preferences can help the process of keeping plants productive.

*** Make superior forage available to animals with the highest needs.**
When forage is limited, livestock handlers may decide that producing and young animals must have first access to new pastures and range with a wide variety of abundant forage. Fencing modifications may be made that allow young stock access to special feeding areas in adjacent fields. Such management methods may reduce or eliminate the need for costly supplements.

*** Investigate the value of various rotational systems.**
Livestock may be grazed continually on a pasture throughout the year. This method does not require extensive fencing, but may cause increased disease build-up and may not take best advantage of seasonal variations in plant growth or provide rest periods from grazing pressure for the land.

To reduce disease build-up and to vary grazing pressures, livestock can be rotated between fields or ranges. They can be moved into crop lands to clean up residues either by fencing or herding. Rotations can be planned on a daily, weekly, or seasonal basis, according to forage production and crop cycles.

There are some studies that suggest, however, that a set stocking system may be as good as a rotational system, as long as the number of livestock is gradually

adjusted to pasture production. One of the major justifications for pasture rotation is that it breaks the life cycle of disease organisms. If the disease organism remains infective in the soil (beyond the rotational period), then this method of livestock handling will not reduce the incidence of the disease.

* Prevent degradation of the range from overgrazing. With heavy grazing of livestock, native plants may not survive. New species whose seeds are brought in, for example, on the hooves of livestock, quickly occupy the place of the native plants. Even when grazing pressure is reduced, the alien species may retain their dominance. These new species may not be eaten readily by livestock.

With heavy grazing, soils become exposed to rain and wind, resulting in massive erosion of topsoils. During the dry seasons, winds blow the top soil until it collects in loose piles. Heavy rainfall at the beginning of the wet season carries the loose soil away.

* Time pasture and range use to minimize soil compaction. Considerable compaction of soil can result when herds are grazing soil that is moist. One result of compacted soils is decreased absorption of water into the soil. As a result, more run-off occurs during rainfall. On the other hand, hoof action can break up dry,

crusted soil, trample mature vegetation, and help work seed into the ground. Timing of the use of range or pasture can therefore have negative or positive effects.

* Adjust herd or flock sizes to forage availability. A herd of 100 cattle might travel 34 kilometers per day in grazing to obtain sufficient forage. Under the same forage conditions, a herd of ten cattle might graze for a distance of only six kilometers. The larger herd would have to graze further because of competition within the herd for forage. Therefore, when forage is poor and herds must walk long distances in search of forage, it may be better to have smaller herds. This would reduce the amount of forage used just for maintenance.

* Understand the use of fire as a management tool. Fire can be used to remove woody growth and mature vegetation. Burning removes the ground litter that normally slows growth of certain types of plants. The nutrients in the ash are another reason for increased plant production following a burn. Research findings indicate that for a year or two, the total biomass on recently burned prairie can exceed the biomass of the unburned prairie. Even if total prevention of grassland fires were desired, it would be difficult, because as dry litter builds up, the probability of a natural fire increases.

* Use labor- or money-intensive methods of forage improvement, if the benefit will justify the cost. If a forage area is severely damaged, the manager may try to improve the land by cultivating the soil, fertilizing, reseeding desirable plant species, filling in gullies, and building dams. Various types of brush removal may be tried. Improved strains of grass can be introduced. Such grasses, however, may require better soils or more fertilization. They may not be well-adapted to the region, resulting in negligible increases in production as compared with the costs involved in weeding. When high-cost methods are involved, weigh the cost against the possible benefit.

* Look for ways to monitor production that will give immediate information on forage condition. For example, milk production is easily measured and may be used to some degree as an indicator of forage quality in the absence of more sophisticated methods. Meat or wool production would not give such an immediate result for feedback; nevertheless, wool production is used by herders in the Andes of South America to determine stocking rates of alpaca on dry season pastures.

* Investigate patterns of ownership of water resources and how changes of ownership can affect forage use. For example, the control of water or critical grazing

lands in dry areas by indiviuals or groups of individuals may be the deciding factor that limits livestock populations and keeps livestock herds from exceeding forage availability. The provision of a publicly owned well may eliminate this limitation on the number of livestock and thus result in an increase in livestock beyond the local grazing capacity.

*** Find management practices that will be effective under local land ownership patterns.**
When land is held in common, management practices must be accepted by a group of people before they are effective. Thus, social and political factors as well as technical factors must be considered. For example, if one herder decides to reduce his flock because of overgrazing and yet other herds grazing on the same land are increased, the individual herder will receive no benefits. Even with such difficulties, however, individual ownership of land often is resisted by herders whose animals must cover extensive range, and who vary their travels according to the seasonal availability of forage and water. Management under such conditions requires joint agreements among the livestock managers involved.

PLANNING QUESTIONS

*** What types of vegetation, including grasses, grow in the area?**

*** What kind of soil does this vegetation indicate (clay, sand, loam)? Are there deficiencies in the soil indicated that might affect the needs of livestock?**

*** Are soils threatened by erosion caused by water or wind? Would livestock expansion increase the possibility of such erosion?**

*** Are steep slopes used for crops or pasture? Will a livestock project affect the ground cover on such slopes?**

*** What rainfall and other climatic patterns may affect livestock?**

*** What natural and man-made disturbances of plant growth such as range fires, wood gathering, or crop production may affect livestock production?**

*** Could more use be made of local vegetation for livestock without danger of overgrazing?**

*** Are there biological changes taking place that are directly related to current livestock numbers?**

*** Are some nutrients being recycled back to the soil?**

*** What effect will pasture clearing have on soil structure,**

wild populations, and community balance?

