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ARID AND SEMI-ARID LAND TRAINING OF TRAINERS WORKSHOP

UNIVERSITY OF ZIMBABWE
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Introduction and Objectives

Workshop Agenda

Lecture Notes

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The Trainers

The Institutions

Local Arrangements

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THE AID/NPS NATURAL RESOURCE EXPANDED INFORMATION BASE PROJECT

In 1979, the National Park Service, Office of International Affairs, entered into a cooperative agreement with the U.S. Agency for International Development (AID). The AID/NPS cooperative program focuses on transferring natural-resource-management information to lesser developed countries (LDCs). The National Park Service was selected to participate in this program because it 1) has had extensive experience in managing a wiue variety of habitats, 2) takes an ecosystem approach to management, 3) has many links with experts in the environmental fields, and 4) strives to balance development with environmental protection.

The growing populations of most developing countries are using up their renewable natural resources at unprecedented rates. The proper management of these resources on a sustainable basis is critical to the long-term economic and social well-being of these nations. However, many developing countries do not have the internal, infrastructural capability or support to plan, fund, and execute projects designed to manage natural resources. To satisfy their immediate needs for food, fuel, and shelter, the long-term consequences of resource degradation are frequently overlooked, often with counterproductive and devastating environmental effects such as deforestation, desertification and soil erosion, silted-up reservoirs, water pollution, saline soils, pesticide-resistant insects, and loss of valuable species of flora and fauna. The ultimate goal of the project is to assist LDCs to improve their capability to conserve and manage their natural resources and environment.

The AID/NPS cooperative program is organized into six phases of project activity and concentrates on three biogeographic regions -- coastal zones, arid and semiarid lands, and the humid tropics. Phases I through IV of the project, which are currently nearing completion, deal with the production and dissemination of information. Over the past 5 years, AID and the NPS have engaged some 200 scientists and international experts to develop publications that will enable host country personnel to

integrate natural resource concerns with social, economic, and institutional factors in development strategies and project planning. Each document translates scientific or technical information into practical applications for development.

The project just recently entered Phases V and VI of implementation. Phase V is designed to train host country personnel from universities or government to train others -- a training of trainers concept. This phase envisions the transformation of information, methodologies, and technologies developed under Phases I through IV of the project into course materials to be used in three workshops on planning and managing natural resources in coastal areas, arid and semiarid lands, and in the humid tropics.

The first of the three workshops -- "Training of Trainers in Coastal Zone Management" -- was recently held in Bangkok, Thailand, in March. It was hosted by the Faculty of Environment and Resource Studies of Mahidol University. Fifteen participants from five countries spent 3 weeks studying the major elements of coastal-area management planning and designed course curricula to implement in their home countries.

The second 3-week workshop, "Training of Trainers in the Integrated Management of Arid and Semiarid Land Resources," is being hosted by the University of Zimbabwe, Department of Land Management. This workshop will intensively examine resource uses in arid and semiarid lands and the related planning and information management, legal context, institutional and administrative arrangements, and social and economic concerns. A week-long field exercise will demonstrate many of the management and planning techniques by using a case study for an integrated regional planning effort. Each participant will 1) identify his/her country's specific issues as related to arid and semiarid land use, 2) prioritize training needs based on the issues, and 3) identify the target audiences to be trained. By the end of the workshop, participants will have prepared a course outline and a plan of action for implementation.

Phase VI of the AID/NPS project concentrates on assisting the host institution (in this case the University of Zimbabwe) to conduct future training courses. It also provides workshop participants with publications, reference materials, and informational assistance to use for courses in their respective countries.

A similar workshop is planned for the management of humid tropic resources in November 1985 in Latin America.

Further information on AID/NPS publications workshop substance, or follow-up activities can be obtained by writing the AID/NPS Expanded Information Base Project, National Park Service, Office of International Affairs, P.O. Box 37127, Washington, D.C. 20013-7127, or by calling (202) 343-7063.

ACKNOWLEDGMENTS

This workshop is being jointly sponsored by the U.S. Agency for International Development and the U.S. National Park Service, with substantial assistance from Winrock International. We wish to express thanks to the University of Zimbabwe for hosting the workshop. We are particularly indebted to Dean Malcolm Blackie, Dr. Kay Muir-Leresche, and the staff of the Department of Land Management, College of Agriculture, who have contributed their time and professional expertise to all phases of the workshop.

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ARID AND SEMIARID LANDS (ASAL)

INTRODUCTION AND DEFINITION OF ASAL

The sessions to be convened here and the activities to be carried out in the next three weeks will deal with problems of ASAL with particular emphasis on possibilities and means for more effectively developing them.

First off, we need to reach an understanding of what constitutes these ASAL. Their major characteristic is aridity meaning a shortage of water so the major ecological factor under consideration is low precipitation. However, it is difficult to delineate these regions solely on the basis of low annual precipitation. Rainfall is the major form of precipitation in these areas and this term will be used henceforth. Rainfall is only one of the factors in the ~~aluatic~~ abiotic portion of the ecological complex since high temperature, low humidity, strong winds, poor soils and difficult topography are also involved. These factors all contribute to limiting the effectiveness of the small amounts of rainfall that do fall, additionally, in dry-land areas rainfall is not only low but the patterns are characterized by great variability from year to year or season to season. Periods of no rain at all are frequent, when rains do occur they are often torrential in nature so that runoff is high and additions to soil moisture supplies are low. After all, it is the moisture in the soil that permits the growth of vegetation so the main consideration is for that water which enters the soil and becomes available.

The regions of the earth of concern to us here are broadly classes as extremely arid, arid, and semiarid. In a rough sense, the term extremely aid refers to zones with average rainfall below 250 mm; arid zones have rainfall between 250 and 700 mm and semiarid from 750 to 1,500 mm. These rainfall figures are only rough approximations because, as indicated, the factor of importance is sufficient moisture in the

soil for a long enough time so that seeds can germinate and plants, grow, mature, and reproduce themselves. Even in the extremely arid areas or driest deserts some rainfall events do occur though they may be at intervals of years. Yet vegetation does exist as sporadic ephemeral plants capable of completing a life cycle in as little as 4 to 6 weeks and producing seeds that remain dormant in the soil until another brief period of favorable soil moisture occurs. With existing technology and cost levels the extremely arid regions have little prospect for development so it is the arid and semiarid zones that mainly occupy our attention.

As an example of classification of dryland regions it is useful to look to East Africa. In the countries of Kenya, Tanzania, and Uganda lands have been subdivided into ecoclimatic zones on the basis of climate or weather conditions, soils, and the vegetation that the preceeding two factors allow to develop. Of the six ecoclimatic zones described we are concerned with the three driest ones.

Ecoclimatic VI zone is defined as very arid with average annual rainfall below 300 mm, bimodal in yearly distribution, very long dry seasons, and extremely great variation from year to year; evaporation is high, strong winds occur and droughts are common. The vegetation is sparse comprised of low shrubs and grasses with annuals dominating in areas of less than 250 mm of rain. The rangeland has low potential for grazing and crop agriculture is not possible.

Ecoclimatic zone V is defined as arid. Rainfall is from 300 to 600 mm, mostly bimodal, highly variable from year to year and with recurrent droughts often of long duration. The vegetation consists of drought resistant shrubs and perennial grasses. Grazing potentials are low, crop agriculture is limited to the most favorable sites. Wildlife is an important form of land use.

Ecoclimatic Zone IV is defined as semiarid with annual rainfall of 600 to 1200 mm. Here the rains tend to be more reliable than in the other two zones but evaporation is high so that shortage of soil moisture continues to be the major factor limiting plant growth. Vegetation is shrubby to low woodland with perennial grasses often in extensive pure stands or intermixed with woody plant species. Potentials for crop agriculture are marginal and limited to drought resistant crops such as sisal or quick growing grain crops on the more favorable soils. Potentials for grazing are fairly high and most of the rangeland livestock of East Africa are supported in this zone. Wildlife populations are generally large and most of the national parks and game resources are in the semiarid zone.

Location of ASAL

Aridity or low precipitation presents problems for vegetative growth in both cold and warm climates. However, discussions here are limited to warmer regions and to the two great belts of deserts and arid lands that encircle the earth in the vicinity of the tropics.

Referring to the attached map of mean animal precipitation in tropical and warm temperate zones, it can be seen that extremely arid areas (0-250 mm) in the northern hemisphere are found in Pakistan, Afghanistan, Iran, Iraq, Saudi Arabia, the Sahara across northern Africa, and the southwest USA and Baja California. In the southern hemisphere extremely aid lands occur in the Namib-Kalahari deserts of southern Africa, the Atcama desert of western South America, and in central Australia.

These extremely arid regions, generally, are surrounded by arid zones. Large expanses of arid lands in the northern hemisphere occur in India, Iran, Saudi Arabia, the Horn of East Africa, both northern and southern Sahara and southwestern USA and Mexico. South of the equator the arid zone includes central Australia, the inland fringes of the Kalahari desert in southern Africa and Peru and Chile in South America. Semiarid

zones border the arid zones throughout and include much of India, North Africa, South of Sahara, western USA, Peru, Argentina, Brazil, and southern Africa.

Extent of ASAL

It has been estimated that about 36% of the earths surface may be classed as extremely arid, arid and semiarid. Of this, 6% is extremely arid having practically no potential for development. Arid zones are estimated to encompass some 2,147 million ha and semiarid 2,071 million ha, a total area equal to the size of both North and South America. Some 60 nations are affected by aridity, most of them in the developing world with Africa and the near East having the greatest expanses.

Uses and Potentials for ASAL

It has been said that ASAL have two major assets; plenty of sunshine and plenty of space. both are receiving considerable interest in the modern world with its exploding human populations. The major difficulty is lack of water, or, more specifically, the shortage and variability of water supplies available to soils, plants and animals including man. The assets are being capitalized upon in some countries as characterized by shifts in population to the so-called "sun belts" but usually at high cost. The lack of water has been tackled with large scale irrigation projects where possibilities exist. Additionally, there are an increasing number of examples of vegetable production through hydroponics, desalinization of water, etc. At present levels of technology, those are at high cost and open only to the most affluent nations or with massive inputs of outside financing.

Excluding the extremely arid areas that are little used except at the barest subsistence levels and have only small development potential, the ASAL are most widely used to support livestock and wildlife. Thus they are essentially rangelands providing milk, meat, fiber, and other animal

products for man's use whether at subsistence or commercial levels. The human users are pastoralists with ways of using the rangelands and controlling their livestock, which seem to be best suited to particular situations. They may be settled peoples operating on lands they own or have control of through agreement or government assent. Many, in the more extreme of the ASAL environments, tend to be migratory moving themselves and their animals to areas where forage is available periodically.

The climatically more favorable portions of the ASAL, particularly where soils are suitable, are used for dryland agriculture and much of the worlds supply of cereal grains comes form these areas.

A wide range of interactions have evolved among users of ASAL. At one extreme may be found the pure farmer, at the other, the pure pastoralist. in between are those who are both, in more or less degree, or who are cooperative in one way or another. All impact on one another creating problems of all kinds. It is clear, however, that the users are a vital part of the ASAL ecosystem.

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COURSE OUTLINE NOTES

(This paper is provided for use in taking notes on the topics that may relate to the development of your course outline.)

TOPIC:

DATE:

SPEAKER(S):

GENERAL NOTES:

LINKED TO:

TRAINING USE OR IDEAS:

FOLLOWUP OR BACKSTOPPING IDEAS:

TRAINING OBJECTIVES -- TARGET AUDIENCES

ABSTRACT OF LECTURE

The objectives of a training of trainers course is to train a cadre of individuals, who in turn, have the capability to institute training programs of their own. The target audiences that can be addressed when designing a training program are varied. The selection of a target audience will depend largely upon the specific country problems you are facing in arid and semiarid land management. Education of school children can in turn, educate families and may eventually help to change value systems and perceptions of environment and conservation. Education of high level government decision-makers may help to facilitate legislative and policy decisions in favor of natural resource concerns, or may help open up lines of communications between agencies that have conflicting interests. Training extension agents will help to reach the people in the field who are actually utilizing and directly effecting the resources.

The type of training program you design, its level of technical detail, its duration, its content and focus on issues, and how you present your information, will depend upon your target audience and the actions needed to solve your particular country problems. Again, government decision-makers can rarely afford to spend more than a few days away from the office; they need their information in a concise package that highlights only major issues and how they relate to the various decisions needed. Training programs designed for field personnel need to include topics of a more technical nature and which are more action oriented.

OBJECTIVES OF LECTURE

In this lecture, participants will identify the major issues, problems, and needs facing their country in the field of arid and semiarid land management. Based on this, they will identify at least one major target

audience to design a course curriculum for. They will outline training requirements needed to accomplish the task of curriculum design (i.e., what their objectives and goals are in training, who are their target audiences, who will be the ultimate clients, what is the general lack of training and duration, etc.).

SAMPLE TARGET AUDIENCES

- A shortcourse for government executives (Ministerial level) on arid/semiarid land issues associated with development projects and(or) the management of natural resources.
- A training course for project design personnel, project implementors, and mid-level government managers on arid and semiarid natural resource issues associated with development projects.
- A training course for higher level politicians and their staffs on arid and semiarid natural resource issues associated with development projects planned or underway in their provinces.
- A university course on the identification and management of natural resources associated with development projects that impact arid and semiarid land resources.
- A short training course that is built around a specific development project that is or may adversely affect one or more arid and semiarid land resources.
- A training course for extension staffs/field staffs who will be involved in implementing natural resource management projects.

It is important to target audiences because:

1. The more specific an audience you have, the more chance you have of understanding why they don't do something you would see as beneficial to them, and then to find ways to help them understand the benefits.
2. You can be more certain of people's needs and concerns related to a topic, and meet those needs more directly. For example, maybe the major problem that you want to tackle is overgrazing in your

country. Make a list of important potential audiences for information about overgrazing:

Ministry of Agriculture administrators, who will have different needs and interests and responsibilities for rangelands than --
Ministry of Agriculture range scientists, who will be different from --
Extension agents, who will differ from --
Livestock producers --
Etc.

In considering an audience to target, there are at least three important factors to consider:

1. Which audience has the greatest potential for affecting change?
2. Which audience has the greatest probability for changing any current negative or neutral attitudes and behaviors and helping bring about change?
3. Which audience is it most probable that you as communicators and educators can reach with messages and have an impact on?

Use criteria like these to help decide which audience or audiences offer the most promise or payoff for your efforts to bring change.

Let's say you decide that Ministry of Agriculture administrators are a key audience for you to target. A next task is to thing through some of the forces that work for and against those administrators supporting a program to overcome overgrazing:

Objective to be accomplished -- To get Ministry of Agriculture administrators to actively support a Ministry program to solve overgrazing.

Forces working for their support	Forces working against their support
Rangeland research unit of Ministry actively supports	The Ministry is under a tight budget, finds it hard to start new programs without killing old
Consumers are complaining about meat shortages	Managing the range is a new concept, not well understood
Drought, dust, sandstorms are affecting city and country	There are not enough trained extension agents to work with livestockmen

Looking at these forces, what ones might you conceivably be able to change or affect Ministry administrators in favor of controlling overgrazing?

Ways to affect the forces include:

1. Making positive forces stronger.
2. Making negative forces weaker.
3. Changing negative forces to positive ones.

You are thinking about conducting training with Ministry administrators to introduce them to the concepts of control of overgrazing, since one force working against their support is that the whole idea of control is new. If successful, this should change this force from being neutral or somewhat negative to being a very positive force.

Involving the Ministry's rangeland research unit in the training might make them more active and supportive of overgrazing control. This would be an example of making an already positive force stronger.

Maybe you have resources to train a few special extension agents to implement overgrazing control programs with some livestockmen. That is an example of weakening a negative force.

It is important to apply a process someting like the one just outlined as you select audiences to target and then decide how to go about influencing them.

Now:

- Write down a statement of some issue you would like to tackle in your own country, in relation to arid and semiarid rangelands.
- Think through some of the audiences key to either supporting or opposing efforts to solve that issue.
- Select one that you feel might be influenced through a workshop.
- Then list the objective to be accomplished with them in a workshop.
- Next, list the two columns of positive and negative factors that affect whether or not that audience will support attacking that issue.
- And finally, look at what forces you might conceivably change via a workshop.

COURSE OUTLINE NOTES

(This paper is provided for use in taking notes on the topics that may relate to the development of your course outline.)

TOPIC:

DATE:

SPEAKER(S):

GENERAL NOTES:

LINKED TO:

TRAINING USE OR IDEAS:

FOLLOWUP OR BACKSTOPPING IDEAS:

PROBLEM IDENTIFICATION

ABSTRACT OF LECTURE

For training purposes, a natural resources problem can be defined and analyzed from a number of alternative perspectives.
Three are presented here:

1. Area problem analysis identifies and attaches weights to the economic problems of natural resources in an area, guiding public programs or other action. The instructor should be able to define the steps of an area problem analysis, leading his trainees through an example.

2. Problem solving is decision making. The instructor should be capable of discussing natural resources problems in the classical framework of problem recognition, problem analysis, the selection of a course of action, and the use of monitoring and evaluation to re-assess alternatives.

3. A problem is sometimes viewed as a conflict among alternative policy objectives. The instructor emphasizes policy criteria, policy formation, and definition of the "public interest."

I. AREA PROBLEM ANALYSIS

REFERENCE

Duerr, William A. 1953. Area problem analysis in forestry. In: Research in the Economic of Forestry (W.A. Duerr and H.J. Vaux, eds.). Charles Lathrop Pack Forestry Foundation, Washington, D.C. pp. 79-83.

Martin, R. B. and R. D. Taylor. 1983. Wildlife conservation in a regional land-use context: The Sebungwe region of Zimbabwe. In: Management of Large Mammals in African Conservation Areas. Haum Educational Publishers, pretoria. pp. 249-270.

DESCRIPTION

Although more than 30 years old, Duerr's portrayal of an area problem analysis still serves as a model for today. This section contains excerpts from Duerr's discussion.

As considered here, an area may range from a village to a nation or beyond. For most effective analysis, the area should be reasonably uniform in its economy. Where it is not, delineation of relatively uniform subdivision as analysis units is usually desirable.

A problem, for present purposes, is a condition that will result in loss of national net real income as compared with an alternative condition, consistent with national ideals, under which net income would be maximized. The amount of this loss measures the magnitude of the problem. The loss is computed after the two indefinite time series of net income -- 1) under a continuation of the existing condition and 2) under the alternative condition -- have been estimated and then discounted to the same point of time at an appropriate rate. By net income is meant real income, both individual and social, from which the real cost of attaining it has been deducted.

Area problem analysis is often the first step in the process of formulating new programs, or of evaluating ongoing programs. It is the technical part of this process, the remainder falling primarily in the field of policy formation. The various steps in program formulation are as follows:

- Identification and ranking of problems (i.e., problem analysis, the present topic).
- Appraisal of ended action. Problems are broken down into actionable units and restated in terms of the types of action needed (e.g., research, education, legislation, and so on).
- Review of past and current programs. What has already been done? What remains for the future?
- Formulation of a program. A list of projects and studies is drawn up, arranged in order of priority. The order is determined by the ranking of the basic problems, the other work completed or in progress, and administrative considerations.

Thus problem analysis, a rather barren undertaking in itself, becomes productive and meaningful when considered in relation to policy making. Conceptually, area problem analysis is accomplished through the following steps:

1. Description of the area's natural resources economy. This is a detailed description of all current conditions, some of which may be significant problems and some not. It includes sufficient reference, also, to past conditions and current trends to permit a prediction of future conditions under the assumption of a continuation in current policies. The purpose of this step is to construct the indefinite time series of net real income under continuing conditions.

2. Definition of an alternative natural resources economy that would be consistent with maximum national net real income and national ideals. This is an exercise in model building. The goal of this step is to estimate the time series of net real income under the desired change of conditions. In computing income, allowance must be made for the costs of attaining the alternative economic organization. Some concept of programs is therefore implicit at this point.

- Listing of those conditions in the area's current natural resources economy that are significantly altered in the model, together with the amounts of increase in net income steming form the alterations. This step defines where the problems lie, and measures their magnitude.

4. Arrangement of the problems in order of magnitude. Each problem in the list -- each current condition -- is described in some detail. The corresponding desired change in that condition is likewise described. Assumptions about concurrent changes in other segments of the natural resources economy (or the general economy) are also made explicit. Finally, assumptions about types and magnitudes of income changes are recorded.

Workable problem analysis will ordinarily depart from the conceptually pure approach in at least two important aspects. First, not every current condition can be treated as a problem. In practice, many current conditions will be passed by on judgment that they are not significant problems, or because not enough is known about them to permit meaningful analysis. Secondly, qualitative analysis will substitute for quantitative analysis in a number of ways. Some or all of the calculations of incomes will be abandoned, and model building will be done more or less generally and informally.

Under such a modified approach to problem analysis, the student/trainee will emphasize learning as much as possible about the natural resources economy of an area in relation to the general economy. This will permit recognition of major maladjustments in the natural resources economy that appear to result in loss of real income. The student/trainee will search the literature and assemble data from a wide variety of sources. Where information is lacking, special studies will be made. Alternatively, the deficiency will be noted as a part of the problem analysis. In the course of weeding out unpromising data, the student/trainee will gradually assemble hypotheses to be tested in the library, in the field,

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and when obtaining ideas from informed persons. The goal is to construct a list of problems, and to answer two questions for each problem: Why is it a problem? Relatively, how large a problem is it?

TEACHING EXERCISE

Have the students/trainees read and evaluate the Sebungwe Plan, as presented by Martin and Taylor. Alternatively, assign them an area problem analysis for a region(s) in your own country. Then ask them to answer the following questions:

- What are the "current conditions" in the Sebungwe region (or the assigned substitute) as described by the authors?

- What is the alternative natural resources economy envisioned by the authors? How does this alternative improve net real income?

- Comparing current conditions with the proposed alternative, what kind of specific problems are identified? Does the analysis discuss the elements of a program to move the Sebungwe in the direction of the alternative?

- In what ways does the Sebungwe Study conform to a good problem analysis? In what ways, if any, does it fall short?

II. PROBLEM SOLVING AS DECISION MAKING

REFERENCES

Duerr, W. A., D. E. Teeguarden, N. B. Christiansen, and S. Guttenberg (Eds). 1979. "Decision process in summary," "Choices and their

prediction," and "Means, ends, and values." W. B. Saunders Company, Philadelphia. pp. 23-56.

"Illustrating the decision process with a fuelwood example," single page. (Included in training materials.)

"Survey of attitudes about natural resources," two pages. (Included in training materials.)

DESCRIPTION

Decisions, or plans, are made by managers. The problem (question0 is specified; alternative solutions (series of means and ends) are forecast; and the series of greatest value is chosen. All of this is brought together in a diagram or flow chart, such as the one included in these notes labeled "The management system: the flow of decisions." Students/trainees should be thoroughly grounded in making and using such diagrams. Use the diagram to present the decision process as a three-step sequence:

1. First is problem recognition. The decision maker receives a stimulus that something is wrong or calls for attention. There is a sense of dissatisfaction, which at this stage is still amorphous and only vaguely defined. But after further thinking and more information come into the picture, these amorphorus thoughts are crystallized into the recognition of a problem. At this point the decision maker deliberates the problem and moves it along to the analysis stage in order to identify and evaluate alternative courses of remedial action.

2. The problem analysis is the center section of the diagram, showing the triangular relation among ends, means, and values. An end is an expression of an organization's purpoes in management, or a goal towards which decisions are directed (e.g., monetary profit, good

public relations, organizational growth, etc.). Goals are arranged in a vertical hierarchy, such that each element in a decision chain is a means to support ends located at higher levels. What is an end when viewed form below is a means when viewed from above. No single means or end has inherent value or significance. Rather, value is determined by subjective judgments at the top of an organization in relation to that organization's identity and image.

3. The problem solving stage follows with selection of a course of action. This is the plan decided upon, given the problem recognition and problem analysis that came before. The decision is carried out (action), and the outcome is reviewed. Was the outcome what was intended? Were its impacts the expected ones? How could the decision have been improved? What amendments are necessary in the ends-means-values series? This review produced information to correct both the problem-analysis and problem-solving stages. The cycle continues until the problem is judged to be satisfactorily resolved.

Presentation of this formal decision model should be accompanied by statements of how the process works in practice.

Points to emphasize include the following:

- Decisions are made by people,and they relate to people. Plants, animals, and inanimate objects are involved only as human beings act upon them. Though one may speak of natural resources management, the object is actually the management of people, with a natural resources result in view.

- The ends (i.e., goals, aims) of management are complex. They come in chains, or series, extending from the specific to the general, and from the immediate to the ultimate. Secondly, at nearly every level in the management system are alternatives to be weighed.

- The decision maker often looks at only a small fraction of the conceivable alternative series of ends and means. Many are never recognized. Others are recognized, but are immediately discarded as unpromising.

- Ends, means, and values are often determined integrally and simultaneously.

- Deliberated decisions -- as discussed here -- are those thought out by a more or less orderly and rational process consciously designed to introduce objective analysis. But many decisions are deliberated virtually not at all. The decision process reduces to a tradition, custom, rule of thumb, or cultural axiom.

TEACHING EXERCISES

- The instructor can have students/trainees run through the decision process with a case study they construct from a problem familiar to them. Alternatively, the instructor may use the fuelwood example included with these training materials. In the fuelwood illustration, is the ends (goal) logically stated? What additional means should be considered? What additional values may the Forest Department hold? What kind of review process should be considered? What levels in the Forest Department will be responsible for the different parts of the decision process? Questions like these can help enliven an otherwise colorless subject.

- The instructor should also consider use of the "Survey of Attitudes About Natural Resources" in the context of teaching about decision process. The survey not only sparks lively discussion (because there are no right answers), but also makes the point that so many decisions in natural resources management are handed down through culture and tradition ("values"). That is, the attitudes survey

brings to light those higher-level policy decisions that do not flow through the formal decision diagram, but rather are taken as "given." This shows the contrast between decision making at the operational level (analytical) vs. the policy level (judgmental and cultural).

To the extent that the students/trainees agree with the survey statements as written, they accept the classical doctrines which have guided much of natural resources decision making in Western society for the past few centuries. To the extent they disagree, there is "cultural drift" (or the subset of students is in some way different from previous resources managers). The reference here is W.A. Duerr and J.B. Duerr, "The Role of Faith in Forest Resource Management," Chapter 4 in Social Science in Forestry (F. Rumsey and W. Duerr, eds.), W. B. Saunders Co., Philadelphia, 1971.

III. CONFLICT AMONG POLICY OBJECTIVES

REFERENCES

Worrell, Albert C. 1970. The objectives of forest policies" and "Criteria for forest policy," Chapters 2 and 4 in Principles of Foresty Policy. McGraw-Hill Book Co., New York.

Clawson, Marion. 1975. A framework for analysis for forest policy, Chapter 3. In: Forests for Whom and for What? Johns Hopkins University press, Baltimore.

DESCRIPTION

Another avenue to approach problem identification is through the study of natural resources policy -- its objectives, formation, and criteria.

Problems are defined by conflicts which arise among different clientele groups for the same limited resources. The teaching of problem identification through the policy framework provides a logical introduction to CONFLICT RESOLUTION, the next unit of this course.

The objectives of natural resources policies are often not clearly stated. In many cases, they are not even clearly known. Confusion about objectives of natural resource policies (and of other policies that affect or conflict with them) be made as explicit as possible.

A useful teaching device is to have the students/trainees critique particular natural resource policies in their own country (or sub-region). The analysis could focus on a particular product line (i.e., grazing, wildlife, water, timber, etc.), or on a topic that cuts across product boundaries (e.g., natural resources price policy, multiple use policy, etc.) What are the intended objective of the policy? What are the unintended consequences? How much of the policy is written on paper (i.e., legislation and regulations), and how much is simply assumed and implicit? What is the historical beginning of the policy? Has the policy responded to changing circumstances? Most importantly, who gains by the policy and who loses by it? It is this latter question which leads to problem identification.

The simplest problem to discuss is that in which one policy objective interferes physically with the attainment of another. Accommodation of shifting agriculture in upland watersheds may interfere with water supply in lowland basins. Domestic grazing on open rangelands may interfere with game cropping on those same lands. In most cases, one objective does not completely exclude attainment of the other, but does interfere with it in some significant way.

Whose objectives should receive priority? Should choices be made by majority rule? Must the rights of minorities always be protected? Will the establishment of a tourist park be used mainly by the wealthy and

perhaps deprive the poor of economic opportunities? Although there is no obvious way to resolve conflicts such as these, it is essential that natural resources managers at least face such questions objectively and systematically so that varying views can be contrasted. The instructor is referred to the recent literature on community participation in resources decision making.

TEACHING EXERCISES

- The reading from Clawson presents five criteria for policy analysis: physical and biological feasibility, economic efficiency, economic equity, social or cultural acceptability, and operational or administrative practicality. Clawson was writing for the context of forest policy in the United States. To what extent is his framework useful for natural resources policy making in the developing countries? To what extent is it not relevant? Let these questions guide the students/trainees in designing an analytical framework for problem identification.

- The philosophical account of the "public interest" in the book by A. C. Worrell offers a stimulating challenge for the motivated student/trainee who wants to understand what lies behind policy criteria. After assigning the reading, pose a few questions to see if the material was understood:

What is the difference between unitary vs. individualistic concepts of the public interest?

Is a policy in the public interest if most of the people do not think it ought to be furthered, even after they understand it completely?

If the public interest is so difficult to define and identify, why even make the attempt?

SURVEY OF ATTITUDES
ABOUT NATURAL RESOURCES

Listed below are eleven statements which may or may not influence thinking in the natural resources profession. Please indicate whether you agree or disagree with these statements, or if you so choose, indicate no opinion.

	Agree	Disagree	No Opinion
1. The world faces a shortage of renewable natural resources.			
2. Timber is the principal product. If resources are managed for timber, the other goods and services will follow in sufficient amount.			
3. Each generation receives its natural resources as a heritage from the preceding generation and should hand them along intact to the following generation.			
4. The yield of renewable natural resources should be sustained in order to produce an even flow of output and thus stabilize the income and employment of dependent communities.			
5. Nature moves and changes slowly and takes a long time to accomplish her purposes. Any one who works with nature must be prepared to wait patiently, to think and plan in long terms, to see change take place slowly, and mitigate the effects of change except where the proper balance of nature has been disturbed and thus needs to be restored.			
6. Private enterprise, notably small enterprise, is short-sighted. It is destructive of resources such as wildlands, where the long view is essential. Therefore, society must exercise influence over private resources management.			
7. Wildlands are a living thing with their own goals and proper destiny; these obey the dictates of the natural law. From knowledge of the natural law - from understanding of the balance and orderly process of nature - the natural resources profession derives the standard of what is right and good in the public interest.			

	Agree	Disagree	No Opinion
8. The wisdom and success of a natural resources program can be judged on the basis of the resulting output. If the output is increased, the general good also will be increased.			
9. Idle land is a cost to society.			
10. The major decisions about natural resources management should be made by natural resources specialists.			
11. Good natural resources management consists of those practices that make for the most complete utilization of the site and the fullest development of the land.			

Illustrating the Decision Process with a Fuelwood Example

1. PROBLEM RECOGNITION

Dissatisfaction.--The leaders of Village X complain to your Forest Department that the women of the village are walking too far to get fuelwood.

Problem crystallization.--An on-site study by one of the Department's foresters helps clarify the problem. Those women who do depend on fuelwood spend an average of six hours per week collecting wood. In neighboring Village Y, the average is only two hours per week. However, in both villages an increasing number of households are observed to be using propane gas.

2. PROBLEM ANALYSIS

Ends.--Relieve pressure from leaders of Village X.

Means.-- (1) Introduce improved wood-burning stoves to extend fuel supplies.

(2) Establish village woodlot.

(3) Subsidize further substitution by propane gas and other fuels.

(4) Attempt to persuade villagers that their problem is not a serious one.

Values.-- (1) Political acceptability ("good will")

(2) Financial cost

(3) Operational practicality

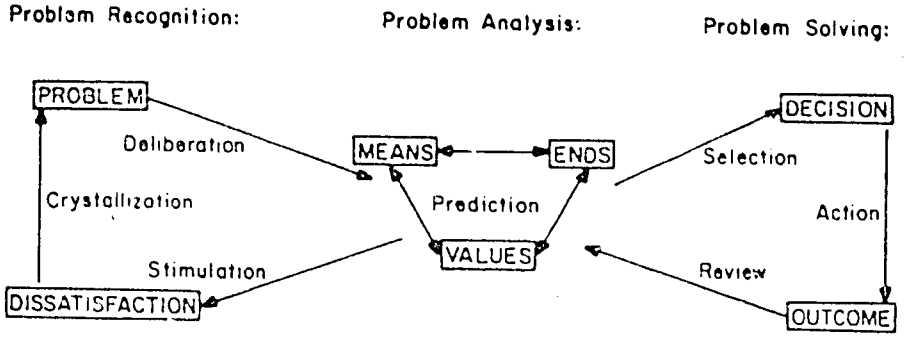
3. PROBLEM SOLVING

Decision is Taken.--(Suppose it is decided to attempt to persuade Village X that its problem is not serious. The Forest Department implicitly places high value on avoiding financial cost.)

Outcome.--The Forest Department sends one of its most persuasive officials to Village X to inform its leaders that six hours per week is not an excessive time for fuelwood activities. (The official refers to Village Z, where the situation is the same, and there are no complaints.) The response in Village X is either to accept or reject the official's response.

Review of Outcome.--If the result in Village X is not favorable for the Forest Department, it must return to the Problem Analysis and re-assess its alternatives.

The Management System: the Flow of Decisions



Source: W.A. Duerr, D.E. Teeguarden, N.B. Christiansen, and S. Guttenberg (eds.), Forest Resource Management, W.B. Saunders, Co., Philadelphia, Pa. (U.S.A.), 1979.

COURSE OUTLINE NOTES

(This paper is provided for use in taking notes on the topics that may relate to the development of your course outline.)

TOPIC:

DATE:

SPEAKER(S):

GENERAL NOTES:

LINKED TO:

TRAINING USE OR IDEAS:

FOLLOWUP OR BACKSTOPPING IDEAS:

CONFLICT RESOLUTION

ABSTRACT OF LECTURE

Natural resources managers devote a substantial proportion of their working time and personal energy to conflict management. Individuals or groups are in conflict when one or both parties are not obtaining what they need or want, and are actively seeking to satisfy their self-interests without regard for the interests of the other party. On occasion the intent is to neutralize, injure, or even eliminate the other party to the extent that the other party is a rival. Conflict is then a struggle over claims to status, power, and scarce resources.

Conflicts over use of natural resources are predictable an even inevitable because of different economic interess. Moreover, conflicts arise among individuals within natural resources agencies because of misunderstandings, personality clashes, differences in values and goals, responsibility issues, and so on.

It is for these reasons that leaders and managers in the natural resources profession need to learn how to creatively manage and cope with conflict. If conflicts can be understood and objectively analyzed, the greater are the opportunities to reduce unnecessary stress and to manage conflicts as constructively as possible.

I. OVERVIEW OF CONFLICT

REFERENCES

Ehrmann, John R. and Patricia A. Bidol. 1982. A bibliography on natural resources and environmental conflict: management strategies and processes. Council of Planning Librarians Bibliography No. 84.

DESCRIPTION

There is no special treatment of conflict resolution as applied to natural resources alone. The principles, concepts, and strategies for conflict resolution are defined only within a very broad framework of the social sciences. The subject encompass the whole social system to include references to class conflict, racial and religious conflict, political revolutions, war, family tensions, and labor-management relations. The underlying disciplines are mainly sociology and psychology, but other disciplines (e.g., economics, political science, philosophy, and anthropology) play a lesser role, as well.

The instructor cannot hope to present a comprehensive discussion of conflict resolution in only one or two modules of a course on natural resources management. But the instructor can attempt to stimulate interest in the subject on the part of the students/trainess, keeping in mind their previous educational attainments and their current professional roles. The objective is to encourage the students/trainees to pursue further reading, and to engage in self-study in conflict resolution.

In the industrialized countries, conflict resolution is the subject of an enormous volume of books and articles. Not all of these are available in the developing countries. The bibliography by Ehrmann and Bidol gives a sampling of the kind of materials that might be found in a relatively recent cross section of the literature. Only some of these are relevant for natural resource management, as the students/trainees will rapidly discover. But it is nevertheless critical for the students/trainees to know how to search for sources of ideas and theories in those broad arena.

II. TEACHING CONFLICT MANAGEMENT

REFERENCES

Louis B. Hart. 1981. Learning from Conflict: A handbook for trainers and group leaders. Addison-Wesley Publishing Co., Reading, Massachusetts.

Rumley, Jacqueline. 1977. Management of differences. Development publication, Washington, D.C. (Included in training materials).

DESCRIPTION

A practical way to teach conflict management is to use formal exercises that put the student/trainee into a real or simulated conflict requiring resolution or mediation. To that end, the selected exercises form Hart and Rumley are designed specifically for trainers and group leaders. Hart's book contains 218 pages, and offers possibilities to choose elements for courses ranging from three hours to five days. Rumley's exercise describes five stages of conflict evolution, and requires students/trainees to concentrate on these areas as they seek alternative solutions.

RECOMMENDED SECTIONS OF HART'S BOOK ARE AS FOLLOWS:

1. pp. xi-xiii. This forward by Lippitt underscores the importance of conflict management in the daily lives of executives and managers.

2. pp. 3-21. Hart introduces the "conflict cycle." and lays out alternative designs for courses (or workshops) of variable length and intensity. The instructor may need to modify the presentation of the conflict cycle to suit local needs.

3. pp. 35-36. This unit has the students/trainees focus on ways in which conflict is destructive and constructive. The exercise is easily accomplished, and links with the itemization on p. 6. The instructor may usefully focus attention on the example of a particular conflict known to the group of course participants.

4. pp. 61-62. If the course is oriented to natural resources specialists representing a particular organization(s), this unit is intended to identify conflicts arising within that organization. The discussion centers on the participants' responses to a worksheet, p. 62. The responses are bound to generate a stimulating and informative exchange of comments.

5. pp. 131-135. This unit on "organizational climate" is a good follow-up to pp. 61-62 (described in the preceding paragraph). Again, the participants are asked to complete worksheets before entering into a general discussion.

6. pp. 147=157. Introduces five methods of conflict resolution (i.e., denial, suppression, power, negotiation, and collaboration) in a useful chart (p. 149) Contains exercises to illustrate the benefits of conflict resolution (pp. 151-155), and to show forces for and against resolution (p. 157).

7. pp. 193-199. This section is a step-by-step guide to the process of conflict resolution. It takes the participants through the analytical stages of describing a problem, defining its causes, searching for alternative solutions, selecting a best solution, and monitoring the outcome of the decision. This process is traced for each of several problems that the participants pose as individuals, but solve as groups.

COURSE OUTLINE NOTES

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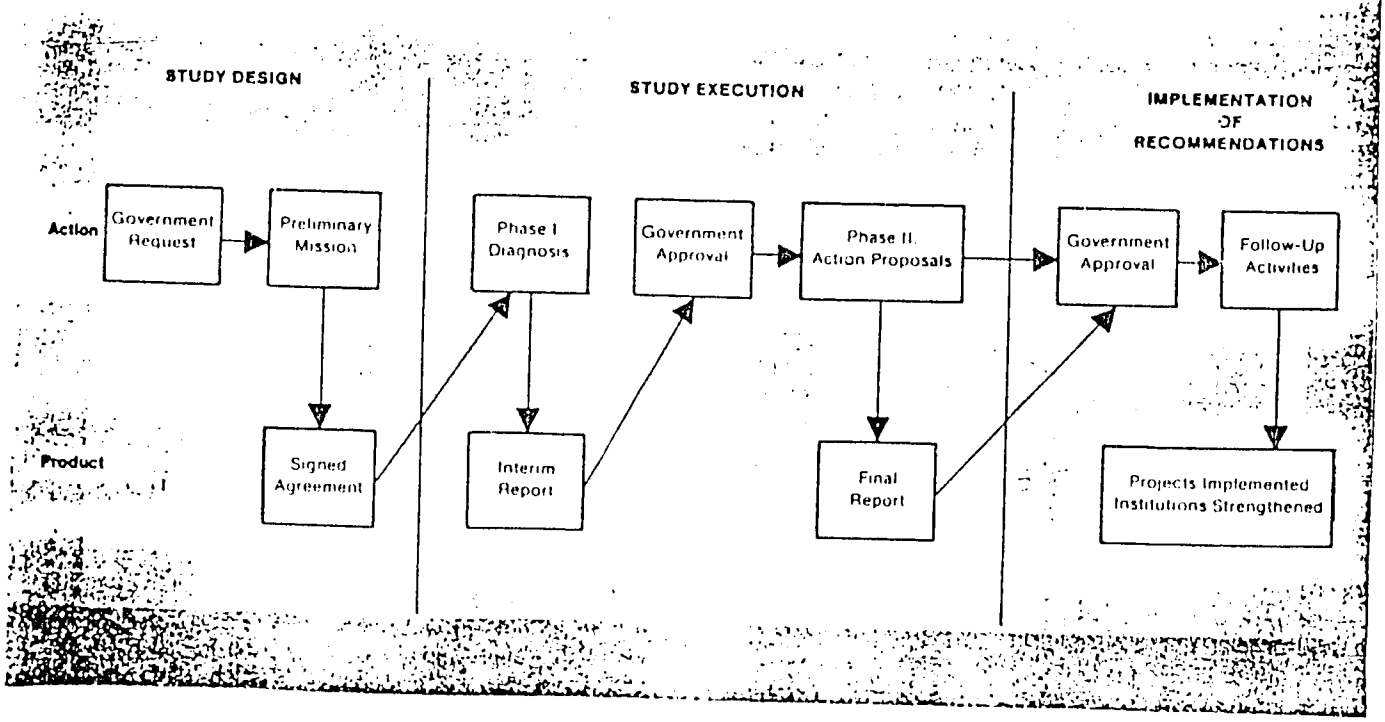
KEY ELEMENTS IN THE PROCESS OF DRD
ASSISTANCE FOR REGIONAL DEVELOPMENT PLANNING



Stages	STUDY DESIGN	STUDY EXECUTION		IMPLEMENTATION OF RECOMMENDATIONS
		PHASE I DEVELOPMENT DIAGNOSIS	PHASE II PROJECT FORMULATION AND PREPARATION OF ACTION PLAN	
Activities	Receipt and analysis of request for cooperation Pr liminary Mission • pre-diagnosis • preparation of cooperation agreement	Diagnosis of region • sectoral analysis • spatial analysis • institutional analysis • environmental analysis • synthesis: needs, problems, potentials, constraints Relation to national plans, strategies, priorities Development strategies • formulation and analysis of alternatives • identification of project ideas	Project formulation (profile or prefeasibility) and evaluation • production sectors (agriculture, forestry, agroindustry, industry, fishing, mining) • support services (marketing, credit, extension) • social development (housing, education, labor training, health) • infrastructure (energy, transportation, communications) • urban services • natural resources management Action plan preparation • formulation of packages of projects • policies for pri. ity areas and sectors • enabling and incentive actions • investment timetable • evaluation of funding sources • institutional development and training • promotion	Assistance for specific programs and projects Assistance in incorporating proposed investments into national budget Advisory services for private sector actions Support to executing agencies Support in inter-institutional coordination
Products	Signed cooperation agreement • definition of products of study • financial commitments of participants • preliminary workplan	Interim Report (Phase I Report) • diagnosis of region • preliminary development strategy • identified projects	Final Report • development strategy • action plan • formulated projects • supporting actions	Government execution of • feasibility and final design studies • implementation of projects • changes in legislation and regulations Improved operational capability of institutions
Time Frame	3 to 6 months	9 to 12 months (12 to 18 months historically)	12 to 18 months	Variable

METHODS: A FRAMEWORK USED FOR DEVELOPING A NATIONAL RANGE PROGRAM FOR JORDAN

Rangelands can be seen in a number of ways: as units of landscape where human activities take place, as units of production, and as ecosystems connected to many other ecosystems.

In a sense, any effort to distinguish between rangeland and watersheds is somewhat fruitless. Jordanean watersheds, more often than not, include landscapes that are rangeland, just as they may also include rain-fed lands, forest, agriculture, and urban lands. Rangeland provides forage for livestock and wildlife; woody vegetation for posts, fuelwood and, eventually, lumber; land for urban construction and agriculture; and water to meet the needs of agriculture, livestock, industry, urbanization, recreation, and health.

Rangeland fits any modern conceptualization of an ecosystem: a more or less arbitrarily delineated area having interacting physical and biological components to which social, cultural, economic, institutional and political components and processes must be added. Rangeland as units of landscape and production have often been discussed in Jordan and numerous proposals to improve their condition or correct any perceived problems have been made.

Within the ecosystems, urbanization and industry conflict with crop production and grazing for the use of rangeland watersheds and all four of these uses increase erosion and sedimentation. However, it is the lack of understanding of the interrelated nature of rangelands on the part of those who use them that causes their deterioration and decreased capability to provide what man deems necessary for improving the quality of life in a sustainable production system.

Consider, for example, the production of water in quantity and quality needed and the service of erosion and sediment control. These natural resources have deteriorated because of overgrazing, removal of permanent

vegetation for the cultivation of annual crops, (which denudes the landscape for varying periods) and use of impervious concrete and asphalt infrastructures. Both overgrazing and changes in land use have been influenced by land tenure customs and regulations that encourage inappropriate technologies. However, these adverse technologies have been encouraged by population pressures and social, cultural, and political factors that must be understood if development projects are to be successful. Using a comprehensive and integrated approach to improving rangeland use is emphasized in the following analyses, discussion, and project design.

The approach chosen for conceiving, designing, and executing a Range Program in Jordan is one of integration and flexibility. Here, a distinction needs to be made between the words "comprehensive" and "integration." Comprehensive in the context of development planning means that the social, cultural, and political sectors, have all been considered. Integration means that not only have all sectors been considered but that the execution of each sector's activities has been integrated with that of others so that conflict between them has been minimized and cooperation has been maximized.

Flexibility is a necessary prerequisite for integration and is obtained through iterative planning and the generation of alternative strategies and projects to meet the development objectives.

