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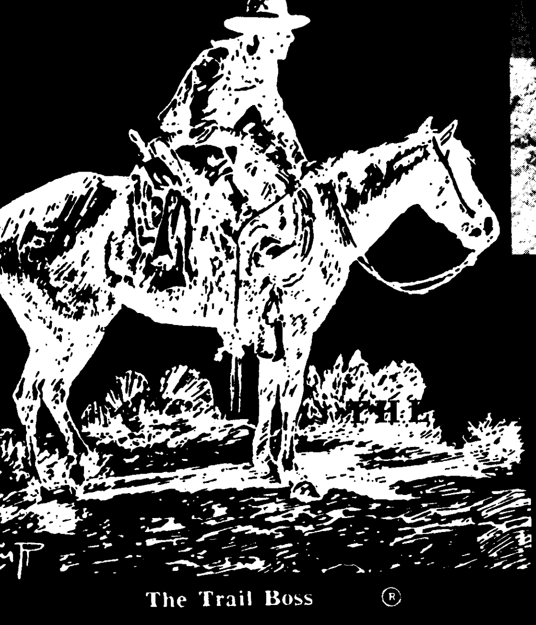

The Trail Boss ®

American Society of Range Management

The American Society of Range Management was created in 1947 to advance the science and art of grazing land management, to promote progress in conservation and sustained use of forage, soil and water resources, to stimulate discussion and understanding of range and pasture problems, to provide a medium for the exchange of ideas and facts among members and with allied scientists, and to encourage professional improvement of members.

Membership: Persons shall be eligible for membership who are interested in or engaged in practicing range or pasture management or animal husbandry; administering grazing lands; or teaching, or conducting research, or engaged in extension activities in range or pasture management or related subjects.

JOURNAL OF RANGE MANAGEMENT

The Journal, published bi-monthly, is the official organ of the American Society of Range Management. The Journal aims to publish something of interest to the entire membership in each issue. The Society, however, assumes no responsibility for the statements and opinions expressed by authors and contributors.

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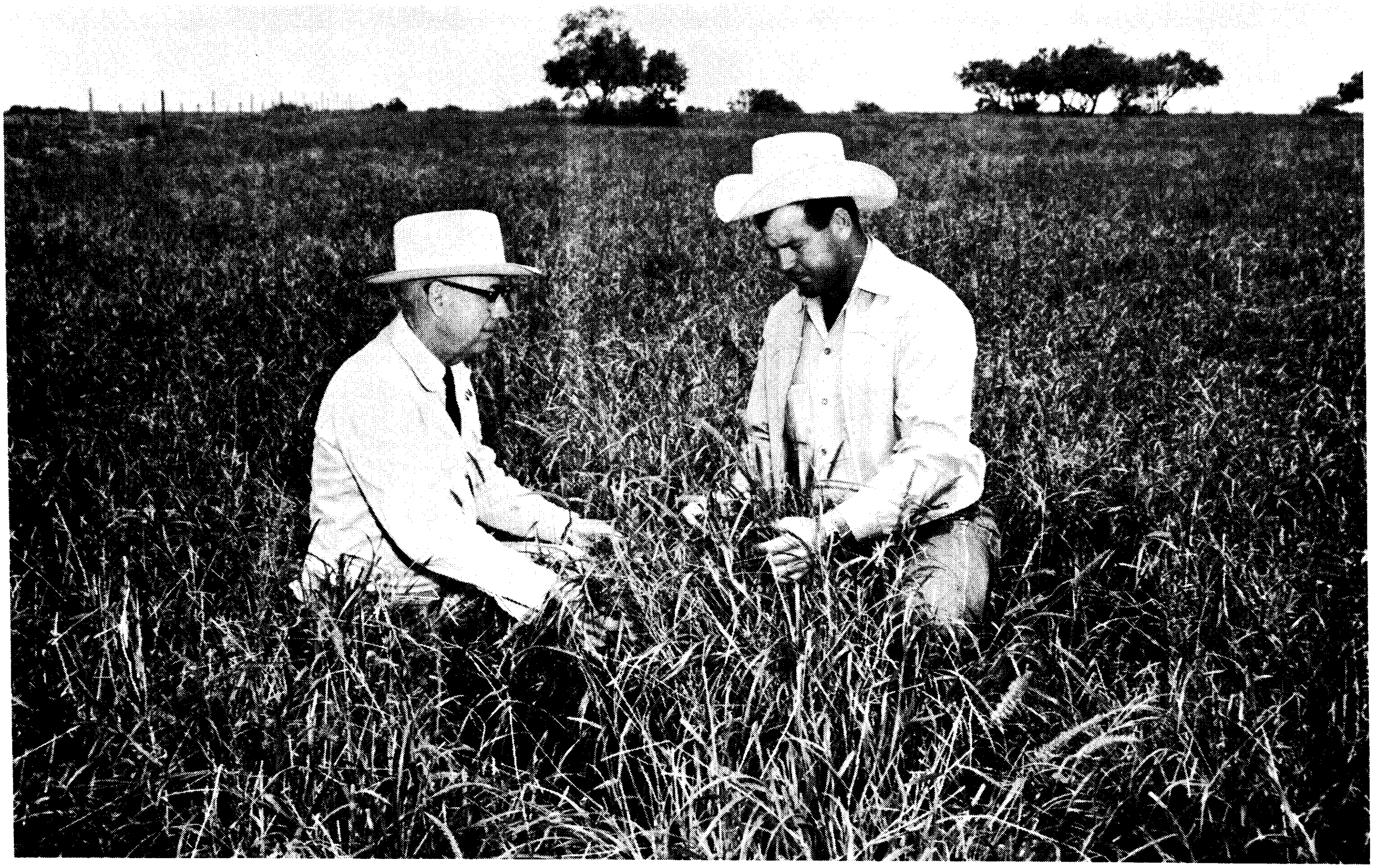


How they multiplied by four the grazing capacity of Los Jaboncillos Ranch

In the early 1950's, it took 30 to 40 acres to support a single cow on Los Jaboncillos Ranch, Premont, Texas. Huisache, mesquite, and black brush had crowded out thousands of acres of the native grasses.

The owners called in a conservation contractor.

Using Cat-built Tractors, he undertook a carefully planned mechanical brush control program. Today, the ranch is lush grassland, supporting one cow to only 7½ acres—a 400% increase in grazing capacity.

The program began with the rootplowing and reseeding of an 800-acre pasture in February of 1953. By October, after fall rains, the land was waist-deep in new blue panic grass.

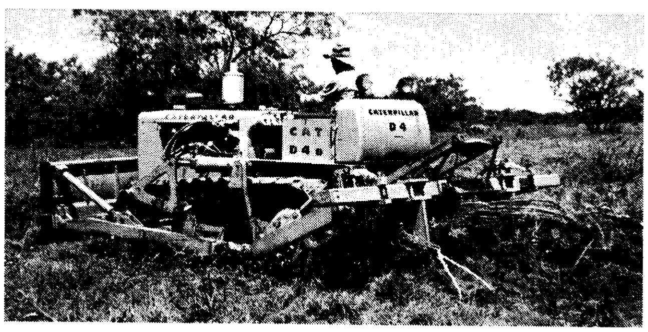
Where 25 head had grazed before, 103 yearlings were turned out. Their gain was measured at 1¼ pounds per yearling per day.

That was all the encouragement the owners of Los Jaboncillos needed. Over the next eight years, an additional 5,400 acres were cleared and reseeded. Costs per acre—for chaining, rootplowing and raking, plus handpicking roots and reseeding—came to $40 per acre.

Compare this with returns.

Annual land costs per animal dropped from $119 to only $45.90.

A sound rangeland reclamation program, built around mechanical brush control, might produce dramatic results for you. For additional information, send for a free booklet, "Success at Los Jaboncillos." Write to Caterpillar Tractor Co., Dept. JR 11, Peoria, Illinois.



CATERPILLAR

Journal of RANGE MANAGEMENT Volume 19 Number 6 November, 1966

INTERNATIONAL GRASSLAND ISSUE

Cover Photo— Efficiency in Rangeland Production in Gilliam County, Oregon.

See Management Note by E. William Anderson, Page 377

Range Management Worldwide[1] Introduction

W. RIDGELY CHAPLINE

Co-Chairman, Session on "Range Management Worldwide", 19th Annual Meeting, ASRM, New Orleans, Louisiana, Feb. 2, 1966.

Nearly half the land area of the World is natural pasture or, as we know it, *range*. These range areas vary from humid, densely covered grasslands and savannahs to almost desert where little vegetation is available for the livestock grazing on them.

On much of this area range livestock production is the main industry, furnishing the living for the people and tax revenues for the governments of many developing nations. Most of these livestock producers are proud of their animals. Unfortunately, in developing countries, many producers do not realize the importance of efficient management of the rangelands they use. The result is that these lands do not produce the meat and other animal products of which they are capable.

Much is being done by the U.S.A., FAO, and private funds in technical assistance, in one form or another, in an effort to improve agricultural production. During the Keynote Session on Feb. 1, C. Kenneth Pearse, in his presentation on "Expanding Range Horizons—Worldwide", gave some background relating to technical assistance concerned with rangelands and some problems confronting FAO in their efforts. His paper is included in this published series.

We, interested in range, would like to see more effort pointed to the range management and improvement problems. The tremendous improvement in range management in the U.S.A. during the last 50 years both on public and private rangelands, indicates the potentials in developing countries.

The session on Range Management Worldwide includes five papers. The first, by Dr. Drosdoff, deals with the broad subject of technical assistance in agricultural development. The next four papers consist of a panel on strengthening range management technical assistance: Dr. Cox from the standpoint of the administrator, Dr. Johnston for the advisor, Dr. McKell and Dr. Adegbola for the receiving country, and Dr. Tomanek for the Range Society.

In addition to papers presented at the Annual Meeting in New Orleans, a special effort has been made to bring together other papers from abroad and also worldwide news and notes of interest to range people in this International Grasslands Issue.

(Note: Before the papers were presented at the session, ASRM members were introduced from Venezuela, Mexico, and Canada.)

Technical Assistance in Agricultural Development[1]

MATHEW DROSDOFF

Administrator, International Agricultural Development Service, U.S.-D.A., Washington, D. C.

World hunger is much in the news today. We read and hear about food shortages. We read about millions of subsistence farmers in many countries who are unable to meet their families' food needs. We read about the exploding populations and the serious food problem in India. The U. S. A. and the world are facing a major challenge—closing the gap between the have and the have nots—the rich and the poor countries. The tragic war in Vietnam, the problems of the Dominican Republic and the serious food shortage in India are all related to the problems in the countryside and their relationship to the political, economic and social issues of the day.

In his recent State of the Union Message, President Johnson said:

"This year I propose major new directions in our program of foreign assistance to help those countries who will help themselves.

"We will conduct a world-wide attack on the problems of hunger and disease and ignorance.

"We will place the matchless skill and the resources of our own great America, in farming and in fertilizers, at the service of those countries committed to developing a modern agriculture."

Despite all we read and hear it is still almost impossible for many of us to understand what life is like in most parts of the world.

Imagine that your yearly income is below $100. You live in a shack with no bathroom, no running water, no electricity, no furniture save a table and one chair, a meager supply of poor quality food.

Imagine no newspapers, magazines, or books—no money for them; your family can't read anyway.

Imagine your nearest clinic or hospital 10 walking miles away; a midwife in charge instead of a doctor.

Imagine expecting to live only 30 or 40 years.

Imagine daily facing hunger and the drudgery of unrewarding labor.

Half the world lives this way.

Of all the people in Africa, Asia, and Latin America, 80%

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[1] *Based on a paper presented at Nineteenth Annual Meeting, American Society of Range Management, New Orleans, Louisiana, February 2, 1966.*

have inadequate or unsuitable food for good health. Over 1.5 billion people in these areas of the world are undernourished.

We know that hunger can be lessened when those who have an abundance give food to those who have too little. In the U.S.A. we have developed the Food for Peace Program, and we cooperate with our fellow members of the United Nations and of FAO through the World Food Program. Sharing abundance not only can relieve hunger and promote better nutrition but also can be directed toward encouraging overall economic growth.

But we also know that food aid cannot by itself solve the problem of world hunger. World hunger can be finally solved only where the food deficits are. The hungry nations themselves will have to do much of the job. We in the well-fed nations can help overcome the difficulties. I am optimistic that they can be overcome, based on three reasons.

First, a real breakthrough has been made in public awareness of the importance of the job to be done. Americans are beginning to realize that, in a world where all countries depend on each other, the future of highly developed and of newly developing nations alike depends on victory in the war against hunger.

Second, we know how to produce abundantly. The greatest and most far-reaching explosion taking place in the world today is the explosion in scientific knowledge. Now, we must learn how to use this new knowledge to bring about the needed increase in food production. The skills can be taught; the technology can be adapted; more research can bring even greater progress.

The third reason for my optimism arises out of the conclusions of a new USDA study of 26 developing nations. It reveals the startling fact that 12 of these 26 are already increasing their agricultural production at rates far higher than those ever achieved by the highly developed nations, including our own.

The experiences of these countries present valuable evidence on possibilities of improving agriculture in less developed countries generally. They demonstrate what *can* be done. Their value as examples is enhanced by the large differences among them in many factors crucial to agricultural progress.

Some of these countries are tropical, some semi-tropical, and some lie in temperate climates. They differ in their potential for expanding farm acreage and in level of economic development. Some have had much lower per capita incomes, much lower levels of literacy, and much poorer education systems than others that have improved their agriculture very little.

The common factor that seems essential to success is a national determination to improve agriculture—strong enough to adopt policies and programs that make the most of existing resources. Geographic, economic, and social conditions, as well as land, labor and capital—these are important factors, but by themselves do not have the power to determine a nation's growth, either in agriculture or in general economic development. It is rather the responses and adaptations to those conditions that determine progress and a national will to move ahead.

Clearly, food production can keep pace with the rapid growth in population only if farmers in these countries can economically raise their food output per acre as well as open up new lands for cultivation. This requires widespread know-how of modern agricultural production — know-how which most of the developing countries do not now have, and it takes enlightened agricultural policies by their governments.

In the tradition of the American farmer to "lend a hand" to his neighbor, the U.S.D.A. is cooperating with the Agency for International Development and other organizations in sharing with these countries our great wealth of agricultural knowledge.

Through its more than 100 years of service, the U.S.D.A. has acquired much knowledge and experience that is vitally important to agricultural progress in developing countries. We have know-how in agricultural economics, supervised credit, agricultural research, forestry, marketing systems, cooperatives, and soil and water conservation. This know-how is what many countries lack.

To use effectively the many resources of U.S.D.A. the International Agricultural Development Service was established in 1963. IADS, as it's called, has the task of coordinating the Department's international technical assistance and training work. It works closely with the Agency for International Development and with our great State and other universities, international organizations, foundations, and other private institutions also providing agricultural assistance abroad. IADS evaluates requests from AID, helps draw up plans for filling them, and then helps in carrying them out.

We in the U. S. A. take for granted many of the foundation stones upon which our modern agriculture stands. Our people can read and write. We have agricultural schools, we have county agents, our government and industry carry on agricultural research, a farmer can borrow money from a commercial bank and many other places, and most farmers in the U. S. A. have a market for their products.

We have county and State boards of agriculture and, of course, a Federal Department of Agriculture.

And, finally, our agriculture rests upon the public policies and legislation which include ownership of land by those who work it, a democratic government, and a free enterprise system in which the workers and the businessman receive the rewards of their labor and investment.

These are the kinds of basic institutions which our U. S. technicians are attempting to provide as part of a coordinated plan under the umbrella of AID and international assistance agencies. In U.S.D.A. we are concentrating our international technical assistance efforts in four general areas:

1. *Education and training.* — Last year, U.S.D.A. coordinated training of over 4,000 agriculturists from 118 countries, and we sent out almost 200 technicians to 26 countries. Of the trainees programmed and supervised by U.S.D.A., 220 studied agricultural economics, 272 studied agronomy, 170 studied animal husbandry, 201 studied extension work. Most were sponsored by AID, which sponsors most of the international technical assistance and training work in which U.S.D.A. is engaged. Of course, we don't do all the actual training. We have many partners to help train these participants; state universities and other institutions, over 300 private companies, farm organizations, cooperatives, and others.

All education in agriculture, of course, is not done in this country.

In Nicaragua, for example, a range management specialist (Gerald Darby, formerly district conservationist, Austin, Texas) began an assignment in May 1965. He is conducting a series of short courses for ranchers and government officials in that country, and introducing improved pasture plants. To us, the job may seem simple, but to the Nicaraguans, he is a real pioneer. Native grasses in Nicaragua are short, provide little feed and dry up during the six-month dry season. Darby is getting several varieties of improved seed, including several legumes, from his parent agency, the Soil Conservation Service. He expects them to provide more feed during the rainy season, and get through the dry season in good shape.

He is also holding a series of short courses, demonstrations, and field trips to show the ranchers the results of controlled grazing and improved range management. He reports he is getting excellent cooperation from the ranchers on the field days and field trips he conducts, and he has already translated several U.S.D.A. publications into Spanish to get his message to more farmers. This is only an example of the many hundreds of technicians from U.S.D.A., universities and other agencies cooperating with AID on technical assistance programs.

2. *Agricultural institutions.*—One of the institutions we are trying to build is credit. A typical farmer in many less developed countries often pays 20 to 200% interest on farm loans—if he can get a loan. Sometimes, a third to a half of his crop goes to the village moneylender. So he lacks motivation to increase crop production—because the moneylender will get the extra yield.

The Farmers Home Administration, in U.S.D.A., has 30 years' experience in lending money to low income farmers, and supervising their farm management. Such supervised credit is just what many less developed countries need. Twenty-two countries have made FHA-type credit available to rural people; seven other countries are setting up such programs. In the past years FHA credit consultants have been on 63 assignments in 35 countries.

In Jordan, for example, an FHA official helped start the "Agricultural Credit Corporation." It has made loans to 115,000 Jordanian farmers. FHA experts are still advising this organization.

In addition, FHA trains agriculturists from abroad—right here in the U. S. A. Last year, FHA training courses were held in 36 states for 481 representatives of 61 countries, mostly from South America and Africa. These folks attended classes, worked in county and state offices, and visited farmers, accompanied by the county FHA supervisors.

We are helping many other agricultural institutions get started—experiment stations, agricultural colleges, extension services, cooperatives, and marketing organizations.

In El Salvador the typical vegetable producer picks his crop, fills a sack, walks to town, and sits at the curb, bargaining with housewives much of the day. The need for a new system is obvious. A U.S.D.A. market expert is now in the midst of plans and loan applications for a central market where farmers will be able to ship their crop, have it graded and sell it for uniform prices.

In Brazil, a market news man from the Department is setting up a government system for reporting farm prices, so that the farmer who has produce to sell will know what prices other farmers in the area are getting. In the U. S. A. we take this for granted, but to the struggling farmers in remote Brazilian villages such information can mean the difference between hope and despair.

3. *Administration and management.*—Over ten years ago the U.S.D.A. Foreign Training Division recognized the need for trained administrators in the less developed countries. In the mid-1950's we set up a special course in "Public Administration in Agricultural Development," one of almost 100 group training programs we conduct. Students include Extension heads from Indonesia, India, Lebanon, Nigeria, and other countries. They comprise Directors of Research, Senior Foresters, college Department heads, Conservationists, Directors of Planning—a total of almost 200 officials.

These are the men who return home either to do a better job, or to move on to more responsible positions. These are the officials who will eventually make policy decisions which may affect food supplies for hundreds of millions around the world.

We also send technicians out to other countries to advise on better administration. Last month, a two-man team returned from Paraguay, where they studied and consulted on reorganizing the Ministry of Agriculture in that country. They found that the Ministry of Agriculture budget amounted to only 2% of the total national budget, whereas agriculture contributed 36% of the Gross National Product.

4. *Public policies and legislation.*—The fourth broad area in which we work is that of public policy toward agriculture. In the less developed

countries, most people are farmers—as many as nine out of every ten in some countries, compared to less than one out of ten here in the U. S. A. Yet these countries lack a public policy to strengthen agriculture. Land ownership tradition often makes it difficult to lend a farmer money, because he does not hold title to his farm. Little or no public funds are allocated to vocational agriculture schools. Sometimes farm prices are kept low in order to placate city populations.

India is a good example. The Indian Government purposely kept a ceiling on farmers' prices in order to keep retail food prices low. Naturally, this was a disincentive to farmers to increase their agricultural production.

Two years ago, when Secretary Freeman visited India, Government officials asked for information about our price support system here in the U. S. A. The Department sent several of its top people to India, and helped set up a Food Corporation, which provides minimum prices to Indian "cultivators" to encourage increased production. With a better price incentive, it is hoped that Indian farmers will risk purchasing fertilizer, improved tools and better seed, which should bring higher yields and higher total production to feed India's 500 million people. This comprehensive task in agricultural technical assistance requires the full support of our great agricultural institutions; U.S.D.A., state universities, foundations, private industry, voluntary agencies, and others.

The great frontier for agricultural development is in the tropical and subtropical countries. Considerable knowledge is available which can be applied in these countries provided adequate testing is done under local conditions. At the same time, research and education efforts must receive increased attention. Hundreds of millions of acres of uncultivated lands in the tropics will require intensive research to make them produce more than a subsistence living.

And, research is not always the answer to an immediate problem. It offers hope, however, for future generations. And the value of technological advancement is most apparent. There is a tremendous need for research in developing nations, and it is discouraging to see how little is being done. In many emerging countries there is not one effective experiment station in operation, or even planned on paper. Seventy-five years ago each of our States had at least one experiment station in full operation.

But research alone is not enough. The results must be made known and put to use. The Extension corps has the job of persuading farmers to give up outmoded habits of cultivation and turn to new methods. Farmers, like everyone else, will not try out the new until they are convinced it will mean improvement, specifically, a higher income and a better life.

All these aspects of international cooperation are directly or indirectly concerned with supplying man's basic need for food and fiber. The need for food has influenced human development since before the dawn of history. But today it has a new urgency, a new imperative.

This new urgency results from accelerated rates of population growth coupled with the fact that food production has not increased enough to meet growing needs. Small gains in food output are quickly absorbed by increasing numbers of people and by rising incomes.

We must not forget that the less-developed countries are primarily agricultural. To strengthen their economies, they must improve their agriculture and develop the rural sector. As a great nation and leader in the free world we in the U.S.A. are obligated to help. It is morally right and is in the interests of world peace. And it is to our own self interests. As nations become economically more sound they become better customers for our products—agricultural as well as industrial.

In 1965, we exported over 6 billion dollars worth of our agricultural products. This year we shall export even more. Japan, to whom we provided technical and food assistance just a few years ago, is our best cash customer for our farm output—700 million dollars last year. Other countries such as Spain, Italy, Taiwan, whom we have helped in developing their agriculture are now commercial customers for our food and fiber. Recent studies by the Economic Research Service show that as a developing country increases its per capita income by 10%, they buy 14% more of our agricultural produce.

The problem of agricultural development, then, is one of the major problems the world faces in the years immediately ahead. For our own security and economic interests we must help these emerging nations develop their agricultural potential—from a humanitarian standpoint, we cannot let them starve.

Strengthening Range Management Assistance—The Administrator[1]

MILO L. COX

Chief, Rural Development Div., Latin American Bureau, AID, U.S. Dep. of State, Washington, D. C.

Highlight

This paper is an outline of factors involved in assisting a developing nation with range resource programs. It includes 10 points, beginning with the need for a range program, and concluding with final transfer of responsibility to the host government.

The outline below was derived largely from the Latin American situation, but the points are generally applicable to other newly emerging or developing regions. The purpose of this outline is to review, for the range management technician or agency, the major points of concern of the administrator when a range management program is proposed.

I. Determining the need for a Range Program

A. The Agricultural Resource

1. Topography and main physical features
2. Soils—depth, slope, texture, permeability, drainage, fertility and degree of erosion
3. Climate
4. Vegetation

These factors are well understood by all range managers.

B. Land Use Patterns

1. Percent of land under cultivation
2. Percent of land not suited to intensive cropping, i.e., lands that are potential pasture, range or forest
3. Patterns of occurrence of land types
4. Patterns of land ownership
5. Tribal or communal grazing rights

These factors help the administrator decide on the advisability of initiating a range program from the standpoint of how land is presently handled, how much land and what kinds of land are available for livestock uses, whether or not there are large blocks under individual ownership and whether or not grazing management is possible. Where tribal lands are used by many families, grazing controls are rarely possible.

C. Country Needs

1. Internal Consumption of Agricultural Products
   a. Total population
   b. Rate of population growth and estimates of future growth
   c. Nutritional levels
   d. Economic levels and estimates of probable increases in standard of living
   e. Relative flexibility of internal markets

These factors are important in determining the pressure on the land for food production, whether or not protein deficiencies are a problem, the level of local demand for livestock products, the possibilities of developing greater internal demand and whether or not the the country in question can afford to put large areas into extensive use.

2. Export of Agricultural Products
   a. Foreign exchange earnings and balance of payment problems
   b. World markets
   c. Local export facilities
   d. Costs, quality, and competition

These factors indicate the need for export earnings, the kinds and quality of products acceptable on world markets, whether or not the country can compete with other exporting nations and whether or not export facilities exist or must be provided.

II. Selling the Idea of a Range Program

A. To the Agency or Agencies (External)

Once satisfactory data are available and a local decision is made to embark upon a Range Program, the administrator must submit the proposal to appropriate programming and planning bodies for substantive approval. At this point the proposal is judged as to its applicability to country needs, financing agency requirements and its degree of fit into the overall country plan.

B. To Host Country Officials

1. National Planning Commission
2. Ministry of Finance
3. Ministry of Agriculture
4. College of Agriculture
5. Private Organizations and Associations—Landowners
6. Industry—slaughterhouses; fertilizer, seed, pesticide, and equipment dealers, etc.

Concurrence in the Range Plan is not required by all of the above agencies but little success is to be expected unless strong support can be developed by most of them. Most lending agencies or donor countries require strong self-help measures

[1] *Presented at Nineteenth Annual Meeting, American Society of Range Management, New Orleans, Louisiana, February 2, 1966.*

before external financing can be arranged.

III. Determining the Magnitude of the Program
  A. Urgency of the need
  B. State of knowledge
  C. Technical personnel availability
  D. Readiness of host country officials and landowners
  E. Host country capability to continue the program after assistance phase-out

These are essential considerations that impinge upon the decision of program magnitude. The administrator knows that host country capability can be increased during the program period but much care must be exercised so that a program is not so large and expensive that it cannot realistically be expected to continue after external financing is exhausted.

IV. Financing the Program
  A. U. S. and/or Third Country Donors
    1. Grant Funds—AID, UN Special Fund, Private Foundation
    2. Loan Funds—AID, IDB, IBRD, etc.

The program may get its initial support from one or more institutions, they may be bilateral or multilateral, they may be grants or loans, they may be short or long term. Range Programs must have long range financing so the appropriate institution must be chosen. These funds are normally used for foreign technicians and any dollar costs, i.e., imported components.

  B. Host Country Contributions
    1. Cash
    2. In Kind

The host country is usually required to contribute about one-half of the total cost. This may consist of local technicians and salaries, travel costs, land, office and laboratory space, storage facilities or other buildings, and any local currency costs such as locally available equipment and supplies.

V. Selection of the Implementing Agency
  A. Direct hire
  B. Contracts
    1. U. S. universities
    2. U. S. Governmental agencies
    3. Private contractors

AID may implement the program with its own direct-hire staff or contract with the USDA or a land grant university to carry out the program. The Administrator must select the institution with care in order to match the institution's expertise and capability with the work to be done.

VI. Getting the Program Approved
  A. U. S. Approval
    1. Program presentation and approval
    2. Congressional presentation and Approval

If AID is to be the financing agency then the project must be presented to Congress for approval.

  B. Host Country Approval
    1. Preparation of agreements—two languages
    2. Getting agreements signed.

An agreement must be prepared in both languages stating the terms of the agreement, scope of work, objectives, cost, timing, etc. The signature of the Ministry of Finance or Agriculture is usually required.

VII. Implementation of the Program
  A. Selection of Qualified Personnel
    1. Foreign advisors
    2. Host country counterparts
  B. Personnel Briefing and Language Training
    1. In the U. S.
    2. In the Host Country
  C. Preparation of Work Plans
    1. Scope of work
    2. Task assignments
    3. Work schedules and reports
  D. Procurement; equipment and supplies
  E. Guidance and Direction of Program
    1. Inter-agency coordination
    2. U. S. commitments
    3. Host country commitments
  F. Evaluation and Follow-Up

VIII. Training of Host Country Personnel
  A. On the Job
  B. In the U. S.

Technicians and administrators are usually trained as the work progresses. Once certain technicians have demonstrated high capability, they may be sent to the U.S. for formal training at a U. S. University. These men form the technical base upon which the program continues after external financing has been phased out.

IX. Institution Building
  A. Selection and modification of Established Institutions
  B. Establishing new Institutions
  C. Building of U. S. and Host Country Institutional Relationships

Long lasting results and continued effort is usually not forthcoming if only individual technicians are trained. Some host country institution such as a University department or a Division within the Ministry of Agriculture must be strengthened or established. Then trained people have continued employment in their field. U. S. training, if properly handled, can help to establish long term associations between the host country and U. S. institutions.

X. Transfer of Responsibility
  A. Financing and Administration

B. Continue U. S. training program
C. Arrange for Short-Term Consultants
D. Phase out Direct Technical Assistance
E. Phase out Financial Assistance

These items refer to the administrator's efforts in turning over operational and ultimately financial responsibility to the host government. People must be trained to do the work and continued U. S. training is desirable. Consultants can be sent to assist in special phases of the program or to help on special problems even after the long-term technicians have left the program.

Strengthening Range Management Technical Assistance—The Advisor[1]

ALEX JOHNSTON

Range Management Specialist, Canada Department of Agriculture, Research Station, Lethbridge, Alberta, Canada.

Highlight

The advisor would be more effective if he would forget detail of his discipline and remember principles; if he would learn as much as possible as quickly as possible about the culture he is supposed to advise; and, if he would apply principles in light of cultural limitations. Often the greatest service the foreign advisor can provide is to speak for the technicians of the country, to add the prestige of his position to the recommendations that local technical officers are confident will succeed.

This paper is based on a single year's experience as a foreign advisor to one Middle Eastern country. It was one of the arid countries of the world where the rangelands have been grazed by cattle, buffalo, sheep, goats, donkeys, horses, and mules for thousands of years and where the native woody vegetation has pro-

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[1] *Paper presented at the Nineteenth Annual Meeting, American Society of Range Management, New Orleans, Louisiana, February 2, 1966.*

vided fuel for the human population equally as long. The vegetation has reached a very low point on the successional scale. It often seemed that the poor rangelands and the livestock dependent on them had reached a sort of precarious balance—the animals being mere frames of low productivity, the vegetation sparse or lacking, the soil eroded leaving great expanses of bare rock or sandy desert. The livestock were little different from the wild animals from which they originated; they thrived during the wet season, starved during drought.

And while there are other developing countries where conditions for plant growth are less harsh, the range management advisor has a difficult job in most of them. His first move will likely be to tour the country of assignment in company with his "counterpart", the national with whom he is going to work. The advisor should remember that, in most countries to which experts are sent, advisors have been going on familiarization tours for at least the last 15 years and he should not be surprised if he is greeted with something less than wild enthusiasm. As he sees the biological problem the advisor will realize that, in spite of the efforts of numerous experts over the 15 years, there has been little change in traditional patterns of grazing; the "wasteland" philosophy of pasture still persists. And yet he will occasionally see areas that will make him hopeful, for example, the tribal ranges in West Pakistan in the former Baluchistan Province, which were managed under a system called "pargore". Members of the tribe agreed that certain areas of rangeland would be deferred for a specified period of time; good stands of *Chrysopogon montanus* were evidence of the success of the practice. The advisor will see in airports, cemeteries, and other areas where grazing is prohibited, an abundance of forage that will show him that the country has a potential to be realized.

But today, in many of the regions of Asia that have climates characterized by summer drought, this is the picture: an extension into the range areas of dryland farming, rapid exhaustion of cultivated lands since all topgrowth is harvested and dung is used as fuel; general overgrazing of the native vegetation and the uprooting of woody species for fuel; seasonal starvation of livestock; and, trampling and erosion of soils, loss of water by runoff, increased evaporation, and the extension of deserts.

There are reasons why the rangelands of these countries have not shown more improvement. It is harder to improve management of rangeland than it is to show the usefulness of a fertilizer program on cropland, for example. Results of a range improvement program are slow to appear and success is difficult to demonstrate. In the past, authorities have authorized range improvement schemes and have abandoned them in disgust because results were so slow in coming. Insistence on quick results fails to recognize the slow nature of vegetative change and the paucity of present knowledge; it works against the long-term planning and sustained effort that are necessary in range improvement programs.

It is important, then, for the advisor to gain an appreciation of the reasons behind the present condition of the rangelands. He will see that the problem is basically one of too many animals attempting to graze too limited a forage resource. He should see that the solution is likely to be complicated and that it will involve much more than a suggestion that livestock numbers should be reduced. He will find himself becoming less concerned with the biological problem and more concerned with the political and social problem;

much hinges on the actions and policies of government and on the attitude of local people.

The advisor will find a lack of basic data and that it is difficult to track down any that he knows are available. Often he will find that previous experts did not make much of an impression, that their reports are lost, that their recommendations make a lengthy list but that few of their suggestions have been implemented. The agencies could do much to provide the advisor with literature in range and related fields but, unbelievable though it may seem, the advisor may not even get the reports of the previous expert. The agencies should make a greater effort to obtain for the advisor all reports —vegetation studies, watershed surveys, statistics on acreages and animal populations, related agronomic studies—available in the country of assignment and from nearby countries with similar rangeland problems.

The advisor should learn as soon as possible some of the unique range and livestock problems that will likely influence his recommendations and suggestions. He will find that there has been a traditional separation of the shepherd and cultivator, a separation typified by the Biblical story of Cain, the tiller of the ground, and Abel, the keeper of sheep. The shepherd has long been a nomad who owns no land. His flocks and herds use the rangelands but he accepts no responsibility for their maintenance or improvement. The cultivator has been sedentary, satisfied with his small acreage and way of life. Both the shepherd and the cultivator have destroyed the land for fuel. And each has destroyed it for his own separate purpose, the shepherd to obtain more forage for his animals, the cultivator to obtain more acres for his crops. (The nomadic grazing of the shepherd is still important in much of Asia and may continue to be the only method of utilizing large areas of arid land. Problems arise when nomadic populations cross national boundaries or enter areas already fully occupied by sedentary cultivators.)

Separation of shepherd and cultivator has reached the point where, should a farmer also own livestock, his animals must rely on the rangelands for their upkeep and they do not form part of the normal farming pattern. No fodder crops are grown to carry livestock over the dry season. With existing methods of cultivation and the near-impossibility of breaking up stands of perennial grasses or grass-legume mixtures using the wooden Asiatic plow, it is unlikely that perennial forages could be grown. Here and there annual clovers are grown but are used mostly for stall feeding milk buffaloes or draft bullocks. This crop is cut several times during the year and hauled into nearby cities for sale; clover fields are never grazed and hence there is no return of fertility in the form of manure. Range livestock are usually kept in the village at night and are trailed out to grazing in the morning. The animals tend to be close-herded by individuals with little or no idea of range management.

The advisor will find that his ideas of uses of domestic animals may be radically altered in the country of his assignment. In some developing countries livestock are kept for reasons of religion. This is best seen in India where about 226 million animals, one-quarter of the world's bovine population, are maintained in a social environment where the slaughter of the cow is banned by law in most States. Many of these animals are of little or no economic value and are inferior in quality. In other areas livestock are kept for reasons of sentiment, of prestige, as capital, as bride price, or as insurance against losses due to disease or to drought.

Similarly, the advisor's ideas of products from the range will be changed. In West Pakistan, for example, the products of the range cattle industry in descending order of importance are bullocks for draft purposes, milk for human consumption, hides, and meat. Beef is an inferior product since the slaughter of agriculturally-useful bovines is prohibited and meat must come from aged animals. The sheep industry produces wool, mutton, skins, and milk. Goats, usually introduced to ranges that have become too poor to support other classes of livestock, are kept for meat, milk, and hides. Camels are kept for transport or motive power, buffalo as milk producers or draft animals, donkeys as beasts of burden, and horses and mules are kept for transport. The latter are usually well looked after. The destructive grazers seem to be goats and camels; a local saying where a weedy plant, Ak *(Calotropis gigantea)*, grows on the sandy wastes around the villages is: "The camel leaves Ak but the goat leaves only the stones".

The relative importance of these various products is of significance to the range manager. The graziers of developing countries tend to be concerned with the immediate needs of themselves and their families. The ranges are grazed in common and, if the first arrivals do not take all the forage, those that follow certainly will. Consciously or unconsciously, graziers believe that they can obtain high production over a short period by deliberately overgrazing the range, even with the attendant destruction of the soil and vegetation. And this knowledge is supported by the results of many of the world's grazing studies. On any particular range at a particular time, regardless of range condition, higher production per unit area can be obtained by overstocking than by moderate grazing. (It is obtained by accepting a lower gain from a greater number of animals; in the developing countries numbers are important and quality is of little consequences.) Higher production per animal is obtained where ranges are moderately grazed and the soil and vegetation maintained in good to excellent condition. Thus, although the advisor knows that the long-term interests of the grazier—and of the developing nation—are best served by a program of moderate grazing, the grazier knows that temporary benefits can be secured through exploitation of the rangelands. A prime task of the advisor is to reconcile these opposing points of view.

Technical range management has been most successful when applied in those areas where large holdings are commonplace, where a considerable investment has been made in land and buildings, and where owners have not been forced to overgraze their ranges. It has been much less successful in those areas where operators own a small number of livestock and are forced to exploit the rangelands instead of managing them for sustained use.

The advisor will encounter attitudes and beliefs that will be strange to him. The grasslands are regarded as a gift of God and it is assumed that, if He wished, God would continue to provide His bounty in spite of continual misuse. Fatalistic beliefs are common and lead to an acceptance of things as they are. If the grasses disappear and the land washes or blows away, it is the will of God and a mere mortal can do little about it. The belief that commercial fertilizers will poison the soil impedes progress in cropland improvement; the belief that meat from an entire male animal confers added virility to the eater of the meat impedes elimination of scrub males and consequent livestock improvement.

An obvious solution is to suggest that animal numbers should be reduced even though large-scale reduction of animals in areas already deficient in animal protein is hardly desirable. But most reports do suggest a reduction in numbers or, conversely, an increase in the forage supply. And even though lowered animal numbers is a simple and obvious solution, it will require much persuasion and education of users and administrators to accomplish needed reductions.

Nevertheless reduction in animal numbers has been attempted, especially of the goat. West Pakistan has a 1960 Goat Restriction Ordinance in effect, which prohibits goats within five miles of forest areas unless stall fed and under license; slaughter houses are required to slaughter four goats for every sheep. The Turkish Forest Service has authority to prohibit goat grazing inside forests but has been unable to enforce the law because of owner resistance. Attempts were once made to reduce the goat population of the island of Cyprus but without much success. The reason for these failures is not hard to find. The goat is looked upon as a "poor man's cow"; it can increase in numbers fairly quickly; it provides meat and skins; it can exist under very difficult range conditions. The livestock owner is aware of these good qualities but fails to recognize the capabilities of the animal for destructive grazing. Thus he makes little or no attempt to control its grazing behavior. Many consider the goat, often called the "curse of Asia", to be an expression of poor land use and not its cause.

The advisor may wrongly conclude that the problem is simply too big for one man to handle. But there is much he can do. He can study the over-all problem and attempt to break it down into manageable proportions. He will work with a national of the country of assignment and thus help to train a sorely-needed technician. Together they can attempt to analyze the problems and endeavor to formulate workable solutions. He can instil feelings of hope and encouragement. He will likely be a member of a team since the team approach seems to have been adopted by most international agencies. It is obvious that the solution to the fodder and livestock problems of the developing countries will not come from a single discipline but rather from a combination of many. Cropland must be used to a far greater extent for fodder production, for example. If the fodder could somehow be harvested by the grazing animal, the return of fertility and improved tilth would improve yields of succeeding crops in the rotation. Improvements in marketing techniques, in storage facilities, and in refrigeration could have major effects on the rangelands.

The advisor may be able to influence the government to draw up a clear statement of policy and thus provide local technical officers with a framework within which to work. While many governments have issued policy statements, there may be a need for a statement of policy to underline the importance of the rangelands to the economy of the country, and to provide a mandate for the land utilization agencies with necessary legislative and administrative backing for the furtherance of a range improvement program on these lands. The advisor may be able to aid in the creation of an organization within the government to assume responsibility for range improvement. Working conditions and other amenities within the organization should be such that the development of a cadre of professionals would be encouraged. In the final analysis, it is members of this cadre who must assess the work and recommendations of foreign experts, who must utilize and adapt their own training, knowledge, and experience for and to the ecological and sociological conditions that prevail, and who must formulate management systems that are acceptable to the graziers of the country.