* Are there plants in the area that are indicators of overgrazing?

* Will the use of purchased feed or concentrates be practical or environmentally sound? Are they affordable?

* What improved strains of forage plants have been used with success under similar conditions?

Chapter VI

MANAGEMENT OF WASTES AND NUTRIENTS

Animal wastes help maintain soil fertility; they contain organic materials that are broken down by decomposers to provide nutrients for plant growth. Manure increases the amount of the soil humus, a complex organic material that slowly decomposes and releases nutrients for plant growth. Humus increases the capacity of the soil to hold water, and helps keep nutrients in the top levels of the soil, where they will be available for plant growth. Humus also makes soil more resistant to wind action.

COMPOSITION OF MANURE

The nutrient content of manure depends upon the type of feed given and the amount of water consumed by the animal. In addition, the composition of the manure depends upon the nutrient requirements of the individual animal. For example, a growing animal will use more of the nutrients in its feed than does a mature animal. Consequently, its manure will be lower in these nutrients. An animal having to forage on nutrient-poor land would have lower nutrient levels in its manure than would the same animal fed with nutrient supplements. The livestock manager who provides feed supplements for his herd will be compensated, in part, by a higher nutrient level in animal manure. If this manure is returned to the land without substantial loss of nutrients, higher soil fertility should result. Such feeding methods, however, should not be looked upon as a substitute for management practices that will directly improve soil fertility.

Manure is also valued for its content of nitrogen, phosphorus, and potassium. When judged by the amount of these nutrients, chicken manure has the highest value, followed in descending order by goat and sheep manure, cattle manure, and pig manure. Because goat, sheep, and horse manure contain less water, they heat up easily when decomposing and are often called "hot" manures.

Animal manures do not have an ideal balance of nitrogen, phosphorus, and potassium, because they are low in phosphorus. Thus, additional phosphate is often used to increase fertility of soils that have been fertilized with animal manures. Manure releases nutrients more slowly than does commercial fertilizer so fewer nutrients are leached from the soil surface during rainstorms.

BEDDING

Much of the valuable nutrient content is excreted as liquid animal wastes. Bedding such as straw, sawdust, or peanut shells keeps animals clean and dry, because it absorbs liquid wastes. The bedding also adds to the amount of organic matter in the wastes. Usually, bedding alone is low in nutrients, but the organic matter in the bedding makes an excellent soil additive when combined with the nutrients in the urine and manure.

<FIGURE>

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NUTRIENT CONTENT OF MANURE

	% NITROGEN	% PHOSPHATE
	2.4	1.4
	1.1	.8
	.7	.3
	.7	.3
	.6	1.4
	.6	.2
	.5	.3

RECYCLING NUTRIENTS

Manure has its highest nutrient levels when fresh and nutrients are lost if manure is poorly handled before it is returned to the soil. Losses are least when manure is returned daily to the soil and plowed under.

If heavy rains should fall right after manure has been spread on the soil, nutrients that are not absorbed in the

soil will wash away. For best results, manure should be spread during periods of light and intermittent rain that can soak the manure into the soil where the nutrients can be used by growing plants.

Manure applications are more effective when the manure is spread thinly over a greater area, rather than when concentrated in a small area. This reduces the time between applications in a given area and increases the total recycling capability of nutrients.

Manure is best spread early in the morning when air is still and(or) when the wind is blowing away from settlements. Low-lying areas where water stands should be avoided.

MANURE AS A POLLUTANT

Manure can be a health hazard for humans and other animals if the manure contains disease organisms or if the manure is allowed to contaminate ground water or other water sources. It should not be applied to ground within 30 meters of a water source.

<FIGURE>

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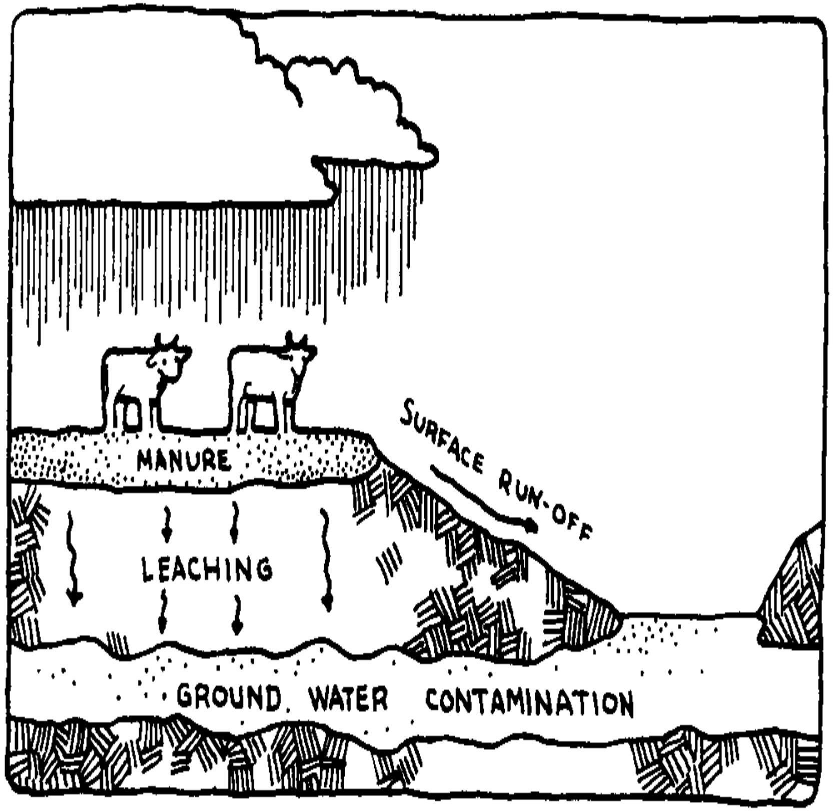