Figure 4 is a diagram of the process leading to implementation of the specific projects that make up the proposed Range Program. Under this model, this preliminary mission undertakes a quick prediagnosis of the range and watershed situations and geographical areas included in the request from the Government of Jordan, and together with representatives of the Government defines the expected final product, and outlines the work plan. The work plan 1) identifies development actions that are imminent or already taking place, and gives them consideration early in the project; 2) defines the technical content of the study, determines the principal problems and potentials and establishes priorities for

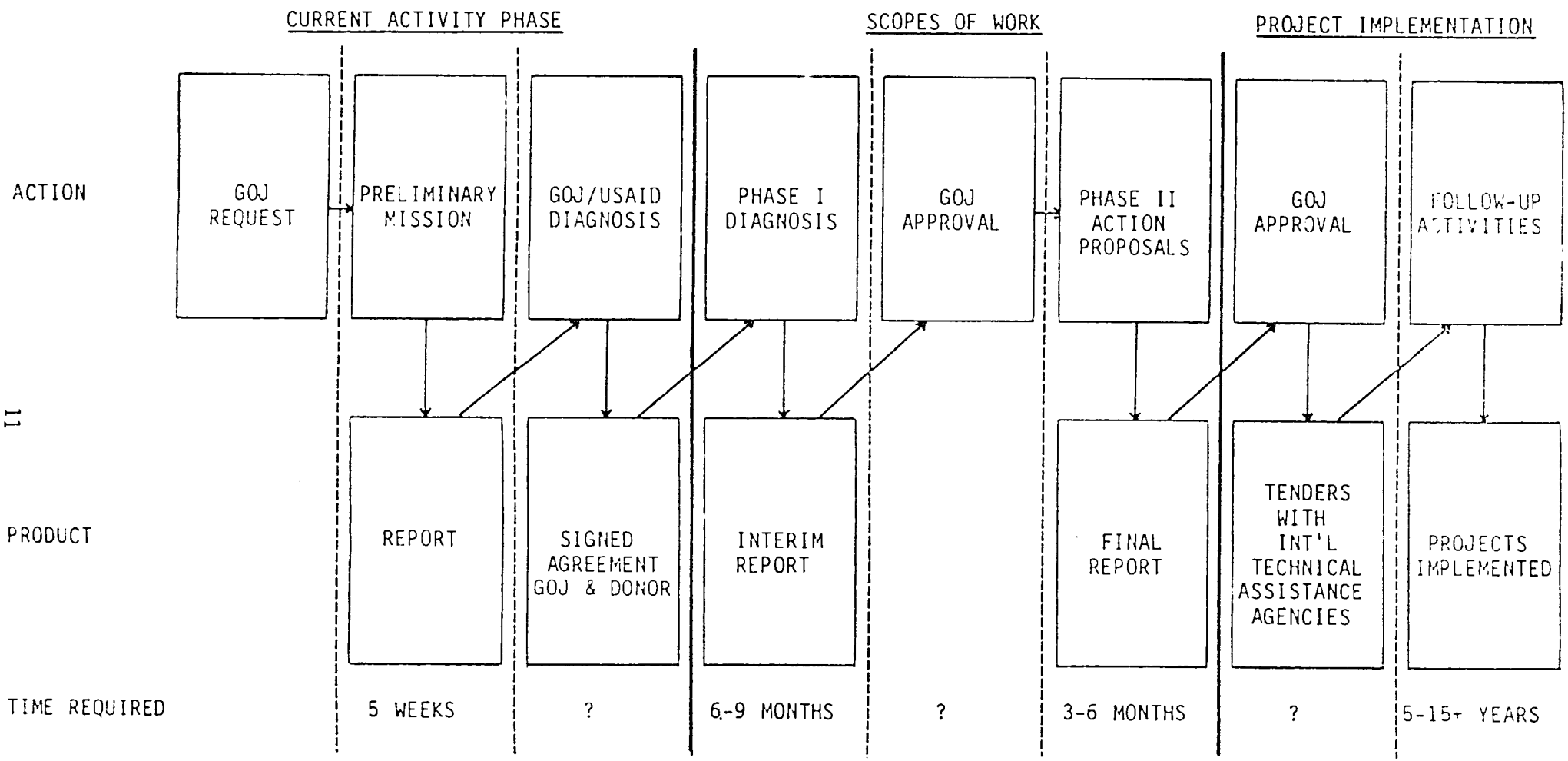


FIGURE 4. PROCESS LEADING TO THE DESIGN AND IMPLEMENTATION OF A NATIONAL RANGE AND WATERSHED PROGRAM

action; and 3) outlines a very general strategy for implementation. The preliminary report of this mission follows this model.

The next step toward implementation of a rangeland watershed program provides a) a detailed diagnosis relating to the problems identified by the preliminary mission and b) the design of a detailed overall strategy including specific projects and activities that will make up a comprehensive and integrated program of range management and rehabilitation in Jordan. Although portions of the program will be implemented very early, 9 to 15 months are envisioned to complete this step.

Design of the overall program should determine distinct portions that can be funded and managed by different groups (ministries, agencies, international development assistance organizations, etc.) while maintaining the integrated nature of the Program.

LONG-TERM DEVELOPMENT PLAN FOR THE RANGELANDS OF JORDAN

The rain-fed and rangeland watersheds in Jordan are extremely complex. Problems on these lands cannot be solved by using an isolated sectorial solution. For example, removing livestock from rain-fed areas suffering from severe erosion may not be the long-term answer since the real problem may be the legislative measures that deal with land tenure. The long-term solutions needed will increase the sustained productivity of these lands by using an integrated systems approach to resource planning, development, and management.

Components of the proposed National Rangeland and Rain-fed Watershed Program can be divided into four broad categories: 1) proposed projects; 2) related projects; 3) support services; and 4) immediate needs. The components within each of these are shown in table 1.

The scope-of-work phase which will follow this mission will outline the requirements needed to undertake and complete a detailed diagnosis for the proposed projects and support services components. The NPC can review the activities of related project activities being developed by other institutions to determine priorities for implementation and(or) detailed diagnosis.

Proposed Projects

The development process for Jordan's natural resource base in the rangeland ecosystems cannot occur on all areas at the same time. Neither the pool of trained citizens nor the physical and financial resources required for such an effort are currently available to turn the trend of gradual degradation of the natural resource base while increasing the long-term productivity of this base to meet the needs of the people of Jordan.

TABLE 1. COMPONENTS OF A NATIONAL RANGELAND AND RAIN-FED WATERSHED PROGRAM

ID#	Component Title	Region
Proposed Projects		
P-1	Wadi Mujib	Plateau/Desert
P-2	Azrak-Duleil	Desert
P-3	Balqa-Salt	Plateau
P-4	Jafr Basin	Desert
P-5	Range Management Improvement	All Rangelands
P-6	Range Revegetation Survey	All Rangelands
P-7	Water Harvest Survey	All Rangelands
Related Projects		
P-8	Al-Hamad	Desert
P-9	Wadi Arab	Plateau
P-10	Wadi Araba	Rift Valley
P-11	Zarqa	Plateau
P-12	Aqaba	Desert
P-13	Highland Agriculture	Plateau
P-14	USAID Rural Development	Plateau
P-15	Australian Land Use	Plateau
P-16	UNEP Lajjun	Desert
Support Services		
T-1	Training	National
T-2	Research and Extension	National
T-3	Documentation Center	National
T-4	Monitoring Evaluation	National
T-5	National Soil and Land-Use Survey	National
Immediate Needs		
O-1	Institutional Restructuring	National
O-2	Regionalization	National
O-3	Regional Planning	National
O-4	Legislation	National

Priorities for beginning the rehabilitation of the regions or subregions depend on many factors. To ensure that national objectives are met, a preliminary ranking should be determined through a process of regionalization. Jordan's National Planning Council is currently in the process of regionalization and a draft map indicating one possible scheme is presented as figure 5. In this scheme, Jordan is divided into 5 regions: 1) Urban Amman, 2) Aqaba, 3) Jordan Valley, 4) Plateau, and 5) Desert. Some of these regions may eventually be divided into subregions and even sub-subregions. Much of the proposed development activities will be focused on the sub subregions because of the greater input of manpower and financial resources required for larger areas.

The capability to undertake regional planning to determine priority areas for development is not sufficiently mature in Jordan. Since some urgency exists, it is proposed that the preliminary work to assess the feasibility for integrated development projects in some major subregions begin immediately, while at the same time encouraging the development of a regional planning capability within Jordan. The most promising projects, according to this assessment, could then be evaluated for funding and implementation. The process would involve training a Jordanean team to continue a regional planning effort that could extend the process throughout the rain-fed ard rangeland watersheds in Jordan.

Two ways to begin developing a program for the rain-fed and rangeland watersheds are: 1) to concentrate on one region/subregion and cluster many projects within that region/subregion and 2) to develop one or two projects in each of the regions/subregions.

Both options have some advantages. Concentrating on one region/subregion tends to maximize the short-term return while developing one or two projects in each region/subregion extends information to the private sector by having model projects in a wide range of ecosystems for easier observation. The second option was selected and a list of the seven project areas selected for this initial evaluation along with some of the important characteristics is shown in table 2.

FIGURE 5. Map of the Hashimite Kingdom of Jordan showing five potential regions for planning purposes.

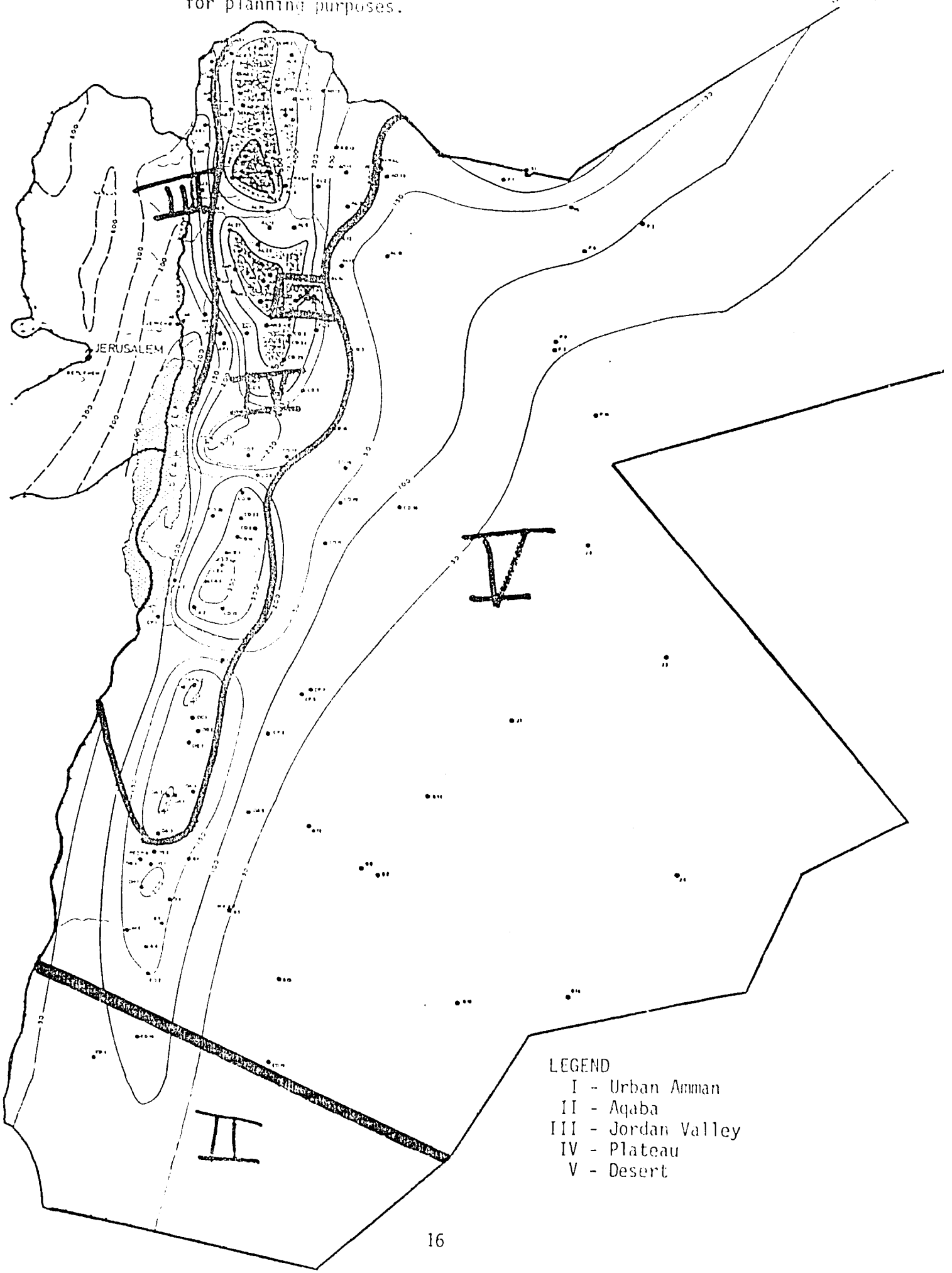


TABLE 2. PROPOSED REGIONAL PROJECTS TO BE IN THE NATIONAL RANGELAND PROGRAM

ID#	Component title	Region	Area of impact (sq. km)	Human pop. (000)	Future invest. ($mil)	Key characteristics for inclusion
P-1	Wadi-Mujib	PLATEAU/ DESERT	2563	73.6	100 plus	Opportunity for mixed crop and livestock production in submarginal areas.
P-2	Azraq-Duleil	DESERT	225	5	50	Wildlife reintroduction research is underway; increase in irrigation; competition for ground water; and depletion of underground aquifers.
P-3	Balqa/salt	PLATEAU	231	15.4	50	An area of relatively steep slopes going down to the Jordan valley. One area has a high population and infrastructural development, the other does not.
P-4	Jafr Basin	DESERT	11985	23	50	Migration to the area due to mineral extraction and associated activities. Limited rainfed agriculture exists, but some range development possible.
P-8	Al-Hamad	DESERT	166000	11	-	A four nation team is developing plans for this area. Al-Hamad is very arid but supports some livestock. Irrigation may be developed.
P-9	Wadi Arab	PLATEAU	267	170.1	100 plus	The Arab League is developing a Regional Development plan for this area; soon available for review.
P-10	Wadi Araba	RIFT VALLEY	1390	8.7	100 plus	Several groups have surveyed this area to determine the feasibility of further development. Regionalization will allow priority comparisons.
P-11	Zarqa	PLATEAU	830	140	100 plus	This project is currently ending the preliminary phase and beginning implementation. Pilot studies carried out have been very successful.
P-12	Aqaba	AQABA	12800	12.8	-	The Aqaba Authority is relatively new and will be developing its own projects as planning continues.

Related Projects

Activities and plans are underway for several related projects. A brief summary of these activities is found in appendix 5. The important characteristics of these project areas are also shown in table 2. The reports and sites of these projects should be reviewed so that all development projects can be evaluated with common terms of reference. Other projects could be added or could replace those proposed for early implementation as the regionalization and regional planning process continues.

Support Services

One of the most important factors that limits the implementation of projects already planned and those in the planning stage is inadequate Jordanean capacity to provide sufficient staff support for sustained and effective implementation. This is caused by inadequate numbers of sufficiently experienced and skilled staff in planning, administration, technical oversight and evaluation and monitoring during project implementation. This is further influenced by noncompetitive salary levels, which make it difficult to retain those staff with the greatest competence and desired skills.

It is desirable that assistance be given the GOJ in developing an inventory of the staff resources that will be needed over the short, medium, and longer term to implemente the projects planned. This will include an inventory of staff resources currently available, the requirements of a staff development program and the specific in-service and longer term training requirements. In addition, action is needed for strengthening the essential support services such as research, extension, documentation, etc. Some of this is being included within the design of the Jordan Highland Development Project and in those of other donors. These need to be designed to fill priority needs in a coordinated manor. It is important that these support services include adequate range improvement and management research and extension to form

a livestock/range/cropland system component. A research and extension conservation farming component is needed that includes the watershed protection and management needs.

An essential requirement for successful implementation of a National Range Program is an adequate national capacity to provide essential support services. These include research, extension, documentation, and data management, monitoring and evaluation, and a national soil for land use study. Implementation needs for these essential support services should be detailed by specific studies in the next phase proposed in this report.

Training

A development plan is needed for each of the support-service components. This should include an inventory of current staff resources, in-service training needs for existing staff, and long-term training needs. Because of the large number of Jordanean students in the university system (and perhaps an even larger number overseas), an inventory of these potential staff resources should also be considered. In addition a study of Jordan's future needs should indicate how the university system can be strengthened to fill identified gaps, such as in natural resource and range management curricula.

Research and Extension

Adequate research and extension backup has been repeatedly demonstrated throughout the world as absolutely essential to the success of development projects. Major voids in range and watershed research and extension are apparent in Jordan. Because agriculture in Jordan is almost entirely based on a livestock/range/cropland farming system, watershed management is an important component. Therefore, the research and extension program should be a team approach to the development and implementation of improvements in this system that will be acceptable to the agricultural producers and improve range and livestock management

methods. The next phase should examine the research and extension needs, determine current capabilities, identify gaps, and establish development plans that will provide the essential level of support services required.

Documentation Center

It is important that the planners, implementation staff, and those dealing with the essential support services have ready access to the current knowledge base or data management systems in Jordan and abroad. In order to provide information services, assist in data management needs, and provide training assistance in use of these systems, an adequate information center is an essential ingredient.

In the next phase recommended in this report, these needs should be detailed and recommendations made on the organizational locus for such a center.

Monitoring and Evaluation

With the multiplicity of Jordanean agencies, international organizations, and donors involved in development activities in Jordan, it is extremely important to be able to track progress, determine shortfalls, identify bottlenecks, and determine corrective measures needed. It is necessary to monitor the effects of all pending plans and relate current and future operations to resource requirements and allocations on the short, medium, and longer term. During the next phase, these monitoring and evaluation needs should be examined along with the best means to fill them.

National Soil and Land-use Study

Development of detailed land-use plans, based on an accurate knowledge of the soil resources, is basic to development of range needs. The basic requirements for developing a national soil and land use study

have been detailed in the June 1984 report of AID consultant William Johnson. This should be used as the basis for developing this support requirement during the next phase.

First-priority Activities Required for Effective Project Implementation

Institutional Restructuring

There is a general awareness that broadly based natural resource development in Jordan requires institutional restructuring to be successful. For development of the Jordan Valley clear lines of authority, responsibility, and accountability were assigned for implementing this type of large interagency project.

The seat of authority has overall responsibility for planning and implementation of development and direct control over financial resources. It is able to establish wage scales much the same as a private sector company. Because the Government of Jordan realizes the need for institutional restructuring for other regional and sectorial development projects, and because donors are insistent on restructuring, an overall restructuring plan for implementing projects having a spatial orientation is in an advanced state of development.

Implementation of this institutional restructuring will require a careful analysis of the specific implementation requirements, establishment of priorities, assessment of available staff resources and supplemental training needed for some staff, and identification of additional staff needed. Nevertheless, its implementation is necessary if parts or all of a National Range Plan is to be implemented. It is not recommended that the "National Range Plan" be raised to the level of "Authority." Indeed, such a sectorial authority would probably fail. The "Plan," however, must be integrated and form a part of any organization established for spatial planning.

With the division of Jordan into a series of development zones as the basis for project planning and implementation, a central project-planning capability is needed for making detailed regional development plans as the basis for project implementation, including rangeland development and management. Figure 6 shows one way the components of a national range program could be integrated within the administrative structure.

The scope of work phase proposes to assist the GOJ develop work plans for four regional projects that have a large component of rangeland development. In this phase plans should be made for soliciting donor financing and developing Jordanean staff who can plan the future project needs with a minimum of short-term "emergency" assistance from international consultants. To train Jordanean staff, the organizational, staffing, and short- and long-term training needs of a regional planning institution must be determined.

Regionalization

Currently the GOJ is in the process of establishing regional boundaries for subdividing the land mass into regional development units. After the initial division has been established, a preliminary assessment should be made of the most urgent needs considering the range and resources available and then set the priorities for the projects planned in the four regions. As projects are implemented, there may be a need for boundary changes or subdivision through either aggregation or redistribution of the areas involved.

Consideration of donor interests and donor financial capabilities is of first priority during initial regionalization assessments so as to attract maximum donor support.

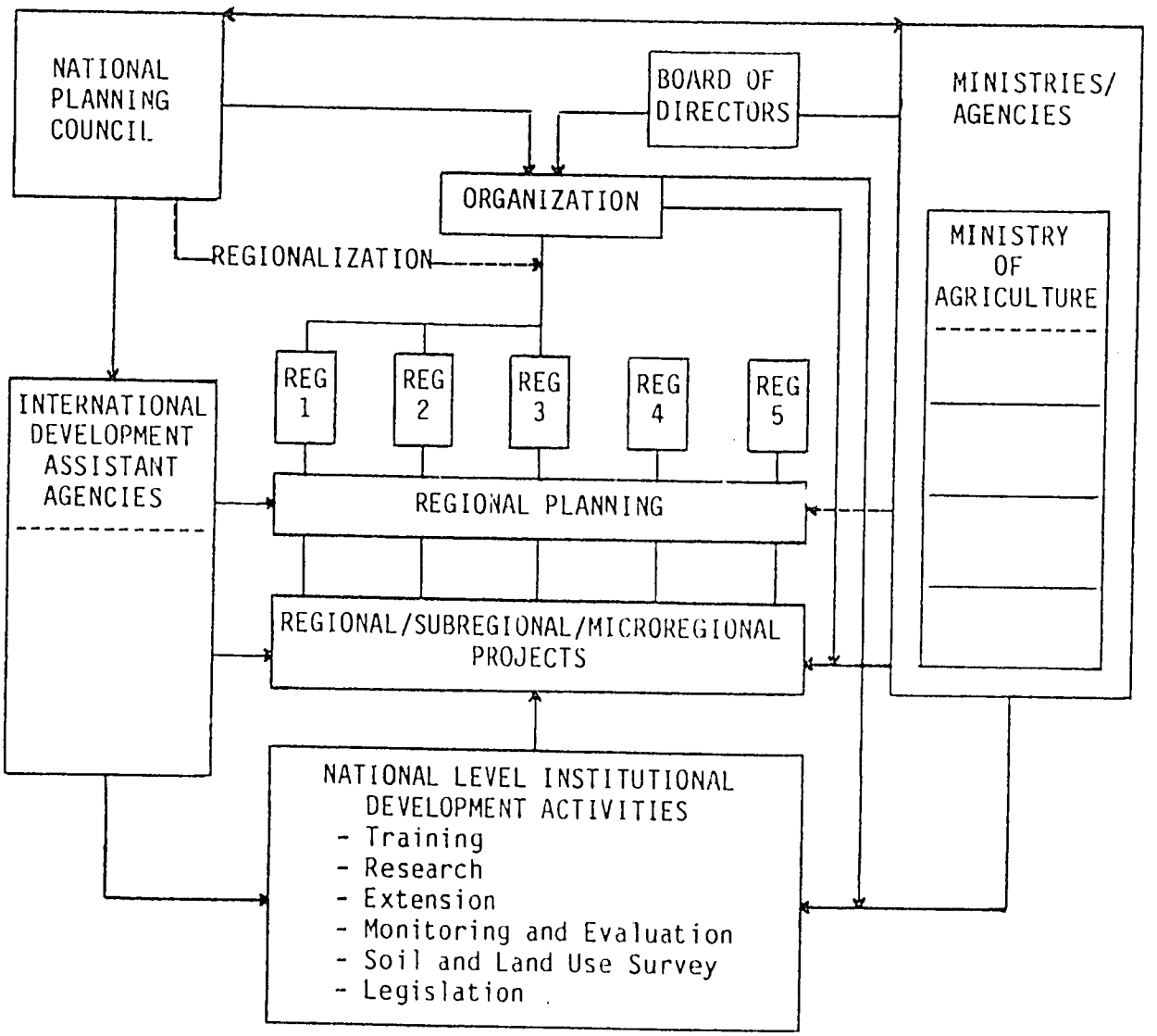


FIGURE 6. RELATIONSHIP BETWEEN THE COMPONENTS OF THE PROPOSED NATIONAL RANGE PROGRAM

Legislation

The current legal basis for the use of rangelands, water, and grazing rights stems from Ottoman and Islamic law, which has been modified by specific legislative acts by the GOJ. In order to implement improvements in and proper management of rangelands, various modifications in legislation will be required to permit the needed enforcement. In addition, inheritance traditions have prevented the sound management of the land resources by accelerating the fragmentation of land ownership. New legislation is needed to discourage further fragmentation and to encourage reaggregation of land so that equity to present land owners is ensured.

Development Plan

A package of three types of projects has been proposed that forms a program for the development of the rangelands of Jordan. A twelve-month period is suggested to complete detailed scopes of work for the four integrated regional development planning projects, to review the related project activities, and to prepare implementation plans for the support service projects. Figure 7 outlines the costs, timing, and products expected from this overall development program. Figure 7 also diagrammatically shows how the integrated regional development plan leads to project implementation using the Wadi-Mujib project as an example.

Using this approach, the detailed scope of work for the Wadi-Mujib project would be available for submission to a donor 2 months after project initiation. The other projects and scopes of work, including the support services projects, would be ready within the first twelve-month period for submission to a donor for implementation or ready for the integrated regional development planning phase.

To prepare for the implementation of projects, the integrated regional planning phase for each of the four regional development areas should 1) involve donors likely to be involved in the project implementation

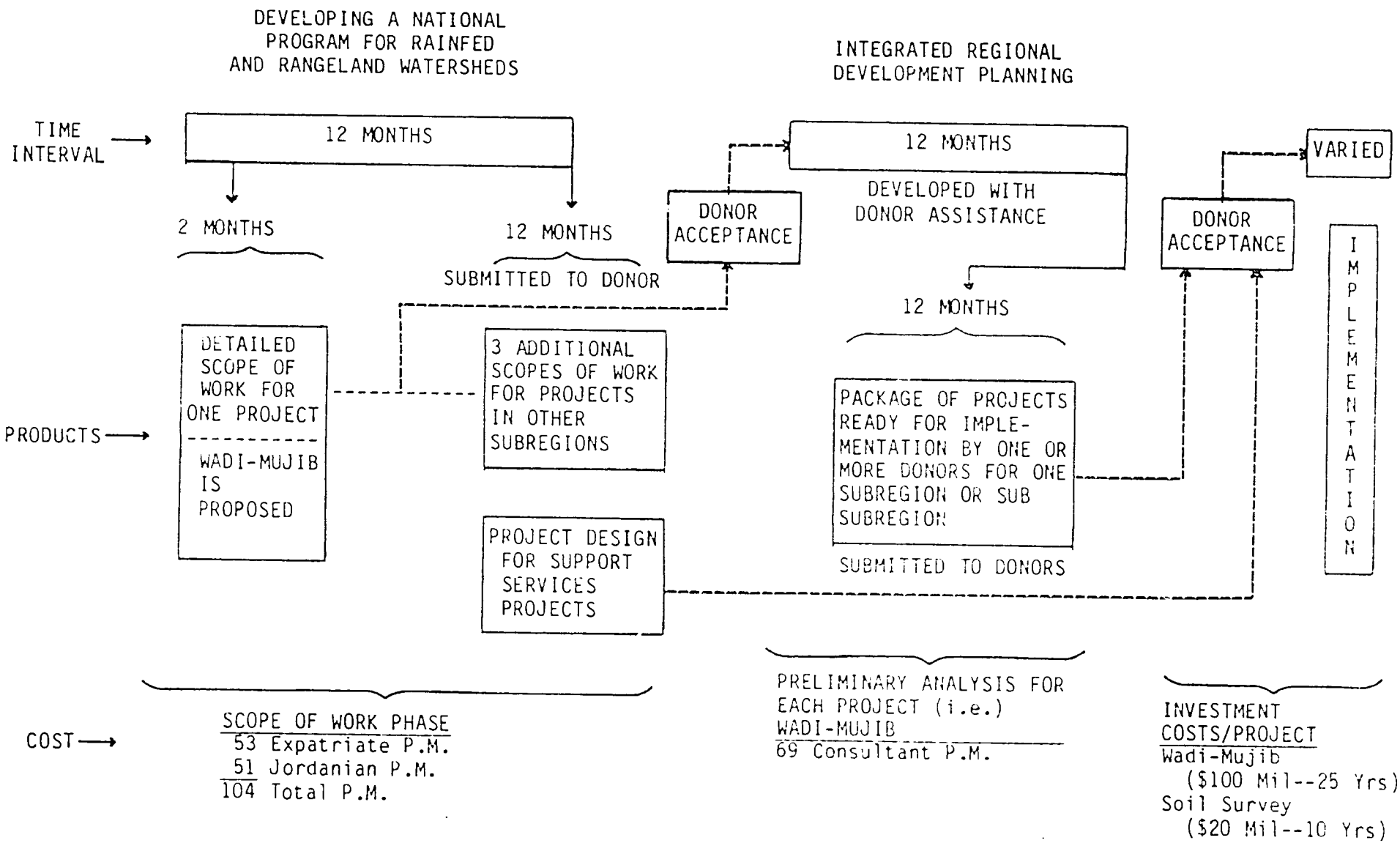


FIGURE 7. TIME INTERVAL, PRODUCTS, AND COSTS

phase; 2) last about 12 months; and 3) require approximately $1 million to prepare.

This paper outlines the anticipated budget and manpower requirements for only one of the four regional projects -- the Wadi-Mujib. These items have been included to illustrate the level of effort required to prepare the total plan for integrating these rangeland areas. Detailed staffing and budget requirements for each of the development projects will be prepared during the scope of work phase.

The team that completed the first twelve-month work phase could feasibly complete this second IRDP phase with input from selected consultants. The expected output from the second phase would be a set of project plans ready for implementation within the specified geographical area. The projects together form a rangeland integrated regional development program for that area. These projects should be divided according to donor interests and level of funding needed. It is estimated that a typical project funding cycle will require at least 28 months from the beginning of the scope of work phase until project implementation can begin.

Scope of Work Summary

An interdisciplinary team will be needed to design the integrated project desired by the GOJ for implementation. Tables 3 and 4 show the projected staffing analysis for each project component and the person months required (by specialty) for the scope of work phase using the integrated regional development plan for the Wadi Mujib as an example. The four-month interim period between these two phases was inserted to allow adequate time for obtaining donor support and involvement for the IRDP phase that follows. Although the requirements for the Wadi Mujib will likely be different from each of the other three areas considered, the approach will be similar.

TABLE 3. PERSON MONTHS REQUIRED TO COMPLETE THE SCOPE OF WORK PHASE AND ONE IRDP PHASE

	Scope of work phase												Interim period				IRDP phase												
Specialist	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	
Coordinator	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	28
Range/watershed	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	28
Reg./urban planning	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	28
Forester	1	1	1	1	1	1	1	1	1	1	1	1						1	1						1				15
Sociologist	1	1	1	1	1	1	1	1	1	1	1	1						1	1	1					1				16
Ag. Engineer	1	1	1	1	1	1	1	1	1	1	1	1						1	1	1					1				16
Economist	1	1	1	1	1	1	1	1	1	1	1	1						1	1	1	1				1	1			18
Training Specialist					1	1																							2
Range Management Educator					1	1																							2
Range Extensionist			1																						1	1			3
Communication Specialist						1																							1
Lawyer					1																								1
Inter. Lawyer					1																								1
Systems Scientist			1	1		1												1	1										5
Org. Planner				1						1																			2
Animal Scientist										1													1	1					3
Wildlife Biologist																		1	1						1				3
Hydrologist										1								1	1						1	1			5
Soils Specialist								1										1	1	1									4
Geologist																		1	1					1					3
Ground H_2O Hydrologist										1								1	1					1					4
Watershed Scientist			1																				1	1					3
Water Resource Use Specialist																							1	1					2
Land Use Specialist								1											1	1									3
Civil Engineer							1																						1
Transporation Specialist																								1	1				2
	7	7	10	9	11	11	8	9	7	11	7	7	3	3	3	3	3	13	14	8	4	3	6	9	11	6	3	3	199

Total PM in 1st Phase	104
Total PM Interim	12
Total PM Preliminary	83
Grand Total	199

TABLE 4. Staffing Analysis for the Scope of Work and IRDP Phases

	Scope of Work Phase												Interim Period				IRDP Phase											
MONTHS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
DISCIPLINE																												
Range/Watershed Specialist	P-1	P-1	P-1 T-2	P-5	T-1	P-6	P-4	T-5 P-7	P-2	P-3	P 2-4	P 2-4	T-1	T-1	T-1	T-1	T-1	P-1	P-1	P-1	P-1	P-1	P-1	P-1	P-1	P-1	P-1	P-1
Regional/Urban Planner	P-1	P-1	P-1 T-2	P-5	T-1	P-6	P-4	T-5 P-7	P-2	P-3	P 2-4	P 2-4	T-1	T-1	T-1	T-1	T-1	P-1	P-1	P-1	P-1	P-1	P-1	P-1	P-1	P-1	P-1	P-1
Forester	P-1	P-1	P-1 T-2	P-5	T-1	P-6	P-4	T-5 P-7	P-2	P-3	P 2-4	P 2-4						P-1	P-1						P-1			
Sociologist	P-1	P-1	P-1 T-2	P-5	T-1	P-6	P-4	T-5 P-7	P-2	P-3	P 2-4	P 2-4						P-1	P-1	P-1					P-1			
Agriculture Engineer	P-1	P-1	P-1 T-2	P-5	T-1	P-6	P-4	T-5 P-7	P-2	P-3	P 2-4	P 2-4						P-1	P-1	P-1					P-1			
Economist	P-1	P-1	P-1 T-2	P-5	T-1	P-6	P-4	T-5 P-7	P-2	P-3	P 2-4	P 2-4						P-1	P-1	P-1	P-1				P-1	P-1		
Training Specialist					T-1	T-3																						
Range Management Educator					T-1	T-3																						
Range Extensionist			T-2																									
Communications Specialist						T-3																			P-1	P-1		
Lawyer					0-4																							
International Lawyer					0-4																							
Systems Scientist			T-2	0-3		T-3				T-4																		
Organizational Planner				0-3														P-1	P-1									
Animal Scientist										T-4																		
Wildlife Biologist																						F-1	F-1					
Hydrologist										T-4								P-1	P-1						P-1			
Soils Specialist								T-5										P-1	P-1						P-1	P-1		
Geologist																		P-1	P-1	P-1								
Ground Water Hydrologist										T-4								P-1	P-1				P-1					
Watershed Scientist		T-2																P-1	P-1				P-1					
Water Resource Use Specialist																						P-1	P-1					
Land Use Specialist							T-5															P-1	P-1					
Civil Engineer						P-4													P-1	P-1								
Transportation Specialist																							P-1	P-1				

The team preparing the scopes of work will be composed of a combination of expatriate and Jordanian experts. It is suggested that six full-time experts (2 expatriates) and an overall coordinator form the principal team assigned to complete the 12-month scope of work phase. Consultants will supplement this team where required. A total of 119 person months will be required during the 12-month scope of work phase. The projected budget (table 5) includes 55 person months of expatriate professional time and 64 person months of Jordanian professional time. The total budget indicates that approximately $1 million will be required to complete this phase, not including the 64 person months of Jordanean time contracted by the GOJ.

Appendix I contains the project profiles for each of the components described in the budget and includes the terms of reference for consultants assigned to this task.

TABLE 5. Budget Analysis for the Scope of Work Phase of a Rangeland Development Project for Jordan

		Project Admin.	Wadi Mujib P-1	Azrak P-2	Balqa Salt P-3	Jafr Basin P-4	Range Mgt. P-5	Range Rev. P-6	Water Harvest P-7	Projects Sub tot	Train. T-1	Research & Ext. T-2	Docum. Center T-3	Monitor & Eval. T-4	Soil Survey T-5	Support Sub tot	Regional-ization O-1	Organ. Restruc. O-2	Regional Planning O-3	Legis-lation O-4	Immediate Need Sub tot	GRAND TOTAL
PERSONNEL																						
EXPATRIATE	PM	12	5	4	4	4	2	2	2	23	4	2	4	4	2	16			2	2	4	55
@ 7300/PM	$	87600	36500	29200	29200	29200	14600	14600	14600	167900	29200	14600	29200	29200	14600	116800	0	0	14600	14600	29200	401500
NATIONAL	PM	12	10	6	6	6	4	4	4	40	2	2	2	2	4	12					0	64
Government of Jordan Contribution																						
SUBTOTAL	PM	24	15	10	10	10	6	6	6	63	6	4	6	6	6	28	0	0	2	2	4	119
OVERHEAD (50% of salaries)		43800	18250	14600	14600	14600	7300	7300	7300	83950	14600	7300	14600	14600	7300	58400	0	0	7300	7300	14600	200750
DIRECT COSTS																						
TRAVEL (int)		12000	3429	3429	3429	3429	3429	3429	3429	24000	3000	4500	4500	6000	3000	21000			3000	3000	6000	57000
TRAVEL (local)		10000	4286	4286	4286	4286	4286	4286	4286	30000						0					0	40000
PER DIEM		9000	2571	2571	2571	2571	2571	2571	2571	18000	6000	9000	9000	12000	6000	42000			6000	6000	12000	81000
RELOCATION (3 IND)		30000	8571	8571	8571	8571	8571	8571	8571	60000						0					0	60000
OFFICE SUPPORT		100000	0	0	0	0	0	0	0							0					0	100000
MISCELANEOUS		50000	4286	4286	4286	4286	4286	4286	4286	30000	5000	5000	3000	7000	5000	25000			5000	5000	10000	115000
TOTAL		342400	77893	66943	66943	66943	45043	45043	45043	413850	57800	48400	60300	68800	35900	263200	0	0	35900	35900	71800	1091250

NOTE: Direct costs for projects P-1 to P-7 have been spread equally over all projects.

COURSE OUTLINE NOTES

(This paper is provided for use in taking notes on the topics that may relate to the development of your course outline.)

TOPIC:

DATE:

SPEAKER(S):

GENERAL NOTES:

LINKED TO:

TRAINING USE OR IDEAS:

FOLLOWUP OR BACKSTOPPING IDEAS:

CLIMATE

ABSTRACT OF LECTURE

The term climate is generally defined as the "average condition" of weather at a locale, over a period of years, as shown by precipitation patterns, temperature regimes, atmospheric moisture, wind, and light. Weather, in turn, is a set of atmospheric conditions at a specified point in time and, therefore, refers to events. Climate is basic to the functioning of an ecosystem because of its significance in soil development and plant productivity. However, climate is also difficult to characterize, due to frequent deficiencies in the length and consistency of necessary meteorological records.

OBJECTIVE

Climate of a site is most easily described from records of the World Meteorological Organization (WMO) of the United Nations, or from source data that are collected by weather offices in a country. Unfortunately, many weather stations from which this information is obtained are poorly distributed; this is especially the case on arid and semiarid lands of many developing countries. Nevertheless, because of its role in soil development and plant productivity, the reasons for evaluating the climate of a site are discussed in this lecture. Additionally, mensurational techniques that are commonly employed to quantify the climate are briefly described.

INTRODUCTION

As mentioned, the weather at a given place is the "sum" of all of the meteorological variables (e.g., precipitation, temperature, humidity, etc.) and the state of the sky at a given time. A study of the simultaneous weather conditions over a relatively large area, and their development leads to, what is called, synoptic meteorology. Even though the changes in the weather are proverbial, it is possible to arrive at a

65

composite of these variations. One speaks, then, of the climate of a region.

The science that studies the climates on the earth is called climatology. It is obviously related to meteorology, and also to geography, since the atmosphere is strongly influenced by the physical nature of the earth's surface. Owing to the "intermediate position" of climatology between meteorology and geography, climatological investigations stress either the meteorological or the geographical aspects. Here, both viewpoints will be emphasized.

STATEMENT OF ISSUES

Because of its role in soil development and plant productivity, a knowledge of climate is obviously important. In this lecture, the reasons for considering precipitation, temperature, atmospheric moisture, wind, and light are described, along with the methodologies that are employed in their quantification and evaluation. Of the abiotic (nonliving) components that are considered in evaluating the potential of a site for land management purposes, climate is generally the most dynamic in nature.

RELATIONSHIP TO OTHER LECTURES

This and several of the subsequent lectures, in general, provide an introduction to abiotic (nonliving) components that, when integrated with biotic components, furnishes a basis in which an ecosystem can be evaluated for purposes of development. In general, the intensity of the effort that is undertaken in evaluating these abiotic and biotic components depends, in large part, on the objectives of the proposed development activity, the complexity of the ecosystem being evaluated, and the completeness of the available, relevant knowledge.

MAIN TOPICS OF LECTURE

This lecture is organized to describe the role of precipitation patterns, temperature regimes, atmospheric moisture, wind, and light in determining the climate of a site. For each, the reasons for evaluating the component are mentioned, and the mensurational techniques employed to quantify the component are briefly described.

Although soil moisture, to which the survival and growth of plants are tied, is mostly derived from rain, not all of the precipitation that falls on a site is equally effective in terms of raising the soil moisture content. For example, the slower, more gentle a rainfall event, the greater the proportion of water that enters the soil. And, the greater the quantity of precipitation in a given rainfall period, the more it will infiltrate the soil. A series of precipitation events that total several millimeters may have little effect in increasing the soil moisture content, because the individuals are too widely separated and too gentle to have a cumulative impact. In arid and semiarid ecosystems, the more severe a drought, the greater the quantity of rain must be to subsequently alleviate it. For these and many other reasons, it may well be necessary to include a measure of the annual and seasonal amounts of precipitation in an evaluation of climate at a site.

Reliable measurements of rainfall are most commonly acquired from networks of rain gauges. There are many types (e.g., standard, recoding, totalizer, etc.) and dimensions of rain gauges, but they all consist essentially of a funnel with a vertical collar, which delivers the water to a collecting reservoir. Only precipitation records that are obtained from rain gauges located where no eddies are likely to occur should be used in a site evaluation. As a general rule, no foreign objects should be closer to a rain gauge than two-times its height above the receiver funnel.

Solar radiation is the source of heat that controls the temperature regimes near the surface of the earth. The temperature at a site is

determined from incoming solar radiation which, in turn, is modified by secondary heat transfers from terrestrial radiation and air movements. Temperatures of either extremes, high or low, can be detrimental to the establishment of growth of plants. Hot temperatures and dry winds, a frequent combination in arid and semiarid regions, can be damaging to recently emerged plants, especially under conditions of minimal soil moisture.

High quality air temperature data are gathered from simple thermometers (for instaneous determinations), maximum-minimum thermometers (to measure temperature extremes), and thermographs (for a continuous record of temperatures). Thermometers are generally housed in shelters with louvered sides to permit air to circulate freely. The shelters should be located at a distance at least two-thirds the height of any obstructions. Biased records of temperature will be obtained from shelters on steep slopes and in hollow areas.

From the standpoint of plant growth, atmospheric moisture is important in changing the water relations of the plant tissue. In general, moisture moves from a plant into the atmosphere, and vice versa. When the vapor pressures are equal, no change of water vapor between the plant and the atmosphere will take place.

Normally, the air within plant leaves is saturated under growing conditions and, therefore, water vapor will move from the leaves into the surrounding atmosphere; this is transpiration. The rate of transpiration is partially dependent upon the atmospheric moisture present. The drier the air, the higher the rate of water loss by transpiration. Transpiration can cause water deficits to occur. Under conditions of limited soil moisture, these water deficits can be responsible for plant growth reductions, or even death.

To characterize atmospheric moisture at a site, in a given period, relative humidity is often measured. Instaneous measures of relative humidity are obtained from manual observations of dry- and wet-bulb

thermometers on a sling psychrometer. Hygrometers, of which several types exist, are used to record relative humidity on a continuous basis. These instruments should be housed in the shelters containing thermometers.

Wind is a climatic factor that affects plants directly by increasing evapotranspiration from the surface of leaves, making possible photosynthesis by circulating carbon dioxide in the air, causing various kinds of mechanical damage (e.g., stem breakage, windthrow, etc), and by disseminating pollen and seed. Biologically, the effect of wind on evapotranspiration can be critical, particularly in dry climates. When a plant is exposed to drying winds and hot temperatures, water deficits in its leaves are likely to occur. This situation is compounded under minimal soil moisture conditions. The desiccating impact of wind on plants is demonstrated by stunted growth and, frequently, death that is commonly observed in many plant communities on arid and semiarid lands.

Unfortunately, source data on wind patterns (e.g., prevailing direction, velocities, seasonal fluctuations, etc.), especially to characterize a particular site, are uncommon in many countries. When this information is available, it is generally derived from instantaneous measurements by an anemometer.

Another climate factor that affects the growth of plants on a site, but a factor that is seldom measured, is light. It is well established that solar radiation in the visible bands of the spectrum controls photosyntheses. In general, individual plant species differ in their relative "tolerances" to either low or high intensities of light.

Also, the photoperiodism of plants differs among species. Some plants require long photoperiods (that is, length of day) to grow and develop while other plants do better with shorter photoperiods. Fortunately, photoperiods can be measured by the length of daylight at a site.

Records of the World Meteorological Organization (WMO) of the United Nations can be used to describe the climate of a site, although more commonly, source data that are collected by national weather offices in a country are employed for this purpose. At times, ecologists that are particularly familiar with a region can supplement insufficient meteorological records from "inferences" of soils and vegetation.

HOMEWORK AND WORK PROBLEMS

PHYSICAL RESOURCES NEEDED FOR LECTURE

The following projection equipment is needed: a 35-millimeter slide projector and an overhead (transparency) projector.

HANDOUT MATERIAL

GLOSSARY OF TERMS

REFERENCES

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HYDROLOGIC CYCLE

ABSTRACT OF LECTURE

In essence, the hydrologic cycle represents the processes and pathways involved in the circulation of water from land and water bodies to the atmosphere, and back again. Quantities of water in the input, output, and storage components of the hydrologic cycle are constantly changing, however, because of the dynamic nature of the hydrologic cycle. Nevertheless, at any one point in time, the quantities of water in the components can be approximated. These approximations, in turn, can be useful in understanding the abiotic (nonliving) components of an ecosystem.

OBJECTIVE

The hydrologic cycle is complex and dynamic, but it can be simplified if one categorizes the hydrologic components into input, output, or storage. Inputs such as rainfall, condensation, and in many regions of the world, snowfall must balance with outputs which include streamflow, groundwater, and evapotranspiration, and with changes in storage. This hydrologic balance, often referred to a water budget, is essentially an accounting procedure, which quantifies and balances the primary components of the hydrologic cycle. It is a useful approach to the study of the hydrologic cycle and the impacts of land management activities on the hydrologic cycle, as outlined in this lecture.

INTRODUCTION

When the total water resource on the earth is considered, only about 3% is fresh water. Nearly three-fourths of this fresh water is tied up in the polar ice caps and glaciers, and about 10% is storage in deep groundwater aquifers, leaving between 10% and 15% for active circulation. Of the amount of water in active circulation, only 0.5% exists in the atmosphere and biosphere. The atmosphere redistributes evaporated

water by precipitation and condensation, while components of the biosphere partition this water into surface runoff, soil water storage, groundwater, or back into the atmosphere.

