INTRODUCTION

Almost half of the earth's surface is covered by rangeland, a renewable resource, a primary source of food, fiber, and contentment--the three needs basic to human life. As world population continues to expand at the annual rate of about 1.7 percent, the priority for food production remains foremost closely followed by the need for proper clothing and housing for an ever-growing population. With affluency comes a demand for more nutritious food, better living conditions, and enhanced improvement in esthetic and recreational opportunities. This Nation's and the world's rangelands can help provide basic needs in the form of goods, services, and values, as demanded by society.

Constraints. Primary constraints must be dealt with if we are to avoid unnecessary pitfalls and approach attainment of the goals for the future. Two primary constraints are a shortage of energy and a scarcity of water--both are already evident and will become more critical in the near future. Food production systems must reduce reliance upon depletable energy reserves. Nonenergy-intensive systems for food production, such as the production of red meat from rangeland, will become increasingly important. Presently, animals are the only practical means of harvesting range vegetation and converting it to food. In many parts of rangelands, water is now a major limiting factor; after the year 2000, many authorities believe that water will be the resource that most limits world food production. Development of production systems that are the most efficient in the use of this scarce resource is paramount if we are to produce the food and other products in the quantity needed by an evergrowing population.

A third constraint is an insufficient reserve technology base that comes from research and the transfer of existing technology to users. Modern technology makes it possible to handle vast quantities of data, but application to solve range problems still relies upon person-to-person contact. If the vast acreages of rangelands are to be managed intensively, the state-of-the-art technology must be transferred to the farms, ranches, and land-management offices throughout the country.

Another constraint that continues to intensify as the population grows is the increasing competition among user groups for the products from the range resources. Increasing regulations, environmental impact statements, and the multiple-use concepts place new demands on our use of existing technology and point to the need for information not now available.

As the demands for goods, services, and recreation from rangelands increase, these constraints make future range management qualitatively different from that in the past.

Toward Modern Range Management. Rangeland is a series of ecosystems, an integration of indivdual range sites. A range site is an area with distinctive physical and biological characteristics that supports a unique plant and animal community. The land manager must know the potential of each site to realize its sustained capability. Because of the complexity of the information needed, it must be updated at frequent intervals. Land managers, both private and public, must consider the economic and cultural demands of the different users, as well as the social and economic costs and benefits.

Improved technology and technical capabilities will be available to public and private range managers including: current, remotely sensed information on animal health and performance, plant biomass, and current weather conditions; improved weather forecasting; up-to-date costs of treatments in terms of both dollars and fossil fuel energy and, perhaps, water inputs; and computerized data-base storage and functional models to transform plant, animal, soil, and environmental information into management decisions.

Rangelands of the United States are comprised of several resources that contribute to meeting food, fiber, timber, water, recreation, and other needs. Collectively, rangelands are producing forage at less than half of their potential. Production can be improved by managing range to encourage succession to a higher stage; by improving practices, such as weed and brush control, surface modification, or renovation; or by replacing existing plant species with more productive native or introduced species. Although in the past three decades progress has been significant in improving the condition of the range, much remains to be done. Many problems face the range manager today. Although many of these problems are unique to a specific ecosystem or location, some are common to all:

1. Range management decisions are diffuclt because of lack of knowledge of the interdependencies among the multiple uses of the range ecosystem, and lack of climatic and economic data.

    a. Our knowledge of the impact of range improvement practices on the environment, e.g., wildlife, erosion, water quality, is inadequate.

    b. Our knowledge of resources and of the probability of using certain environmental conditions to predict the long-term effect of management decisions is inadequate.

    c. Data on longevity of improvement practices and resulting increases in plant and animal production are lacking.

    d. Because of seasonal variations in productivity of base forage species, alternatives for complementary pastures and feedstuffs are inadequate.

    e. Adequate knowledge of the impact of wildlife on domestic livestock production and vice versa is needed.

    f. The acreages of disturbed sites (strip mines, abandoned cropland, recreational damage, etc.) are increasing, whereas our knowledge of soil, water, and plant requirements for successful revegetation to prevent deterioration and to meet local environmental laws is lacking.

g. Our knowledge of economics of alternative management opportunities is incomplete.

h. Adequate economic input and output data to adequately assess range-improvement practices for benefit of private and public managers and society in general is lacking.

i. Transfer of currently available technology is not adequate.