Nitrates (chemical compounds of nitrogen) that enter the body in water or food are changed to nitrites (a different compound) by bacteria in the stomach. These nitrites can be absorbed into the bloodstream. The nitrites combine with hemoglobin in the blood and reduce the blood's ability to carry oxygen, a condition of nitrite poisoning known as methemoglobinemia. Symptoms of nitrite poisoning include fatigue, weakness, rapid heart beat, headaches and dizziness. Cattle, young animals, and children are especially

sensitive to high concentrations of nitrates in drinking water.

In lakes and streams, large amounts of nutrients such as nitrogen and phosphate stimulate the growth of aquatic plants and algae, a process known as eutrophication. The algae form a scum on the water surface. As these large algae blooms die off, the decaying plants use up the dissolved oxygen in the water, harming fish and other aquatic life.

To avoid waste contamination of water supplies and eutrophication of lakes and streams, animal pens and manure piles must be located away from water sources and slopes that lead directly into these water sources. Also, animals should not be penned in high concentrations where there is danger of nitrates and other substances moving through the soil structure and into ground water.

MANURE STORAGE

If manure is not spread immediately, it must be stored in a way that will prevent the loss of nutrients. If possible, a manure pile should be located on a solid surface and be protected from rain by a shed roof. It should be kept well-packed and damp. This helps prevent the formation of ammonia, a nitrogen compound that escapes from the manure as a gas and is a cause of odor. Manure of various animal species should be mixed, if possible.

Well-decayed manure may be better than fresh manure, especially when fresh manure is mixed with quantities of straw. If manure with straw is added immediately to the soil, a nitrogen shortage may occur, because the decomposing straw slows down the formation of nitrates.

COMPOSTING

Composting is a more complex method of building manure piles to receive the most benefit from the various materials added to the pile. In many countries, composting is a traditional method of manure treatment. Compost piles may be built with manure, straw, kitchen and garden wastes, leaves, weeds, seaweed and other organic matter. The planner should examine local methods, available materials and community attitudes.

<FIGURE>

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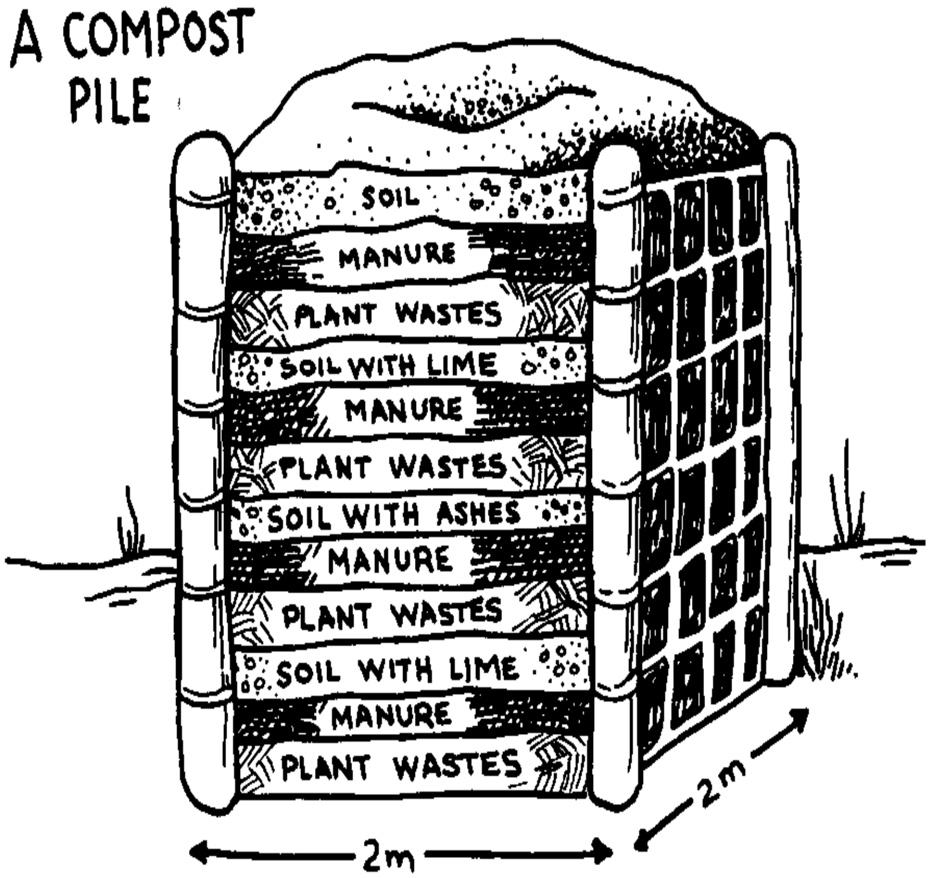

Composting uses waste materials and costs little or nothing, except the labor needed to gather the materials and turn the pile. If done correctly, it can reduce the risk of spreading disease organisms in manure. A well-built compost pile will reach temperatures up to 70 [degrees] C, which is sufficient to kill eggs, larvae, bacteria, and other disease-producing organisms.