It is important to note that the hydrologic processes of the biosphere, and the effects of vegetation and soil on these processes are of particular interest to watershed managers. Processes such as precipitation, infiltration and percolation, evapotranspiration, surface and subsurface runoff, and groundwater flow can all be affected by land management activities. Likewise, the magnitude of various storage components, including soil water, lakes and reservoirs, and rivers can be altered. With a knowledge of the hydrologic cycle, one can examine the nature of watershed systems, quantify the effects of land management impacts on the components of the hydrologic cycle, and in some instances, estimate the hydrologic consequences of proposed or future land management practices.

STATEMENT OF ISSUES

The hydrologic cycle is a useful "vehicle" for the study of climate, soil, land form and relief, and water in a holistic manner. Furthermore, the hydrologic cycle is a logical framework in which to measure and then analyze the basic components of precipitation, evapotranspiration, infiltration and percolation, and the pathways of runoff on a watershed basis. This framework, in turn, can be a helpful method to estimate the hydrologic consequences of current and proposed land management activities.

RELATIONSHIP TO OTHER LECTURES

This lecture provides a reference in which the previous lecture on climate and the subsequent lectures on the other abiotic (nonliving) components of an ecosystem can be interpreted. As mentioned above, the hydrologic cycle provides a "systems approach" to the assessment of the abiotic components of a ecosystem. In this approach, a study of the

interacting abiotic components that function simultaneously in an ecosystem is, to the extent that is possible, all encompassing.

MAIN TOPICS OF THE LECTURE

In essence, the various processes in the hydrologic cycle, including precipitation, interception of precipitation by vegetation, movement of water into and through the soil, evapotranspiration, and the pathways by which excess water becomes runoff are discussed in this lecture. Additionally, these processes are functionally related together by the water budget and energy budget concepts.

Precipitation occurs when the atmosphere becomes saturated, small particles or nuclei (upon which condensation or sublimation takes place) are present, and water or ice particles unite and grow large enough to fall to the ground under the influence of gravity. Most commonly, precipitation occurs when an air mass is lifted by frontal systems, orographic effects, or convection, becomes cooled, and reaches its saturated vapor pressure.

Once precipitation has occurred, the type, extent, and condition of the vegetation on a site can influence where and how much of the precipitation reaches the ground through the interception process. Not all of the precipitation that is intercepted is lost to the atmosphere, however, as much may drip off the foliage or otherwise reach the soil surface. Furthermore, not all of the precipitation that penetrates the vegetative canopy enter the soil or becomes available for runoff, because the litter on the ground surface can store large quantities of precipitation which ultimately evaporates.

Once precipitation reaches the ground surface, a portion may enter the soil, a process known as infiltration. Infiltration results from the combined forces of, initially, capillarity and, eventually, gravity. The process of saturated water flow through the soil mantle under gravitational force is called percolation.

Evaporation of precipitation from soils, plant surfaces, and water bodies, and transportation of water vapor through plant stomata are often considered collectively, as evapotranspiration. Evapotranspiration is of particular interest to watershed managers because it strongly affects the water yielding characteristics of an area and is often influenced by land management practices. In general, the requirements for evapotranspiration include a flow of energy to the evaporating or transpiring surface, a flow of water vapor away from these surface, and a flow of liquid water to these surfaces. When one or more of these flows are changed, there is a corresponding change in the total evapotranspiration loss.

Runoff, by definition, refers to the various processes and pathways by which excess water becomes streamflow. Excess water represents that part of the precipitation input that runs off the land surface and that which drains from the soil and is, therefore, not consumed by evapotranspiration. A perennial stream (e.g., one which flows throughout the year) is most fed by groundwater. However, once precipitation occurs, several additional pathways of water flow can contribute to streamflow. The most direct pathway from precipitation to streamflow is that part which falls directly into the stream channel, called channel interception. Overland flow occurs from impervious areas or from areas on which the precipitation rate exceeds the infiltration capacity of the soil. Interflow is that part of the precipitation that infiltrates, but arrives at the stream channel over a short enough time period to be considered a part of the so-called "storm hydrograph." The sum of channel interception, overland flow, and interflow is considered to be "direct runoff," which is a flood-producing characteristic of watersheds.

The water budget is simply an application of the conservation of mass principle to the hydrologic cycle. That is, for a watershed and a particular time interval, the difference between inflow of water to a system and outflow of water from the system represents the change in storage of the volume of water in the system. Water budgets can be

determined for small plots, headwater drainages, large river basins, or even continents. The application of a water budget as a hydrologic tool, a common task of watershed managers, is relatively simple. If all but one component of a system can either be measured or otherwise estimated, then one can solve directly for the unknown component.

As with the water budget, the basic components of the energy budget can be identified and partitioned. Some of these components can then be related to the components of the water budget. The linkage between the water and energy budgets is direct. Net energy solar available at the earth's surface can be apportioned largely as a result of quantities of water in the various storage components in a water budget. The energy budget concept has been widely employed to estimate evaporation from bodies of water and the potential evapotranspiration rate for terrestrial systems.

HOMEWORK AND WORK PROBLEMS

PHYSICAL RESOURCES NEEDED FOR LECTURE

The following projection equipment is needed: a 35 millimeter slide projector and an overhead (transparency) projector.

HANDOUT MATERIALS

GLOSSARY OF TERMS

REFERENCES

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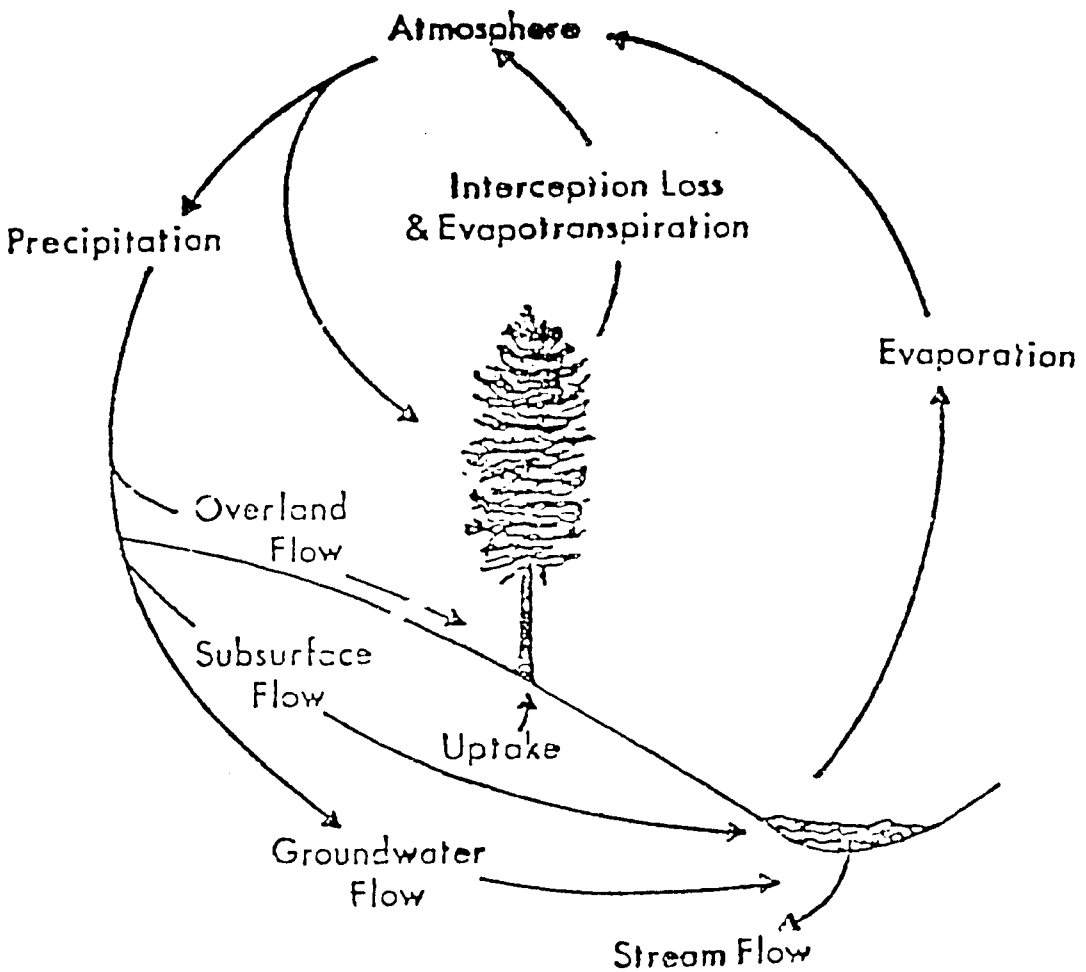
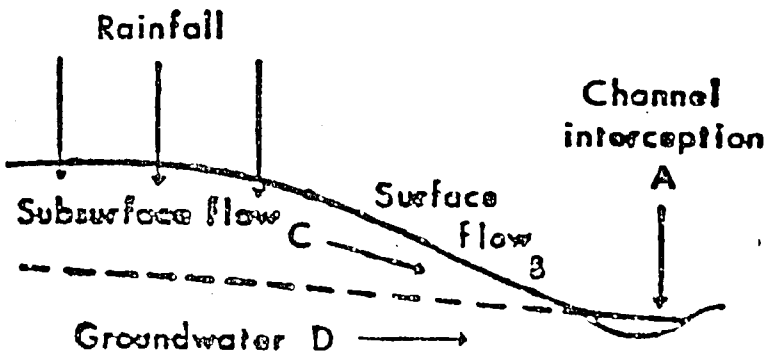
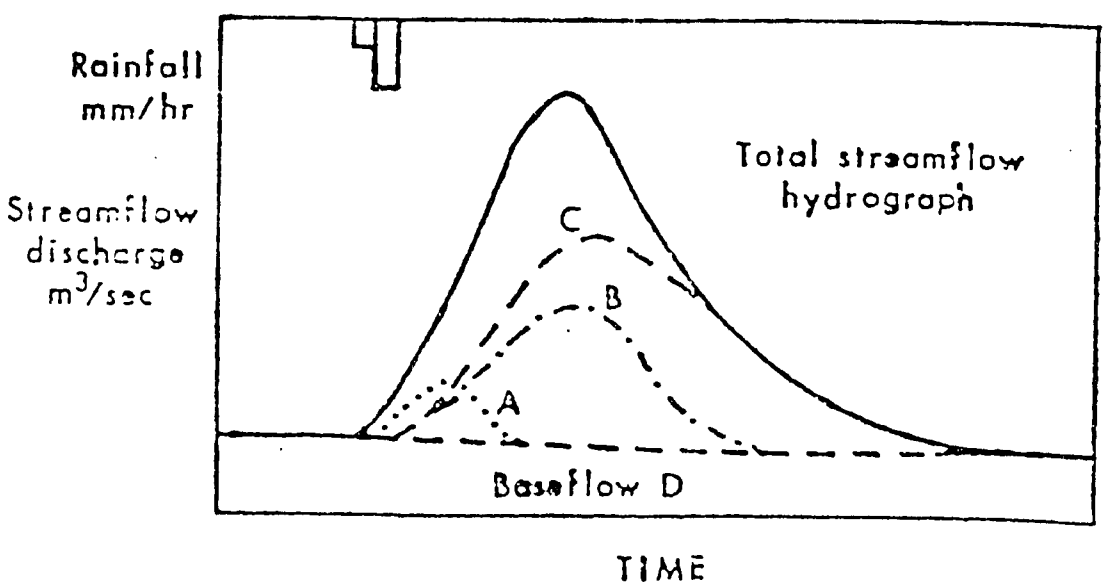
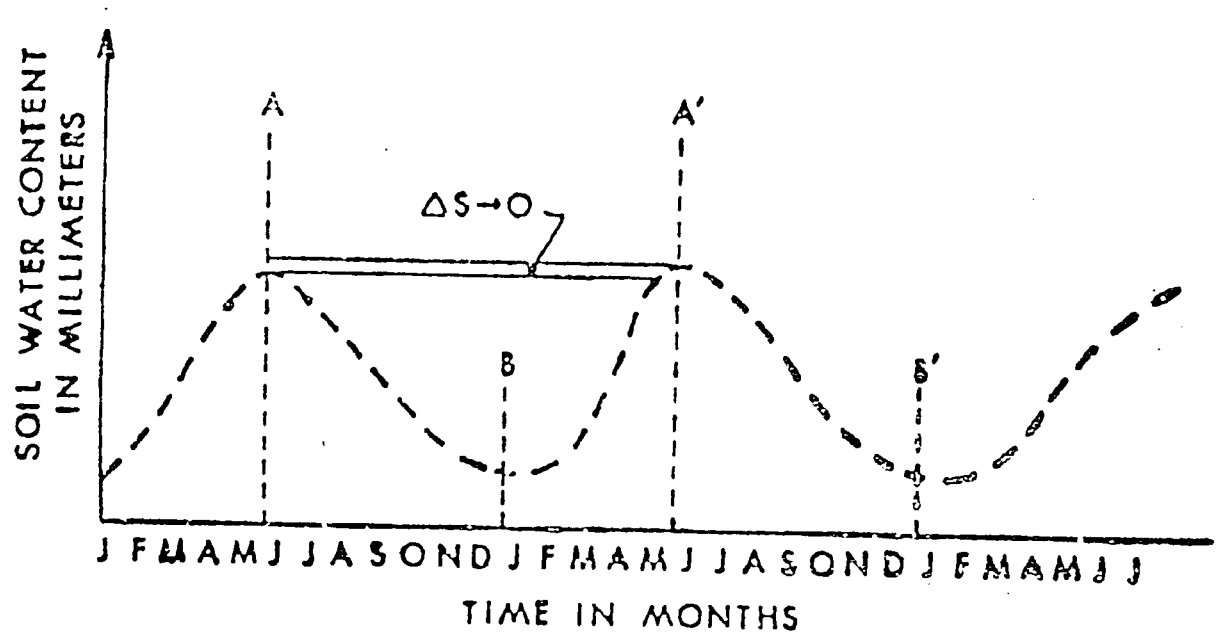
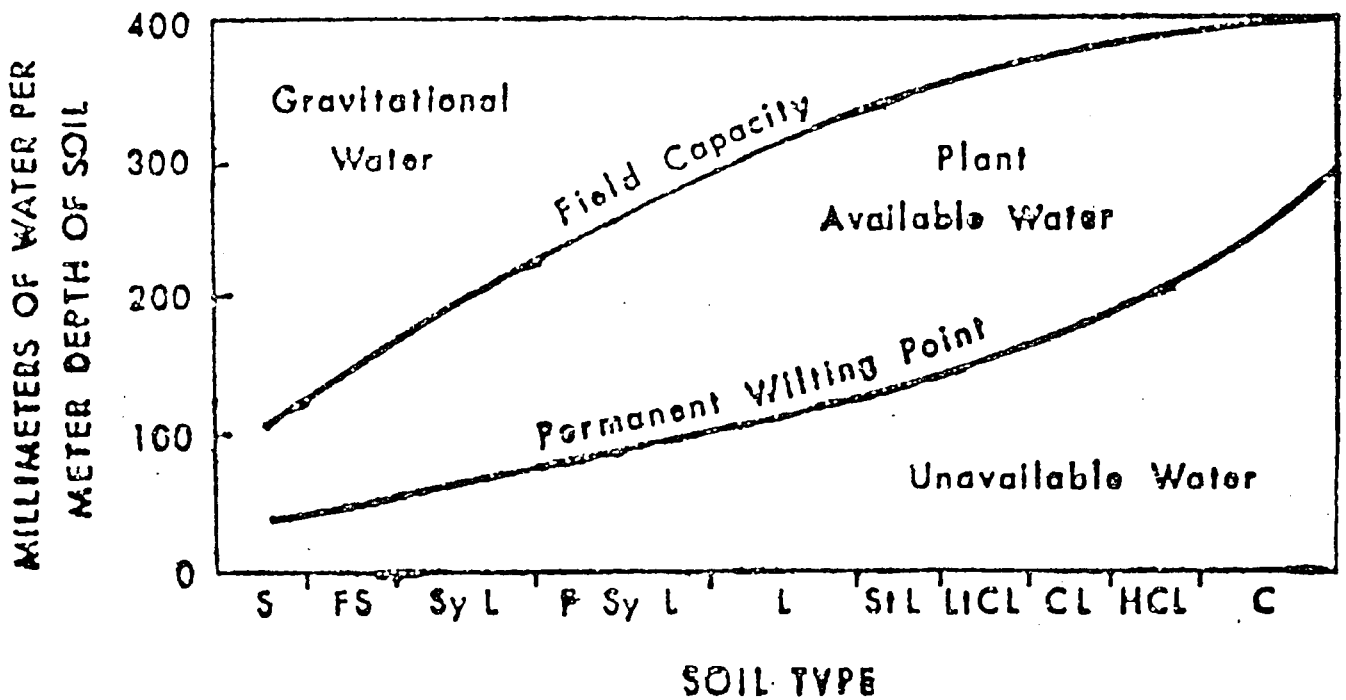

Atmosphere
Interception Loss
& Evapotranspiration
Precipitation
Evaporation
Overland
Flow
Subsurface
Flow
Uptake
Groundwater
Flow
Stream Flow


Rainfall
Channel interception
A
Subsurface flow
C
Surface flow
B
Groundwater D


Rainfall mm/hr
Streamflow discharge m³/sec
Total streamflow hydrograph
C
B
A
Baseflow D
TIME


SOIL WATER CONTENT IN MILLIMETERS
A
A'
ΔS→O
B
B'
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J
TIME IN MONTHS



S	Sand			F	Fine
L	Loam	Sy	Sandy	Li	Light
C	Clay	Si	Silt	H	Heavy

COURSE OUTLINE NOTES

(This paper is provided for use in taking notes on the topics that may relate to the development of your course outline.)

TOPIC:

DATE:

SPEAKER(S):

GENERAL NOTES:

LINKED TO:

TRAINING USE OR IDEAS:

FOLLOWUP OR BACKSTOPPING IDEAS:

WATER RESOURCES INVENTORY AND MONITORING

ABSTRACT OF LECTURE

Fundamental to the management of natural and agricultural resources is an accurate, unbiased evaluation of the components of an ecosystem. In this lecture, techniques to measure the water resource, including precipitation, streamflow, and water quality parameters, are presented. Water is important to resource managers in its liquid, solid, and vapor forms. It is one of the most dynamic of the natural resources, and at times, it may completely "dominate" the use and management of other resources on the land.

OBJECTIVE

Due to its importance, the inventory and monitoring of the water resource is a priority mensurational undertaking. Therefore, it is necessary that natural and agricultural resource managers and land use planners know the basic inventory and monitoring techniques that are employed to quantify this critical resource. Emphasis in this lecture is placed on methodologies of measuring precipitation, streamflow, and water quality.

INTRODUCTION

Water is one of the most important of the natural resources, in that it greatly influences the production rates of timber, forage, and wildlife. Also, liquid water on and from upland watersheds can affect the fishery resources in an area, and in many localities, streamflow runoff derived from liquid or solid precipitation forms constitues an important source of water for municipal, agricultural, and industrial applications downstream. Runoff can provide hydropower to aid in satisfying energy needs, although excessive runoff may cause damage as a result of erosion, sedimentation, and flooding. Therefore, the quantity, timing,

and quality of water that is yielded from upland watersheds are of critical importance.

Additionally, interactions between water and the utilization of other resources can be important. To illustrate, the harvesting of trees or excessive utilization of forage resources may increase streamflow yields, at least temporarily. Simultaneously, poor road engineering may increase the rates of erosion and subsequent sedimentation. It is, therefore, apparent that water not only affects other resources, but the use and management of those resources affects the quantity and quality of the water resource. To evaluate the significance of water, both on and off the land, it is necessary to inventory and monitor the water resource in its various forms, just as it is necessary to do so for timber, rangeland, and wildlife resources.

STATEMENT OF ISSUES

The distribution and availability of water is critically important to the management of natural and agricultural resources. The seasonal availability of surface water must be known in terms of surface flows and impoundments, and seeps and springs. Locations of existing wells and promising groundwater acquifers (for subsequent development) should also be studied. Water quality, both physical and chemical, needs to be considered in the evaluation of a site if, as part of the management regime, artificial watering is required. In this lecture, emphasis is placed on the inventory and monitoring of precipitation inputs and streamflow outputs that characterize an ecosystem, and on water quality parameters.

RELATIONSHIP TO OTHER LECTURES

In essence, this lecture presents the inventory and monitoring procedures that are used to quantify, in part, the hydrologic cycle, the topic of a previous lecture. Techniques that are employed to measure

other components of the hydrologic cycle have been, or will be described in subsequent lectures.

MAIN TOPICS OF LECTURE

For convenience in presentation, the lecture is organized into three parts: precipitation measurements, streamflow measurements, and water quality measurements, with inventory and monitoring techniques described for each.

Measurement of precipitation is an integral aspect of most hydrologic projects. Information on the amount, intensity, type, frequency, and duration of precipitation regimes is essential to the development of operational programs in the management of natural and agricultural resources.

Precipitation is commonly measured in one of three types of gauges: the standard gauge, the storage gauge, and for continuous monitoring, the recording gauge. Of importance is the selection of the gauging site, as topography can influence the performance of the gauge. Turbulence and eddy currents near the gauging site must be avoided to the extent that is possible. The number of gauges that are required to measure precipitation increases with the size of the area monitored. Whenever possible, random sampling should be imposed as a means of excluding bias in the selection of the gauging sites.

The mean depth of precipitation over an area is required in most investigations. Several procedures are employed in deriving this value, the three most common being the arithmetic, the Thiessen, and the isohyetal methods. In using the arithmetic methods, a straight arithmetic average is assumed to be "representative" of the mean depth of the precipitation input. The Thiessen method involves a determination of an area of influence for the individual gauging sites. In essence, polygons are formed, and the area of the polygons used to weigh the precipitation amount of the gauging sites and amounts of recorded

precipitation are plotted on a suitable map, and contours of equal precipitation (isohyets) are drawn. The average depth of precipitation is determined by computing and dividing by the total area. The choice of procedure to employ in deriving a measure of the mean depth of precipitation depends, in large part, on the nature of the precipitation regime and the topography of the area being monitored.

Source data on streamflow volumes are, perhaps, the most important information needed by both the water resource manager and the hydrologic engineer. Peak flow data are required in planning for flood control and engineering structures (e.g., bridges, culverts, etc.). Information on minimum flows are needed to estimate the dependability of water supplies. Total runoff and its variation must be known for reservoir management and a number of design purposes.

A stream hydrograph is a record of the discharge of water from an upland watershed as it changes with time. It is a basic record that shows the effects of hydrologic processes which occur on a watershed and, therefore, the hydrologic "condition" of the watershed. The depth (or stage) of water in a stream is readily measured with a staff gauge or a clock-driven water level recorder. The problem is to convert a record of the depth of water in a stream to discharge, or quantity of flow per unit of time. In general, this task is accomplished by stream gauging or through the use of precalibrated structures, such as flumes or weirs, that are constructed in the stream.

To evaluate the kinds and amounts of substances in water, representative water quality measurements are taken. Normally, a sampling program is necessary, as continuous monitoring of water quality is difficult and costly. A "good" water sampling program requires a knowledge of the hydrologic system being sampled, and an understanding of the time and space distribution patterns of the variables being sampled.

The chemical constituents of water are derived from many sources, including gases from the atmosphere, weathering products of rocks and

soils, and decomposition of plants and other organic materials. Many land management activities can affect the kind, and amounts of chemicals present. In general, the methods of measuring the chemical quality of water include analysis of a standard volume of water obtained in a sample and direct measurements of a particular constituent in the aquatic environment.

To measure sediment, two components of the sedimentation process are recognized; suspended sediment and bedload. Once a suspended sediment sample is obtained, the liquid portion is removed by evaporating, filtering, or employing a centrifuge, and the amount of sediment is weighed. Bedload is the larger, heavier sediments (e.g., sands, gravels, cobbles, etc.) that slide, roll, or bounce along the bottom of a stream channel. Unfortunately, no single devise is available to reliably measure the bedload. Occasionally, estimates of bedload can be obtained by measuring the amount of material deposited in basins or trapped behind sediment dams.

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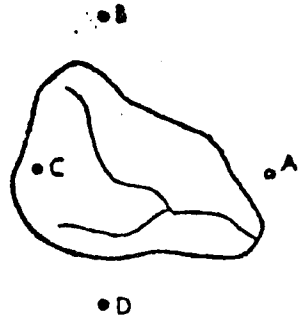


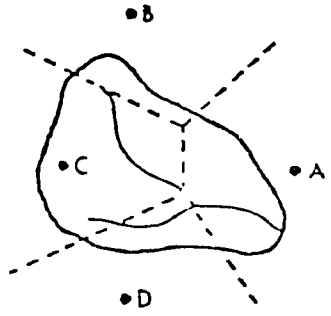
SOURCE DATA:

Daily rainfall measured at each gage in centimeters

A	B	C	D
4	8	10	6

Arithmetic Mean = $\frac{4 + 8 + 10 + 6}{4}$

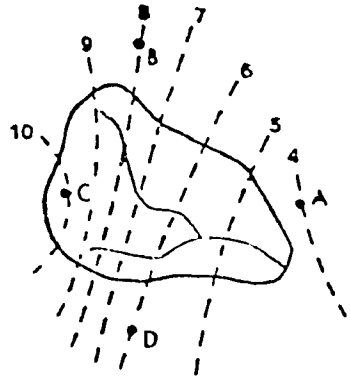
= 7 centimeters



THIESSEN POLYGON:

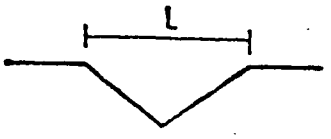
Station	Depth (cm)		Area in Polygon*		Volume (cm)
A	4	x	.28	=	1.12
B	8	x	.09	=	0.72
C	10	x	.49	=	4.90
D	6	x	.14	=	0.84
			sum	=	7.6 cm

*As a fraction of total area



ISOHYETAL:

Mean Depth (cm)		Area Between Isohyets*		Volume (cm)
4.5	x	0.12	=	0.54
5.5	x	0.25	=	1.38
6.5	x	0.14	=	0.91
7.5	x	0.13	=	0.98
8.5	x	0.18	=	1.53
9.5	x	0.14	=	1.33
10.5	x	0.04	=	0.42
		sum	=	7.1 cm



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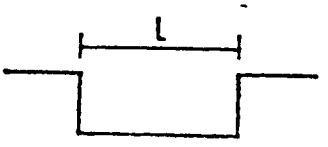
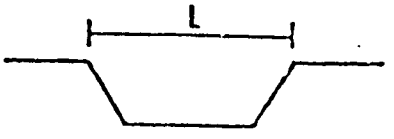
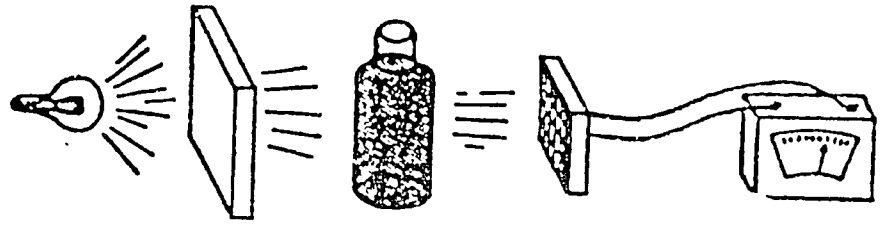


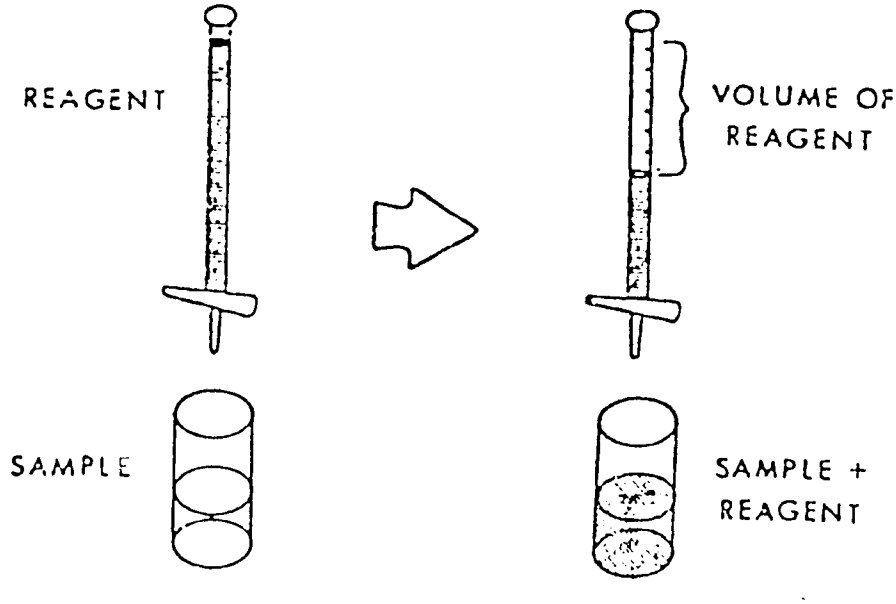
RECTANGULAR



TRAPEZOIDAL



LIGHT SOURCE | COLOR FILTER | SAMPLE + REAGENT | PHOTO-CELL | METER



BEGINNING OF TITRATION

IMMEDIATELY AFTER COLOR CHANGE

COURSE OUTLINE NOTES

(This paper is provided for use in taking notes on the topics that may relate to the development of your course outline.)

TOPIC:

DATE:

SPEAKER(S):

GENERAL NOTES:

LINKED TO:

TRAINING USE OR IDEAS:

FOLLOWUP OR BACKSTOPPING IDEAS:

SOILS

DEFINITION

The term "soil" has been variously defined. However, it can b said that soils are an integral part of every terrestrial ecosystem. They are the natural medium for plant growth and, by supporting plants, they are the basis for food production for all animals. Additionally, plant production from the soil base provides fiber, building materials, drugs, in fact, the majority of those items essential for human life on earth. Soils form the biologically active layer of the earth's crust. They are dynamic changing over time, and are variously affected by man's activities as well as natural processes including geologic and climatic ones.

Soils are often degraded by inappropriate exploitation and management and thereby decline in productivity. Conversely, soil productivity and stability can be improved by human intervention. It is to increase in soil productivity and its maintenance that we must look if the quality of human life is to be continued.

SOIL FORMATION AND DEVELOPMENT

Soils are a product of the action of climatic and biological (plant and animal) processes on the native rock or parent material from which they are ultimately developed. The result from innumerable interactions, over time, between plants and animals as controlled by climatic influences is a great variety of soils.

A sample, perhaps over simplified, formula has long been used to illustrate soil formulation:

Soil = Parent Material + Climate + Biota + Topography +Time.

A brief consideration of the role of each element in the formula may be worthwhile.

Parent Material

As indicated, these are the basic rock materials which are broken down to form a soil. The physical and chemical nature of these materials influence, in many ways, the kind of soil which is formed and are reflected particularly in:

- Size of soil particles (soil texture)
- Kinds and amounts of clay minerals
- Nutrients, minerals such as P and K
- Moisture relationships
- Stability, resistance to erosion

Climate

Climatic factors have, perhaps the paramount influence on soil formation. The magnitude of the earth's climatic diversity has resulted in the evolution of a great variety of soils. The extent of these variations and the numbers of distinctions involved add to the problems of soil classification and understanding. The most important elements among the factors of climate are:

- Precipitation; kind, amount, season, duration, etc.
- Temperature; maximum, minimum, variation, etc.
- Wind movement, soil transport, erosion

Biota - The living component of ecosystems

Plants. Natural vegetation profoundly affects the formation of a soil and the final product. Vegetation also has a continuing influence on soil development as well as protective benefits. Soils formed under grass vegetation types tend to have higher inherent productive capacities than soils formed under humid, tropical forests where nutrients are heavily leached or remain bound within the vegetation. Consequently, management considerations, including types of crops which may be grown, are strongly influenced. The delineation of soil types is closely

associated with recognition of the natural vegetation and becomes an important element in soil survey and classification.

Animals. Influences of larger animals on soil formation are, perhaps, less direct than plant influence but may exert local influences through such factors as compaction, mixing, addition of manure and are important in cycling of nutrients through consumption, digestion, and excretion of plant parts. Smaller, soil inhabitating animals play important roles in soil mixing, aeration, improved moisture relationships and, again, recycling of nutrients.

Micro fauna and flora. The myriads of these tiny organisms are associated with decomposition and remineralization resulting in the ultimate release of nutrients bound up in plant and animal remains. Their influences are less well understood than those of larger plants and animals but certainly they are paramount in the recycling of nutrients throughout the ecosystem.

Topography. The shape or physiography of the land influences soil formation through such factors as slope (angle, length) which contributes to gravity movement of parent material, to water flow and to exposure and altitude effects on climatic and plant growth factors.

Time. Soil development is an evolutionary process requiring passage of time and rates of development over time are highly variable because of the multiplicity of interactive influencing factors. Generally, the time span is long and the process is slow laying stress on the need to maintain all of our existing soils by all means possible.

SOIL SUITABILITY FOR AGRICULTURE

Differences in soils and their suitability for different crops have been recognized by cultivators from the beginning of farming to the modern day. Similarly, different range forage production characteristics on varying soils have been recognized and taken advantage of by people

herding livestock. Assessments of soil suitability and categorical classification provides the policymaker and land use planner with invaluable information for both immediate and long-range development. Major items considered in field tests for soil suitability include:

Topography

The greater the slope the less suitable for crop farming. Slope is less significant relative to livestock grazing but can become a factor in rangeland use. For most crops, slopes of greater than 5% are unsuitable although tea, coffee, rubber, and other tree crops may be grown on much steeper slopes.

Soil Texture

The size of particles in the soil affect moisture relationships, ease of cultivation and stability, among others. Medium textured (loamy) soils are desirable for most crops and are likely to be the most productive of range forage.

Soil Structure

This refers to the arrangement of particles within a soil. Soils having granular structure with the particles variously clumped together are easiest to cultivate, facilitate plant root growth, and water and air movement. Soil structure can be improved by the addition of organic matter and soils developed under grass vegetation generally have a better inherent structure.

Soil Depth

Soils with a depth of 1 meter or more provide ample room for root development and water penetration. Shallow soils have rock or impervious layers close to the surface, lack rooting space and are subject to erosion. The soil profile which is a basic for soil classification is

related to depth. This is a vertical section through a soil, where it is possible to recognize divisions into horizons or layers having different characteristics. A, B, and C horizons are differentiated.

Soil Reaction

The relative acidity or alkalinity of the soil. Soils with reactions deviating from the neutral condition in either direction require a careful selection of crops and must often be amended to improve productivity. Similarly, soil reaction profoundly affects the kinds of native plants which grow on a site and thereby affect range forage productivity and quality.

Soil Salinity

A high soluble salt content in the soil is toxic to plant growth. This factor becomes important where irrigation without adequate drainage is practiced. It is a common problem in many problems where large irrigation projects have been developed in efforts to increase food production. This emphasizes the need for making full use of soils information in development planning.

Stoniness

The more stones in a soil the more difficult cultivation becomes and the less space for plany root development.

Land Capability Classification

Utilizing information on the factors listed above and others, systems of classifying land for various uses have been developed. Generally, these systems rate lands on scales from I upward with Class I lands suitable for all types of cultivation and are used for range livestock grazing, forestry, and wildlife.

SOIL SURVEY AND CLASSIFICATION

Soil resource inventories and information for use in management and development decisionmaking are generated from soil surveys. The data are presented on maps with supporting information provided to the degree required for particular purposes. These surveys have been and are being carried out in most countries of the world with varying degrees of sophistication. Hundreds of agencies with differing techniques are involved. The FAO and UNESCO have recently completed the Soil Maps of the World which provides a quick look at soils in each country but the necessary mapscale precludes use for localized areas within any country.

The actual survey will depend on the intended use of the information and becomes more detailed as the planned use becomes more intense. In general, land forms and soil variations are mapped using remote sensing techniques varying from LANDSAT overviews to conventional aerial photography supported by ground truth data to substantiate divisions and subdivisions. Ground surveys are conducted to develop information required and involves sampling at adequate level. The soil profile is examined and described at many points to detect differences. Associated laboratory tests develop information on soil factors of importance to the planned use and include the items listed in section III above.

Soil surveys are made at several intensities. In the U.S.A, five orders of soil surveys are considered and these are listed for illustrative purposes:

1. 1st Order soil surveys are the most detailed and provide information for highly intensive land use. They are produced on the largest scale maps at scale of 1:12,000 or larger. Soils are classified in the most precise categories and intensive field survey is required.
2. 2nd Order soil surveys provide information for intensive use such as high value agriculture, urban, or industrial use. Map scale ranges from 1:12,000 to 1:32,000.

3. Extensive field surveys at the 3rd Order are used for more extensive use such as woodland, rangeland, wateshed, or wildlife management. Map scales range up to 1:250,000 and field survey is limited to the sampling necessary to detect only the more significant dissimilarities.
4. 4th Order soil surveys are used for broad land use planning at provincial, regional, or country level. Map scales range up to 1:300,000.
5. 5th Order surveys provide information for very broad interpretations and would normally be considered for broadly defining potentials for cropland, rangeland, urban development, etc. Map scales go up to 1:1,000,000. Once the potential of large tracts is identified, then detailed surveys are required for final selection of the most appropriate use.

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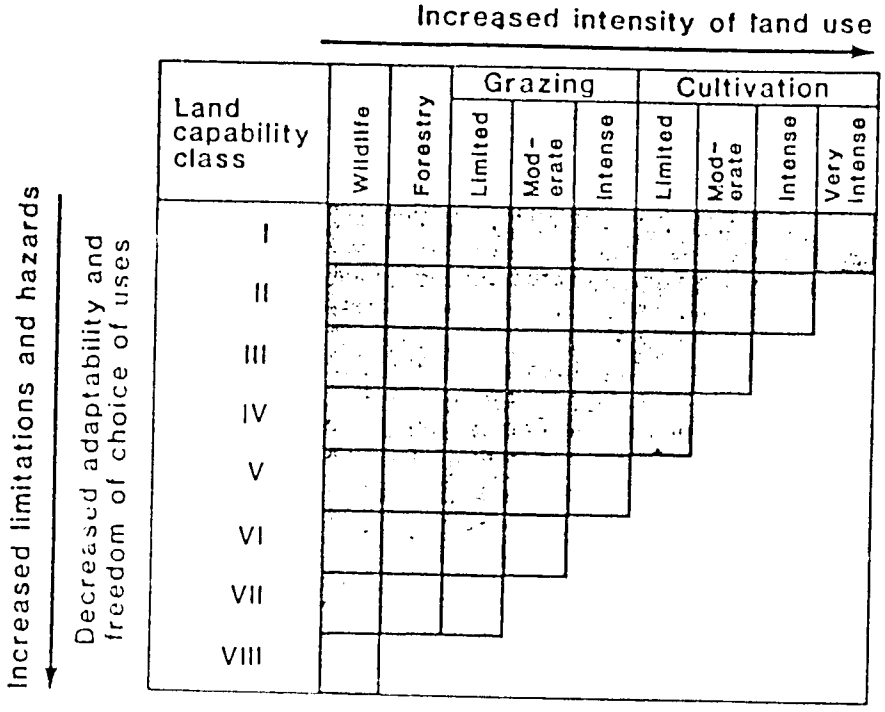

Figure 3.2 Relation between USDA land capability classification classes and the intensity with which classes can be used safely. [Source: Brady (1974)]

COURSE OUTLINE NOTES

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PUBLIC EDUCATION IN LAND AND WATER MANAGEMENT: A NEW USE FOR COMPUTERS

John R. Amend

THE PROBLEM

Every year we as citizens must make some tough decisions about the management of our natural resources. Sometimes these decisions are on the ballot, sometimes they must be made by elected groups, and sometimes ordinary citizens have to look at opposing views and figure out who is right. Responsible management of these resources must be based on sound technical principles and requires the support of an informed public.

Building public understanding of principles of land and water management is a difficult task. The learner's attention is often difficult to capture, the time he or she has available is limited, and there is a shortage of people with adequate technical background and time to conduct public workshops.

A SOLUTION

Computer simulation has proven to be an extremely effective way to help youth and adults understand the major problems involved in management of natural resource systems. Forty-five minute to 90 min workshops place participants in management situations involving real problems and alternatives. They are not offered solutions, but instead are offered an opportunity to experiment with different management strategies and to observe the probable consequences of their actions. The unique nature of computer simulation captures attention at fairs, service club presentations, and in school classes. Active participation maintains interest and assures learning. And the fact that the computer model for each natural resource system was developed by a group of experienced engineers, scientists, and resource managers assures the workshop leader or teacher that problems and concepts encountered will be presented honestly and in context.

Over the last 11 yr, Montana State University has developed computer simulations for public education programs

on energy, water resource management, electrical power management, grazing land management, and home energy conservation. At this time the energy, water resource, and grazing land programs are used by more than 120 universities, school districts, and agencies in the U.S. and Canada. This article describes the grazing lands and water resource programs.

GRAZING LANDS: A PUBLIC EDUCATION PROGRAM

One-third of the total land area of the United States is grazing land -- land on which forage is routinely harvested by grazing animals. When land that is occasionally grazed is included, the fraction increases to one-half. It is our largest use of land. Public understanding of the value of this resource and of the principles involved in its wise management are essential.

The Grazing Land Education program consists of resource materials, workshop plans, instructor training, and a grazing-land-management simulator. The program is designed for use with community and school groups. Its development was sponsored by the National Cattlemen's Association, the Soil Conservation Service, the Bureau of Indian Affairs, the U.S. Forest Service, the Cooperative Extension Service, and the Bureau of Land Management.

The Grazing Land Simulator (figure 1) is an interactive computer that depicts the ecology of grazing lands. Each year it provides its operators with actual herbage growth data based on precipitation and soil conditions for the region modeled. Livestock and wildlife consume the forage while the human population demands food, fiber, and water from the grazing land. Participants must develop and implement management strategies that will meet the demand for food, fiber, and clean water while maintaining the productivity of the land. As time progresses, the economic and environmental consequences of their management strategies are projected by the simulator.

The simulator poses problems to participants, acts according to their decisions, and forces them to live with the consequences of these decisions. Through a process of successive trial, error, and optimization of variables (figure 2), participants develop an understanding of the operation of the system and of the alternatives available.

Participants also often change their idea of what is "optimum" after being faced with the realities of the system. If the variables and problem are real, the participants will see their decisionmaking process as having consequences far beyond the simulation.

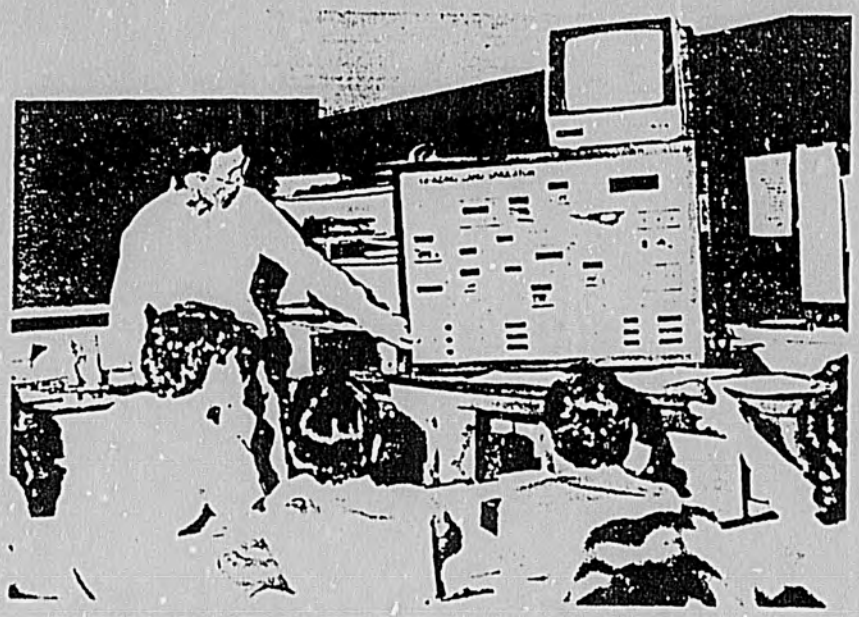

Figure 1. Students give full attention as Dr. John Lacey, MSR Extension Range Specialist, demonstrates the Grazing Land Simulator.

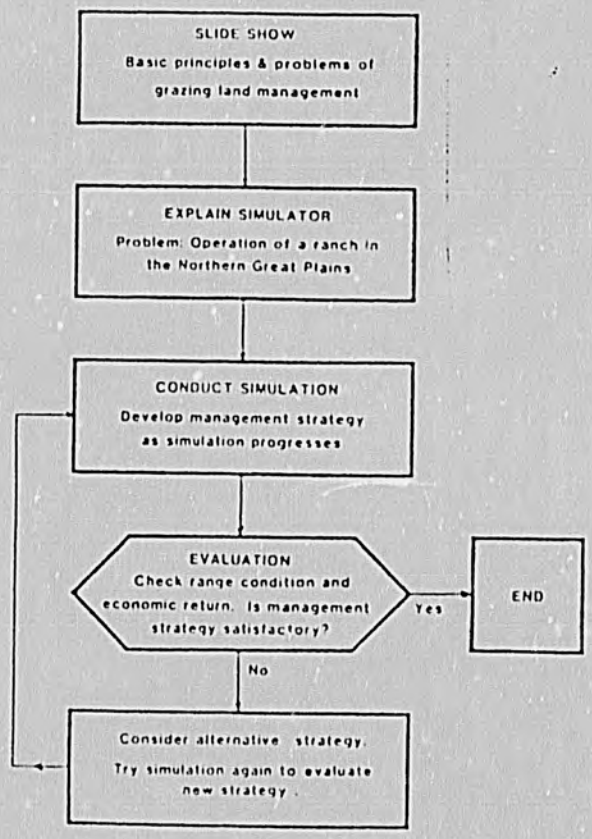

Figure 2. Organization of a group workshop with the Grazing Land Simulator.

This type of simulation differs from standard digital computer simulations in that it operates in "real time" (10 to 20 sec/mo) and presents information concerning all of its variables simultaneously during the run. It is an **interactive** computer; the group conducting the simulation may interact with the model at any time, using simple controls to implement their management decisions. After observing the result of a given simulation, participants may discuss the strong and weak points of their management policy, modify their strategy, press the reset button, and try again.