This brings me to my final point: my belief that the most important function of the foreign advisor is to speak for the technicians of the country of his assignment, to add the weight and prestige of his position and office to the recommendations that local technical officers are confident will succeed. There are few developing countries where some technicians have not received training in the United States, Australia, Europe, or elsewhere. A few remain in range management, usually. These technicians are aware of the principles of range and pasture management. Further, they have a knowledge of the country and of its people that the advisor can never attain. The ability to pick the right men to listen to and speak for will be the hallmark of a successful assignment.

Need for a Range Management Approach for Nigerian Grasslands[1]

CYRUS M. McKELL AND ANTHONY A. ADEGBOLA

Associate Professor of Agronomy, University of California, Riverside; and Acting Dean, Faculty of Agriculture, University of Ife, Ibadan Branch, Ibadan, Nigeria.

Highlight

Development of extensive Nigerian grasslands should follow a range management philosophy. A range management approach offers the best solution for utilization of resources already at hand without the initial need for planting improved forage varieties, fertilization, complicated management schemes, etc. Research information is needed relative to utilizing existing grasslands that can also serve as a base for later development.

Nigeria is a relatively new African nation with great agricultural potential. Increased agricultural productivity will be required to support a burgeoning population of over 50 million. One area of agriculture that has received little professional attention in the past and should be emphasized in the future, is range or grassland management. Because of the great differences among the main vegetation types the same problems are not to be found in each region and consequently different research and management programs are required. However, the same general principles apply and point to the need for a range management approach in solving the grasslands problems of Nigeria.

Grassland Vegetation

From the Atlantic coast inland to the north there is a general decline in rainfall from 140 inches to 20 inches at the border of Niger Republic (Buchanan and Pugh, 1955). Rainfall occurs every month near the Atlantic coast and diminishes to a 2-season pattern inland with an extreme of 5-months drought in the northern one-third of the country.

Vegetation types (Rattray, 1960) change with decreasing precipitation, going from mangrove swamps near the coast to tropical forest farther inland and out of the flooded river bottoms. A "derived savannah" type has been developed on the interior margin of the tropical forest by intensive tree cutting and brush clearing. Farther inland the Southern Guinea Grassland zone exists in a 45-60-inch rainfall area. This mixed savannah of *Andropogon gayanus, Pennisetum purpureum, Panicum maximum* and other species blends into a more open savannah of shorter grasses and woodland in the Northern Guinea Grassland zone. Here the 45-inch annual rainfall occurs from April to October. Farther inland the grasses become shorter and thorny shrubs and annual species are in great abundance in the Sudan zone of 25-35-inches rainfall. The vegetation of this zone has been modified almost completely by burning and grazing of domestic livestock over many years so that the present cover bears little resemblance to the true climax (Rains, 1963). The extended dry period of up to 5 months is one of the most important factors controlling the vegetation of the Sudan zone.

Nigeria is divided into three main geographic areas by the Niger and Benue rivers and their broad river basins. Vital bridges connect the regions and funnel the agricultural commerce along a few main routes. Such routes offer convenient points for veterinary inspections and livestock census taking but restrict the flow of livestock to market.

The Livestock Industry

Production of livestock is inadequate to meet the nutritional

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needs of the population. Quality is low and several years are required to produce an animal for market. Over 26 times more cattle are produced in the north than in the south. Several reasons may explain the greater animal population in the north: 1). There are extensive grassland areas in the north not dominated by forest. 2). The north has relatively greater freedom from tsetse fly (*Glossina* spp.) problems during part or all the year (Davies, 1962). 3). Livestock herding is part of the social tradition for such tribes as the Fulani and Tiv.

The predominant animal breeds in the north are Zebu types; the White Fulani and Red Bororo. These cattle are not resistant to trypanosomiasis (sleeping sickness). Nearer to the middle belt is found the Keteku and N'Dama which are considered to be naturally resistant to trypanosomiasis and, although smaller than the White Fulani and Red Bororo, possess numerous favorable beef characteristics. In the derived savannah and tropical forest the Muturu is the adapted livestock type. It has a high degree of acquired tolerance to trypanosomiasis but is a small animal (300-450 lb) and is slow to mature.

Some effort is presently being directed to breed improvement by the introduction of European and American bloodlines. But considerably more emphasis needs to be given to developing crosses and strains that mature fast, are resistant to sleeping sickness, have a good size, and show an efficient rate of gain.

A common practice is to select the large, older animals in the herd for market. By the time an animal is thus selected it may be from 6 to 8 years old and has gone through several seasons of gain on green forage and almost as much loss of weight on dry forage. After several years of incremental gains an animal is sent to market at a weight of from 600 to 800 lb. It is clear that greater livestock production could be obtained if animals were not allowed to regress in weight each dry season. Better management of existing forage sources or development of supplemental feeds for use in dry seasons would permit continuous gain and earlier marketability.

Along with improved livestock breeds must also come a better system of livestock marketing. Instead of a large number of animals being trailed to a market where quality receives no consideration and animals are slaughtered for immediate consumption, a transporting, packing, storage, and retail marketing, system must be developed to accommodate the improved livestock produced by more modern methods.

Range Management Approach Needed

A large proportion of Nigerian grasslands may be considered in the accepted definition (Range Term Glossary Committee, 1964) of range; i.e., land producing native forage for animal consumption or lands that are naturally or artificially revegetated and managed like native vegetation. A range management approach to the utilization of the Nigerian grasslands would require that the plans and directions for range use seek to obtain maximum animal production consistent with perpetuation of the natural resources.

An example of an extensive grassland area that is managed according to range mangaement principles is the prairie of the USA. Here the extensive grassland areas have been studied from various aspects and the necessary management procedures established for sustained plant and animal productivity.

In what way does a range management approach differ from others such as a botanic or agronomic approach that might be utilized? The main difference lies more in the beginning than what happens later. Range management emphasizes management and improvement of the extensive forage resources which are already at hand. After simple and productive management programs have been developed, it follows then that other practices may be initiated which are common to the general field of range and pasture improvement. The experiences gained in the management of present grasslands would be vital to the success of programs for intensive pasture development in suitable areas. The revenues thus obtained would also provide a broader base for necessary capital improvements.

In Nigeria over 140 million acres of grassland already exist and only require the application of range management principles to provide greater carrying capacity and more efficient livestock production. These lands cannot be ignored while small areas come under intensive management. An exception to this, of course, is the derived savannah zone where replacement of trees with grass has already been on an intensive basis over a period of many years.

How might the range management approach be applied to the development of Nigerian grasslands or other grasslands of the world where increased productivity is necessary? Several steps are available in this evaluation. First of all, there should be an improvement in the understanding of the present use and land tenure patterns, including knowledge of the response of the forage species to management and other conditions of use imposed by the livestock grazier.

Second, reliable information should be developed concerning the nutritional value of the principal forage species, estimates of present and potential water available for livestock use, an evaluation of the seasonality of forage production and the alternatives available for livestock feeding during the periods of low forage quality and production.

A third step is to determine the opportunities for range improvement and more efficient livestock use, starting with the present forage resources.

Grassland problems are being studied at research stations in various parts of the country. Also, each state university and the University of Ibadan have grassland research programs. Contributions to grassland knowledge are also being made by the farm settlement schemes and commercial livestock ranches. Some of the typical problems being investigated include species introduction and evaluation, pasture species mixtures, cutting height and frequency, ley farming (using grass in the crop rotation scheme) and some work on preservation of plant materials for silage. Much of the research effort appears to be directed toward solving problems of improved, intensively-managed pastures. Such emphasis in the derived savannah zone is appropriate but in the Guinea Grassland zones and the Sudan zone the large expanses of grassland require a much different approach. Utilization and development of these large interior grassland areas should follow a range management philosophy.

Reaction of grassland vegetation to use should receive considerable attention. In range management terminology "range condition and trend" studies (Stoddart and Smith, 1955) would help to answer questions as to the effect of current stocking rates, seasons of use, and burning on the stability or deterioration of natural grasslands. The research must be directed along practical lines to provide early solutions to problems. Even though range condition and trend studies, by their very nature, are long-term, it may be possible to extrapolate from information developed in other rangeland areas by careful and frequent reference to local situations for guidance.

In many of the forest reserves, protection from livestock use and burning has undoubtedly had a significant impact on the pattern of species composition. Where beneficial results have occurred it would be desirable to utilize such results for improving management of livestock on forest reserves and adjacent areas. Cooperation between forestry, livestock, and grasslands research and administrative personnel is essential. Presently, few of the forest reserves are used as grazing reserves.

Too little attention has been given to the effect of burning in Nigerian grassland ecology. More study should be made of the benefits and disadvantages of burning in modifying plant succession and influencing competition between herbaceous and woody plant. In Northern Nigeria burning is a common custom and may have a place in grassland management. However, specific information is lacking (Rains, 1963).

Near villages the common practice of bush fallow needs to be studied in relation to grazing management and cropping. Is bush fallow in the derived savannah as beneficial as believed in the past? Other alternatives may accomplish the same end. As population pressure increases, particularly in the south, greater use is required of the land and it is possible that the bush fallow system may be replaced by a mixed-farming system employing an area of improved grassland to supplement extensive grazing areas during the dry season.

As an aid to management of natural grasslands greater knowledge of the important native forage species is necessary. Such perennial species as *Andropogon gayanus, Pennisetum purpureum, Panicum maximum, Stylosanthes gracilis* are recognized for their particular forage qualities but more information on their autecology would facilitate grassland management and range improvement. Particularly needed is information about the distribution, variability, ecologic amplitude, seasonal reaction to grazing, palatability and seedling vigor of the important forage species, including annuals in the drier parts of the country. Physiological research could provide a basis for improving grassland management and would provide answers to such questions as seasonal changes in nutritive value, requirements of seed germination, and differences in dormancy of the various species. Control of weedy species such as cogon or speargrass *(Imperata cylindrica)* depends to a large degree on both ecological and physiological information.

A study should be given to methods of obtaining proper livestock distribution consistent with plant and soil productivity under conditions of Nigerian land tenure systems. Local adaptation of such means as salting, spacing of available stock water, herding, and camp systems could provide for better grassland utilization and range improvement.

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How the Society Can Help Individual Advisors and Country Workers[1]

G. W. TOMANEK

Division of Biological Sciences, Fort Hays Kansas State College, Hays, Kansas

Highlight

This paper suggests that the American Society of Range Management maintain services to visiting trainees to USA and to technicians on overseas assignments; and in other ways help gain needed attention and work on ranges worldwide.

Range Management advisors are going to other countries in ever increasing numbers. As a technician in Argentina I felt the need of help many times. Some of the answers I needed could have been provided by an organization like the American Society of Range Management. ASRM has a tremendous opportunity to advance the cause of range management worldwide, through aid in selecting, and by

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assisting technicians involved in overseas range management problems. There are several possible approaches to how our society can help make our overseas programs more effective. They might be categorized as follows:

(1) To assist various agencies in selection of technicians best qualified for the purposes of a particular program in a certain country.

(2) To help technicians become well oriented to the task ahead before they visit another country.

(3) To help technicians while they are working in another country.

(4) To assist in making visits of foreign ranchers and technicians to our country more meaningful.

To accomplish this type of assistance, I would like to discuss some ideas which have been given me by many of our members who have had experience as range technicians in other countries. We should evaluate these ideas and determine which ones are feasible for our organization. Then without further delay I believe we should make this type of program one of the primary objectives of the American Society of Range Management. A strong vigorous program of this nature could be one of the finest contributions our organization could make.

1. The Society could maintain a list of people who are interested and *qualified* for overseas assignments. This list can be shared with hiring agencies such as AID, FAO and others, and active assistance given in procuring the best qualified men for the various positions. The Society might serve effectively as a clearing house for information about other range-trained individuals who may be available to serve in overeas jobs. The selection of individuals who are going to take overseas assignments in range management is extremely important. They should be trained and oriented in range management but equally important should be interested and concerned about the people they are going to help and, if necessary, be able to handle or learn the language.

2. We could maintain a range management contact in Washington, D. C. both as a service to hiring and training agencies and for point of contact or clearing house for overseas technicians to contact for any service the Society might offer him.

3. The Society should compile and maintain an up-to-date list of men who have been or are currently abroad on foreign assignments in range management. The list could be a brief record of the men and their assignments including perhaps:

a. Name of country.

b. Name of worker and address.

c. Educational background.

d. Experience previous to foreign assignment.

e. Nature of foreign assignment.

f. Length of assignment.

g. Bibliography of publications or reports on assignment.

When a new man goes on a foreign assignment, he could request through ASRM, the names of the men, plus pertinent data on them, who have been to that country.

4. The Society could compile a list of foreign nationals who have been on training programs in this country, classified by country of origin and nature of training programs they participate in while here. It would give a new man an opportunity to find contacts in the country to which he was assigned.

5. The Society should urge the addition of a range man or men to the staff of agencies hiring overseas technicians who could aid these agencies in the selection of qualified men. These men should act as backstops for

their men overseas and get various types of vital information for them such as sources of seed, names of nearby technicians, identification of plants, references, etc. There are some range men on the staff of these organizations, such as Milo Cox, but they are burdened with other important duties.

6. The Society should maintain a good bibliography of range management literature published about other countries and make this list available to people needing it for overseas assignments.

7. We should carry more international material in the Journal, not only technical articles but also news and notes about activities in other countries. The Society should encourage more foreign nationals to prepare suitable articles. This should be particularly instrumental in bringing about a better understanding of the variety of range problems existing in the different parts of the world. It has been suggested that in order to better fulfill this objective a fairly standard pattern could be evolved for authors to follow to insure that comparative information would become available. For example, there should be a description of the environment, including certain social aspects, a definition of the basic problems, and some suggestions for solutions being tried or solutions that might be feasible. Eventually it might be possible to publish these in the form of a pamphlet or book.

The maintenance of good accounts of overseas workers in the news and notes section of the Journal would not only help to stimulate interest but also provide good contacts for people planning overseas work.

8. The Society should supply information about our organization. Any worker going to a foreign country where there is natural grassland should at least know of all the Society publications; the Journal, the Range Glossary, our book on Range Problems and Research Techniques, the Spanish summaries, the annual meeting abstracts, the regional or state handbooks for youth, and the section newsletters. This is quite a list and perhaps not all could be carried but a worker could at least carry samples of all of them. The Society should compile a list and make the material available to USAID, FAO and other professionals who go to work in range countries.

9. We should find a way to help impress our administrators of foreign-aid programs and administrators in other countries of the importance of the range resource and the complexities involved in dealing with it. Many people have related that many officials they have encountered in overseas assignments have very little understanding or appreciation of the range as a natural resource. Most have agronomy or veterinary training and are primarily concerned with improved pastures or some livestock problem. Some feel range values too low to justify attention even though 90% of the country may be range, with range livestock the main business. I think, too, that our Society could help in trying to convince certain hiring agencies that it is impossible to visit a country and come up with all the solutions in two months or two years without some knowledge of the vegetation. Some research is going to be necessary in order to get answers. Very few people can fly out of Kansas or Texas to some country in Africa or South America and prescribe immediate solutions. Many times the best we can do is suggest ways of finding the solutions.

10. The cost of membership in our Society for people in important range countries should be adjusted according to the abilities of the people in that country to pay. This is one of the few ways we have of maintaining an influence in a country after the technician has left. Our Society has worked with this problem for some time. The Board authorized a $6 membership for underdeveloped country personnel but this is high for many countries. We should keep trying, for the benefit of those who have only pesos, bolivars, sols, cruzeiros, etc., and find it difficult to get dollars. Perhaps one of the foundations, such as Rockefeller, with activity in most Latin American and some African countries, would be willing to act as our agent, accepting local currency for subscriptions, and paying us in dollars.

11. The Society might assist in developing training courses for updating foreign service technicians on home leave. Many technicians spend several years in other countries and need to be informed on the latest findings in our country. The Society could be useful in promoting short courses at, or visits to, Universities and Experiment Stations.

12. The Society should encourage (working through AID, FAO, etc.) the contracting country to establish a "grass roots" extension position with each of our range management missions. He would be valuable in helping the consultant reach his own people more effectively. This man would be a native of the country visited and would be a person of recognized scientific stature, if possible. He would help the visitor reach the people more effectively.

13. Hiring agencies could publish a list of open positions in the Journal. Many capable and interested people might respond who might otherwise never be contacted.

14. We should help foreign visitors, interested in range, plan their itinerary in this country. A great difference exists in the attitude of range technicians in this country regarding the time and effort they are willing to spend showing foreign visitors the work being accomplished here. The Society could determine areas and technicians where foreign visitors are well received and shown interesting and informative things. Often there is too much time spent in short office visits in the cities where our technicians are headquartered and not enough time out on the ground with the visitors. I would like to illustrate the importance of these visits with a personal experience. I spent some time in LaPampa Province in Argentina in 1961. I was supposed to analyze their problems and suggest some solutions. Some of my recommendations dealt with demonstrations of good management practices. We sought a few respected and influential ranchers to conduct some of these demonstrations, knowing that if they found any of our suggestions worthwhile the neighboring ranchers would adopt them. One such rancher was Roberto Souto. Between my first and second visits Mr. Souto and eight of his friends came to this country, at their own expense, to see some of our practices. They spent ten days with us at Hays touring our studies but mostly visiting ranches in our area. When I returned to Argentina, Mr. Souto told me that their visit to the States was a very valuable experience. He said, rather apologetically, that my visit to his country was fine and that they got some ideas from me that turned out okay but it was hard for him to accept some of them until he saw them in operation on ranches in the States. So, I think their visits are very important and our Society can help in planning a good itinerary for them.

I have listed a number of possible ways our Society could be helpful to our effort in range management overseas. Most of the ideas came from many of our members with experience overseas. There are too many suggestions on the list for our Society to implement at once. We should push forward vigorously on the ones already underway. Then we could select the other more urgent ones and get started on them. Some might be hard to implement but others are quite possible for us to accomplish. Most of our activities are carried on by volunteers and all of us are busy so that many features of the program stay mostly in the talking stage. It might be possible for the Society to cooperate with some agency or foundation in setting up a position for one or more of our members to administer some of these suggestions.

Perhaps our major contribution could be in helping to get the very best qualified people into overseas assignments. Individuals vary greatly in their temperament or personality when it comes to dealing with technicians of another country, perhaps of a different race and brought up in an entirely different atmosphere. Some people adapt well to cultural situations they find while others remain aloof to the cultural benefits available and segregate themselves with other Americans located there. This segregating arrangement certainly limits their effectiveness. We need to have people who will get out in the country with the people, on the land, if they are going to be effective. This is as true in foreign countries as it is in the United States. Probably the most important characteristic of a technician is a willingness to look and listen before trying to offer advice in a foreign country.

I haven't proposed a good strong mechanism for our Society to use in carrying on some of these proposals. However, I feel sure we can come up with the mechanism to handle essential parts of the program. The committee for International Affairs chaired by Dr. Hedrick made a report similar to this one several years ago. It should have been given whole-hearted support of the Board and the Society as a whole. The ASRM International Relations Committee, under Chairman W. R. Chapline, has pursued a vigorous program within the limits of volunteer workers and limited finances. Let's move aggressively forward because as one of our past presidents said in his letter to me "The stakes in foreign assignments are sufficiently high to warrant our special efforts."

Expanding Horizons in Worldwide Range Management[1]

C. KENNETH PEARSE

Agricultural Officer (Pasture Management), Pasture and Fodder Crops Branch, FAO, Rome, Italy[2]

Highlight

Range management must play an increasingly important role in the efforts of the developing countries to increase their output of livestock products. Technical assistance to guide improvement in the management and use of range and pasture resources can best be provided by international organizations. It is essential to establish a philosophy of range management based on sound ecological principles and shared by a body of dedicated range specialists in each of the countries. Gaining acceptance of such a doctrine, and building up such a body of specialists, then becomes the real objective of technical assistance in range management.

To evaluate the possibilities for expansion of range management horizons throughout the world, it is useful to think back to the early days of the range in the U.S.A. Since the turn of the century, our production and efficiency of use has increased tremendously. Far more important, however, has been the very great increase in the understanding and appreciation of the value and use of our range resources. Such an understanding could not have been achieved without the build-up of a body of range scientists and practical range managers dedicated to a common goal, and the formation of a philosophy of range management aimed at sound use of our grazing lands. It is this development that has been largely responsible for our progress, and will serve as the basis for future expansion.

Expanding Horizons in the Developing Countries

In most of the developing countries, the range problems are strikingly similar to those that faced the pioneer range men in western U.S.A. a half century ago. Governments still tend to take grasslands for granted and give them minimum consideration. No country has more than a handful of competent grassland scientists and their voices are seldom heard or heeded. The level of management is pitifully low but with the comparatively low prices received for livestock products and the difficulties of transport, intensive management is difficult to justify. Lack of understanding and support, and political expediency make it difficult or impossible to maintain the continued programs of investigation or regulation that are essential for progress.

There are additional obstacles. Ethnic tradition and religious dogma have resulted in grazing practices and ways of life that have gone unchanged for centuries and cannot be readily modified. Some of these traditional methods, it is true, have been established over generations as the best means of survival in a particular environment. To change them simply because they differ from our methods and without understanding the reasons for them can be disastrous. But they should be reevaluated in the light of present conditions to see if they still provide the best basis for management.

Range management problems differ from country to country. The American range technician assigned to Egypt's Western Desert, where annual rainfall averages less than four inches, will be faced with new and challenging situations and problems. He would find different, but no less difficult, problems on Guatemala's Pacific slope where annual rainfall exceeds 100 inches per year. Other range environments appear much more familiar. Parts of Iran's rangelands look much like those of Utah or Nevada. In Lebanon conditions are similar to California's Central Valley. Yet practices that are proven at home can seldom be transferred directly, but must be applied carefully with due regard to basic relationships.

Mediterranean and Near East.—In the Mediterranean and Near East, stretching from Morocco to Egypt, Greece, Turkey, and on through Iran and Pakistan, range livestock production has long been established as a way of life. In this great expanse of desert and semi-desert rangeland, over-stocking is almost everywhere. Recent evidence indicates that this overstocking began only in recent times and not centuries ago as had been assumed. Records show, for example, that in Baluchistan livestock numbers more than doubled between 1901 and 1951.[3] This being so, immediate action is necessary for it can no longer be said that the ranges have withstood abuse for centuries and will not deteriorate further.

Grazing is mainly in the hands of tribal leaders who seldom recognize either national boundaries or national authority. Tradition and the acceptance of livestock numbers as status symbols make change difficult. Nomadism has been accepted as the way of life that gives the best chance for survival under the rigorous climate and fluctuating forage supplies of the Near East. Un-

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[2] *Presently Project Manager, Pasture and Fodder Crops, Investigation Project, UNDP(SF), Tehran, Iran.*

[3] *Lodge, Robert W. 1965. Range management research in West Pakistan. FAO Report 1968.*

fortunately, nomadism also insures that practically each and every forage plant is closely grazed year after year, whenever it produces grazable herbage.

Many native plants have shown remarkable resistance to this abuse, but in recent decades pressures have increased. Water developments without corresponding grazing control have extended the areas of depletion. Animal health programs have helped to build up and maintain animal numbers. Emergency feeding programs are preventing some of the periodic decimation of herds and thus denying the rangelands even a few years of lightened stocking such as they formerly enjoyed following severe drought. And the increasingly widespread use of tractors has accelerated the misguided plowing of rangelands for marginal cereal production.

Opportunities for improved yields of livestock and livestock products are evident everywhere. Such seemingly obvious measures as culling nonproductive animals and improved and more timely marketing could probably reduce grazing pressures by 30% and double production almost immediately.

Throughout the area development of more supplemental forage and fodder supplies on cultivated lands, and closer integration of croplands and ranges is feasible and could contribute significantly to better yearlong nutrition of animals.

In short, great expansion of range livestock production throughout North Africa and the Near East is possible. The question is when and by what means it can be achieved.

Africa South of the Sahara.— In Africa south of the Sahara the situation is similar although prolonged heavy stocking has been confined to the savannah and drier areas, mainly on the northern parts and extending into the semi-desert. Progress in these zones, where domestic livestock have long been established, will depend on obtaining better management through grazing control despite tribal customs and traditions which tend to resist change. Antipathy and enmity between pastoralists and farmers runs high and impedes the correlation of effort and resources that offers the best hope for providing adequate yearlong forage.

The more humid areas of Africa are mostly understocked. However, disease problems which hindered livestock raising are now being solved, and there are vast areas where animal production could soon be the most important industry. Large game populations present a unique situation and domestic livestock and game will have to be carefully integrated. Fortunately, at least some of the governments concerned seem to recognize the need for starting on a sound basis and for providing the essential research, training, extension, and administrative institutions that will help insure logical development and the maintenance of the basic forage and soil resource.

Latin America. — Grazing of the extensive native grasslands began soon after settlement. Conditions vary tremendously from the semi-desert ranges of northern Mexico to the dry tropical grass and brushlands of Central America, Peru, northern Chile, and Brazil's northeast; to the savannahs and llanos of Venezuela, Colombia, the Guianas, northern Brazil and Paraguay; to the pampas of Argentina and Uruguay; and to the steppes of Patagonia. Cattle and sheep, mainly of European origin, have spread over this vast area and everywhere the combination of abundant land, poor transportation, undeveloped markets and low prices has led to build-up of livestock numbers and little regard for, or reward from, management of the livestock, of the range resource, or of the whole ranching enterprise. However, livestock production is of major importance and in many areas is the basis of the economy.

In recent years, mainly during the last decade, there has been a generally awakened interest in the possibilities of and the need for better range management. Natural conditions of climate, soils and vegetation are extremely favorable in much of the region. Some Government officials as well as ranchers are now recognizing the possibilities but there is little general understanding of the need for balancing livestock numbers with available forage supplies, the importance of adequate yearlong nutrition and other range and livestock management principles. Nevertheless, as in the Western United States when development was in a comparable stage, the possibilities for expanding production are great and change could be rapid. Considerable basic knowledge is available; it is beginning to be applied to local conditions and there is an awakening of the desire for higher returns through increased efficiency.

In the humid tropics of Central and South America livestock production is based primarily on grasslands established on land that was originally forest. Indigenous forage grasses are few and most pastures are composed of grasses naturalized from other parts of the world. Extensive and productive grazing lands have thus been established. Guinea grass *(Panicum maximum)*, Jaraguá *(Hyparrhenia hirta)*, Pará *(Brachiaria mutica)* and more recently Pangola *(Digitaria decumbens)*, have been introduced and are well established. In many cases management is fairly adequate and production is good.

Demand for animal protein is increasing throughout tropical America to meet the recognized need for more adequate nutrition and in response to a rising standard of living and an increased tourist trade. Also countries that have depended mainly on coffee, cocoa or bananas as a source of foreign exchange have been faced with saturated world markets and declining world prices. Among possible alternate export products, livestock is one of the most promising. Establishment of pastures for beef and dairy production is thus being stimulated. For example in Brazil, 900,000 ha of a total of 1,300,000 ha are being taken out of coffee production in the state of Paraná alone and most of this will go into grass. Similar programs are under way in Guatemala, El Salvador, Colombia and other coffee producing countries. Livestock development is being fostered and encouraged by Governments and doubtless will expand considerably.

Technical and Developmental Assistance

The diversity and complexity of many basic and interrelated problems of expanding range livestock development demand a broad scale attack that is beyond the resources of any developing nation. Group action and external assistance is essential.

The U.S. AID program and its various predecessor agencies have given a prominent place to range and pasture development in most of the more than 60 countries in which operations have been conducted. Other bilateral programs, notably those of France and Israel, have stressed range, ecology, livestock, and grassland aspects. Range management and related forage and fodder problems have received some attention from the large private foundations that operate in Latin America, Asia, and Africa.

Among the United Nations agencies, the Food and Agriculture Organization is primarily responsible for encouraging forage, fodder and livestock production and development. When it was founded 20 years ago, FAO was mainly a statistics gathering unit, seeking to level out shortages and surpluses of food and fibre throughout the world. The need for rendering technical assistance in agriculture to the member nations was recognized from the beginning, but it was not until 1950 that the Expanded Technical Assistance Program of the United Nations permitted help through sending subject matter experts, providing limited equipment and organizing training centers and fellowships. This program is being vigorously continued and the Pasture and Fodder Crops Branch has 23 EPTA experts in the field or under recruitment.

In 1958, to help low income nations speed their social and economic progress, the United Nations established a Special Fund. Of the 659 major Special Fund projects now in operation in 130 developing countries, 265 are operated by FAO. Pasture and fodder crop development is an important aspect in 23 national and 2 regional projects, with 44 experts in Vegetation Survey, Ecology, Range Management, Pasture Agronomy, Taxonomy, Physiology and similar fields.

Many important basic fundamentals and recent trends in the concepts and methods of how best to pursue development aid are exemplified by procedures followed in the Special Fund projects. These may be highlighted as:

1. Attack is centered on specific, clearly defined problems which are integrated with the larger development problem. Requests for assistance receive detailed review by high level boards using reports of well qualified consultants before being approved. Thus, their technical, economic, political and practical feasibility are carefully considered before operations begin.

2. A team approach is used to insure a rounded attack. A project that is primarily in the field of range development may have in the team, in addition to Ecologists and Range Management experts, an Animal Nutritionist, a Biochemist, a Soil Surveyor, a Farm Machinery Expert and an Economist. Advice in other fields is provided by short-term consultants. Most teams include scientists from three, four or more countries.

3. Equipment and materials required are specified in the plan, and are provided either by the Government or the Special Fund.

4. Every possible means is used to insure a lasting impact and continued development long after the project has concluded. Governments must indicate their genuine interest by providing a major portion of the total cost. Local counterparts are required to work closely with the foreign experts; they receive on-the-job training as well as study abroad to prepare them for continuing the work. Whenever possible, projects are planned to include or lead into pre-investment surveys for actual development.

Appraisal of Results of Technical Assistance

During the past 20 years under the various programs of FAO and other agencies, many worthwhile activities have been initiated. Trials and demonstrations of improved grazing management, range reseeding, fodder production, forage conservation, water and soil conservation and other practices have demonstrated the economic benefits that can result in many countries. Surveys have been made and action programs recommended.

Often these activities are well received and are accepted with enthusiasm by the Governments as well as by farmers and stockmen. But a case-by-case appraisal of the lasting results of technical assistance is likely to be disappointing. Too often programs fall apart soon after the foreign expert leaves. Reports and recommendations, sometimes several on a single problem in the same country, are forgotten and lost. In country after country, range study enclosures, species adaptability trials, even whole experiment stations are abandoned.

Thus, tangible results from foreign technical aid seem far from adequate, especially when judged by Western standards and in the light of the possibilities. There are, however, important intangible benefits. Not the least of these is an increasing awareness of the importance and value of well conceived, scientifically sound development plans for making better use of natural resources. This awareness may not yet be reflected by action programs but it is evident and is clearly growing. A scattering of scientists and technicians trained under technical assistance programs and convinced of the possibilities for progress are moving into positions of authority in their home countries. More and more of the top men in the Ministries of Agriculture; Department heads, Experiment Station Directors, Extension Directors and even some Deputy Ministers, not only have a technical understanding but also know their people—the villagers and the politicians—and know how to work with them. Requests for technical assistance are increasing.

Technical assistance has in the past often been sought as a way to obtain modern equipment or training junkets abroad or to develop ivory tower research institutes that contributed little except prestige. Now, more and more countries are focusing their attention on studies that will attract investment capital and on technical training and applied research that will bring quick results to bear on development needs. The developing countries themselves are quick to complain if assistance is not of top quality and are demanding that programs must promise early application and usable results.

This brings us to an important reason for the lack of follow-up action and the failure of past programs to make a lasting impact—shortage of funds. Private loans for livestock development, when available, cost in excess of 2%/month. Government loan funds are extremely limited. Doubtless in recognition of this, AID shifted its approach several years ago from technical to economic assistance, and emphasized the financial aspect of development. And in FAO, Director-General Sen recently wrote:—

"During the last few years, FAO has changed from a primarily technical organization to become one of the world's most important development agencies and is concentrating more and more on operational work. Out of some 65 million dollars to be spent this year through FAO, about 45 million dollars will be devoted to development operations". (Letter from Director-General Sen to Ministers of Agriculture, August 1965).

The change in emphasis is significant and important. It will undoubtedly reduce the losses caused by lack of continuity and will promote real development that increases production, raises the standards of living, and improves national income. By shifting assistance programs to meet the financial as well as technical needs of the developing countries we can hope for much greater success in the future.

However, the shift from technical to economic assistance can easily go too far. The need for a new approach can generate a sense of urgency and, as frequently happens, the old methods, both good and bad, may be cast aside for the new. Technical and economic development are both needed, and neither can be hurried. Continued and consistent effort is essential.

Unfortunately, consistency of action may often be ruled out by political expediency. A biologist can appreciate the frustration of having field activities stopped for political reasons, perhaps for only a few weeks but just at the time when cross-pollinations must be made, or yield data taken. Politicians, on the other hand, are seldom aware of biological laws when making their decisions.

In my experience, international agencies are in the best position to provide the many requirements of foreign aid. In a very real sense, FAO is the servant of its member governments. Therefore, political considerations do not form the basis for approval or denial, or continuing or breaking off assistance programs.

The professional staff of FAO includes representatives of 92 nations. It is a most gratifying and thrilling experience to work on a problem as a team member with scientists of half-a-dozen nationalities and to see how understanding and respect develop and differences in training and experience are used to advantage in solving common problems. Jealousies and frictions arising because of differences in origins are rare.

Working with a multi-national organization does present a challenge. Differences in approach, in work habits and methods and even in performance standards are real and can be frustrating. Much effort is being devoted to making FAO a more efficient organization.

Recruitment of well-qualified staff is a continuing problem. The range scientist in developing countries needs special qualifications. Good basic training, wide experience and mature judgment are the prerequisites but, beyond these, adaptability and imagination to adapt the principles and methods to widely different and often more rigorous ecological situations are needed. Just as important as technical qualifications is the ability to understand, respect and genuinely like people of other cultures. Good working relationships cannot be developed without these characteristics. Finally a nice sense of balance between patience and *laissez-faire*, between forceful insistence and compromise is invaluable. When, to all these requirements, the need for an understanding and sympathetic wife is added, our recruitment difficulties can be appreciated.

This is an appeal to American range men to weigh other than monetary rewards when considering an assignment with FAO. These include the opportunities to live in foreign lands and thus obtain a broader understanding of other peoples, and the satisfaction of tackling a job that is of the greatest importance to mankind.

Perhaps I have emphasized too much the frustrations of the FAO officer and the disappointing lack of tangible results. To some, it is these very difficulties that seem to present an irresistible challenge that, once faced, cannot be ignored. Beyond that, the foreign aid technician often has great freedom to select the best possibilities for success in a virtually untouched field. If, as a result of his knowledge, skill, and perseverance, success can be achieved, his efforts can be extremely rewarding. True, expected results may be realized less frequently than at home where more knowledge has been accumulated and work is highly organized, but one can seldom forget the tremendously greater possibilities for success on a really large scale.

Chances for Success

Some analysts believe that the limited success of aid programs in achieving the great social and economic goals that were hoped for is due to more basic deficiencies than have been generally recognized. These hold that the problem is neither technical nor financial, but cultural. Inevitably, people of developing countries have different aspirations, different impulses, different values from those who have gone through the political, economic, technical, and cultural revolutions that have been the history of the developed nations. They are beset by problems and often lacking in organization and skills to effectively confront these problems.

One overriding fact, however, must not be lost sight of: the immense urge and drive of underdeveloped countries to advance as rapidly as possible. This fact, despite traditional, economic, cultural, institutional, and other handicaps, gives cause for optimism and underscores the need for sustained effort on broad fronts, for better analysis and understanding of obstacles and for the services of the most capable technicians.

Perhaps by way of a summary it can be said that what has held back the expansion of range management abroad is the lack of a doctrine of range management such as we know it. Sustained progress demands faith in the knowledge that management of natural resources based on sound ecological principles will lead to fullest development and productivity. To establish such a doctrine and make its force felt in the developing countries can be done only through the local people. Our job, then, becomes one of using technical assistance to build up in each country a body of scientists dedicated to a philosophy of range management and use that will yield the "greatest good for the greatest number in the long run".

Journals and Reprints for Foreign Use

Dr. A. A. Beetle, Head, Range Management, University of Wyoming has agreed to serve in assembling copies and reprints of the Journal of Range Management for distribution to foreign universities, colleges and government departments interested in range management and improvement. Word has come from Latin America that such material would be very helpful in bringing about a better appreciation of range and its potentialities in those countries. The International Relations Committee has made available current or recent issues on many occasions, usually to individual visitors, here for training or other purposes.

It is hoped that many members of the American Society of Range Management would donate copies, either currently, or at their death, when such a proposal is called to their attention. Authors might donate a supply of reprints currently. Such gifts, of course, have value and could serve as deductible items for income tax purposes. Dr. Beetle's Section will receive, assemble, store and keep an inventory record of such material. Journals and reprints should be sent: care of Dr. A. A. Beetle, University Station, P. O. Box 3354, Laramie, Wyo. 82071.

Sixth World Forestry Congress

The Sixth World Forestry Congress was held in Madrid, Spain, June 6-18, 1966. There were 2,000 delegates, representing nearly 100 countries. The theme of the Congress was: "The Role of Forestry in the Changing World Economy". In some respects, this was a further expression of the concepts developed at the Fifth Congress in Seattle, 1960, on "Multiple Uses of Forest Lands". There were 10 Technical Commissions, none dealing specifically with Range Management. Several Commission sessions recognized the role of ecology, and in the National Park, Recreation, and Wildlife Session in particular, the nontimber values of both public and private forests were stressed. The conference as a whole called attention to the importance of tropical forests and the need for more attention in this area. The location of the Seventh Congress will be made public later by FAO. Informal invitations have been received from U.S.S.R., Argentina, and Chile. Tours before and after the Congress included forest and other land uses, and tourist interest in Spain, Portugal, and North Africa.—*Lloyd W. Swift*, Washington D.C.

Germination of Range Plant Seeds at Fixed Temperatures[1]

SIGMUND J. ELLERN AND NAPHTALI H. TADMOR
Department of Agronomy, Volcani Institute of Agricultural Research, Rehovot, Israel

Highlight

Low temperatures in the 4-10C (39-50F) range were found in the laboratory to delay germination of pasture plants, especially of perennial grasses. Analysis of meteorological data showed temperatures in this range to be prevalent during rainfall periods in the winter (sowing) season in Israel's semi-arid South, and they are considered a critical factor in seeding perennial grasses on arid range. Germination may be improved by agronomic measures, such as plant selection and breeding for cold resistance and seedling vigour, timing of seeding operations, and soil surface treatments to increase soil temperature.

In an arid environment, the establishment of plants otherwise adapted to climatic extremes often presents additional difficulties. The soil surface is wetted only infrequently, and the germinating seed as well as the developing seedling must compete for the rapidly diminishing moisture of the seedbed. Seedlings may be regarded as established only after their roots have reached the moist deeper soil layers. Where rainfall comes in the cool season (winter rainfall), low temperatures may further retard and adversely affect germination and seedling growth. This may have been the cause of frequent past failures in range seeding operations (Tadmor and Hillel, 1956; Negbi, 1957; Arnon, 1958).

There have been many studies on the temperature dependence of germination (reviewed amongst others by Lehmann and Aichele, 1931; Koller, 1955; Mayer and Poljakoff-Mayber, 1961). However, few were found relevant to the species studied in this work or to semi-arid environments (Koller and Negbi 1955; Koller, 1957). Most of the more relevant recent work has been reviewed by Dubetz, et al. (1962), who studied emergence from soil. The work of Went (1949) and of Jühren, Hiesey and Went (1953) was based on parallel field trials and controlled environment facilities designed to reproduce field conditions as far as possible. McGinnies (1960) studied the interaction of temperature and moisture stress as affecting germination of grasses.

The present paper summarizes data on the temperature dependence of germination for ten cool-season range plants and is part of a more general investigation of environmental factors bearing on establishment of these plants in semi-arid winter rainfall regions (Tadmor et al., 1964, 1965).

Materials and Methods

Soil temperatures were measured by the Israel Meteorological Service at Beersheba (long. 34° 48′ E; lat. 31° 15′ N; alt. 280m) in undisturbed soil at 2 and 5 cm depths, with Amarel bent-step mercury-in-glass thermometers at 3-hr intervals throughout the year since 1956. Data for the rainy (sowing) season were analyzed to determine temperatures employed in this study: 4, 10, 15, 20, 25 and 30C.