Nitrogen is fixed by decomposers in the compost pile and

thus can be released slowly to plants. In contrast, the phosphorus and potash compounds in compost are more easily dissolved in water. They are therefore immediately available for plant growth, but they also may be leached from the soil during heavy rainfall.

The amount of nitrogen in the pile affects speed of composting and the temperature of the heap. The ratio of carbon to nitrogen also affects efficiency. Decomposing microorganisms work best at a carbon/nitrogen ratio of 30-to-1. Each of the ingredients in the compost pile contains given amounts of carbon and(or) nitrogen. Once that is determined the ratio can be achieved by varying the relative amounts of the ingredients. For example, sawdust has a ratio of 511-to-1, and some manures a ratio of 14-to-1. Goat, sheep, and horse manures -- the "hot" manures -- will heat up a compost pile faster than will pig or cow manure which have a different carbon/nitrogen ratio.

The heap should be large enough to allow materials to heat up, and should be kept moist. A 2-meter square heap should be adequate. Larger heaps can be built if sufficient manure and labor are available. The pile is usually built with layers of plant wastes and manure alternated with soil to which lime or wood ash is added. Once decomposition has begun, compost heaps are turned in order to mix in materials from the edges and to supply air to the microorganisms.

Sheet composting is a method of composting on the soil surface. First, plowed fields are left until weed seedlings have germinated and have grown to about ten centimeters in height. The young plant growth is spread with manure and sawdust or other organic material. These materials are plowed into the soil. Initially, there is a nitrogen shortage as bacteria break down the organic material. If the type of crop to be planted in the field will have an immediate need for nitrogen, the sawdust is spread on the surface after manure is plowed under or as a mulch around young plants.

MANURE MIXED IN WATER

Manure is sometimes mixed in water to form a slurry before field application. A manure slurry will increase immediate absorption of nutrients by plants. With applications of large quantities there are problems with surface runoff. The slurry may block soil pores, reduce aeration, and thus reduce the nitrification process.

BIOGAS DIGESTERS

Animal wastes can be used to generate biogas, a mixture of methane and other gases formed from the decomposition of organic matter. Like other gas fuels, biogas can be used for cooking, lighting, and running small engines.

In some parts of the world, users of biogas have found that labor requirements and construction costs may outweigh the benefits of biogas production. They feel that other uses of manure would be more suitable. However, biogas production has been given major emphasis in China, where seven million biogas plants were in place in 1981. This biogas is used to run engines, pump water, irrigate, husk rice, mill flour, thresh rice, and generate electricity.

The feasibility of biogas generation depends on the quantity of organic material available, the alternative demands for these materials, the other energy sources and their costs, and the economics of day-to-day management of the digester. Feasibility also depends on the labor available for construction and operation, as well as the technology used in construction.

A biogas digester is a container that holds a slurry of organic material and captures the gases produced as bacteria digests the nutrients in the slurry. Types of structures that can serve as digesters include clay pits, inner tubes, fifty-five gallon drums, plastic bags, giant steel tanks, and waste dumps covered with plastic.

Biogas digesters produce a usable form of energy for lighting, cooking and heating, as well as a high-quality fertilizer that contains nutrients (such as nitrogen) in a more stable form than those in raw manure. The smell and the amount of disease-producing organisms are reduced in this form. The recycling of nutrients can be the most important aspect of the process.

The quantity of gas produced and the size of a digester depend on how much organic material is available for the slurry. The total daily amount of manure excreted by two or three well-fed pigs can produce enough gas to cook one meal. The manure from ten cows could produce enough to cook five meals, or run a biogas lamp and cook several meals each day.

The larger the system, the greater the planning needed, and the greater the expense. The physical handling of the organic material causes the most problems. If the material is too coarse, gas lines become clogged or the scum floating on top of the slurry prohibits gas from escaping. The best slurry is well mixed with solid particles small enough to remain suspended in the creamy mixture.

In assessing the quantity and quality of waste organic matter, close attention must be paid to the ratio of carbon to nitrogen in the slurry. A mixture of 25-to-1 is best for biogas production. Any additional carbon would begin to adversely affect the process of digestion; however, less carbon (for example, a ratio of 5-to-1 or 10-to-1) would still function. The ratio is usually adjusted by adding small amounts of well-chopped vegetable matter to a manure slurry. Temperature should be maintained at about 35 [degrees] C, although several types of methanogenic bacteria work at temperatures higher and lower than this. In warm areas it is easy to keep the slurry warm. In colder areas the slurry

must be insulated and heated by burning a portion of the gas.

Small digesters include the batch type and the continuous-feed type. The batch type is useful for coarser types of organic material and requires less daily maintenance. Usually three batch digesters are necessary to maintain a continuous flow of gas. While one is producing, one is slowing down, and one is being loaded with new slurry. Daily agitation of a batch digester is necessary. In a continuous-feed digester, a small amount of slurry is mixed and added daily to the digester and an equal amount removed. Gas production is continuous. Cleaning the slurry tank is necessary only when inorganic solids fill the bottom with sediment and reduce the volume of active slurry.