THE GRAZING LAND SIMULATOR

The front panel of the Grazing Land Simulator (figure 3) depicts a ranch with three pastures -- Arrowhead, Black Butte, and Cottonwood. Size and range site for each pasture is set at the beginning of the simulation. Displays show the number of wildlife and livestock grazing the pasture, percentage use, range trend, and vegetation rating.

A clock in the upper right corner of the panel shows passage of time in months and years, and a display in the upper left shows precipitation. Quantity and quality of run-off water are shown by a downstream display in the lower right, and the balance between food and fiber production and population demand is shown by a balance indicator in the lower center. Colored lamps display animal health and reproductive capability. Management practices implemented by livestock and forage management groups -- hay production and feeding, hunting, seeding, and fencing -- are indicated by displays on the panel. The economic impact of these management decisions -- cost per animal unit month, projected percentage calf crop for the current and coming year, and cumulative profit or loss -- are displayed on indicators in the center and lower right.

Forage growth is programmed from the historical records of 10 representative years for several different range sites in the region modeled. The current model represents the Northern Great Plains; data have been provided by the Ekalaka Experiment Station in Eastern Montana. The simulator may be programmed for other climate and soil conditions by obtaining forage growth records for the region of interest.

THE WATER RESOURCES EDUCATION PROJECT

A mosaic in the rotunda of the Colorado State Capitol concludes with the statement, "This is a land where life is written in water." The combination of land, sunlight, and water is essential to life and to the agricultural community that supports life. The problems of water management, however, are even less understood by the general public than the problems of grazing land management. This is demon-

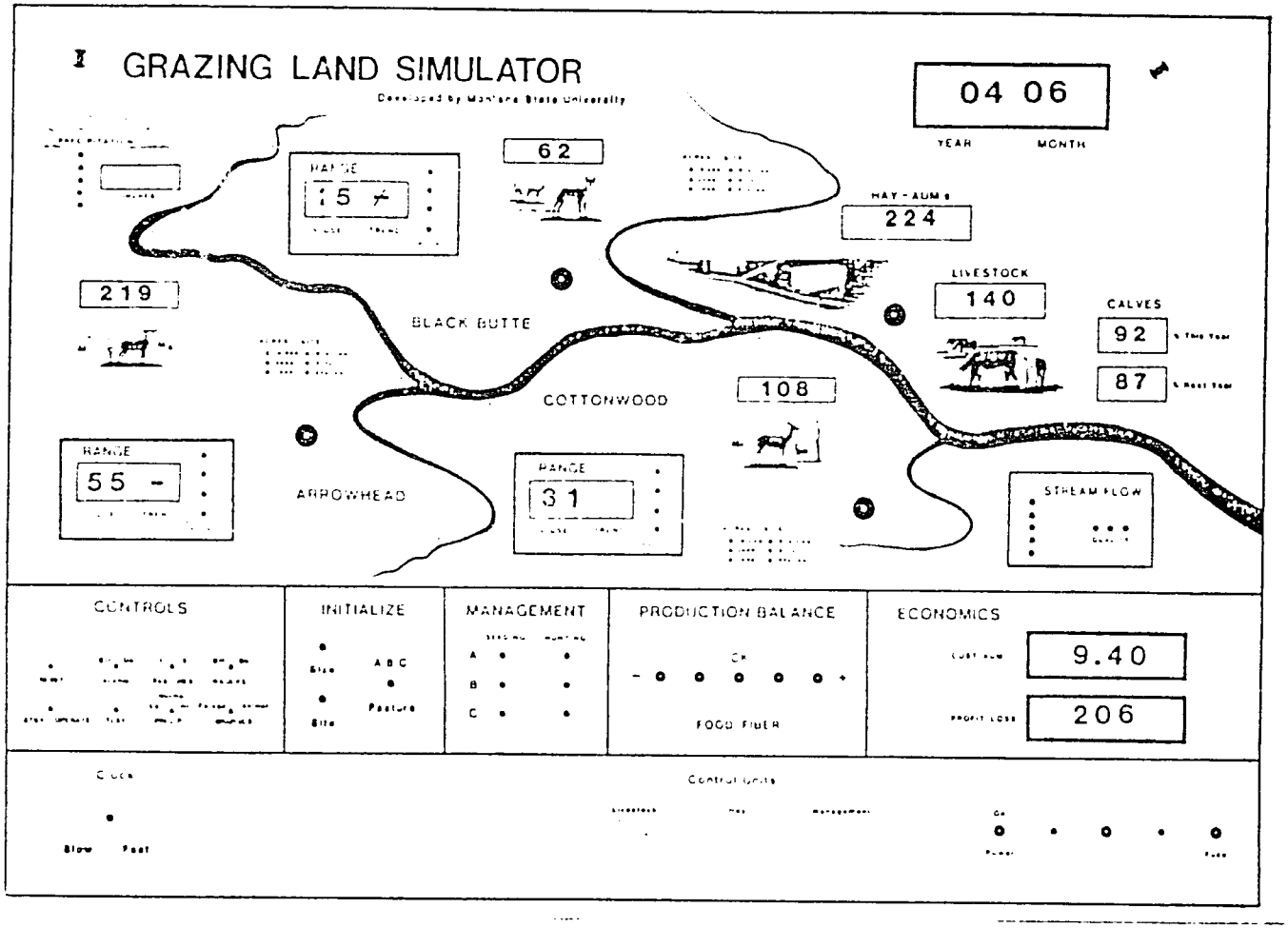

Figure 3. The front panel of the Grazing Land Simulator. The size of this version is approximately 18 in. x 24 in. It is mounted in an aluminum suitcase for easy portability and contains two digital computers using approximately 102 K of memory. Small control consoles placed in the audience (figure 4) are used to implement management decisions.

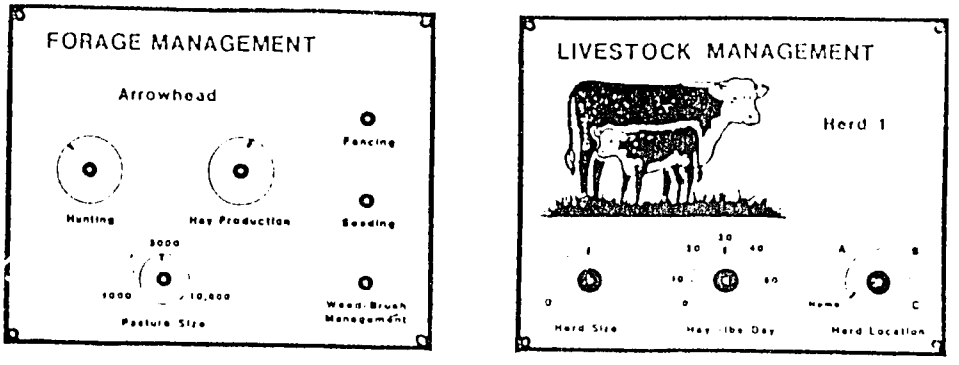

Figure 4. Small control consoles are used by participants to implement their management decisions.

strated by the statement of a workshop participant who, when faced with the fact that the time of maximum stream flow in the western U.S. precedes the peak demand for water by about 2 mo (figure 5) said, "That's easy. Just irrigate early."

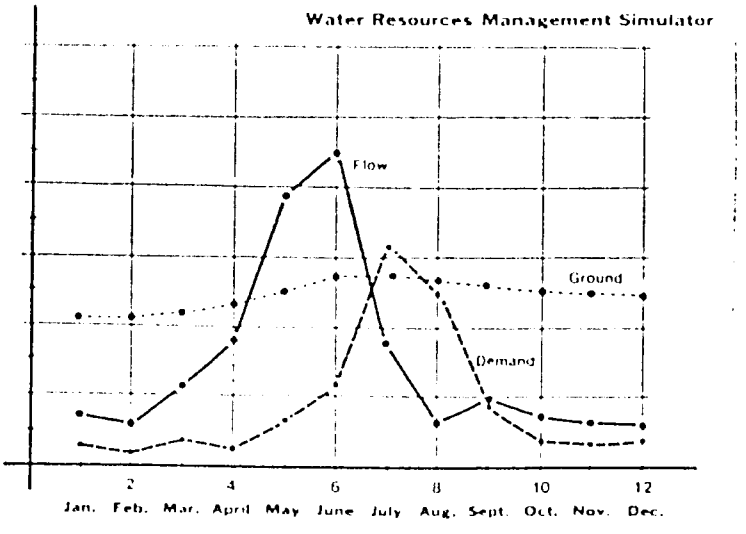

Figure 5. The lack of overlap in time of peak stream flow and water demand for irrigation -- the principal water management problem in the western United States -- is clearly illustrated by this plot reproduced from the TV graphics display of the Water Resources Management Simulator. Infiltration and ground water recharge are also illustrated.

Development of the Water Resources Education Project was a cooperative effort involving the Bureau of Reclamation, state water agencies in several states, the Old West Regional Commission, and several universities and school

districts. The results of this effort are instructional materials, a leadership training program, and the Water Resources Management Simulator. This program is again designed for use with community and school groups.

THE WATER RESOURCES MANAGEMENT SIMULATOR

The Water Resources Management Simulator, illustrated in figure 6, is used in our water resource education workshops. Four problem areas are treated in these workshops: 1) sources and quantity of water; 2) uses of water; 3) quality of water; and 4) political management of the water resource. Hydrologic information of a general nature is provided through a short slide talk. Workshop participants are then given a hands-on opportunity to develop and evaluate water management strategies through use of the simulator.

The Water Resources Management Simulator is a digital computer that models a region's water-supply-and-demand situation. Groups from the audience use remote consoles (figure 7) to make water management decisions. Controls on the simulator's back panel permit selection of a number of different stream basins throughout the country. Artwork on the panel may be changed to represent the region of the country in which the simulator is principally used.

The Water Resources Management Simulator asks its operators to make some hard decisions. Each year it provides them with snow-pack and stream-flow data that represent the historical behavior of their region. For some years there will be adequate water. In other years there will be too much or too little. Using the available supply of water, the operators must provide for their region's water needs -- irrigation, energy, livestock, and municipal and industrial uses. They will want to prevent drought or flood from destroying crops or land. They will want to reserve adequate stream flow to support downstream users and fish and wildlife. For each of their water uses, they must decide if the water will come from surface or underground water. They must decide the technology for each of their water uses. And, if they wish, they may flood some of their basin to create a reservoir for storage of surface water.

As the simulator operates, a colored graphic display of stream flow, water demand, and surface or ground water reserve is plotted on a TV monitor. After observing the results of a given simulator run, participants discuss the strong and weak points of their water management policy, modify their strategy, press the reset button, and try again.

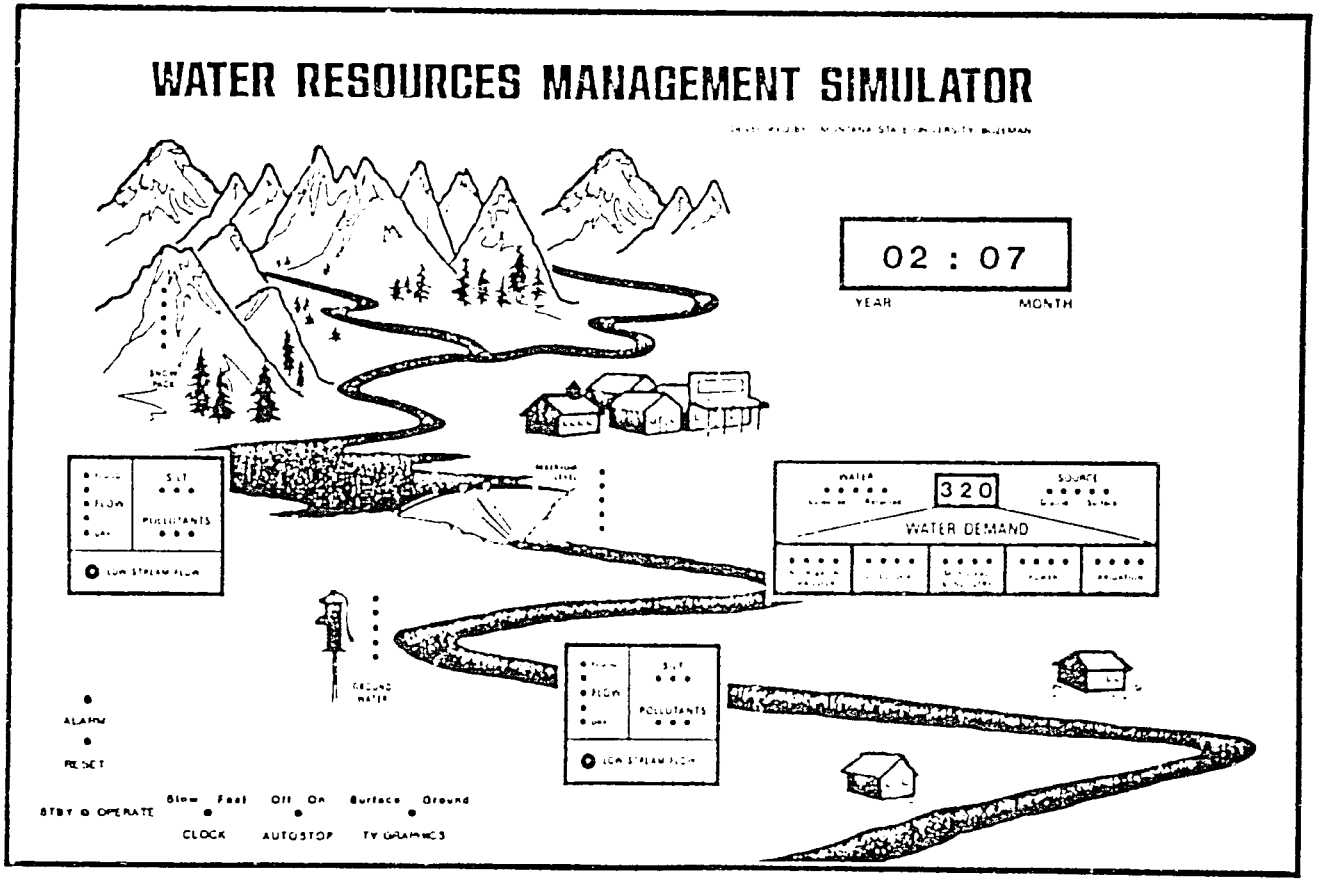

Figure 6. Information concerning stream flow, water use, and water reserve is shown by displays on the panel of the Water Resources Management Simulator. The reservoir overlay is attached to the panel with velcro.

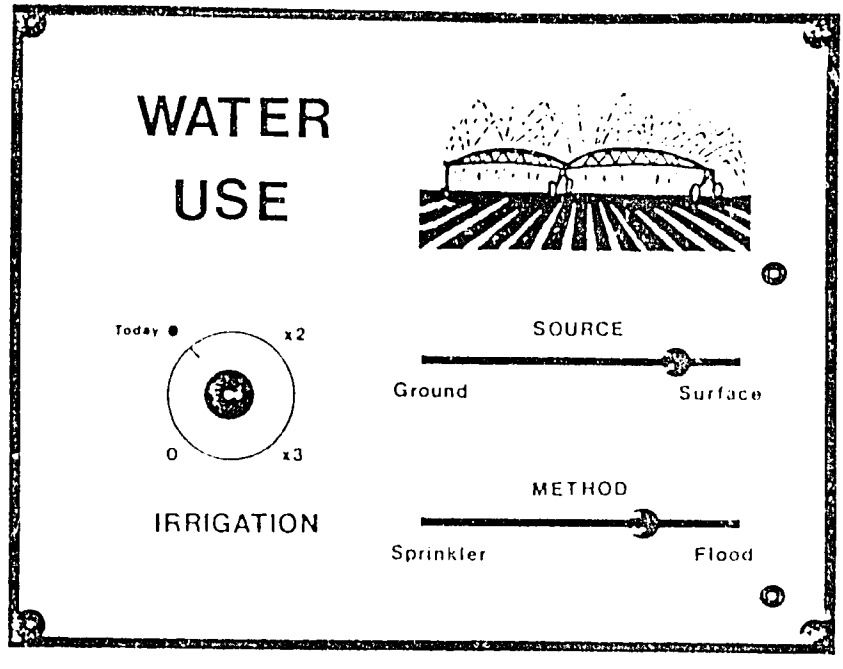

Figure 7. Participants use remote consoles, such as this irrigation control module, to make water management decisions regarding sources of water, water use, and storage of surface water.

SIMULATION AS A TEACHING TOOL

A major advantage of computer simulation lies in the fact that the workshop leader does not present a certain point of view. Participants are presented real problems, an opportunity to experiment with different strategies and policies, and a chance to observe the probable consequences of different courses of action (figure 8). The workshop leader's role is one of moderator and helper rather than lecturer; the integrity of the program is assured by the computer model's honest presentation of problems and its realistic response to participant actions. In effect, the teacher or workshop leader's background is supplemented by the scientific and management background of the simulator's design team.

The importance of active participation in any educational effort cannot be overemphasized. The value of experience has been well understood from the time of the ancient apprentice. One could learn to plow by walking behind the ox and to shoe a horse by working beside the blacksmith, but learning to fly an airplane and to experiment with land or water management policy are far more difficult problems. Computer technology makes it possible to experience these complex problems, and to experiment with alternatives, in a safe, low-cost manner.

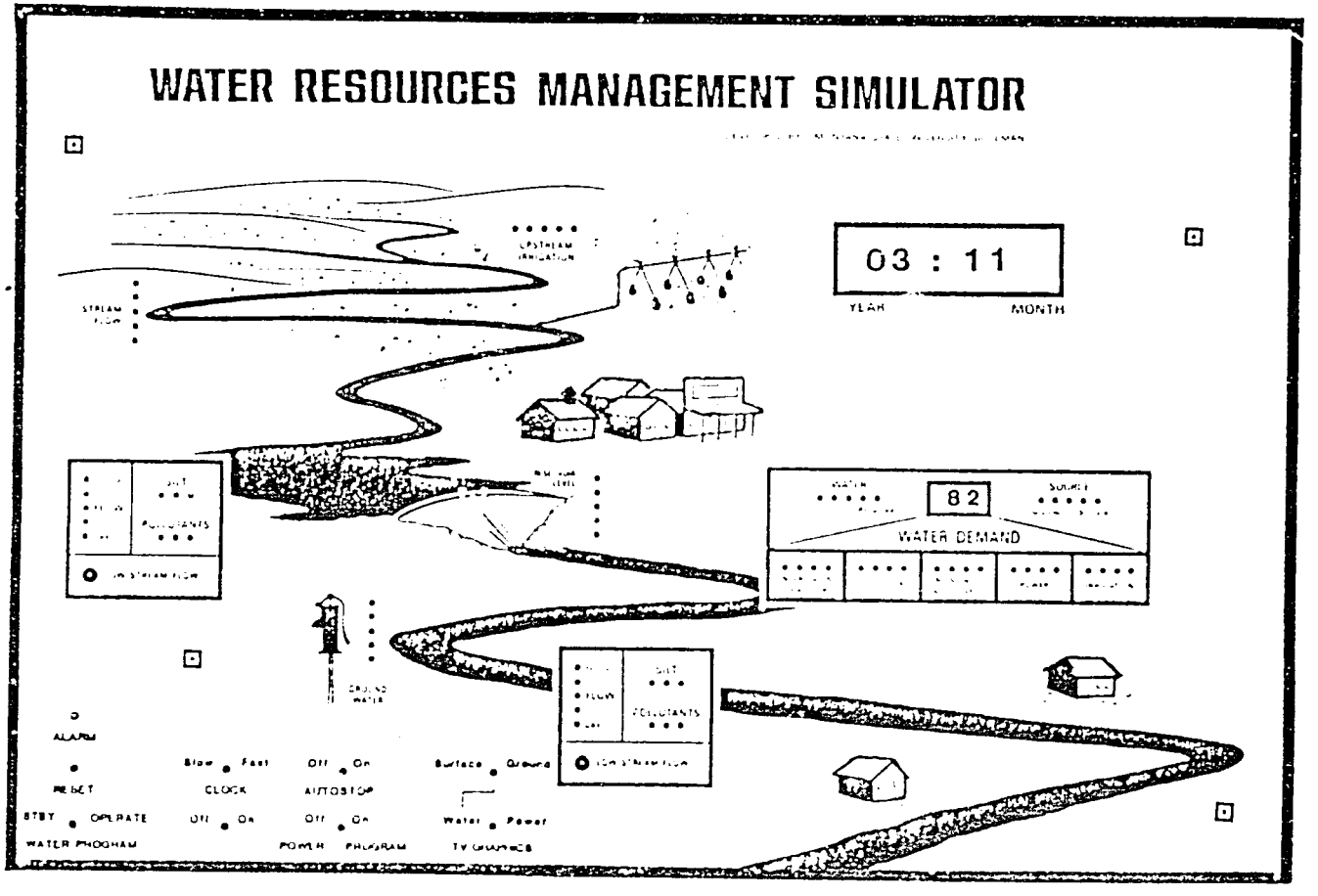

Figure 8. The simulator's front panel artwork may be changed to represent the region of principal use. This panel was designed for the central Great Plains and demonstrates the effect of upstream irrigation on reservoir management.

COURSE OUTLINE NOTES

(This paper is provided for use in taking notes on the topics that may relate to the development of your course outline.)

TOPIC:

DATE:

SPEAKER(S):

GENERAL NOTES:

LINKED TO:

TRAINING USE OR IDEAS:

FOLLOWUP OR BACKSTOPPING IDEAS:

ECOLOGICAL PRINCIPLES

INTRODUCTION

Throughout modern history, people have learned new management strategies for farm and ranch units by observing the strategies of others and adapting them to their own units. In the past, these strategies were often seen on neighboring ranches with similar ecological and socio-economic situations. Today, through communication systems, land managers are learning about other management strategies from remote parts of the world, and many of them seem to offer tremendous potential for a variety of farm and ranch situations.

Webster defines a principle as "a fundamental truth, law, doctrine, or motivating force upon which others are based; the law of nature by which things operate." This definition implies that a principle is an absolute truth, something that is inflexible and does not change or adapt to the environment it operates within.

Even though the rangelands of the world are extremely varied, they have some common characteristics that still classify them as rangeland. Despite their differences, are there any principles of range management that do have universal applications?

SELECTED ECOLOGICAL PRINCIPLES THAT RELATE TO RANGE MANAGEMENT

Rangeland as an ecosystem. Rangeland fits any modern conceptualization of an ecosystem: an arbitrarily delineated area having interacting physical and biological components to which social, cultural, economic, institutional, and political components must be added. Units of rangeland can be 1) units of landscape where human activities take place, 2) units of production, 3) habitat for a great variety of wildlife, and 4) ecosystems connected to many other ecosystems. The relationships between components of the rangeland ecosystem are commonly illustrated with a net-like diagram (figure 1). Some linkages that connect

each component with all other components are direct and easily observed. However, other linkages are often somewhat indirect and more difficult to observe.

THE RANGE ECOSYSTEM

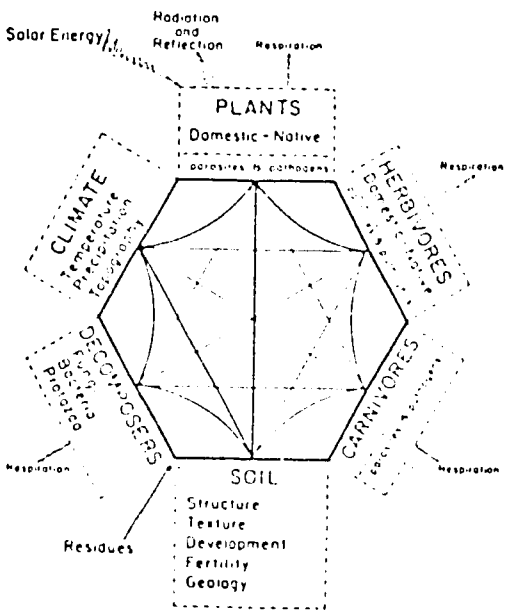

Figure 1. A flow chart showing structural characteristics of the ecosystem in six compartmental areas and connecting interaction linkage among compartments as a function process (Cook, J. Range Manage. 23:387).

EXAMPLE: Direct relationships between livestock (primary consumers) and coyotes (predators) are generally easy to observe. But indirect interactions resulting from ranchers' (humans) direct management of livestock (primary consumers) on a quail population (another primary consumer) may not be as obvious. Many ranchers have altered their resource base in an effort to increase the numbers of livestock and afterwards have wondered what happened to their once-numerous quail population.

Management of units as a total system. Ranchers and other resource managers must visualize and manage their unit as a total system and should not become preoccupied with one component.

EXAMPLE: Managers are often confronted by salespersons and promoters trying to persuade them to use a specific product, breed, or management strategy. The decision to select a larger breed of cattle can impact on many

components of an operation; larger calves might result in calving problems and higher related costs; feed requirements during critical periods might require different grazing and feeding strategies that could change land requirements; physical handling facilities might need to be altered, etc.

Uniqueness of each individual and each ecosystem. Each ecosystem, delineated area, ranch, or pasture is unique and will respond to management in a different way from any other. This uniqueness not only adds beauty and variety to this earth, but it also adds resilience and flexibility to management systems as they face a variety of stresses and demands.

EXAMPLE: The variability within a species has provided the opportunity for genetic selection of varieties of plants and animals that will better meet the needs of a particular production system. Genetic selection and genetic engineering in the field of agriculture will continue to provide improved plant and animal resources to meet the additional food needs of the future.

EXAMPLE: Management practices used on one pasture, ranch, or in a region may not be appropriate for any other pasture or ranch within the same region. Ranch managers have often observed pastures that appear to be identical but still respond differently to a particular management strategy (e.g., plant response to a fertilizer treatment or animal response to a grazing method/system).

Energy flow in rangeland ecosystems. The sun is the source of energy by which all human food is produced. In the process of photosynthesis, plants capture the sun's energy for man to use. However, energy is lost during each step in the food chain, and so chains that have fewer steps are more efficient than those going through additional steps. This loss is illustrated by an energy-flow diagram of a community in figure 2. The direct consumption of plant products by man is generally more efficient than passing the energy through an animal.

However, much of the world's land resources do not favor the production of plant foods for direct consumption by man. The most efficient way for man to utilize these lands is to use animals for harvesting the vegetation and coverting it into meat. The efficiency of this conversion is affected by many factors.

EXAMPLE: The overstory/understory relationship is a factor in areas where shrubs and trees in significant number are an important component of the ecosystem. The growth rate of forage under a tree canopy in various types of plantations is reduced as the canopy closes over. The competition for light and nutrients affects the production of forage plants on millions of acres throughout the world.

EXAMPLE: Different photosynthetic pathways vary in their conversion efficiency of the sun's energy into plant biomass (carbohydrates). Warm season grasses (C4 pathway)

are more efficient than cool season grasses (C3 pathway) in this conversion process (Sosebee, 1977). This difference in efficiency accounts in part for the variety of management strategies using combinations of coastal Bermudagrass (warm season) and Kentucky fescue or annual ryegrass (cool season) in the southeastern U.S. When temperatures and light are favorable for plant growth, warm season species that are growing with cold season species will out produce them through more efficient conversion of energy. In contrast, the cool season grasses do well during the spring and fall when the growth of warm season grasses is reduced.

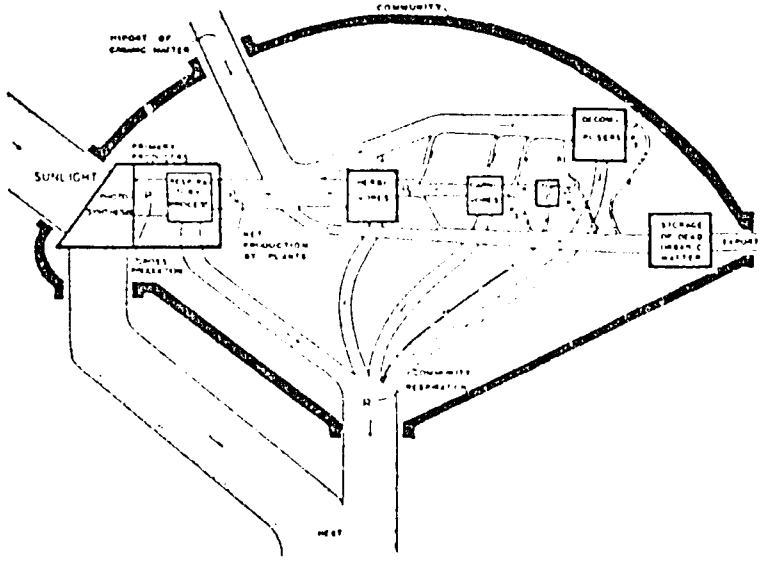

Figure 2. Energy-flow diagram of a community with a large import and a smaller export of organic matter, showing successive fixation and transfer by components and the large respiratory losses at each transfer. P = gross primary production, P_n = net primary production, and P_2, P_4, P_5 = secondary production at the indicated levels. (Redrawn from H.T. Odum, 1956.)

Nutrient cycles within the ecosystem. Nutrient cycles within an ecosystem can be illustrated by the nitrogen and phosphorus cycles in figure 3. Harvesting the products of agricultural land and rangeland will deplete the soil of some essential and potentially limiting nutrients. The rate of this depletion can be altered by using different management strategies. It is also possible, though expensive, to recharge the supply of nutrients in a particular rangeland ecosystem.

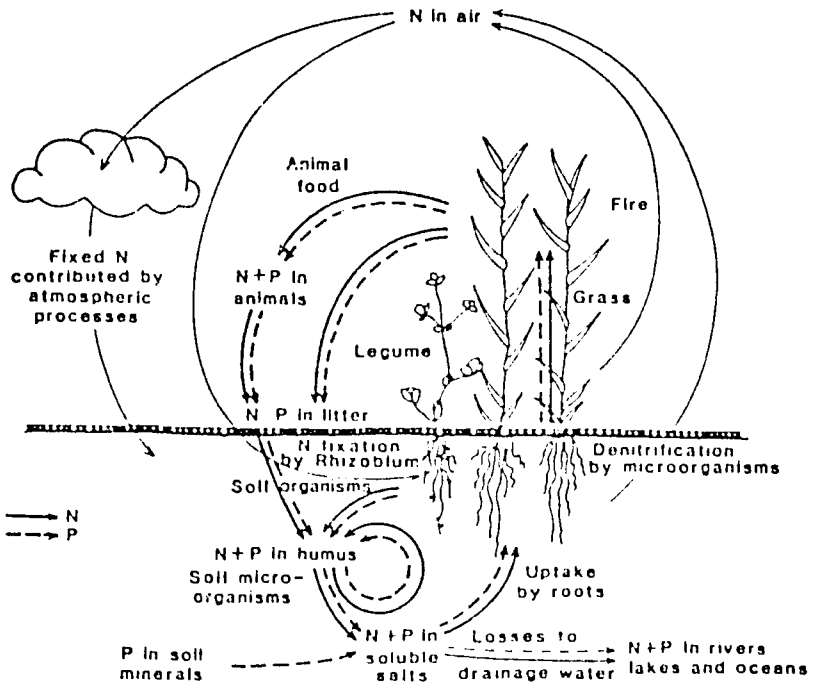

Figure 3. The nitrogen and phosphorus cycles and the soil. [Source: Bradshaw and Chadwick (1980)]

EXAMPLE: Forage grazing results in a lower net loss of nutrients than does harvesting the forage and feeding it as hay or silage to animals. The nutrients lost from grazing are only those that remain in the tissues of animals removed from the management unit. The vast majority of the nutrients consumed are excreted in the feces and urine and only about 4% of those consumed are actually removed via the animal. The return of the excreted nutrients into the plant growth portion of the cycle is actually faster when passing through an animal than when the plants die and decompose.

EXAMPLE: The replenishment of nutrients into the active production cycle is expensive. Fertilization is practiced on some improved pastures but many managers have found that fertilizing rangeland is not economical. Because of the link between fossil fuels and commercial fertilizer, the cost of fertilizer is not likely to decrease enough to be used economically or extensively on marginal lands.

Other soil treatments have been proposed that may accelerate the growth of soil organisms and the development of humus (Walters and Fenzau, 1979). The treatments being tested speed the process that releases nutrients in the soil and makes them available for plant growth, thus allowing them to become active in the nutrient cycle. If effective,

they may reduce the amount of nutrients required to replace those removed through agricultural harvesting.

Successional development and stability. More mature successional stages are more stable, though less productive, than developmental stages. Many of the agricultural systems used today are still destroying the diverse native vegetation from the land and planting a monoculture. This procedure is used to maximize the gross production of exportable products from the land base. Monocultures (developmental successional stages) have proved to be less efficient in the conservation of nutrients and more susceptible to natural catastrophies. This balance between higher production (lower stability and higher risk) and lower production (greater stability and lower risk) must be considered in the development of long-term management strategies.

EXAMPLE: Agroforestry and mixed crop/livestock farming systems are designed to increase the ecological and economic diversity on the management units and should be encouraged.

OTHER PRINCIPLES IMPORTANT TO RESOURCE MANAGEMENT

It is not enough to simply know that a technology or management strategy works. Does it pay? Does it fit within the sociopolitical environment? These questions sound simple but in practice are very difficult to answer. The complexities of national and international agriculture and the attempts to rapidly increase food production to meet the needs of our growing population have spawned some inappropriate management strategies both at home and abroad.

The sustainable use and management of the rangeland resources in developing countries will require that a more holistic approach be taken during project planning, implementation, evaluation, and monitoring (Child et al., 1984). Only in recent years have social scientists been involved in agricultural development projects. In the past the social scientist and the agricultural scientist were often only brought together after the fact. The full involvement of the people in the host country is also critical to the success of development programs.

SUMMARY AND CONCLUSIONS

Are there any range management principles that have universal application? There are probably no basic principles that are unique or peculiar to range management. Rather, there are sets or combinations of basic ecological, social, and economic principles relating to rangeland that have been used to develop management strategies for a particular unit of rangeland. These strategies are often developed to meet short- and long-term goals for a particular management unit. The management strategy may

include a grazing method, vegetation management, integration of wildlife harvesting with livestock management, or a livestock management/marketing plan.

There is a tendency to observe the success of a particular management strategy on a unit of rangeland in one area and attempt to transfer the strategy to a similar rangeland unit. This has often occurred without an understanding of the principles involved or the management goals critical to the strategy's success. And in some instances, management strategies have unfortunately been assumed to be principles.

Since every unit of rangeland has its own set of management goals, environmental characteristics, available external resources, and combination of basic ecological principles, the particular management strategy developed for that unit of rangeland will not necessarily be appropriate for any other unit. Good range management must view each management unit as a system having interrelated parts and utilize basic principles from many disciplines including ecology, economics, political science, and sociology.

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COURSE OUTLINE NOTES

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WOODY VEGETATION

ABSTRACT OF LECTURE

With increasing demands for woody biomass by people living in the arid and semiarid ecosystems of the world, a means of inventorying and analyzing the quantities of biomass that are potentially available for utilization by humans is needed. In particular, this need is apparent for the so-called "noncommercial" species of woody plants, for which standardized mensurational techniques are, in general, incomplete. Rather, methods of inventory and analysis are developed, more-or-less, in response to the needs of a particular locale.

OBJECTIVE

In this lecture, a collection of "methodologies" on the inventory and aralysis of woody biomass will be outlined. These are not necessarily innovative methods, but rather applications of known approaches to meet specific needs for quantifying the biomass of woody plants that might be available for fuelwood, fiber, and fodder.

INTRODUCTION

Over the past several years, inventory specialists and resource analysts have attempted to develop mensurational techniques to quantify the biomass of tree species and woody shrubs in arid and semiarid ecosystems that might be available for utilization by humans. Although a standardization of techniques has not been completed, a collection of methodologies has evolved. For the most part, these methods are not necessarily innovative, but rather applications of known approaches to meet specific needs in a particular locale. However, because "noncommercial" species of woody plants have little value for traditional primary wood products (e.g., lumber, veneer, poles, etc.), it is not uncommon that only limited funding and time is allocated to their assessment. Never-

theless, the inventory and analysis of this woody biomass resource can be a critically important mensurational undertaking.

STATEMENT OF ISSUES

Throughout the world, demands for woody biomass as a source of energy, building material, and food are increasing. For example, many households, and even whole communities, are entirely dependent upon biomass derived from woody plants for cooking and heating. With these increasing demands, methods of inventorying and analyzing the biomass quantities of woody plants that are potentially available for use are needed. In particular, this need is apparent for "noncommercial" tree species and woody shrubs, for which mensurational techniques are frequently incomplete.

RELATIONSHIP TO OTHER LECTURES

Two broad sets of components are recognized in the evaluation of a site for management planning, namely, abiotic (nonliving) components and biotic components. Climate, soil, land form and relief, and water resources are abiotic components and, to a large degree, have been the subject of earlier lectures. Plants and animals, of all forms including humans, are biotic components. These biotic components will be the topics of this and subsequent lectures, starting with a discussion on the inventory and analysis of woody vegetation.

MAIN TOPICS OF LECTURE

In this discussion of inventory and analysis of woody vegetation, three main topics will be mentioned: primary sampling designs, selection of tree and woody shrubs for measurement, and individual tree and woody shrub measurements. A major emphasis will be placed on individual tree and woody shrub measurements that are employed to estimate biomass quantities, however.

Nearly any and almost all primary sampling designs can be or are being used to measure woody biomass. Only rarely are complete enumerations of populations justified, but simple and stratified random sampling designs, and numerous combinations thereof, have all been employed at one time or another. Where statistical integrity is less rigid, systematic sampling designs are also used. Frequently, measurements of "noncommercial" woody biomass are "piggybacked" onto primary sampling designs that are utilized to inventory and analyze other natural resources, such as commercial timber, forage, and soil.

Tree species and woody shrubs can be selected for biomass measurement through the implementation of one of three general theories of sampling probability: probability of selection proportional to frequency (fixed-sized plots), probability of selection proportional to size (point sampling), and in a few cases, probability of selection proportional to prediction (3P). Most commonly, fixed-sized plots or point sampling techniques are employed. Tree species and woody shrubs also have been selected for measurement by 3P methods in a few instances, however.

The individual tree and woody shrub measurements taken depend, in large part, upon the purpose of the biomass determination. In general, tree and woody shrub biomass can be quantified in terms of volume (cubic meters, cubic feet, stacked roundwood volume, etc.), weight (kilograms, metric tons, pounds, etc.), or potential energy equivalents (kilojoules, Btu's, calories, etc.). However, estimation of volume is, frequently, the most difficult task.

In taking the individual tree and woody shrub measurements, two general plant growth forms, differentiated by the type of branching, are often recognized: excurrent and deliquescent. Woody plants possessing a terminal leader, whose growth is prolonged to form an undivided main bole, are considered to be excurrent. On the other hand, woody plants whose main bole is not so evident, but instead divides into a number of limbs, are said to be deliquescent. As might be expected, however,

there are a number of variations within these general plant growth forms. Nevertheless, through a recognition of these two general growth forms, sets of individual tree and woody shrub measurements are prescribed to quantify the woody biomass in terms specified by the users, as described in the lecture.

Woody plants characterized by an excurrent form are relatively easy to measure. One simply tallies by species (to identify the apporpriate specific gravity value for determination of potential energy equivalents), diameter, and for a subsample, height. When available, volume tables are interpreted to obtain estimates of plant volume. In contrast to plants of excurrent form, woody plants that exhibit a deliquescent form are more difficult to measure and quantify. Quite often, the "traditional" measurements of diameter and height are discarded, to be replaced with measurements that, based frequently on destructive sampling, relate to the total volume of biomass.

From previous experiences in attempting to inventory and analyze woody biomass in arid and semiarid ecosystems, various mensurational research needs can be recognized. Cost-efficient sampling designs to determine woody biomass on a large-scale are needed. Improved volume tables that describe more representative biomass volumes should be constructed. Identification of variations in specific gravity values, from which estimates of heat content values are derived, are necessary. More species-specific estimates of heat content values to determine potential energy equivalents are required. Satisfying, at least in part, these and other research deficiencies should greatly enhance one's ability to quantify biomass for energy and other uses in the future.

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COURSE OUTLINE NOTES

(This paper is provided for use in taking notes on the topics that may relate to the development of your course outline.)

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HERBACEOUS NATURAL VEGETATION

INTRODUCTION

This section considers natural vegetation mainly from the standpoint of utilization by animals, both domestic livestock and herbivorous wildlife. Kinds of vegetation included are the grasses and their allies, broad-leafed herbaceous plants, called forbs, and shrubby vegetation which has value as browse. Therefore, the considerations become those of rangeland ecosystems. These ecosystems include grasslands, shrublands, semideserts, open forests and, to some extent, seasonally flooded or marshy areas which may be occupied by herbivores intermittently. Rangeland ecosystems include up to 50% of the earth's land surface and it can be said that they are those lands unsuitable for utilization other than by herbivorous animals and the peoples who depend principally upon livestock for their existence. Major products from these ecosystems include meat, milk, fiber, hides, and skins, but they also provide many plant resources such as building materials, fuel, and drugs. Additionally, they are reservoirs of plant genetic material -- a gene pool from which all crop plants have been developed and which still contain genetic materials with as yet unknown values for crop plant improvement.

UTILIZATION AND MANAGEMENT

Use and management of rangeland ecosystems has two principal goals. One of these is the protection, conservation, improvement, and continued welfare of the resources of land, plants, and animals. A second goal is to maintain and increase the well-being of rangeland peoples and others dependent on rangeland production. These aims are integrated in complex systems that include human welfare, market economy, political entities, and conservation. They are sometimes global in extent, sometimes local in scale and involve managerial problems in both short- and long-terms. In many countries of the world, the use and management of rangeland ecosystems constitute the most important facet of development.

Paramount, of course, is an understanding of the basic fact that plants are fundamental to the existence of life because of their ability to take carbon dioxide from the air and transform it into simple carbohydrate. This simple carbohydrate is the basis for more complex organic compounds from which living organisms, both plant and animal, are constituted. This primary production by various types of plants is, in the final analysis, responsible for life on earth. Thus, one of the major roles of development is to increase primary production by manipulating plant life and mitigating environmental stresses.

VEGETATION CLASSIFICATION

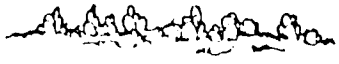
The vast diversity of climates and land forms on the earth leads naturally to diversity in vegetation. The spectrum extends from the sparse plant cover of semideserts to dense rain forests. Accordingly, classification presents many complexities.

The study and classification of vegetation has been a subject of interest for several centuries. Consequently, many classification schemes have been proposed and are still in the process of development. None of the existing systems are universally accepted at present and it is not necessary to review them in detail. Therefore, we will consider here, for purposes of illustration, a modification of the system developed by Bourliere (1983). Most of the ecosystems described approximate many of the vegetation types of Agrica. Table 1 lists the systems to be discussed with certain key characteristics related to their uses for producing livestock.

Savannas With Tall Grasses

These ecosystems occupy vast land areas in the tropics and subtropics where wet and dry seasons alternate. They are characterized by a general aspect of relatively open grassland with scattered trees and shrubs. Precipitation ranges from 350 mm to 700 mm, temperatures vary widely throughout the seasons and from day to night, humidity is mostly

Table 1 Key Characteristics of Major Tropical Rangeland Systems.

Systems	Length of Dry Season	Type of Grazing	Cattle per Person	Animals/ km^2	Site Potential	Agroforestry
Savannas with tall grasses	6-9 mo.	Transhumance and village based	6-15	25, all domestic species	Low to high	Semiarid trees — mostly legumes
Deciduous forests with high grasses	3-6 mo.	Transhumance and village based	1-4	15, all domestic species	High with seeded legumes	Wide range of possibilities
Desert shrub and grasslands 	9-12 mo	Nomadic	0-4	10, mostly camels and goats	Low except with water harvesting	Local leguminous shrubs and trees
Seasonally flooded and wetland vegetation	NA	Seasonal use	NA	NA	High	Slight possibility
Tropical rainforests	<3 mo.	Sedentary	± 1	<5, all domestic species	High with legumes	Local species
Winter rainfall vegetation	5-7 mo.	Yearlong	6-15	10, all domestic species	High with legumes	Coniferous trees
Montane forests	<5 mo.	Yearlong	NA	>25, on improved pastures of temperate species	High with legumes	Coniferous trees

pg. 4 does not exist

low, and sunlight is intense. The plant growin recurrent droughts are common. Crop agricult because of unreliable precipitation and is limite sites. Grazing by ungulate animals is the maj suitable and, often, the only use of these ecosystems. In general, vegetative production in quantitative terms is relatively high but variations from season to season are great. Quality of the forage is variable and nutritional values of the tall grasses become quite low in the dry seasons. These deficiencies may be compensated for, in part, by the availability of shrubby plants which are browsed. Reasonable grazing by herbivores is not detrimental to grassland ecosystems and the open grassland savanna aspect is maintained by continuing grazing and by fire. Without these influences, many of the savannas would revert to shrub or woodland types. Grazing use may be by large ranches, village based, or transhumant.

Deciduous Forests With High Grasses

These ecosystems have the aspect of a thin deciduous, or sometimes evergreen, tree canopy that is more or less continuous with a grass understory varying from thin to quite dense. Precipitation varies from as low as 700 mm to about 1,500 mm and the wet season is from 5 to 8 months. The dry season is a time of stress for herbivores because the nutritive value of mature tall grasses is below that of animal requirements. Mature grasses have less than 1% crude protein and over 70% fiber which is largely indigestible. As in the savanna, browse plants may help to mitigate nutritional stress. Grazing use is similar to that of the savannas.

A major problem within many of these ecosystems is the tsetse fly vector of sleeping sickness. This prohibits grazing of fly-occupied areas by domestic herbivores and occupance by humans. Efforts to reduce the impact of tsetse have been underway since the early 1900s but with only limited success.

Desert Shrub and Grassland

The driest of the rangeland ecosystems with annual precipitation receives less than 350 mm. Temperatures fluctuate as much as 50°C diurnally. High daytime temperatures make for high evaporation which reduces the effectiveness of the limited precipitation. Droughts are frequent and often of long duration. The vegetation is of drought resistant grasses and shrubs and, in many areas, annual species dominate. Dry area forages tend to be higher in nutritional value than those of savannas because the plants develop less fiber. The major limiting factor to animal use is the low quantity of forage because primary productivity under the limited precipitation and generally poor soils is low. Livestock production may be from large ranches as in Australia and South America or from nomadic pastoralist herds in Africa and the Near East.