The seeds used were those of ten range plants suited to a semi-arid winter rainfall environment with wheat and barley for comparison: the perennial grasses *Agropyron elongatum* Host. P.B. (tall wheatgrass); *Agropyron desertorum* (Fisch.) Schult. (crested wheatgrass, vars. Fairway and Nordan); *Phalaris bulbosa* L. (hardinggrass, local ecotype); *Oryzopsis holciformis* (M.B.) Hack. (hairy ricegrass); and *Hordeum bulbosum* L. (bulbous barley); the annuals wheat *(Triticum aestivum* L. var. Florence Aurore), barley *(Hordeum vulgare* L. var. Beecher) and *Avena sterilis* L. (animated oats); and the annual legumes *Medicago hispida* Gaertn. (bur medic), *M. truncatula* Gaertn. (barrel medic) and *Trifolium purpureum* Loisel (purple clover). While no attempt was made at grading the seed, light or off-color seeds or empty glumes were eliminated as far as possible. Of *Avena sterilis*, only the two lowermost seeds of the spikelet were used after separation from each other and removal of the awns. Seeds were stored in the laboratory at room temperature prior to the experiment.

Seeds were germinated in 9-cm petri dishes, on one layer of filter paper equivalent to Whatman No. 3. 3 ml of tap water were added on zero day and 2 ml more on zero + 2 day. There were 50 seeds in each dish, with 4 replicates, except for the larger-seeded *Avena sterilis*, of which 25 seeds were placed in each dish, with 8 replicates.

Germination was carried out in humidified incubators at temperatures held constant to within ± 0.8C, in the dark except for daily germination counts made in daylight. Counts were terminated on the 30th day or after no further germination had occurred for 7 days. Two parameters were used for analysis: days to "onset" of germination, defined as the day on which 10% of final (30-day) germination was reached; and days to "full" germination defined as the day on which 80% of final germination was reached at any one temperature. In addition, mean days to germination (M.D.G.) were calculated, following Gassner as cited by Lehmann and Aichele (1931, p. 306). This is, in fact, the reciprocal of Kotowski's (1926) coefficient of velocity, and calculated as $\frac{\Sigma(n.Dn)}{\Sigma n}$, where Σn is the total

[1] *Research financed in part by a grant by the U.S. Department of Agriculture under P.L. 480, contract No. A10-CR-45. Contribution from the National and University Institute of Agriculture, Rehovot, Israel, 1965 Series, No. 945-E. Grateful acknowledgment is made to the Israel Meteorological Service for soil temperatures and rainfall data from Beersheba and to Miss Ruth Hofbauer for help in the laboratory; also to Dr. W. Heydecker of the University of Nottingham School of Agriculture for kindly commenting on the manuscript.*

number of seeds germinated, n the number of seeds germinated on any one day, and Dn the number of days elapsed on that day since zero day (of wetting).

The effect of ageing of seeds and after-ripening on germination was not studied in this work. Seeds were normally tested one year, and at the least several months, after harvesting. While Harper (1964) has drawn attention to the significance of seed polymorphism in relation to bulking seed lots for germination experiments, this problem has not been dealt with.

Results

The analysis of rainfall and soil temperature data obtained for the rainy season at 2-5cm depths (Tadmor et al., 1964) showed daily mean temperatures to be often in the 8-20C range. Daily maxima in dry periods reached 30-35C and on clouded or rainy days dropped to 10-12C or less. Daily minimum temperatures were mostly in the 4-10C range and minima of 2-4C were by no means rare. Monthly means for minima ranged from 5-10C, for maxima from 15-30C and for daily means from 10-20C. These data guided the selection of temperatures employed in germination.

Days to onset of germination.—The data for onset of germination are presented in Fig. 1 and 2. The perennial grasses except for *Hordeum bulbosum* and the annual *Avena sterilis* were retarded by low temperature (4-10C). The majority of the annuals and the perennial grass *Hordeum bulbosum* were, on the contrary, hardly retarded by these temperatures; and while *Hordeum bulbosum* was retarded by high temperature (25-30C), wheat, barley, the *Medicago* spp. and *Trifolium purpureum* were relatively unaffected by temperature extremes.

Full germination.—Fig. 3 and 4 show that as in onset the perennial grasses were retarded by the low temperatures (4-10C). *Avena* and *Hordeum bulbosum* were highly sensitive, being retarded by both the high (25-30C) and the low temperatures. The two *Medicago* spp. were retarded by the high temperatures. Wheat, barley and *Trifolium purpureum* were less sensitive.

Mean days to germination (M.D.G.).—As might have been expected, the data for M.D.G. (Fig. 5 and 6) agree well with those for onset and full germination. The behavior of species is practically identical for full germination and M.D.G.

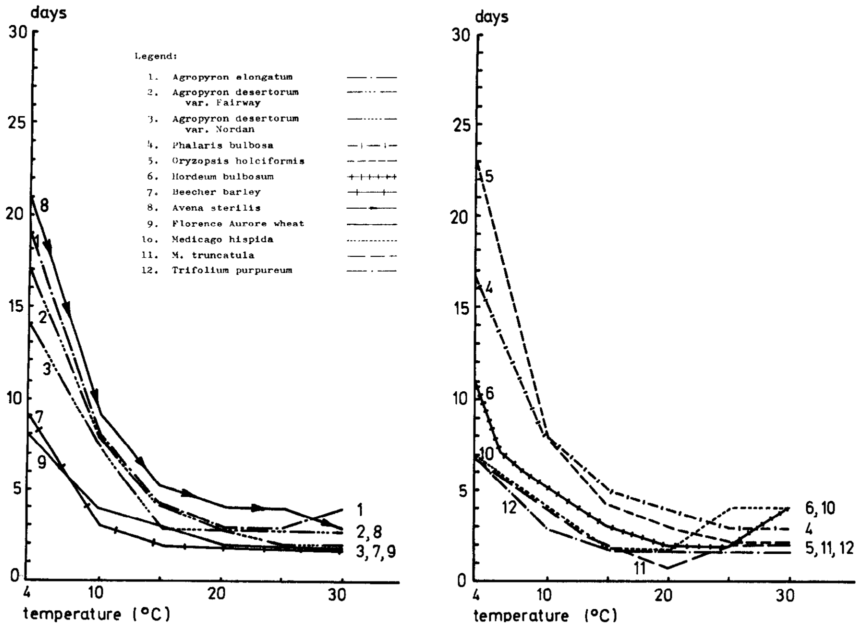

FIG. 1 (left) and 2 (right). Days to onset of germination (10% of final germination) as a function of temperature.

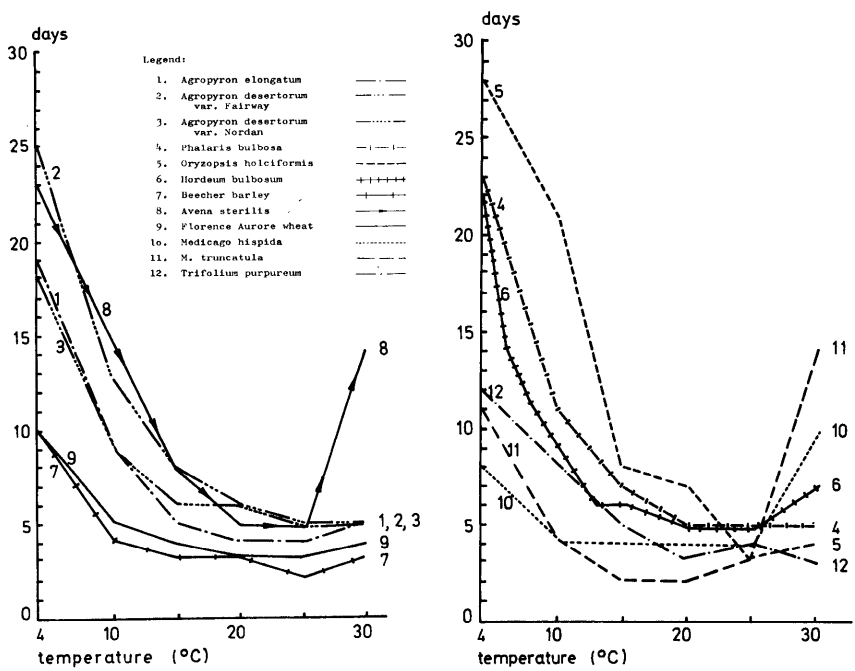

FIG. 3 (left) and 4 (right). Days of full germination (80% of final germination) as a function of temperature.

Final germination.—There was no clear optimum temperature range for final germination (at 30 days) in six of the species studied once the time factor was eliminated (Fig. 7). This agrees with Harrington (1963). Nevertheless, final germination percentage shows clearly the unfavorable effect of 4C and especially of 30C on the germination percentage of some of the species, including *Trifolium purpureum,* which was so consistent in its relative indifference to temperature extremes regarding its time to germination.

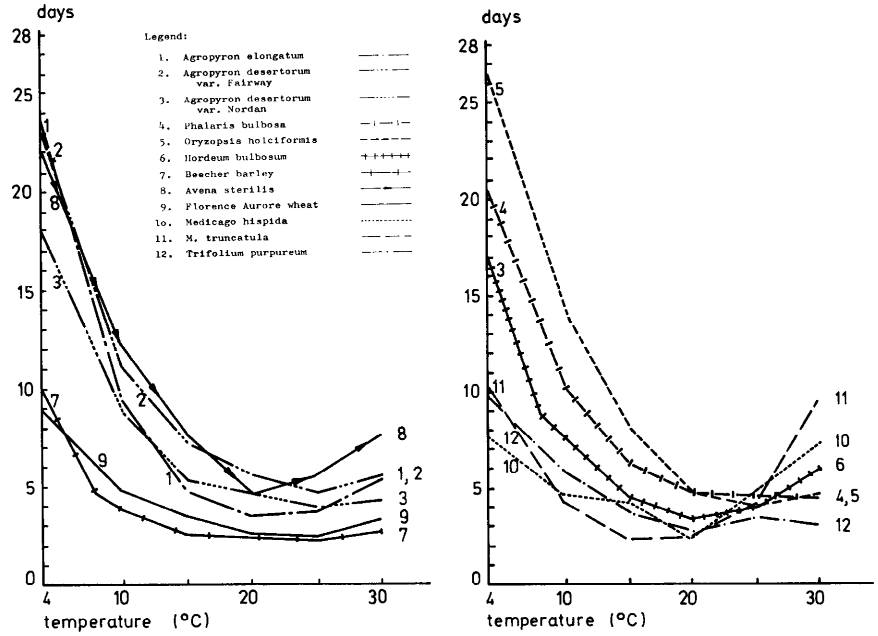

FIG. 5 (left) and 6 (right). Mean days to germination (M.D.G.) as a function of temperature.

Discussion

The speed with which range plants germinate may be the critical factor in establishment under the seedbed conditions prevailing in a semi-arid environment. Low temperatures in the 4-10C range, which are of frequent occurrence during the rainy (sowing) season in the Negev markedly retarded onset and full germination of all the perennial grasses investigated, except onset of *Hordeum bulbosum.* The annuals, both gramineae (except *Avena)* and legumes were less adversely affected by low temperatures. Past failures of the cold-sensitive species in seeding operations may be explained by this germination behavior. Low temperatures may have slowed germination to such an extent that the seedbed dried out and the seeds lost their viability prior to emergence. Possible causes of failure to emerge are discussed by Leslie (1965). This contrasts with the germination behavior of the crop plants such as barley and wheat, which were not markedly retarded by low temperatures.

Although it may sound odd, range plant improvement for successful establishment should aim at plants able to germinate and develop rapidly at low temperatures in order to withstand a hot dry climate. A parallel exists in recent work attempting to incorporate the low temperature growth ability of Mediterranean into British grass strains for "early bite" (Morgan, 1964).

Another, more short-term approach to ensuring establishment may be to alter seedbed temperatures by soil surface treatments and other agrotechnical means (Bement et al. 1961). This seems to be a prerequisite to successful seeding under present conditions. Work on this point is in progress and preliminary results are promising (Cohen et al. 1965).

Eight of the species were sensitive to the high temperatures normally encountered in the seedbed only in early and late winter (November and March). High temperatures should therefore not be limiting if sowing is suitably timed. While both the low (4-10C) and the high (25-30C) temperatures adversely affected germination, the low temperatures delayed germination rather than depressing germination percentage. Thus, even at 4C *Oryzopsis holciformis* germinated, but only reached "onset" on the 23rd and "full" germination on the 28th day (Fig. 2 and 4). While by the 30th day "final" germination percentage was below 20% at 4C as compared with over 60% at 10C (Fig. 7), even at 4C, germination eventually reached 60% if counts were continued beyond the 30th day.

The high temperatures, on the other hand, depressed germination rather than delaying it. They hastened or did not delay onset of germination (Fig. 1 and 2). Full germination of species sensitive to the high temperatures such as *Medicago* was much less delayed by the high temperatures (25-30C) than full germination of the cold-sensitive perennial grasses by the low temperatures (Fig. 3 and 4). The adverse effect of high temperature (30C) was most marked in depressing final germination percentage of *Hordeum bulbosum* and *Trifolium purpureum* to well below 10%. This difference between the effect on germination of low and of high temperature, noted also by McGinnies (1960), does not seem to have received sufficient attention. Otherwise, our data are in general agreement with previous studies (Lehmann and Aichele, 1931; Dubetz et al. 1962; Harrington, 1963). Low germination of *Avena sterilis* may have been due to dormancy. As reported elsewhere (Tadmor et al. 1965), piercing the seedcoat of ungerminated grains remaining on the 30th day, as described by Thurston (1957) resulted in almost all tests in additional germination by the 50th day.

The concepts of time to "onset" and "full" germination were employed in analysis of the data, since the time factor seemed of overriding importance in discussion of temperature dependence of germination in a semi-arid environment. The method was adapted from Koller (1957) and compares well with other forms of presentation. The choice of 10% of final germination for onset and 80% for full germination is arbitrary. 10% rather than 20% of final germination was chosen for onset because of the positive skewness of the daily germination curve (Hepton, 1957). It is important to distinguish here between "time to germination" and total or "final" germination percentage. Time to germination is the more important in this context. As shown by the low final germination percentage of *Hordeum bulbosum* and *Trifolium purpureum* at 30 C (Fig. 7) and as stated by Heydecker (1960), speedy germination does not necessarily coincide with high germination percentage. Mean days to germination (M.D.G.) were calculated for the analysis of our data following Harrington (1963). This parameter was more comparable to days to onset and full germination than Kotowski's (1926) coefficient of velocity used by Heydecker (1960) and Dubetz et al. (1962). M.D.G. has the advantage over onset and full germination of one single parameter integrating the time and quantity components of germination and hence giving smoother graphs. On the other hand, the problem referred to by Heydecker is not resolved. Final germination percentage in our data is not at all consistent with the time-dependent parameters (onset, full, M.D.G.) and there may be no alternative to using both together in evaluating germination (Dubetz et al. 1962).

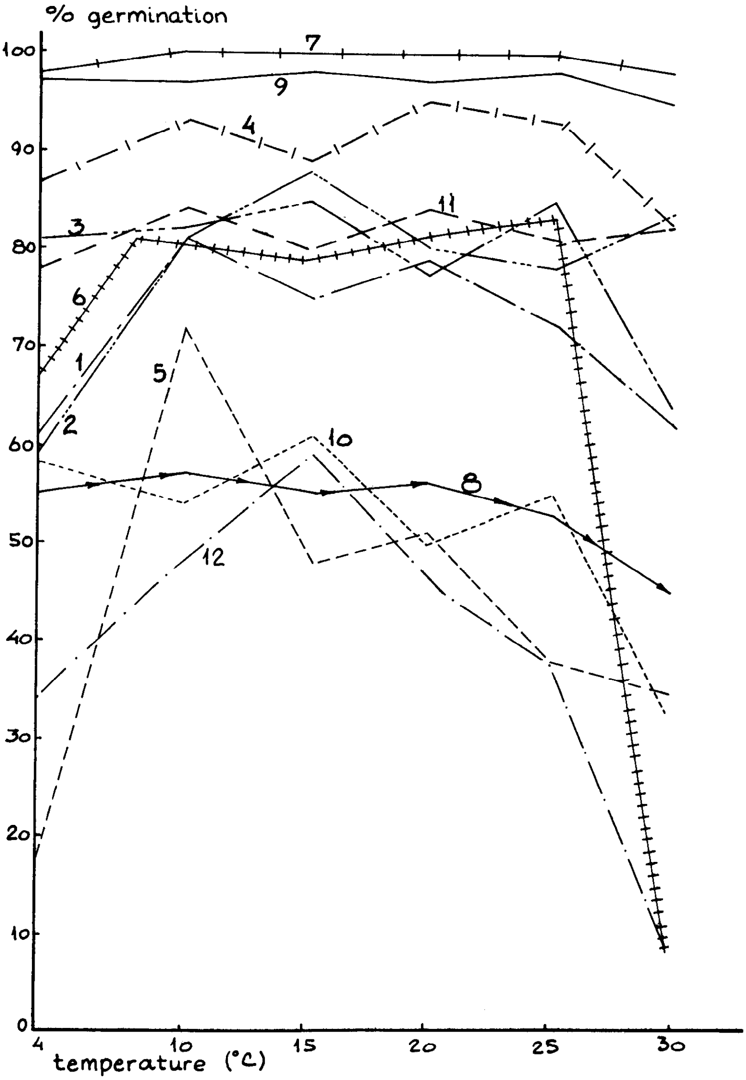

FIG. 7. Final percent germination as a function of temperature.

Summary and Conclusions

Ten range plants, with wheat and barley for comparison, were germinated at fixed temperatures of 4, 10, 15, 20, 25 and 30 C. The germination of the perennial grasses was markedly retarded by low (4-10 C) temperatures, whereas the annuals (except *Avena sterilis)* were much less sensitive to temperature extremes. As low temperatures frequently prevail during the sowing season in semi-arid winter rainfall regions, this is a critical factor in seeding operations. Plant breeding and selection as well as agronomic measures, such as adjusting seedtime and especially soil surface treatments to raise seedbed temperatures, are necessary to hasten germination and establishment of perennial grasses during the wet and cold winter months.

High temperatures (25-30C) had a less adverse effect on germination although they affected eight of the species. They should

not adversely affect suitably timed seeding operations.

The usefulness of parameters other than final percent germination is discussed in evaluating germination data for semi-arid range plants.

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Cassady to FAO Assignment in Kenya

John T. Cassady left the Southeastern Forest Experiment Station and the Forest Service on August 1 to accept an assignment with the Food and Agriculture Organization of the United Nations in Kenya.

John is a charter member of the American Society of Range Management and is truly the "Father of the Southern Section." He organized the Section in 1951 and was elected as its first Chairman in 1952. He wrote the guidelines for our first constitution and bylaws and also wrote the Section history in 1957. He nursed the Section along through the critical early years and has always given a helping hand year after year. Happily he will continue as a Section member while in his new job.

John wrote this about his new assignment: "I am being appointed as Agricultural Officer (Range Management and Ecology). My work will be in the Plant Production and Protection Division, Food and Agriculture Organization of the United Nations. I will be conducting research as a member of a research team made up of a Wildlife Biologist, Plant Physiologist, Bush Control Specialist, and a Livestock Specialist. I will hold down the Range Management spot.

"The team will undertake studies of grazing management that involve rotational systems of grazing, stocking rates, joint use between cattle, sheep, goats, as well as wild ungulates, range improvement, bush control, and the use of fire in grazing management.

"The assignment is expected to last about three years. We will work with local specialists, training them to take over the work when we leave."

John is seriously interested in forming a Society Section in Kenya. His new address is: c/o UNDP, P.O. Box 30218 Nairobi, Kenya.

Rainfall Effects on Soil Surface Characteristics Following Range Improvement Treatments[1]

DAVID R. KINCAID AND GERALD WILLIAMS

Research Botanist and Agricultural Research Technician, Southwest Watershed Research Center, Agricultural Research Service, U. S. D. A., Tucson, Arizona.

Highlight

Range improvement treatments—brush clearing, pitting, and seeding to grass—were imposed on twenty-four 6 by 12-foot plots near Tombstone, Arizona. One summer's rainfall of average amount and intensity reduced roughness due to pitting; and such other surface characteristics as erosion pavement and exposed soil approached a state of stability similar to the untreated plots. Surface runoff exhibited little correlation with treatment, but showed a statistically significant negative correlation with crown cover of vegetation.

In the semiarid Southwest, rainfall is too little in amount and uncertain in distribution to maintain vegetation that adequately protects the soil. Rainfall often occurs in severe storms that produce large volumes of surface runoff and cause serious erosion.

Because of the sparsity of vegetation, soil surface conditions become important in the infiltration-runoff balance. The purpose of this study was to determine effects of seasonal rainfall on soil surface characteristics after various treatments used in range reseeding and improvement, and to evaluate possible effects of range conservation practices on water yield.

In a range conservation program, brush control and reseeding of grasses in cleared or depleted areas, together with soil treatments that impede runoff and help establish reseeded grasses, are important measures. Although more or less successful methods of reseeding semidesert rangelands have been worked out, few data are available showing how such induced changes in vegetation affect yields of water and sediment. Also, although benefits from range management have been amply demonstrated, few experimental data are available that show the length of time required for stabilization of the soil surface after pitting, contour furrowing, or brush removal.

Caird and McCorkle (1946), working in grassland areas of Texas, found that contour furrows in rangeland functioned from four to seven years, during which a twofold increase in forage production was noted. On the other hand, Valentine (1947) found that certain structures, such as widely spaced terraces, brush dams, and contour structures, intended to conserve runoff from semidesert rangeland in New Mexico, did not improve vegetation cover.

Many studies draw attention to the importance of vegetation in reducing runoff. Duley and Kelly (1939) reported that vegetational cover and litter have a greater effect on infiltration rates than slope, intensity of rainfall, or soil type. Rauzi (1960) indicated that, regardless of soil type, water-intake rates depend on the type of plant cover, the amount of standing vegetation, and the amount of mulch material on the ground. Beutner and Anderson (1942) found that mulch and grass cover decreased surface runoff as much as 20 to 60%.

The literature indicates that the surface layer of the soil is usually the most important factor in water intake. Alteration of the surface by pitting, contour furrows, etc., to allow longer infiltration opportunity, usually increases water intake for a time; but without adequate vegetation cover, compaction from raindrops causes puddling, lessening infiltration rates and increasing runoff (Stallings, 1952; Ellison, 1945; 1949).

Several investigators have used microrelief meters to measure changes in soil surface characteristics (Kuipers and van Ouwerkeck, 1963; Burwell, 1964; Mesavage and Smith, 1962; Subcommittee, Range Research Methods, 1963). All of these relief meters are based on the same principle. A frame is placed over the area to be measured, and sliding pins are dropped through it to the soil surface. A measurement board behind the tops of these pins allows direct reading of ground elevations, and microrelief may be determined from these readings.

The principal objective of this study was to investigate changes in the soil surface resulting from one summer rainy season following brush removal, pitting, seeding, and combination of these treatments. Subordinate objectives were to investigate:

1. Relations of soil surface characteristics resulting from these treatments to on-site runoff.
2. Influence of treatment on soil movement.
3. Influences of vegetational cover on rainfall-induced changes of the soil surface.
4. Relation of on-site runoff to vegetational cover.

Study Area and Methods

The area selected for the study lies within the Walnut Gulch Experimental Watershed, a 58-square-mile watershed surrounding Tombstone, Arizona, where the Agricultural Research Service of the U. S.-

[1]*Contribution from the Southwest Branch, Soil and Water Conservation Research Division, ARS, U. S. D. A., in cooperation with the Arizona Agricultural Experiment Station.*

D. A. is conducting hydrologic research.

Average annual precipitation is approximately 14 inches, of which about 60% falls during convectional thunderstorms in July, August, and September. With rare exceptions, these are the only storms that produce runoff. The remaining 40% falls as rain or snow resulting from low-intensity, frontal storms, most of which occur during the winter months.

The study site was selected for uniformity of soil, slope, aspect and vegetation. The soil, a gravelly sandy loam, was derived from a calcareous base material. Texture to a depth of 4 inches is approximately 55% gravel, 33% sand, 5% silt, and 7% clay.

Vegetation of the site was comprised mainly of shrubs: whitethorn *(Acacia constricta* var. *vernicosa)*, creosotebush *(Larrea tridentata)*, tarbush *(Flourensia cernua)*, and scattered plants of a few others. Although grass plants were sparse, there was some black grama *(Bouteloua eriopoda)*, bush muhly *(Muhlenbergia porteri)* and fluffgrass *(Tridens pulchellus)*.

Twenty-four 6- by 12-ft plots, established before the summer rainy season of 1963, were left untreated until January 1964. Each plot was bordered by a partially buried, galvanized plate. Runoff from the plot was diverted into two 55-gallon covered containers, and the collected water was measured after each storm. Two plots were equipped with water-level recorders to determine time and rate of runoff. Rainfall was measured with a recording rain gauge near the center of the site. The imposed treatments, replicated three times in a randomized factorial arrangement, comprised seeding to grass, clearing of brush, and soil pitting, alone and in all the possible combinations. As a check, three plots were untreated. Clearing of brush was accomplished by manually uprooting all shrubs with the least possible soil disturbance. Pitting, to simulate that done with an eccentric disk, was done with a shovel. The soil was turned downslope, leaving a pit 6 inches deep and 4 ft long. The pits were about 2 ft apart, arranged across the plot on the contour. For seeding, native hay was spread on the plot and then raked to cover the seed. The hay was left on the plot as a mulch. A fairly good stand of native perennial grasses was established the first year.

Surface characteristics and vegetational cover were measured with the microrelief meter in June and in September 1964, before and after the summer rains. Characteristics recorded were: (1) microtopography, or roughness of the soil surface; (2) erosion pavement (particles 2 mm in diameter or greater); (3) exposed soil (particles less than 2 mm in diameter); (4) litter; (5) crown cover of vegetation.

The relief meter used in this study consists of a plot frame, meter frame, measurement board, and 11 sliding pins (Fig. 1). The plot frame is an angle-iron frame placed around a plot. The plot frame rests on mounts, parallel to the soil surface.

The meter frame is placed across, and perpendicular to, the plot frame. There are 23 positions at 0.5-ft intervals along the plot frame.

The meter frame contains 11 pins spaced at 0.5-ft intervals across the plot. Thus, there is a total of 253 point measurements for each 6- by 12-ft plot.

To determine microtopography, or roughness, elevation of each pin was read from the measuring board when the point of the pin touched the soil surface. From the 253 readings, the "roughness index" was determined. As the plot frame was parallel to the ground surface at the edges of the plots, the datum surface from which point readings were made was essentially parallel to the plot surface. The statistical variance, which depends on the deviations of the points from their mean, is used as the index of roughness. The variance was arrived at by using the formula:

$$s^2 = \frac{\Sigma X_i{}^2 - \frac{(\Sigma X_i)^2}{n}}{n-1}$$

where: s^2 = variance

X_i = each relief meter elevation reading

n = number of measurements (253).

From the statistical equation $s^2{}_1/s^2{}_2 = F$, it is possible to determine whether there exists a difference (or if a significant change took place) in the "roughness index" during the summer. In the formula, the numerator is the larger of the two roughness indices determined for each plot.

For determination of the other characteristics, the microrelief meter was used as a point-quadrat frame. When the pins were lowered to the soil surface to make the elevation readings, the object touched by the pin point was recorded and the percentage of the ground occupied by that characteristic was calculated.

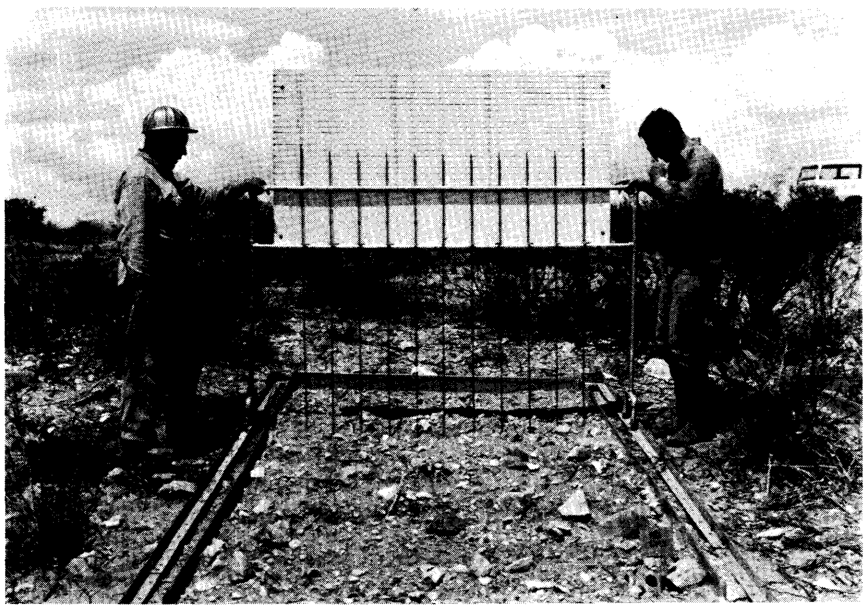

FIG. 1. Reliefmeter in place on a cleared, pitted, and seeded plot. Measurement being made prior to onset of summer rainy season 1964.

Table 1. Runoff (inches) by treatments from convective storms as affected by treatments.[1]

Date (1964)	Rainfall (inches)	Control	Clear	Pit	Clear, Pit	Seed	Clear, Seed	Pit, Seed	Clear Pit, Seed	Mean
July 14	.37	.054	.086	.018	.020	.017	.036	.018	.018	.033
July 23	1.49	.358	.485	.262	.456	.217	.463	.209	.304	.344
August 1	.52	.195	.267	.183	.222	.123	.180	.126	.165	.183
August 9	.62	.109	.168	.085	.166	.043	.104	.060	.079	.102
August 17	.82	.435	.535	.398	.516	.231	.372	.242	.410	.392
September 9	1.00	.384	.540	.430	.561	.137	.296	.213	.299	.358
September 10	1.02	.388	.400	.356	.475	.209	.346	.238	.389	.350
Total	5.84	1.923	2.481	1.732	2.416	.977	1.797	1.106	1.664	1.762

[1] Runoff figures larger than the mean of all plots are underscored.

When a plant was struck by the point, the scientific name was recorded. If in its descent the pin struck the aerial portion of a plant, the height of the pin on the measurement board was recorded along with the species name. An analysis of variance was made on each group of plots containing the same treatment to determine whether a statistically significant change, related to the characteristic studied, had occurred.

Table 2. Changes in roughness index during summer 1964.

Treatment	Pooled s^2 before summer rains	Pooled s^2 after summer rains	Change in s^2	Percentage change in s^2	F[1]
Control	33.98	30.83	− 3.15	9.27	1.10
Clear	41.18	32.65	− 8.53	20.71	1.26**
Pit	92.80	53.92	−38.88	41.90	1.72**
Clear, Pit	117.96	55.42	−62.54	53.02	2.13**
Seed	25.42	28.23	+ 2.81	11.05	1.11
Clear, Seed	11.07	12.01	+ 0.94	8.49	1.08
Pit, Seed	100.14	78.52	−21.62	21.60	1.28**
Clear, Pit, Seed	96.30	55.08	−41.22	42.80	1.75**

** Change significant at the 1 percent level.

[1] F is the ratio $\frac{s^2 \text{ larger}}{s^2 \text{ smaller}}$. With pooled s^2 of three replications, there are 756 degrees of freedom per treatment. For significance at the 1 percent level, F must be 1.22; at the 5 percent level, 1.16.

Results

The study site received 7.65 inches of precipitation between July 10 and September 13, 1964. Of this amount, 5.84 inches fell during seven runoff-producing storms (Table 1). These seven storms yielded almost 2 inches of surface runoff from the untreated plots.

One season's data on surface runoff show little correlation between runoff and treatment (Table 1). Plots that were pitted and/or cleared had generally more surface runoff than plots that were seeded. Reduced runoff seemed to be related to the pitting treatment in the earlier summer storms, but later in the summer pitting was related to increased runoff.

Microrelief

Response of surface roughness (microrelief) to 1964 summer rainfall relative to treatment is presented in Table 2 as roughness indices. Each index is the mean of those from the three replications of the treatment. The response varied from statistically nonsignificant changes in the untreated, the seeded, and the cleared and seeded plots to statistically highly significant changes in the plots of the other treatments.

Control.—The untreated plots showed a slight, nonsignficant decrease in surface roughness.

Cleared. — The cleared plots showed that summer rains caused a significant decrease in roughness.

Pitted.—Roughness of the pitted plots before the rainy season was nearly three times that of the untreated plots. After the rains, it had been reduced by 42%, but it was still much higher than that of the untreated plots.

Cleared and Pitted.—The combination of pitting and brush removal left the plots of this treatment with a higher roughness index than that of any other treatment. In the fall, however, this had been reduced to a value comparable to that of the "pitted only" plots.

Seeded.—The seeded plots increased in roughness, but the increase was not statistically significant.

Cleared and Seeded. — The cleared and seeded plots were initially the smoothest of all treated plots. The summer rains had a slight roughening effect.

Pitted and Seeded.—Initially, pitting and seeding in combination left the plots very rough. Although there was a significant

Table 3. Soil surface materials before and after summer rains (Percent soil cover).

	Erosion Pavement (Rock 2mm or more)			Soil (Less than 2mm)			Vegetation[1] (at ground level)		
Treatment	Before	After	Change	Before	After	Change	Before	After	Change
Control	57	59	+ 2	30	26	− 4	13	15	+ 2
Clear	57	57	no change	39	31	− 8**	4	12	+ 8**
Pit	38	54	+16**	54	34	−20**	8	12	+ 4**
Clear, Pit	54	64	+10**	44	29	−15**	2	7	+ 5
Seed	62	64	+ 2	16	22	+ 6**	22	14	− 8**
Clear, Seed	65	70	+ 5	21	25	+ 4**	14	5	− 9**
Pit, Seed	44	62	+18**	37	28	− 9	19	10	− 9**
Clear, Pit, Seed	43	54	+11**	42	36	− 6	15	10	− 5**

[1] Includes basal cover, prostrate plants and litter.
** Change significant at the 1 percent level of probability.

smoothing of the plots, it was less than other plots included in the pitting treatment.

Cleared, Pitted, and Seeded.— Reduction of roughness in the plots that were cleared of brush, pitted, and seeded was comparable to the plots that were pitted only. They decreased in roughness more than the pitted and seeded plots, but less than the cleared and pitted plots.

Changes in Soil Surface Characteristics

Response of soil-sized particles at the surface and of basal cover of vegetation to the summer rains varied with treatment (Table 3). In the untreated plots, no statistically significant changes in erosion pavement, soil-sized particles or basal area of vegetation were observed. On the plots cleared of brush, there was no change in erosion pavement, but the percentage of soil particles under 2 mm decreased and litter increased by statistically significant amounts. On the pitted plots and those pitted and cleared, erosion pavement increased and percentage of particles less than 2 mm decreased by statistically highly significant amounts.

At the end of the summer rains, seeding alone, and in all combinations of treatments, was accompanied by a statistically significant decrease in litter. This was probably due to the removing of mulch litter through overland runoff.

Table 4. Reduction in soil volume in ft^2 upper and lower halves of the study plots[1].

Treatment	Upper half	Lower half	Diff.
Control	0.73	1.23	+ .50
Clear	0.52	1.19	+ .67
Pit	1.10	1.45	+ .35
Clear-Pit	1.60	1.53	− .07
Seed	1.14	1.41	+ .27
Clear-Seed	1.25	1.21	− .04
Pit, Seed	1.95	2.04	+ .09
Clear-Pit-Seed	1.02	.67	− .35

[1] Based on elevation change of each half plot.

Effect of Treatments on Soil Movement

Numerous studies have shown a direct relation between degree and length of slope and the force that water can exert on the eroding surface. The longer the slope, the greater is the amount of erosion or soil loss. The study plots were measured to determine the elevational change of the soil surface following summer rains and to compare the amount of erosion on the upper and the lower half of each plot. The results are presented as the mean values of the three replications of each treatment (Table 4). Under four treatments—the control plots, the cleared plots, the pitted plots, and the seeded plots—erosion on the lower half of the plot was considerably greater than that on the upper half. On the plots that were cleared and pitted, cleared and seeded, or pitted and seeded, it was nearly equal on the two halves. In contrast, erosion on the upper half of the cleared, pitted, and seeded plots was considerably greater than that on the lower half.

Crown Cover Effects

Runoff values per storm were compared using an analysis of variance appropriate to factorial experiments. Although the clear and seed treatments appeared to have affected runoff, inter-replication variation was such that significance could not be established.

The nonsignificant effects of treatment, coupled with the tendency for plots where cover was increased (by seeding) to have less runoff, and plots where cover was decreased (by clearing) to have more runoff, indicated that some characteristic of the plot not brought about by treatments might be important. It appeared that crown cover of vegetation could be more closely associated with runoff than could treatment effects.

Relation of Crown Cover and Surface Runoff. — A linear regression analysis was used to compare mean runoff (Table 1) with percent crown cover. The crown cover was taken as the mean of the measurements before and after the summer rainy season (Table 5). Also, an analysis

Table 5. Changes in vegetation crown cover (percent) summer 1964.

Treatment	Before	After	Mean	Incr.
Control	16.7	36.6	26.7	19.9
Clear	0.5	16.8	9.7	16.2
Pit	10.8	27.9	19.5	17.1
Clear-Pit	0.1	14.6	7.4	14.5
Seed	8.8	44.6	26.7	35.8
Clear-Seed	0	30.8	15.9	30.8
Pit-Seed	7.8	38.6	23.2	30.8
Clear-Pit-Seed	0	33.2	16.6	33.2

was made of the relation between runoff from the storm of September 9, 1964, and the percent crown cover, using the measurements near the time of the storm (at the end of the rainy season). Linear regressions for this comparison showed a high negative correlation between crown cover and runoff, indicating that a decrease in rain-site surface runoff was related to increase in crown cover (Fig. 2 and 3).

Relation of Crown Cover and Microrelief Smoothing.—Percent crown cover was compared to the percent of microrelief smoothing, using data from the 12 plots containing a pitting treatment either alone or in combination with other treatments. These plots were chosen because of the larger microrelief index, which would reflect a change due to rains more readily than would plots having a small microrelief index. Some negative correlation exists between these two factors though it was not found to be statistically significant.

Summary and Conclusions

Much evidence is available on benefits of range conservation treatments, but few experimental data are available on adjustments of the soil surface after such treatments. The purpose of this study was to determine effects of rainfall on soil surface characteristics after various treatments used in range improvement.

The study after one season indicates some of the relationships between soil surface characteristics, range improvement treatments, and crown cover of vegetation on the one hand, and runoff generation and soil erosion on the other. The observed runoff and soil erosion resulted from summer rainfall of about average amount and intensity.

Microrelief Changes. — Before any treatment, the soil surface had become relatively stable, and the summer rains had no significant effect on surface roughness. Change in microrelief appeared to vary with the treatment practice or combination of practices. The plots with large roughness indices following treatment showed greater smoothing by the first season's rainfall than plots with small initial roughness indices. This was due, apparently, to their greater potential for smoothing or microrelief change.

Plots with a combination of seeding and any other practice or practices had smaller microrelief changes following the treatment than plots with the same treatment practices without seeding. This may be a result of the prior smoothing effect of the seeding treatment, as well as later protection of the soil surface by grass.

Changes in Soil Surface Characteristics. — The control plots represent approximate equilibrium with the environment. The pitted plots had soil exposed on the surface which was washed away by the summer rains. The mulch-seeded plots showed a decrease in litter, possibly because of the washing away of litter and uncovering of erosion pavement or soil. From the similarity in erosion pavement and exposed soil on all plots, it appears that

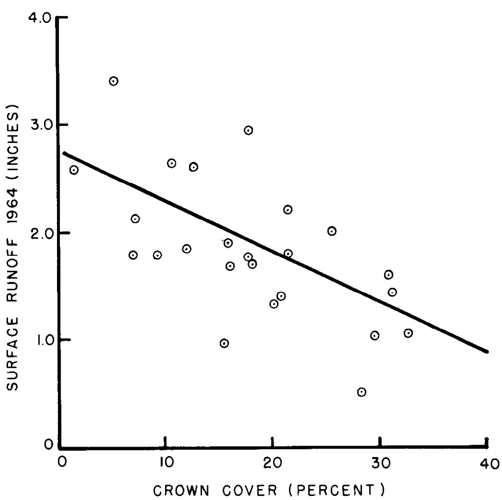

Fig. 2. Relation of crown cover to surface runoff. Total runoff for 8 storms *vs.* crown cover (the mean of measurements made in June and September 1964) (r = –.637**).