<FIGURE>

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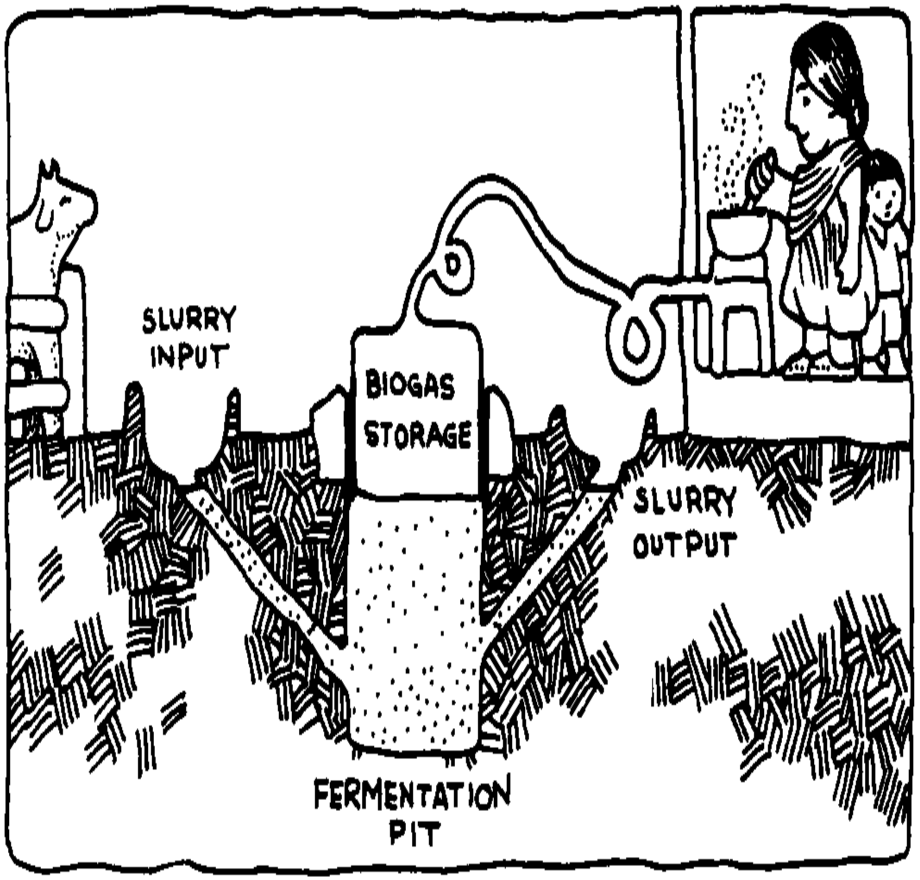

Just as farm animals are sensitive to temperature, nutrients, and toxins, so are the bacteria in the slurry tank. The success of a biogas digester depends on how the methanogenic bacteria are treated. Guidelines are difficult to establish that will apply to all situations. For example, a given animal eating different feeds will produce manure in different quantities and with varying amounts of nutrients. If chemicals are used to kill pests on cattle, they pass with the organic waste into the digester and kill the bacteria.

Mixed slurry will produce gas within a few days to a few weeks. The quality of the gas may not be high in methane at first. However, further experimentation and control of the temperature, texture, carbon-to-nitrogen ratio, and agitation of the slurry should produce a better quality gas. A word of caution: biogas with a concentration of 4% to 15% methane is highly explosive and can be a continuing danger caused by mismanaged digesters.

Study is needed on management of the exhausted slurry or sludge. If the exact content of the nutrients in the effluent is not known, tests should be made before endangering an entire crop. The land must be able to accept the slurry without becoming waterlogged. Continual application may increase the acidity of the soil, which can be counteracted by lime added to the soil. Sludge also can be discharged into lagoons to produce algae to feed back into digesters or to feed fish such as tilapia or carp.

The location of the digester needs to be carefully considered. To keep drinking water safe and ground water supplies unpolluted, digesters should be located at least 30 meters from wells or springs. If the tank is below the groundwater line, the bottom of the tank should be sealed to prevent seepage. Also, the digester should be away from flammable structures but close to the source of organic waste, the effluent use area, and the biogas use areas. Water needs to be readily available for diluting the slurry. Locating the digester far from the biogas-use area risks clogged gas lines and low pressure at the appliance.

PLANNING QUESTIONS

* What kind of manure is available? How much is produced daily?

* What are the traditional uses of manure? Are there alternative uses?

* What are community and family attitudes toward waste handling?

* How is manure handled traditionally? Are these methods responsible for disease problems in the area? Will alternative methods create health problems or aid in eliminating health problems?

* What are the day-to-day labor requirements for various possible waste handling systems?

* Will introduction of new kinds of livestock or change in livestock management practices require changes in manure management?

* Are sources of water being polluted as a result of contamination by manure?

* Do local practices of manure handling reduce the loss of nutrients by runoff, erosion, or leaching? What alternative management practices might be more effective?

* What organic wastes are available to use with manure to make compost or to run a biogas digester? What is the composition of those wastes?

* How can the design of the farm system reduce labor requirements for transfer of wastes?

Chapter VII

HEALTH AND HUSBANDRY

Animal health can be closely related to community health. Because many animal diseases also can infect human populations, the community attitude towards care of animals will have a direct effect on the total health of the community.