Seasonally Flooded and Wetland Vegetation

Areas of this nature are generally small and scattered and frequently are not indicated on maps of countries or regions because of map scale. However, they are highly important because of high production potential. Herbivorous animals often concentrate on such areas during dry seasons when upland grazing is of poor nutritional quality. Little use is made of them during wet seasons because the soils are poorly drained, sticky when wet, and hard when dry. Large populations of blood-sucking insects in the wet season also prohibit animal occupance. The vegetation is mostly hydrophytic such as reeds, papyrus, sedges, and grasses capable of tolerating high water levels. Wetlands are mostly used in conjunction with other grazing ecosystems on a seasonal basis and are often important for nearby subsistence farmers with only few livestock. Transhumant pastoralists also use wetlands seasonally as a part of normal migration patterns.

Tropical Rain Forests

These ecosystems are some of the most humid on earth. Grazing is limited to the margins. These ecosystems will be discussed in other lectures.

Winter Rainfall Ecosystems

These ecosystems, commonly referred to as the Mediterranean type, consist of combined woodland, shrubland, and grassland. The climate is characterized by cool, moist winter seasons alternating with hot, dry summers. The grass species are often annual but grazing values are enhanced by the presence of numerous legume species which provide nitrogen to the soil and protein to animal diets. Oftentimes, shrubby vegetation becomes so dense as to interfere with grazing use. The mild climate accommodates grazing on a year-long basis.

Montane Forest Ecosystems

These areas constitute high altitude forests at elevations mostly above 1,800 meters. A complex mixture of tree species occur with an understory of grasses, forbs, and shrubs. Grazing use tends to be seasonal. Cultivation occupies all areas where climate, soil, and absence of heavy tree cover will permit it. Potentials for development are good with agroforestry and hydrology values of paramount importance.

VEGETATION EVALUATION

Purpose

The purposes of vegetation inventory and assessment is to categorize the landscape in terms of plant communities that occupy certain sites. A site is a particular and unique kind of landscape with a particular combination of climatic, land form, soil and biotic conditions that make it distinct from other sites. Sites can be grouped together or

separated and described according to similarities or dissimilarities in vegetation, productivity, and response to man's influences. The site then is a basic unit of the landscape and decisions can be made as to its most efficient use and to its management as a productive entity. Because the same factors are operating in the vegetational development of an ecological site as in soil formation and development, a site will also be represented by a definable set of soil conditions. This is one reason why recognition of vegetation types is useful in soil classification as was indicated in the lecture on soil.

Vegetation Inventory Goals

The objective of a vegetation inventory is to characterize and map ecosystems and ecological conditions as they vary and are repeated across a landscape so that similarities and differences in land productivity and potential are easier to understand by land-use planners and land managers. Data on the vegetation and its responses to ecological factors permit interpretation of the vegetation in relation to its utility for grazing, farming, tree production, or other forms of land use. Follow-up observation at benchmark locations provide data allowing the manager to assess the impacts of particular kinds of land use and to develop methods for increasing productivity or reducing deterioration as the case may be.

Observations and Measurements

Many kinds of vegetation observation and measurement are possible depending on the scale and intensity of examination and the use that is to be made of the information obtained. Significant observations would include the following:

1. Plant growth form, plant species composition, plant community structure. This shows what is present on a given site and indicates optimal periods for animal utilization and possible stress periods.

2. Seasonal development of growth and maturity patterns in the vegetation. This allows definition of optimal periods for animal utilization, periods of growth stress, and the evolution of management options.
3. Vegetative productivity, measurement of yield. This indicates quality of the specific environment, provides estimates of allowable stocking rates and may suggest the management intensity that can be economically justified.
4. Ecological succession and climax. The long-term changes in vegetation on a site and its ultimate natural condition with indications of stability, vegetational change over time (positive or negative), or deterioration. From this, the present condition or health of a site can be estimated and observation made on positive or negative change over time or in response to particular kinds of use.
5. Distribution of grazing use in relation to stage of plant growth and on individual species. Useful for assessing stocking rates, kinds of grazing animals, grazing patterns, and animal response.
6. Plant species receiving greatest or least use. This indicates animal species, plant species tolerance to grazing, species which may become a problem such as invading bush.
7. Amount of plant residues remaining at the end of grazing in relation to ecologically allowable maximums. A measure of proper or allowable use of the vegetation if the site is to be maintained or improved.
8. Impacts of fire as an ecological or management factor.

Levels of Vegetation Assessment (Intensity of Surveys)

As with soil assessment, vegetation is measured at some 5 levels depending on the amount and depth of information required and the use that is to be made of the data. A first level reconnaissance would be broad and provide information for country policy establishment, priorities, and objectives. Levels 2 through 5 would become increasingly more detailed and intense with the highest level providing information for the most intensive management of a given site.

Measurement Methods

The methods and techniques for vegetation measurement, mapping, and analysis are too numerous to cover here. Suffice it to say that remote sensing techniques will provide the information for developing initial maps of the vegetation and can be used to indicate change over time and with various patterns of use.

Techniques for plant inventory, required sampling intensity, and specific ground study methods and approaches are adequately reviewed in the first reference listed below.

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CROP ECOLOGY

INTRODUCTION

Crop ecology is directly related to the worlds food supply and affects people in every economic and social condition. Because of this, it is a major concern to political entities and to national development planners.

The numerous patterns of crop distribution around the world have developed following natural principles of plant ecology and the evolution of plant species. These developments have been strongly influenced by man's ingenuity and ambitions so that modern day agricultural crops are a result of man's manipulations over centuries of time. It is interesting to note that traditions of peoples strongly influence the kinds of crops grown in particular regions. As a result of tradition, rather specialized human food habits and desire for particular kinds of food crops have become firmly entrenched and are difficult to break down. These habits often cause problems in shifting food products from areas of high or surplus production into areas of shortages. They may also cause farmers to persist in growing a poorly suited or less productive crop variety because it is preferred even though it is no more nutritious than higher yielding varieties.

Yet, through generations of trial and error the more suitable crops for given regions and particular soils have been discovered and utilized. The success of these crops is based on selection of kinds of plants with the best adaptation to the ecological conditions and to man's manipulation of the environment in every way possible to him.

Broadly classified, crops can be considered as subsistence crops, cash and(or) commercial crops and forage or fodder crops. Subsistence crops are generally grown on a small scale and are intended to meet the demands of the grower and his immediate family. Inputs tend to be in

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the form of hand labor with only limited use of machinery, fuel energy, artificial fertilizers or specialized weed and insect control techniques. However, land manipulations such as terrace construction or small scale irrigation have long been a part of this form of farming. Although any surplus production above the family's needs may enter the market economy, this tends to be limited in amount.

Cash crops are grown to supply market demands and are commercial in nature. Size of operation and use of modern technology varies greatly and, in many cases, small scale operations and the use of traditional farming practices still prevail. Locally grown and marketed cash crops and increases in their production are the best means for meeting food deficits in any country. However, when cash crops are grown for export along with purely commercial or industrial crops such as cotton, coffee, rubber, etc., they face the problems of world market economics where competition from highly productive regions makes for low prices or even lack of markets. Attempts to keep up production through mechanization, artificial fertilizer or pesticides, all of which need to be imported at high cost, often raise the expenses of production to more than the market value of the crop. Additionally, these inputs may be greatly damaging to local environments.

Several observers have pointed out that shifts from production of crops grown for local use to commercial crops for export may be a major cause of food shortages and the need to import food into many developing countries. Development planners need to pay more attention to increasing food production for in-country use.

Forage and fodder crops are grown to provide feedstuffs for animals (mostly ruminants) which supply meat, milk, fiber, hides or work production. The products may be considered as subsistence crops where only family use is made of the end product or as cash crops where the animal products are eventually sold. Growing forage crops as an integral part of the crop rotation patterns is one of the better means for improving

degenerated soils, increasing nitrogen in the soil where legume crops are grown and reducing erosion. They can also contribute substantially to improved livestock production through supplementing rangeland forage supplies or in the direct fattening of livestock. For these reasons, the integration of forage crops into food production cropping systems has long been advocated by agricultural advisors.

CROP ECOLOGY AND FARMING ECOSYSTEMS

Crop ecology is a complex science involving all component of farming ecosystems but is, perhaps, more subject to manipulation by man than are other land ecosystems. An understanding of the abiotic components of the ecosystem (climate, soil, physiography) and of the biotic components (living organisms) is essential for selecting the kinds of crops most suitable for particular regions and for growing those crops. Throughout the sessions convened here, the ecosystem concept and its components will be covered in some detail. The major biotic component -- humans -- will receive attention as a controlling influence.

REQUIREMENTS FOR INCREASED CROP PRODUCTION

Selecting and growing the crops best suited to and most productive in particular regions is a matter of paramount importance in meeting the demands for food to support growing populations. The requirements include seed supplies including those of new varieties that are continually being developed, improved cultural practices, fertilizers, weed and pest control, water supply and the range of economic measures such as credit and commercial facilities, markets, education and extension. All of these are components of the "Green Revolution" which has assisted in increasing cereal grain production in parts of Asia. That this revolution has not been wholly successful provides a good lesson. It has become clear that <u>all</u> of the requirements listed above form a package of practices and inputs. Unless all are supplied simultaneously

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and continually updated the expected increases in production will not materialize. Perhaps the least understood component and the one to which least attention is paid is the human element. The "Green Revolution," as with all other advances in crop production, has shown that manipulation and management by man is a major factor and, perhaps, the most deserving of attention.

MEASUREMENTS OF PRODUCTION

Measuring crop production is a matter of enumeration and censusing and is generally carried out by agricultural organizations in the country. Crop yields may be measured on the farm or at markets where products are sold. New advances in the use of remote sensing using LANDSAT on other aerial sensing method adds a new dimension yielding data on crop acreages and even potential yields in some instances.

Determination of the crops best suited for particular areas is a matter of field studies, adaptation trials, assessment of inherent productivity and determining the optimal levels of fertilizer, water, pesticides, etc. that will increase production in the most economic way. These trials may be the responsibility of research organizations or they may be carried out in cooperation with farmers through extension service personnel. The latter approach directly involves farmer participation and may be the most effective.

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THE WILDLIFE COMPONENT IN ARID AND SEMIARID LAND SYSTEMS

ABSTRACT OF LECTURE

The wildlife component in arid and semiarid land systems is described and characterized. Major environmental factors and their influence on plant and animal life are described in terms of driving forces and tracing variables. These include rainfall, geomorphology, soils and fire. The relationships between rainfall, primary production, biomass and carrying capacity are examined. Resource limitation of animal populations is discussed as is the influence of environment on nonsocial behavior, organization and ecological adaptation. animals, in turn, influence their environment and this topic is also discussed and examined. This includes the biomass structure of large herbivore communities, their influence on plants and plan cover, geomorphology, soils, nutrients and production.

OBJECTIVE

Describe and characterize the wildlife component in arid and semiarid land systems.

INTRODUCTION

In order to understand how to manage and use natural resources in arid and semiarid lands, it is necessary at the outset to recognize what the components of the system are, and how they operate. This topic covers the wildlife component, and describes and discusses the underlying factors that influence, an are influenced by, wildlife.

MAIN TOPICS

- Environment influences: Driving forces and tracing variables
- Rainfall, and rainfall variability
- Geomorphology and soils
- Influence on primary production, biomass and carrying capacity
- Vegetation structure, and modification by biotic components such as animals and fire
- The food supply and other resource requirements. Resource limitation and population regulation
- Environmental influences on nonsocial behavior, organization and ecological adaptations of animal populations
- Influence of animals on environment, in particular herbivores on savanna structure
- Biomass structure of large herbivore communities
- Influence on plants and plant cover, geomorphology, soils, nutrients and production

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DOMESTIC ANIMALS

INTRODUCTION

This section will be a broad discussion of domesticated herbivorous animals, their environmental requirements, control, and management by man and the role they play in converting the vegetative production of rangeland ecosystems into products useful to man. Without livestock the productivity of these ecosystems would largely be useless to man. It is this secondary production process which turns the primary production of plants into food and other useful items. These products consist of meat, milk, wool, hair, hides, transport, and draft power. A number of social benefits also accrue to the pastoralist peoples who keep livestock.

In many countries of Africa, livestock account for up to one-third or more of the gross national product providing food, employment, and income for substantial parts of the human population. An overview of livestock production in total would include the highly intensified operations of commercial milk production, or feed-lot production of meat. However, we are concerned here with the more extensive types of livestock management carried out within the several rangeland ecosystems. This discussion will deal with those domesticated herbivores of primary significance for rangeland production -- cattle, sheep, goats, camels, and donkeys. Horses are frequently part of the range ecosystems as well but are of less significance as producers.

ORIGIN AND DOMESTICATION OF LIVESTOCK

Cattle, sheep, goats, and dromedary camels were first domesticated in the Mediterranean region or elsewhere in the Near East. Sheep were probably the first to be domesticated around 9000 B.C. followed by goats and cattle at about 5000 B.C. Camels were brought under human control around 4000 B.C. in Arabia and donkeys at about the same time, probably in Egypt.

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It is clear that these different kinds of animals had their origins in somewhat different environments and, after domestication, each species was moved to still more different situations by migratory humans and they were utilized for a variety of purposes. Thus, each of the kinds of animals have distinctive qualities that characterize them as species. It is likely that the earlier products of animal domestication were meat for food and hides for protection. It was probably somewhat later that milk became important along with the use of animals for transport and draft power.

The wide range of environments under which the initially wild species of animals evolved contributed to their diversity. Interbreeding of different races occurred adding more to this diversity and environmental selection processes were operative. To the present day, man makes use of this genetic and adaptational diversity in developing specific breeds of livestock to more closely fit into various environments and to suit particular production purposes.

As a result of generation after generation of evolutionary development, animals differ in their adaptive physiology and in food and water requirements so different environments favor different kinds of livestock. Camels replace cattle in semideserts, small stock, especially goats, outnumber other livestock in bushland areas impoverished by overgrazing or other detrimental environmental change. The present day distribution of livestock is, therefore, due to differences in the ecology of the various environments but is also influenced by the social values of the species. The selection of species for the various rangeland ecosystems is mainly attributed to the need of pastoralists living under difficult conditions to maintain supplies of meat and milk or for the production of meat and(or) wool under more settled forms of management.

SPECIES OF DOMESTIC LIVESTOCK

As indicated, attention here will be confined to cattle, sheep, goats, camels, and, to a lesser extent, donkeys. The emphasis is on those species chiefly of importance within the rangeland ecosystems of Africa.

Cattle

African cattle are made up principally from breeds described as humpless longhorns, humpless shorthorn, and humped Zebu, with subsequent breed types resulting from interbreeding. The interaction of these breeds and movements associated with control by man have resulted in a number of recognized breed types adapted to the variety of environments which they occupy. Most of the native stock are resistant to heat stress and high humidity -- much more so than the European breeds which developed under cooler conditions. The Zebu is particularly well suited for hot climates because of body cooling mechanisms associated with sweating and hair coats capable of reflecting incoming radiation and releasing heat to the atmosphere. The Zebu also has a higher rate of dry matter intake per unit of body weight, a higher digestion coefficient, and better absorption of nutrients from the digestive system. These characteristics have caused the Zebu to be utilized for meat production and(or) crossbreeding in warmer climates around the world. European cattle do not have the heat-enduring qualities of the Zebu and seldom thrive as well in Africa. They have, however, been widely used in crossbreeding where attempts are made to increase the productivity of local types. Generally speaking, a higher level of management and mitigation of the environment, particularly improved feed supplies, are necessary if European cattle or their crosses are to realize their productive potential.

Sheep

As with cattle, attention here is given only to those breeds of sheep mainly utilized in the African rangeland ecosystems. It is useful to

note that all sheep have evolved from the wild mouflon ancestor and have become adapted to most of the climatic conditions of the earth although they are less well suited to the highly humid tropics. This adaptability is a result of the high genetic variability associated with further variations accumulated over the thousands of years of adaptation to the environment as well as selection and breeding by man.

African sheep are classified as thin-tailed (hairy or wooly), fat-tailed, or fat-rumped. There are many variations within these general types and specific breeds of each are recognized. Fat-tailed and fat-rumped sheep are thought to be good examples of animal selection designed to meet particular human needs. Here the need was for fat in the very arid areas where other sources of fats and oils were not readily available. The fat tail or rump also serves as a place for the animal to store reserve energy to be drawn upon in times of adversity. This last may have only been coincidental to human objectives but it certainly has survival values. Sheep are kept principally for meat production, although skins are of considerable value, and milk is less important.

Goats

Goats are the most unbiquitous of the domesticated animals in Africa and are well distributed even into tropical areas. They are most abundant in the savanna ecosystems and it is here that the greatest number of varying types occur. Goats have been reported as being more reproductive in relation to their total biomass than are other animal species. This is due to the high reproductive rate, rapid growth, and resistance to many diseases. Additionally, goats tend to be more adaptable in diet than other animals. Although they are selective grazers or browsers when conditions are favorable they readily shift to less desirable kinds of plants when necessary. The ability of the goat to survive on deteriorated rangelands has caused it to be blamed, in many cases, for decline in range productivity and even a cause of the spread of

deserts. As with so many cases of this kind, it is mismanagement of the goat by man which is the root cause.

Goats and sheep together are referred to as "small stock" and are frequently kept together in mixed flocks or herds. Within African pastoral conditions, they are extremely useful because of the small size. A family is able to slaughter one animal and use it up as food before spoilage under conditions where storage is not possible. Cattle, being larger, cannot be used in this manner.

Camels

Dromedary camels are found in most of the arid regions of Africa and the Near and Middle East. Their southern extension is restricted by humidity and tsetse fly to which they are quite susceptible. In East Africa, Kenya is the southern limit of camels. It is likely that camels have less genetic diversity than cattle, sheep, or goats. Selection and breeding by man has been at a lower level perhaps because of the more limited climatic range and the slower rate of development in livestock production within the arid zones. However, camel types have been selected for riding or for transport of heavy loads. The milk, meat, hides, and hair are all used by transhumant pastoralists with milk perhaps the most important. Still, little attention has been paid to the selection and breeding of camels for milk or meat production. Among the nomadic pastoral tribes of East Africa, the camel plays important social and religious roles and are highly prized.

Donkeys

Donkeys are far more important in Africa than are horses. This is partly due to their utility as a beast of burden but also to their adaptability to poor vegetation conditions and adverse ecological conditions. Next to camels, donkeys have the greatest resistance to desiccation of all animals and they can utilize plants so harsh as to be untouched by other domesticated herbivores. They survive with little

management and no attention has been paid to their selection and breeding.

ADAPTATION TO THE ABIOTIC ENVIRONMENT

Climate

Among the elements of climate, temperature perhaps has the greatest direct influence on domestic animal performance. Precipitation, of course, is additionally important but more secondary in its role as a plant production factor. Cold temperatures are seldom a constraint to animal production in Africa except at high elevations outside of the range of most livestock. However, cold and wet periods during the time when young are born can cause high mortality and special management may be required during these periods.

Heat, especially in association with high humidity, is a major constraint to the production of livestock in the tropics and most arid zones. As an abiotic factor, heat perhaps has played a major role in the selection processes which led to the rise of livestock breeds suited to these environments. It has been indicated that Zebu cattle have heat control mechanisms not associated with European breeds. Similarly, sheep of the warmer regions tend to have a hair cover rather than the dense wool of sheep from colder climates.

Heat stress results in lowered food intake, reduced milk production, slower growth, and lowered rates of reproduction. Heat also affects the grazing habits of animals. They will not graze during the hottest times of the day so that actual grazing time may be insufficient for them to obtain sufficient forage.

The water requirements of animals are important to adaptation to heat and dry climates and water consumption varies with temperature, humidity, feed supply, stage of growth, pregnancy, and activity. Cattle are most susceptible to shortages of water followed by sheep, goats,

donkeys, and camels. In general, cattle require water on a daily basis, sheep and goats can do without water for 2 to 3 days and camels often go for a week or more without water. This information is important to management in determining distances animals can travel between water points and grazing areas. It has a bearing on the location of water points in respect to proper utilization of the vegetation on a grazing area.

ADAPTATION TO THE BIOTIC ENVIRONMENT

The biotic and abiotic environment determines the type of vegetation present, its period of growth and its quantity and quality. The abiotic environment strongly influences the ability of different animals to use vegetation effectively. In consequences, the adequacy of the nutritional environment on rangelands depends on interactions between animals and the forage plants that are present.

Animals use plants in different ways and show definite preferences for kinds of plants. Cattle and sheep will select grass by preference though sheep will also utilize herbaceous broad-leafed plants as well. Goats make use of shrubby plants as well as grass and camels will use even more shrubby vegetation while being able to browse on much taller trees. These differences in preference lead to suggestions that the best overall utilization of plant species can be made by a variety of animal species. Hence, the concept of combination or mixed species grazing. These varying preferences also suggest the use of animals as a means of manipulating vegetation. For example, goats may help to control brush, the quality of the available forage as it changes throughout the periods of growth and maturity is also important. As a general rule, herbivores require feeds withover 5% protein, 50% to 60% carbohydrates, sufficient vitamins and minerals, and digestibility of the forage should be at least 50%.

LIVESTOCK PRODUCTION SYSTEMS IN AFRICA

The traditional livestock production systems in Africa are diverse and complex and have evolved over centuries. They may appear to be primitive in certain ways but they are, in many cases, the optimal systems under prevailing conditions. This diversity results from differences in local climates, range vegetation conditions, diseases, markets, and political and social circumstances.

Three broad and general types of livestock production systems are recognized.

Commercial Systems

Commercial livestock production is usually on privately or communally owned and controlled land. These types of operation are referred to as "ranches" and use modern ranching technology including a high level of pasture, livestock and water management, disease control, and produce for relatively sure markets.

Pastoral and Semipastoral Systems

The majority of African cattle and camels, and many small ruminants are maintained in pastoral or semipastoral herds. Many of the animals are owned by sedentary farmers and nonfarm households who entrust them to herders in return for various kinds of payment. Others are owned by families of the various livestock holding tribes. These herds are moved along regular patterns often around one or more permanent or semipermanent homesteads or temporary encampments. The migration patterns may vary from year to year according to seasonal constraints and opportunities such as the availability of pasture and water and the avoidance of disease. This system is an excellent adaptation to uncertain environmental conditions and appears to promote the most efficient use of forage and water in the marginal rainfall areas. The animals of pastoralists are an integral part of their culture. In addition to

providing milk, meat, fiber, transport, and other products, they play important roles in maintaining social relationships.

Migratory movements of livestock have become increasingly difficult in recent years due to cropping pressure on land, restrictions on movement across borders, and other governmental regulations. These factors appear to be inducing shifts toward mixed farming and more sedentary lifestyles among pastoralists. There is a need, however, for continuing selective support for pastoralists by way of measures which encourage the economic use of more arid rangeland ecosystems.

Mixed Farming Systems

Mixed farmers are usually permanently settled and livestock production is only one part of an integrated agricultural system which is mainly dependent on crop production. This type of agricultural production is growing more and more important as human pressures on the land increase. The concept of agroforestry where tree crops are integrated into the system is growing.

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ECOLOGICAL INVENTORY AND LAND USE SUITABILITY ANALYSIS
(20 MINUTE LECTURE IN 'EXAMPLES OF RESOURCE ASSESSMENT')

OBJECTIVE: TO ILLUSTRATE THE EFFECTIVENESS OF USING MAPS AND OVERLAYS IN DISPLAYING RESOURCE INFORMATION, IN SOLVING LAND USE ISSUES, AND IN INTEGRATED REGIONAL PLANNING.

ABSTRACT: THIS LECTURE ILLUSTRATES ONE TYPE OF PLANNING METHODOLOGY USED FOR ASOTIN COUNTY, WASHINGTON, USA, A RURAL AGRICULTURAL AREA RECEIVING ABOUT 19 INCHES OF PRECIPITATION PER YEAR. THE METHOD WAS DESCRIBED BY IAN McHARG IN DESIGN WITH NATURE, AND USES A THREE-PHASE APPROACH: 1) AN INVENTORY AND MAPPING OF THE BIO-PHYSICAL AND SOCIO-CULTURAL SYSTEMS OF THE AREA, 2) OVERLAYING OF TRANSPARANT MAPS IN DIFFERENT COMBINATIONS TO EXAMINE THE WAYS IN WHICH THE VARIOUS FACTORS RELATE TO EACH OTHER AND 3) A SUITABILITY ANALYSIS FOR SEVERAL POTENTIAL LAND USES BASED ON THE INTER-RELATIONSHIP OF THE BIO-PHYSICAL AND SOCIO-ECONOMIC SYSTEMS, AND SUBSEQUENT DEFINITION OF VARIOUS PLANNING OPTIONS AND TREIR CONSEQUENCES

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LECTURE OUTLINE

I. WHY STUDY WAS UNDERTAKEN

II. THE ECOLOGICAL INVENTORY AND LAND USE SUITABILITY ANALYSIS PROCESS

A. INVENTORY AND MAPPING
- BEDROCK GEOLOGY
- SLOPE
- ELEVATION
- SOIL SERIES
- SOIL EROSION POTENTIAL
- SOIL DRAINAGE CAPABILITY
- SURFACE HYDROLOGY
- POTENTIAL GROUNDWATER RECHARGE AREAS
- LIFE ZONES
- ZOOLOGICALLY NOTEWORTHY HABITATS
- SOCIAL AND CULTURAL CONSTRAINTS
- EXISTING LAND USE

B. SYNTHESIS OF SYSTEMS SHOWING THEIR RELATIONSHIPS AND DEPENDENCIES

C. SUITABILITY STUDY FOR SEVERAL POTENTIAL LAND USES
- URBAN RESIDENTIAL
- RURAL RESIDENTIAL
- SUBURBAN RESIDENTIAL
- IRRIGATED CROPS
- DRYLAND CROPS
- PASTURE
- RANGELAND
- INDUSTRY
- COMMERCIAL
- NATURAL RELREATION
- DISPERSED RECREATION
- INTENSIVE RECREATION
- PHYSICAL CONSTRAINT AREAS
- BIOLOGICAL CONSTRAINT AREAS
- SOCIAL CONSTRAINT AREAS

III. THE VALUE AND EFFECTIVENESS OF THE PROCESS

COURSE OUTLINE NOTES

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CROPPING FARMING SYSTEMS

LECTURE OUTLINE

Introduction -- 20 minutes.

Population pressure: increasing man/land ratios; the movement of people who traditionally crop for a living onto land which cannot sustain it; the search for alternatives -- brief ref. to animal alternatives; the need to consider other crops. Farming systems research philosophy; the importance of the bottom-up approach; the importance of interdisciplinary approach; past concentration on crops moving to total system -- mainly concerned with cropping because that is often (particularly in semiarid areas) what is of particular concern to farmers. Now moving towards animal alternatives. Range management systems originally concentrated on animal production systems and because of importance of crops to the people being planned for now also moving to crops. Essential difference is that farming systems approach has been designed to direct research rather than planning development of the area. But the approach does have much to offer development planners.

Farming Systems Research -- 60 minutes

- Purposes, definition, characteristics;
- Target and research area selection, survey design and analysis, problem identification;
- On-farm research analysis;
- Implementation of results and development planning;
- Extension

Crop Production in Arid and Semiarid Lands -- 40 minutes

- The potential for irrigation
- Handout on the crops which can be grown without irrigation in ASAL
- Factors to be considered in crop planning -- without the essential agronomic characteristics for the crops considered -- not possible to grow them. Without demand for the products very little chance

of success. Most of the other factors for success can be supplied if the national resources allow -- technology, capital, infrastructure, etc.

- Handout on factors to be considered in classifying land-types for cropping systems: existing cropping patterns and their effects on the components in the system; rainfall; local demand; market demand; infrastructural requirements; landscape and geomorphology; soil texture; fertility and chemical conditions; pests; disease; technology; extension, credit
- Use examples from Zimbabwe on crop yield potential in higher rainfall areas; lack of attention to lower rainfall areas and recent measures to correct this.
- Discuss the importance of both agronomic and economic factors: millets in Tanzania and Zimbabwe; importance of infrastructure and economic incentives Zambia and Malawi
- Discuss the importance of an integrated approach when planning cropping systems -- stress the fragility of ASAL ecosystems

HANDOUTS

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CIMMMYT Notes

1. An analytical sequence using a systems perspective for understanding small farmers by informal surveys.
2. A case study of a diagnostic survey of a farming system in Zambia.

M. Collinson Notes

1. Development of the Farming System in Chibi South (Zimbabwe). Results of and prognosis from the informal survey.
2. Understanding Small Farmers, 1979.

S. Franzel

Small farmers' management strategies

R. K. Perrin, D. L. Winkelmann, E.R. Moscardi, and J. R. Anderson

From Agronomic data to farmer recommendations

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WOODLAND PRODUCTION SYSTEMS

ABSTRACT OF LECTURE

Woodland production systems are an integral part of many land use practices of many countries. However, in contrast to situations in the humid tropics and the temperate zones of the world, the woodland production systems in arid and semiarid regions are, in general, less intensive and of small-scale. Therefore, the focus of this lecture will be the woodland and production systems that are developed and implemented at a local farm level and primarily for the benefit of the local people. Typically, only one or two farmsteads with land holdings of a few hectares are involved, or these systems could involve an entire rural community in a cooperative effort extending over several hundred hectares. In any case, without woodland production in rural areas, people cannot be sustained. Nevertheless, these rural people are the most vulnerable members of society, as they are the first to feel the effects of "hard" times. Environmentally sound woodland production systems, even when smallscale, can help to moderate the ups and downs of local economies by providing sustained woodland products and the associated benefits there from over long time periods.

OBJECTIVE

Smallscale woodland production systems in arid and semiarid ecosystems may be comprised of fuelwood management components, agroforestry systems, shelterbelt and windbreak plantings, or reforestation and afforestation programs for a variety of purposes. Regardless of the composition, a goal of these systems should be to provide, on a sustained basis, the woodland products and associated benefits required by the rural people. To meet this goal, the ecosystems must be integrated with agricultural and other land uses. In this lecture, technical and environmental aspects of smallscale woodland productions systems will be introduced within a general planning framework.

INTRODUCTION

Rural people cannot be sustained without woodland products and the associated benefits that are derived from woodland management practices. Furthermore, without woodland production, on a sound ecological basis, the general "well being" of a country may be placed in jeopardy. Technically and environmentally sound smallscale woodland production systems should, therefore, be a requirement to the comprehensive land use planning that meets a country's needs at all societal levels.

Besides the technical and environmental concerns, comprehensive land use planning of smallscale woodland production systems, regardless of the goals, involves the difficult tasks of understanding and working with social and economic constraints which, invariably, prevail at local, regional, and national levels in all countries. Unfortunately, it is beyond the scope of this lecture to elaborate on these problems, although the general theme has been developed in a number of earlier presentations. Instead, the technical and environmental issues that are, to a large degree, the ultimate basis for planning and implementing smallscale woodland production systems will be described, specifically in terms of the more common systems components in arid and semiarid ecosystems.

STATEMENT OF ISSUES

Most lands that are capable of growing trees and woody shrubs have "limits" in size and ability to produce or sustain woodland products and the associated benefits. Nevertheless, these lands can contribute to the well being of people, when they are properly managed and protected. A proper balance between the social and economic benefits derived from the woodland product and benefits, and the social and economic costs required for the management of the woodland is a prerequisite, however. To achieve this balance, comprehensive planning is needed.

RELATIONSHIP TO OTHER LECTURES

The abiotic (nonliving) and biotic components of arid and semiarid ecosystems have been described in earlier lectures. Knowledge of these components provides a basis to a systems approach to land management practices. One of these systems, and the topic of this lecture, concerns woodland production. In most instances, the products and associated benefits from smallscale woodland production systems are "critical" to the livelihood of many people.

MAIN TOPICS OF LECTURE

In essence, the lecture is organized into two basic parts: a review of a planning process for the development of smallscale woodland production systems, and, within a general planning framework, the technical and environmental aspects of smallscale woodland production systems designed to meet specific needs. Among these needs are fuelwood supplies, combined production of agriculture and forestry (e.g., agroforestry), shelterbelts and windbreaks, and the reforestation or afforestation of arid and semiarid landscapes.

A planning process for the development of smallscale woodland production systems can follow a sequence of several phases. Although the overall process might be described in different ways, the major steps are: identifying problems and objectives, establishing criteria of "acceptance," and evaluating the various alternative and trade-offs involved in the selection of a course of action. Various quantitative techniques may be employed to aid in completing the basic phases of the planning process. Some of these techniques can be quite detailed. However, as discussed herein, a checklist of steps to be considered as the planning proceeds may be adequate.

Throughout the world, demands for fuelwood are increasing. Many households and even whole communities are entirely dependent upon wood for cooking and heating. Over time, it is likely that more people will

become dependent on fuelwood for energy. It is not surprising, therefore, that forests and woodlands are often subjected to complete deforestation. Frequent and continuous harvesting of fuelwood poses dangers of soil compaction, soil erosion, and nutrient and organic material depletion. Environmental consequences of these dangers include dislodging of plant, animal, and human populations, degradation of soils and site productivities, and reduction of genetic diversities of native species.

When properly managed, the use of woody materials from smallscale woodland production systems has obvious advantages: a dependable and renewable supply of energy, a more even spread of developmental activities through reforestation and, when feasible, afforestation of marginal lands, and the generation of employment in rural areas which are usually closer to the woodland source. Consequently, the world stands to gain from the use of fuelwood and other woody biomass for energy, necessitating environmentally sound planning.

The woodland ecosystems of the world are being subjected to ever increasing pressure by subsistence farmers. Therefore, combined production systems, also called "agroforestry," offers a means of bringing the activities of rural people into greater harmony with the environment by developing "complementary" associations between agricultural crops and woody plants. A detailed discussion of combined production systems is not presented here, as it is a topic in a subsequent lecture.

Quite often, smallscale woodland production systems in arid and semiarid regions involve shelterbelt and windbreak plantings. Shelterbelts and windbreaks are, by definition, barriers of trees and woody shrubs planted in one or more rows at right angles to the prevailing winds. Their main purpose is to reduce the velocity of winds across agricultural crops and pastures, or around buildings and livestock enclosures. Properly-managed shelterbelts and windbreaks can yield usable products from thinnings, sanitation cuts, prunings, and rotational cuts without greatly reducing the barrier effects. Indeed, these cuttings are

frequently planned and often necessary to maintain the structure and vitality of the barriers.

Natural forests and woodlands have been depleted, and in many cases, completely eradicated in many countries throughout the world. Therefore, plans for reforestation on areas that once supported forests and woodlands, and afforestation on areas previously devoid of trees and woody shrubs cannot be made too soon. The goals of reforestation or afforestation plantings are varied. In general, trees and woody shrubs are planted for wood products, including fuelwood, as parts of combined production systems, in shelterbelts and windbreaks, and to lessen environmental degradation by erosion. Through planning, a number of these goals can be attained simultaneously in smallscale woodland production systems.

In this lecture, the full range of smallscale woodland production systems that could be considered for a given locale cannot be mentioned. Instead, examples of some of the more common systems is discussed. It is important that decisionmakers and others interested in planning, implementation, or management of smallscale woodland production systems thoroughly explore all of the possibilities for "creatively" utilizing a particular woodland ecosystem in the most beneficial manner.

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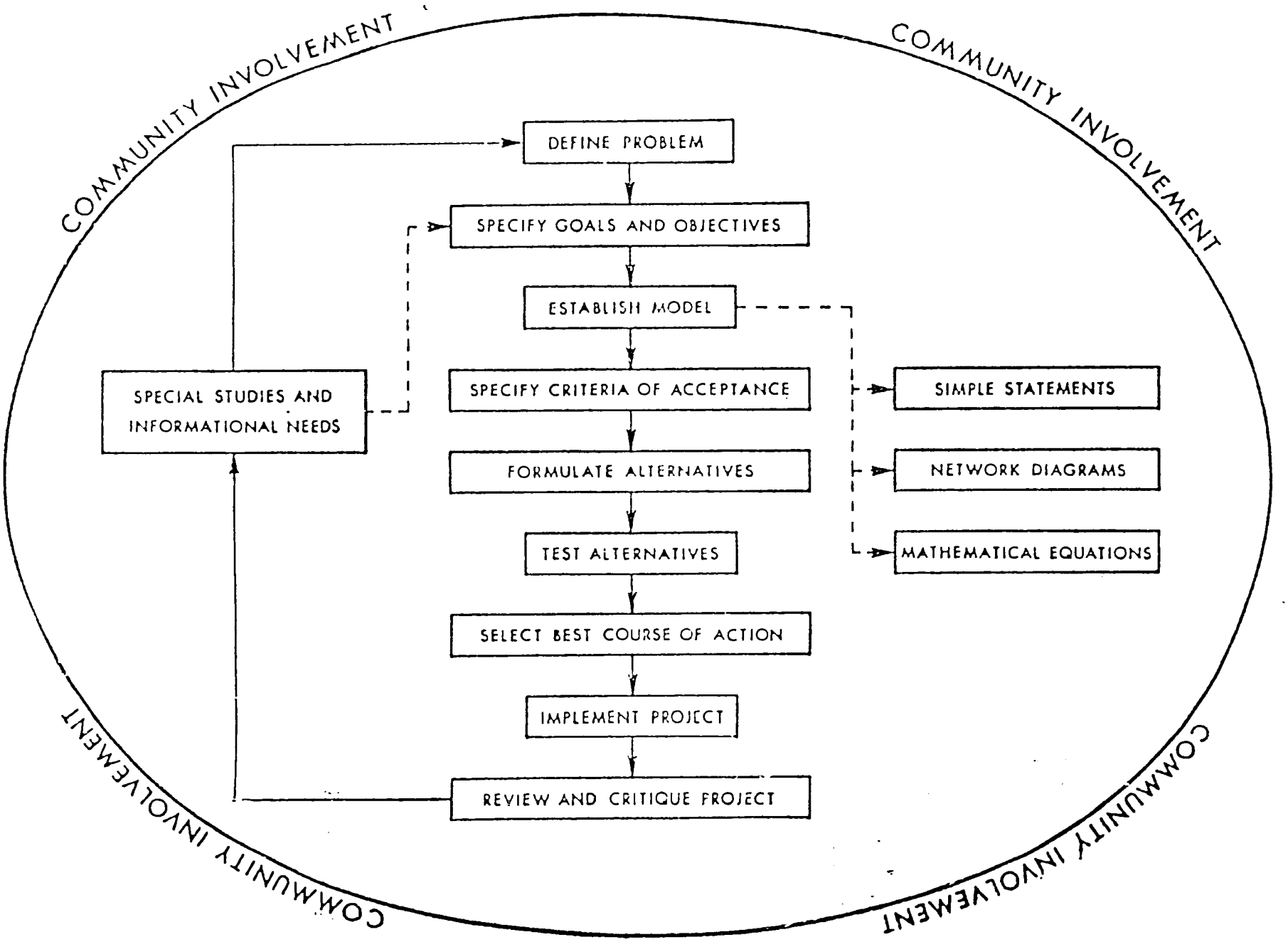
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SPECIFY GOALS AND OBJECTIVES
ESTABLISH MODEL
SPECIFY CRITERIA OF ACCEPTANCE
FORMULATE ALTERNATIVES
TEST ALTERNATIVES
SELECT BEST COURSE OF ACTION
IMPLEMENT PROJECT
REVIEW AND CRITIQUE PROJECT
SPECIAL STUDIES AND INFORMATIONAL NEEDS
SIMPLE STATEMENTS
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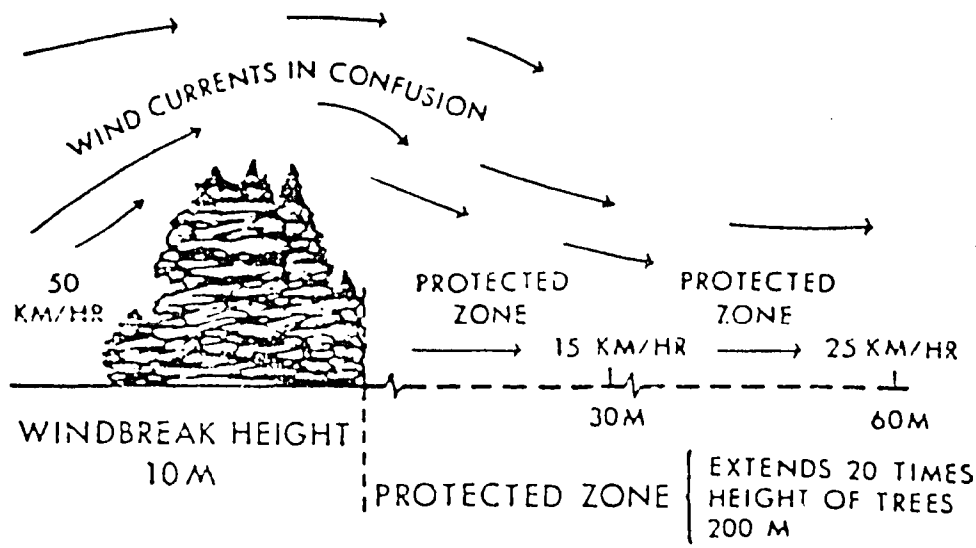
MATHEMATICAL EQUATIONS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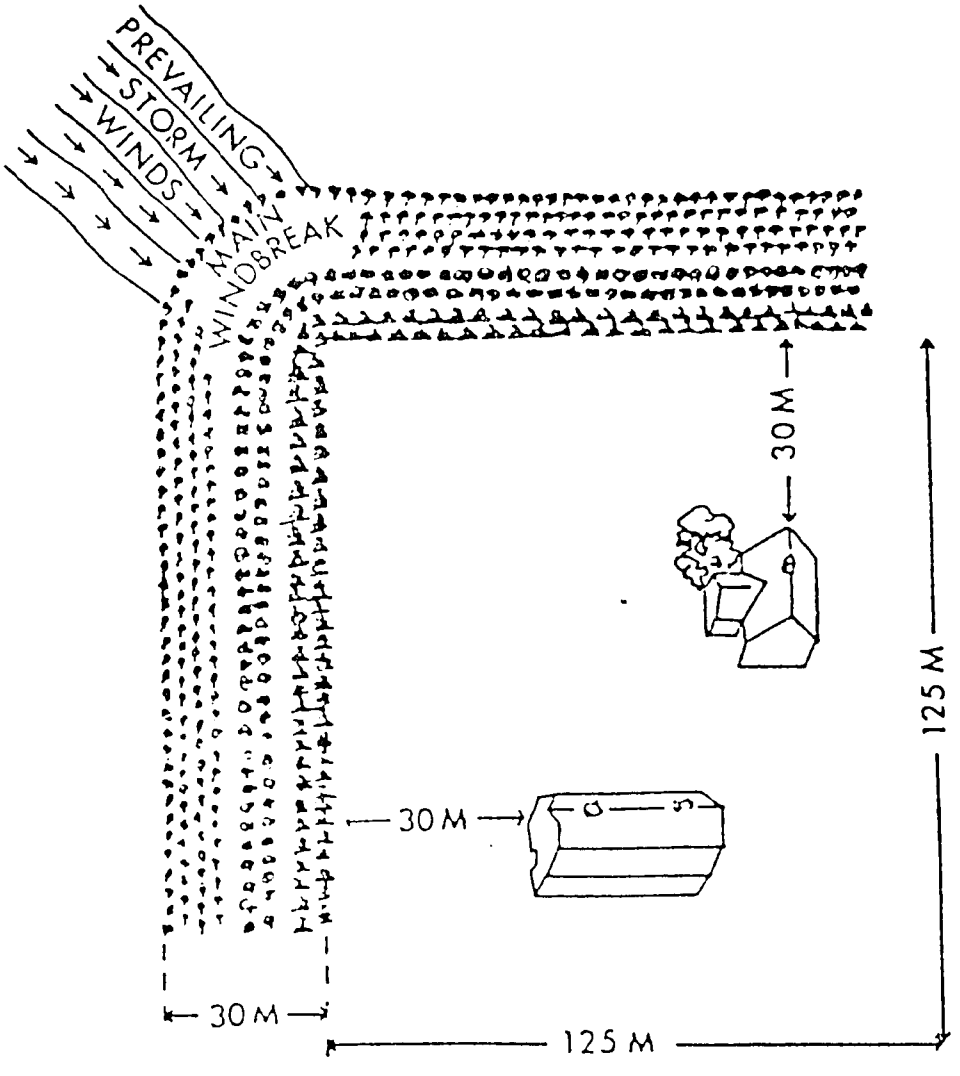
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COMBINED PRODUCTION SYSTEMS

ABSTRACT OF LECTURE

In combined production systems, agriculture and forestry are practiced, more-or-less, on the same piece of land, simultaneously, sequentially, or spatially. Such combinations, also called "agroforestry," involve agricultural crop production and (or) animal husbandry, in which woody vegetation (e.g., trees, shrubs, palms, bamboos, etc.) play a dominant role. A basic purpose of combined production systems to ensure ecological stability and, at the same time, to provide maximum benefits to the users of the land, both in the short- and long-terms.

OBJECTIVE

Combined production systems are, by definition, a collection of land-use systems and technologies where woody vegetation is deliberately grown on the same land with agricultural crops and(or) domestic livestock, in either spacial or temporal arrangements. Implementation of these systems is not necessarily a new form of land management, although the term "agroforestry," used to describe many of these systems, is a relatively new word. The novelty of the concept of combined production systems lies in formally recognizing that many different woody plant-based land use systems possess a number of common features that, in many instances, hold great promise. In this lecture, some of the more prominent combined production systems in arid and semiarid ecosystems will be described.

INTRODUCTION

On fertile and well-watered alluvial soils, where traditional farming is based, in general, on the monocropping of rice, wheat, and other cereal grains, it may be possible to increase yields by adapting modern, temperate-zone technologies. But, on less well-situated sites, attempts to replace traditional farming systems with modern monocrop agriculture

have failed, in many instances, because of high risks from climate, pests, and difficult soil conditions, and because of the complex socio-economic conditions that can prevail. Therefore, in recent years, agricultural scientists, foresters, and range managers have begun developing modern technologies to improve, rather than replace the traditional farming systems. Quite often, these new technologies are based on the implementation of combined production systems.

Intensive systems of combined production, or agroforestry, like intensive agriculture, can support dense population on fertile lands. However, combined production systems are probably more important for improving and sustaining the productivity of lands with soil fertility and soil moisture deficiencies, and where a lack of rural infrastructure and cash makes it necessary for the people to produce their own basic needs for food, fodder, fuel, and shelter. This situation is not uncommon in both developed and developing countries with extensive "marginal" arid or semiarid environments.