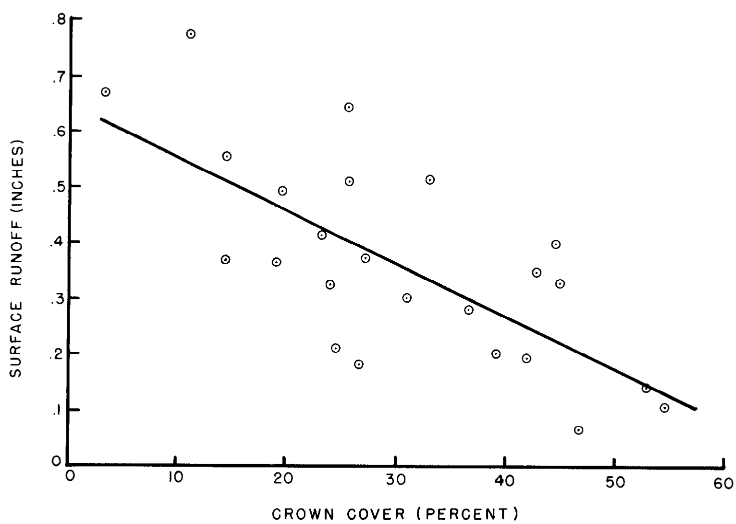

Fig. 3. Relation of crown cover of vegetation to surface runoff. Storm of September 9, 1964 (r = –.717**).

these surface characteristics stabilize after one summer's rainfall.

Soil Movement on the Plots.—Generally, the lower half of the 12-ft-long plots underwent more erosion than the upper half, possibly owing to increased velocity and quantity of surface flow on the lower half. The cleared, pitted, and seeded plots were the only ones showing distinctly greater erosion from the upper half than from the lower half. The cleared and pitted plots, the cleared and seeded plots, and the pitted and seeded plots, showed equal amounts of erosion in the upper and lower halves.

Effects of Treatments on Surface Runoff.—There was little correlation between treatments and surface runoff, although clearing appeared to increase rain-site runoff, and seeding appeared to reduce it.

Effects of Crown Cover.—Crown cover appeared to have a greater effect in reducing rain-site runoff than did soil treatments. As the crown cover increased, the surface runoff decreased significantly. Also, crown cover slightly reduced the microrelief change.

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Water Intake and Runoff as Affected by Intensity of Grazing

FRANK RAUZI AND CLAYTON L. HANSON[1]

Soil Scientist and Agricultural Engineer, Soil and Water Conservation Research Division, Agricultural Research Service, USDA, Laramie, Wyoming and Newell, South Dakota.

Highlight

Water intake rates on differentially grazed rangeland watersheds were nearly linear with the heavily grazed watershed having the lowest and the lightly grazed watershed the highest rate. Annual runoff was greatest from the heavily grazed watersheds and least from the lightly grazed. Storm characteristics were a factor in the production of runoff.

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Grazing-intensity studies on native rangeland at many locations have been conducted primarily to obtain basic information from vegetative and livestock responses. Other information of value has also been obtained.

Sharp et al. (1964) obtained basic hydrologic data at Cottonwood, South Dakota, from small rangeland watersheds grazed lightly, moderately, and heavily. Johnston (1962), Rauzi (1963), and Rhoades et al. (1964) made water-intake studies on native pastures differentially grazed for 20 years or more. Basic soils information was obtained (Rhoades et al. 1964) from pastures differentially grazed. Thus the grazing-intensity studies have and are yielding additional information beyond what was originally planned.

Production of kind and amount of native herbage for a given soil type is influenced largely by the amount and distribution of precipitation. In turn, the water-intake rates may be influenced by management, surface, and subsurface soil conditions, the kind and amount of vegetal cover present, and intensity of rainfall (Rauzi and Kuhlman, 1961).

The study reported herein was conducted at the Cottonwood Range Field Experiment Station, Cottonwood, South Dakota. Purpose was to evaluate effects of grazing intensities and vegetal cover on water-intake rates. Some additional soil properties, thought to be of importance, were also measured.

Study Area and Procedure

The small rangeland watersheds used in this study were situated on pastures grazed lightly, moderately, and heavily since 1942. Research results have been reported on by Johnson et al. (1951) and Lewis et al. (1956). Cattle stocking rates have averaged 3.25, 2.42, and 1.35 acres/AUM (animal unit month) for the light, moderate, and heavy grazing, respectively.

Vegetation is considered mixed prairie. Principal shortgrass species are blue grama *(Bouteloua gracilis)*, buffalograss *(Buchloe dactyloides)*, Sandberg bluegrass *(Poa secunda)*, and needleleaf sedge *(Carex eleocharis)*. Midgrasses include western wheatgrass *(Agropyron smithii)*, green needlegrass *(Stipa viridula)*, needle and thread *(Stipa comata)*, and little bluestem *(Andropogon scoparius)*.

Soils on the study area have been classified as Pierre-Promise association. These soils are modertely deep and underlain by Pierre shale. Surface soils are friable silty clay on silty clay loam. Subsurface cracking may be more pronounced than surface cracking as these soils dry.

Wavy gilgai microrelief, a succession of microvalleys and microridges that run with the slope, are present throughout the watersheds and have been described by White and Bonestall (1960). Our preliminary studies indicate that the rate of water intake may be affected by the microrelief, but in this study we made no attempt to evaluate such an effect.

We are indebted to the South Dakota Agricultural Experiment Station and the Cottonwood Range Field Experiment Station for use of the pasture areas, which are a part of long-time grazing studies conducted by the South Dakota Agricultural Experiment Station at Brookings.

Watershed-study areas on each of the three differentially grazed pastures were established in 1962. Within each 8-acre watershed site in each pasture, four contiguous watersheds approximately 2 acres in size were constructed (Sharp et al. 1964). The soil and aspect of the three sites were very nearly the same. The slope was nearly the same and averaged 7.8, 7.6, and 7.9%, respectively, in the lightly, moderately, and heavily grazed pastures.

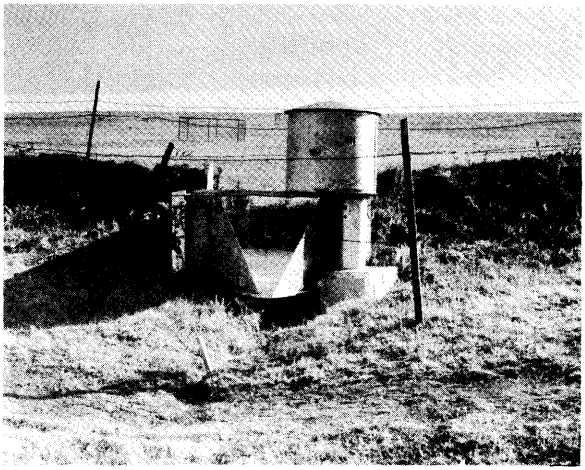

FIG. 1. H-type flume with stage recorder to measure runoff from small rangeland watersheds.

To measure runoff water from naturally occurring rain storms, each watershed is equipped with a 2-foot H-type flume with approach box and FW-1 stage recorder (Fig. 1).

Simulated rainfall was applied with a mobile infiltrometer (Rauzi, 1963) to a circular area of approximately 13 ft^2. The test plot was 2 ft square and located in the center of the area receiving rainfall. Simulated rainfall was applied to the test plots for 1-hour periods at intensities varying from 2.90 to 4.12 inches/hr. A higher intensity of simulated rainfall was required on the lightly grazed watersheds than on the heavily or moderately grazed watershed to obtain runoff early in the test period. Water intake was measured as the difference between the amount applied and measured runoff. The equipment was left in place after the last test of the day. On the following morning a wet run of 1-hour duration was made on the previously wetted plot. Average elapsed time between the dry and wet run was 16 hrs and 40 min. A wet run was made on each replication of each watershed, making a total of four wet runs per watershed.

Three tests were made on each replication for a total of 12 tests on each of the three watersheds. The raindrop applicator was moved to a different replication or watershed daily.

Moisture content of the soil at the time water-intake measurements were made was determined gravimetrically from soil samples taken near each test plot at the 0- to 6- and 6- to 12-inch depths.

All standing vegetation on the test plots, including the previous year's growth, was clipped at ground level after the water-intake measurement was made. The vegetation was separated into the following categories: midgrasses, shortgrasses, annual grasses, sedges, and forbs. All mulch material on the test plot was collected. These materials were air-dried and weighed; yields were then computed. Species composition of each test plot was determined by the vertical point-quadrat method.

Three cores of soil 3.5 inches in diameter and 4 inches long were taken from each grazing treatment in each watershed. Bulk density and pore space (drained between 0 and 70 cm H_2O tension) were determined on each of these cores.[2]

Results and Discussion

Water Intake — Water-intake rates on the watersheds varied with intensity of grazing (Table 1). During the second 30-minute period of the 1-hour test, the water-intake rate on the moderately grazed watershed was nearly twice that on the heavily grazed watershed. Water-intake rate during the second 30-minute period on the lightly grazed

[2] *Determinations made by W. D. Kemper. Soil Scientist, Agricultural Research Service, USDA, and Colorado State University, Fort Collins.*

watershed was nearly four times that on the heavily grazed watershed and over twice that on the moderately grazed watershed. Total water intake during the 1-hr test on the heavily, moderately, and lightly grazed watersheds followed a similar pattern.

On basis of the water-intake data obtained during the second 30-minute period of the 1-hour test, no runoff would occur from a 30-minute storm having an intensity of 2.00 inches on the moderately and heavily grazed watersheds. During the summer months, short-duration, high-intensity rainstorms occur frequently. A 5-minute storm with rainfall intensity of 6.00 inches/hour would produce runoff from most rangelands. A storm of this magnitude can be expected once in 10 years in the study area.

A storm of 1 inch of rainfall during a 30-minute period (2 inches/hr) can be expected in the Cottonwood area once every two years. A storm with an intensity of 4.00 inches/hr for a 30-minute period may be expected once in 25 years (Hershfield 1961).

Soil-moisture content measured on July 12 on the heavily grazed watershed varied from 14 to 26% for the 0- to 6-inch depth. One rain of consequence was recorded during the beginning of the study period. Thereafter, the soils became progressively drier, and after a few days soil moisture was near or below the wilting percentage in the top foot of soil. For this series of tests, no correlations were found between percent soil moisture and water-intake rates.

The comparison of water-intake rates between the dry and wet runs is presented in Table 2. Water-intake rates were markedly reduced on the wet run. Total water intake was slightly less than half that measured for the dry runs. The soils on the wet run had not reached field capacity, but the swelling clays had sealed off the surface cracks. The wet runs showed the same water-intake trend that was shown by the dry runs on the three differentially grazed watersheds. This indicates that the intensity of grazing may have altered the soil structure as well as the kinds and amounts of vegetative cover.

Table 1. Air-dry herbage and mulch (lb/acre) and rate of water intake (inches/hr) on small native range watersheds grazed heavily, moderately, and lightly. Cottonwood, South Dakota, 1964.

Study Area[1]	Total Herbage	Mulch	Rate of Water Intake: First 30-min.	Second 30-min.	Ave. for 1-hr. period
Heavily grazed	910[c]	456[b]	1.40[c]	0.71[c]	1.05[c]
Moderately grazed	1,345[b]	399[b]	2.16[b]	1.21[b]	1.69[b]
Lightly grazed	1,869[a]	1,100[a]	3.19[a]	2.72[a]	2.95[a]

[1]Twelve test plots on each study area. Means with the same letter superscript are not statistically different from each other at the 0.05 level of significance.

Table 2. Water-intake rates (inches/hr) during first and second 30-minute period and total for 1-hour test for dry and wet runs on watersheds grazed heavily, moderately and lightly. Cottonwood, South Dakota, 1964.

Study Area[1]	Dry Run: First 30-min.	Dry Run: Second 30-min.	Dry Run: Total 1-hr.	Wet Run: First 30-min.	Wet Run: Second 30-min.	Wet Run: Total 1-hr.
Heavily grazed	1.50	0.72	1.11	0.66	0.36	0.51
Moderately grazed	2.26	1.20	1.73	0.84	0.54	0.69
Lightly grazed	3.12	2.34	2.73	1.46	0.96	1.26

[1]Four test plots on each study area.

Vegetal Cover. — Twice as much total herbage was present on the lightly grazed watershed as on the heavily grazed one (Table 1). Only a trace of midgrasses was present on the heavily grazed watershed, whereas nearly 50% of the total herbage on the lightly grazed watershed was midgrasses (Fig. 2).

More dryland sedges were present on the heavily grazed watershed than on the moderately or lightly grazed watersheds. Forb species were more abundant on the moderately grazed watershed than on either the moderate or heavily grazed watershed. Annual grasses, chiefly Japanese brome *(Bromus japonicus)*, were associated with the lightly grazed watershed.

The amount of natural mulch material on the test plots varied with the grazing intensity (Table 1). Natural mulch as defined by Dyksterhuis (1947) is the nonliving plant material on the soil surface. Test plots on the lightly grazed watershed had nearly 2.5 times more mulch than did the heavily grazed watershed and 2.75 times more than the moderately grazed watershed. There was an abundance of buffalograss seed present on the heavily grazed watershed, and this was included in the mulch material collected. The amount of mulch material varied with kind and amount of vegetative cover. Amount of mulch present increased with an increase of midgrasses and Japanese brome.

Species composition on the plots was determined by the vertical point quadrat and by weighing. Blue grama and buffalograss accounted for 97, 80, and 49% of the composition as measured by the point quadrat, and 94, 78 and 41% by weight, for the watersheds grazed heavily, moderately, and lightly, respectively.

Water Intake and Vegetal Cover — Water-intake rate, amount of total herbage, and mulch from the three watersheds

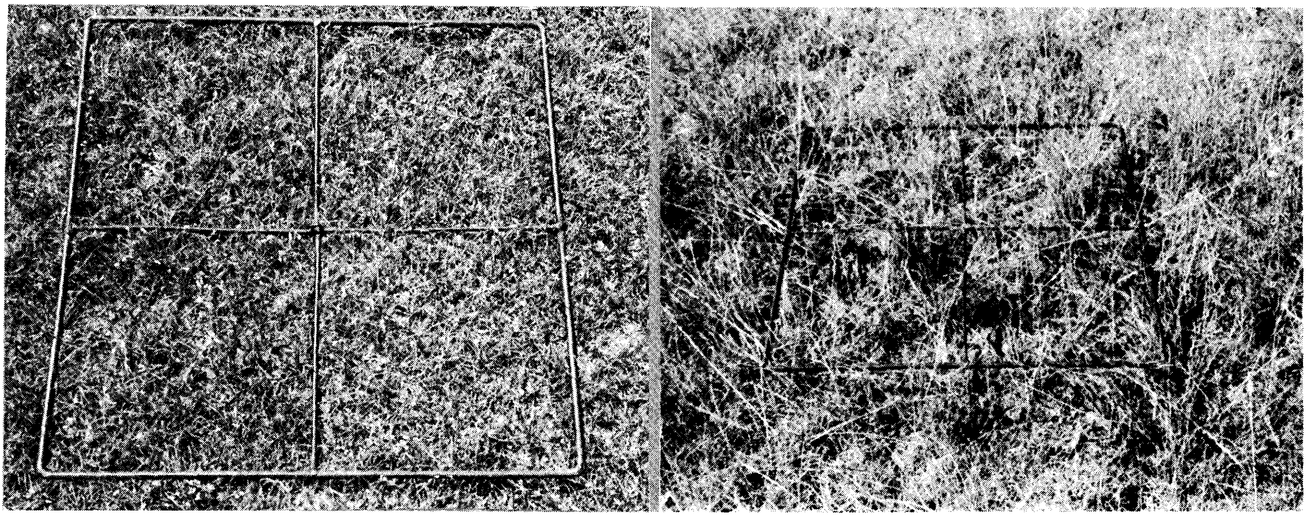

FIG. 2. Comparison of vegetative cover on the heavily grazed (left) and lightly grazed (right) watersheds.

were used in a multiple-regression analysis. Water-intake rate during the second 30-minute period of the 1-hr test was the dependent variable; total herbage and mulch (both in lb/acre) were the independent variables. The correlation coefficient for the multiple regression analysis was 0.845. The analysis showed that total herbage and mulch accounted for 71% of the variation in water intake on the three differentially grazed watersheds. The simple correlation coefficient for water intake and total herbage was 0.734, and was 0.801 for total herbage and mulch material. Both the total herbage and mulch material contributed significantly to the rate of water intake at the 0.01 level. The multiple-regression analysis resulted in the following equation:

$$Y = .0007x_1 + .0013x_2 - 0.26$$

Where Y = water intake (inches/hr)

x_1 = Total vegetal cover (lb/acre)

x_2 = Total mulch (lb/acre)

The regression equation was statistically significant at the 0.01 level of probability.

Bulk Density and Pore Space—Bulk density and pore space (drained from 0 to 70 cm H_2O tension) is shown in Table 3. Differences between soil bulk densities were all highly significant. Pore space of the lightly grazed treatment was significantly larger than in the moderate and heavily grazed treatments at the 0.01 level. The probability that the moderately grazed areas have more pore spaces than the heavily grazed area is about 70% (0.3 level).

Table 3. Effect of grazing intensity on bulk density (g/cc) and pore space (% of total volume).

Grazing Treatment	Bulk density	Pore space[1]
Heavy	1.29	7.7
Moderate	1.24	8.4
Light	1.17	10.6

[1] Pores drained from 0 to 70 cm H_2O tension.

Runoff from Watersheds — Runoff data for 1963 and 1964 are available for the watersheds. Four rainfall-runoff events during 1963 produced the runoff shown in Table 4. The first runoff-producing storm on May 30 followed a period of approximately normal precipitation (Sharp et al. 1964). This high intensity storm produced about 3 inches of rain. The maximum 10-minute rainfall intensities varied from a high of 7.80 inches/hr on the lightly grazed watershed to 4.80 inches/hr on the heavily grazed watershed. An intensity of 7.80 inches/hr for a 10-minute rainfall is approximately equal to a 100-year storm (Hershfield, 1961). Runoff from the heavily grazed watershed was 1.4 times greater than from the moderately grazed watershed and about 9 times greater than the lightly grazed watershed. The second runoff-

Table 4. Precipitation and runoff during 1963 and 1964 on watersheds grazed heavily, moderately, and lightly. Cottonwood, South Dakota.

Year and Grazing Treatment	Inches Precip. Annual	Inches Precip. Runoff Prod.	Runoff-Prod. Precip. % of Ann. Precip.	Inches Runoff	Runoff % of Ann. Precip.
1963					
Heavy	15.19	7.40	48.7	1.77	11.7
Moderate	14.97	7.15	47.8	1.53	10.2
Light	15.86	7.47	47.1	1.39	8.8
1964					
Heavy	13.74	5.82	42.4	.87	6.3
Moderate	13.63	4.19	30.7	.32	2.3
Light	13.02	2.94	22.6	.05	0.4

producing storm of 0.59 inch was on June 6. Runoff from this small storm was the greatest from the heavily grazed watershed and least from the lightly grazed watershed. On June 15 another 3-inch storm occurred and the lightly grazed watershed produced 1.23 inches of runoff which was 2.2 and 4.2 times more runoff than from the moderately and heavily grazed watersheds, respectively. The maximum 10-minute rainfall intensity was 1.4 inches/hr for each of the watersheds. The reason for the high runoff amount from the lightly grazed watershed was probably the previous abundant rainfall resulting in a high antecedent soil moisture (Sharp et al. 1964). The fourth storm, on July 29, was a high-intensity, short-duration storm. The runoff from this storm was greatest from the heavily grazed watershed and least from the lightly grazed.

The 1963 total annual runoff from the three watersheds grazed heavily, moderately, and lightly was 1.77, 1.53, and 1.39 inches, respectively (Table 4). The proportion of annual runoff to annual precipitation was greatest on the heavily grazed watershed and least on the lightly grazed.

The number of runoff-producing storms during 1964 was 8, 7, and 5, respectively, for the heavily, moderately, and lightly grazed watersheds. A low-intensity storm on April 20 was the only storm during the year that had a rainfall over 1 inch, and runoff occurred only on the heavily grazed watershed. Some runoff occurred on both the heavily and moderately grazed watersheds from a small storm on May 2. The first storm to produce runoff on all the watersheds was on May 15, when approximately 0.62 inch of rain produced 0.03 inch, 0.01 inch, and a trace of runoff on the heavily, moderately, and lightly grazed watersheds, respectively. Four June storms all caused runoff from all three watersheds, the greatest runoff coming from the heavily grazed watershed and the least from the lightly grazed. The last runoff-producing storm was on July 9, when the rainfall on the heavily and moderately grazed watersheds was about 0.63 inch, while the lightly grazed watershed received only 0.18 inch. Probably because of this difference in precipitation, runoff occurred from the heavily and moderately grazed watersheds, but no runoff occurred on the lightly grazed watershed. The 1964 total annual runoff was 0.87, 0.32, and 0.05 inch for the heavily, moderately, and lightly grazed watersheds, respectively (Table 4). The proportion of runoff to annual precipitation was the greatest for the heavily grazed watershed and the least for the lightly grazed.

A few high-rainfall and high-intensity storms during 1963 caused more runoff than a greater number of smaller storms during 1964. Runoff never occurred on any of the watersheds with less than a 0.43-inch rainfall, and runoff always occurred when the rainfall was greater than 0.75 inch. All storms with a maximum 10-minute intensity of 1.80 inches/hr or more produced runoff on all watersheds. During 1963 and 1964 there were seven storms with maximum 10-minute intensities of 1.80 inches/hr or more. These factors indicate that the characteristics of the storms are among the controlling factors in runoff production on any watershed.

There has been no snowmelt runoff since the project was started.

Summary

During July 1964, water-intake studies were conducted on three small differentially grazed rangeland watersheds at the Cottonwood Range Field Experiment Station, Cottonwood, South Dakota. In 1962, the small watersheds were superimposed on pastures grazed lightly, moderately, and heavily since 1942.

Water-intake rates were nearly linear with grazing intensity. Total water intake on the lightly grazed watershed was 2.5 times greater than on the heavily grazed watershed and 1.8 times greater than on the moderately grazed watershed.

Species composition on the test plots on the three differentially grazed watersheds showed marked differences. Blue grama and buffalograss were the dominant species on the heavily and moderately grazed watersheds, accounting for 97 and 80% of the total composition, respectively. Western wheatgrass was the dominant midgrass and Japanese brome the dominant annual grass found almost exclusively on the lightly grazed pasture.

Water-intake rates during wet runs were reduced to nearly half those during dry runs. Water-intake rates from the wet runs showed the same nearly linear trends on the differentially grazed watersheds that were obtained from the dry test runs. The dry and wet runs indicated that not only has the species composition been altered by 22 years of differential grazing but possibly the soil properties have been changed.

Bulk density and pore-space measurements further showed a change in soil properties. Heavy grazing compacted the soil and significantly decreased the pore spaces in the top 4 inches of the soil when compared with light grazing.

Two years' runoff data indicate that, on an annual basis, the heavily grazed watershed produces the most runoff and the lightly grazed watershed produces the least. The data indicate that storm characteristics are a dominant factor in the production of runoff from areas differentially grazed. Thus, management of grazing can decrease

runoff and increase the amount of available precipitation entering the soil for plant use.

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Application and Integration of Multiple Linear Regression and Linear Programming in Renewable Resource Analyses[1,2]

GEORGE M. VAN DYNE[3]

Ecologist, Radiation Ecology Section, Health Physics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee, and Associate Professor of Biology, University of Tennessee, Knoxville.

Highlight

This paper presents preliminary results of formulating quantitatively the influence of site factors on various nutrient production measures and using these relationships in linear programming models to determine the optimum protein production on a foothill range. Site characteristics for optimum protein production were constrained to fall within the range of variables measured, and were constrained to satisfy certain inherent relationships known about these variables. This example shows a useful application of an operations research technique to resource evaluation problems.

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[2] *Paper presented at 19th annual meeting, American Society of Range Management, New Orleans, La., February 1-4, 1966.*

[3] *Present address: College of Forestry and Natural Resources, Colorado State University, Fort Collins.*

Large, fast digital computers have become available in the last 15 years and have allowed the development of special methods of analyzing and studying complex systems in industry and government. Range ecosystems are good examples of complex systems, and it is inevitable that mathematical analysis will become increasingly important in the future in range research and range management, as well as in many phases of renewable resource management. To take advantage of the methodological and conceptual advances from operations research and systems analysis means we will have to give increased attention to formulating and studying range problems in mathematical terms.

This paper reports only an *introductory* approach in applying and integrating multiple linear regression and linear programming methods in studying what I call the "optimum site problem." The work at present is neither exhaustive nor complete but will serve to show, with realistic examples, the potential of these techniques for learning more about range ecosystems.

The purpose of this paper is (i) to show the development of the quantitative formulation of site relationships to vegetation productivity, (ii) to use multiple linear regression equations as objective functions in, and to develop constraints for linear programming models, and (iii) to show by example and discussion where these approaches have application in analysis of renewable resource management problems.

The Range Site

Foothill ranges are good examples of complex and diverse environments. A schematic simplification is given in Fig. 1. Different geologic formations may outcrop at different levels providing various parent materials for residual soils, and parent materials for some soils may be transported onto the site. Variations in degree of slope and exposure also are characteristic of foothill rangelands. Important variable climatic influences in-

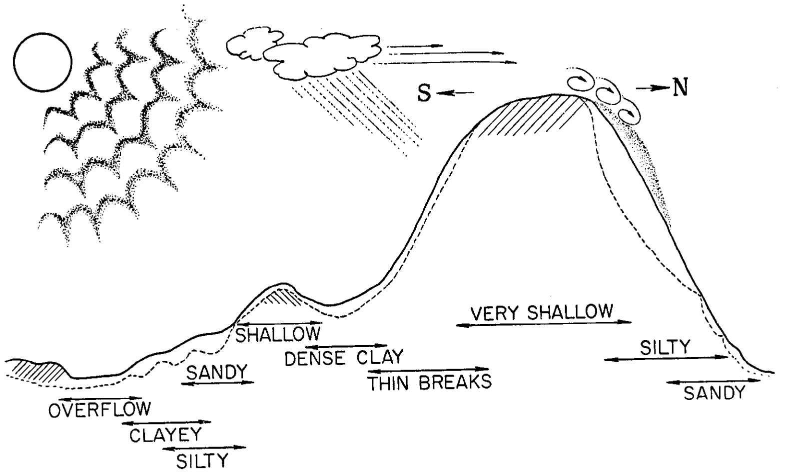

FIG. 1. A diagrammatic representation of the foothill range site complex showing variations in parent materials, soil depths, elevation, exposure, and climatic factors. Double-ended arrows show that boundaries of range sites are not discrete.

clude the angle at which sunlight strikes the soil surface and the exposure to the prevailing winds, which may be especially important in drifting snow onto leeward slopes. The ultimate result is the development, over a long period of time, of varying soils and topographic features which, when considered together with precipitation zones, we group arbitrarily into range sites, and to which we can ascribe a characteristic kind and amount of vegetation. The boundaries of range sites usually are not distinct, but they tend to intergrade and overlap in part. The range site name as such is of value, especially for large-scale surveys, but adds little to our quantitative knowledge about the relationships of the vegetation to the site factors.

Often it is desirable to be able to assess or to rank a given environmental complex such as a range site, a forest area, or some other unit according to some prescribed scheme of practical or theoretical importance. The assessment or ranking of a site implies that the various properties of this site have a functional relationship to criteria which are being ranked. Means of assessing the combined effects of site variables on some criteria have undergone long development originating with qualitative characterizations, and more recently turning to quantitative assessments.

Historical Development

An early qualitative statement, pertinent to the range site problem and attributed to Darwin, is that a particular plant community is selected from the available flora by the environment of a particular locale. This statement illustrates the early recognition that the various environmental factors, acting upon an original flora, lead to the development of a particular plant community. This notion was developed further by Dokuchaev (1898, referred to by Jenny, 1961), the Russian soil scientist, who formulated the following relationship.

$$S = f\,(Cl, O, P) \qquad (1)$$

where S refers to soils, Cl refers to macroclimate, O to organisms (presumably both plants and animals), and P to parent material. Later Jenny (1941) reformulated this relationship and added two new independent variables as follows:

$$S = f\,(Cl, O, R, P, t) \qquad (2)$$

where Cl, P, and S are defined as above, R refers to relief, and t to time. Jenny defines O as available flora and fauna so that it can be considered an independent variable rather than a dependent variable. This equation states that soil properties are dependent upon the influences of the climate acting over time on the original conditions of organisms, relief, and parent material. Similarly, Major (1951) has shown that vegetation is a function of the same state factors or independent variables. Later Jenny (1961) formulated a more general set of equations for an open system as follows:

$$l, s, v, \text{ or } a = f\,(L_o, P_x, t) \qquad (3)$$

where the dependent variables are any property of the total ecosystem (l), soils (s), vegetation(v), or animal community (a). The independent variables here are specified by the vector L_o which gives the initial state conditions, P_x which are the flux potentials, and t again referring to time. In the present sense, flux refers to the movement of matter and energy to and from contiguous ecosystems.

In all of the above formulations the time scale aproximates that of primary succession, evolutionary time, or geologic time. For a short time scale, such as much less than the time required for secondary succession, and for practical purposes, certain of the variables considered dependent variables in the above formulations may be considered to be independent variables. A change in terminology is introduced so that now independent and dependent are used in the conventional statistical sense rather than adhering strictly to Jenny's (1941) meanings. The statistical usage is denoted by asterisks. Thus, a new relationship may be formulated as follows:

$$V^* = f\,(Cl^*, R^*, S^*) \qquad (4)$$

or

$$Y = f\,(X_1, X_2, \ldots X_m \,|\, b_1, b_2, \ldots b_m)$$

where V* refers to some property of the vegetation which varies widely in a short period of time, for example, to the annual yield or composition of vegetation on a given site. The independent variables essentially are fixed in a short period of time and are Cl*, or macroclimate, R*, the relief features which would include such factors as elevation, slope, and exposure, and S*, the physical and chemical characteristics of the soil. A vegetation variable can be defined as a dependent variable, Y, and the site variables as independent variables X_i, in a multiple regression equation, and the b_i

are partial regression coefficients. The number of independent variables on any given range site is large, and their measurement becomes subject to practical considerations.

The Regression Model

The relationship of the vegetation variable, i.e., yield or composition, to any given independent variable may be nonlinear, and certain independent variables may have interacting influences. Development of a "mechanistic" model for predicting a vegetation variable, say productivity, no matter how interesting a modelling task, is unnecessary for the present purposes. As a first approximation and simplification for illustrative purposes, an empirical model for predicting a vegetation variable may be obtained by regression analyses. Multiple regression analysis techniques may be used to derive a first order model (linear terms only, without interaction) relating the independent site variables and the dependent vegetation variable, giving an equation as follows:

$$Y = b_o X_o + b_1 X_1 + b_2 X_2 + \ldots b_n X_n \quad \text{or} \quad Y = \sum_{i=O}^{n} (b_i X_i) \qquad (5)$$

where Y is the dependent variable, e.g., yield or composition of the vegetation, X_o is assigned the value one and the other X's are the independent variables, i.e., independent concerning time fixed to a narrow range. The value of such equations, of course, depends upon the sampling scheme in which the data were collected, the inherent variability of the population being sampled, and many other factors whose discussion is beyond the scope of this paper. Further information on the development and use of multiple regression models, both linear and nonlinear, may be found in statistical texts such as Ostle (1963), Hamilton (1964), and Keeping (1962).

The Linear Programming Model

The question may be asked, *"How can we select values for the site variables which will maximize the value of the vegetation property?"* The above multiple regression equation for predicting a vegetation variable can be used in a linear programming model as an objective function. Then we are interested in learning the values of the X's which would give us the maximum or minimum value, depending on which is desired, of the vegetation variable. If there were no constraints on selecting the values for the X's and we desired to maximize our vegetation variable, one could simply take an extremely large value for each site factor which has a positive partial regression coefficient and an extremely small value for those with negative coefficients. However, in real life this is not possible. Often there is a functional relationship between the variables which can be shown by a set of inequalities as follows:

$$\begin{array}{l} a_{11} X_1 + a_{12} X_2 + \ldots + a_{1m} X_m \leqq c_1 \\ \vdots \\ a_{i1} X_1 + a_{i2} X_2 \ldots a_{ij} X_j \ldots a_{im} X_m \leqq c_i \\ \vdots \\ a_{n1} X_1 + a_{n2} X_2 + \ldots + a_{nm} X_m \leqq c_n \end{array} \qquad (6)$$

where the a_{ij} and c_i are constants. In these inequalities the coefficients a_{ij} may be zero for many of the terms providing that at least one a_{ij} is greater than zero. An additional set of constraints in the linear programming model is that $X_i \geqq 0$ for all i. Further background on linear programming models and applications may be found in such texts as Spivey (1963) for introductory treatment and Hadley (1962) for more advanced treatment. Further considerations about constraints pertinent to the optimum site problem follow.

Constraints on the Solution

There are three general types of constraints: (a) inherent relations, (b) those constraints to make the solution realistic, and (c) those imposed to evaluate economical or biological factors.

Constraints which are inherent in the nature of the independent variables include the following examples: (i) sand + silt + clay = 100, where mechanical composition data are expressed in percent; (ii) A horizon depth + B horizon depth = depth to C horizon; and (iii) depth to B horizon $\leqq$ depth to C horizon. Here, for example, depths of the horizons have functional or predictable relationships following from their definitions.

Certain constraints are imposed upon the selection of values for the site factors in order to keep the solution realistic. Thus, for example, the following conditions represent a first approximation of some boundary conditions for the selection of each site variable in the solution vector:

$$\text{min. in field} \leqq \text{site variable}_j \leqq \text{max. in field} \qquad (7)$$

Constraints may be imposed when certain economical or biological factors are to be considered and which have a functional relationship to the dependent variable which is being maximized or minimized. In general,

$$\mathbf{X}^*_{1xm} \mathbf{B}^*_{mx1} \geqq \mathbf{Y}^*_{1x1} \qquad (8)$$

where $\mathbf{X}^*$, $\mathbf{B}^*$, and $\mathbf{Y}^*$ are components of regression functions for other dependent variables, whose minimum or maximum values are being set according to some heuristic decision about the nature of the solution. An example of such an imposed constraint follows.

Assume heights and ages of two species of trees are measured in plots along with site variables. Multiple regression equations are developed to predict height of each tree species from the set of site variables. Let the regression equation for species 1 be used as the objective function in the linear programming model. Assume we would like to find the site conditions to maximize height of species 1, yet we want these site conditions to provide at least better than average height for species 2. This can be accomplished by using the regression equation for species 2 as an inequality to be greater than or equal to the mean height of species 2. Four constraints of this type, developed from regression equations for dependent variables other than protein yield, were included in this problem and are discussed in more detail in the section on the optimum site.

Another realistic consideration concerning constraints is that all of the variables in the regression function, i.e., the objective function, are not equally important. Site factors having highly significant relationships with the vegetation parameter could be given additional consideration in the solution, i.e., the solution can be weighted for these variables. A preliminary suggestion on a method to accomplish this would be to use factor or principle component analyses to get an equation which would be a new linear combination of the more important independent variables. Such an equation could be used as a constraint to be satisfied in the linear programming solution.

From Data to Models

The above equations show how a property of the vegetation may be related quantitatively to measurable site factors, and they show how these relationships can be used to formulate an objective function and constraints in a linear programming model. The regression model is based on experimental data for the dependent vegetation parameters and the independent site factors collected under an appropriate experimental design or sampling plan. To provide a realistic example, site data and nutrient production data, collected from plots located by multistage randomization, are taken from range experiments of Van Dyne and Kittams (1960) and the following matrices are defined:

$$\mathbf{Y}_{nxj} = \begin{bmatrix} Y_{11} & Y_{12} & \cdots & Y_{1j} \\ Y_{21} & Y_{22} & \cdots & Y_{2j} \\ \vdots & & & \\ Y_{n1} & Y_{n2} & \cdots & Y_{nj} \end{bmatrix} \qquad \mathbf{X}_{nxm} = \begin{bmatrix} X_{11} & X_{12} & \cdots & X_{1j} \\ X_{21} & X_{22} & \cdots & X_{2j} \\ \vdots & & & \\ X_{n1} & X_{n2} & \cdots & X_{nj} \end{bmatrix} \quad (9)$$

In both **Y** and **X**, n = 1,2 . . . 66 plots in one year and 151 plots in another. Each plot or location is considered a site and independent and dependent variables were measured at each. In **Y**, j = 1,2, . . . 5 dependent variables: protein yield, grass and sedge composition, perennial grass yield, phosphorus yield, and lignin composition. In **X**, m = 1,2, . . . 11 topographic and edaphic variables: elevation, exposure, and slope and the soil variables of concentration or content of sand, rock, clay, phosphorus, organic matter, conductivity, and pH (Table 1). Many other variables could have been measured in the field, such as microclimatic variables, if unlimited funds were available. Many additional variables could be generated from powers and products of the existing 11 variables, however, for purposes of illustration only these 11 variables will be considered in this introductory study.

In the multiple linear regression analyses the **Y** matrix was considered columnwise so that in each univariate multiple regression analysis a vector, **B**, of regression coefficients was selected so as to minimize the function

$$Q = (\mathbf{Y} - \mathbf{XB})^T (\mathbf{Y} - \mathbf{XB}), \quad (10)$$

and was accomplished for each column vector by finding

$$\mathbf{B} = (\mathbf{X}^T \mathbf{X})^{-1} \mathbf{X}^T \mathbf{Y}. \quad (11)$$

For the following discussion, each dependent variable is considered separately.

The relationship between the linear regression model and the linear programming model is as follows. The regression equation (5),

$$\mathbf{Y}_{1x1} = \mathbf{X}_{1xm} \mathbf{B}_{mx1}, \quad (12)$$

Table 1. Dependent and independent variables measured in individual plots on foothill range and used in regression and linear programming analyses.

Dependent		Independent	
Y_1	Protein yield	X_1	Elevation
Y_2	Grass + sedge composition	X_2	Exposure
Y_3	Perennial grass yield	X_3	Sand content of soil
Y_4	Phosphorus yield	X_4	Clay content of soil
Y_5	Lignin composition	X_5	Rock content
		X_6	Phosphorus in soil
		X_7	Organic matter in soil
		X_8	pH of soil
		X_9	Conductivity of soil
		X_{10}	Slope
		X_{11}	Soil depth

Objective function:

$$Y = 14. + .02X_1 - 11.X_2 - .78X_3 - 1.6X_4 + .47X_5 + .02X_6 + 3.4X_7 - 4.6X_8 - 22.X_9 - .09X_{10} + 6.0X_{11}$$

Constraints:

$$4780. \leq X_1 \leq 5980. \qquad .3 \leq X_7 \leq 56$$
$$0 \leq X_2 \leq 2.0 \qquad 5.8 \leq X_8 \leq 8.0$$
$$46. \leq X_3 \leq 93. \qquad 0. \leq X_9 \leq 18.$$
$$2. \leq X_4 \leq 19. \qquad 1. \leq X_{10} \leq 55.$$
$$1.2 \leq X_5 \leq 62. \qquad 2. \leq X_{11} \leq 24.$$
$$33. \leq X_6 \leq 222.$$

$$X_3 + X_4 \leq 100$$

$$.01X_1 - 6.1X_2 - 1.7X_3 - .88X_4 - .36X_5 + .03X_6 - 3.4X_7 - 4.4X_8 + 3.2X_9 - .32X_{10} - .24X_{11} \leq -150.$$
$$.13X_1 - 79.X_2 - 16.X_3 - 12.X_4 - 6.9X_5 + .26X_6 - 39.X_7 + 140.X_8 - 519.X_9 - 4.3X_{10} + 24.X_{11} \leq 73.$$
$$.01X_1 + .01X_2 - .02X_3 - .03X_4 + .01X_5 - .01X_6 - .07X_7 - .17X_8 + 4.7X_9 - .01X_{10} + .08X_{11} \leq -2.1$$
$$.01X_1 - 1.0X_2 + .05X_3 - .03X_4 + .01X_5 + .01X_6 + .59X_7 - .28X_8 - 20.X_9 + .04X_{10} + .12X_{11} \leq 3.4$$

Table 2. The objective function and constraints of the linear programming model for determination of site characteristics (X_i) for optimum crude protein yield (Y).

becomes the objective function,

$$f = \mathbf{X}_{1 \times m} \mathbf{B}_{m \times 1}, \qquad (13)$$

which is to be maximized according to the constraints (6),

$$\mathbf{A}_{n \times m} \mathbf{X}_{1 \times m} \leqq \mathbf{C}_{n \times 1}, \qquad (14)$$

where **A** and **C** respectively are a matrix and a column vector.