CAUSES OF DISEASE

Disease is a general term that indicates an abnormal condition or an absence of health. Disease can be caused by internal problems, such as faulty body processes, genetic defects, or aging. It can also be caused by environmental factors, such as scarcity of food, lack of specific nutrients, parasites, stress, and(or) accidents. Management of animal and environmental interactions to avoid disease is stressed here.

To maintain or restore health in an animal, disease processes must be understood. Knowledge of life cycles of disease-causing organisms such as bacteria, viruses, and various internal and external parasites may help prevent or reduce their contact with healthy livestock.

Knowing how a disease-causing organism enters and leaves the body of an animal and what other animals it infects will help determine methods of control. For example, the adult hookworm lives in the intestines of a host animal, where it feeds upon the host animal's blood. The female worms produce eggs that leave the body with the host's droppings. There they develop into larvae that can enter another host when the animal feeds on infected pastures. The larvae can also enter the body through the skin. Larvae that enter the skin get into the bloodstream and are carried to the heart and then the lungs. Here, they break through the cell wall into the air space. Passed up the windpipe, they are swallowed and pass to the large intestine where the cycle begins again. Breaking the cycle requires careful handling of manure and avoidance of infected pastures.

Of major importance to community health are those diseases that infect both animals and humans. The adult liver fluke lives in sheep and cattle. The sheep seed the soil or water with the eggs in their droppings. The larval form uses an alternate host, a snail, and eventually encysts on vegetation. Here they are reingested by animals, including humans. One control method for liver flukes is the reduction of the habitat of the intermediate host, the snail, by the drainage of low, wet pastures.

<FIGURE>

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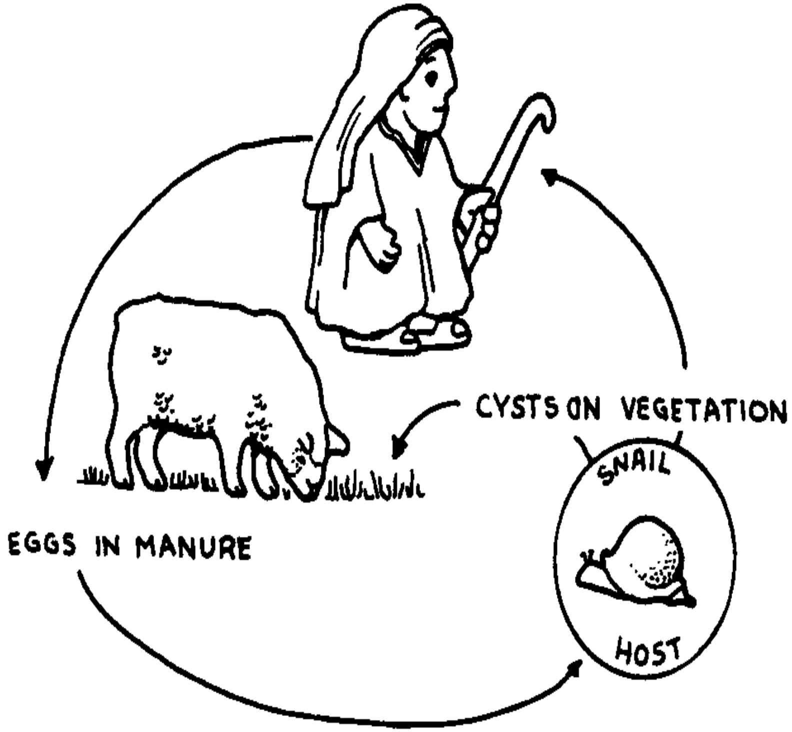

LIVER FLUKE LIFE CYCLE

DISEASE RESISTANCE

Different animal species may vary in their tolerance to a disease. For example, a specific strain of yellow fever may infect and multiply in a population of opossum with no apparent injury to the opossum, but, at the same time, that same strain may be fatal to a certain monkey species. Tolerance to a disease can develop over generations of exposure. For example, when a deadly disease spreads epidemically through an entire population, animals with no resistance die, but some of the surviving animals may have been protected by a hereditary variation that made them more resistant to the disease. Later generations of these animals may inherit this resistance and, in the future, the entire population may become more resistant to the disease. In a study of this concept, white leghorn chickens were injected with fowl typhoid. Only the most resistant animals were used for breeding and mortality rates from the disease were reduced by 90% by the fifth generation.

Animal breeders take advantage of this concept in selecting for disease resistance and developing strains within a breed that are resistant to a specific disease. Local animals that are resistant to disease also might be used in such breeding programs.

As breeding programs select for specific characteristics, the genetic variation between different animals in the population may be reduced. Such lack of genetic variability could reduce the genetic resistance to new diseases that might invade the population. When resistant strains are limited, the possibility of a major epidemic is increased; thus sound breeding programs maintain some measure of genetic variability.

As animal populations are being modified by deadly diseases, the disease organisms themselves may adapt their life processes for survival. A disease that kills an entire host population faces extinction itself. Through the process of evolution, a disease and its host population evolve to

survive. In this way, a usually fatal disease becomes less dangerous.
When animals are imported from other countries or regions, the balance between disease organisms and host populations can be upset and major fluctuations in animal populations might occur. For example, in Africa, imported cattle brought a viral disease called rinderpest. This disease invaded native animal herds, causing widespread death losses and continues to limit grazing on former rangeland. In contrast, pigs that were brought to Africa were extremely susceptible to African swine fever, a disease to which the native wild pigs had developed a tolerance.