STATEMENTS OF ISSUES

Although not a new approach to land management, combined production systems (as defined in this lecture) attempt to "optimize" ecological and economic interactions between various production components (e.g., trees and shrubs, agricultural crops, domestic livestock, etc.) to obtain a higher, more diversified, and more sustainable total production that is possible with a single land use. In meeting these goals, combined production systems can provide range of goods and services. Fuelwood and a variety of other "raw materials" derived from the woody vegetation can be produced for farmers' subsistence, for local sale, and sometime, for export. The soil's productive potential can be protected and, at times, improved. Social and economic conditions in rural areas are often improved by creating jobs and income, and reducing the risks to farming practices. Depending upon the particular situation, all of these goods and services may be provided to varying levels of satisfaction by combined production systems.

RELATIONSHIP TO OTHER LECTURES

In previous lectures, the various components of arid and semiarid land management have been discussed. With this background, these components can provide a basis to a systems approach to land management practices. Agricultural and woody production systems, as management entities, were described earlier. Herein, these so-called "single-purpose" production systems are being integrated into combined production systems to "optimize" the ecological and economic benefits of an ecosystem.

MAIN TOPICS OF LECTURE

Many reviews of combined production systems and practices have been published, although most are only descriptive. Rarely are quantitative data included on the respective yields of the production components, or the number of people or areas involved. Nor have many in-depth analyses of the ecological and economic advantages or disadvantages of these agroforestry systems been reported. However, these reviews do suggest that combined production systems have been practiced for a long time, with apparent success in many parts of the dry tropical and subtropical worlds.

Combined production systems have been classified in a number of ways, according to their physical structure, temporal arrangement, relative importance and role of the production components, production outputs, and social and economic features. In this lecture, the discussion of combined production systems, or agroforestry, is based on the combination of production components: in specific, agrisilviculture, silvipasture, and agrosilvipasture. These categories are not discrete, however, rather they represent a "continuum" of agroforestry systems. Nevertheless, they are a suitable basis for discussing the potentials and problems of further development, and largescale implementation of combined production systems.

Agrisilviculture is the land-use system where both agricultural crops and wood products are produced. In essence, agrisilviculture represents a general improvement of the old traditional system of shifting cultivation, a "primitive" methods of cyclical cultivation where a farmer cuts some or all of the woody plants, typically burns them, and raises agricultural crops for one or more years before moving on to another site and repeating the process. However, a system of agrisilviculture can be ecologically sound, provided that the fallow period is long enough to allow the woody vegetation to restore the soil fertility. To shorten the fallow, under many agrisilviculture systems, the woody plants are sown or planted when the farmer abandons the land, instead of depending upon the uncertainties of natural regeneration.

Silvipasture is practiced when a primary land use is the raising of domestic livestock through grazing. Frequently, it includes the "controlled" grazing of woody vegetation. Additionally, these woody plants may yield fuelwood and other wood products. Traditional silvipasture systems have evolved over the centuries, where the "better" grazing lands have been converted to agricultural production, forcing nomadic farmers and their domestic livestock onto "inferior" areas.

It must be realized that a limit exists as to the number of livestock an area can support. Therefore, a proper management of the grasslands to prevent overgrazing is vitally important in silvipasture systems. Furthermore, it can be feasible to introduce woody browse into the grassland, since a combination of trees, shrubs, and grasses can offer the optimal benefits. Additionally, individual trees and woody shrubs on grasslands offer the benefit of providing shade and shelter for the animals. Importantly, to avoid the problems of overgrazing, a concerted effort must be made to reduce the number of grazing domestic livestock to the "carrying capacity" of the range.

As the name implies, an agrosilvipasture system is a combination of agricultural and silvipasture systems. In general, the land use is a mixture of agriculture and livestock raising, relying heavily on fodder

from the woody vegetation. Once again, the woody plants may furnish a variety of wood products. In arid and semiarid areas, agrosilvipasture systems are typically found in a valley, where agriculture is practiced on the valley floor and silvipasture is employed on the woody-covered slopes around the valley. Agrosilvipasture can also be practiced on the same piece of land, but in general, not always at the same time. In some instances, fields in which woody vegetation is growing are only farmed during certain periods of the year, and then grazed by domestic livestock during the other periods.

As might be expected in a discussion of agroforestry, there are numerous variations of these rather arbitrary categories of combined production systems. However, in all cases, the concept of agroforestry systems as a sustainable approach to land use is sound. The aim is to create productive farming systems able to supply an increasing and sustainable output of basic human needs and satisfactions.

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RANGE LIVESTOCK PRODUCTION AS A SYSTEM

INTRODUCTION

This lecture considers range management with livestock production as the goal. An attempt has been made to integrate all of the factors which go into the management of rangelands and to utilizing these lands for the production of meat, milk, fiber, and other livestock products. Consideration is given to uses other than livestock grazing to which these lands may be put such as crop farming, forestry, watersheds, or other productive or conservation enterprises. The attached systemized chart serves as a basis for this discussion.

THE ENVIRONMENT

The range environment including its abiotic and biotic components is taken as a starting point.

Abiotic

Soil. A lecture has been presented on soil and it is sufficient here merely to list the factors within soils which are of significance in relation to plant growth. Consideration is given to the parent material from which soils are formed and to its characteristics (texture, structure, depth, profile, organic material, fertility, minerals, water relations, biota, and reaction. These characteristics, in association with other abiotic and biotic constituents of the environment profoundly influence plant growth which is the basis for animal production on rangelands as it is for all plant production.

Climate. Climate is a term to describe the broad atmospheric conditions which surround the earth's surface and influence this surface as well as everything growing on it. The role of climate in influencing soil formation and development has been discussed as has its effects on vegetation and the hydrological cycle. Precipitation is perhaps the

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single most important segment of climate influencing plant growth. The kind of precipitation (rain, snow, hail, etc.), the amount, the season of fall in relation to plant development stages, intensity, and the reliability, all influence plant growth and animal activities. Temperatures, evaporation, humidity, wind, growing season, and light are additional components of the complex that makes up climate.

Physiography. This refers to the shapes and arrangement of the land surface. It has been indicated as influential in soil formation. Additionally, plant growth and use of the land surfaces by animals are variously affected by altitude, slopes (steepness, stability, exposure, length), and the pressure of water bodies such as rivers, lakes, etc.

Biotic (The living portion of the environment.)

Past use. This implies man's impact on the environment and would be considered as a biotic factor. Man's influence is exerted through farming activities, herding of animals, wood cutting and burning. These activities are more often detrimental if proper management techniques are not applied but they can also benefit the environment.

Fire. Fire is considered here as a biotic factor although it may be essentially abiotic when fires occur naturally as a result of climatic or geological causes. Fires from lightning strikes have influenced vegetation development from the beginning and are still evident. Fire has been used as a tool by man for at least 350,000 years to facilitate cross-country travel, to concentrate game, to remove mature vegetation, or to control insect pests. Fire is today a major tool in vegetation manipulation and the use of planned burning has developed into a specialized field of its own.

Vegetation. This refers to plant growth on the soil and includes vegetation from lower plant forms such as lichens and mosses through grasses, forbs, shrubs, and trees. On the system chart it is shown as a product of the abiotic environment and past use. Relative to vegetation

it is necessary to know, among other things, the kinds of plants, productivity, ability to withstand grazing, animal preferences, the form and structure of plants and how they grow and respond to environmental conditions. All of these factors are included in the listing under vegetation. Vegetation is influenced by grazing management particularly in regard to degree of grazing use (overgrazing), season of grazing, and kind of animals (grazers, browsers). Range development also affects vegetation especially where range management practices are undertaken.

RANGE FORAGE

The portion of the vegetation which can be and is utilized by animals is referred to as forage -- the feed supply. Obviously, a plant must be within reach of the animal and must be located within the distance an animal can move to and from a source of water if it is to be foragable. Tall trees are out of reach, some plants are distasteful, some are poisonous. Additionally, plants are able to withstand removal of only a part of their animal production if they are to live and reproduce themselves. Roughly speaking, plants can withstand removal of little more than one-half of their current growth or even less when stress conditions occur. Information on the portion of vegetation that is forage and how to utilize it with animals on a sustained yield basis is of paramount importance to livestock producers on rangelands.

GRAZING MANAGEMENT

The management of the animals (livestock) which are to harvest the range forage crop and convert it into products useful to man. The rate of stocking of numbers on a given range area is a primary concern. The objective is to maintain those numbers which will utilize the forage crop in an orderly and productive manner without causing damage to the vegetation and soil. Too large a number of animals causes overgrazing with damage to the forage plants sufficient to cause their death or results in ecological changes reflected by a change from useful forage plants to useless plant species. If this overgrazing is continued the

soil itself may be damaged with resultant erosion. Carrying capacity relates to livestock numbers which may be suitably supported on a rangeland area. It is a measure of the ability of that area to support productive livestock over time. Balancing livestock numbers with carrying capacity is one of the most important tasks of the range manager and often the most difficult.

The kinds of animals utilized on given range areas (cattle, sheep, goats, camels, donkeys, or wildlife) may be a result of choice or preference by the human owners. A strong influence in this regard, however, is the reaction of animals to rangeland environments. For example, camels are well known as inhabitants of the driest environments for which they are ideally adapted. Cattle do not thrive in the drier deserts or in the hottest and most humid tropical areas. Additionally, the kinds of animals have preferences for different kinds of vegetative materials or plants. Roughly speaking, cattle are considered to prefer grass to other plants, sheep show a preference for succulent broad-leafed plants (forbs), goats and camels are considered to be browsing animals. However, it must be understood that animal preference for types of plants is strongly influenced by availability and any animal will shift to less preferable forage plants when conditions require it. In any case, recognition of preferences makes it possible to utilize several kinds of animals on a given range area and thereby make more suitable use of all of the different species of plants that exist there. This is a consideration of "combination stocking" -- a mix of animal species on one area.

The actual management of livestock on rangelands involves distributing them over the area so that all plants of the landscape are used to the degree possible. Distribution is manipulated, in part, through the elements listed under range development and improvement, but location of watering points is perhaps the most important. Management also involves allowing animal use at the most suitable season from the standpoint of the plants ability to withstand removal of its tissues. Consideration of season of use and response of plants to grazing at different times

has led to development of a number of specialized grazing systems such as rotational or deferred. These systems attempt to utilize the forage to the highest degree possible without causing lasting damage to the plants. The objective is to attain maximum livestock production while maintaining and improving the plant and soil base.

LIVESTOCK MANAGEMENT

The management of livestock on rangelands is primarily a matter of grazing management. However, there are considerations which are specific to the animals themselves. The nutrition of animals is a major consideration and we have seen that adequate nutrition and the provision of, at least, minimal amounts of essential nutrients is basic to animal productivity. Range animal nutrition is a complex subject because of the variety of plants on a landscape with variable nutrient levels, the seasonal changes which occur, and other variations. Animal quality is a matter of attempting to utilize the most productive animals through selection of adapted herds and upgrading by genetic selection. Reproduction rates or the numbers of young produced, is generally the best measure of range livestock productivity. It is a matter of maintaining the herd as well as producing a saleable or usable surplus. This is referred to as percent of calf, lamb, or kid crop. Other elements of importance in livestock management include disease conditions and control, supplementary feeding to supply nutrient deficiencies existing in the natural forage, marketing of surplus animals, etc. The economics of production is often the controlling factor in range livestock management, as in other forms of land use because costs are involved and returns must be realized to balance these costs and provide maintenance for the pastoralist. Costs and returns need not be calculated solely in monetary terms. Benefits may be in the form of subsistence food or other values obtained in exchange for labor expended.

RANGE DEVELOPMENT AND IMPROVEMENT

Practices included under this heading include all means which are taken to maximize safe utilization of the range forage crop and to maintain and increase productivity from the livestock which use it. Some of these, such as fences, water supply, or livestock facilities, are rather specific for managing the animals themselves. Many range improvements such as water spreading, revegetation, or bush control, are aimed at improving the vegetation. Thus, range improvement influences both the plant and the animal segments of the rangeland/livestock production complex.

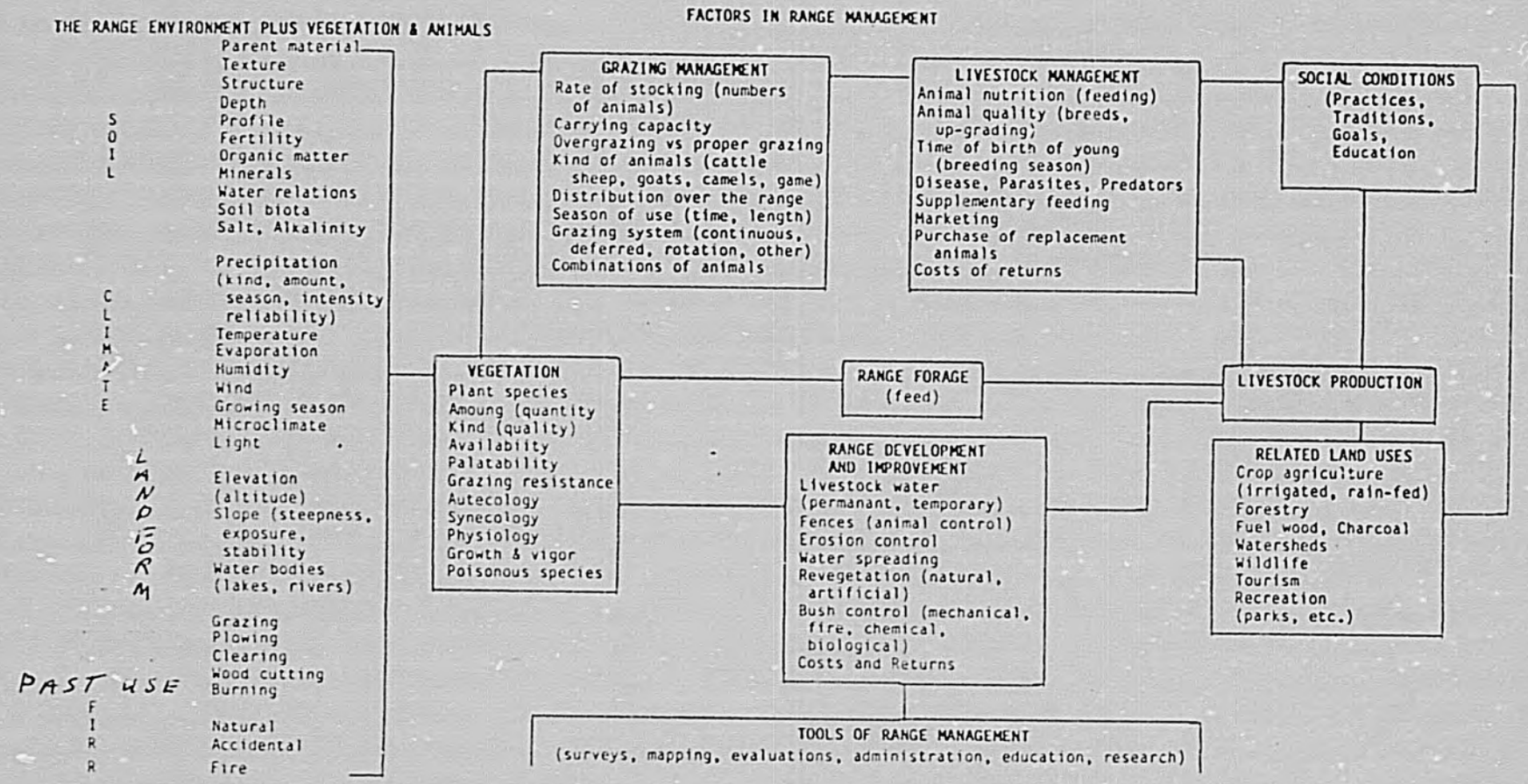
LIVESTOCK PRODUCTION

Production is the key to the entire process, the purpose of the exercise, and the end point. Livestock production is here shown to be the ultimate outcome from the complex of abiotic and biotic factors existing in rangeland ecosystems, and the manipulation of these factors by man to achieve desired goals. The objective of these manipulations should be to produce the greatest amount of livestock products possible while maintaining and improving the land resource base from which it comes.

CONCLUSION

In conclusion, it is necessary to point out that grazing use of rangeland areas is not the only choice for land ecosystems. In fact, there is seldom and single use possible and on most range lands, many uses may be integrated and carried out together. Land areas which will support crop farming are already under this form of use or will be in time. Forestry, fuel wood production, watershed values, wildlife uses, and recreation use are all possibilities. Significantly, the prevailing social conditions, the traditions, desires, and goals of the human occupants of land ecosystems should be a controlling guide although this facet is often overlooked or only given lip service in developing land-use projects. It is the responsibility of the country development

planner to utilize all information available from plant, soil, animal, and people surveys and studies to devise projects which will be of the greatest benefit to a nation on a continuing basis and consistent with the needs and desires of the land users.


THE RANGE ENVIRONMENT PLUS VEGETATION & ANIMALS
FACTORS IN RANGE MANAGEMENT
SOIL
Parent material
Texture
Structure
Depth
Profile
Fertility
Organic matter
Minerals
Water relations
Soil biota
Salt, Alkalinity
CLIMATE
Precipitation (kind, amount, season, intensity reliability)
Temperature
Evaporation
Humidity
Wind
Growing season
Microclimate
Light
LANDFORM
Elevation (altitude)
Slope (steepness, exposure, stability
Water bodies (lakes, rivers)
PAST USE
Grazing
Plowing
Clearing
Wood cutting
Burning
FIRE
Natural
Accidental
Fire
GRAZING MANAGEMENT
Rate of stocking (numbers of animals)
Carrying capacity
Overgrazing vs proper grazing
Kind of animals (cattle sheep, goats, camels, game)
Distribution over the range
Season of use (time, length)
Grazing system (continuous, deferred, rotation, other)
Combinations of animals
LIVESTOCK MANAGEMENT
Animal nutrition (feeding)
Animal quality (breeds, up-grading)
Time of birth of young (breeding season)
Disease, Parasites, Predators
Supplementary feeding
Marketing
Purchase of replacement animals
Costs of returns
SOCIAL CONDITIONS
(Practices, Traditions, Goals, Education
VEGETATION
Plant species
Amoung (quantity
Kind (quality)
Availability
Palatability
Grazing resistance
Autecology
Synecology
Physiology
Growth & vigor
Poisonous species
RANGE FORAGE
(feed)
LIVESTOCK PRODUCTION
RANGE DEVELOPMENT AND IMPROVEMENT
Livestock water (permanant, temporary)
Fences (animal control)
Erosion control
Water spreading
Revegetation (natural, artificial)
Bush control (mechanical, fire, chemical, biological)
Costs and Returns
RELATED LAND USES
Crop agriculture (irrigated, rain-fed)
Forestry
Fuel wood, Charcoal
Watersheds
Wildlife
Tourism
Recreation (parks, etc.)
TOOLS OF RANGE MANAGEMENT
(surveys, mapping, evaluations, administration, education, research)

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COST-BENEFIT ANALYSIS -- PART II
CASE STUDIES

ABSTRACT OF LECTURE

The teaching of principles and methods of cost-benefit analysis (CBA) is usefully combined with case studies showing direct applications. One such source of cases is produced by the Food and Agriculture Organization (FAO). Although addressing CBA for projects in forestry and forest industries only, the FAO cases illustrate methods, problems, and data needs common to CBA in natural resources projects more generally.

I. CASE STUDIES AS A TEACHING DEVICE

DESCRIPTION

The case study, as used in this context, presents a record of a natural resources issue or issues that have been faced by actual decision makers. The use of the case method calls for discussion of real-life situations requiring CBA for resolution or clarification. These situations have been described so as to give the students/trainees pertinent information for the CBA -- within the constraints of manageable length..

Since each case is in some respects unique, there is no single standard pattern for evaluting a CBA. Each case will need individual attention. However, the following guidelines will help the instructor ensue that the students/trainees obtain the maximum learning experience from the cases:

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1. Have the students/trainees quickly read through a case in its entirety to get a general grasp of its context. Then have them go back and read the case very carefully to develop a complete mastery of the case facts.

2. When figures are presented, encourage students/trainees to personally check them with pocket calculators to determine numerical interrelationships. If student/trainees do not understand the computations of cash flow, a remedial session (or separate course component) may be required to correct deficiencies.

3. Have the student/trainees define the main economic issues in the case, writing them down on paper in precise terms. Then have the students/trainees exchange views to make sure all view the problem in more or less the same way.

4. The student/trainees should critique the case to evaluate the extent to which it conforms to good CBA. Among the points to be considered are the following:

   - the definition of benefit(s) and the definition of cost(s)
   - valuation concepts and procedures, especially or project inputs and outputs not covered by market prices
   - the investment criterion used (net present value, rate of return, etc.), and the justification (if any) for that choice
   - the discount rate(s) used, and the justification (if any) for that choice
   - the difference in results between financial analysis and economic analysis, and likely explanations for that difference
   - the extent and care with which "shadow prices" are derived and applied in the economic analysis
   - the extent of sensitivity analysis, and the usefulness of the discussion that accompanies it

- the extent, relevance, and strength of the sections which qualitatively discuss project effects not expressed in monetary terms
- the overall strengths and weaknesses of the CBA, accompanied by supporting reasons.

II. EXAMPLES OF CASE STUDIES PREPARED BY FAO

REFERENCES

1979. Economic Analysis of Forestry Projects: Case Studies. Food and Agriculture Organization of the united nations, Rome. Available as FAO Forestry Paper No. 17, supplement 1. Cases are as follows:

1. Philippine Smallholder Tree-Farming Project.
2. Village Fuelwood Plantations in Korea.
3. South American Natural Forest Utilization Project.
4. Kenya I Sawlog and Pulpwood Plantation Project.
5. Kenya II Sawlog and Pulpwood Plantation Project.
6. Zambia Industrial Forestry Project.

These studies generally lend themselves to the kind of review and evaluation described in the preceding section. The cases may be studies in conjunction with the main volume of FAO Forestry paper No. 17 (Economic analysis of Forestry Projects), and Supplement 2 of the same paper (Economic Analysis of Projects: Readings).

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THE ROLE OF PROTECTED AREAS IN DEVELOPMENT

AND

THE VALUE OF CONSERVING GENETIC RESOURCES

ABSTRACT: THE ROLE OF PROTECTED AREAS IN RELATION TO DEVELOPMENT AND CONSERVATION IS DISCUSSED. THE WORLD CONSERVATION STRATEGY OUTLINED THREE OBJECTIVES FOR CONSERVATION AND THE PRIORITY REQUIREMENTS NEEDED TO MEET THOSE OBJECTIVES, INCLUDING NATIONAL ACTIONS TO INTEGRATE CONSERVATION AND DEVELOPMENT. PROTECTED AREAS CAN HELP TO MEET THE OBJECTIVES OF THE WORLD CONSERVATION STRATEGY AT THE NATIONAL LEVEL BY REDEFINING THE COMPATABILITY OF CONSERVATION AND DEVELOPMENT THROUGH INTEGRATED REGIONAL PLANNING. IUCN'S CLASSIFICATION OF PROTECTED AREA CATEGORIES IS PRESENTED.

THE BENEFITS OF CONSERVING GENETIC RESOURCES AS IT RELATES TO ECONOMIC AND SOCIAL WELL-BEING IS DISCUSSED. THE PRESERVATION OF GENETIC DIVERSITY IS NEESSARY TO SUSTAIN AND IMPROVE AGRICULTURE, FORESTRY, FISHERIES, TO KEEP OPEN FUTURE OPTIONS,AS A BUFFER AGAINST ENVIRONMENTAL CHANGE, AS RAW MATERIAL FOR SCIENTIFIC AND INDUSTRIAL MOTIVATION, AND AS A MATTER OF MORAL PRINCIPLE. THE CONCEPTS OF EX SITU VS. IN SITU CONSERVATION, PROVANANCES, AND MINIMUM CRITICAL SIZE ECOSYSTEM ARE PRESENTED WITH SPECIFIC REFERENCE TO PROTECTED AREAS. SPECIFIC EXAMPLES ILLUSTRATE THE VALUABEL ECONOMIC USES OF GENETIC RESOURCES, INCLUDING BOTH WILD AND DOMESTIC PLANT AND ANIMAL RESOURCES USED FOR FOOD AND MEDICINE.

OBJECTIVES: TO EMPHASIZE THE IMPORTANCE AND COMPATABILITY OF PROTECTED AREAS AND GENETIC RESOURCES IN REGIONAL PLANNING, MANAGEMENT AND DEVELOPMENT.

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LECTURE OUTLINE

A. ROLE OF PROTECTED AREAS IN DEVELOPMENT

I. WHY CONSERVATION IS CRITICAL TO SUSTAINED DEVELOPMENT

II. WHY DONOR ORGANIZATIONS HAVEN'T CONTRIBUTED MORE TOWARDS CONSERVATION EFFORTS

III. EMERGENCE OF THE WORLD CONSERVATION STRATEGY AS A MEANS TO INTEGRATE CONSERVATION AND DEVELOPMENT

IV. THE WORLD CONSERVATION STRATEGY
- a. DEFINITION OF CONSERVATION
- b. THREE MAIN OBJECTIVES OF CONSERVATION
  1. MAINTAIN ESSENTIAL ECOLOGICAL PROCESSES AND LIFE SUPPORT SYSTEMS
  2. PRESERVATION OF GENETIC DIVERSITY
  3. SUSTAINABLE USE OF SPECIES AND ECOSYSTEMS
- c. PRIORITY REQUIREMENTS NEEDED TO IMPLEMENT THE OBJECTIVES
- d. PRIORITY NATIONAL ACTIONS
  1. PREPARATION AND IMPLEMENTATION OF NATIONAL AND/OR SUBNATIONAL CONSERVATION STRATEGIES
  2. INTEGRATION OF CONSERVATION AND DEVELOPMENT
  3. IMPROVE ENVIRONMENTAL PLANNING AND ALLOCATION OF LAND USE
  4. IMPROVE LEGISLATION AND ORGANIZATION
  5. IMPROVE TRAINING AND RESEARCH
  6. BUILD SUPPORT FOR CONSERVATION
  7. CONSERVATION BASED RURAL DEVELOPMENT
- e. PRIORITY INTERNATIONAL ACTIONS

V. ROLE OF PROTECTED AREAS IN MEETING OBJECTIVES OF THE WORLD CONSERVATION STRATEGY

VI. CHANGING PERCEPTIONS OF PROTECTED AREAS AND THEIR COMPATABILITY WITH A COUNTRY'S SOCIAL, ECONOMIC, AND DEVELOPMENT NEEDS

VII. THE IUCN CONSERVATION AREA CLASSIFICATION SYSTEM

VIII. LINKING PROTECTED AREAS WITH ADJACENT LANDS THROUGH INTEGRATED REGIONAL PLANNING

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B. THE VALUE OF CONSERVING GENETIC RESOURCES

I. WHY CONSERVE GENETIC RESOURCES

II. HOW TO CONSERVE
- a. EX SITU VERSUS IN SITU
- b. PROVENANCES
- c. MINIMUM CRITICAL SIZE ECOSYSTEMS

III. VALUABLE ECONOMIC USES OF WILD AND DOMESTIC GENETIC RESOURCES
- a. PLANT RESOURCES AND FOOD PRODUCTION
- b. ANIMAL RESOURCES AND FOOD PRODUCTION
- c. MEDICINAL PLANT AND ANIMAL RESOURCES

IV. GENETIC CONSERVATION AND INTERNATIONAL PROGRAMS

SELECT REFERENCES:

GUIDELINES FOR THE MANAGEMENT OF LARGE MAMMALS IN AFRICAN CONSERVATION AREAS. (ED. A.A. FERRAR). SOUTH AFRICAN NATIONAL SCIENTIFIC PROGRAMMES, REPORT NO. 69, PRETORIA, 1983.

GENETICS AND CONSERVATION (EDS. C.M. SCHONEWALD-COX ET AL). BENJAMIN-CUMMINGS, LONDON, 1983.

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ROLE OF PROTECTED AREAS IN ARID AND SEMIARID LAND MANAGEMENT

ABSTRACT OF LECTURE

The role of protected areas in relation to conservation and development is discussed, with special reference to arid and semiarid lands. Changing perceptions towards protected ares include external or international attitudes, as well as those at a national and local level. The relationship between human density and tolerance towards wildlife strongly affects these perceptions. The role of protected areas as environmental baselines for detecting change in similar ecosystems that are being exploited by man is discussed. The conservation of genetic resources can only be assured through the adequate provision of protected areas, and the value and importance of this to society as a whole is emphasized.

OBJECTIVE

To emphasize the importance of protected areas in conservation, management and development of arid and semiarid lands.

INTRODUCTION

The role of protected area in sustaining society is an extremely important and valuable one, for a variety of reasons, which are outlined and discussed in this lecture topic. However, differing social perceptions towards conservation and protected areas require analysis, so that their benefits, direct and indirect, immediate and distant, tangible and aesthetic, can be more easily understood by all levels of society.

MAIN TOPICS

- Protected areas and socioeconomic and sociopolitical issues
- Role of protected areas in the implementation of world conservation strategy
- Human density and tolerance of wildlife and the relationship between protected areas and indigenous peoples
- External or international attitudes and their influence on protected areas
- National perceptions of park values
- Constraints at a local level
- Protected areas as environmental baselines
- Monitoring within and outside protected areas
- Conservation of genetic resources and the role of protected areas
- Extinction rates and protected areas
- Determinants of minimum area requirements

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WATERSHED MANAGEMENT

ABSTRACT OF LECTURE

Over 80% of the land on earth is nonagricultural and nonurban. In general, these lands are called watersheds, and they consist of forests, rangelands, and undeveloped wildland areas. Many of these watershed lands are habitable, and their growing populations are becoming more and more dependent upon the areas for the production of food, fiber, energy, and living space. It is not surprising, therefore, that watersheds are frequently misused, and a severe deterioration is taking pace in many parts of the world. There is a growing concern over the biological, physical, social, and economic problems that result from this deterioration. The inhabitants of watersheds see a gradual decline in the productivity of these lands, accompanied by a loss of natural resources. Furthermore, excessive flooding, sedimentation of productive agricultural lands, and siltation of reservoirs and irrigation systems adversely impact the economy and general welfare of people living downstream of these areas. The processes of deterioration will continue until long-term commitments are made to correct existing land use practices through the implementation of sound watershed management.

OBJECTIVE

It is imperative that people understand the principles and concepts of watershed management, and more importantly, develop ways of implementing natural and agricultural resource management practices that are conducive to "good" land husbandry. Such practices must be economically feasible and socially acceptable. The purpose of this lecture is to discuss, in a general sense, the basis of watershed management and review some of the problems and solutions that have been observed historically.

INTRODUCTION

Watersheds and the resources on watersheds play a significant role in the development of any country. Dependent upon its location, a watershed can furnish a diversity of primary wood products, contribute forage for domestic livestock and wildlife species, yield water for municipal, agricultural, and industrial developments, and provide many forms of aesthetic and recreational enjoyment.

With respect to water, runoff from upland watersheds flows downstream, supplying water to valleys and joining lakes, rivers, and eventually oceans. Along this path, the activities of people may significantly alter the natural hydrologic flow. Land-use manipulations for agriculture, forest harvesting, urban development, and engineering and mining purposes are important developmental activities. Unfortunately, these activities can have destructive consequences, such as increasing the rate of sedimentation. Whether or not the land-use manipulations bring about the desired "optimum" benefits depends, in large part, upon the magnitude of the destruction to the environment. Therefore, in addition to the various natural and agricultural resource products and uses derived from a watershed, the associated disadvantages of developmental activities must also be fully evaluated. It is here where the role of effective watershed management becomes important.

STATEMENT OF ISSUES

Effective watershed management in many countries is currently in the formulative stages. Although there may be a trend to effectively manage a country's watersheds and the natural and agricultural resources thereon, the accumulated effects of past, and often abusive use of the watersheds will continue to be "felt" for some time into the future. This situation is particularly evident in many arid and semiarid environments, where the "recovery" is both slow and prolonged. It is urgent, therefore, for all concerned with the management of watershed

resources the know and apply relevant strategies and techniques that will promote the effective management of a country's resources.

RELATIONSHIP TO OTHER LECTURES

To complete the lectures on production systems, it is important to discuss the "collective" management of the agricultural and natural resources on a watersheds basis. The term "watershed management" refers to the management of all of the resources on a watershed to maintain, protect, or in some cases, increase the water resource. Land-use planning and, therefore, management can be implemented in terms of watershed units. Watershed management should be viewed as integrated multiple resource management (to be outlined in the following lecture) within the boundaries of a watershed.

MAIN TOPICS OF LECTURE

Good watershed management practices as synonymous with good forest, range, and agricultural management practices. In general, land-use practices associated with watershed management may be grouped into: activities or management guidelines that prevent adverse impacts to soil and water resources from occurring, restoration or rehabilitation activities needed to bring a watershed from a poor, mismanaged conditions to a productive states, and activities designed to increase water yields. Within the framework of these categories, watershed management problems and opportunities will be examined from a global perspective.

Between 50% and 80% of the population of developing countries live on watershed lands that, in general, are marginal in terms of agricultural crop production. For millions of these people, it is a fact that the harder they work, the poorer they become. Their land is either too steep or too dry, or the soil is too poor to support more than a subsistence level of existence.

Arid and semiarid regions, the primary focus of this lecture, are not often thought of as watershed lands. However, the water relationships of these areas are, perhaps, more important to a greater number of people than those of the more humid regions. Water is always in "critical" balance in these dry environments, and this balance is currently being upset by man and his animals at alarming rates over vast areas. Present land-use patterns in arid and semiarid ecosystems must change, so that delicate water relations are not pushed beyond their limits. As the number of people and animals living in these regions increases and, as a result, the quality of the land on which they must live declines, the impact will be certain unless solutions are found.

It is important to recognize that the problems of watershed lands in arid and semiarid regions do not necessarily arise from physical limitations, nor from lack of technical knowledge. Wood harvesting practices, reforestation methods, and grazing management techniques have been developed to minimize the adverse impacts on soil and water resources. The "technology" is at hand to solve most of the watershed problems. However, methods are needed to effectively demonstrate the benefits of instituting good watershed management programs. The social and economic benefits derived from these programs must also be quantified and compared to the costs of not implementing the programs. Importantly, the inhabitants of watersheds and their livelihood must be considered as an essential part of all watershed management programs. This goal requires the integration of social, political, and economic factors, in addition to biological and physical considerations.

To illustrate the above, a slide-tape presentation of the so-called Beaver Creek Program will be shown. The Beaver Creek area is a large watershed, located in the arid and semiarid region of the southwestern United States. It is part of a major river basin that yields much of the water for the more heavily populated urban areas in the region. The goals of the Beaver Creek Program, to be highlighted by the slide-tape presentation, are to provide land managers with: essential facts about the biological, physical, social, and economic effects of integrated

multiple resource management in the region, and better ways to predict, display, and evaluate differences among the probable results of management alternatives before actions are initiated. Many organizations are involved in the Beaver Creek Program, including federal and state agencies, universities, foundations, and private concerns. Their varied skills and expertise are vital to its success.

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Dunne, T. and L. B. Leopold. 1978. Water in environmental planning. W. H. Freeman and Co., San Francisco, California. 818 p.

Kunkle, S. H. and J. L. Thames. 1976. Hydrological techniques for upstream conservation. Food and Agriculture Organization of the United Nations, FAO Conservation Guide No. 2. 74 p.

O'Loughlin, R. E. and A. J. Pearce. 1984. Symposium on effects of forest land use on erosion and slope stability. Environment and Policy Institute, East-West Center, Honolulu, Hawaii. 310 p.

Satterlund, D. R. 1972. Wildland watershed management. The Ronald Press Co., New York. 370 p.

COURSE OUTLINE NOTES

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FOLLOWUP OR BACKSTOPPING IDEAS:

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INTEGRATION OF THE WILDLIFE COMPONENT INTO ARID AND SEMIARID LAND MANAGEMENT

ABSTRACT OF LECTURE

The ecological and economic role of wildlife in arid and semiarid land is described and discussed. National Parks, Safari Areas and other land categories are discussed in relation to the nonconsumptive and consumptive use to which wildlife may be put. The integration of wildlife into farming systems, e.g. game ranching and game farming, is examined. The compatability of wildlife use with farming systems, human/wildlife interactions and conflict resolution is discussed. Methods and techniques important to wildlife management and utilization such as resource inventory and ecological monitoring, are described.

OBJECTIVE

The integration of the wildlife component into arid and semiarid land management.

INTRODUCTION

Having described and characterized the wildlife component earlier, this lecture topic now describes how to go about integrating the wildlife component into a systems approach to the management and use of natural resources in arid and semiarid lands. A prerequisite to the incorporation of the wildlife component into an integrated management approach is an inventory of the resource, and thereafter management by objective. Careful monitoring should accompany management and use of the resource.

MAIN TOPICS

- Role of wildlife: economic, ecological
- National Parks, Safari Areas and nonconsumptive and consumptive use of the wildlife resource.
- Integration into farming systems. Game ranching, game farming Domestic versus wild; mixed domestic and wild livestock
- Intensification of farming systems and compatibility with wildlife.
- Human/wildlife interaction and conflict resolution
- The relationship intensification of farming systems with other forms of land use and the world conservation strategy
- Goals and objectives of wildlife management.
- National Parks, Safari Areas, other land categories
- Over-population and sustained yield harvesting
- Resource inventories and baseline surveys
- Landscape and habitat classification
- Climate
- Soils, water resources, hydrology, erosion and nutrient flow (see elsewhere).
- Numbers and distribution of animal populations
- Ecological monitoring -- what to monitor and how to monitor it
- Detecting change -- ecosystem models and monitoring programs
- Frequency and scale of monitoring
- Components that require monitoring
- Methods of measuring components to be monitored

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Grimsdell, J.J. R. 1978. Ecological Monitoring. Handbooks on techniques currently used in African wildlife ecology. No. 4. African Wildlife Leadership Foundation, Nairobi.

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Ajayi, S.S. and L. B. Halstead (eds.). 1979. Wildlife management in savannah woodland. Taylor and Francis, London.

Riney, Thane. 1982. Study and management of large mammals. Wiley Interscience, Chichester.

Ferrar, A. A. (ed.). 1983. Guidelines for the Management of Large Mammals in African Conservation Areas. South African National Scientific Programmes Report, No. 69, Pretoria.

Owen-Smith, R.N. (ed.). 1983. Managment of large mammals in African conservation areas. Haum, Pretoria.

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INTEGRATED MULTIPLE RESOURCE MANAGEMENT

ABSTRACT OF LECTURE

Quite often, the management of a tract of land involves only a few natural or agricultural resources on a land unit, or, when one resource is considered, only a few uses of that resource. The resources on a land unit may be timber, agricultural crops, and water, or the uses of the one resource, timber, for example, may be lumber, pulp, and fuelwood. Usually, this kind of management is dictated, in part, by a critical demand for the commodities or amentities being produced. Generation of income and satisfactions from this kind of "dominant" management philosophy may appear to be adequate for the apparent needs at present. However, in managing for only a few resources or resource uses, the possibilities of diversifying and increasing the level of income from the management scheme is frequently restricted or even overlooked. To the extent that decisionmakers can incorporate a "multiple use" management philosophy into a planning strategy, the level of income and satisfactions that is generated by the management of the tract of land can be enhanced through an integrated approach to land management.

OBJECTIVE

The basic objective of integrated multiple resource management is, regardless of the management focus, to manage the natural and agricultural resource complex for the most bereficial combination of present and future uses. The idea of maximizing the income and satisfactions from a given resource base is not new, but it has become more important as competition for limited and interrelated resource products increases. These increased pressures have forced many countries, both developing and developed, to enact the legislation necessary to establish multiple use as a policy of resource management. However, the multiple use concept, as often described by law, does not necessarily demand that every land management unit in question should be utilized for all of the possible uses and resource products simultaneously.

Instead, most lands are to be utilized, to varying degrees, for a wide array of uses, as dictated by productivity and demands.

INTRODUCTION

The term "multiple use" may be applied either to area of land or to particular natural or agricultural resources. When applied to land areas, multiple use refers to the production and management of various resources on a particular land management unit. When applied to a particular natural or agricultural resource, multiple use refers to the utilization of the resource for various purposes. In either case, the relationships may be competitive, complementary, or supplementary. Therefore, it is important to recognize what area of a relationship is being confronted. In practice, integrated multiple resource management involves both the multiple use of land areas and of resource products. Demands on particular resources (e.g., trees) for specific uses (e.g., fuelwood), in turn, place demands on the land areas where the resources are produced (e.g., upland watersheds).

STATEMENT OF ISSUES

In many discussions of land management, multiple use is cited as a guiding principle. At times, one gets the impression that multiple use is a "panacea" for all of the problems of land management. However, while there has been little difficulty in gaining acceptance of the multiple concept, it has had far less success as a working tool of management. Most people concede that timber or agriculture is not necessarily the sole production function for a land unit, and that water, forage, and wildlife should also be considered in management decisions. In fact, by excluding these other production functions in the management program, income and satisfactions may well be foregone. But, how much managerial effort should be allocated to each potential use is a problem that decisionmakers have not always been able to resolve. Reconciliation of conflicting interests has been, and continues to be an important responsibility of land managers.

RELATIONSHIP TO OTHER LECTURES

In previous lectures, agricultural, woodland, domestic livestock and wildlife production systems (and combined production systems thereof), and watershed management have been examined. The purpose of this lecture is to build from these earlier presentations by recognizing the multiple use potentials of the component production systems and management schemes, and incorporating them into comprehensive, integrated land management planning. By doing so, a more efficient utilization can be made of the resource base on a unit of land.

MAIN TOPICS OF LECTURE

The problems of implementating an integrated multiple resource management program are not always realized by decisionmakers. Although these problems may often be structured in resource-oriented management objectives during the initial phases of management implementation, decisionmakers must continually be aware of area-oriented management implications, especially when management plans and systems are developed for application over large areas. A number of land management considerations, and policy formulations and institutional conflicts are confronted in attempting to integrate the components of multiple use for enhanced income and satisfaction generation, as discussed in the lecture.

To effectively incorporate the multiple use concept into land management, decisionmakers should possess: on-site measurements of the yields of natural and agricultural resource products for the alternative multiple use management systems under consideration; knowledge of the benefits and costs that are associated with each of the alternatives; and a recognition of the externalities, or the off-site impacts that are related to each of the alternatives. From this information, decisionmakers may undertake economic evaluations of the alternative multiple use management systems to form a basis for selecting the best course of action. Importantly, these economic evaluations must be "tempered" to

satisfy the goals of multiple use, as stated by the societal groups that will benefit and also pay for the decision to be implemented.

Given an array of economic relationships as derived from economic evaluations, decisionmakers should be able to choose the best course of action. However, it should also be anticipated that there may be a number of policy issues and institutional conflicts that must be resolved before an integrated multiple resource management program becomes operational.

The question of who will pay for the establishment of a new multiple use management system specifically designed to alter, for example, fuelwood or agricultural production, must be answered. The group of people that implements the system may not derive benefits from all of the multiple uses affected. Undoubtedly, the role, regarding costs, of societal groups benefiting from increased fuelwood or agricultural production will have to be established.

Benefits and costs of a multiple use management system designed to alter resource production to better meet societal needs in a country must also be ascertained. Various viewpoints (e.g., local, regional, national, etc.) will need to be adopted so people can determine how a system is going to affect them individually and collectively.

Perhaps, the greatest problem confronting decisionmakers pursuing land management in a multiple use context is that of the development of an efficient and responsive institutional framework through which land areas subjected to multiple use can be managed. A realistic multiple use management plan, such as that outlining a system to alter fuelwood or agricultural production, must either work within the existing institutional structure or modify it to be effective. An evaluation of the political and social organizations through which natural and agricultural resources are currently administered may suggest a necessity for institutional reform.

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Dykstra, D. P. 1984. Mathematical programming for natural resource management. McGraw-Hill Book Co., New York. 338 p.

Gregory, G. R. 1972. Forest resource economics. The Ronald Press Co., New York. 548 p.

Hewlett, J. D. and J. E. Douglas. 1968. Blending forest uses. USDA Forest Service, Research Paper SE-37. 15 p.

Ridd, M. K. 1965. Area-oriented multiple use analysis. USDA Forest, Research Paper INT-21. 14 p.

USDA Forest Service. 1980. Research on multiple use of forest resources. USDA Forest Service, General Technical Report WO-25. 161 p.

A Framework of a Hypothetical Product Mix Representation for Alternative Land Management Systems on a Watershed

Item	M_0	M_1	M_2
Timber cut (cubic meters)	x_{01}	x_{11}	x_{21}
Timber growth (cubic meters)	x_{02}	x_{12}	x_{22}
Agricultural production (kilograms)	x_{03}	x_{13}	x_{23}
Livestock (kilograms gain)	x_{04}	x_{14}	x_{24}
Wildlife (number)	x_{05}	x_{15}	x_{25}
Water (centimeters)	x_{06}	x_{16}	x_{26}

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SELECTED INFORMATION RESOURCES FOR ARID AND SEMIARID LANDS

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INTRODUCTION

This document was compiled to help planners, educators, researchers, and managers of arid and semiarid lands in developing countries locate sources of current information and to enable the establishment of communication links with institutions having similar interests. It is not intended to be a complete listing of all the resources available, rather resources were selected for inclusion that were thought to be both readily available and that provided up-to-date information. Information was gathered from a variety of secondary sources including:

Agricultural Research Centres: A world directory of organizations and programs (Longman reference on research series) 7th ed. N. Harvey, consultant editor. Longmand Group Ltd., Professional and Information Publ. Div., 6th Floor, Westgage House, The High, Harlow, Essex CM20 1NE, UK. Tel: Harlow (0279) 442601. Distributed exclusively in the USA and Canada by Gale Research Co., Book Tower, Detroit, MI 48226, USA.

Encyclopedia of Associations. Volume 1: National Organizations of the U.S. 1983 17th edition. D. S. Akey (Ed.). Gale Research Co., Book Tower, Detroit, MI 48226, USA.

Research Centers Directory. 6th ed. 1979. A. M. Palmer (Ed.). Gale Research Co., Book Tower, Detroit, MI 48226, USA.

The Europa Yearbook. A World Survey. 1978 and 1985. Europa Publications Limited. Gale Research Co., Book Tower, Detroit, MI 48226, USA.

Ulrich's International Periodicals Directory. 21st edition. 1982. A Bowker Serials Bibliography. R. R. Bowker Order Dept., P.O. Box 1807, Ann Arbor, MI 48106.

EBSCO Subscription Services Librarian's Handbook. 1984-1985. 5350 Alpha Road, Dallas, TX 75240.