Also, the linear programming model requires the following constraints which are consistent with the values of variables measured in real life,

$$\mathbf{X}_{1 \times m} \geqq \mathbf{O}_{1 \times m} \quad . \qquad (15)$$

The multiple linear regression model (Table 2) shows the relationship between protein production and 11 topographic and edaphic site variables. This equation, less the constant term, becomes the objective function for the linear programming model. Values for the site variables are selected to maximize this function subject to the constraints that the variables for each site are within the limits found in the field for that site (22 constraints), that inherent relationships among these site variables are satisfied (1 constraint), and that additional inequalities (described below) are satisfied so that certain nutritional and management criteria are met (4 constraints).

The Optimum Site

He have used an optimization technique to determine maximum protein yields under a given set of conditions. Specifically, the objective in this problem was to produce protein for utilization by cattle and sheep during the nonwinter period i.e., to maximize Y_1 (Table 1) subject to various constraints. Important economical and biological constraints were: (1) Sites having a higher than average grass and sedge composition in the herbage were being sought in contrast to those having a large percentage of woody vegetation. (2) A higher than average percentage of grass and sedge alone is inadequate for the selection of a site; an additional constraint was imposed that the site must have better than average grass and sedge yield. (3-4) Other constraints, based on nutritional criteria, were that the site must have better than average phosphorus yield as well as having herbage with less than average lignin concentration. The four multiple linear regression equations relating site factors to grass and sedge composition and phosphorus yield, and lignin concentration were used to derive these inequality constraints. This was accomplished by using the appropriate mean value of the parameter as the Y term in the regression function, and then the constant term was subtracted from both sides of the inequality.

Although highly simplified models were used in this illustrative example, the value of these methods of analysis is illustrated when comparing the predicted optimum protein yield with the average yield which was measured. The value of the objective function for the optimum solution was a protein yield of 129 lb/acre. This compares to the measured range of protein yield from 24 to 211 lb/acre, with a mean of 77 lb/acre.

Because important powers and products of independent variables were omitted from the regression functions, the values for the site factors of the optimum site may or may not be entirely realistic. The values for site factors for the "optimum site" for protein production were at or near the maximum values found in the field for soil phosphorus content, pH, and soil depth. The optimum site values were at or near the minimum field values for elevation, soil organic matter, and sand and clay (implying a relatively high silt content). The optimum site would be nearly level and would be on north to east exposures. Values for soil conductivity and rock content for the optimum site would be intermediate to the extremes measured in the field.

The above conditions apply, of course, to the constraints used in this particular model. Altering the constraints, even though using the same objective function, would lead to a different set of values for site factors. The impact of each constraint on the solution could be evaluated by adding one constraint at a time in successive runs using the same objective function. Therefore, the influences of different biological or management objectives could be assessed.

Discussion

It is obvious that the site factors themselves cannot be manipulated easily. If this were the case, then perhaps we would have more cropland and less rangeland. Still it is informative from a management and ecological viewpoint to determine what values these site factors have when our defined optimum conditions exist. This set of site conditions will vary as we vary our definition of optimum by varying the constraints. Thus, for example, we could use these methods to help evaluate alternative uses for a given allotment, ranch, or grazing district. Knowledge of functional relationships between site factors and various dependent vegetation variables can be used to maximize other vegetation parameters. For example, it may be desirable to determine the site factors for maximum watershed value. Then, a good cover or yield of grass and sedge herbage may be the factor to be maximized. Alternatively, it may be desirable to select the site producing the maximum amount of winter forage for game animals by maximizing yield for palatable shrubs. Topographic restrictions may be desirable here to select sites with limited snow cover. Constraints could be put on the percent slope, the degree of exposure, or some combination of these factors which would provide suitable exposures for winter game range.

This approach to combining linear programming and multiple regression models implies it is possible to derive empirical equations interrelating dependent and independent site variables. The equations presented herein were based on data derived from studies of sites on a 12,000-acre foothill range. The coefficient of determination for the objective function was greater than 65%. Considering (1) the large acreage involved, (2) the relatively small number of site variables which were measured, and (3) that the model used is only a first approximation, such a relationship appears adequate. For smaller acreages and where more independent variables are measured, perhaps better predictive equations would be required. In this example a first approximation linear regression model was used, but additional exploration of the data may show improvement in the coefficient of determination by considering nonlinearity of some site variables and by considering interaction influences of independent variables on the dependent variable.

Technically, the linear programming model implies that the dependent variable is determined by the objective function without appreciable random variation. However, the objective functions never are completely deterministic in practice because of errors due to measurement, to sampling, and to factors omitted from the model. This occurs to some degree even in industrial and business situations where linear programming has been used so successfully and extensively in the last decade.

Yet to be resolved is the full impact of the nondeterministic nature of biological models on results and inferences in linear programming. Further studies are required on this matter, and perhaps Monte Carlo trials could be run with models similar to the one described in this paper to resolve this problem. Knowledge of the variances of each partial regression coefficient could be used in selecting at random a large number of similar objective functions for such trials. The results of such trials would be used to give mean values for and variances of the site factors for the optimum site.

This linear regression—linear programming approach also can be utilized in forestry situations. In forestry practice, equations are developed to predict site index for a given tree species from different site variables. Sometimes site index equations are developed for different tree species on the same plots (analogous to obtaining yield of different plant groups in this problem). Site index is a parameter with less experimental error than is herbage yield, and thus the objective functions would be more nearly deterministic. Site index measurement is based on tree properties which are the integrated result of many years of growth in contrast to highly variable annual yield of rangelands. Much sampling variation is therefore eliminated in the forestry situation, and coefficients of determination for many site index models are correspondingly high.

Another important use of linear programming in renewable resource management could be the situation where more than one species of livestock and game animals utilize a given rangeland, and it is desired to select optimum combinations of grazing animals. This approach requires sufficient knowledge concerning the impact of each herbivore on the vegetation resource. An example here would be to maintain a certain percent of the vegetation in woody plants, which may be desirable forage for certain groups of game animals, and yet to maximize the livestock yield from the range as well as to maintain an adequate type and amount of vegetation to prevent soil erosion.

These and other mathematical and statistical methods will be used increasingly in the future by natural resource scientists and managers. In this problem the digital computer could be used as an analytical tool for further extensive modelling and analysis of data already available to provide additional insight into the functioning of this foothill range system. This illustrates the need for training more and more natural resource scientists in computer, mathematical, and statistical disciplines as well as giving them sound background in ecological, economical, and management disciplines (Van Dyne, 1966).

Summary

As we learn more about range complexes and the interrelationships of their components we will be better able to express these factors mathematically. Mathematical expression of environmental relationships is necessary if we are to utilize many of the powerful new tools that have been developed in operations research and systems analysis for study of complex systems.

An example of this approach was given. Multiple linear regression equations were developed to interrelate five dependent vegetation yield and composition variables each with eleven independent soil and topographic variables. These multiple regression equations were used as the objective function and as constraints in a linear programming model to determine the values for site factors for the maximum crude protein yield from a foothill range. Suggestions also were made concerning the applicability of some mathematical programming techniques in resource management anaylsis.

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Grazing Effects on Grassland Soils of Varanasi, India

HARSHWARDAN R. SANT[1]

Department of Botany, Banaras Hindu University, Varanasi-5, India.

Highlight

Moisture content, organic content, carbonate, and calcium content of soils were higher in protected fields than in grazed fields. Soils in overgrazed fields were comparatively coarser in texture and lower in total porosity than in protected fields. Soil pH and nitrate contents showed no marked differences.

Grasslands are the chief source of fodder for cattle in the Varanasi area of India. The effects of grazing on the grasslands are varied. The purpose of this study was to determine the effects of grazing on soil factors.

The experimental areas are in the Upper Gangetic plains on level grounds near the west bank of the Ganges. They are three miles south of Varanasi, which lies at 28° 18′ north latitude and 83° 1′ east longtitude. Varanasi is approximately 76.19 m above sea level. The climate is distinctly continental and shows a wide range of temperature. The rainy season extends from July to October; winter stretches from November to February; and the so-called summer extends from March to June. The annual average rainfall is 153.73 mm. Soils are characteristiced by rich alluvium with a composition which varies from sand and clay to fine clay.

The grasslands of Varanasi are subjected to varying intensity of grazing and are conveniently grouped as protected, medium-grazed and overgrazed (Sant, 1963).

The dominant grasses in the protected fields (Fig. 1) are *Dichanthium annulatum* Stapf., *Bothriochloa pertusa* A. Camus., *Kyllinga triceps* Rottb., and *Setaria glauca* Beauv. Associated species are *Indigofera linifolia* Linn., *Alysicarpus longifolius* W.&.A.Prd., *Desmodium triflorum* DC., and *Blumea lacera* DC. Grazing brings about extermination of the dominant grasses and prevalence of *Cynodon dactylon* Pers., *Eragrostis tenella* Roem. et Schult., *E. viscosa* Stapf., *Panicum psilopodium* Trin., *Paspalidium flavidum* A. Camus., *Dactyloctenum aegyptium* (L.) Beauv., *Sporobolus diander* Beauv., *Evolvulus alsinoides* L., *Vernonia cenera* Less., etc. Certain plants, such as *Convolvulus pluricaulis* L. and *Euphorbia hirta* L., occur equally under protection as well as overgrazing.

Methods

In order to study the indirect effects of grazing on the different soil

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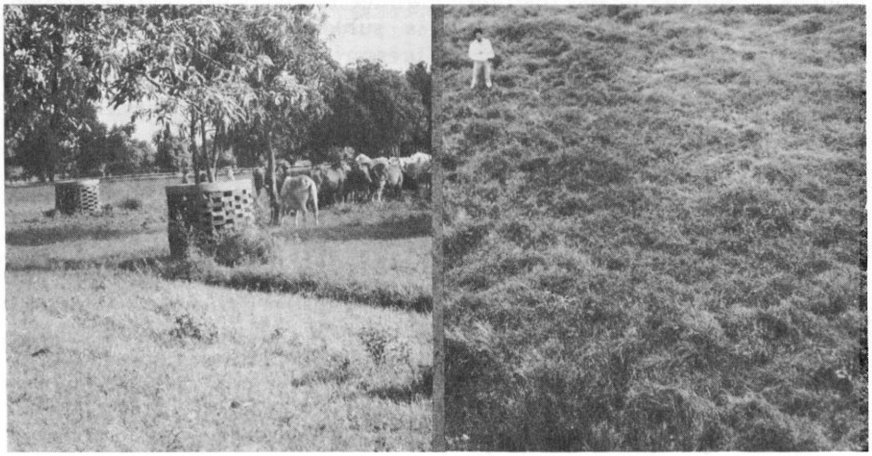

FIG. 1. Overgrazed area (left) and ungrazed area (right) near Varanasi, India.

layers, soil samples were collected from protected, medium-grazed and overgrazed fields, in the rainy, winter and summer seasons. Samples were taken from the same spot in each field at three depths (5, 15 and 25 cm). The samples were analyzed for pH by photovolt meter; moisture content by loss of weight; total porosity, capillary porosity and non-capillary porosity as given by Daubenmire (1947). The rainy season samples were also analyzed for organic content by Robinson's method (Wright, 1939); nitrate content colorimetrically (Snell and Snell, 1949); carbonate content by Hutchinson and McLennan's method (Piper, 1944); and exchangeable calcium by normal ammonium acetate method (Piper, 1944). Mechanical composition was determined in the top layer samples only by the International pipette method (Piper, 1944 and Wright, 1939).

The averages for moisture, pH and porosities were determined by taking 99 samples from protected field, 177 samples from mediumgrazed fields, and 156 from overgrazed field. For mechanical composition, 15 samples were taken from protected and mediumgrazed fields and 20 from overgrazed field. For carbonate, nitrate, organic matter and calcium contents, 45 samples were taken from protected and mediumgrazed fields and 60 from overgrazed fields.

Results

The role of grassland cover in conservation of soil moisture is clearly shown in Fig. 2. The moisture content in the protected field

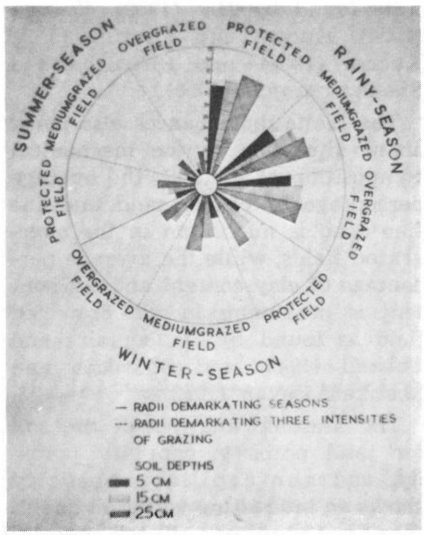

FIG. 2. Histogram of soil moisture at three depths for three seasons with three intensities of grazing, Varanasi, India.

was highest during the rainy season and lowest during the summer. In all three seasons moisture was maximum at 25 cm depth. In rainy season the difference in moisture content at three depths is very little, because of frequent rains. Moisture in the overgrazed field was lowest in all three seasons. Kelting (1954) while studying the effect of moderate grazing on tall grass prairie observed that adequate soil moisture was available in the virgin prairie in both levels of soil throughout the major portion of the grazing season.

The textural grades of the soil from different grazing grounds at 5 cm depth are given in Table 1. Coarse sand was 3.26% in overgrazed as compared to 1.77% in the protected field. Fine sand percentage was maximum in the overgrazed fields and minimum in the protected field. The clay content which forms the bulk of the colloidal complex of the soil and from which nutrients are largely available to plants has a higher value in the protected field.

Table 1. Effect of grazing intensities on mechanical composition (percent) of soil at 5 cm depth.

Mechanical analysis	Grazing intensity Protect	Medium	Over
Coarse sand	1.77	1.99	3.26
Fine sand	50.13	72.69	78.16
Silt	33.18	18.08	11.97
Clay	15.30	7.46	7.03

Table 2 shows that the total porosity is higher in the protected field, presumably on account of plant roots. Total porosity is lower in the overgrazed and mediumgrazed fields. Non-capillary porosity is higher in the protected field and lower in the overgrazed fields. The non-capillary porosity shows seasonal variation, e.g., during the summer season when the maximum grazing takes place the value is reduced in overgrazed field as compared to other fields. But during the rainy season the difference in non-capillary porosity in different grazing fields is lessened. Finally, once again during winter the biotic pressure increases on the overgrazed and mediumgrazed fields and the non-capillary porosity is reduced.

The pH data at three depths and in different seasons are given in Fig. 3. The pH in different fields and in different seasons is more or less similar with the exception of few soils which show slightly acidic nature in the upper layers.

The organic matter is higher near the surface in all the fields and decreases with depth (Table 3). Maximum organic matter was observed in the protected fields at all the depths when compared to other fields, mainly because of thick vegetation. The carbonate content increases as the depth of the soil increases in all the grazing fields. It is higher at all depths in protected field when compared with other fields because of the compact nature of the soil.

Nitrate content distribution is irregular during rainy season. Nitrates

Table 2. Seasonal variation in average volume of porosity of soil (percent) of different grazing fields.

Grazing intensity	Summer Total	Summer Capillary	Summer Non-cap.	Rainy Total	Rainy Capillary	Rainy Non-cap.	Winter Total	Winter Capillary	Winter Non-cap.
Protect	45.12	33.13	11.13	53.56	34.08	19.48	47.28	33.56	13.72
Medium	42.22	33.70	8.52	54.78	34.92	19.74	44.28	28.62	16.20
Over	41.43	36.05	5.38	52.36	33.58	18.78	41.36	32.84	8.52

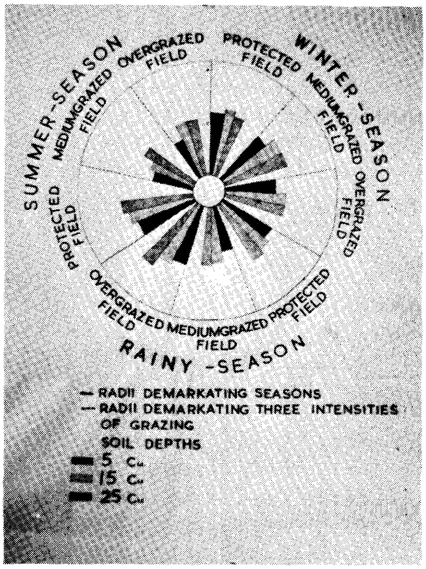

FIG. 3. Histogram of soil pH at three depths for three seasons with three intensities of grazing, Varanasi, India.

are rapidly absorbed by plants and readily leached out by rain water.

Exchangeable calcium content is greater at lower depths, as it is leached downward by the rains. It is higher in the protected fields at all the depths when compared with the other fields.

Discussion

The essential consequences of grazing on the grasslands of Varanasi are deleterious modification of the vegetational composition, and of the physical and chemical factors. The estimation of the soil moisture content during the different seasons and at different depths show that it is maximum for all seasons in the protected fields and the lowest in the overgrazed field, similar to results found by Dix (1959), Kelting (1954), Kucera and Martin (1957), Kucera (1958), and Bharucha and Shankarnarayan (1958).

The biotic disturbances also bring about alteration in the mechanical composition of the soil; the average percentage of coarse sand and the fine sand is maximum in the overgrazed fields, while the average percentage of clay content and silt content is maximum in the protected field as found by Daubenmire and Colwell (1942) and Bharucha and Shankarnarayan (1958).

The seasonal analysis of the soil for total porosity, capillary porosity, and non-capillary porosity shows an interesting variation due to grazing and season. Total porosity is maximum in the protected fields where the vegetation is thick in all the seasons as compared to other fields; and is lowest in the summer season in all the fields, when the biotic pressure on the general vegetation is maximum. But in the rainy season total porosity increases where the vegetation is thick and the biotic pressure is minimum. Again in the winter season when the vegetation is subjected to increasing biotic pressure, the total porosity also decreases. The same trend is present for the non-capillary porosity as found by Kelting (1954), Kucera and Martin (1957), and Kucera (1958). Thus soil porosity and moisture appear directly correlated with amount of vegetation.

Table 3. Chemical analysis of soils from three different depths and grazing intensities.

Item	Protect			Medium			Over		
Depth	5	15	25	5	15	25	5	15	25
CO_3 %	0.69	0.70	0.68	0.04	0.06	0.09	0.15	0.22	0.40
Exch. Ca. M E %	18.6	20.5	22.6	12.1	16.10	18.10	11.4	12.9	14.8
NO_3 [1]	4.4	4.3	4.3	4.02	4.15	4.21	4.21	3.97	3.96
Organ. matter %	3.4	2.1	1.6	1.99	1.15	0.94	0.89	0.62	0.47

(Grazing intensity: Protect, Medium, Over)

[1] Mg per 100 g.

Organic content of the soil increases in the protected fields at all the depths as compared to the mediumgrazed and overgrazed fields. Hence the amount of organic matter seems to be related to the quantity of living plant material, as the dead material is rapidly decomposed.

Carbonate content and the exchangeable calcium content are greater at lower depth in all the fields. It is greater at all depths in the protected field. Thus the amount of calcium is also proportional to the amount of vegetation.

The soil pH and nitrate content are not affected by grazing. This finding is in conformity with similar results obtained by Perring (1959, 1960) and Kelting (1954).

Summary

Grazing brings about changes in vegetational composition, as well as physical and chemical factors in the soil. The moisture content, organic content, carbonate and calcium content show higher values in the protected fields as compared with the grazed fields.

Mechanical composition of the soil shows a comparatively coarser texture in overgrazed, while the total porosity is higher in the protected fields. Soil pH and nitrate contents do not show marked difference in the different fields.

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Cultural Conflicts with the Cattle Business in Zambia, Africa

FLOYD D. LARSON

Agricultural Officer, U. S. A.I.D., Lusaka, Zambia, Africa.

Highlight

African cattle production and marketing in Zambia is far below its favorable potential. Stubborn cultural impediments are slowly being overcome. The process involves two basic steps: (1) stimulating the economic wants of the cattle-owning people to the point where these wants become compelling; (2) improving production and marketing practices to the point that sales prices of cattle prove satisfying to the potential seller.

Zambia's Chief Animal Husbandry Officer asserted that if the level of production among African farmers could be raised to that already achieved on neighboring ranches managed by Europeans, the national herd of cattle would increase about five-fold. He pointed out that the major need was to increase take-off from African herds, which was estimated at 3%/year as compared to 14% in the White-owned herds (Rhodes, 1964).

Production and marketing factors are favorable for cattle-raising in Zambia. Grass and browse grazing is ample in the summer months (mid-November through mid-May). Most farmers have sufficient farm land on which to raise the supplemental feed needed through the winter season if good farming methods are practiced. The native cattle make efficient gains on good feed. The meat of a well-fattened native beast compares favorably with that of a beef-breed animal of the same age. Whereas in many developing countries marketing facilities for rural cattle leave much to be desired, in Zambia the marketing facilities are first-rate. Government has established ample sales yards throughout the country, and the sales dates are well advertised in advance. The animals are bought at a fair price by the Cold Storage Board on a grade and weight basis, with experienced Government graders doing the grading. Payment is in cash on-the-spot (Fig. 1). Thus the important physical factors are conducive to a thriving cattle business. Indeed, the small number of progressive cattle-raisers show efficient production and good profits.

Cultural Impediments

The lag in the African cattle-business is due mostly to adverse cultural factors. Zambian farmers do not think of cattle-raising as a business. Speaking of the less-progressive majority of farmers, *cattle are not regarded as a crop.* To their owners the social and cultural values of the cattle exceed their economic worth. The objectives of the average Zambian livestock-raiser are neither towards efficient

FIG. 1. On-the-spot cash payment stimulates selling of animals at Government-sponsored cattle sales.

gains nor towards gaining the best market price. An eminent anthropologist said: "It is obvious that until recent years the Tonga[1] desire for cattle was not conditioned entirely by the practical benefits derived from their possession. Forty years ago, little or nothing was done to turn them into what the European would regard as an economic asset." And again: "I have yet to hear them comment on milk records or beef production as criteria affecting their judgments of particular beasts, though they have begun to appraise them in terms of their market price. By the older Tonga, at least, cattle are valued for quite different reasons. They are important in a social context, and in the ritual that dramatizes social ties" (Colson, 1962). In the same reference Colson then lists various ways in which cattle enter into the social and ritualistic life of the Plateau Tonga as follows:

1. Bridewealth, that is, payment of cattle by the male to the female's father according to the bride-price terms agreed upon between the two families.

2. Feasting on cattle to celebrate the emergence of a girl into the status of a marriageable woman.

3. Feasting on cattle during the mourning for deaths of adults. The number of beasts killed was in ratio to the importance of the deceased in the community.

4. Killing of cattle at religious shrines when the community met to propitiate the spirits believed to be causing them mischief, such as drought or pestilence.

5. Gifts of cattle in recompense for hostile acts such as adultery, theft, bodily injury, and murder. These cattle gifts bought off revenge.

6. Herding arrangements which bound groups of people together in a common interest.

Similar uses of cattle in the social and ritualistic life of the Mashona tribe in neighboring Rhodesia are reported (Gelfand, 1959). Traditional African culture in Zambia employed a simple financial system, with beads, hoes, shells, or other commonly valued articles as a medium of exchange (Colson, 1960). Thus, it was within the cultural experience readily to adapt to the use of minted currency. On the other hand, savings accounts and interest on investments are new concepts difficult for the traditional farmer to comprehend and believe in. Likewise, a 3 to 4% interest return per year on savings seems much too low to an African farmer, who can buy a young cow, turn her out on free grazing, and get a calf as income in roughly the same period. Bank and post-office savings accounts are thus viewed with disinterest or even distrust. The result of these cultural reactions towards economic considerations is that the traditional farmer tends to sell cattle not when they might fetch the best price, but when he needs money to satisfy urgent immediate wants. Even then he prefers, if he has a choice, to sell crops such as corn, tobacco, or peanuts, which carry less cultural values.

Security is cattle.—Colson (1962) reported that when she asks a Plateau Tonga why he wants to keep cattle he is likely to reply: "They are a good thing to have. They help you if you are in trouble." Historically, this deep common feeling present in most or all cattle-owning tribes goes back to the raiding days before colonial rule. The raids caused economic ruin and untold hardship (Brelsford, 1956). Cattle were one of the chief prizes of war. The victims tried to retain a nucleus of their herds by scattering the animals in the bush when a raid was imminent. Even today among a protein-hungry rural people there is still what amounts almost to a social taboo against a family killing and eating a cow or an ox except on ceremonial occasions, or when the animal is soon expected to die.

Finally, even when the individual reaches the point where all of the above prejudices against selling cattle lose their grip upon him, he likely will not sell simply from lack of stimulus to do so. Though he is in a culture already undergoing change, his wants are still relatively simple and easily satisfied. He builds his own house, principally out of locally-produced free materials. His farmland was obtained free from his village headman. He does not live in an area where public utilities are offered. Grazing is free. Polygamy supplies adequate family labor for the farm. Basic medical services are free or inexpensive. Taxes are low. A warm climate and a simple standard-of-living reduces family clothing costs to a minimum. His food is furnished from his own farm and from the forest, except for such items as salt, sugar, and tea. He produces his own beer and raises his own tobacco. When he is tempted to sell a beast, many doubts assail him. He reflects that it takes the yearly production of two cows to produce one calf (50% calf crop or less). He also reflects that for every mature animal he has raised another died before maturity from disease or lack of feed (Rhodes, 1964). The animal that he has in mind to sell may be perhaps 10 or more years old, weighs about 800 lb., is in poor condition, and is thus in a low grade. It may fetch a return of no more than $28. Perhaps he decides he will keep the beast and sell some corn instead. The

[1] *The Tonga is a large, progressive tribe in southern Zambia. The reference is to the Plateau Tonga; the Valley Tonga had no cattle because of tsetse fly.*

extension officer may point out that the farmer could realize a much better price for his cattle if he would follow the animal husbandry officer's advice about night paddocks, internal parasite control, winter feeding, etc., but these practices are all new to the traditional farmer. He may look with disfavor or distrust upon them, or he may simply lack the motivation to break with strong cultural habits and beliefs. His neighbors might even inflict reprisals upon him if he tried to rise above them in wealth. In the rural areas of this part of Africa the individual is expected to conform to the village norm in all things.

Inducing Change in Cultural Factors

Hopeful signs of change for the better are appearing. The Tonga are beginning to think of their cattle as an economic asset rather than a means of acquiring prestige (Colson, 1962). Cattle sales and grade quality in the main cattle areas are steadily climbing (Table 1). With cheap grass and cheap labor and with ample potential for increasing corn yields to provide cattle feed, Zambia could become an important exporter of beef. How can growth of the cattle business be accelerated?

First, *the farmer must be motivated to produce and sell beef.* This is not easy in a situation where the subsistence-economy dominates. Where the few wants which have been developed are easily satisfied, there is more truth than humor in a lament of one frustrated extension officer, "It seems that the greatest felt-need of these people is for leisure time." However, to suppose that the rural people lead an idyllic life because their present wants are easily satisfied is mischievous thinking. Malnutrition and disease are their constant companions. It is humane and right to stimulate in such people felt-needs for more education, better sanitation, better clothing, better food, and the benefits of medical science. This requires the joint field program efforts of the Ministries of Health, Education, and Agriculture, and the Department of Community Development.

Table 1. Increase in Cattle Sales in Zambia.

Province and grade	1962-63	63-64	64-65	65-66
EASTERN			Unavail.	
Stand. A	1	94		
Good	110	606		
Fair	313	749		
Compound	440	873		
Inferior	13	13		
Young	174	373		
Total	1051	2708		
BAROTSE				
Total	3229	4003	5712	7500

It is only when the farmer says, "But how can I get these desirable things?" that he is ready for the extension officer to tell him how to grow more and better livestock and crops. Cultural outlook and habits cause the rural producer to hold on to his cattle as long as he can satisfy his wants by selling farm crops. Perhaps for this reason priority in promoting production and marketing of cattle should be in the areas where livestock are the main, or possibly the only, market crop, as in Barotse Province.

As a result of a good extension program in Kalomo area of the Southern Province, pre-sale cattle feeding increased from 2% in 1961 to 15% in 1963, with considerable increase in the number of cattle sold (Alder, 1964). In the Central Province 10 farmers participated in a pre-sales feeding result-demonstration. The purpose was to show that cattle in the low grades could profitably be brought into higher grades by supplemental feeding of corn-and-cob meal with added protein. Net profit was $26.90 head for the 68-day feeding period (Ministry of Agriculture, 1965). In the Eastern Province the animal husbandry officer had good success with a device which cuts cattle away from all cultural considerations. This was a feeding project in which the Ministry of Agriculture procured feeder cattle and contracted with selected farmers to feed them according to instructions in the Agreement. The officer distributed protein supplement to these farmers and checked on the animals at frequent intervals. He also determined when they were to be sold. This practice is a most effective form of result-demonstration when contract animals are identified and sold at the sales with other cattle, because the former bring a much higher price. A Zambian Information Press Release of March 8, 1965 stated that for the year ending January 31, 1965 the Eastern Province Grazier Scheme (mentioned above) involved 309 head of cattle with a net average profit of $25.20 over a feeding period of approximately 100 days. Only 59 head were in the Scheme in 1964.

Zambia's Chief Animal Husbandry Officer believes that the contract feeding operations can be considerably increased, with resulting increase in numbers and quality of beasts marketed. The plan might include a Government subsidized price to be paid for young feeder stock in the areas best suited to breeding herd operations, such as Barotse Province. The feeders bought by the Government would be contracted to farmers for fattening in the good corn-producing areas of the Southern and Central Provinces. In this way livestock production and marketing would be stimulated and improved in both the pastureland and the farming areas.

In the Namwala District of the Southern Province, where cattle are the chief cash crop, sales of cattle dropped seriously when the private buyer ceased operations. The farmers had been selling cattle whenever they needed money. A number of local cattlemen were selected to become small-scale cattle buyers and were provided with loans to do so through a Government-operated loan fund. This restoration of the services of the local cattle buyer stimulated sales and was also regarded as a successful pilot project in developing local African cattle buyers (Parry, 1963). As a follow-up, the Ministry of Agriculture in 1964 selected nine cattle buyers and financed them with $1400 each to buy cattle along the Angola border in Barotse Province, where there are no Government sales yards. This operation was also successful in promoting sales of cattle.

Various other measures have been taken by the Zambian Government to encourage production and marketing of cattle. In the Eastern Province abattoir facilities have been improved so that cattle can be slaughtered locally and the carcasses shipped in refrigerated trucks to market. The savings in transportation costs are passed on to the producer and represent almost a doubling of the price paid for the lower grade animals. The Government has adjusted prices paid for cattle to provide a more attractive price to the seller of lower grade cattle as a sales-inducement to dispose of such animals. Large State cattle ranches are being set up in several provinces, partly to overcome the present under-production of beef, but also to train Zambians in proper methods of livestock husbandry.

Much dependence must be placed upon the agricultural extension service to help boost cattle production and sales. It must be enlarged, but skilled personnel and even high-school graduates are scarce. Therefore eighth-grade graduates are screened and the best of these put through a combination of on-the-job training and in-service short-courses. The trainees become extension "demonstrators", assistants to the field extension officers. Such "demonstrators" provided to extension work in animal husbandry have proved their worth. A sometimes overlooked requirement in extension work in less-developed countries is that the farmers must be frequently visited until newly taught farming skills and methods become habitual. One of the chief values of the demonstrator is performing this visiting function. Without this service the cattle feeding projects among Zambian farmers might be hazardous.

Summary

Zambia, which has a most favorable cattle production potential, finds it difficult to make progress towards becoming a beef-exporting country. The principal reason for this is that the traditional farmers do not regard cattle as a crop. That is, social and cultural values of cattle exceed economic values with the majority of owners. However, this attitude is breaking down as the rural people develop more wants in the cash-crop economy. As these wants increase, the extension service moves in with a program of teaching better cattle production and marketing methods. Government at the same time is taking a number of steps to increase the profits realized in the cattle business. Results are encouraging. Perhaps the most promising technique to emerge thus far is the Government cattle-fattening contract with the traditional farmers. By this means the Government retains ownership of the feeder cattle and thus avoids all the cultural difficulties encountered where individually owned animals are involved.

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Water Resources Booklet

This booklet, "It's Time We Face America's Water Problem," is receiving wide acclaim for an outstanding job of illustrating the vital importance of America's program in water resources management.

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Two Modifications to the Vegetation Photographic Charting Method

RAMON CLAVERAN A.

Graduate Student from Mexico at the Department of Watershed Management, University of Arizona, Tucson.

Highlight

Two modifications to the vegetation photographic charting method are suggested: The use of Polaroid film to identify species and density in the field and the use of stereoscopic pairs to facilitate detailed analysis of vegetation and site characteristics in the laboratory.

Vegetation charting has long been used as a means of providing information about plant composition and the extent to which the ground surface is covered by plants. Several charting methods have been developed; but, in general, all of them have two principal disadvantages. These are (a) variation in the personal factor, and (b) accuracy in relation to the time expended in the field measurements. As a consequence, a high degree of accuracy in a short time can usually be obtained only by skilled workers.

Photography has been used in ecological studies since the early years of the present century. Oblique photographs of square quadrats were recommended by Clements (1905) to obtain vegetational data and also to obtain a permanent record of vegetation changes. Cooper (1924) developed an apparatus to take vertical photographs of one m^2 quadrats of dune vegetation. The principal limitation that he found was that vegetation must be relatively uniform in height and not very tall. Cooper's data, however, were suitable for statistical analysis. J. F. V. Phillips (West, 1937) developed a charting technique that involved drawing from a glass plate which replaced the focusing screen of a camera. This method was improved later by Rowland and Hector (1934), who recommended it under circumstances that required photographing the charted vegetation. Booth (1934) developed another charting method based on the same principle although by direct observation without a camera.

Charting from vertical photographs is proposed here as a method that increases accuracy by decreasing personal error and permits faster operations; however, there are some difficulties such as overlapping of plant overstories and species identification. Stoddart and Smith (1955) observed that "identification from photographs of similar-appearing plants is impossible except with detailed field notes".

Two innovations in the photographic recording of ground cover are presented here in an attempt to solve, at least partially, some of these previously indicated difficulties.

A 4 x 5-inch Crown-Graphic camera with a special back for Polaroid film was mounted on a metal tripod on which two legs had been opened by using 6-inch wood bars (Fig. 1). The camera lens was 70 inches above the central point of a m^2 quadrat. Polaroid positive/negative 55-type film (20-seconds developing process) was used.

Several square meter quadrats were located in the desert grassland of southern Arizona. A vertical photograph was taken of each quadrat, with the equipment described. The Polaroid system made it possible to obtain immediately positive prints on which the following operations were carried out: a).—Each plant that appeared on the photograph was labeled with its name or number. b). — Plant basal area boundaries were delineated using black carbon ink in a 00 Radiograph pen (Fig. 2). c).—The area covered by each plant was calculated with a transparent dot grid in which the number of dots had been previously determined by the formula described by Avery (1962). The entire procedure from adjusting the camera on the plot until basal area calculation required an average time of about 30 min/quadrat.

For two of the quadrats, the plant basal area was previously determined by three different pairs of operators using a chartograph apparatus similar to the type reported by Pearse, Pechanec, and Pickford (1935). The time required was about two to three hr/quadrat. These quadrats were also recorded by the vertical photographic method. A comparison between total plant basal area obtained with each method showed a difference of less than 5%.

Overlapping of plant overstories is frequent when two or more plants of different heights and habits are present. In an attempt to obtain photographs of the same area from dif-

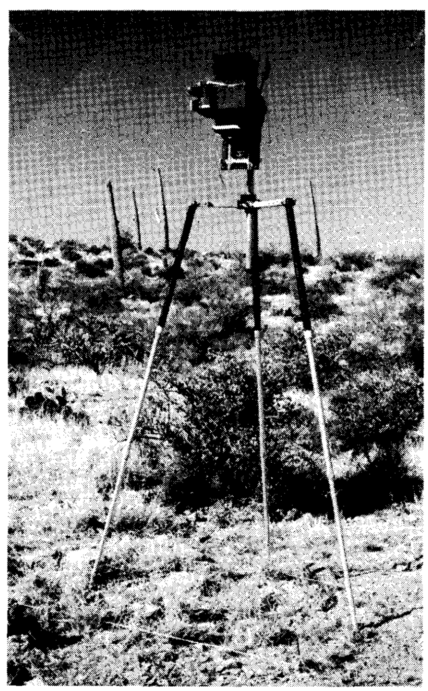

FIG. 1. Crown-Graphic camera with Polaroid back mounted on a modified tripod ready to take photograph.

ferent points of view to eliminate in part the overlapping, the following modification of the technique was employed. Two photographs were taken at each plot. The "camera stations" were about 8 inches apart with the imaginary line between them passing by the vertical projection of the central point about 70 inches above the ground surface.

The plants were then identified on a positive print and the area boundaries recorded as described above. With this pair of photographs, a stereogram can be made which permits calculation of plant basal area, litter and rock cover by using a pocket stereoscope in the field or a mirror stereoscope in the laboratory (Fig. 3).

The principal advantages of adding to accepted techniques the two modifications of (1) Polaroid film and (2) Stereoscopy are: (a).—The quality of the photograph is immediately known. (b).—All the species are easily identified. (c).—Only one person is required. (d).—There is a minimum of personal error. (e).—The operation is more rapid than with a chartograph and similar results are obtained. (f).—By using stereo vision, there is depth perception which makes it possible to observe plants that overlap in a single vertical photograph. (g).—The immediate knowledge (in the field) of the percent basal area occupied by a species is useful and saves time.

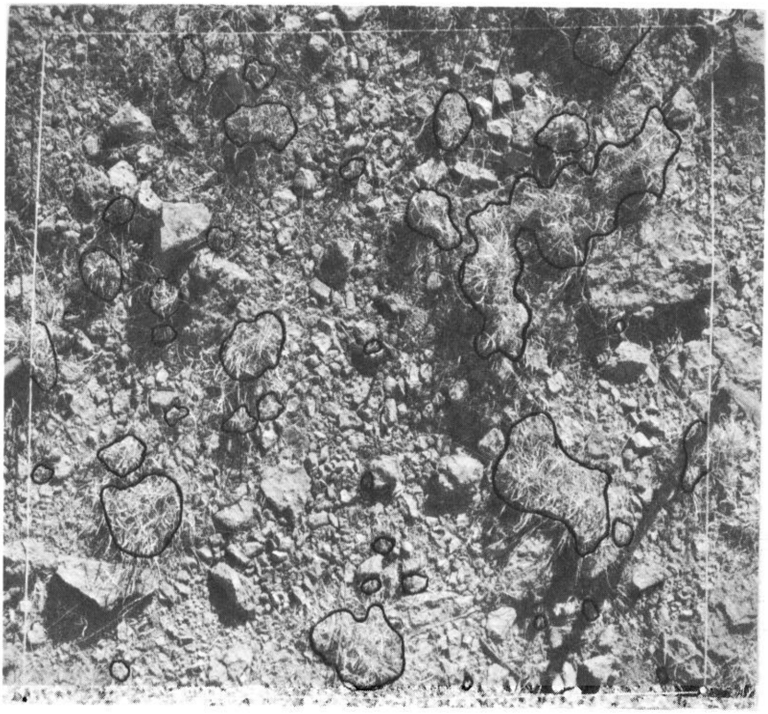

FIG. 2. Vertical photograph of a quadrat with the basal boundaries of the curly mesquite *(Hilaria belangeri)* grass plants.

The main disadvantages in applying the two suggested innovations are: (a). — Higher cost because the film used is more expensive than non-Polaroid film. (b).—Stereogram construction requires two photographs per plot. (c).—Image displacement from the central point is a source of error (could be decreased by using calculated dot grids to compensate for the area differences caused by displacement). (d).—This method is suitable only for low-growing vegetation. (e).—Not suitable for other vegetation, especially rhizomatous species or dense vegetation.