When livestock management practices are designed to prevent the spread of disease to other areas, other animals do not require a resistance to the disease. However, continuous vigilance is necessary to prevent a disease from spreading to new areas. In the event of an outbreak, emergency clean-up operations can be costly. For example, when cases of African swine fever were discovered in Haiti, the entire native pig population was eliminated in an effort to halt the spread of the disease to other countries.

METHODS OF CONTROL

Common methods of disease control are quarantine, sanitation, vaccination and medication. Quarantine (isolation of animals) and sanitation (cleaning and disinfection of animal quarters) are both attempts to prevent the spread of

disease-producing organisms to healthy animals. Vaccination is an artificial method of developing disease resistance, whereas effective medication is a means to reduce symptoms or kill the disease organisms in the body.

<FIGURE>

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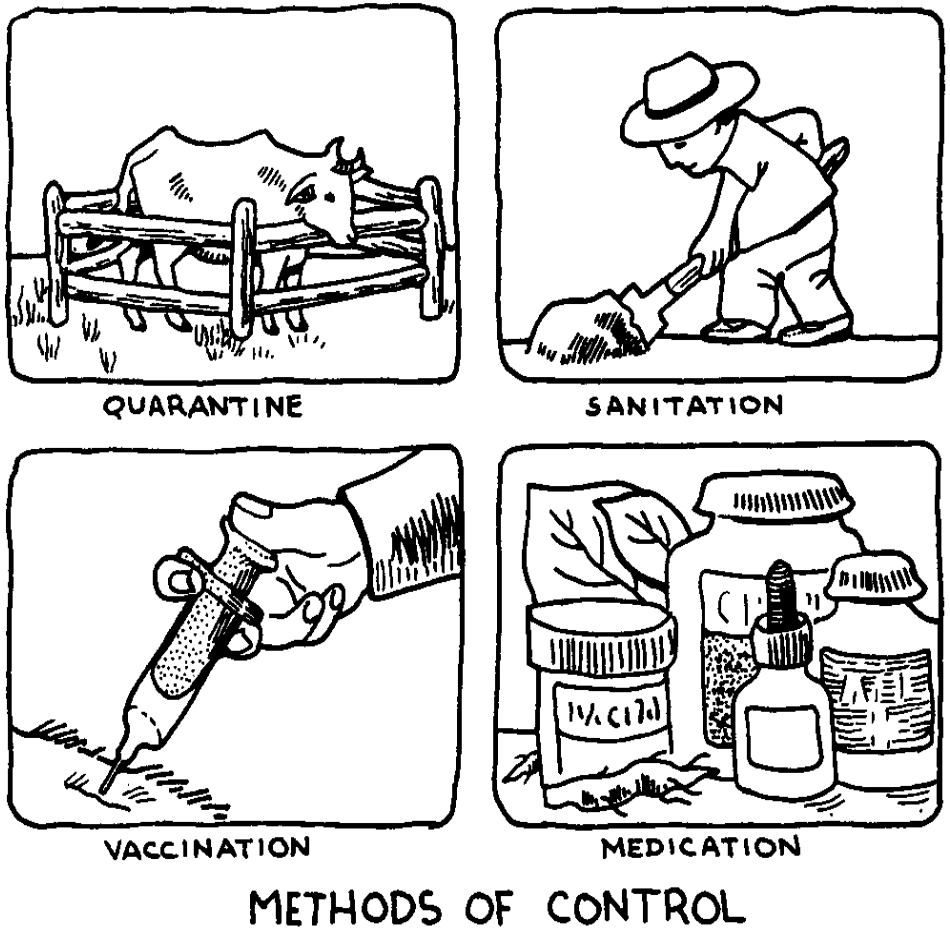

Quarantine and Sanitation

Animals should be placed in quarantine, that is, isolated from other animals, if they have an infectious disease. In addition, animals that have been imported or bought from neighboring farmers should be kept isolated from other animals for a time to ensure that no new diseases are

transmitted to farm livestock.

Sanitation is the most effective means for control of parasites, but medication may be used especially for severe infection. Parasites usually infect a whole herd or flock, thus control measures are effective only if used for the entire group. Sanitation methods break the disease organism's life cycle. Reinfection of animals in close confinement can be reduced by keeping housing free of accumulated droppings and, if necessary, using disinfectants.

Vaccination

When disease-producing organisms (such as bacteria and viruses) invade an animal, the animal's body attempts to find, neutralize, and ultimately destroy the organism. The body's white blood cells produce chemical substances called antibodies in response to specific foreign matter. The antibody coats the foreign substance or combines with it so that it cannot infect body cells. Because antibodies are specific to the foreign substance encountered, and remain in the bloodstream for varied lengths of time, an animal may acquire immunity to a disease by successfully surviving an attack. Vaccination is a way of artificially creating the immunity. A vaccine is usually a weakened or dead culture of the agent causing the disease. The vaccine stimulates the formation of the antibodies that will later be able to successfully prevent disease organisms from invading body cells. For these reasons, vaccines are not effective for animals that are already ill, and are effective only for diseases for which they have been developed.

Medication

Of the animal disease control medications developed during this century, the antibiotics have been one of the most effective for combatting disease. Antibiotics are substances, usually obtained from microorganisms, that stop the growth of or destroy other microorganisms. Some, such as the tetracyclines, are effective against a wide range of bacteria. Others are much more specific in their actions.