Numerous annual reports.

The lists in each section and subsection are not to be considered complete. Omissions are unintentional and it is hoped that future updates will include important literature, agencies, institutions, and foundations overlooked in this inventory. Descriptions of institutional interests and activities in this document are brief and general in nature. For more detailed and current information it is best to write directly to the institution using the address provided.

The lists developed in this publication are divided into two main sections:

- Selected Literature Resources. Three subsections provide information on: 1) Annotated references, 2) Periodicals, and 3) Bibliographies. Where possible the complete mailing address of the publisher and the approximate subscription costs are included.

- Selected Institutional Resources. Four subsections provide addresses and brief descriptions of the types of resources available from: 1) International Institutions, 2) National Institutions, 3) Universities that provide training, and 4) NTIS.

SECTION I: SELECTED LITERATURE RESOURCES

REFERENCES

Abercrombie, F. D. 1974. Range development and management in Africa. Office of the Development Services, Bureau for Africa. USAID, State Dept. Bldg., 320-21st St., NW, Washington, D.C. 20523.

This basic review of general range management in Africa covers many aspects of infrastructure relating to range management.

Bailey, A., W. Elder, and T. D. McKinney (Eds.). 1974. Readings in Wildlife Conservation. The Wildlife Society, 5410 Grosvenor Lane, Bethesda, MD 20814. 722 pp.

A compilation of ecological and management papers dealing with wildlife, which were published in various journals and periodicals. A good summary of the field.

Bale, J. B., D. Conte, D. Goehring, and D. S. Simonett (Eds). 1974. Remote Sensing Applications in Resource Management Problems in the Sahel. Report prepared for USAID, Contract No. AID afr-c-1058. Earth Satellite Corp., USAID, State Dept. Bldg., 320-21st St., NW, Washington, D.C. 20523.

A comprehensive treatment of the 1974 state of the art in remote-sensing applications in the analysis of all aspects of the rangeland ecosystem. Procedures are outlined and recommended for use of Landsat, aerial photography, and low-altitude and ground observation.

Baumgartner, A. and E. Reichel. 1975. The World Water Balance. Elsevier Sci. Pub. Co., P.O. Box 211, Amsterdam, The Netherlands. 179 pp.

Written in two columns, one in German and one in English, the world, continental, and regional supplies of fresh water are described on the basis of tables and maps showing precipitation, evaporation, and discharge.

Beer, Stafford. 1975. Platform for Change. Wiley Interscience Pubs., One Wiley Dr., Somerset, NJ 08873. 457 pp.

This book examines the way we currently view our world and its affect on management. Beer theorizes that the world is changing and that we are managing it using tools and concepts from our views of a now-vanished world. Arguments are presented to support this hypothesis, with suggestions of ways to meet the needs of the present and future world.

Bement, R. E. 1981. Biological Response Curves for Balancing Livestock with Vegetation. In: Food Production Systems and Environmental Rehabilitation in Somalia. Somali Research Group. Arlington, VA.

This paper develops a concept for determining proper stocking rates.

Bennett, J. 1980. Human Ecology as Human Behavior: A Normative Anthropology of Resource Use & Abuse. In: Human Behavior and Environment: Advances in Theory and Research, Vol. 4 -- Environment and Culture (ed. by I. Altman, et al.). Plenum Press, 233 Spring St., New York, NY 10013. pp. 243-277.

An overview of both the relevance of and differences in cultural beliefs, values, and ethics as they relate to specific resource-development issues and environmental abuses.

Bernsten, R. and A. H. Jacobs. 1983. Socio-Economic Aspects of Range Research in Kenya: A Plan for Reaching the Ultimate Target Groups. Technical report submitted to the Ministry of Livestock Development, Government of Kenya, by Winrock International, Route 3, Morrilton, AR 72110-9537.

Outlines both the rationale and a strategy for conducting adaptive, "pre-extension" development research among Kenya's rangeland peoples, incorporating many of the ideas and experiences that have proved useful in the farming-systems-research approach.

Bishay, A. and W. G. McGinnies (Eds.). 1979. Advances in Desert and Arid Land Technology and Development. Vol. 1. International Conference on the Applications of Science and Technology for Desert Development, Cairo, 1978. Harwood Academic Publishers, P.O. Box 786, Cooper Station, New York, NY 10276. 618 pp.

This book documents how different societies have been affected by their environments. Social organization as well as technology are discussed as important variables affecting the ways in which populations adapt to, or cope with, desertification. Case studies from around the world are presented.

Bourliere, F. 1983. Ecosystems of the World. Number 13: Tropical Savannas. Elsevier Sci. Pub. Co., 52 Vanderbilt Ave., New York, NY 10017. 730 pp.

This book has 31 chapters and 28 contributors, of whom 11 are French. The book describes and reviews the ecological research on most components of the savanna ecosystem that lies between deserts and humid forests. Its coverage is in as much detail as the information permits. Discussions of land and animal management are not included. Literature citations are extensive.

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Branson, F. A., G. F. Gifford, and J. R. Owen. 1981. Rangeland Hydrology. Range Science Series No. 1 (Second Ed.). Society for Range Management, 2760 W. 5th Ave., Denver, CO 80204. 340 pp.

Several authors give up-to-date reviews of the principles of hydrology on rangelands. Much applies to tropical rangelands as well as to temperate zones.

Chambers, R. 1980. Shortcut methods in information gathering for rural development projects. Institute for Development Studies, Univ. of Sussex, United Kingdom. 24 pp.

Principles discussed are applicable to rangeland resource assessment. Discusses reason why many resource appraisals fall short of providing information needs for rural development projects. Some of the reasons covered are timeliness, biases from five common causes, overkill of information (unusable), unnecessary accuracy, not taking enough time, failure to search out existing information, failure to acquire indigenous technical knowledge from the people on the land, listening with the mouth, being misled by myths, failure to cross-check information.

Colwell, R. N. (Ed.). 1983. Manual of Remote Sensing (2nd Ed.). Amer. Soc. Photogrammetry, 105 N. Virginia Ave., Falls Church, VA 22046. 2,724 pp.

Volume 1 contains material on theory, hardware, and software; Volume 2 includes chapters on rangeland applications, forest resources assessment, applications in agriculture, water resources applications, and geology.

Conant, F., P. Rogers, M. Baumgardner, C. McKell, R. Dasmann, and P. Reining (Eds.). 1983. Resource Inventory and Baseline Study Methods for Developing Countries. A report to the U.S. National Park Service. National Academy of Science, 2101 Constitution Ave., Washington, D.C. 20418. (Multilith), 539 pp.

This book is an attempt to draw together in a single volume the current methodologies for renewable-natural-resource inventories and baseline surveys appropriate for strategic planning and project assessment. Its purpose is to assist development planners in designing and managing economic-assistance programs and to help field officers select experts, methodologies, and levels of effort for resource inventories and baseline surveys. The work is presented in an ecosystem context and covers aquatic ecosystems, soils, plants, and wildlife. Each chapter includes cited literature and a recommended reading list.

Davis, D. E. (Ed.). 1982. Handbook of Census Methods of Terrestrial Vertebrates. CRC Press, 2000 N.W. 24th St., Boca Raton, FL 33431. 397 pp.

A very good series of papers solicited from various authors to give elemental information on techniques for censusing a great many kinds of mammals and birds.

Draz, O. 1983. The Syrian Arab Republic Rangeland Conservation and Development. World Animal Rev. 47:2-14.

The history and use of the hema system are reviewed.

Ehrhardt, R., A. Hansen, C. Sanger, and B. Wood. 1981. Canadian Aid and the Environment. A joint study by the Institute for Resource and Environmental Studies (IRES), Dalhousie University, and the North-South Institute. IRES, Halifax, Nova Scotia. 94 pp.

Canada's current and potential role in international development as it relates to the environment is discussed. Seven projects are reviewed with information on how the environmental concerns are interwoven with them.

Epstein, H. 1971. The Origin of Domestic Animals of Africa. Vol. I (513 pp.) and Vol. II (719 pp.). Revised in collaboration with I. L. Mason. Africana Publishing Corporation, Div. of Holmes & Meier, 30 Irving Place, New York, NY 10003.

An immense contribution especially valuable in illustrating the tremendous variability of livestock breeds that exist in Africa and how they are distributed. Included is considerable discussion about conflicting theories of origin, which the author attempts to resolve.

Galaty, J. G., D. Aronson, P. C. Salzman, and A. Chouinard (Eds.). 1981. The Future of Pastoral Peoples. International Development Research Centre, Ottawa, Canada. 396 pp.

Proceedings of the most recent and extensive effort by mainly social scientists to analyze development needs and trends among pastoralists of the tropical rangelands, based on a conference held in Nairobi, Kenya, 4 to 8 August, 1980.

Gonzales, N. L. (Ed.). 1978. Social and Technological Management in Dry Lands. Past and Present, Indigenous and Imposed. AAAS Selected Symposium 10. Westview Press, 5500 Central Ave., Boulder, CO 80301. 199 pp.

This book is the proceedings of the international workshop on the "Applications of Science and Technology for Desert Development" held in Cairo, Egypt in 1978. The papers cover a wide range of problems that need to be solved for the improvement of human life in arid environments throughout the world.

Goodland, R. J. A., C. Watson, and G. Ledec. 1984. Environmental Management in Tropical Agriculture. Westview Press, Boulder, CO 80301 USA. 237 pp.

Management of the agricultural environment is approached from two perspectives: 1) the sustained production of food and raw materials, and 2) the mitigation of extra-sectoral impacts. The chapters are divided into crop groups and address soil and water management, pest and weed control, and processing conditions. Although humid areas are emphasized, the principles are appropriate for arid and semiarid lands.

Gwynne, M. D. and H. Croze. 1975. Concept and Practice of Ecological Monitoring over Large Areas of Land: The Systematic Reconnaissance Flight (SRF). In: Proceedings of a seminar, Bamako, Mali, March 3-8, 1975. International Livestock Centre for Africa, Addis Ababa, Ethiopia.

This paper presents a direct observational method for documenting animal and human populations and certain vegetation conditions. The method allows statistical confidence statements of the parameters. It is very cost effective for remote regions, but requires specially equipped aircraft; it can also provide factual data for remote-sensing interpretation.

Hafez, E. S. E. (Ed.). 1968. Adaptation of Domestic Animals. Lea and Febiger, 600 S. Washington Square, Philadelphia, PA 19106. 415 pp.

Covers the range of environments relevant to the adaptation of cattle, sheep, goats, swine, and poultry. Includes information on the specific adaptation of many of the more common breeds of sheep and goats. The paucity of information on breeds from developing countries is illustrative of the prevailing bias in scholarship.

Heady, H. F. and E. B. Heady. 1982. Range and Wildlife Management in the Tropics. Longman Inc., 19 W. 44th St., Suite 1012, New York, NY 10036.

This short book describes principles and practices of rangeland management for diploma-level students. It is illustrated with black-and-white photos and suggests many publications for further reading.

Heady, H. F. 1985. Forest Grazing Management: Guidelines for Agro-Silvo-Pastoralism. (In press.)

This is a review of the worldwide literature on agroforestry with emphasis on grazing. Over 1000 publications were searched and about 140 cited. Chapters are on vegetational types, pastoral systems and customs, grazing management, planning for development, and institution building.

Howard, J. A. and J. Schade. 1982. Towards a Standardized Hierarchical Classification of Vegetation for Remote Sensing. RSC Series 11 Bull. Food and Agriculture Organisation of the United Nations, Rome, Italy. 30 pp.

The classification attempts to follow the UNESCO System for Classification and Mapping of Vegetation on a World Basis. It uses a two-digit numeric descriptor for each class starting with 17 climatic classes in the primary, 4 classes each for height and cover in the secondary, and treating evergreen vs deciduous and broadleaved vs needleleaved in the tertiary category. The fourth level treats regrowth and succession and induced vegetation without providing for floristic criteria. The fifth level, not developed by the authors, allows for floristic, edaphic, and economic considerations.

Humphreys, L. R. 1978. Tropical Pastures and Fodder Crops. Longman Inc., 95 Church St., White Plains, NY 10601.

Legumes and grasses used in seeding pastures and rangelands are described in terms of their forage value and culture including seeding, fertilization, planting mixtures, seed production, and grazing management.

International Livestock Centre for Africa (ILCA). 1975. Evaluation and Mapping of Tropical African Rangelands. Proceedings of a seminar, Bamako, Mali, March 3-8, 1975. ILCA, Box 5689, Addis Ababa, Ethiopia.

A comprehensive seminar by world leaders and recognized authorities in grazing-lands assessment and management. The recommendations of the conference are summarized under the following six categories: categories of rangeland survey and evaluation, review of experiences, site development, parameters and methods, sampling and data processing, cartography, and guidelines for the future. The latter category emphasizes the importance of training Africans to do the work of assessment and of performing the work as an integrated inventory by multidisciplinary teams of experts.

Jacobs, A. H. 1972. The Pastoral Maasai of Kenya and Tanzania: Guidelines for Planning Innovations. In: Cultural Source Materials for Population Planning in East Africa, Vol. 2 -- Innovations and Communication (ed. by A. Molnos). Nairobi, Kenya. pp. 334-348.

A concise example of specific social theories relevant to development planning of a pastoral people, related both to previous development efforts among them and their principal cultural characteristics.

Keay, R. W. J. 1959. Vegetation Map of Africa. Oxford Univ. Press, 200 Madison Ave., New York, NY 10016. 24 pp.

The Yamgambi Vegetational Classification Scheme of 1956 as revised by Keay is accepted by many as the best for Africa. It is small scale and more useful for country and regional planning than for project analysis.

Kingdom, J. East African Mammals. An atlas of evolution in Africa.
Vol 1 - Primates, Hyrakes, Pangolins, Protoungulates, and Sirenians. 1971. 456 pp.
Vol. 2, Part A. - Insectivores and Bats. 1975. 404 pp.
Vol. 2, Part B. - Hares and Rodents. 1975. 430 pp.
Vol. 3, Part A. - Carnivores. 1978. 484 pp.
Vol. 3, Part B. - Large Mammals. 1979. 484 pp.
Vol. 3, Part C. - Bovids, Horned Ungulates. 1982. 404 pp.
Vol. 3, Part D. - Bovids, Horned Ungulates. 1982. 358 pp.
Academic Press, Inc., 111 5th Ave., New York, NY 10003, USA.

In this set of remarkable books the author details the behavior and anatomy of the mammals of East Africa. The physiology, distribution, social systems, habitat, ecology, and evolution are described in text and excellent drawings. Volumes 3c and 3d on bovids and horned ungulates are particularly useful.

Le Houerou, H. N. 1981. Phytoecological Surveys for Land Use Planning and Agricultural Development: 25 Years of Experience in the Arid Zones of Africa. In: Arid Land Resource Inventories: Developing Cost-efficient Methods. Forest Service General Tech. Report WO-28. South Agriculture Bldg., (Room 3107), Independence Ave., between 12th and 14th Sts. SW, Washington, D.C. 20250. U.S. Department of Agriculture, Washington, D.C. pp. 154-158.

Summarizes a wealth of information about the vegetation of West Africa and its environmental relationships, productivity, and use.

Little, E. C. S. 1972. Kenya Bush Control. United Nations Development Program/Food and Agriculture Organization (UNDP/FAO), Nairobi, Kenya.

Summarized work on controlling bush, including charcoaling as a means of reducing control costs.

Mabbutt, J. A. 1977. Desert Landforms. 340 pp. (An Introduction to Systematic Geomorphology; V. 2.) MIT Press, Massachussets Institute of Technology, Cambridge MA 02142 USA.

This book discusses landforms and landforming processes in a range of physiographic settings, from upland desert to sand desert. The approach taken assumes that geomorphic response to desert controls is profoundly influenced by structure and major relief.

Matlock, W. G. 1981. Realistic Planning for Arid Lands. Natural Resource Limitations to Agricultural Development. Advances in Desert and Arid Land Technology and Development. Volume 2. Harwood Academic Publishers, P.O. Box 786, Cooper Station, New York, NY 10276 USA. 261 pp.

The problems associated with the arid lands of developing countries are described. The elements of agricultural production systems are presented as they relate to the current and future activities of development. Planning methodologies are then suggested to implement programs meeting the needs of people.

Milligan, K. 1982. Assessing Human, Animal and Environmental Conditions by Low Altitude Aerial Survey: The ILCA Experience in the Sahel. Paper prepared for the Sahel Resource Inventory and Mapping Coordination Workshop, Bamako, Mali, 20-24 May 1982. (Mimeo), 17 pp. (Available from ILCA, PMB 2248, Keduna, Nigeria).

An excellent example of the practical use of systematic reconnaissance flight and observation as a data-gathering technique in remote areas.

Moris, Jon R. 1981. Managing Induced Rural Development. International Development Institute, 400 E. 7th St., Bloomington, IN 47401. 190 pp.

This book has 10 chapters that discuss the development process in rangeland areas. Chapter8 presents an excellent case study of the Maasai Range Development Project. This project was sponsored by USAID in three phases running from 1970 to 1980. The case study offers several lessons learned from rural development programs generally.

Mukasa M. E. 1981. The Camel (Camelus dromedarius): A Bibliographical Review. ILCA Monograph. Int. Livestock Centre for Africa (ILCA), Box 5689, Addis Ababa, Ethiopia. 147 pp.

A comprehensive and well-organized summary of what is known about the dromedary camel.

Organization of American States (OAS). 1984. Integrated Regional Development Planning: Guidelines and Case Studies from OAS Experience. Dept. of Regional Development, 17th and Constitution, Washington, D.C. 20006. 230 pp.

This book documents experience in regional-development planning and investment-project formulation, and includes the incorporation of environmental considerations into this process. It was prepared in cooperation with the National Park Service-USDI and the U.S. Agency for International Development. It includes six excellent case studies of regional development from Latin America. Available in English and Spanish.

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Poulton, C. E. 1972. A Comprehensive Remote Sensing Legend System for the Ecological Characterization and Annotation of Natural and Altered Landscapes. Proc. 8th International Symposium on Remote Sensing of Environment, 2-6 October, 1972. Univ. of Michigan, Ann Arbor, MI 48106. 16 pp.

A computer-compatible, numeric-legend system is presented that provides for the notation of land cover, land use, and environmental parameters in a consistent logic. The first three vegetation levels are based on physiognomic criteria, the fourth on floristic considerations, and the fifth and sixth on phytosociological criteria. The legend provides for various classes of barren land, water surfaces and features, introduced permanent vegetation, agricultural crops, and urban, industrial, and transportation features. On the environmental side, the numeric descriptors provide for macrorelief, landform, surficial geology, and soils.

Pratt, D. J. and M. D. Gwynne. 1977. Rangeland Management and Ecology in East Africa. Krieger Pub. Co. Inc., P.O. Box 9542, Melbourne, FL 32901. 310 pp.

The 25 contributors describe the rangeland vegetation, principles of use, management, rangeland improvements, livestock enterprises, and wildlife relationships in a technical yet readable form. The reference list is extensive.

Riney, T. 1982. Study and Management of Large Mammals. Wiley Interscience Publication, One Wiley Drive, Somerset, NJ 08873.

This is perhaps the very best recent text on management of wildlife in the developing world and the strategies used for finding funds, for enlisting support of governments, and for including wildlife in economic development.

Salzman, P. C. (Ed.). 1980. When Nomads Settle: Processes of Sedentarization as Adaptation and Response. Praeger Special Studies. Praeger Pubs., Div. of Holt Rinehart & Winston/CBS, 521 5th Ave., New York, NY 10175.

A collection of empirical studies highlighting the sociopolitical difficulties and the economic and environmental dangers of attempting to develop rangelands by either strict or forced settlement of its nomadic peoples.

Sandford, S. 1983. Management of Pastoral Development in the Third World. John Wiley & Sons, 1530 S. Redwood Rd., Salt Lake City, UT 84104.

The most recent and perhaps most comprehensive attempt to summarize and analyze the complex socioeconomic dimensions, resource characteristics, and recent development experiences and trends of mainly pastoral rangelands in the Third World, with particular emphasis on problems and issues of local, regional, or national administration.

Sandford, S. 1983. Management of pastoral development in the Third World. John Wiley and Sons, 1530 S. Redwood Rd., Salt Lake City, UT 84104. 316 pp.

An excellent review of problems of rangeland development in the Third World. Many examples from rangelands around the world are provided.

Sandford, S. 1983. Management of Pastoral Development in the Third World. John Wiley and Sons, 1530 S. Redwood Rd., Salt Lake City, UT 84014. 316 pp.

Many guidelines to grazing management are given.

Schemnitz, S. D. (Ed.). 1980. Wildlife Management Techniques Manual. The Wildlife Society, 5410 Grosvenor Lane, Bethesda, MD 20814. 686 pp.

The Wildlife Society's techniques manual is the bible for practicing wildlife managers. It contains a very good discussion of the techniques used in population management, habitat manipulation, and administration and policy for wildlife resources.

Schmidt-Nielsen, K. 1964. Desert Animals: Physiological Problems of Heat and Water. Oxford University Press, 16-00 Pollitt Dr., Fair Lawn, NJ 07410. 277 pp.

A classic on the way animals adapt and adjust to the desert conditions. Includes discussion of basic phenomena with detailed consideration of camels, cattle, donkeys, and sheep.

Sigler, W. F. 1972. Wildlife Law Enforcement (2nd Ed.). William C. Brown Co., 2460 Kerper Blvd., Dubuque, IA 52001. 360 pp.

This is the best text on wildlife-law enforcement in print. Explanations of laws and the duties and responsibilities of law-enforcement personnel are included. Tactics of investigation, arrest, and evaluation of evidence are important topics.

Smith, A. D. and D. D. Dwyer. 1981. Range management training in developing African nations. J. Range Management 34:11-13.

Discussion of alternatives for providing range management training for African students.

Sprague, H. B. 1981. The Status and Challenge of Dryland Agriculture in Developing Countries of the Tropics and Subtropics. Bureau for Program and Policy Coordination, Rural Development Division, U.S. Agency for International Development, Washington, D.C. 20523. 119 pp.

This book develops the status and challenges of dryland agriculture in developing countries. Management practices for specific crops are made by climatic regions. Plant growth characteristics for annual and perennial crops (including trees) as they relate to limited water are discussed.

Squires, V. 1981. Livestock Management in the Arid Zone. Inkata Press Pty. Ltd., 4 Longbourne Ave., Clayton NTH Vic., 3168 Australia. 280 pp.

The book is divided into four parts: 1) comparisons are made between the arid areas of Australia and similar areas of the world, 2) describes animal behavior in the management and handling of animals, 3) discusses the importance of sheep behavior in extensive grazing conditions, and 4) discusses the interactions between livestock and wild and ferral animals. Even though the focus of the book is on inland Australia, the principles developed apply worldwide.

Stevens, M. E. 1976. Erosion Hazard Classification and Inventory Techniques in Mountainous Areas. FAO Conservation Guide 2:13-21. Via delle Terme di Caracalla, 00100 Rome, Italy.

The Conservation Guide series, especially numbers 2 and 3, contain many papers on erosion control, water management, and soil conservation in tropical areas. Rangelands and forests, as well as cultivated land, are included.

Teague, R. and E. Decker (Eds.). Wildlife Conservation Principles and Practices. The Wildlife Society, 7101 Wisconsin Ave., No. 611, Washington, D.C. 20014. 280 pp.

A very good series of papers describing the various management practices and philosophies for wildlife. This text has been used extensively for teaching shortcourses in wildlife management in developing countries.

Thomas, G. W. 1980. The Sahelian/Sudanian zones of Africa: Profile of a fragile environment. New Mexico State Univ. Internat. Pub. Ser. Tech. Infor. Pub. 1-81. New Mexico State Univ., Las Cruces, NM 88003.

In-depth analysis of range management problems and alternatives for this area.

United Nations Educational, Scientific and Cultural Organization (UNESCO). 1979. Tropical Grazing Land Ecosystems. UNESCO/UNEP/FAO. UNESCO, 7 place du Fontenoy, 75700 Paris, France. 655 pp.

A state-of-knowledge report that presents a comprehensive review of rangeland ecosystems and man's patterns of use. Case studies from Africa, America, and Asia are presented.

United Nations Educational Scientific and Cultural Organization (UNESCO). 1979. Tropical Grazing Land Ecosystems. Natural Resources Research Series 16. UNESCO, 7 place du Fontenoy, 75700 Paris, France. 655 pp.

This large book describes tropical ecosystems in terms of floristic composition, climate, water, soil, erosion, and biomass turnover. Over half the pages are devoted to socioeconomics of tropical ecosystems, and a number of case studies are described.

Vink, A. P. A. 1967. Integrated Surveys of Natural Grazing Areas. Proc. 2nd International Seminar. ITC-UNESCO Centre for Integrated Surveys, Delft, The Netherlands.

This is an excellent series of 14 papers (S15 through S28) still quite relevant to the planning and design of resource-assessment work in the developing nations. S16 by Vinogradov treats "The Landscape Concept and Its Use in the Study of Grassland Territories," S16 by Peterson treats "Grassland Surveys and Grassland Production Problems," S27 by Satyanarayan discusses "Integrated Surveys of Arid and Semi-arid Grazing Areas of Asia and Africa," and in S28 Mohrhann discusses "Some Principles and Practices for the Integrated Survey and Planning of Grassland Areas in the Arid and Semi-Arid Zones."

Wilson, R. T., P. N. de Leeuw, and C. de Haan (Eds.). 1983. Research on the Production Systems of the Arid Zones of Mali - Preliminary Results. International Livestock Centre for Africa (ILCA), Addis Ababa, Ethiopia. 189 pp.

The book is based on the research programs of ILCA under their "Arid Zone Programme." The research was conducted from ILCA's West African base in Bamako, Mali and covers the period from 1977 to early 1981. Livestock production systems are described and classified.

Wont van den, Bor (Ed.). 1983. The Art of Beginning. Pudoc Wageningen, P.O. Box 4, 6700 AA, Wageningen, Netherlands. 174 pp.

This book contains 12 case studies giving the first experiences and problems of western expatriates in developing countries with special emphasis on rural development and rural education. It also contains an annotated bibliography of other case studies.

PERIODICALS

Agricultura de las America's. Monthly. $20. Departmento do Circulacion. P.O. Box 12901, Overland, KS 66212-8981, USA.

Agricultura de las America's is specially edited for anyone directly or indirectly related to any aspect of the livestock and agriculture industry.

Agricultural Systems. Quarterly. $242.90. Applied Sci. Publ. Ltd., 22 Rippleside, Commercial Estate, Ripple Road, Barking, Essex, England.

Agricultural Systems publishes the results of studies of whole agricultural systems or relevant parts of them, whether at the level of a production process, an enterprise, a farm, regional agriculture or on a world basis.

Agroforestry Systems. Quarterly. $38. Martinus Nijhoff Publ. Agr. Div., P.O. Box 566, 2501CN, The Hague, The Netherlands.

Agroforestry Systems is an international, multidisciplinary journal that provides a rapid publication outlet for all types of research concerned with the various aspects of agroforestry systems and for critical reviews on all sustainable land management systems that combine agriculture, animal husbandry, and trees on the same unit of land.

Agronomy Journal. Bimonthly. $65. American Society of Agronomy, 677 Segoe Road, Madison, WI 53711, USA.

Agronomy Journal publishes articles of original research findings in soil-plant relationships; crop science; soil science; biometry; crop, soil, pasture, and range management; crop, forage, and pasture production and utilization; turfgrass; agroclimatology and agronomic modeling.

Ambio. A Journal of the Human Environment. Bimonthly. Individual -- $29 plus postage. Pergamon Press Ltd., Headington Hill Hall, Oxford OX3 OBW, England.

Ambio publishes recent work in the inter-related fields of environmental management technology and the natural sciences. It is directed not only to experts, but also to scientists in other fields and to other interested readers.

American Journal Agricultural Economics. 5/year. $50. Dept. of Econ., Iowa State University, Ames, IA 50011, USA.

American Journal Agricultural Economics provides a forum for creative and scholarly work in agricultural economics related to economics in agriculture, natural resources, or rural and community development.

Animal Feed Science and Technology. Quarterly. $127.69. Elsevier Sci. Publ. Co., P.O. Box 211, Amsterdam, The Netherlands.

Animal Feed Science and Technology publishes scientific papers dealing with the production, composition and nutritive value of feeds for animals. At the same time it is intended only to treat matter that is of relevance to an international readership.

Animal Production. Bimonthly. $130. P.O. Box 271, Bletchley, Milton Keynes, England MK3 7R2.

Animal Production publishes reports in English of original works in the field of animal productoin or in any related scientific field.

Annals of Arid Zone. Quarterly. Arid Zone Research Association of India. Jodhpur, Central Arid Zone Research Institute, 342003 Rajasthan, India.

Annals of Arid Zone publishes in the fields of basic resources, plants, wind power and solar utilization, animal, soil-water-plant relationships, human factor, extension and training, agricultural economics, rodent research and training, alternative energy sources/dryland farming, millet improvement, arid zone horticulture, soil salinity research.

Australian Journal of Agricultural Research. Bimonthly. $79.08. Editor-in-Chief, Australian Journal of Agricultural Research, 314 Albert St., E. Melbourne, Victoria 3002, Australia.

Australian Journal of Agricultural Research is a journal for the publication of original contributions towards the understanding of some part of the physical, chemical, and(or) biological aspects of an agricultural system having relevance to Australian conditions. 'Agricultural' is interpreted in the widest sense and includes rangelands; 'systems' embraces aerial, soil, plant, domestic animal and microbiolgocal components and their interrelationships and integration.

Australian Journal of Experimental Agriculture and Animal Husbandry. Bimonthly. $62.50. CSIRO, P.O. Box 89, E. Melbourne, Victoria 3002, Australia.

Australian Journal of Experimental Agriculture and Animal Husbandry publishes the results of applied research in the soil, plant, and animal sciences of relevance to Australian agriculture or animal husbandry.

Australian Rangeland Journal. Semiannual. $45. Membership Registrar, Australian Rangeland Society, c/o Dept. of Agriculture, Jarran Road, South Perth, W.A. 6151, Australia.

The purposes of the Australian Rangeland Journal are: to develop communication between all those involved with rangelands; to develop and foster a philosophy of rangeland use attuned to Australian needs both social and environmental; to speak authoratively on matters affecting rangeland and its uses; to represent the body of rangeland users by presenting a consensus of their aspirations and ideals; to point out deficiencies in our present approaches to rangeland use, to extension effort, to education and to research activity.

Biological Conservation. Monthly. $264.24. Elsevier Applied Science Publishers Ltd., Ripple Road, Barking, Essex, England.

Biological Conservation is an international journal presenting technical reports that generally address the conservation of plants and wildlife.

Ceres. FAO Review on Agriculture and Development. Bimonthly. $15. (Arabic, Eng., Fr., Sp.). USA-UNIPUB, P.O. Box 433, Murray Hill Station, New York, N.Y. 10016 or FAO-Ceres Circulation Office, C-116, Via delle Terme di Caracalla, 00100 Rome, Italy.

Ceres reports in-depth on the multiple aspects of agriculture and socioeconomic progress in developing countries, and deals with al aspects of trade, technology, foreign and international finance legislation, education and training, the protection of the world from pollution, world affairs, and food production.

Crop Science. Bimonthly. $65. Executive Vice President, 677 S. Segoe Road, Madison, WI 53711, USA.

Crop Science is the normal channel for publication of original research findings in plant genetics, breeding, cytology, physiology, ecology, weed science, and crop quality and utilization.

Cuban Journal of Agricultural Science. Quarterly. $28.49. (Eng., Sp.). Editor-in-Chief, Tulipan No. 1011, Nueva Velado 6, La Habana, Cuba.

Cuban Journal of Agricultural Science publishes papers in the general field of animal and crop production with particular emphasis on the problems of tropical and subtropical areas.

Desarrollo Rural en las Americas. 3/year. $5. IICA, San Jose, Costa Rica.

Desarrollo Rural en las Americas' principal objective is to promote professional interest in the many problems of rural development in the Americas.

Desert Rancher. Monthly. $10. 1677 Sixth St., Box 1088, Coachella, CA 92236, USA.

Desert Rancher publishes articles, comment, and news related to desert agriculture.

Ecology Law Quarterly. Quarterly. US$20. Ecology Law Quarterly, University of California, School of Law, Berkeley, CA 94720, USA.

Ecology Law Quarterly presents articles and comments on environmental law and conservation.

Environment. Monthly, except bimonthly January/February and July/August. Individual - $26. Environment, HELDREF Publications, 4000 Albemarle Street NW, Washington, DC 20016, USA.

Environment contains a variety of nontechnical articles, comments, and news on issues of environmental and political interest.

Environmental Conservation. Quarterly. $70. Environmental Conservation, Elsevier Sequoia S.A., P.O. Box 851, 1001 Lausanne 1, Switzerland.

Environmental Conservation is global in scope, and presents articles, reports, news, and comment on the sound use and management of the environment. Topics range from past case histories to the presentation of new methods and techniques.

Environmental International - A Journal of Science, Technology, Health, Monitoring and Policy. Bimonthly. $130. Pergamon Press Ltd., Headington Hill Hall, Oxford OX3 OBW, England.

Environmental International's main themes include the causes and effects of various kinds of pollution and methods of treatment and protection.

Environmental Literature. Bimonthly. Free. Environmental Literature, School of Forestry and Environmental Studies, Yale Unversity, 205 Prospect Street, New Haven, CT 06511, USA.

Each issue of Environmental Literature contains approximately 200 annotated citations of articles, reports, and books on environmental topics.

Environmental Management - An International Journal for Decision Makers and Scientists. Bimonthly. DM 241.00 plus postage and handling. Springer-Verlag, Heidelberger Platz 3, D-1000, Berlin 33, Germany.

Environmental Management is a multidisciplinary journal whose aim is to promote communicaiton between workers in the different fields involved in management of the environment.

Experimental Agriculture. Quarterly. $110. Cambridge Univ. Press, 32 E. 57th St., New York, NY 10022, USA.

Experimental Agriculture publishes the results of original research on the agronomy of economically significant field and industrial crops, of fruit and vegetable crops important for the incomes or nutriton of rural people, of herbage and forage crops used in animal production, and of systems of agricultural production, including their social and economic aspects, particularly in the warmer regions of the earth.

FAO Documentation - Current Bibliography. Monthly. FAO Via delle Terme di Caracalla, 00100 Rome, Italy.

Current bibliography is a list of selected documents and publications produced by or on behalf of FAO; it includes a subject, geographic, and author index. All aspects of agriculture are included in the bibliography.

Grass and Forage Science. Quarterly. $96.50. Blackwell Scientific Publ., 527 Madison Ave., Suite 1217, New York, NY 10022, USA.

Grass and Forage Science publishes the results of research and development in grass and forage production, management, and utilization. The main emphasis is on the temperate regions although relevant papers from other regions may be published.

Indian Journal of Agricultural Economics. Quarterly. $30. Indian Society of Agricultural Economics, 46-48 Esplande Mansion, Mahatma Gandhi Rd., Fort Bombay-400 023 India.

The objective of the Journal is to provide a forum for dissemination and exchange of findings of research on agricultural economics.

Interciencia. 6/year. $55. Pergamon Press, Inc., Fairview Park, Elmsford, NY 10523, USA.

Interciencia publishes articles of special interest for the men and women of the Americas on: Food and nutrition; energy; health and population, arid lands; tropical forests; marine sciences; hydrology; tropical agriculture; ecology and environmental problems; sciences policy; technology transfer; renewable and nonrenewable resources; science education.

International Agricultural Development. Bimonthly. $45.48. Pharos Publ. Service, Ltd., 5-11 Lovington St., London SE1 0NZ, U.K.

International Agricultural Development publishes articles that play a role in helping to publicise the policies and technologies that are needed for agricultural development and the all-important task of growing more food for an every-hungry world.

Issues in Science and Technology. Quarterly. $24. NAS, 2101 Constitution Ave., Washington, DC 20418, USA.

Issues in Science and Technology is published to inform public opinion and to raise the quality of private and public decision-making by providing a forum for discussion and debate.

IUCN Bulletin - A Quarterly Journal of the International Union for Conservation of Nature and Natural Resources. Quarterly. $30. International Union for Conservation of Nature and Natural Resources, Avenue du Mont-Blanc, 1196 Gland, Switzerland.

IUCN Bulletin contains news and short articles on conservation and regulation projects throughout the world.

Journal of Agricultural Science. Bimonthly. $260. Cambridge Univ. Press, P.O. Box 739, New Rochelle, NY 10802, USA.

Journal of Agricultural Science publishes concise papers reporting original experimental data or experimental methods, or new analyses of already existing data, in any aspect of agricultural science.

Journal of Arid Environments. Quarterly. $106.50. Academic Press, Inc., Journals Dept., Orlando, FL 32887-0016 USA (or) List Maintenance Dept., 24-28 Oval Road, London, NW1 7DX, England.

The Journal of Arid Environments publishes articles on the physiological, geophysical, anthropological, ecological, and geological aspects of international desert environments.

Journal of Environmental Management. 8/year. $183.50. Academic Press, Inc. (London) Ltd., High Street, Foots Cray, Sidcup, Kent DA145HP, England.

Journal of Environmental Management publishes technical reports covering topics in the areas of environmental assessment and management techniques.

Journal of Environmental Quality Quarterly. 677 S. Segoe Rd. Madison, WI 53711.

Journal of Environmental Quality Quarterly publishes reports of original research or brief reviews and analyses dealing with some aspect of environmental quality in natural and agricultural ecosytems.

Journal of Heredity. Bimonthly. $50. American Genetics Assn., 818 18th St. N.W., Washington, DC 20006, USA.

Journal of Heredity features articles from many leading authorities promoting a knowledge of the laws of herdity and their application to improvement of plants, animals, and human welfare. These reports and interpretations are an excellent source of genetic information to scientists, students, and laymen who are interested in current techniques and advances.

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Journal of Range Management. Bimonthly. $56. Society for Range Management, 2760 W. 5th St., Denver, CO 80204, USA.

Journal of Range Management serves as a forum for the presentation and discussion of facts, ideas, and philosophies pertaining to the study, management, and use of rangelands and their several resources.

Journal of Remote Sensing. Bimonthly. Free. Sensing Institute, 6151 Freeport Boulevard, Sacramento, CA 95822, USA.

Journal of Remote Sensing is a semitechnical publication stressing the use of photography in environmental monitoring and planning.

Journal of the Australian Institute of Agricultural Science. Quarterly. $25.00. Executive Officer AIAS, 191 Royale Parade, Parkville, Victoria 3052, Australia.

The Journal of the Australian Institute of Agriculture Science publishes original articles, thesis summaries, comment, book reviews, and technical notes in all fields of agricultural science.

Journal of Wildlife Management. (Includes Wildlife Monographs.) Quarterly. $24. The Wildlife Society, 5410 Grosvenor Lane, Bethesda, MD 20814, USA.

Journal of Wildlife Management publishes articles on all phases of wildlife management.

Livestock International. Bimonthly. $18.19. Agraria Press, Yew Tree House, Normandy, Guildford, Surrey, U.K.

Livestock International is the journal of stockbreeding, animal health, nutrition, and husbandry. It is concerned with livestock in a global context, not only in the traditional Commonwealth areas, but also in the arid and humid tropical regions.

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Livestock Production Sciences. Quarterly. $102.50. Elsevier Assn. of Scientific Publ., P.O. Box 211, Amsterdam, The Netherlands.

Livestock Production Sciences publishes original research papers and comprehensive reviews in the field of livestock production. The object of the association is to promote sound development of livestock production by the international exchange and synthesis of research results.

National Geographic Research. 1600 M. Street, N.W., Washington, D.C. 20036. $40.00

National Geographic Research is an interdisciplinary journal, reflecting the range of research activities assisted by the society.

Natural Resource Technical Bulletin. Quarterly. Free. AID/NPS Expanded Information Base Project. Document and Information Handling Facility. 7222 47th St., Chevy Chase, MD 20815, USA.

Natural Resource Technical Bulletin reviews and lists current literature on natural resource management and development planning. Issues revolve around identified themes such as genetic diversity, training, and role of protected areas in development.

Nature and Resources; International News and Information about UNESCO programmes Concerning Environmental Activities, Natural Resources Research, and Conservation. Quarterly. $15. UNESCO, 7 Place de Fontenoy, 75700 Paris, France.

Nature and Resources contains short articles and abstracts of new books and publications.

New Zealand Journal of Agricultural Research. Quarterly. $31.05. Publications Officer, Science Information Publishing Centre, DSIR, P.O. Box 9741, Wellington, New Zealand.

New Zealand Journal of Agricultural Research publishes research papers in all fields of agriculture, including animal husbandry, horticulture, agronomy, fertilizer trials and soil science, weed research, and pathology.

Nutrition Abstracts and Reviews, Series B - Livestock Feeds and Feeding. Monthly. $279. Central Sales, CAB, Farnham Royal, Slough SL2-3BN, U.K.

Nutrition Abstracts and Reviews, Series B - Livestock Feeds and Feeding lists citations treating the areas of technique, technology, feeding stuffs and feeds, physiology and biochemistry, feeding of animals, and diet in aetiology of disease. It also lists related reports, conferences, and book reviews.

ODI Review. A Journal of Development Policy. Overseas Development Institute. 10-11 Percy Street, London W1P 0JB.

The functions of the institute are: to provide a center for research in development issues and problems and to conduct studies on its owr; to be a forum for the exchange of views and information among those, in Britian and abroad, who are directly concerned with overseas development, in business, in government and in other organizations; to keep the urgency of development issues and problems before the public and the responsible authorities.

Oxford Agrarian Studies. Institute of Agricultural Economics, Dartington House, Little Clarendon St. Oxford OX1 2JX, U.K. Annual. $9.10.

Oxford Agrarian Studies publishes articles treating all phases of agricultural economics and management, with particular emphasis on developing countries.

Pastizales. Bimonthly. $20. Instituto Nacional de Investigaciones Pecuarias, Rancho Experimental la Campana, Apdo. 682, Chihuahua, Mexico.

Pastizales publishes original research results on various aspects of pastures.

Pastoralist and Grazier Newsletter. Monthly. Aust. $15. Pastoralist and Grazier Association of W.A., 789 Wellington St., 156 St. George's Terrace, Perth WA 6000, Australia.

Proceedings of the New Zealand Society of Animal Production. Annual. $12.15. Editorial Services Ltd., P.O. Box 6443, Wellington, New Zealand.

Proceedings of the New Zealand Society of Animal Production publishes papers on all aspects of animal production.

Proceedings of the Nutrition Society. 3/year. $135. Cambridge Univ. Press, 32 W. 57th St., New York, NY 10022, USA.

Proceedings of the Nutrition Society has as its objective the advancement of the scientific study of nutrition and its application to the maintenance of human and animal health.

Rangelands. Bimonthly. $30. Society of Range Management, 2120 S. Birch St., Denver, CO 80222, USA.

Rangelands serves as a forum for the presentation and discussion of facts, ideas, and philosophies pertaining to the study, management, and use of rangelands and their several resources.

Remote Sensing of Environment - An Interdisciplinary Journal. Bi-monthly. $217.50. Journals Fulfillment Department, Elsevier Science Publishing Co., Inc., 52 Vanderbilt Avenue, New York, NY 10017, USA.

Remote Sensing of Environment publishes reports of the latest research in, and applications of, remote sensing.

Renewable Resources Journal. Quarterly. $20. Renewable Natural Resources Foundation, Subscriptions, 5410 Grosvenor Lane, Bethesda, MD 20814, USA.

Renewable Resouces Journal contains news and nontechnical articles directed at those with an interest in the management and renewable uses of natural resources.

Resources and Conservation - An International Journal. Quarterly. Dfl 216.00 Elsevier Science Publishers B.V., P.O. Box 211, 1000 AE Amsterdam, The Netherlands.

Resources and Conservation is a technical journal containing articles on the management and conservation of renewable and nonrenewable resources.

Revista Cubana de Ciencia Agricola. 3/year. (Eng., Sp.). $17.70. Empresa Ediciones Cubanas, Apdo. 605, La Habana 1, Cuba.

Revista Cubana de Ciencia Agricola publishes scientific works on the disciplines of tropical animal production. Topics included are animal genetics, pastures and forages, animal nutrition, and occasionally investigations of agricultural mechanization and equipment. (Sp.)

Rural Research. Quarterly. $5. Rural Research Subscriptions. CSIRO Editorial, Box 89-E, Melbourne, Victoria 3002, Australia.

Rural Research brings together the results of CSIRO's research in agriculture and biology; it also discusses the organization's work in context with that done in Australian State Departments of Agriculture, universities, and other research bodies. Articles relate to the research of the solution of practical problems or provide an insight into underlying biological processes.

Span 3/yr. Commonwealth Agricultural Bureaux, Farnham House, Farnham Royal, Slough, SL2 3 BN, Bucks, UK. $50.00

Span is an international journal and specializes in review articles ranging over the whole field of agricultural and horticultural policies, economics, science and technology, of interest to policy makers, professional workers, and those concerned with the business of farming.

Studies in Third World Societies. Quarterly. $28. Dept. of Anthropology, College of William and Mary, Williamsburg, VA 23185, USA.

Tropical Agriculture. Quarterly. $104. Butterworth Scientific Ltd., P.O. Box 63, Westbury House, Bury St., Guilford, Surrey GU2 5BH, U.K.

Tropical Agriculture publishes manuscripts in English concerning tropical agriculture with particular emphasis on subjects such as agronomy crops and pastures, biology and physiology of eocnomic crops, biomass for energy, crop breeding, ecology of the tropics and land-and-water use capability, economics and sociology of agriculture, farming systems, horticulture, livestock breeding, management and nutrition, plantation crops, post-harvest technology, protection against pests, diseases and weeds and soil science and management.

Tropical Animal Health and Production. Quarterly. $64. Univ. of Edenburgh, Longman Group Ltd., 43-45 Annadale St., Edinburgh, Scotland.

Tropical Animal Health and Production publishes the results of orginal research, investigation and observation in any field of animal health and production that may lead to improved health and productivity of livestock and better utilization of animal resources in developing countries particularly in tropical and subtropical zones.

Tropical Grasslands. Quarterly. $35. Tropical Grassland Society of Australia, CSIRO, 306 Carmody Road, St. Lucia, Brisbane, Queensland, Australia, 4067.

Tropical Grasslands publishes articles of international interest on results of applied research, species testing, pasture establishment, development maintenance and evaluation, animal performance studies and soil fertility studies, critical field observation and documented case studies of successful primary enterprises.

Turrialba. Quarterly. $12. (Eng., Sp., Port.). Instituto de Ciencias Agricolas. Apt. 10281, San Jose, Costa Rica.