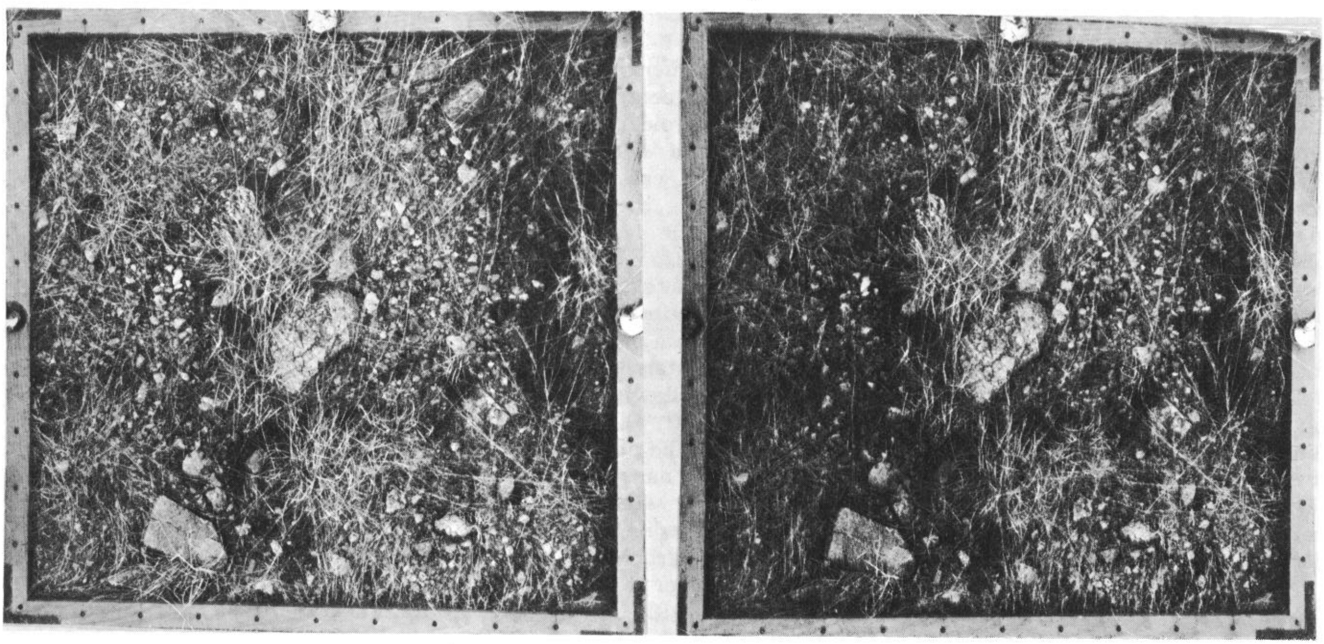

FIG. 3. Stereogram made with two vertical photographs taken in blue grama *(Bouteloua gracilis)* desert grassland.

The two modifications proposed in this paper were used on a small number of plots. It is possible that charting a large number of plots in different vegetation by different operators might introduce additional advantages or disadvantages or might emphasize some of those mentioned above.

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Cliffrose Browse Yield on Bulldozed Pinyon-Juniper Areas in Northern Arizona[1]

CLAY Y. McCULLOCH

Research Biologist, Arizona Game and Fish Department, Phoenix.

Highlight

Where large pinyon and juniper trees were killed 4 to 6 years earlier by bulldozing, cliffrose browse yield was 3.5 lb/acre greater than on untreated sites. Most of the gain represented growth on cliffrose plants established before treatment.

Cliffrose *(Cowania mexicana* var. *stansburiana* (Torr.) Jepson) is a conspicuous shrub of the pinyon-juniper woodland *(Pinus edulis* Engelm. and *Juniperus* spp.) in the Grand Canyon region of Arizona. It was among the 5 most abundant items in contents of several sample series totalling more than 130 deer stomachs examined from winter ranges of the North Kaibab Plateau (Arrington, 1950; Rasmussen, 1941; Wright, 1950). Decisions to regulate hunting pressure in northern Arizona are based partly on periodic estimates of linear amounts of cliffrose twigs removed by mule deer *(Odocoileus hemionus* Rafinesque).

Woodland control by killing of pinyon and juniper trees may tend to increase or decrease cliffrose browse, depending on destructiveness of tree control methods to cliffrose populations. This note compares some characteristics of cliffrose stands on untreated pinyon-juniper sites with those where the tree control method and natural abundance of cliffrose were expected to favor maximum production of cliffrose browse.

Procedure

Observations were made on winter deer range on the west side of the North Kaibab. Cliffrose stems were counted in 1961 on 1000 circular plots of 0.01 acre each (diameter 23.6 ft) arranged in a series of 20 rectangular grids each containing 50 plots and encompassing 4 acres. Grids were systematically spaced on the ridges where cliffrose stands occurred. There were 10 grids on untreated pinyon-juniper areas and 10 where all but the smallest trees (< 2 ft tall) were killed 4 to 6 years earlier by bulldozers, a method known as "pushing." Dozer operators had been instructed to avoid killing cliffrose.

Oven-dry weights of browse within reach of deer were determined for each of 3 height classes of cliffrose, namely, <2, 2 to 5, and >5 ft. Current annual twig growth was clipped to the 5-ft height on 260 plants systematically selected at the grids described above. The yield/acre figure was derived from mean weight of clippings per plant of each height class and the stand density of that class. Clipping was done from 29 Aug. to 1 Sept. 1961. Twigs less than 1 cm long were not collected.

Results and Discussion

On areas of pushed pinyon-juniper, estimated production of cliffrose browse was 2.7 times that of untreated sites (Table 1). However, this large relative difference amounted to only 3.5 lb/acre. Little of the apparent browse increase resulted from cliffrose reproduction following pinyon-juniper control. Shrub seedlings which may have been established after trees were killed apparently had not attained a height of 2 ft by 1961. The sample plot populations of large shrubs, 2 ft high or taller, were no denser on areas where trees were pushed than on untreated ones. Precise counts of smaller plants on the large plots were difficult. It was nevertheless obvious that small cliffrose plants were common on both site types and that they produced less than 10% of the browse (Table 1).

Subsurface sprouting from cliffrose roots after aerial crown destruction was not seen on the North Kaibab nor among stands examined elsewhere in Arizona. Some plants had bud calluses on stems at the soil surface similar to those described for bitterbrush *(Purshia tridentata*

Table 1. North Kaibab cliffrose stands and browse yields.

Height	Pushed Pinyon-Juniper Sites			Standing Pinyon-Juniper Sites		
Class	lb/acre	g/plant	plants/acre	lb/acre	g/plant	plants/acre
<2 ft	0.07	0.52±0.22	62	0.15	0.87±0.60	77
2-5 ft	3.33	9.61±2.80	157	1.09	3.10±1.50	159
>5 ft	2.21	16.20±4.45	62	0.91	4.64±1.93	89
Total	5.61	—— ——	281	2.15	—— ——	3.25

[1] *Contribution of Arizona Game and Fish Department Federal Aid to Wildlife Restoration Project W78R. Assistance of Kaibab National Forest personnel with the shrub clipping is gratefully acknowledged, as is manuscript review by J. F. Arnold, H. G. Reynolds, P. J. Urness, and O. C. Wallmo.*

(Pursh) DC) (Blaisdell and Mueggler, 1956). Sprouting from that basal bud zone was seen occasionally among cliffrose plants sustaining crown damage.

The increased growth on shrubs present before treatment was presumed largely due to reduced competition from trees. The pruning effect of accidental damage by bulldozers stimulated growth on some cliffrose plants. It was unlikely that the difference between sites (Table 1) was due to animal use. Counts of droppings, accumulated on the sample grids during an unknown period up to 1961, showed no difference between areas in either deer or cattle presence.

Cliffrose yield estimates for pushed and untreated areas both tended to be conservative, since clipping was done a month before end of the potential growing season. Elsewhere, more than half of the annual twig elongation has occurred during the last month of the growth season of some years (Neff, 1964). Mean length of current annual twigs on the North Kaibab varied greatly from year to year. The mean for 1961 was below the midpoint of the range reported for annual measurements 1956-1964 (Russo, 1964; Project Personnel, 1965). Relationship, if any, of mean twig length to production on a weight/acre basis is not known, but extreme annual variation may also characterize the latter. Field estimates of browse on the shrubs in 1948 indicated 17 lb/acre production for cliffrose on untreated pinyon-juniper sites (Kimball and Watkins, 1951).

Considered by itself, the cliffrose yield after pinyon-juniper pushing represented a gain in the deer food supply within cliffrose occupied portions of the range. The browse requirement for deer was estimated at 15 lb/acre for the entire winter range, based on a population of 10,000 deer and a minimum intake of 2.6 lb/deer/day (Russo, 1964; Smith, 1950). It appeared that cliffrose in 1961 supplied only a fraction of that requirement even on sites of greatest yield. Sagebrush (*Artemisia tridentata* Nutt.), juniper, grasses, forbs, and in one year pinyon were major items in deer rumens on Kaibab winter range (Arrington, 1950; Rasmussen, 1941; Wright, 1950). Thus, any cliffrose improvement is difficult to evaluate for deer apart from availability of and deer preferences for other foods altered by the pinyon-juniper treatment.

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How Reliable is a Forage Chemical Analysis?

DONALD R. DIETZ AND RICHARD D. CURNOW

Wildlife Biologist and Range Aid, Rocky Mountain Forest and Range Experiment Station, Forest Service, U. S. Department of Agriculture, Rapid City, South Dakota[1]

Highlight

Material collected from aspen and mixed meadow grasses was sent to four nutrition laboratories for chemical analysis. The results obtained were closely comparable in most cases, but some discrepancies were noted, especially for one laboratory.

[1] *Central headquarters maintained in cooperation with Colorado State University at Fort Collins. Research reported here was conducted in cooperation with the South Dakota School of Mines and Technology at Rapid City.*

Many workers interested in the nutritional content of range forages have questioned the reliability of chemical analyses performed by various laboratories. Although most laboratories use A.O.A.C. (1960) methods, these are often modified. There is also variation in the way technicians operate equipment, mix reagents, and observe chemical endpoints. Thus one might expect results to vary widely. Schneider and Lucas (1950) reported that variations in nutritional results were due to many factors, including differences between laboratories.

To determine the extent of variability between different laboratories, we sent samples of the same plant materials to four laboratories. The laboratories were not informed they were being checked on, nor were they questioned on the testing procedures employed. The laboratories have been designated A, B, C, and D in this paper.

Samples of aspen (*Populus tremuloides* Michx.) and mixed meadow grasses (mostly *Poa pratensis* L. and *Phleum pratense* L.) were collected in September 1963. The air-dry material from each sample was ground in a laboratory mill and thoroughly mixed. This material was separated into equal parts of approximately 40 g each, bottled and sent to each of the four laboratories. Determinations in duplicate for percent protein, calcium, phosphorus, moisture,

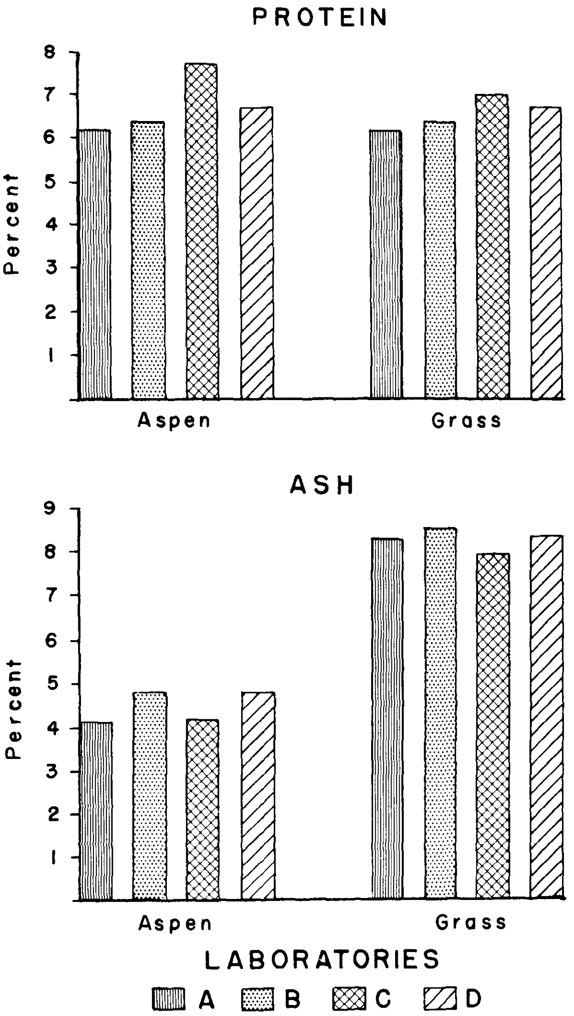

FIG. 1. Comparative protein and ash percentages for similar samples of aspen and mixed meadow grasses reported by four laboratories.

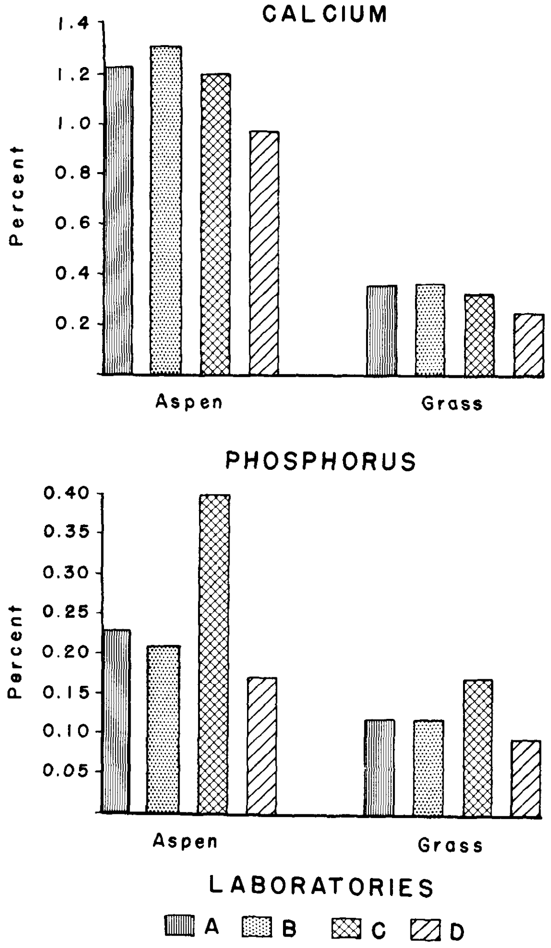

FIG. 2. Comparative calcium and phosphorus percentages for similar samples of aspen and mixed meadow grasses reported by four laboratories.

and ash were requested. The plant material was assumed to be homogeneous as each sample was made up of portions of individual plants and was subjected to thorough grinding and mixing. This lack of variation in sample material was shown by the precision between duplicate samples reported by laboratories. Results of the laboratory analyses presented in Fig. 1 and 2 are averages of duplicate samples.

Protein percentages reported for aspen by laboratories A, B, and D showed relatively close agreement. The protein content for aspen reported by laboratory C was 26% higher than for laboratory A and 15% higher than the mean of the 4 samples. Protein percentages of the grass mixture reported by the four laboratories had a fairly even distribution.

A comparison of the ash determinations for aspen showed laboratories A and C grouping closely together below the mean, while B and D grouped closely together above the mean (Fig. 1). The four laboratories reported an even distribution of ash percentages for the grass mixture, all within a narrow range.

The calcium percentages reported for both samples were close with the exception of laboratory D, which reported a 44% lower calcium content for the grass mixture than laboratory B and 28% lower than the mean.

Phosphorus percentages for laboratories A and B showed very close agreement. The results of laboratory D were also close to those of A and B. The phosphorus percentage for aspen determined by laboratory C was 135% higher than that reported by laboratory D and 60% higher than the mean. Laboratory C also reported a 70% higher phosphorus value for the grass sample than laboratory D and a 31% higher percentage than the sample mean.

In general the results of the four laboratories, as can be seen in Fig. 1 and 2, are fairly close. The protein percentage for aspen and the phosphorus percentages for both aspen and grass appear, however, to be high by laboratory C. Also, the calcium percentage for grass reported by laboratory D is low in comparison with results from the laboratories.

Besides discrepancies in results among different laboratories, individual laboratories may not be consistent in their results over a period of time. While not tested in this study, this type of error should be investigated. Many technicians and ranchers regard nutritional analyses of feeds and range plants as absolutely accurate and never suspect the results may be in error. This could lead to several types of difficulties. In the one case, a feed of adequate nutritional value could be incorrectly reported as deficient in one or more nutrients. This could result in unnecessary and expensive supplementation with little or no additional animal response. For example a rancher with ewes in early lactation on bluegrass and timothy range might unnecessarily feed a calcium supplement based on the 0.25% calcium reported by laboratory D. The actual calcium was probably between 0.30 and 0.35% which exceeds the 0.28 to 0.30% recommended for ewes in early lactation given by the National Academy of Sciences-National Research Council (1957).

In another case a rancher with ewes in the last weeks of gestation might fail to feed phosphorus supplement based on the 0.17% phosphorus reported on the grass mixture by laboratory C. This could result in serious and costly consequences because the true phosphorus content was likely in the 12 to 13% range which is deficient.

If the animals show signs of a nutritional deficiency while on a reportedly adequate diet, then analysis should be immediately suspected and rechecked.

The charges for nutritive analyses of the forage samples varied greatly. One laboratory (publicly supported) charged $5.00 for a complete sample analysis for protein, moisture, ash, calcium, and phosphorus—all tested in duplicate. At the other extreme, a commercial laboratory charged $18.50 for the same sample. The other laboratories charged or reported costs somewhere between these figures.

These limited comparisons indicate one can expect the results of nutritional analyses to be reasonably reliable, but occasionally individual results may be misleadingly high or low. This possibility must be considered when reporting, reading, and using results of nutritional analyses. It indicates a need for laboratories to check their analysis results periodically with at least two other laboratories on selected identical samples and for technicians and ranchers to suspect analyses which appear contradictory to animal responses.

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Chemical Control of Alpine Avens

DIXIE R. SMITH AND HAROLD P. ALLEY

Plant Ecologist, Rocky Mountain Forest and Range Experiment Station, Forest Service, U.S.D.A.[1] *Laramie, Wyoming; and Associate Professor, University of Wyoming, Laramie.*

Highlight

Both 2,4-D and 2,4,5-T at 1, 2, and 3 lb/acre gave about 98% control. By the third growing season, grasses filled voids left by avens and other forbs.

The sedge-hairgrass community is the most extensive and productive vegetation of the alpine zone in Wyoming. Alpine avens (*Geum rossii* Ser.) is always an important component of the community, and at times may dominate it (Johnson 1962; Johnson and Billings 1962; and Marr 1961). However, alpine avens is seldom palatable to sheep or other grazing animals.

Chemical control of big sagebrush (*Artemisia tridentata* Nutt.) at lower elevations has changed the vegetative composition and substantially increased forage yields (Alley and Bohmont, 1958). Because of the similarities in abundance and palatability, an analogous hypothesis was advanced for chemical control of avens. The purpose of this preliminary study was to compare two standard chemicals and four rates of application as a means of control.

Methods and Procedures

Study areas were located on the Medicine Bow Mountains about 40 miles west of Laramie, Wyoming. Elevations of the study areas ranged from 10,500 to 11,000 ft.

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[1] *Central headquarters maintained at Fort Collins, Colorado, in cooperation with Colorado State University; research reported here was conducted at Laramie, Wyoming in cooperation with the University of Wyoming.*

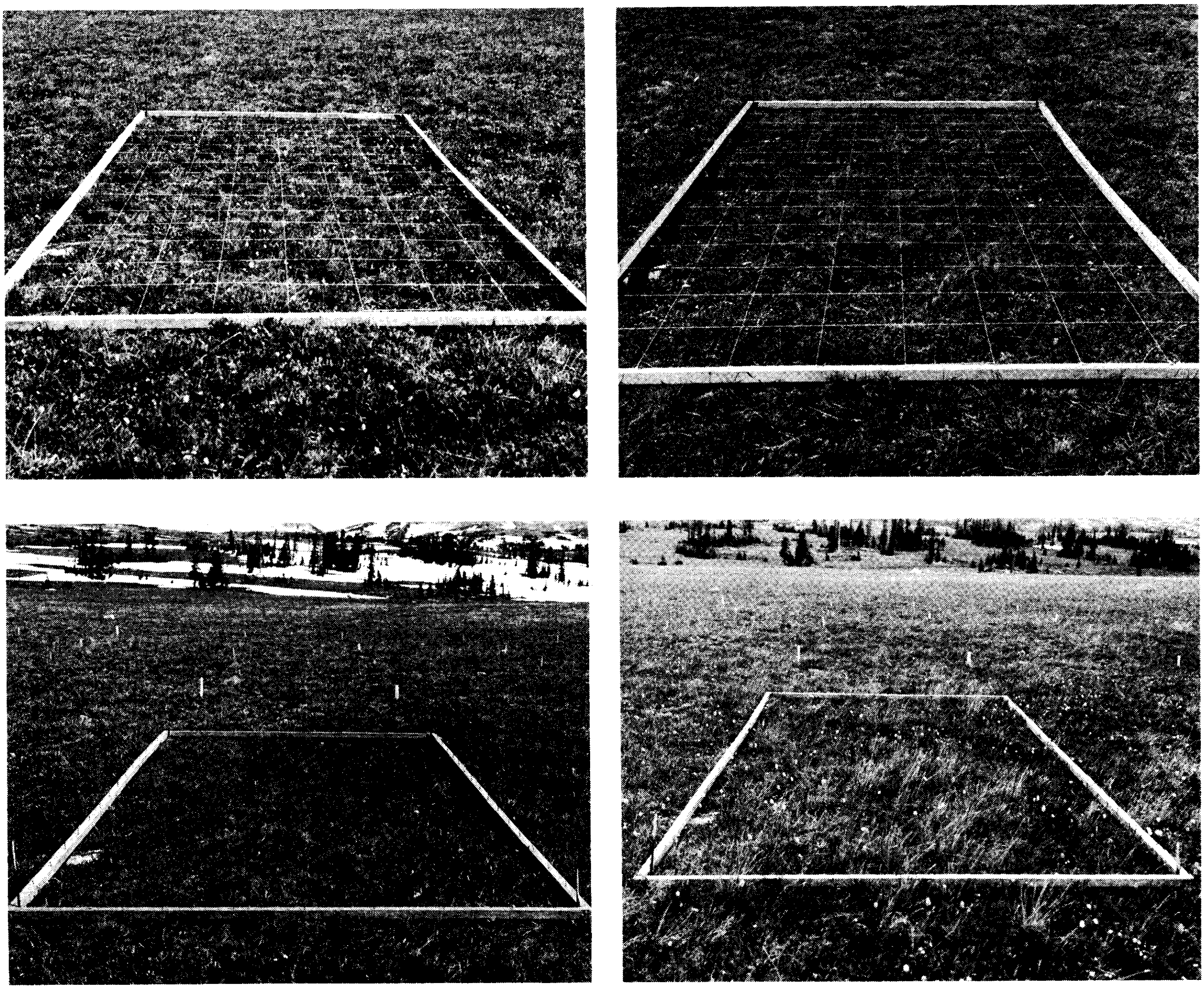

FIG. 1. Effects of avens control on associated vegetation: (Upper left) Pretreatment, July 1963, (Upper right) Posttreatment, August 1963, (Lower left) Posttreatment, June 1964, and (Lower right) Posttreatment, August 1965.

Treatments consisted of a factorial arrangement of 2,4-D and 2,4,5-T at rates of 0, 1, 2, and 3 lb/acre of active ingredient. Both herbicides were applied in the form of propylene glycol butyl ether ester. X-77[2] was used as a wetting agent at the rate of 0.1 pint/20 gal of solution. All treatments were applied in water plus wetting agent at a total volume of 20 gal/acre. The applications were made with a hand sprayer.

The basic experimental design was a randomized complete block with four replications. Experimental units were 8 by 16 ft with buffer strips 10 ft wide between units.

The response of avens to treatment was measured by plant density counts immediately before spraying and the following summer. The counts were made on a sample of twelve 1 x 1 ft subsample per experimental unit.

Results

Carbohydrate reserves in avens are depleted by early shoot growth. After early bloom there is a rapid accumulation of carbohydrates in the rhizomes and roots (Mooney and Billings, 1960). This annual cycle suggests that phenoxy herbicides would be most effective if applied just before early bloom. However, access to these high elevations is limited by large snowdrifts until July. Applications were made on July 2, 1963 and about July 12, 1964. On these dates, avens was in an early bloom stage.

The application of herbicides drastically decreased the density of avens. The two herbicides were equally effective both years. Rates of 1, 2, and 3 lb/acre were, with one exception, also equally effective, and all rates resulted in about 98% control. The 1963 application did show that the 1 lb/acre of 2,4,5-T was 9% less effective than the 2 or 3 lb rates. The difference, although statistically significant, was of little practical significance and the 1964 application failed to substantiate its existence.

The response of associated vegetation to avens control must be determined thru additional research, but some evidence is obtained by the

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[2] *Trade names and company names are used for the benefit of the reader and do not imply endorsement or preferential treatment by the U. S. Department of Agriculture.*

analysis of repeat photographs (Fig. 1). These observations indicate that forbs associated with avens are largely eliminated from the vegetation. The amount of bare ground is increased during the first and second growing season, but by the third growing season, tufted hairgrass (*Deschampsia caespitosa* (L.) Beauv.) and other grasses fill the void left by forbs.

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BOOK REVIEWS

Nutrient Minerals in Grassland Herbage. By D. C. Whitehead. The Grassland Research Institute, Hurley. *Mimeo. Pub. No. 1/66. Commonwealth Bureau of Pastures and Field Crops, Hurley, Berkshire. April 1966. $2.25.*

This publication is a literature review of the need for and effect of mineral nutrient fertilizers in humid area pastures. The effect of mineral nutrients on animal performance is stressed. It contains many references (226) and few general conclusions. Since the information is particular rather than general in nature it cannot be abstracted here with any justice to the author. The majority of the references listed are later than 1960 so the work is certainly up to date. Geographically the references are almost entirely limited to the British Commonwealth, Eastern United States, the Low Countries of Europe, and Cambodia. Researchers and graduate students working with fertilizers and mineral nutrition of animals in humid and irrigated areas will find this a valuable publication, others will find it of little interest.—*Donald A. Jameson,* Rocky Mt. Forest and Range Exp. Sta., Flagstaff, Arizona.

Pastoral Plants of the Riverine Plain. By J. H. Leigh and W. E. Mulham. *The Jacaranda Press, 73 Elizabeth Street, Brisbane, Queensland. 154 p. 1965. $10.50.*

The purpose of this book is to describe the grasses, herbs and shrubs of the Riverine Plain in Australia for the grazier and the administrator. The format consists of a guide to identification based on gross characteristics, illustrations and descriptions of 270 plants, a bibliography and an index. The plants are illustrated with 120 color photographs, 100 line drawings, and 50 black and white half-tones. The recommended common name, scientific name and family, and other common names are given in order for each species. A description which includes longevity; growth form; leaf, flower and fruit characteristics; habitat and distribution; season of growth; forage value; reaction to grazing; and means of control are presented in clear, brief statements. This book will be helpful for the man in the field in identifying plants, interpreting their reactions to grazing, and in outlining systems of grazing management.—*A. C. Everson,* Colorado State University, Fort Collins.

NEW PUBLICATIONS

FARMING TECHNIQUE FROM PREHISTORIC TO MODERN TIMES.—G. E. Fussel reviews the development of farming methods, implements, crops, cropping systems, land drainage, fertilization, and livestock husbandry in this interesting and novel book. The review is restricted to the Middle and Near East for the early stages of farming, then expands to include Western Europe and America. In each chapter of time, the author describes the historical setting and social development in which changes in farming were invented. Pergamon Press, Long Island City, New York 11101. 269 p. 1966. $4.95.

MANAGEMENT NOTES

Efficiency in Rangeland Production

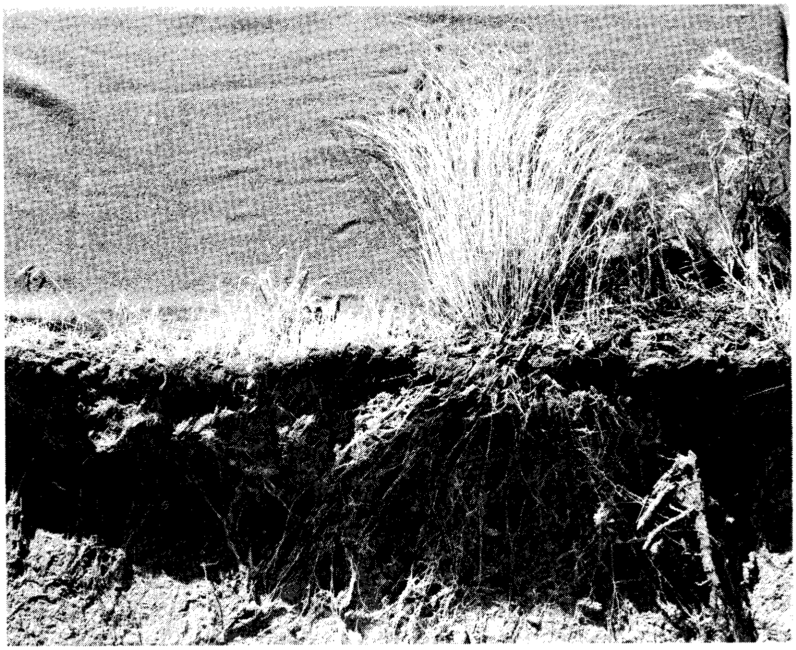
E. WILLIAM ANDERSON

Oregon Range Specialist, U.S. Soil Conservation Service, Portland, Oregon.

Three blades of grass where one grows now. In some situations this sort of prediction is unrealistic. In this case, it is reasonable.

Illustrated are two examples of the same range site and soil located about 100 feet apart in Gilliam County, Oregon. An ownership fence separates them. Both areas represented are harvested by cattle each year, but in different ways. The FAIR condition class area (top) has a safe initial stocking rate of about two acres and the EXCELLENT class area (bottom) about 0.75 acre/cow month. Weights were about 350 vs 1275 lb/acre air dry, clipped to simulate safe use.

The soil profile in FAIR is only partially occupied by roots whereas the soil is fully occupied by roots in EXCELLENT condition class. This suggests only partial use of the available moisture and nutrients each year under FAIR condition. Three deep-rooted native bunchgrass plants *(Agropyron spicatum* and *Festuca idahoensis)* grow thriftily in the same space under EXCELLENT as one bunchgrass plant *(A. spicatum)* under FAIR condition class. Nearly all of the productiveness under EXCELLENT is devoted to deep-rooted, high-quality bunchgrasses. Under FAIR, annuals and shallow-rooted, low-value grasses and shrubs use up much of the productiveness of the site. Under EXCELLENT the soil is stable as indicated by the straight-line surface. Under FAIR the wavy surface represents loss of topsoil and long-lasting depletion of the basic resource.



Each year the FAIR area was grazed in the spring and early summer while water was available in nearby Hay Creek. This resulted in grazing for nearly the full growing season of the key species annually. The owner of the EXCELLENT area developed a spring which provided a season-long water supply. As a result, this area was reserved for summer grazing every other year when the adjacent cropland was in wheat. It was grazed in the spring in alternate years when the cropland was fallow. On both areas the forage crop was harvested annually, but in different ways.

The factors of range management which result in such examples of FAIR versus EXCELLENT are basic to maintaining or improving the grazing resources. These factors include: (1) A rest from grazing for the full growing season once every three to five years, which allows the key species to maintain or improve vigor and stand; (2) Change season of grazing in consecutive years, where practical, to avoid grazing an area at the same season year after year; (3) Delay spring turn-out until the key species have six to eight inches new leaf growth and the soil surface is not so wet as to be damaged by trampling; and (4) Leave sufficient growth on key species to maintain their vigor and to minimize soil and water losses. These factors are represented by the range practices known locally as Deferred Grazing and Rotation of Deferred Grazing, Range Readiness and Proper Use.

On numerous occasions over a period of more than 20 years, these factors have been discussed and observed indoors and out, both scientifically and practically, by Northwest rancher-technician groups. Generally, more rangelands still are represented by the FAIR example than by the EXCELLENT. In contrast, during this same period of time, remarkable improvements have been made widespread in quality of livestock, machinery, equipment, and marketing.

Economic considerations of range production are important, too. The property tax per acre is the same on each example. The cost of improvements necessary for grazing livestock on each is reasonably the same. The cost of operating a cow unit is the same on each and, in fact, may favor the EXCELLENT because it takes less area per cow-month of grazing. The investment in land is about the same on each since both would sell for a going price per acre which is as high as the seller thinks he can get irrespective of quality or quantity of forage.

The returns differ markedly, however. Theoretically, the FAIR produces about one third that of the EXCELLENT.

In a comparable situation of cost and returns within an industry, the efficiency of the producing unit certainly is evaluated carefully. Steps are taken aggressively to improve the efficiency of production and thereby narrow the margin between costs and returns. The object is to increase NET PROFIT.

Much attention has been devoted over the years to improving the production efficiency of range livestock. This is true also of ranch machinery, farm forage crops, transportation and marketing. It is obvious that there is a general need for greatly increasing the attention given to improving the production efficiency of the land. For some ranches the time to do this is NOW.

(Author's note: For details on how to prepare plant monoliths, see J. Range Manage. 4(5):323-326, September 1951).

A Rancher's Success with Continuous Deferred Grazing in Washington State

CLAUDE C. DILLON AND DANIEL WALLENMEYER

Range Conservationist and Work Unit Conservationist, Soil Conservation Service, USDA, Spokane and Ritzville, Washington.

Highlight

Deferred or very light grazing is an excellent way to manage bluebunch wheatgrass range in low rainfall areas of eastern Washington. The success of Ralph Snyder, rancher near Benge, Washington, is due to his practicing deferred grazing on his ranges since 1955. Range conditions have improved greatly and the cow months of grazing have increased from 1,000 to 2,310.

Current results of range management on ranches in low rainfall areas (7 to 15 inches) of eastern Washington indicate that deferred grazing or very light grazing during the spring green growth period is important to improvement of bluebunch wheatgrass (*Agropyron spicatum*) rangelands. When we were assisting a rancher with his range management plan last fall, we observed improvements so great in the condition of bunchgrass ranges that we thought the story should be passed along.

Ralph Snyder, cattle rancher near Benge, Washington, a long-time member of ASRM, by improving range condition since 1955 has more than doubled the forage yields on his ranges. His ranch, located along Cow Creek in southeastern Washington, consists of 6,500 acres of rangeland, with an additional 225 acres of irrigated pasture. Alflafa hay, used to supplement range in winter, is raised on an irrigated unit in the Columbia Basin. The basic cattle herd consists of 410 brood cows, 13 bulls, and 200 yearlings. Cattle numbers are varied seasonally to meet differences in range forage production.

The annual precipitation at the Snyder ranch is 10 to 15 inches with about two-thirds falling during the winter months. Temperatures range from as low as −15 to 100 F. Summers are usually hot and dry. The main growth period for the range grasses is from mid-April to mid-June.

The rangelands on the ranch are composed of channeled scablands

Fig. 1. Discussing plan on 6500-acre Snyder ranch in fall, 1965, Washington State. L. to R. Dan Wallenmeyer and Claude Dillon of SCS and owner Ralph Snyder.

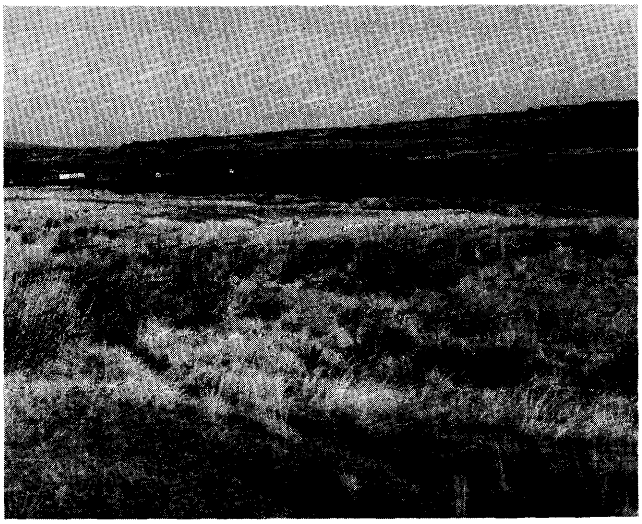


Fig. 2. Headquarters of Ralph Snyder ranch. Note basin wildrye and bluebunch wheatgrass in foreground.

and open bunchgrass plains. The scablands contain small "pothole" like alkali meadows. Bluebunch wheatgrass, basin wildrye *(Elymus cinereus)*, and inland saltgrass *(Distichlis stricta)* are the primary forage plants in these meadows. The open bunchgrass plains produce bluebunch wheatgrass with an understory of Sandberg bluegrass *(Poa secunda)*.

Snyder uses these ranges primarily for fall and early winter grazing; summer grazing is limited mainly to the saltgrass of the alkali sites. Cattle are usually kept off the ranges from February through June. They are fed alfalfa hay during winter and early spring until the irrigated pasture is ready the first part of May. Alfalfa hay is also used to supplement range for weaner calves when grasses are dry. Snyder says that shortening the winter feeding period with improvement of bluebunch wheatgrass has enabled him to graze cattle during December and January. The total amount of alfalfa hay used for winter feeding and supplement to range is about one ton/AU/year. This is approximately the same amount per animal that was used prior to range improvement, when more hay was used in the winter feedlot and none was used to supplement the dry ranges.

As a cooperator of the Ritzville Soil and Water Conservation District, Snyder received a range site and condition survey and conservation planning assistance from the Soil Conservation Service in 1955. A new survey in 1965 showed that most of the poor condition range had improved to fair; the fair condition range of 1955 had improved to good, and in some places excellent, condition.

The cattle stocking rate totaled 1,000 cow months of grazing from rangeland in 1955; this had increased to 2,310 cow months of grazing in 1965. During this period, if a pasture had to be grazed during June, it was only lightly grazed and was deferred from grazing the next spring. The range management Snyder has been practicing during the past 10 years is summed up in his own words: "We try not to use the grass too close . . . When we quit grazing our bunchgrass during May and June, it really started to come." His statement refers to two basic practices as understood by range technicians—proper range use and deferred grazing.

The increase in stocking rate, concurrent with striking improvements in range condition is evidence that bluebunch wheatgrass can make rapid improvement with deferred or light spring grazing. Indications are that refraining from spring grazing entirely in dry years may be the best way to improve bluebunch wheatgrass ranges in this area. Three years of experimental clipping of bluebunch wheatgrass in the spring reduced yield 70% in the fourth year (Wilson et al. 1966).

Snyder's bluebunch wheatgrass stands improved rapidly when used only for fall and winter grazing, with spring grazing deferred. Perhaps spring grazing of bluebunch wheatgrass ranges should be limited to areas where Sandberg bluegrass and cheatgrass brome *(Bromus tectorum)* are present. Cattle prefer these two species during the green growth period, and grazing them during the spring would leave more moisture for the bluebunch wheatgrass.

It is well-known that grazing during the growing season upsets normal plant growth and development. The morphology of bluebunch wheatgrass makes it vulnerable to damage when grazed during the spring growing season. The leaves grow from higher up on the stems than many grasses. When leaf "sugar factories" are excessively removed, root reserves are called on to replace them. This means that the time schedule for production of seed is set back and root growth is restricted (Harris, 1957).

The growing season is short for bluebunch wheatgrass in climates like that of the Snyder upland range. Lack of moisture is the dominant limiting factor of growth. Temperatures are not warm enough for much growth before May 1, and the moisture usually runs out by the middle of June. It could very well be that low-vigor bluebunch wheatgrass needs all of its leaves in order to improve, especially when the stand has been invaded by cheatgrass.

We conclude that bluebunch wheatgrass ranges in low rainfall areas of eastern Washington will improve most rapidly when other pastures or feed are provided during May and June, the main growth period. We recommend that whenever possible, bluebunch wheatgrass in this area should be rested during the spring in years of low forage production, especially where stands are weak. Deferred grazing assures fast recovery for bluebunch wheatgrass ranges for soil and water conservation and improved forage production.

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Range Production Improved by Renovation and Protection

ALBERT P. THATCHER

Range Conservationist, Soil Conservation Service, USDA, Casper, Wyoming.

Highlight

Herbage yield increased approximately 100% by discing rangeland in eastern Wyoming where remnants of western wheatgrass and green needlegrass remained as part of the plant association. This increase came about through a decrease in the amounts of blue grama and big sagebrush. Protection from grazing allowed these mid-grasses to become established.

The classification of the rangeland of eastern Wyoming as "Central Great Plains Shortgrass," by Klipple and Costello (1960), and "Shortgrass Range," by Lang et al. (1956), and others would indicate that the potential for the natural grasslands is shortgrass. Their classification is justified on the basis of a frequency sampling procedure.

The short grasses blue grama, buffalograss, and threadleaf sedge are important constituents of the vegetative associations. However, when the vegetation is in excellent condition (75% to 100% of edaphic climax) and measured by the weight of the annual herbage produced, it is found that in eastern Wyoming most range sites will be dominated by the midgrasses—western wheatgrass, needleandthread, and green needlegrass. A list of common and scientific plant names is shown in Table 1.