Because antibiotics have been so effective, they have been used widely and at times indiscriminately. Low levels of some antibiotics are being mixed into some commercially prepared animal feeds to prevent infections. Although experimental results suggest that this practice will improve young-animal growth and development, such use gives disease-producing microorganisms an opportunity to develop resistance to the antibiotics.

When the microorganism population is continually exposed to the antibiotic, those few microorganisms that may have a genetic resistance to the level of antibiotic can survive and multiply, thus increasing the number of microorganisms resistant to the antibiotic in the population. Eventually, the population would be made up of resistant microorganisms entirely.

Another danger is that this low-level exposure of antibiotics would sensitize animals, so that exposed animals would be unable to tolerate larger doses later, when necessary to treat an infection.

Drug-resistant microorganisms are becoming more and more common. For example, a number of staphylococcic bacteria have developed resistance to penicillin. An increasing number of bacteria are resistant to aureomycin, terramycin, and erythromycin. Also, organisms that develop resistance to one antibiotic may simultaneously develop resistance to another. Continued drug experimentation and testing are needed as microorganisms develop resistance to drugs that are currently effective. As a general guideline, use of antibiotics for less serious diseases should be avoided. However, when antibiotics are used for therapeutic purposes to treat sick animals, be certain to follow the manufacturer's recommendations.

Environmental Modification

Measures to control disease also may have unplanned and undesirable environmental effects. For example in Africa, the disease trypanosomiasis (sleeping sickness) is spread by the tsetse fly. To get rid of the fly, trees and brush were cleared to eliminate the moist shade used as a breeding area. As a result, shade-loving grasses and herbs were replaced by poorer quality grasses. In this case, the tradeoff (getting rid of the tsetse fly) probably outweighed the loss of grazing quality, but the example shows how attempts to modify the environment may have unexpected results.

THE BREEDING PROGRAM

We have discussed how the genetic make-up of an animal population may have a direct effect on herd health. In many countries, regional breeds can be found that are adapted to the local climate, disease problems and livestock management practices. These breeds often have traits that should be preserved, such as hardiness, longevity, feed utilization efficiency and(or) desirable reproductive characteristics.

Breeding stock that has shown outstanding production in a temperate zone may give disappointing results in the tropics. Temperature extremes can cause stress, resulting in lower productivity. Breeds developed for dairying and the intensive beef industry are not necessarily the best animals for other types of farming systems. For example, small farmers may be more satisfied with an animal that is able to produce without costly supplemental feeding, rather than one that produces milk in large volume.

Goals of an effective breeding program should reflect the total management program and the local environment. Appropriate emphasis needs to be placed on reproductive ability, climatic tolerance, longevity, feed efficiency, growth rate, individual disease resistance, and overall production. The program will seek to eliminate defects such as infertility and structural unsoundness.

After breeding goals are established, the process is begun to cull animals that are unproductive, have defects, or appear unthrifty. The removal of unneeded and less desirable animals also will reduce pressure on feed resources.

Fertility

The fertility of animals is affected by climate, physiological condition, and nutritional status. Improvement of nutrition and reduction of temperature stress should increase successful matings.

Breeding age is closely related to the level of feeding and nutrition and can vary by as much as 50% depending on whether animals are fed a balanced or an unbalanced diet. This is influenced by regional climatic differences, and by level of husbandry.

In Guatemala, researchers studied the viability of sperm produced by imported bulls and rams and found that many of the animals did not produce live sperm until two years after importation. This was attributed to lack of minerals.

Breeding Season

The period of sexual receptivity of the female is controlled by physiological mechanisms. Some species mate throughout the year. Others mate only throughout a season within the year. In some types of sheep, for example, the length of the breeding season is related to the severity of the climate where the breed was developed. In temperate zones, where spring weather is severe, sheep that give birth in the early part of the season often lose their lambs. Thus genetic pressure has served to shorten the season to a time compatible with a mild lambing season. If the breeding season can be altered by livestock management practices, animals with young will benefit from timing the birthing period to coincide with the availability of large amounts of high quality feed.

Selection of Stock

Selection and handling of males for breeding purposes is often a difficult problem for the producer with limited funds and a limited quantity of animals. For example, one livestock owner kept one male from a different female each year. After his animals were bred that year, he butchered the male. His cost for upkeep of the male was minimal, he spent nothing on breeding fees, and he did not have to handle a mature male over an entire year. On the other hand, genetic defects were perpetuated through the herd because of the in-breeding.

Alternatively, he could have purchased a superior animal from a top breeder and later sold that animal to purchase another animal for the following year. This procedure would involve more time and expense. It might not be as satisfactory to a small farmer who is interested more in convenience and minimum upkeep than total production.

A more satisfactory alternative might be for this farmer to exchange male offspring each year with another small farmer, and continue to butcher the animals at the end of the breeding season. He would lose the opportunity to test for a good breeding male, but he would not have to deal with a difficult animal through an entire year. Herd sires can be aggressive and protective of their herd.

In some cases, a producer may find it profitable to maintain a superior male and charge breeding fees. Several family groups could cooperatively purchase and maintain a superior male. The general guideline is to adjust breeding systems to the goals, skill, and resources of the livestock manager.

Artificial insemination might be considered if proper facilities and trained technicians are available. However, in most small-scale production systems, such programs have not been too successful because of a lack of management expertise and the low fertility of animals fed a poor diet.

Management objectives that can be expected to improve the breeding program include: improving the nutritional status

of the animals, decreasing losses from disease, and culling unproductive animals. With these improvements, animal