Turrialba publishes original research material, technical notices and literature reviews on agricultural sciences.

World Agricultural Economics and Rural Sociology Abstracts. Monthly. $371. Commonwealth Agricultural Bureau, Dartington House, Little Clarendon St., Oxford OX1 2HH, U.K.

World Agricultural Economics and Rural Sociology Abstracts includes citations on agricultural economics, policy, finance and credit policy, production economics, cooperatives, education and rural sociology.

World Animal Review. Quarterly. $10. (Eng., Fr., Sp.). Distribution and Sales Section, FAO, Via delle Terme di Caracalla, 00100 Rome, Italy.

World Animal Review reviews developments in animal production, animal health and animal products, with particular reference to these spheres in Asia, Africa, and Latin America.

World Review of Animal Production. Quarterly. $75. International Publishing Enterprises s.r.l., Via di Tor Vergata 85/87, Rome, Italy.

World Review of Animal Production publishes review articles and papers reporting the results of original research in all areas of animal production.

BIBLIOGRAPHY

Anderson, T. J. 1976. Land Tenure and Agrarian Reform in Africa and the Near East: Bibliography. Land Tenure Center, University of Wisconsin, Madison, WI 53706. 423 pp.

CAB. Arid Land Abstracts. Monthly. Farnham Royal, Slough SL2 3BN, UK.

Carbory, M. 1976. A Bibliography of Land and Natural Resource Information Systems. Bibliography No. 1139. Council of Planning Librarians, P.O. Box 229, Monticello, IL 61856 USA. 24 pp. 238 refs.

CILSS/Club du Sahel. 1982. Bibliographie Relative a L'Hydraulique Vellageoise Dans Les Pays du Sahel. (French only.) BP7049, Ouagadougou, Burkina Faso (Upper Volta).

CILSS/Club du Sahel. 1982. Bibliographie sur L'Utilisation des Cerales Locales: Mils et Sorghos. (French only.) BP7049, Ouagadougou, Burkina Faso (Upper Volta).

CILSS/Club du Sahel. 1982. Les Etudes en Nutrition et Alimentation dans les Pays du Sahel: Bibliographie analytique. (French only.) BP7049, Ouagadougou, Burkina Faso (Upper Volta).

CILSS/Club du Sahel. 1981. Elements for a Bibliography on the Informal Sector. BP7049, Ouagadougou, Burkina Faso (Upper Volta).

CILSS/Club du Sahel. 1981. Planning, Management, and Participatory Development Issues in Irrigation Projects. A select Annotated Bibliography. BP7049, Ouagadougou, Burkina Faso (Upper Volta).

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Grant, A. P. 1980. Draft Environmental Report on Mali. University of Arizona, Office of Arid Land Studies, Arid Land Information Center, Tuscon, AZ 85719. 73 pp.

Hopkins, S. T. and D. E. Jones. 1983. Research Guide to the Arid Lands of the World. Oryx Press, 2214 N. Central Ave., Phoenix, AZ 85004.

Kernick, M. D. 1978. Ecological Management of Arid and Semi-Arid Rangelands in Africa and the Near and Middle East (EMASAR-Phase II). Vol. 4. Indigenous Arid and Semi-Arid Forage Plants of North Africa, the Near and Middle East. Technical Data, FAO Via delle Terme di Caracalla, 00100, Rome, Italy. 689 pp.

Krumpe, P. F. 1976. The World Remote Sensing Bibliographic Index. A Comprehensive Geographic Index Bibliography to Remote Sensing Site Investigations of Natural and Agricultural Resorces Throughout the World. Tensor Industries, Inc., 8415 Arlington Blvd., Fairfax, VA 22030, USA. 619 pp. 4,000 refs.

McCarl, H. N. and J. Handlin. 1981. Bibliography on Environmental Economics. Public Administration Series: Bibliography P-804. Vance Bibliographies, P.O. Box 229, Monticello, IL 61856 USA. 18 pp. 235 refs.

Office of Arid Land Studies, Arid Lands Information Center. 1980. Draft Environmental Report on Yemen (Yemen Arab Republic). University of Arizona, Office of Arid Lands Studies, Arid Lands Information Center, Tuscon, AZ 85719. 92 pp.

Office of Arid Land Studies, Arid Land Information Center. 1980. Draft Environmental Report on Tunisia. University of Arizona, Office of Arid Lands Studies, Arid Land Information Center, Tuscon, AZ 85719. 73 pp.

Ouedraogo, I., M. D. Newman, and D. W. Norman. 1982. Farmer in the Semi-Arid Tropics of West Africa: A partially annotated bibliography. ICRISAT Research Bulletin No. 4, Vol. 2. ICRISAT, Patancheru P. O., Andhra Pradesh, 502324, India. 122 pp.

Schultz, V. 1976. Bibliography of Quantitative Ecology. Academic Press, Inc., 111 5th Ave., New York, NY 92037. 361 pp.

Taylor, S. N., B. K. Mortensen, and C. Dunford. 1982. Inventory of Arid Lands Research Institutions and Their Sources of Financial Support. For: United Nations Environment Programme, Nairobi, Kenya. Office of Arid Lands Studies, University of Arizona, 845 N. Park Avenue, Tuscon, AZ 85719 USA. 133 pp.

Vallentine, J. F. and P. L. Sims. 1980. Range Science: A guide to Information Sources. Gale Research Co., Book Tower, Detroit, MI 48226.

Wood, D. A. 1977. Endangered Species: A Bibliography on the World's Rare, Endangered and Recently Extinct Wildlife and Plants. Environmental Institute, Oklahoma State University, Stillwater, OK 74074 USA. 85 pp. 1,149 refs.

SECTION II: SELECTED INSTITUTIONAL RESOURCES

INTERNATIONAL CENTERS

ADC

Agricultural Development Council
Merged with International Agency for International Development (IADS) and Winrock International Livestock and Research Center (Winrock).
Merger date: 30 June 1985
See WIIAD (Winrock International Institute for Agricultural Development

BOSTID

The Board on Science and Technology for International Development -- Commission on International Relations
National Academy of Sciences
National Research Council
2101 Constitution Ave., NW
JH-210
Washington, D.C. 20418 USA
Tel: (202) 334-2639
TX: 248664NASWS UR
Cable: NARECO

Publications:
- Monographs
- Proceedings of conferences, workshops, and symposia
- BOSTID Development (3/yr)

CAB

Commonwealth Agricultural Bureaux
Farnham House
Farnham Royal
Slough SL2 3BN, UK
Tel: (02814) 2281
TX: 847964

Publications:
- Abstract journals

CARDI

Caribbean Agricultural Research and Development Institute
University Campus
St. Augustine, Trinidad
Tel: (662) 5511

Publications:

- Annual reports
- Newsletter
- Technical bulletins and reports
- Special bulletins
- Proceedings of workshops, seminars, and conferences
- Consultants reports

CGIAR

Consultative Group on International Agricultural Research
CGIAR Secretariat
1818 H St., NW
Washington, D.C. 20433 USA
Tel: (202) 477-5347
TX: WORLDBANK 440098
Cable: INTBAFRAD

Publications:

- Annual reports
- Slide sets, videotapes

CIAT

Centro Internacional de Agricultura Tropical
Apdo
Aereo 6713
Cali, Valle del Cauca
Colombia
Tel: 680111
TX: 05769

Publications:

- Annual reports
- Tropical Pastures Program Annual Report
- Special studies

CILSS

Permanent Interstate Committee for Drought Control in the Sahel
BP/244
Ouagadougou, Burkina Faso (formerly Upper Volta)
Tel: 320 13
TX: COMITEM 5263

Publications:
Annual reports

CILSS and The Club du Sahel publish studies in the areas of:
Global strategy
Economic policy
Sectoral studies
Demography and statistics
Evaluations
Donor flows to Sahelian countries
Bibliographies

CIMMYT

Centro Internacional de Mejoramiento de Maiz y Trigo
(International Center for Maize and Wheat Improvement)
Lindero 40
Apdo
Postal 6-641
06600 Mexico, D.F.
Tel: 585-43-55
TX: 17/1925 CIMMYM
Cable: CENCIMMYT

Publications:
CIMMYT Today
CIMMYT staff publications
Annual reports

Proceedings:
Regional Workshop for Sheep and Forage Improvement. 11-14 February 1974, CIMMYT.

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CIAP

Cornell International Agriculture Program
New York State College of Agriculture and Life Sciences
A Statutory College of the State University
Cornell University
261 Roberts Hall
Ithaca, NY 14850 USA
Tel: (607) 256-2283

Publications:

Research results published in professional journals and bulletins
Cornell International Agricultural Development Bulletins (irregularly)
Proceedings of semiars, workshops, conferences
International Agriculture Newsletter

Series:

Cornell International Agriculture Mimeographs
Cornell International Agriculture Bulletins
Potential Increases in Food Supply Through Research in Agriculture
Cornell University Latin American Studies Program Dissertation Series
Special Series on "Landlessness and Near-Landlessness"
Rural Development Occasional Papers Series
Special Series on "Agriculture Research and Extension"
Monographs Series

Club du Sahel

See: CILSS

FAO

Food and Agricultural Organization of the United Nations
Via delle Terme di Caracalla
00100 Rome, Italy
Tel: 06/5797
TX: 61181FOODAGRI

Regional Offices:

Africa
P.O. Box 1628
Accra, Ghana

Europe
FAO Headquarters
Via delle Terme di Caracalla
00100 Rome, Italy

Near East
FAO Headquarters
Via delle Terme di Caracalla
00100 Rome, Italy

FAO Liaison Office for the United Nations
United Nations Headquarters
42nd Street and 1st Avenue
New York, NY 10017, USA

Asia and the Pacific
Maliwan Mansion
Phra Atit Road
Bangkok 2, Thailand

Latin America
Avenida Providencia 871
Santiago, Chile

FAO Liaison Office for North America
1776 F Street, NW
Suite 101
Washington, D.C. 20437
USA

Publications:

- Agricultural Development Papers
- Agricultural studies
- Plant Protection Bulletin
- Regional conference proceedings
- Arid zone research
- Ecology and Conservation Series
- Annuals
  - The State of Food and Agriculture; yearbooks on various subjects such as animal health, forest products, production, trade, fishery statistics.
- Periodicals
  - Ceres (FAO review on development)
  - Monthly Bulletin of Agricultural and Economic Statistics
  - Food and Agricultural Legislation
  - World Animal Review
- Reviews and statistics on grains, fertilizer, rice, and other commodities
- Studies and manuals
- Husbandry and Health of the Domestic Buffalo
- Publications catalog

FAO (cont)

Proceedings:

Arid Lands Agricultural Development Conference. 14-17 June, 1982. Ajaccio, Corsica.

Sudanian Zone. Report of the Regional Conference for the Establishment of an Agricultural Research Programme on an Ecological Basis in Africa. 11-15 Nov. 1968. Rome, Italy. 128 pp.

GTZ

Deutsche Gesellschaft fur Technische Zusammenarbelt
GmbH (Germany Agency for Technical Cooperation)
Dag-Hammerskjold-Weg 1, D-6236 Eschborn/TS.1
Tel: 06196-790
TX: 417405gtzd

Publications:

Schriftenreihe der Gtz (gtz series)
Special Issues
Appropriate Technology

IADS

International Agricultural Development Service
Merged with Agricultural Development Council (ADC) and Winrock International Livestock Research and Training Center
Merged date: 30 June 1985
See WIIAD (Winrock International Institute for Agricultural Development)

ICARDA

International Center for Agricultural Research in the Dry Areas
P.O. Box 5466
Aleppo, Syria
Tel: 51280; 50465; 52113
TX: 312065Y
Cable: ICARDA/ALEPPO
(or)
P.O. Box 114/5055
Beirut, Lebanon
Tel: 303860
TX: 22509LE
Cable: ICARDA/BEIRUT

Publications:

- Annual reports
- Reference books
- Proceedings of conferences, workshops, and symposia
- Newsletters
- Technical training manuals
- ICARDA Research Highlights
- Miscellaneous reports and information brochures
- Publications list
- Discussion papers
- Project reports and research reports
- Bibliographies, directories, and abstracts

ICASALS

International Center for Arid and Semi-Arid Land Studies
P.O. Box 4620
Texas Tech University
Lubbock, TX 79409 USA

Publications:

- Newsletter (semi-annual)
- Abstracts (annual)
- Directory (annual)

Proceedings:

"Frontiers of the Semi-Arid World: An International Symposium. 14-18 October 1974. Lubbock, Texas

ICRAF

International Council for Research in Agroforestry
P.O. Box 30677
Nairobi, Kenya
Tel: 29867
TX: 22048
Cable: ICRAF

Publications:

Proceedings of conferences, workshops, seminars, etc.
Individually authored work
ICRAF Working Papers Series (WP)
ICRAF Research Reports Series (IRR)
Science and Practice of Agroforestry Series (SPA)
ICRAF Reprint Series (IR)
About ICRAF

Proceedings:

Plant Research and Agroforestry. Consultative Meeting. International Council for Research in Agroforestry. 8-15 April 1981, Nairobi, Kenya. 1983. 617 pp.

ICRISAT

International Crops Research Institute for the Semi-Arid Tropics
Patancheru P.O.
Andhra Pradesh
502324, India

Publications:

Economics Program Progress Report
Progress reports
Annual reports
Proceedings

Proceedings:

Socio-Economic Constraints to Development of Semi-Arid Tropical Agriculture Workshop. 19-23 Feb. 1979. Hyderabad, India. 435 pp.
Agroclimatical Research Needs of the Semi-Arid Tropics. 1978. 230 pp.

IDI

International Development Institute
400 E. 7th Street
Bloomington, IN 47401, USA
Tel: (812) 337-8596

IDRC

International Development Research Centre
P.O. Box 8500
Ottawa, Canada K1G 3H9
Tel: (613) 236-6163
TX: 053-3753
Cable: RECENTRE

Publications:

Annual reports
IDRC Reports (quarterly)
IDRC Features (monthly)
Echo (biweekly)
IDRC staff publishes in workshop, seminar, and conference proceedings and contribute to scientific journals
IDRC supported research projects generate their own publications -- reports, texts, and newsletters -- that are not produced or distributed by the Centre
Books, Films, Bibliographies, Checklist of Publications

Proceedings:

Future of Pastoral Peoples. Nairobi, Kenya. 4-8 Aug 1980. 396 pp.
Pastoral Systems Research in Sub-Saharan Africa. Workshop ILCA, 21-24 March 1983. 479 pp.
Intercropping in Semi-Arid Areas. Symposium. 10-12 May 1976. Faculty of Agriculture, Forestry and Veterinary Science, University of Dar es Salaam, Morogoro, Tanzania. 72 pp.

IGC

International Grassland Congress
For information contact:
American Society of Agronomy
677 S. Segoe Road
Madison, WI 53711, USA
Tel: (608) 274-1212

IIA

Institute of International Agriculture
Michigan State University
118 Agriculture Hall
East Lansing, MI 48824, USA
Tel: (517) 355-0174

Publications

Research results published in monographs and project reports

IIASA

International Institute for Applied Systems Analysis
Schloss, Laxenburg
Schlossplatz 1
A-2361 Laxenburgh
Austria
Tel: (02236) 715210
TX: 079137

Publications:

- Annual reports
- Energy systems program papers
- Books
- Contract reports
- General research papers in:
  - Systems and decision sciences area
  - Management and technology area
  - Human settlements and services area
- Food and agriculture program papers
- Contribute papers to journals, external conferences
- Conduct lectures and seminars

Proceedings:

- IIASA Conference. 10-13 May 1976. 251 pp.

IICA

Interamerican Institute for Cooperation on Agriculture
Apdo. 55-2200
Coronado, Provincia de San Jose, Costa Rica
Tel: 29-02-22
TX: 2144 IICA
Cable: IICASANJOSE

Publications:

- El IICA en America (quarterly)
- Indice Agricola de America Latina el Caribe (quarterly)
- Informacion y Documentacion para el Desarrollo Agricola (quarterly)
- Turrialba (quarterly)
- Desarrollo Rural en las Americas (3/yr)
- Official Documents (semiannual)
- Annual Reports
- Catalogo de Profesionales del IICA (annual)
- Series of bibliographies, technical bulletins, teaching materials, manuals, and texts

IIED

International Institute for Environment and Development
1302 18th Street, NW
Suite 501
Washington, D.C. 20036 USA
Tel: (202) 462-0900

Publications:

Earthscan Bulletin (bimonthly)
Annual Reports
Research Reports

IITA

International Institute of Tropical Agriculture
Oyo Road
PMB5320
Ibadan, Oyo State
Nigeria
Tel: 413440; 413011
TX: TROP-IBNG 31417

Publications:

Annual reports
Research Highlights (Annual)
IITA Research Briefs
IITA Proceedings Series
Conference and seminar papers
Discussion papers

ILCA

International Livestock Centre for Africa
P.O. Box 5689
Addis Ababa, Ethiopia
Tel: 18 2510
TX: 21207 ILCA/ADDIS

Publications:

Annual reports
Research reports
Monographs
Bulletins
Indexes
Staff publications
Systems studies
Bibliographies, directories, and abstracts
ILCA Bulletin (quarterly)
ILCA Newsletter (quarterly)

Proceedings:

Evaluation and Mapping of Tropical African Rangelands. Seminar. 3-8 March 1975, Bamoko, Mali. 399 pp.

Le Houerow, H. N. (Ed.). 1982. Browse in Africa: The current state of knowledge. International Symposium. 8-12 April 1980, ILCA.

Westley, S. B. (Ed.). 1982. East African Pastoralism: Anthropological perspectives and development needs. Conference. 22-26 August 1977, ILCA.

ILRI

International Institute for Land Reclamation and Improvement
Staring Building
Marijkeweg 11
POB45
Wageningen
Tel: 08370
TX: 75230VISA

Publications:

Annual reports
Bibliographies
Bulletins

Proceedings:

Siderius, W. (ed.) 1984. International Workshop on Land Evaluation for Extensive Grazing (LEEG). 343 pp.

IOBC

International Organization for Biological Control Against Noxious Animals and Plants
1 rue Le Notre
75016, Paris, France

Publications:

Entomophaga

ISNAR

International Service for National Agricultural Research
Postbus 93375
2509 AJ
The Hague, Netherlands
Tel: 070/47.29.91
TX: 33746
Cable: ISNAR

Publications:

Annual reports
Monographs
Proceedings of conferences, workshops, and symposia
ISNAR review mission reports (by country)
Miscellaneous reports
ISNAR newsletter (trimestrial)

ISRM

International Society for Range Management
2760 W. 5th Ave.
Denver, CO 80204 USA
Tel: (303) 571-0174

Publications:

Presents papers at meetings.
Journal of Range Management (bimonthly)
Rangelands (bimonthly)
Proceedings of Convention/Meeting (semiannual)

IUCNR/NR

International Union for Conservation of Nature and Natural Resources (Union Internationale pour la Conservation de la Nature et de ses Ressources), 1196 Gland, Switzerland
Tel: (022) 64-71-81
Telex: 22618

Publications:

Bulletin (quarterly)
Red Data Book
World Conservation Strategy
Parks Magazine (quarterly)

OAS

Organization of American States
17th and Constitution
Washington, D.C. 20006 USA
Tel: (202) 789-3621

Publications:

- Americas (monthly, Eng. and Sp.)
- Series and occasional papers on specialized subjects
- Reports and studies
- Official records of OAS, such as texts of multilateral treaties, conventions, pacts, and agreements
- Records and proceedings of various conferences
- Professional and technical journals

SEARCA

Southeast Asian Regional Center for Graduate Study and Research in Agriculture
College Laguna
3720 Philippines
Tel: 2290, 2317
TX: 64628 SEARCA pn.

Publications:

- SEARCA Dairy, a monthly newsletter
- Annual reports

The Club du Sahel

See CILSS

UNDP

United Nations Development Programme
New York, NY 10017 USA
Tel: (212) 754-1234

Publications:

- Annual reports
- Reports by the Governing Council
- Action UNDP (bimonthly)
- Commitment (semimonthly)
- Business Bulletin (monthly)
- Booklets
- Leaflets
- Speech reprints
- Audiovisual materials
- Papers on key economic and social developments

UNEP

United Nations Environment Programme
P.O. Box 30552
Nairobi, Kenya
Tel: 333930
TX: 22068

Publications:

Uniterca
UNEP Annual Review
Mazingira
UNEP Reports and Proceedings Series
UNEP Reference series [an Environmental Bibliography (E) Vol. 2.]
UNEP Studies Series
UNEP Executive Series

UNESCO

United Nations Educational, Scientific, and Cultural Organization
7 place du Fontenoy
75700 Paris
France
Tel: 577-16-10

Publications:

Publishes a wide range of specialized works, including source books and works of reference.

Series:

IPAL Technical Report Series (UNESCO/FRG/MAB) (Integrated Project in Arid Lands
Natural Resources Research (UNESCO/UNEP/FAO)
UNESCO Courier
UNESCO Chronicle
Impact of Science on Society
International Social Science Journal
Proceedings
Publications catalog

USAID
(AID)

United States Agency for International Development
(International Development Cooperation Agency, United States)
State Department Bldg.
320-21st St., NW
Washington, D.C. 20523 USA
Tel: (202) 632-9614 (Public inquiries)

Publications:

World Development Letter (biweekly)

Series:

Agricultural Technology for Developing Countries: Technical Series Bulletins and Technical Series Papers
Country Development Strategy Statements
Country Profiles
Economics and sector planning: occasional papers
Evaluation special studies
Occasional papers
Policy papers
Proceedings of conferences, workshops, and symposia
Project evaluation reports
Project impact evaluation papers
Program design and evaluation methods
Program evaluation discussion papers
Program evaluation reports
Research and development papers
Staff papers
Technical series bulletins

WIIAD

Winrock International Institute for Agricultural Development
Route 3
Morrilton, AR 72110-9537
Tel: (501) 727-5435
TX: 910-720-6616

Publications:

ADC-
- Annual Reports
- Monographs
- Research Paper Series - Nepal
- Proceedings of conferences, workshops, symposia

IADS-
- Annual Reports
- Development-oriented literature series

Winrock-
- Annual Reports
- Small Ruminant Collaborative Research Support Program
- Technical Series
- Books
- TechNotes/TechNotas -- a factsheet series (Eng., Sp.)
- International Stockmen's School Handbooks
- Videotapes
- Staff-authored journal articles, papers presented at conferences, workshops, symposia
- Proceedings of conferences, workshops, symposia
- Bibliographies
- Handbooks
- The Bulletin
- Outpost

WILRTC

Winrock International Livestock Research and Training Center
Merged with Agricultural Development Council (ADC) and International Agricultural Development Service (IADS)
Merger date: 30 June 1985
See WIIAD (Winrock International Institute for Agricultural Development)

WORLD BANK

1818 H Street, NW
Washington, D.C. 24433, USA
Tel: (202/477-1234)
TX: WUI64145WORLDBANK

Publications address:

World Bank Publications
P.O. Box 37525
Washington, D.C. 20013, USA

or

World Bank Publications
66, Avenue D'Lena
75116 Paris, France

European office:

66, Avenue D'Lena
75116 Paris, France
Tel: (1/723-5421)
TX: 842-620628

Tokyo office:

Koshusai Bldg
1-1, Marunouchi 3 chome
Chiyoda-ku
Tokyo 100, Japan
Tel: (03/215-5001)
TX: 781-26838

Publications:

World Bank Papers
World Bank Issues Papers
Sector Policy Papers
EDI series
Proceedings
World Bank Reprint Series
World Bank Commodity Working Papers
Country Studies
World Development Report
World Bank Atlas
World Tables
World Debt Tables
Annual reports
Catalog of Publications

NATIONAL CENTERS

Argentina

IADIZA

Argentine Institute for reserch on Arid Lands
C.C. 507
Mendoza 5500, Argentina

Australia

CSIRO

Commonwealth Scientific and Industrial Research Organization
P.O. Box 225
Dickson ACT 2602
Australia

Publications:

Arid Zone Newsletter

Fowlers Gap Arid Zone Research Station

School of Zoology
University of South Wales
Fowlers Gap
Via Broken Hill
New South Wales 2880

Publications:

Annual reports
Annual research reports

RRC

Rangelands Research Centre
Institute of Earth Resources
Division of Land Resources Management
Private Bag
PO, Deniliquin
New South Wales 2710
Tel: 058-81-1133
TX: 55457

School of Australian Environmental Studies

Griffith University
Nathan, Bresbane
Queensland 4111
Australia
Tel: 07-272-7111
TX: AA 40362

Publications:

Annual reports

Botswana

Department of Agricultural Research
Agricultural Research Station
Animal Production Research Unit
Private Bag 003,
Gaborone, Botswana
Tel: 52381

Publications:
Annual reports

Brazil

Centro de Pesquisa Agropecuaria do Tropico Semi-Arido
cp 23
56 300 Petrolina
PE Brazil
Tel: 961 0122

Egypt

Egyptian Desert Institute
Mataria, Cairo
Egypt

France

Centre d'Etudes Phytosociologiques et Ecologiques Louis-Emberger
route de Mende
BP5051
34033 Montpellier
Cedex, France

Ghana

Institute of Renewable Natural Resources
Department of Wildlife and Range Management
University of Science and Technology
University Post Office
Kumasi, Ghana
Tel: 5350, 5351-9
Telegrams: KUMASITECH KUMASI

Publications:
Annual research reports

India

Central Arid Zone Research Institute
Jodhpur 342003 Rajasthan, India

Publications:
Annals of Arid Zone (quarterly)

Kenya

Grassland Research Station
P.O. Box 144
Molo, Kenya
(Substation of the National Agricultural Research Station, Kitali, Kenya)

IBAR
Interafrican Bureau for Animal Resources
Central Bank of Kenya
Haile Selassie Ave.
P.O.B. 30786
Nairobi, Kenya

Publications:
Bulletin of Animal Health and Production in Africa (quarterly)
IBAR Information Leaflets (monthly)

IPAL
Integrated Project in Arid Lands
UNESCO/IPAL
P.O. Box 30592
Nairobi, Kenya

Publications:
Annual reports
Technical reports

NRRS - Kiboko
National Range Research Station - Kiboko
Ministry of Agriculture and Livestock Development
Box 12
Makindu, Kenya

Publications:
Annual and semiannual reports
Technical report series

Mexico

Desert Lands Research Institute
Universidad Autonoma de San Luis Potosi Alvaro Obregon 64
San Luis Potosi SLP Mexico
Tel: 481 2-66-04

Publications:
Acta Cientifica Potosina (quarterly)

Nigeria

Lake Chad Research Institute
PMB1293
Maiduguri
Borno State, Nigeria

Publications:
Annual reports

Senegal

LNERV
National Laboratory of Animal Health and Production
BP2057
Dakar, Senegal
Tel: (320)21 12 75; 21 51 46

Publications:
Annual reports

South Africa

Department of Agriculture and Fisheries
Private Bag X250
Pretoria, 0001, South Africa
Tel: (021) 284657

Highveld Region: Agricultural Research Institute, Private Bag X804, Potchefstroom, 2520, South Africa. Tel: (01481) 4221.

Eastern Cape Region: Agricultural Research Institute, Private Bag X15, Stutterhiem, 4930, South Africa. Tel: 710-714

Karoo Region: Agricultural Research Centre, Private Bag X529, Middelburg, 5900, Cape Province, South Africa.

Natal Region: Agricultural Research Institute, Private Bag X9059, Pietermaritzburg, 3200, Natal, South Africa. Tel: (0331) 33371.

Dundee Research Centre: Private Bag 626, Dundee, 300, Natal, South Africa. Tel: (0341) 22479.

Estcourt Research Complex: Private Bag X752, Estcourt, 3310, Natal, South Africa. Tel: (03631) 3070.

Kokstad Research Station: Private Bag X501, Kokstad, 4700, Natal, South Africa. Tel: (0372) 72.

Publications:

Agroanimalia (animal sciences)
Agrochemophysica (soil, chemical, and physical sciences)
Botanical Survey Memoirs
Bothalia
Entomology Memoirs
Flora of Southern Africa
Flowering Plants of Africa
Onderstepoort Journal of Veterinary Research
Phylophyactica (plant protection sciences and microbiology)
Agroplantae (plant sciences)
Crops and Markets
Trends in the Agricultural Sector
Abstract of Agriculture Statistics on Fresh Markets

Spain

Estacion Experimental de Zonas Aridas
Calle General Segura 1
Almeria, Spain
Tel: 951-23-65-00

Syria

ACSAD
Arab Center for the Studies of Arid Zones and Dry Lands
P.O. Box 2440
Damascus, Syria
Tel: 111 817 - 111913
Cable: ASCAD

Publications:

Annual reports
Progress and project reports
Papers

Taiwan

FFTC

Food and Fertilizer Technology Center
P.O. Box 22-149
Taipei City, Taiwan

Publications:

Extension bulletins
Book series
Technical bulletins

Tanzania

Kongwa Pasture Research Station

Kituo Cha Utafiti wa Uzalishaji Mifugo
(Livestock Production Research Institute)
Private Bag, Mpwapwa
Dodoma Region, Tanzania
Tel: MPWAPWA 21

Publications:

Progressive Stockmen Periodical (quarterly)
Annual reports

United Arab Emirates

ALRC

Arid Lands Research Center
P.O. Box 638
Abu Dhabi
United Arab Emirates
(Arid Lands Research Center, University of Arizona)

United Kingdom

Commonwealth Bureaux of Pasture and Field Crops

c/o The Grassland Research Institute
Hurley
Maidenhead, Berkshire
SL6 5LR UK

Publications:

Herbage Abstracts (monthly)

GRI

The Grassland Research Institute
Hurley
Maidenhead, Berkshire
SL6 5LR UK
Tel: Littlewick Green 0 62 882 3631

Publications:

Annual reports
Technical reports
Publishes in scientific journals and other media
Miscellaneous publications

LRDC

Land Resources Development Centre
Tolworth Tower
Surbiton, Surrey K76 7DY
Tel: (01) 399-5281
Telex: 263907

Publications:

Progress reports
Technical bulletins
Land resource studies
Bibliographies

United States of America

AAAS

American Association for the Advancement of Science
1515 Mass. Ave.
Washington, D.C. 20005
Tel: (202) 467-4400

Publications:

Science (weekly)
Science 85 (monthly)
Science Education News (quarterly)
Handbook (annual)
Science books and films (irregular)
Symposium volumes, compendia from science and general reference works
Annual reports

AALS

Association for Arid Land Studies
c/o ICASALS
P.O. Box 4620
Texas Tech University
Lubbock, TX 79409 USA
Tel: (806) 742-2218

Publications:

Newsletters (semiannual)
Abstracts (annual)
Directory (annual)

AID/NPS Expanded Information Base Project: Integrating Natural Resource Management and Economic Development

AID/NPS Expanded Information Base Project
AID/S&T/FNR, Department of State
Washington, D.C. 20523, USA
Tel: (703) 235-2559

Publications address:
AID/NPS Expanded Information Base Project
Document and Information Handling Facility
7222 47th Street
Chevy Chase, MD 20815

Publications:
Natural Resource Technical Bulletin (NRTB), quarterly, free
Country Development Strategy Statements (CDSS)
Project Identification Documents (PID)
Project Papers (PP)
Environmental Examination (EE)
Environmental Assessments (EA)

AFGC

American Forage and Grassland Council
121 Dantzler Ct.
Lexington, KY 40503
Tel: (606) 278-3609

Coordinates and distributes new information on grassland farming as it becomes available

Publications:
Forage and Grassland Progress (quarterly)
Forage and Grassland Conference Proceedings (annual)
Membership Directory (annual)
Also publishes books and booklets on good grassland farming practices.

ALRC

Arid Lands Research Center
University of Arizona
Office of Arid Land Studies
Tuscon, AZ 85719 USA
Tel: (602) 884-2711

Publications:
Progressive Agriculture (6/yr)
Research results published in professional journals, technical society proceedings, technical bulletins, project reports, and popular articles

ANG

Association of National Grasslands
c/o Lynn Wolfe
Haynes, ND 58637
Tel: (605) 564-2172

Publications:

Descriptive Brochure

Arid Pasture and Range Investigations

U.S. Department of Agriculture/
ARS Plant Science Research Division
Utah State University
Logan, Utah 84321 USA

ASA

American Society of Agronomy
677 S. Segoe Rd
Madison, WI 53711
Tel: (608) 274-1212

Publications:

Crops and Soils Mazazine. 9/yr
Agronomy Journal, bimonthly
Agronomy News, bimonthly
Journal of Environmental Quality, quarterly
Journal of Agronomic Education, semiannual
Agronomy Abstracts, annual
5-year Indexes
Industrial Agronomist Directory
Agronomy monograph series and special publications series

CRF

Conservation and Research Foundation
Box 1445
Connecticut College
New London, CT 06320, USA
Tel: (203) 873-8514

Publications:

Five Year Report

CTA

Center for Tropical Agriculture
University of Florida
2001 McCarty Hall
Gainesville, FL 32611 USA
Tel: (904) 392-1965

Publications:

Newsletter
Research results published in professional journals and books

CUSWDASA

Council of Universities for Soil and Water Development in Arid and Sub-humid Areas
403 Business Building
UMC35
Utah State University
Logan, UT 84322 USA

(Nonprofit consortium with its own board of control, operates as facilitating agent for research arms of Colorado and Utah State Universities and Universities of Arizona and California at Riverside and Davis.)

Publications:

Research results published directly by the universities concerned, including a number bearing emblem of the Council

Desert Research Institute

University of Nevada
Desert Research Institute
Reno, Nevada 89507 USA
Tel: (702) 784-5131

Publications:

Technical reports
Bulletins

ESA

Ecological Society of America
Evergreen State College
Olympia, WA 98505 USA

Publications:

Ecology (bimonthly)
Bulletin (quarterly)
Ecological Monographs (quarterly)
Directory (triennial)

Ford Foundation

Office of Reports
320 E. 43 St.
New York, NY 10017

Publications:

Ford Foundation Letter (6/yr)
Annual reports
Reports describing particular program activities
Publications and film lists

Proceedings:

Regional Sheep and Forage Production. Workshop. 11-14 Feb 1974. Arid Lands Agricultural Development Program. Beirut, Lebanon.

LTC

Land Tenure Center
University of Wisconsin
1300 University Avenue
Madison, WI 53706, USA

Publications:

LTC Research Papers

NAS

National Academy of Sciences
National Research Council (NRC)
Office of Information
2101 Constitution Avenue
Washington, D.C. 20418
Tel: (202) 334-2000

Nephi Dryland Field Station

Utah State University
Levan, Utah 84639

Publications:

Research results published in professional journals and experiment station publications.

RFF

Resources for the Future
1755 Massachusetts Ave., NW
Washington, D.C. 20036 USA
Tel: (202) 462-4400

Publications:

Annual reports
Outside staff publications
RFF books
RFF research results
Institutional literature
Annotated publications catalog
Reprint series
Discussion papers
Resources (3/yr)
Books

Southern Utah Range Livestock Field Station

Utah State University
Cedar City, Utah

Publications:

Research results published in professional journals and experiment station publications.

300

SRM

Society for Range Management
2760 W. 5th Avenue
Denver, CO 80204
Tel: (303) 571-0174

Publications:

Journal of Range Management (bimonthly)
Rangelands (bimonthly)
Mini-Directory (annual)
Bulletins, papers, proceedings

The Rockefeller Foundation

1133 Avenue of the America
New York, NY 10036 USA
Tel: (212) 869-8500

Publications:

President's Review and Annual Report
R.F. Illustrated
Working papers
Occasional special reports

Utah Agricultural Experiment Station

Utah State University
College Hill
Logan, Utah 84322
Tel: 801-752-4100

Publications:

Research results published in professional journals, bulletins, and circulars:
Utah Science (quarterly)

301

Zimbabwe

ARC

Agricultural Research Council
P.O. Box 8108
Harare, Zimbabwe
Tel: (01) 704531

Grasslands Research Station, P.O. Box 3701, Marondera, Zimbabwe. Tel: (128) 3527.

Henderson Research Station, P.O. Box 2004, Harare, Zimbabwe. Tel: (Mazowe) 481. Telex: AGROZOE.

Makoholi Experiment Station, P.O. Box 9182, Fort Victoria, 16 Victoria, Zimbabwe.

Matopos Research Station, P.O. Box K5137, Bulawayo, Zimbabwe. Tel: 2/18.

Range Ecology and Management Section

Publications:

Annual reports - Division of Livestock and Pastures
Other technical and divisional reports

UNIVERSITY TRAINING

Most university programs are offered at U.S. universities. However, there are now a few universities in other countries that offer a B.S. degree. Examples of these are as follows.

- University of Nairobi, Nairobi, Kenya
- Hassan II Institute of Agronomy and Veterinary Medicine, Rabat, Morocco
- University of Ceara, Fortelaza, Brazil
- University of Queensland, Brisbane, Australia
- University of Adelaide, Adelaide, Australia
- University of Chihuahua, Chihuahua, Mexico
- Monterrey Technological Institute, Monterrey, Mexico
- Antonio Norro University, Saltillo, Mexico

In the United States, range management curricula are given in English. The following list gives the mailing address of universities in the United States with range programs and are active in the Range Science Education Council. The list was current as of July 19, 1984.

Arizona

Division of Agriculture
Arizona State University
Tempe, AZ 85287

School of Forestry
Northern Arizona University
Flagstaff, AZ 86001

School of Renewable Natural Resources
University of Arizona
Tucson, AZ 85721

California

Department of Animal Science
California State Polytechnic College
San Luis Obispo, CA 93401

Department of Plant Sciences
California State University
Chico, CA 95926

College of Natural Resources
Humboldt State University
Arcata, CA 95521

College of Forestry and Resource Management
University of California
Berkeley, CA 94720

Department of Agronomy and Range Science
University of California
Davis, CA 95616

Colorado

Department of Range Science
Colorado State University
Fort Collins, CO 80521

Florida

School of Forest Resources and Conservation
305 Rolfs Hall
University of Florida
Gainesville, FL 32611

Idaho

Department of Biology
Idaho State University
Pocatello, ID 83209

College of Forestry
Wildlife and Range Resources
University of Idaho
Moscow, ID 83843

Iowa

Department of Forestry
Iowa State University
Ames, IA 50010

Kansas

Division of Natural Resources and Mathematics
Fort Hays Kansas State College
Hays, KS 67601

Department of Agronomy
Kansas State University
Manhattan, KS 66502

Missouri

Department of Agriculture and Natural Resources
Box 21
Lincoln University
Jefferson, MO 65101

Montana

Department of Animal and
Range Science
Montana State University
Bozeman, MT 59717

School of Forestry
University of Montana
Missoula, MT 59801

Nebraska

Department of Agronomy
University of Nebraska
Lincoln, NB 68503

Nevada

Knudtsen Renewable Resources
Center
University of Nevada
1000 Valley Road
Reno, NV 89557

New Mexico

Department of Animal and
Range Science
Box 31
New Mexico State University
Las Cruces, NM 88003

North Dakota

Department of Botany
North Dakota State University
Fargo, ND 58105

Oklahoma

Department of Agronomy
Oklahoma State University
Stillwater, OK 74078

Oregon

Department of Rangeland
Resources
Oregon State University
Corvallis, OR 97331

South Dakota

Department of Animal Science
South Dakota State University
Brookings, SD 57007

Texas

Department of Range and
Animal Science
Sul Ross State University
Alpine, TX 79380

College of Agriculture
Texas A&M University
Kingsville, TX 78363

Department of Range Science
Texas A&M University
College Station, TX 77843

Department of Range and Wildlife
Management
Texas Tech University
Lubbock, TX 79409

Utah

Department of Botany and
Range Science
Brigham Young University
Provo, UT 84601

Department of Range Science
Utah State University
Logan, UT 84321

Washington

College of Forest Resources
University of Washington
Seattle, WA 98105

Department of Forestry and
Range Management
Washington State University
Pullman, WA 99163

Wyoming

Range Management Department
College of Agriculture
University of Wyoming
Laramie, WY 82071

Canada

Department of Plant Science
University of Alberta
Edmonton 7, Alberta
Canada

Faculty of Forestry
University of British Columbia
Vancouver, British Columbia
Canada

Mexico

Escuela de Zootecnia
Universidad de Chihuahua
Apartado Postal F-28
Chihuahua, Chihuahua
Mexico

International Programs
Institution Technologico de
Estudios Superiores de
Monterrey
Sousal de Correos "J"
Monterrey, Nuevo Leon
Mexico

Universidad Autonoma Agraria
"Antonio Narro"
Buena Vista
Saltillo, Coah.
Mexico

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Telex: 24851

Bangladesh
Micro-industry Development
Assistance Society (MIDAS)
ATTN: Mamoon al Rasheed
G.P.O. Box 800
Dacca 2
Street address:
House No. 56
Road No. 7/A
Dhanmondi
R. A. Dacca 9
Phone: 326-558
Cable: MIDAS

Barbados
Caribbean Development Bank
Technology Unit
ATTN: Ingrid Douglas
P.O. Box 408
Wildey, St. Michael
Barbados, W.I.
Phone: 61-152
Telex: WB 287
Cable: CARIBANK

Bolivia
Direccion General de Normas y
Tecnologia (DGNT)
ATTN: Ing. Carlos Garvizu T.
Jefe del SITI
Casilia 4430
La Paz
Phone: 37-20-47, 37-73-09
Telex: BX 5263

Botswana
The Botswana Technology Centre
ATTN: Derek Medford
P.O. Box 438
Gaborone
Phone: 524-88

Brazil
Barroslearn
ATTN: B. Cohen
Rua 24 de Maio, 62-5/Andar
Sao Paulo, CEP 01041
Phone: 223-6011
Telex: 01131770 PBAS BR
Cable: ENGEBARO

Chile
Instituto de Investigaciones
Tecnologicas (INTEC/CHILE)
ATTN: Sra. Margarita Barraza C.
Casilla 667
Avenida Santa Maria 06500 (Lo Curro)
Santiago
Phone: 228-9066
Telex: 40421 CORFO CL

China
Institute of Scientific & Technical
Information of China (ISTIC)
P.O. Box 640, Beijing
Phone: 46-47-46
Telex: ISTIC

Colombia
Fondo Colombiano de Investigaciones
Cientificas (COLCIENCIAS)
Division Projectos Especiales
ATTN: German Escorcia S.
Apartado Aereo 051 580
Bogota, D.E.
Phone: 2740660, 2740004

Costa Rica
Instituto Tecnologico de Costa Rica
(ITCR)
ATTN: Ing. Rocio Valverde G.
Centro de Informacion Tecnologica
Apartado 159
Cartago
Phone: 51-53-33, ext. 262
Telex: 8013 ITCR CR

Dominican Republic
Instituto Dominicano de Tecnologia
Industrial (INDOTEC)
ATTN: NTIS Division
Ave. Nunez de Caceres
Apartado Postal 329-2
Santo Domingo
Phone: 566-8121 thru 29
Telex: RCA 326-4378 INDEC DR

Ecuador
Centro de Desarrollo
Industrial del Ecuador (CENDES)
Servicio de Informacion Tecnica
ATTN: Dr. Aldefonso Bohorquez
Apartado 5833
Guayaquil
Phone: 308500; 307628
Telex: 3603 cendes ED
Cable: CENDES

Escuela Politecnica Nacional (EPN)
Instituto de Investigaciones
Tecnologicas
ATTN: Jaime Velasquez
Apartado 2759
Quito
Phone: 541-794; 522-067
Telex: Espono 2650
Cable: EPN

El Salvador
Centro Nacional de Productividad
(CENAP)
ATTN: Alicia Goria
Servicio de Informacion y
Transferencia de Tecnologia
Avenida Espana 732
San Salvador
Phone: 22-30-64, 22-77-40

France
MIKRO CERID
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Haiti
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Honduras
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via Giacomo Trevis 88
00147 Rome
Phone: 514-0176
Telex: 613408 IPORES I

Jamaica
Scientific Research Council
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Technical Information Officer
P.O. Box 350
Kingston 6
Phone: 927-4471/4
Cable: SCIENTIST

Japan
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(MRI)
ATTN: Yasoro Nobuhara
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P.O. Box 205
Cheong Ryang Ri
Seoul
Phone: 965-6211/8
Telex: K 25850
Cable: KIET HN

Mexico
INFOTEC
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Col. MIXCOAC, Benito Juarez
Apartado 19-194
03910, Mexico, D.F.
Phone: 559-52-11
Telex: 001 777 569 INFOME

Nepal
Research Centre for Applied Science
and Technology (RECAST)
National Council for Science
and Technology
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Tribhuvan University
Kirtipur, Kathmandu
Phone: 14303, 13277, ext. 69
Cable: RECAST KATHMANDU

New Zealand
R. Hill and Son
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Ideal House
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New Market
Auckland 1
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Telex: 2704

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Pakistan Science Foundation
National Centre
P-13, El Markez Square
Sector F-7/2
Islamabad
Phone: 24161 - Dr. A. R. Mohajir

Panama
Grupo de Tecnologia Apropiada (GTA)
ATTN: Samuel Bern
Apartado 8046
Panama 7
Phone: 61-73-53

Paraguay
Instituto nacional de Tecnologia y Normalization (INTN)
Avenida General Artigas y General Roa
ATTN: Dr. Jose Martino
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Asuncion
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Telex: 306 PY INTN

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Casilla 11431
Lima 14
Phone: 40-24-45
Telex: 25129 PE-NOV/ING

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TRC Building
Buendia Avenue Extension
Makati Metro Manila
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Telex: 64002 TRC PN
Cable: TECHCENTER

Senegal
Secretaire d'Etat pour la Recherche Scientifique et Technologique
61 Boulevard Pinet-Laprade
B.P. 3218, Dakar
Phone: 1-79-33
Cable: RECHERSI TEKNIKE

South Africa
Council for Scientific and Industrial Research
Centre for Scientific and Technical Information
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Cable: NAVORSLIG

Sri Lanka
National Science Council of Sri Lanka
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Tanzania Research Information Service (TANRIS)
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Kivukoni Front
Dar es Salaam
Phone: 25802, 20678
Cable: UTAFITI Dar es Salaam

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Thailand Management Association
(TMA)
ATTN: Mr. Suthep Visavakul
308 Silom Road
Bangkok 5
Phone: 234-2624
Telex: 82831 STICORP TH

Tunisia
Societe Tunisienne de Diffusion
ATTN: Mme. Sarrah Klibi
5, Ave. de Carthage
Tunis
Phone: 255000
Telex: STUDIF 12521 TN

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Alton, Hampshire GU 34 2 PG
England
Phone: 420-84300
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