Because the decline of the taller growing species in many cases has been gradual, coupled with the inability of these plants to reestablish quickly when deferment and proper use are practiced, many ranchers be-

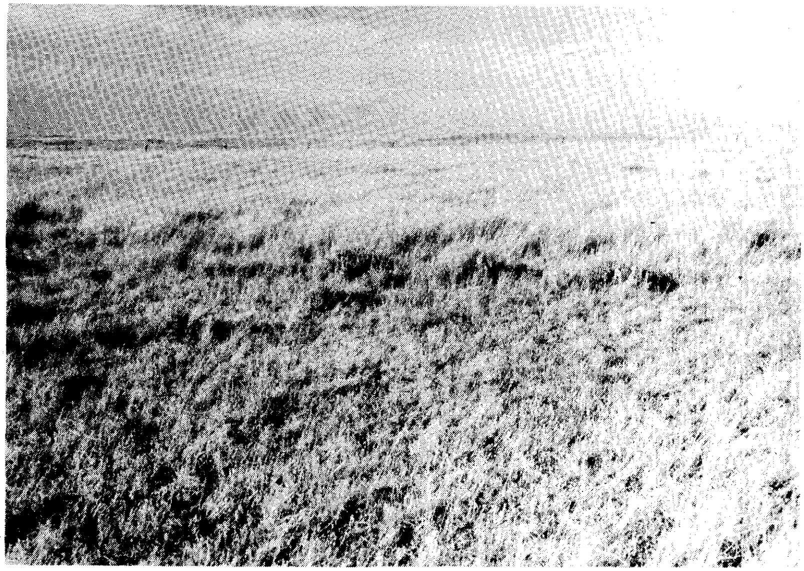

FIG. 1. Comparison of renovated range (background) and undisturbed range (foreground). Renovated area treated in 1960; both areas protected since that time.

Table 1. Herbage yield (lb/acre, airdry) on undisturbed and renovated rangeland areas in eastern Wyoming (Campbell County)[1].

	Undisturbed		Renovated	
	1964	1965	1964	1965
Western wheatgrass *(Agropyron smithii)*	200	140	850	900
Blue grama *(Bouteloua gracilis)*	190	140	0	0
Sandberg bluegrass *(Poa secunda)*	10	15	0	0
Green needlegrass *(Stipa viridula)*	20	20	200	300
Cheatgrass brome *(Bromus tectorum)*	15	10	30	20
Sixweeks fescue *(Festuca octaflora)*	10	10	20	15
Woolly plantain *(Plantago purshi)*	10	10	0	0
Hoods phlox *(Phlox hoodii)*	20	25	0	0
Big sagebrush *(Artemisia tridentata)*	110	100	0	0
TOTAL	565	470	1100	1235

[1]Data from ten clipped plots (each 9.6 ft^2) along a 100-ft transect for each area.

lieve the shortgrasses are all their ranges can or should produce.

Many range experimenters have recognized that the mid-grasses can be increased through mechanical treatments. Rauzi et al. (1962) demonstrated an increase in lamb weight and in herbage production through range pitting. Hickey and Dortignac (1958) showed that soil ripping was highly effective in reducing surface runoff—which would increase herbage production.

Hubbard and Smoliak (1953) were unable to increase the productivity of range in Alberta, Canada, by constructing furrows 4 to 5 inches deep. Their explanation for lack of response was that the furrows were too shallow and readily silted full; also, the spacing interval was too great. Brown and Everson (1952) increased the productivity of Arizona desert rangeland 25-fold by constructing furrows. Remarkable changes in vegetation occurred in the area of the furrows with little change between the furrows.

In southwestern Campbell County, Wyoming, an interesting development has taken place which would indicate that the mechanical treatments we have applied in the past have not been as severe as they should have been. In the spring of 1960, a rancher decided to break out some rangeland to grow wheat. One area of the field was plowed and fallowed during spring and summer of 1960; this area was then seeded to winter wheat in the fall of 1960. Another area was disc-plowed one time in the spring of 1961. Still another portion of the field was left undisturbed. During the spring of 1961, the rancher then decided to abandon his farming venture. The entire area has been protected from grazing since that time. This a clayey range site in the Renohill clay loam, soil series.

The area that was plowed and fallowed for one year is now producing mostly cheatgrass brome with some islands of western wheatgrass. The area that was disc-plowed once produced a total of 1100 lb/acre air-dried herbage in 1964 and 1235 lb/acre in 1965 (Table 1). The area left undisturbed produced 565 lb/acre of herbage in 1964 and 470 lb in 1965. This undisturbed range is very similar to adjacent range that has been grazed throughout this period.

This demonstration indicates the following conclusions:

1. Disc-plowing of this area which had a remnant of western wheatgrass and green needlegrass increased herbage production approximately 100%.

2. Under protection from grazing, the dominants became established on the disced area.

3. Protection from grazing alone, for five years, showed no appreciable change in vegetation.

4. The common practice of pitting and furrowing of rangeland on clayey range sites of eastern Wyoming may not be as beneficial as disc-plowing. Further research appears needed.

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INTERNATIONAL NEWS

X International Grassland Congress

The X International Grassland Congress was held in Helsinki, Finland July 7-16, 1966. Finland was an appropriate location because the agriculture of the country is highly oriented to grassland production. Finland is one of the most northerly regions where modern farming is practiced. It has difficult problems not only related to the cold climate and short growing season, but also in land development, particularly drainage and soil fertilization. In today's world, with its rapidly-expanding population and increasing demands for food, advance of the agricultural economy and efficient production of animal protein are universally important. The Congress offered an exceptional opportunity for exchange of information among the World's leading scientists dealing with all aspects of grassland research and management, including animal production.

The Congress was attended by 408 registered members representing 43 countries. The United States had 62, more than 20 of whom are concerned with range, and about 20 associate members, wives and children over 16. Five members of the 7-man Official

US Delegation are interested in range.

The formal scientific program was headquartered at the newly-constructed Porthania Hall, University of Helsinki. The building was well-suited for the meeting. Four 6-day Pre-Congress Tours were held involving visits to farms, forests, and grassland experiment stations. Three were mainly to southern Finland; the fourth was to mid-east and north Finland. A Post-Congress Tour of five days was made to north Finland and Lapland. It covered work mainly under way at the Polar Circle Agricultural Experiment Station and the Kevo Sub-Artic Research Station of the University of Turku on grasslands and leys for grazing, hay, silage, animal husbandry, and forestry. The tours were well planned and conducted so as to present a good cross-section of the country, its agriculture and industries, its people and their way of life. Interpreters on the tours were capable and well-informed.

American Society of Range Management exhibit at X International Grassland Congress, Helsinki, Finland, July 1966. Dr. R. Milton Moore (left), delegate from Australia, receiving information brochure from Dr. Don Cornelius, ASRM representative to the Congress.

Eleven plenary papers and 290 scientific papers were presented. Scientific papers were arranged in four sections with a separate lecture hall for each: 1.) Grassland Production. 2.) Grassland Utilization. 3.) Plant Breeding and Seed Production. 4.) Improvement of Grass Production and Utilization on Natural Grassland in Different Climates. There were a total of 63 papers by authors from the U. S. A., including two now with FAO in Rome. Eighteen of these were presented in the Section 4 program dealing with natural grassland. A total of 45 papers were presented in this section from all continents. Seventeen Americans also served as Chairmen of various sessions. All papers were printed in preliminary form and available to all members at the start of the meeting.

The Congress began with a welcome by Prof. Jouko Vuorinen, Chairman of the Organizing Committee. N. Kaasalainen, Minister of Agriculture, pointed out that in Finland about 80% of cultivated fields are devoted to production of livestock feed, mainly red clover-timothy; pasture development has increased rapidly, particularly since World War II; climate requires an 8-month indoor feeding period; and the uneconomic practice of forest grazing has been abandoned on some 5 million ha.

Plenary papers covered such subject matter as: Production and utilization of grass in Finnish agriculture, possibilities of increasing grassland production with nitrogen fertilizers in European agriculture, and efficiency of dairy farming in different environments. Two of the best were: "Investment development in grassland" by C. P. McMeekan of New Zealand, formerly with the World Bank, and "International training center for grassland research" by Roald A. Peterson, FAO, Rome.

Technical papers were devoted to plant physiology, plant breeding and genetics, nutritive value of forage and silage, grazing intake, nutrition of grazing animals, pasture and range (including forest lands) management and improvement, varying climatically from humid to arid and tropical to subartic, and research techniques.

Receptions were given by the City Council of Helsinki, the Minister of Agriculture, and by the Rikkihappo and the Typpi Corporations. There was also a Congress Dinner. Finnish Folk Dances and Folk Music were also presented at the Outdoor Museum. Visits were made to several experimental farms during the regular Congress period.

The XI International Grassland Congress will be held in Australia in the spring of 1970.—*Kenneth W. Parker and Donald R. Cornelius.*

The Fund For Overseas Research Grants and Education, Inc. (Forge)

This non-profit, tax-exempt foundation offers grants to Latin American university teachers of science and engineering to help them do independent research. Emphasis is on helping younger, recently-trained faculty to start projects of promise for worthwhile results and effective teaching. Funds go directly to the researchers for supplies, equipment and student assistants.

FORGE, established in 1963, is supported by private corporations and individuals. The amounts granted are modest, averaging $2000 or less. They are given on the assumption that small amounts of U. S. currency may be used with great advantage in institutions in developing countries. The grants are based on scientific merit, need, and reasonable promise of fruitful results. Applications are evaluated by professional judges and the evidence reviewed by a Grants Review Panel of scientists and educators.

FORGE welcomes individual proposals for support of research of purely academic interest but is also concerned with well-thought-out proposals for practical research related to the problems of development of a country. It is in this latter category that most projects relating to range management would appear to fall. Executive Director Alfred Kelleher has stated FORGE would be willing to consider range proposals if they meet the requirements.

In view of the great need for ecology and range management teaching in Latin American Universities, it is hoped that capable professors will consider this possibility for furthering their activities. FORGE espouses the concept that meaningful, independent, active faculty research, with students involved, develops scientific and technological strength at university level, ensures better teaching in science, and contributes to the broader technological base necessary to a strong modern economy.

FORGE suggests that rather than provide an application form without knowing if a proposal would be competitive, they would prefer that a prospective applicant write first about the proposed project, covering the following information:

1. Significance of the research (academic, practical or both).
2. Plan of procedure.
3. Degree of student participation expected.
4. Relationship to other work of the writer or his colleagues.
5. Nature of research support and facilities already available.
6. A budget outline.
7. Rank and training of prospective applicant.

With this information FORGE can advise whether the proposal is outside its interests or, if it qualifies, provide application forms.

In order that the International Relations Committee of ASRM may be kept informed and be in a position to offer assistance, it would be glad to receive a copy of any range proposal which may be made.

Additional information is available from the Executive Director, FORGE, Room 4310, 60 East 42nd Street, New York 10017.

Bettering Range Management in Developing Countries

If number of American range men on overseas assignments can be taken as a criterion of progress in range management and improvement, 1966 should prove one of the best years. The continuing programs of the Agency for International Development of the State Department and the expanding program of FAO under the able leadership of Dr. Roald A. Peterson, Chief of the Pasture and Fodder Branch of the Plant Industry Division, indicate real possibilities. There is also correlative support in wildlife management under T. A. Riney, formerly of FS, in charge of wildlife conservation in the Forest and Forest Products Division of FAO.

Assignments and something as to responsibilities by countries is as follows, although this listing may be incomplete:

Argentina. E. J. Woolfolk, FS retired, is continuing for FAO as head of the UN Special Fund, now UN Development Program, project at Concepcion del Uruguay. Orval Winkler, FS retired (January Journal note), is also with FAO in Argentina.

Australia. Harold F. Heady, University of California School of Forestry (May Journal), is on a Fulbright Foundation grant at the University of Queensland, Brisbane.

Brazil. Dwane J. Sykes is handling the Pasture and Soil-Plant Moisture Relations research program for the Purdue Project, AID contract, at the Rural University of Minas Gerais, Vicosa. Robert R. Humphrey, Advisor, Forage Crops and Range Management, completed his assignment under the University of Arizona AID contract with the University of Ceara, Fortaleza. Two SCS soil scientists with AID are also making soil surveys and training Brazilians in that work.

Leland (Bud) Fallon, BLM, is in Rio de Janeiro with AID, setting up a Youth Corps. It is intended that 50,000 boys will work and receive training in resource conservation, road construction and other worthwhile endeavors. This corps will be patterned after a Youth Corps in Kenya which Bud actively organized and put in operation. *Ghana.* R. E. Genelly, FS, is in Accra on wildlife management.

Iran. Kenneth Pearse, formerly of FS, until recently assistant to Peterson in Rome, has transferred to take charge of the FAO program on range management and reseeding under dry land conditions, in cooperation with the Ministry of Agriculture. Charles A. Graham, FS, is also working on that program.

Jordan. B. C. Park, FS retired, is with FAO conducting training and demonstrations in range and forest management and afforestation.

Kenya. FAO has a major UN Development Program project aimed at development and efficient use of the vast Kenyan rangelands and wildlife. It is handled in cooperation with the Range Management Division of the Ministry of Agriculture. Victor L. Bunderson, FS, is the project manager. John T. Cassady, FS, and John Thilenius, FS, are there as range management and ecology advisors. Robert Casebeer, FS, and R. N. Denny, Colorado Game, Fish and Parks Department, are wildlife biologists. Calvin C. Boykin, Texas A&M College, is there on range economics. David R. Bishop, FS, handles range education. Also Joseph H. Robertson, University of Nevada, and Chandler V. Jensen, SCS retired, (March Journal) have conducted a range management course under the West Virginia University AID contract at Egerton College, Njoro. *Korea.* Kenneth Platt, formerly of BLM, is on range and related work with AID.

Laos. Don Davis, SCS retired, is Food and Agriculture Officer with AID.

Mali. Merrill Carter, SCS, under Participating Agency Service Agreement, AID, spent 2 months considering the range situation and proposing a suitable program.
Morocco. Merrill Carter, SCS PASA AID, spent 2 months examining rangelands and proposed a program.

Nicaragua. Gerald Darby, SCS, is working on pasture and range development with AID.

Nigeria. Under the BLM, PASA program with AID has intensified during the last 2 years. The purpose is to assist the Nigerian Government in the formulation and development of a program of range management and grazing administration, especially in the northern provinces. A new grazing law has recently been passed, and this effort aims to help implement that law. Edward F. Spang is the leader. Jack McIntosh and Rex Hendryx are assisting, and Kelly Hammond will join them this winter. There are also engineers and heavy equipment operators primarily developing water and land treatments. Glen Fulcher conducted a review and evaluation of the program during the summer.
The government has requested BLM to conduct a school relating to range management principles. Floyd E. Kinsinger is developing a curriculum and a teaching outline for the course which will be given at Mando Road School, Kaduna. Virgil Hart, BLM, will follow on a 2-year assignment.
The government has also requested BLM for a team to make an in-depth analysis of its range program. Howard DeLano and Carl McCrillis have been assigned. Dave Thornburg of New Mexico will join the team to consider livestock credit and there will also be an agricultural economist.
The BLM PASA group have completed a report on Watershed/Management Plan, for development and use of the Wase Grazing Reserve and Central Wase and Zok Gaji Forest Reserves.
The SCS also has a PASA AID program for Catsina and Mubi areas of Nigeria concerned mostly with conservation on small land holdings. While there are no specific range personnel, range is carefully considered where it comes into the picture.
Paul Mast, FS, is also with AID as a range management advisor.

Pakistan. Norman French, formerly BLM, is continuing his range management and related work with AID in close cooperation with the Pakistan Forest Service. D. L. Goodwin, USU, is range management expert handling the UN Development Program, FAO, forestry research and training program at the Pakistan Forest Institute, Peshawar University.

Panama. Jack McCorkle, SCS retired, is handling consulting work on range.

Paraguay. Leon W. Kimberline, SCS, has been looking into the pasture and range problem for several months on a PASA AID program.

Saudi Arabia. Bill Allred, SCS retired, and R. J. Drabs, BLM, are on the FAO range, pasture, and livestock Trust Fund team with headquarters at Riyadh.

Somalia. Thad W. Box, Texas Tech, spent 6 weeks as a range ecology consultant for FAO.

Sudan. W. O. Shepherd, FS, is serving with FAO to help formulate a program for future expansion and development of the Range Management and Pasture Section of the Ministry of Agriculture and Animal Resources.

Thailand. Dale Schott, team leader, and Clyde Lowe, Darrell and Charles Bordsen of SCS are with the PASA AID program in the northeastern part of the country. There will be aspects of range and improved pastures.

Tunisia. A team of nine SCS representatives are working on a pilot watershed; work is being expanded to the entire country under the PASA AID program. Les Albee who was handling range management work throughout the country has become project manager for the Oued Marguellil Watershed Work Plan. He will also continue as range consultant. Durwood Ball has worked on range problems of the watershed and is handling a large grass nursery.

Turkey. Hugh Martin, FS, is a range management advisor in the AID forestry program. Don Cornelius, ARS, (July Journal) has completed his FAO assignment.

Uganda. Robert Sweet, BLM, is on range and related work with AID.
Zambia. Floyd Larson, formerly BLM, is on range and related work with AID. D. P. Patton is a wildlife biologist with FAO.

In addition to the range men from U. S. A. there are a number of animal husbandmen working on projects concerned with use of range lands. Also Ronald W. Peake of Lethbridge, Canada is with FOA in Uruguay.

Foreign Range Visitors to USA in 1966

In addition to the visitors from Canada, Mexico, and Venezuela at the annual meeting in New Orleans, some 37 or more range workers, who are nationals from other countries, were in the USA for various periods of 1966. A number of others interested in some degree in range problems were also here for training in subjects closely related to range. Most of the trainees from Africa and Asia were here under AID sponsorship. By countries, those known to the International Relations Committee were as follows:

Australia: Rolf Waldemar Albrecht, District Agronomist, Northern Territory, is spending approximately one year, considering among other things, range management and research. He will have visited work of the ARS, FS, and SCS in Arizona, New Mexico, Colorado, Utah, and Oklahoma.

Dr. N. H. Speck, Ecologist from Canberra, on the FAO staff in Argentina, spent several weeks during January in Florida, Arizona, and California on his way to Australia for home leave.

Ethiopia: Hale Astatke, a teacher in an Agricultural School is scheduled to attend Colorado State University.
India: Narsingh Dass Arora, studying range management and forage production at Ohio State University

for a PhD degree, spent the summer visiting the New Mexico and Texas Agricultural Experiment Stations and SCS work in Oklahoma.

Iran: Mowar Seraj, Head, Forage Plant Research Unit in Ministry of Agriculture will be in USA for a year as an FAO Fellow. He will observe range conservation and nursery practices of SCS in California, Montana, and Wyoming and will visit State Experiment Stations and ARS research in Oklahoma, New Mexico, and Colorado and finally spend 6 months in special study at Utah State University.

Kenya: Four undergraduates, three of whom were already assigned to aspects of the range management program are spending approximately one year of special study at California State Polytechnic College. This training is in support of the goal of utilizing and developing Kenya's range lands and strengthening its research. The four are Lucas Joseph Ayuko, Robert Kipyegon Langat, Arthur Meshak Chege, and Kimisik Albert Mutai.

Samson Lekakeny, an Agricultural Technical Assistant, Ministry of Agriculture, will complete his range studies at Colorado State University this year.

Nigeria: Nigeria had the largest number of range visitors of all countries.

Alhaji Tijjani Malumfashi, in charge of the range management activities of the Ministry of Animal and Forest Resources, Northern Regional Government, Kaduna, attended a special course in Pittsburgh, Pa., and then visited BLM work in Colorado, New Mexico, and Wyoming. Director Boyd Rasmussen presented the United States Technical Cooperation Program Certificate of Merit to Mr. Malumfashi.

Three area managers, Abubakar Zakari Bida, Mohamed Abubakar Balarabe and John L. Laven of the Ministry of Animal and Forest Resource, Northern Region, who received on-the-job training with the BLM team in Northern Nigeria will now work in BLM districts. Mr. Bida is being assigned to Malta, Montana; Mr. Balarabe to Boise, Idaho; and Mr. Laven to Vale, Oregon, until late October when they will each be reassigned to districts in New Mexico and Arizona. Mallam Isa Anka of the Sokoto Province Native Authority, Northern Nigeria, spent several months in BLM offices in Oregon and New Mexico.

Simon A. Iyange, a student at Montana University participated in FS work during the summer. Abdu Mohamed continued his range training at California Polytechnic College. Yerima Umaru Zambuk also continued his range training at Lincoln University, Missouri. Basiru Muh. Gwarzo, continued his studies and five other students arrived in August to start range training at New Mexico State University; Malami Gusan, Sani Kaliah, Samu Ibrahin Nadabo, Bello Sule, and Habidu Suleiman Suleiman.

Norway: Dr. Kristian Bjor, Ecologist with the Norwegian Forest Research Institute, Vollebekk, spent about two months with FS Experiment Stations in Washington, Oregon, California, and Utah considering watershed and wildlife problems, and particularly control of damage to forest trees from grazing.

Pakistan: Several Divisional Forest Officers from West Pakistan, completed their training. Ihaz Hussain received an MS degree at Utah State University and Muhammad Ashraf Hafeez completed special studies there, then observed SCS range conservation work. K. M. Shams completed his training at Colorado State University and then visited SCS work in Colorado and FS work in Utah. Safdar Ali and A. R. Khan have started studies at Colorado State. Mohammad Anwar Khan has started graduate range management studies at the University of Wyoming.

Somalia: Mohamed M. Awaleh completed range management training at University of Arizona, then visited FS and SCS work in Colorado and California.

Poland: Dr. Ryszard Dzreciolowski, Principal Investigator, in charge of the PL 480 project spent about five weeks considering wildlife and wildlife habitat research in North Carolina and Virginia, Texas, Arizona, Oregon, Washington, Montana, Colorado, and Michigan.

South Africa: Professor John Phillips of the University at Pietermaritzburg, is serving as a visiting Professor at the University of Pennsylvania and coordinator of a study group on the Delaware River Basin.

Sudan: Ali Darag Ali of the Ministry of Animal Resources, Elobied, completed his graduate work as an FAO Fellow at the University of Arizona.

Zambia: Solomon Kalulu, Minister of Lands and Natural Resources and Lazarus Petro Mwanza, Permanent Secretary of the Ministry of Lands and Natural Resources spent approximately one month in May. While their interests were broad, they visited a number of National forests and educational institutions considering multiple use management of forest lands, including range and wildlife management.

The International Relations Committee is anxious to know of all visitors directly interested in range management and improvement. If you know of others, please send information to W. R. Chapline, Chairman, 4225, 43rd St., N.W., Washington, D. C. 20016.

CENTO Working Group on Development of Ranges

A CENTO working group meets in Peshawar, West Pakistan, October 10-13, 1966, to discuss range management activities in Iran, Pakistan, and Turkey. The meeting is sponsored by the U. S. Economic Coordinators for CENTO Affairs. Pakistan will host the meeting.

The U. S. Delegation will consist of Hugh Martin, Range Management Adviser, USAID/Turkey, and Norman French, Range Management Adviser, USAID/Pakistan, Mr. A. Baron, Economic Adviser, CENTO Affairs, Turkey, Dr. John Norris, Colorado State University, and Robert S. Rummell, Forest Service, U. S. Department of Agriculture.

The Peshawar meeting will discuss recommendation of a 1964 Traveling Seminar on Range Management in the CENTO countries and other matters. The conference is preceded on October 6-7 by the Pakistan National Range Management Conference.

Enroute to Pakistan, Rummell will confer with Dr. Peterson of FAO in Rome and then visit range areas in Turkey in company of Hugh Martin, and with AID and FAO personnel in Iran.

NEWS AND NOTES

Material from many sources; not necessarily the opinion or position of the EDITOR or OFFICERS of THE AMERICAN SOCIETY OF RANGE MANAGEMENT

USDA Announces new SCS State conservationist for Utah—Algot R. Swanson of Portland, Oregon, will be the new State Conservationist for the Soil Conservation Service in Utah at Salt Lake City. Mr. Swanson succeeds Josiah Libby, Utah State conservationist since 1951, who is retiring after 39 years of Federal Service.

Thomas E. Bedell, awarded the PhD degree at Oregon State University in 1966, was appointed to the Range Management staff on July 1. Bedell's graduate research involved determination and evaluation of seasonal diets of grazing animals on subclover-tall fescue and subclover-perennial ryegrass improved pastures. This work is being continued and expanded currently as the range-pasture livestock economy in western Oregon is rapidly increasing. His teaching responsibilities include courses in Range Improvement and Range Plants.

Before coming to OSU for graduate work, Tom spent six years in the University of California Agricultural Extension Service as a Livestock-Range Farm Advisor. He holds a M.S. in Range Management from University of California, Berkeley, 1957, and B.S. in Animal Husbandry from California Polytechnic College, San Luis Obispo, 1953. Bedell has been an ASRM member since 1955.

James P. Blaisdell of Washington, D. C., was appointed Assistant Director for Range Management and wildlife habitat Research at Intermountain Forest and Range Experiment Station on July 31, according to Joseph F. Pechanec, Station Director.

Dr. Blaisdell, a westerner by birth, is a Forest Service career man and has specialized in range management and research. He has just completed nine years as Assistant Director of Range and Wildlife Habitat Research in Washington, D. C. He began his career as technician at the U.S. Sheep Station Experimental Range near Dubois, Idaho, and later was stationed at Missoula, Montana.

Jim graduated from Utah State University in 1939 with a major in range management. During World War II he served with the Corps of Engineers. Following wartime service, he obtained his MS degree at University of Idaho and his PhD in botany at University of Minnesota. He is a member of ASRM and other professional groups, and has published numerous articles and Government bulletins on range research.

Perhaps Our Approach is Wrong

Leroy J. Young, President, Texas Section

For many years I have been seeking an answer to the following question. If proper range management is as good as professional range workers know it to be, why haven't many more ranchers adopted good range management practices? Recently I have been wondering if our approach to ranchers concerning the adoption of good range management practices is based on factors that psychologically and economically lack the proper appeal. To give a specific example, when an SCS Technician begins working with a rancher on a ranch plan he will, in many instances, find that the range is overstocked. The rancher may or may not agree with this, but when the suggestion is made that the number of animal units on the ranch should be reduced, he loses the rancher right there. This is true despite the fact that the Technician may be able to cite examples of ranchers who have reduced their stocking rate and still made a greater net profit. The Technician can also point out that this reduction in the number of animal units will result in an improvement in the range so that in some distant time in the future the ranch will properly carry more livestock. This does not appeal to a man ranching on our high priced rangelands and with large principal and interest payments to make every year. He can not see how he can reduce the number of livestock on his ranch and stay there.

Perhaps a much stronger appeal can be made if a plan is worked out whereby the rancher maintains his present livestock numbers or even increases them. This is not impossible! Rob Brown, in his paper presented to the Texas Section at Del Rio, showed where he had profitably increased his ranch operation by 100 cows through the use of silage produced on his cultivatable land. Other ranchers are doing the same thing by the proper inclusion of their cultivatable land in the over-all ranch program. This cultivated land may be used for silage, grazing, hay crops, or feed grains. I think there is much food for thought along this line in the article written by Dr. George Ellis in the January-February Newsletter.

Of course we have ranches in the state with no cultivatable acreage or a very limited amount. Under these conditions, if the ranch is overstocked and the present number of animal units are to be continued, it may be necessary to supplement the range by the drylot feeding of purchased feeds. Some research has been done in this area; more is needed.

Dr. Leo Merrill, at the Sonora Station, is of the opinion that if a deferred-rotation grazing system is to be installed on a ranch, the number of livestock must be reduced to a proper stocking rate. He is probably right, but here again I am wondering if this is always true. I would like to cite an example of a rancher in our area, whose range is overstocked according to the best information we have on proper stocking. This operator adopted an improved grazing system involving range deferment and did a limited amount of mesquite control several years ago. His ranch is in better condition than it was five years ago, his livestock production is higher, and his net profit is greater. I will admit that he is still ranching primarily on increaser plants (Side Oats Grama, Texas Winter, Buffalo grass and

Curly Mesquite). But he is making a greater profit and some decreaser grasses (Little Bluestem and Indian grass) are showing up on the ranch.

Another approach to the selling of improved range management practices should be examined. Many of the efforts to sell these practices have been through the use of the conservation appeal, rather than through financial gain and stability. Conservation is good and has an appeal to the rancher, but as pointed out in some material which I recently received from Dr. Don Huss of Texas A&M, "in light of the present day price-cost squeeze that the rancher faces, conservation is not attractive, but financial gain through higher livestock production and lower cost of production is attractive." (Don is Chairman of the ASRM Public Relation Committee.)

Certainly all of us want to improve our method of selling good range management. If any member has some thoughts along this line that he would like to present, the Newsletter will be happy to print them.

Robert M. Hyde recently moved to Kansas State University at Manhattan, where he is Extension Range Management Specialist. He was formerly at the University of Wyoming, Laramie, where he held a similar position. Hyde received his BS and MS from Fort Hays Kansas State College in 1959 and 1960 and his PhD from the University of Wyoming in 1964. He has been active in the ASRM in both the Kansas-Oklahoma and Wyoming Sections. He was Secretary-Treasurer of the Wyoming Section from 1963 to 1966.

IN MEMORIAM

Dr. John E. Weaver, emeritus professor of botany at the University of Nebraska, passed away at Lincoln, Nebraska, on June 8, 1966.

Dr. Weaver was the recipient of the first Nebraska range management award and was a charter member of both the National ASRM and the Nebraska Section. His was a lifetime of devotion to the study of ecology and management of rangelands.

Edward H. Graham

Conservation in all of its ramifications lost a sensitive scientist and searching pathfinder in the death, on May 16, of one of its most discerning advocates — Edward H. Graham.

He perceived early in his career the necessity of conservation as a means of saving the world's natural resources. This was brought out in his many articles and books, notably in one early book, "Natural Principles of Land Use."

For 27 years with Soil Conservation Service, Dr. Graham held numerous positions of responsibility in the planning and in the administration of soil and water conservation. From biologist and chief of the biology division, he advanced to other positions of responsibility and ended his career as assistant to the administrator for international programs.

After his retirement in 1964, Dr. Graham became senior associate of the Conservation Foundation and a Ford Foundation consultant. He served as chairman of the Commission on Ecology of the International Union of Conservation of Nature and Natural Resources. He was slated to become the organization's next president.

During 1965 Dr. Graham made a long trip to India, Thailand, the Philippines, and Japan. As deputy convenor of the Conservation Section of the International Biological Programme, he endeavored to bring together science and the other elements essential to an effective conservation program. A report on this mission indicated a successful undertaking.

A native of Pittsburgh, Dr. Graham received his BS and later his PhD in 1932 from the University of Pittsburgh. He taught for one term at Harvard University summer school and for several years at the Department of Agriculture Graduate School.

Throughout his long career in conservation, Dr. Graham's patience and persuasiveness did much to make conservation a serious concern of the scientist.

Dr. Arthur D. Smith—Who has served on the faculty of Utah State University since 1937, has been granted a leave of absence from his duties as Professor of Range Science to serve with the Public Land Law Review Commission as a range and wildlife specialist, in Washington, D.C.

Soil Conservation Society Of America

The Soil Conservation Society of America at its 21st annual meeting in Albuquerque, conferred honors upon several members of the ASRM. Marion Clawson, director, Land Use Management Program, Resources for the Future, Washington, D.C., received honorary membership in that Society. A commendation award in recognition of significant contributions to the objectives of the Society, was bestowed upon Joseph L. Schuster, professor of range management, Texas Technological College, Lubbock, Texas.

The degree of Fellow, was awarded to: Val W. Silkett, director, Resource

Development Division, Soil Conservation Service, Washington, D.C. Courtney A. Tidwell, state conservationist, Soil Conservation Service, Stillwater, Oklahoma, Harold E. Tower, field representative, Soil Conservation Service, Upper Darby, Pennsylvania and Hollis R. Williams, deputy administrator for watersheds, Soil Conservation Service, Washington, D.C.

An Extravaganza To Celebrate 100 Years Of Change In Grassland Agriculture

Nebraska will host the 1967 National Grassland Field Day & Conference. This extravaganza will help Nebraska celebrate its Centennial with a pertinent theme, "100 Years of Change in Grassland Agriculture." Dates for the event are July 12-14, 1967. The University of Nebraska Field Laboratory near Mead is the designated location for all activities except for a trip through "God's Own Cow Country."

Attendance is expected to exceed the 30,000 people that attended the last Field Day and Conference held last year in Tennessee. The event in 1967 will be co-sponsored by the University of Nebraska and the American Grassland Council. Dr. Donald F. Burzlaff, Lincoln, is chairman of the arrangements committee and encourages anyone interested in arranging for his own display, demonstration, or exhibit to contact him as soon as possible.

Samuel Chumo received a membership in the Society as a scholarship award as the best range student in the 1966 class at Egerton College, Njoro, Kenya. His class is believed to be the first to be granted diplomas in range management in East Africa. Samuel is now Assistant Range Officer stationed at the Animal Health and Industry Training Institute, Kabete, Kenya. **Joseph H. Robertson,** former professor at the University of Nevada is teaching range management at Egerton. **Chandler Jensen,** left the S.C.S. in Red Bluff, California to join the staff at Egerton.

Society members known to be serving in Africa at this time include **Robert L. Casebeer** of Jackson, Wyoming and **Richard N. Denney** of the Game Research Center in Fort Collins, Colorado now at P.O. Box 30218, Nairobi, Kenya; **John H. Fenley** and **Harley N. Tulley** both c/o American Embassy, Lago, Nigeria; **Jack McIntosh,** formerly with B.L.M. in Eastern Oregon now at P.O. Box 28, Bauchi, Nigeria.

Russell J. Drabbs has left the B.L.M. in Alaska. His new address is P.O. Box 558, Riyadh, Saudi Arabia.

Claude A. Martin, immediate Past President of the New Mexico Section, ASRM, has moved to Rawlins, Wyoming. For the past five years Claude has been Manager of the New Mexico District No. 1 of the Bureau of Land Management with headquarters in Albuquerque. He has been transferred as Manager of Wyoming District No. 3 with headquarters in Rawlins, Wyoming.

Claude traded jobs with Warren R. Gray who has moved to Albuquerque as Manager of the Albuquerque District. Warren Gray has been an active member of the Wyoming Section.

WITH THE SECTIONS

KANSAS-OKLAHOMA

The Section reports on the 6th Range Youth Camp at Cheyenne, Oklahoma, August 1-4, 1966, as a worthwhile experience for young people. The campers are members of the top-placing teams in the International Land, Pasture and Range judging contest held annually at Oklahoma City. A total of about 32 FFA and 4-H youngsters attend. The camp is sponsored by the Upper Washita Soil and Water Conservation District and the Kansas-Oklahoma Section of ASRM. Local ranchers cooperate in the program.

Topics discussed in the 1966 camp included geology, plant identification, proper use of range, opportunities in ranch management, jobs of running a ranch, poisonous plant problems with livestock, ranching recreation and wildlife management, and similar subjects.

SCS, Wildlife Service, Oklahoma State University personnel, and local ranchers and businessmen were on the program.

Entertainment included a trip to a lake where the Cheyenne Kiwanis Club furnished boats, and a picnic was held. A calf-roping event was staged by the local roundup club, and a banquet meal was provided on one evening.

One of the unique and most educational features of the camp is a half-day in which a local rancher takes "his" boys, usually four in number to his ranch. Problems of water, range and livestock management are discussed, and questions freely asked and answered. This has been one of the most interesting sessions, the boys say, when they can visit with successful ranchers.

Another unique event is the range judging contest. Since all of the boys were winners in the international event, they are already competent judges. However, in the contest at the camp, each team of "ranch hands" is allowed to turn in only one set of judging cards, which means they must agree on the conditions that exist before the cards are marked. Beautiful large bound volumes of "Pasture and Range Plants" were presented to the four members of the winning group, and to the rancher whose brand they wear.

On the last morning each camper is called on to give his impressions of the camp, and the reports glow with enthusiasm. "Its great", about sums up the reports.

Adults responsible for the camp include Fred Whittington, range conservationist, Elk City; Tom Perryman, soil conservationist, Cheyenne; L. L. Males, banker at Cheyenne; J. C. Rogers, vocational agriculture instructor at Cheyenne; local ranchers, and extension personnel for their part in establishing and maintaining the camp. Ranchers who helped with this year's camp included: C. W. Lester, A. F. Beaty, B. L. Eakins, Harlan Thomas, Ray Cole, Bob Green, C. L. Hickey, and Hoot Stickley.

TEXAS

1966 4-H Range Judging Results

Crockett County scored 787 points to win the Senior 4-H Judging Contest conducted at San Angelo, May 28. Members of the winning team coached by Pete Jacoby, County Agent, were Duwain Vinson, Steve Taliaferro, Fred Chandler, and Jesse Deaton. Fred Chandler was high scoring individual with 275, while Duwain Vinson was second high with 269.

A Sutton County team of Mark Jacoby, Bill Green and Steve Thorp coached by D. C. Langford, County Agent, was second with 758. Mark Jacoby was third high individual with 259.

Sterling County was third with 693. Arthur Barlemann, Jr., County Agent, coached the team composed of Chris Frizzell, Debbie Reed, and Frank Price.

In the Junior Division, Sutton County was first with 732 while Crockett County teams placed second and third with 721 and 696. D. C. Langford coached the Sutton Junior Team and Pete Jacoby coached the Crockett teams. High individuals in the Junior Division were: Eugene Vinson, Crockett County, with 273; Rick Street, Sutton County, with 265; and Kerry Joy, Sutton County, with 255. Other Sutton County team members were Steve Street and Mark Rousselot. Pat Fitzhugh, Cydnie Whitehead, Rodney Walker, Kathy Williams, Alton Everett, Steve Hubbord and Fred Deaton were the other Crockett County team members.

The Texas Section, American Society of Range Management presented trophies to the two winning teams.

The Field Day at Water Valley

An excellent group of 120 ranchers, agency technicians, seed dealers, college representatives, conservation contractors, and equipment dealers gathered at George Skeete's ranch near Water Valley, Texas, on June 24, 1966. Program Chairman Ben Sims with help of J. L. Richmond and George Skeete had a grand planned program for all of those in attendance. The program covered the outstanding example of conservation that George Skeete has done on his ranch. Of course the plan is not finished as yet but is well on the road to completion. Mr. Skeete, Dr. Don Huss and Dr. C. L. Leinweber of Texas A & M University and Mr. Howard Passey and J. L. Richmond of Soil Conservation Service contributions to the program were well presented.

Dean Gerald Thomas of Texas Tech, as master of ceremonies, carried the program on at a good pace throughout the day. President Leroy Young commented during the day on what a high percent of ranchers were in attendance at the meeting. Program Chairman Sims, George Skeete and local arrangements committee are to be congratulated on such a good field day and getting so many ranchers in attendance.

PACIFIC NORTHWEST

George Garrison, of the Pacific Northwestern Experiment Station in La Grande, Oregon, presented a paper at the International Grassland Congress at Helsinki, Finland, July 7-16, 1966. The title of his paper was "Response of Plant Reserves to Systems and Intensities of Grazing on Mountain Rangeland in Northwest U.S.A." Following the Congress, George spent 2½ weeks visiting the revegetation project at the Swiss Avalanche Research Institute and the British Grassland Research Institute near Maidenhead, England, and visited its Scotch equivalent at the Hillfarms Research Institute at Edinburgh, Scotland.

Oregon Range Youth Camp—An excellent group of 60 boys, representing 20 counties, attended the Youth Range Camp at Logan Valley, in August. The boy who won the top score this year was Charles Ballard of Dayville. The boy selected as best camper was Paul Chamberlain of Lapine, who also had been elected head wrangler at the beginning of camp. The other elected officer, camp foreman, was John Griffith of Gresham. All of these boys conducted themselves in an exemplary manner during the camp.

NEW MEXICO

The New Mexico Section Scholarship has been awarded to Mr. James L. Sullins of Ruidoso. Jim is a 1966 graduate of Ruidoso High School and has just completed pre-registration for the Fall semester at New Mexico State University. Jim has an excellent high school record, ranking fourth out of 53 in his class.

SOCIETY BUSINESS

PHOTOS AND DISPLAYS CONTESTS

20th Annual Meeting
Seattle, Washington
February 14 to 17, 1967

Photo Contest

All members of the American Society of Range Management are invited to participate in the photographic contest at the annual meeting to be held in the Olympic Hotel at Seattle, Washington. Both black and white photographs and color slides may be entered.

Categories

1. Black and White Photos and Color Slides
   a. Range Plant(s)
   b. Range Animal(s)
   c. Range Condition
   d. Range Improvement
   e. Range and Ranch Scene
   f. Range Vegetation Trend (Sequence of two or more photos, maximum of four, to show changes in native vegetation or results of cultural treatment) Contestant will specify the category in which pictures or slides are to be judged.
2. Picture Story

A photo series with captions (and short narrative if needed) showing and telling a story concerning Range Management which would be appropriate for publication in the Journal.

Each picture in the series must be related to the others to tell a story and sufficient captions used to explain this activity. Only black and white pictures may be used. Any size negatives may be used as long as acceptable prints may be obtained. Negatives or extra prints of winning entry must be made available upon request. Any size prints may be submitted up to 11″ x 14″, however, *8″ x 10″* enlargements are recommended.

A maximum of six photos per entry and a minimum of three may be submitted. Winner will be selected on the basis of story telling ability, photographic clearness and caption explanations. Entries must be related to range management and in tune with the objectives of the Society.

There is no limit on number of entries. All photos must have been taken by entrant except in the case of a historical "before" picture to emphasize certain points.

Eligibility

Any member of the American Society of Range Management may enter a maximum of six exhibits but not more than one in a category under item one, *Black and White Photos and Color Slides*. There is no limit on the number of entries in item 2, *Picture Story*.

Contestants need not be present, but have responsibility to deliver and reclaim entries from the Contest and Displays Committee. Contestant's name, address and category must be on back of each photo (both black and white and slides). All photographs must have been taken by the contestant except in the range vegetation trend categories in which at least one of the pictures in the sequence must have been taken by the contestant. Negatives or extra prints of winning entries must be made available upon request. Grand champion winners (photos, not people) of previous contests are not eligible.

Size of Photos

Black and white photographs must be no larger than 11 x 14-inch prints of glossy to mat finish. They should be mounted in such a manner that the photo will remain flat. Use mount board approximately 16 x 20 inches in size, but do not put photographs in a frame.

Deadline

Photos and slides must be received for exhibit by 12:00 noon Tuesday, February 14, 1967, at the ASRM registration desk in the Olympic Hotel, Seattle, Washington.

Scoring

Each person who registers for the meeting will receive a ballot to vote on the black and white photos and color slides. Judges will be selected by the committee to determine the winner of the picture story contest.

Awards

First, second and third place ribbons will be awarded to the winners of each category. In addition a grand champion ribbon and an appropriate award will be presented to the entry receiving the most votes. Candidates for the grand champion award will be limited to those who placed first in their respective categories. Awards for winners and grand champion will be presented at a combined session on Thursday.

Journal Cover Photos

Winning entries will be eligible for selection as cover pictures for forthcoming issues of the Journal of Range Management.

Exhibits and Displays

State and Area sections and other professional organizations are urged to prepare exhibits for display during the annual meeting. Members of the committee will assist in placement of exhibits in the Olympic Hotel from 1:00 p.m. to 9:00 p.m. Monday, and from 8:00 a.m. to 1:00 p.m. Tuesday.

Exhibits should conform generally to the convention theme "The Next Twenty Years." All exhibits will be judged and recognition given to the exhibitors.

Professional organizations and industrial companies who wish to submit an exhibit should notify Lee Sharp, College of Forestry, University of Idaho, Moscow, Idaho, indicating spatial requirements.

CONTEST RULES
RANGE PLANT CONTEST—1967

Eligibility

Group 1. Teams: Each college may enter one team composed of three or four members. If the team consists of four members the three highest scoring individuals will be considered the team for the college. The contestants must be enrolled undergraduates in any regular college course of study at the time of the contest or must have been enrolled undergraduates in the fall semester or quarter immediately preceding the contest.

Group 2. Individuals: Any undergraduate student in any regular college course of study may compete for individual honors. Team members will be automatically entered in the individual competition.

Contest Rules

1. A minimum of one hundred (100) plants, appearing on the master list, will be selected from specimens brought to the meeting by team coaches and interested parties. These specimens will not have been seen by any contestant and each mount must carry the following information:

   Generic name________________

   Specific name________________

   Verified by________________

   Property of________________

   Also, each perennial specimen must show characteristics that identify it as a perennial.
2. Minimum distance between specimen sheets during the contest will be twenty-two (22) inches.
3. Contestants will have fifty-five (55) seconds to write in the family or tribe, genus, species, and to check the longevity and origin columns. Five (5) seconds will be allowed to move to the next plant. Total elapsed time per plant will be one (1) minute.
4. Contestants will have three (3) minutes at the end of the contest to check their papers. Contestants will not be allowed to look at a plant a second time.
5. There will be no restriction on the number of duplicate mounts.
6. Contestants will not be permitted to handle the mounts. However, a hand lens may be used to assist in the identification of plants.
7. While the contest is in progress there shall be no conferring between contestants. Only the contestants and designated supervisors will be in the contest room during the contest.

Contest Scoring

1. The range plant contest committee will select the contest specimens, conduct the contest, and score the contestants' papers. The papers will not be returned to the coaches or students.
2. Scoring will be as follows:
   a. Ten points are assigned to each plant

Family or tribe	4
Genus	2
Species	2
Longevity	1
Origin	1
	10

   b. Family or tribe only correct is 4 points
   c. Genus only correct is 2 points
   d. Family or tribe and genus correct is 6 points
   e. Family or tribe, genus and species correct is 8 points.
   f. Family or tribe, genus, species and origin correct is 9 points.
   g. Longevity will be scored separately and is not tied to genus and species.
   h. The plant must be correctly identified as to genus to get credit for species.
   i. The plant must be correctly identified as to genus and species to get credit for origin.

j. One point will be deducted from each family, tribe, genus, or species that is correctly identified but misspelled.

Contest Awards

1. A rotating plaque will be awarded the first-place team. This plaque becomes permanent property of the first school to win three times. The wins need not be in succession.
2. Team and individual awards will be given for the first three places. In the event of tie scores for team or individual places duplicate awards will be given.
3. Plaques for permanent possession will be awarded to the first-, the second- and the third-place teams. Individual members of these three teams will receive appropriate certificates.
4. The three highest scoring individuals will each be awarded a plaque for permanent possesson.
5. Ten (10) dollars will be given to each official team member up to four from each school that enters a team in the contest.
6. The awards will be presented at the annual meeting.

Summer Meeting, 1966

The First Summer Meeting of the Society to be held in Utah was at Logan on July 28-30. The First Annual Meeting of the Society was held 18 years ago in Utah at Salt Lake City on January 30-31, 1948. The Logan meeting was well attended with 134 members and 66 wives and children for a total of 209. Those attending came from 19 states and Canada.

Another milestone was the first Youth Forum on range management, held concurrently with the Summer Meeting. A total of 16 youth delegates, representing 8 states and Canada, and sponsored by 8 Society Sections met to discuss range management. See separate report by John F. Vallentine, Chairman, Range Youth Committee.

The first general activity of the Summer Meeting was Thursday afternoon, July 28. Hallie Cox, Utah Section President, welcomed the visitors and was then chairman for a program of talks by Dr. L. A. Stoddart, Head, Department of Range Science at USU; Edward Clyde, attorney and stockman, Salt Lake City; Dan Freed, Vice-President, Deseret Livestock Company, Salt Lake City; and Hugh Colton, Chairman, National Lands Coordinating Committee, Vernal. Thursday evening Dr. Leonard Arrington, professor of Economics at USU spoke on the early history of livestock and ranching in Utah.

On Friday an all-day range and scenic tour took the participants to the winter elk-feeding area at the Hardware Ranch, then south to Ogden Canyon and last over Monte Cristo to the Bear River Valley, north to Bear Lake and down Logan Canyon to Logan. Saturday was a choice of four tours featuring ranching and range, wildlife, watershed management, and range research.

Mrs. Ben Heywood was in charge of the ladies' program and there were many activities for the women and children who attended these meetings with their husbands. A tour conducted by Mrs. A. C. Hull took the women to the Water Research Laboratory, the large Rocky Mountain Cheese Plant and the Mormon Temple grounds.

Delegates enjoyed the famed smorgasbord by the Utah State University Union Building staff and a steak barbecue in Logan Canyon by the Carroll Draper family.

Ben Heywood of the SCS at Logan was general chairman for the summer meeting. Chairmen of the various subcommittees also from Logan were: A. T. Bleak, George Coltharp, Wayne Cook, Hallie Cox, Jim Grumbles, Mrs. Doris Holmgren, Mrs. Trudy Heywood, Jack Hooper, A. C. Hull, Jr., Bill Laycock, Karl Parker, Neil West, and D. S. Winn.—*A. C. Hall, Jr.*, Ch., Information Committee, Logan, Utah.

(Editor's note: It was a fine meeting, enjoyed by all, and the Utah Section did a fine job.)

1966 Range Youth Forum

Attending the 1966 Range Youth Forum July 27-30, on the Utah State University Campus at Logan were 16 official youth delegates, sponsored by Sections as indicated:

Robert Anderson, Arizona
Gary Henly, Arizona
Ben Daugherty, Colorado
Roland Cross, Colorado
Roland Shaw, Idaho
Frank Heying, Nebraska

President Melvin Morris and four boys attending the Range Youth Forum. Left to right: Ronald Cross, David Jacoby, Gail Harford, Roland Shaw, and Melvin Morris.

Gail Harford, Nebraska
Warren Schweitzer, International Mountain
John Cartwright, International Mountain
David Jacoby, Texas
Glen Lich, Texas
Lavon Rasmussen, Utah
Steven Roberts, Utah
Don Swasey, Utah
Steven Burzlaff, Wyoming
Mat Terry, Wyoming

The program included Section reports on range youth activities, careers, and college training in range management, papers on range management topics by both adults and youth delegates, an all-day range tour in northeastern Utah, and a visit to the poisonous plant research laboratory. Evening programs included a smorgasbord followed by a program on "Early History of Utah Ranching," and a barbecue at Guinavah Campground.

The 1966 Forum was held in conjunction with the Annual Summer Meeting of the Society. Some Forum meetings were held jointly with the adult sessions, others were held separately. Transportation for official delegates and counselors was provided by the respective Sections. Expenses of the delegates while at Logan were met through a grant from the ASRM.

A major goal of the 1966 Forum was to evaluate a full-scale Forum program and recommend a program for future Forums. Committees composed of both adults and Forum delegates evaluated the following phases: goals of a Range Youth Forum program, arrangements and program, selection of delegates, finances, and implementation of future Forums. The Forum plans to be presented to the ASRM President and Board call for annual Forums to be held in conjunction with the annual winter meetings of the ASRM.

David Jacoby, Texas, and Gail Harford, Nebraska, were elected chairman and vice-chairman of a Forum Youth Committee to help publicize Forum plans among ASRM members and youth. All youth delegates approached the offerings and business of the Forum with mature judgment and interest.—*John F. Vallentine*, Ch., Range Youth Forum Committee, North Platte, Nebraska.

Important actions taken by the Board of Directors at the Summer Meeting included the decision to study carefully a proposal on Student Membership presented by resolution from the Pacific Northwest Section before taking final action. It was decided to establish the grade of "Fellow" but that selection of individuals to that grade be subject to approval by the Board of Directors. Meritorious awards will be given at the 1967 convention to five people yet to be selected. A National scholarship of $500.00 will be awarded to one high school student entering a course in Range Management in College. The student will be selected by a committee in accordance with plans proposed and approved previously. Action to expand the Public Relations work of the Society including the preparation of a Public Relations Handbook was taken. Santa Barbara, California was selected as the site of the 1967 Summer meeting and the third week in July the time.

Howard R. De Lano, Chairman of the ASRM Advisory Council, has recently written to each Section President, presenting topics which will be discussed at the council meeting in Seattle in February. New proposals for consideration by the council should be sent to him prior to January 1.

His letter stated, "According to the Mode of Operations, these proposals shall be distributed to all Sections by September 15. They can then be acted upon by each Section at their winter meeting. Any new proposals that the Sections may have should be sent to me by January 1. Both the enclosed resolutions and any new proposal received prior to January 1 will be presented at the winter meeting in Seattle, Washington for action by the Council. The recommendations from the Council will then be presented to the Board of Directors." Howard is President of the Pacific Northwest Section.

Statement of Ownership, Management and Circulation

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I certify that the above statements made by me above are correct and complete.

Sept. 15, 1966

John G. Clouston,
Business Manager

SEATTLE

FEBRUARY 14, 1966

Seattle is Adventure

There is more to see . . . more to do . . . more to enjoy in Seattle! Lively people come to Seattle to catch salmon, sail a boat, ski a slope, climb a mountain, ride a monorail, marvel at the scene from atop the Space Needle. In other moods cosmopolitan Seattle offers elegant dining, brilliant opera, exciting symphony concerts, theater, after dark diversions.

Seattle is a Gateway

Seattle is your prelude and port of entry to the wonderful worlds of the Puget Sound Country, neighboring British Columbia.

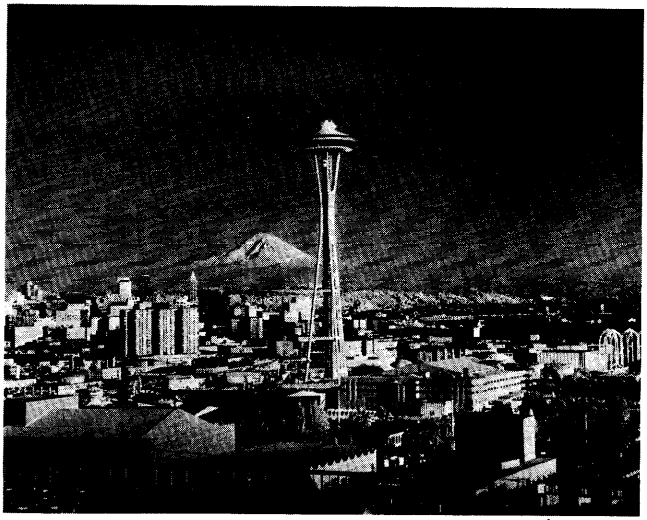
Seattle Slim used to say there was no place that could equal the joys of Seattle in June. Seattle Slim didn't ever make it. It seems there was always a comely red-head in Butte, Portland, Spokane or Vancouver that interfered with his plans and used up his stake. He shrugged it off, said, "Next year," and went back to the woods or the ranch or the mine.

Seattle in February isn't Seattle in June but, it's still Seattle. It could be covered with ice from a silver thaw or it could be the nicest winter weather you ever experienced so far north. So if you are bothered by a red-head or blonde or brunette, just load her in the car or the train or the plane and come to the fabulous Pacific Northwest. Come to Washington, come to Seattle for a city and scenic experience you'll never forget. Besides, there's a program for her while you are busy attending the sessions.

For this twentieth Convention of your society the local arrangements people and the program folks have prepared a three-day meeting par excellence. At the beginning of our twentieth year we'll look ahead to what lies in store for us. Review the program in this issue and come to listen, observe and take part.

Right here is a reservation card. Tear it out and send it in now. Please use it, or if you lose it be sure to mention the A.S.R.M. Convention. Only if you do will you get the convention rate on your room.

Your officers welcome you, the Pacific Northwest Section Welcomes you and here is a special welcome from the Northwest part of the Continent:



INVITATION

We, representing the majority of the livestock producers in the Pacific Northwest, feel that within this region exists an unusual diversity of ranch and pasture types and management practices. We believe that some of you who will be in attendance at the American Society of Range Management convention in Seattle on February 14-17, 1967 may be interested in extending your stay and seeing some of what goes on in this region. We wish to assure you that our members would welcome an opportunity to show you over their operations and exchange information with you.

Many of us will be at the convention, and we ask that you feel free to call on us for any information or assistance that we may be able to furnish.
In any event, we join in extending to all a welcome to Seattle and the Pacific Northwest.

Oregon Cattlemen's Association

Washington Cattlemen's Association

British Columbia Sheep Breeders'

Cooperative Association

Washington Wool Growers' Association

Oregon Wool Growers' Association

OTHER HOTELS

	Single	Double	Twin
Heart of Seattle	$ 8.00	$10.00	$12.00
	FREE parking if available.		
Hungerford	$ 8.00	$11.00	$15.00
	Parking $2.25 per day.		
Stratford	$ 5.25- 5.75	$ 6.50- 7.50	$ 8.00
	Parking Extra.		
Emel Motor Hotel	$10.50-12.50	$14.00-16.00	$15.00-18.00
	FREE parking for all guests.		

Program

Twentieth Annual Meeting

American Society of Range Management

Olympic Hotel, Seattle, Washington
February 13-17, 1967

Theme: The Next 20 Years—The Foundation on Which We Build

Registration: 8:00 a.m. Monday, February 13, to 12 Noon Thursday, February 16.

Host: Pacific Northwest Section, ASRM, Howard DeLano, President.

Ladies Program: To be arranged.

Monday, February 13

Board of Directors Meeting. Advisory Council Meeting.

Tuesday, Morning, February 14

Opening Session

Call to Order: Melvin S. Morris, President, ASRM

Invocation:

Welcome to Seattle:

Welcome to Washington:

Plenary Session: Range and Related Resources of The Pacific Northwest

Co-Chairmen: Lysle H. Parsons and Walter F. Mueggler. Charles E. Poulton, Presiding.

THE PACIFIC NORTHWEST—A DEVELOPING FRONTIER—Harry H. Holloway, Vice President, Public Relations, Pacific Northwest Bell, Seattle, Washington.

THE PACIFIC NORTHWEST AS A PLACE TO PLAY—Fred J. Overly, Regional Director, Pacific Northwest Region, Bureau of Outdoor Recreation, Seattle, Washington.

FOOD FROM THE SEA—Richard Van Cleave, Dean, College of Fisheries, University of Washington, Seattle.

GENERAL ECOLOGY OF THE NORTHWEST—Gordon Alcorn, Dept. of Biology, University of Puget Sound, Tacoma, Washington.

THE GROWING IMPORTANCE OF OUR FOREST RESOURCE—Walter G. Hughes, I. & C. Management Division, British Columbia Forest Service, Victoria, B. C.

LIVESTOCK INDUSTRY OF THE PACIFIC NORTHWEST—William McGregor, McGregor Land & Livestock Company, Hooper, Washington.

Tuesday Afternoon, February 14

Photos and Displays Contests

Keynote Session: The Next 20 Years—The Foundation on Which We Build

Co-Chairmen: A. L. McLean, Presiding, and E. H. McIlvain.

THE FIRST 20 YEARS AS A BASIS FOR THE SECOND—J. F. Pechanec, Director, Intermountain Forest & Range Expt. Station, USDA, Forest Service, Ogden, Utah.

GRAZING POLICIES ON FOREST LANDS FOR THE NEXT 20 YEARS—E. P. Cliff, Chief, USDA, Forest Service, Washington, D. C.

RANGE RESEARCH IN THE NEXT 20 YEARS—C. M. McKell, Chairman, Agronomy Dept. University of California, Riverside.

THE LIVESTOCK INDUSTRY IN THE NEXT 20 YEARS—C. F. Sierk, Principal Animal Husbandman, USDA, Cooperative State Research Service, Washington, D. C.

RANGE EDUCATION NEEDS FOR THE NEXT 20 YEARS—C. L. Leinweber, Head, Dept. of Range Science, Texas A & M University, College Station.

Annual Business Meeting

The Presidential Address: Melvin S. Morris

Report of the Executive Secretary: John G. Clouston

Report of the Editor: Robert S. Campbell

Other Business:

Installation of New Officers and Directors

Response: C. Wayne Cook, Incoming President

Wednesday, Morning, February 15

Plant Identification Contest
3 Concurrent Sessions

Water Resources and Changes in Land Use in the West

Co-Chairmen: John D. Freeman, Presiding, and Robert Harris

CANADIAN VIEWPOINTS ON COLUMBIA RIVER DEVELOPMENTS: Jack Davis, Member of Parliament, Coast Capilano, Ottawa, Canada.

PROPOSALS FOR DIVERSION OF NORTHWEST WATER AND POSSIBLE EFFECTS ON LAND USE IN THE WEST—Floyd E. Dominy, Commissioner, U. S. Bureau of Reclamation, Washington, D. C.

POLITICAL IMPLICATIONS OF DIVERSION OF NORTHWEST WATER TO THE SOUTHWEST—H. Maurice Ahlquist, Director, Dept. of Conservation, Olympia, Washington.

WATER DEMANDS OF THE SOUTHWEST—Rich Johnson, Executive Director, Arizona Interstate Stream Commission, Phoenix, Arizona.

RECREATION IMPLICATIONS OF WATER DEVELOPMENT IN THE PACIFIC NORTHWEST AND BRITISH COLUMBIA—D. B. Turner, Deputy Minister, Dept. of Recreation and Conservation, Victoria, B. C., Canada.

WATER AND LAND USE CHANGES ON PRIVATELY OWNED LAND, INCLUDING RANGE, UNDERWAY NOW IN CALIFORNIA, AND A PROJECTION INTO THE FUTURE—Thomas B. Helseth, State Conservationist, Soil Conservation Service, Berkeley, California.

Technical Session—Improvements

Co-Chairmen: Dayton Klingman and Lysle Parsons. G. A. Rogler, Presiding.

REPRODUCTION AND GROWTH OF PRICKLYPEAR (*OPUNTIA* SPP.)—J. D. Dodd and T. W. Clapp, Texas A & M University, College Station.

PRICKLYPEAR (*OPUNTIA* SPP.) REACTIONS UPON THE SOIL—T. W. Clapp and J. D. Dodd, Texas A & M University, College Station.

SOIL FACTORS FOR PREDICTING RANGELAND-SEEDING SUCCESS—H. F. Mayland, Snake River Conservation Research Center, Kimberly, Idaho.

SEED DORMANCY, AGE OF SEED, AND RATE OF PLANTING IN RELATION TO STAND ESTABLISHMENT OF SWITCHGRASS AND INDIANGRASS—E. C. Conrad and Raymond G. Sall, University of Nebraska, Lincoln

RANGE LEGUME INOCULATION AND NITROGEN FIXATION BY ROOT NODULE BACTERIA—J. E. Street and A. A. Holland, University of California, Davis.

CONTROL OF DALMATIAN TOADFLAX—W. C. Robocker, Agricultural Research Service, Washington Agricultural Experiment Station, Pullman.

PLANT SUCCESSION ON MEDUSAHEAD INFESTED BUNCHGRASS RANGE FOLLOWING SELECTIVE HERBICIDE APPLICATIONS—Robert B. Turner, Oregon State University, Corvallis.

BEEF PRODUCTION FROM FERTILIZED CRESTED WHEATGRASS IN NORTHERN PLAINS—G. A. Rogler and R. J. Lorenz, Agricultural Research Service, Mandan, North Dakota.

THE USE OF CHICKEN MANURE AS AN ANNUAL RANGELAND FERTILIZER—C. M. McKell and Victor W. Brown, University of California, Riverside.

PRODUCTION-LINE TESTING OF RANGE LEGUME VARIETIES—J. E. Street and W. A. Williams, University of California, Davis.

ALFALFA AND SWEET CLOVER ESTABLISHMENT AND GRAZING ON IDAHO FESCUE-BLUEBUNCH WHEATGRASS RANGE—Arthur D. Miles, Livingston, Montana.

WHY *SITANION HYSTRIX* IS MORE TOLERANT TO BURNING THAN *STIPA COMATA*—Henry A. Wright, Intermountain Forest & Range Expt. Station, Dubois, Idaho.

Technical Session—Range Production and Management

Presiding: Larry Williams, President, Oregon Cattlemen's Association, Canyon City, Oregon.

HOW WILL THE PUBLIC VIEW MANAGEMENT OF THEIR RANGELANDS IN THE NEXT 20 YEARS—R. Gordon Bentley, Area Manager, Bureau of Land Management, St. George, Utah.

COMPARISON OF VEGETATION ON THREE GRAZED AND UNGRAZED SITES IN SOUTH-CENTRAL NEW MEXICO—Rex D. Pieper, Assistant Prof. Range Science, New Mexico State University, University Park.

SOIL MOISTURE AND TEMPERATURE CHARACTERISTICS AS RELATED TO GRASS PRODUCTION FOLLOWING SHRUB CONTROL UNDER GRAZED AND NONGRAZED CONDITIONS—Herbert G. Fisser, Assistant Prof. Range Management, University of Wyoming, Laramie.

PROGRESS IN AUTOMATIC WEIGHING OF RANGE CATTLE—S. Clark Martin, Rocky Mountain Forest & Range Expt. Station, Tucson, Arizona.

GRAZING LOOSE SANDY SOILS, CHEATGRASS, AND CRESTED WHEATGRASS—

Richard A. Gerity and Kenneth E. Harrison, Bureau of Land Management, Shoshone, Idaho.

NEW CONCEPTS OF RANGE MANAGEMENT AS PRACTICED IN WESTERN OREGON—Charles Colegrove, ASC Office Manager Roseburg, Oregon.

WESTERN HARVESTER ANT ABUNDANCE IN RELATION TO GRAZING, VEGETATION AND SOIL IN NORTH-CENTRAL WYOMING—Dale R. Kirkham, University of Wyoming, Laramie.

COOPERATIVE GRAZING TRIALS AT FORT ROCK, OREGON, ON ONE-CROP AND TWO-CROP MANAGEMENT OF CRESTED WHEATGRASS—Reub Long, Fort Rock, Oregon; D. W. Hedrick, Prof. Range Management, Oregon State University, Corvallis, and Bill Moser, County Extension Agent, Lakeview, Oregon.

SEASONAL CATTLE GAIN AND GRAZING CAPACITY ON CHEATGRASS RANGE IN SOUTHERN IDAHO—R. B. Murray and J. O. Klemmedson, Intermountain Forest & Range Expt. Station, Boise, Idaho.

Range Youth Forum

Presiding: John F. Vallentine, Range Management Specialist, North Platte Expt. Station, North Platte, Nebraska.

RANGE YOUTH FORUM PROGRAM—David Jacoby, Ozona, Texas, and Gail Harford, Haigler, Nebraska.

Wednesday, Afternoon, February 15

3 Concurrent Sessions

Methodology for Management

Co-Chairmen: Phil Ogden, Presiding, Floyd Kinsinger and Dayton Klingman.

METHODOLOGY FOR MANAGEMENT OF FEDERAL LANDS—Bill Luscher and Floyd Kinsinger, Bureau of Land Management, Washington, D. C.

METHODOLOGY FOR MANAGEMENT OF A LIVESTOCK OPERATION—Allan Banta, Banta & Willoughby, Keating, Ore.

MODERN METHODS OF PRESENTING RANGE RESEARCH INFORMATION—J. E. Taylor and Don Ryerson, Montana State University, Bozeman.

LOW COST RANGE INVENTORY—Thomas R. Bunch, Area Range Agent, Bend, Oregon.

INSTALLATION AND OPERATION OF BUTYL RUBBER "RAIN TRAPS" ON FISHLAKE NATIONAL FOREST AS A SOURCE OF WATER FOR LIVESTOCK AND WILDLIFE—Grant G. Williams, Staff Officer, U. S. Forest Service, Richfield, Utah.

GRAZING SYSTEMS AS METHODS OF MANAGING THE RANGE RESOURCE—E. William Anderson, Range Specialist, Soil Conservation Service, Portland, Oregon.

Recreational Uses of Grazing Lands in the Next 20 Years

Co-Chairmen: Walter F. Mueggler, and Robert McNeil. E. W. Tisdale, Presiding.

RELATIVE DEMANDS ON OUR RANGE LANDS FOR RECREATION VS. LIVESTOCK GRAZING IN THE NEXT 20 YEARS—Richard Costley, Director, Division of Recreation, U. S. Forest Service, Washington, D. C.

EVALUATION OF RECREATION ON PUBLIC RANG LANDS; (HOW CAN THE USEFULNESS OF RANGELANDS FOR RECREATION BE ANALYZED)—Ayres Brinser and Charles Cooper, University of Michigan, Ann Arbor.

CONFLICTS BETWEEN LIVESTOCK AND RECREATION USE OF THE SAME LANDS—Open.

THE COMPATIBILITY OF RANGE USE AND OUTDOOR RECREATION: THE EUROPEAN EXPERIENCE—Anthony Netboy, Portland State College, Portland, Oregon.

CONFLICTS IN RECREATION—ELK VS. ASPEN IN YELLOWSTONE PARK—William Baremore, Wildlife Management Biologist, Yellowstone National Park.

IMPACT OF RECREATIONAL HORSE USE ON WILDERNESS AREAS AND HIGH ALTITUDE WATERSHEDS—Archie Mills, U. S. Forest Service, Wenatchee, Washington.

Ecology—A Basis for Understanding the Range Resource

Co-Chairmen: J. B. Hilmon, Presiding, and Floyd Kinsinger.

THE ECOLOGICAL APPROACH TO MANAGEMENT OF THE RANGE RESOURCE AS NEEDED BY A MANAGEMENT AGENCY—Stanley A. Cain, Assistant Secretary, Fish, Wildlife, and Parks, USDI, Washington, D. C.

COMMUNITY ECOLOGY AND RANGE MANAGEMENT—G. W. Tomanek, Chairman, Division of Biological Sciences, Fort Hays Kansas State College, Hays.

LIFE HISTORY STUDIES OF SIGNIFICANT RANGE PLANTS—Neil West, Dept. Range Science, Utah State University, Logan.

TAXONOMY AND ECOLOGY OF THE CRESTED WHEATGRASS COMPLEX—William R. Meiners, Watershed Specialist, Bureau of Land Management, Boise, Idaho.

THE NATIONAL ECOLOGY SURVEY—J. L. Buckley, Office of the Science Advisor, USDI, Washington, D. C.

GENECOLOGICAL INVESTIGATIONS OF MEDUSAHEAD—Jack R. Nelson, Junior Forester, Dept. Forestry & Range Management, Washington State University, Pullman.

SEASONAL, DIURNAL, AND SPECIES VARIATION IN FORAGE MOISTURE CONTENT IN RELATION TO SITE ON MOUNTAIN SUMMER RANGE OF NORTHERN UTAH—M. Sharif Chaudry and Neil West, Dept. Range Science, Utah State University, Logan.

Thursday, February 16

Board of Directors meet all day.

Thursday Morning, February 16

4 Concurrent Sessions

Range-Wildlife Relationships

Co-Chairmen: Arthur D. Smith, Presiding, and Harold Biswell

FOOD HABITS OF SAGE GROUSE CHICKS—Donald A. Klebenow, Idaho Cooperative Wildlife Research Unit, University of Idaho, Moscow; and Gene Grey, Idaho Dept. of Fish & Game, Boise.

VEGETATIONAL CHANGES ON SOME EASTERN WASHINGTON WINTER GAME RANGE—E. Reade Brown and C. Fred Martinsen, Washington Dept. of Game, Olympia.

WATERFOWL PLANTS FOR THE RANGE—Robert D. Slayback, Soil Conservation Service Pleasanton California, and Harry A. George, Dept. of Fish & Game, Gridley, California.

INFLUENCE OF RANGE IMPROVEMENT PRACTICES ON COMPOSITION, PRODUCTION, AND UTILIZATION OF *ARTEMISIA* DEER WINTER RANGE IN CENTRAL OREGON—Philip J. Urness, Forest Hydrology Lab., Arizona State University, Tempe.

USE OF LIVESTOCK TO MANIPULATE FORAGE FOR WILDLIFE HABITAT—Leo B. Merrill, Range Scientist, Texas Agricultural Expt. Station, Sonora.

HOW COMPATIBLE ARE WILDLIFE AND DOMESTIC LIVESTOCK—Eldon H. Smith, Montana Cooperative Extension Service, Bozeman.

Technical Session—Range Production and Management

Co-Chairmen: Garlyn O. Hoffman, Presiding, and A. L. McLean.

SOIL-PLANT INTERRELATIONSHIPS—James E. Street, Extension Range Specialist, University of California, Davis.

FORAGE AND BEEF PRODUCTION FROM PONDEROSA RANGE IN THE SOUTHWEST—Henry A. Pearson, Range Scientist, Rocky Mountain Forest & Range Expt. Station, Flagstaff, Arizona.

DIFFERENCES IN CALF PRODUCTION ATTRIBUTABLE TO GRAZING SYSTEMS—William J. Waldrip, E. E. Parker and P. T. Marion, Texas A & M University, Seymour.

SEEDED SPECIES IMPROVE YEARLONG GRAZING MANAGEMENT ON COLORADO MOUNTAIN RANGES—Pat O. Currie, Range Scientist, Rocky Mountain Forest & Range Expt. Station, Fort Collins, Colorado.

SEASONAL BOTANICAL COMPOSITION OF CATTLE AND SHEEP DIETS IN TWO DRYLAND IMPROVED PASTURE MIXTURES IN WESTERN OREGON—Thomas E. Bedell, Range Management, Oregon State University, Corvallis.

PROTEIN AND ENERGY RELATIONSHIP OF RANGE SUPPLEMENTATION—D. C. Clanton, University of Nebraska, North Platte, Nebraska.

RANGE AND PASTURE PRODUCTION IN PUERTO RICO: PROBLEMS AND POTENTIALS—B. Ira Judd, Arizona State University, Tempe.

UPLAND GAME BIRD HABITAT IMPROVEMENT AND DEVELOPMENT ON RANGELANDS—Robert E. Wagner, Range Manager, U. S. Forest Service, Springfield, Colorado.

NEED FOR GRAZING DEFERMENT FOLLOWING CHEMICAL CONTROL OF SAGEBRUSH, BIG HORN MOUNTAINS, WYOMING—Dixie R. Smith, Plant Ecologist, Rocky Mountain Forest & Range Expt. Station, Laramie, Wyoming.

Technical Session—Range Techniques and Methods

Co-Chairmen: Harold H. Biswell, Presiding, and J. B. Hilmon.

DOCUMENTING CHANGES ON THE LAND—Richard D. Burr, Division of Economics and Basin Studies, USDI, Bureau of Land Management, Denver, Colorado.

A COMPARISON OF DENSITY SAMPLING METHODS IN A SHRUB COMMUNITY— L. Jack Lyon, Wildlife Research Biologist, Intermountain Forest & Range Expt. Station, Missoula, Montana.

OPTIMUM PLOT SIZE FOR PLANT FREQUENCY SAMPLING—Gerald S. Strickler, Plant Ecologist, Pacific Northwest Forest & Range Expt. Station, U. S. Forest Service, La Grande, Oregon.

A COMPARISON OF UTILIZATION TECHNIQUES ON PINE-BLUESTEM RANGE—Harold E. Grelen, U. S. Forest Service, Southern Forest Expt. Station, Alexandria, Louisiana.

ESTIMATING FOLIAGE YIELDS OF UTAH JUNIPER, JUNIPERUS OSTEOSPERMA—Lamar Mason, Soil Conservation Service, Salt Lake City, Utah, and Selar S. Hutchings, Intermountain Forest & Range Expt. Station, Ogden, Utah.

VEGETATIVE RESPONSES FOLLOWING SPRING SHEEP GRAZING AND MOWING ON A MEDUSAHEAD DOMINATED WESTERN OREGON FOOTHILL RANGE—Robert B. Turner, Assistant in Range Management, Oregon State University, Corvallis.

THE PHYSICAL EFFECTS OF FIRE ON SEED GERMINATION — Charles T. Cushwa, Assoc. Wildlife Biologist, USDA, Forest Service, Southeastern Forest Expt. Station, Blacksburg, Virginia, and Robert E. Martin, Prof Forestry & Wildlife, Virginia Polytechnic Institute, Blacksburg.

MEASURE OF CARBOHYDRATE RESERVES IN FOUR MOUNTAIN RANGE PLANTS WITH RESPECT TO PHENOLOGICAL STAGE OF DEVELOPMENT AND ARTIFICIAL DEFOLIATION—Gary B. Donart, Assistant Prof. Range Management, Humboldt State College, Arcata, California.

EFFECTS OF SIEVE MESH SIZE AND VOLUMETRIC AND GRAVIMETRIC ANALYSES ON RUMEN CONTENT DETERMINATIONS—George W. Scotter, Research Ecologist, Dept. Northern Affairs and National Resources, National Parks Branch, Canadian Wildlife Service, Edmonton, Alberta, Canada.

BLUE OAK CANOPY EFFECT ON HERBAGE YIELD ON CENTRAL CALIFORNIA FOOTHILL RANGELAND—Don A. Duncan, Range Conservationist (research), San Joaquin Expt. Range, Coarsegold, California.

MICROCLIMATOLOGY OF MOUNTAIN RANGE LAND—F. Robert Gartner, Range Management, University of Wyoming, Laramie.

NONLINEAR PROGRAMMING PREDICTION OF CHEMICAL COMPOSITION OF DIETARY CONSTITUENTS—George M. Van Dyne, Radiation Ecology Section, Health Physics Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Financing The Ranch Operation

Co-Chairmen: Robert Harris, Presiding, and Garlyn O. Hoffman.

GRAZING RESOURCES IN THE RURAL ECONOMY—George Bradley, Deputy Director, Rural Community Development Service, USDA, Washington, D. C.

SOME BUSINESS ASPECTS OF A RANGE MANAGEMENT AND IMPROVEMENT PROGRAM—Richard Cowan, Suntex Ranch, Burns, Oregon.

FARM HOME ADMINISTRATION PROGRAM FOR RANCHERS — Arthur Garton, Director, Farm Home Administration, State of Washington, Wenatchee, Washington.

PRIVATE CAPITAL AND RANCH FINANCING PROGRAMS—Joe H. Sackett, Manager, Farm Loan Division, The Travelers Insurance Companies, Portland, Oregon.
Louis C. Chesnut, Vice President, Federal Land Bank of Spokane, Spokane, Washington.

DISCUSSION—Lynn Rader, Range Economist, Division of Range Management, U. S. Forest Service, Washington D. C.

Thursday Afternoon, February 16

Plenary Session—The Challenge of the Next 20 Years

Co-Chairmen: T. S. Ronningen, Presiding, and Arthur D. Smith.

RANGELANDS—CHALLENGE FOR THE NATION—James H. Jensen, President, Oregon State University, Corvallis.

RANGELANDS—CHALLENGE TO THE POCKETBOOK—M. L. Upchurch, Administrator, Economic Research Service, USDA, Washington D. C.

RANGELANDS—CHALLENGE TO THE MIND —Wynne Thorne, Vice President for Research, Utah State University, Logan.

RANGELANDS—AN ENJOYMENT CHALLENGE—Walter Hopkins, Division of Watershed, Recreation and Range Research, U. S. Forest Service, Washington, D. C.

Thursday Evening, February 16

No host cocktail party.

Annual banquet.

Friday, February 17

All day tours to be arranged.

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Journal of Range Management

"To Advance the Science and Art of Grazing Land Management"

Official publication of

The American Society of Range Management

Volume 19, 1966

Published Bimonthly by

THE AMERICAN SOCIETY OF RANGE MANAGEMENT

American Society of Range Management

The American Society of Range Management was created in 1947 to advance the science and art of grazing land management, to promote progress in conservation and sustained use of forage, soil and water resources, to stimulate discussion and understanding of range and pasture problems, to provide a medium for the exchange of ideas and facts among members and with allied scientists, and to encourage professional improvement of members.

Membership: Persons shall be eligible for membership who are interested in or engaged in practicing range or pasture management or animal husbandry; administering grazing lands; or teaching, or conducting research, or engaged in extension activities in range or pasture management or related subjects.

JOURNAL OF RANGE MANAGEMENT

The Journal, published bi-monthly, is the official organ of the American Society of Range Management. The Journal aims to publish something of interest to the entire membership in each issue. The Society, however, assumes no responsibility for the statements and opinions expressed by authors and contributors.

Subscriptions. Correspondence concerning subscriptions, purchase price of single copies and back issues and related business should be addressed to the Executive Secretary, P. O. Box 5041, Portland, Oregon 97213. Subscriptions are accepted on a calendar year basis only. Subscription price is $10.00 per year in the U. S. and insular possessions, Canada and Mexico; $10.50 in other places. Checks should be made payable to the American Society of Range Management. Subscribers outside the United States are requested to remit by International Money Order or by draft on a New York bank.

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Membership Dues. Dues for regular members are $10.00 per year in the United States, Canada and Mexico, $10.50 elsewhere. Student memberships are $5.00 per year. Life Memberships are $300. Dues include a subscription to the Journal. Remittance must be in U. S. funds.

Post Office Entry. Second-class postage paid at Portland, Oregon, and at additional offices.

Manuscripts. Address manuscripts and correspondence concerning them to the Editor, Journal of Range Management. Instructions to authors appear in the March Journal. Copies are available in the Editor's office.

Reprints. Reprints of papers in the Journal are obtainable only from the authors or their institutions.

News And Notes. Announcements about meetings, personnel changes and other items of interest to Society members should be sent directly to the Executive Secretary.

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