2. Competing biologic components reduce productivity.

   a. Because of mismanagement and changing ecosystem parameters, brush and weed encroachment are problems.

   b. Technically adequate and economically viable control practices for all brush species or combination of brush species are lacking.

   c. Our knowledge of revegetation practices associated with various weed control practices is lacking.

   d. Native and introduced species are needed that are more productive and easily established.

3. Water shortage (inadequate amount and undesirable seasonal distribution) limits productivity.

   a. Our knowledge of plant-soil-fertility relationships, when soil water is limiting, is inadequate

   b. Our knowledge of differences among plant species in water-use efficiency is lacking.

   c. Our knowledge of moisture-harvesting techniques is inadequate.

   d. Our knowledge of the effect of increasing upstream water use on downstream water supply and quality is lacking.

4. Our knowledge of nutrient cycling in relation to soil-plant interactions, soil fertility, water supply, and animal performance and production is inadequate.

   a. Our knowledge of plant response to fertilizer and time and frequency of application is inadequate.

   b. The effect of rangeland soil's fertility on plant productivity, animal performance, root distribution, and water use efficiency is not known.

   c. Persistent productive legumes to reduce reliance on fertilizer and increase animal performance are needed.

d. Our knowledge of biological N-fixation under arid conditions is inadequate.

e. Our knowledge of fertility requirement for maximizing success of establishment of persistent species on reclaimed range sites is inadequate.

f. The role of below-ground herbivores is generally unknown and limits our development of photosynthate allocation strategies for increased range ecosystem productivity.

5. Our knowledge of optimum livestock breeds, crosses, and species for various ecosystems and management systems is lacking.

a. Adequate knowledge of cross breeding and rebreeding, calving problems, and calf performance and production is lacking.

b. Our knowledge of mixed-species management systems on forage utilization, brush and weed control, and total livestock production is lacking.

c. Our knowledge of management system for preventing or reducing animal losses from toxic plants is lacking.

STATUS OF RANGE AND RANGE RESEARCH

This review of range research was initiated in 1977 by Agricultural Research, Science and Education Administration, U.S. Department of Agriculture (SEA-AR). In this initial phase, we assessed range research and identified research needs within SEA-AR in the 17 contiguous Western States. These research needs are summarized herein. Subsequently, we will need to assess range research in the 17 Western States conducted by the total range community, including Forest Service (USFS), State Agricultural Experiment Stations (SAES), and other colleges and universities, and develop a plan for implementing a coordinated range research program. Additionally, we will need to assess the forage, pasture, and range program in the remaining States.

Characterization of Rangelands and SEA-AR Research. The first step in this assessment was to develop the following information for each of 17 SEA-AR range research locations.

(1) land resource region and area (LRA) to include land use, elevation, climate, and soils,

(2) ecosystem,

(3) potential natural vegetation and major plant species,

(4) potential seeded species,

(5) wildlife (animal) dominants,

(6) principal and related National Research Programs (NRP's),

(7) type of range research,

(8) missions, objectives, status, plans, and obstacles of research program,

(9) plant species needing improvement, plants useful for revegetation, unwanted plants, plants toxic to animals, and other range pests,

(10) estimates of land use and wildlife, and

(11) research needs.

We also determined for each of the 17 Western States information concerning:

(1) total land area,

(2) land area, percent grazed, average animal unit month (AUM) stocking rate per acre, and total AUM's for each forest-range ecosystem,

(3) condition, and present and potential stocking of each range ecosystem, and

(4) numbers and animal units (AU's) of beef cattle and stock sheep

Each SEA-AR scientist, working on rangeland was asked to complete three forms:

(1) Federal Range Research Program in SEA-AR,

(2) 1978 Range Review, and

(3) Information Available and Research Needs

Based on the information from each location and State, we divided the 17 Western States into five subregions, based on their physiography, vegetation, and management scheme. These subregions and States are:

Northern Great Plains--North and South Dakota, and Montana
Central Great Plains--Colorado, Kansas, Nebraska, and Wyoming
Southern Great Plains--Oklahoma and Texas
Southwest--Arizona, California, and New Mexico
Northwest--Idaho, Nevada, Oregon, Utah, and Washington

A comprehensive detailed report, developed for each subdivision and published separately, is summarized below.

Western Rangeland and SEA-AR Research. The range condition in each of the ecosystems is predominantly in fair to poor condition (Table 1).

Thus their full potential is not being realized. SEA-AR scientists have estimated that improving the range through the development and application of new and improved technology would more than double productivity (see footnote 2 of Table 1 for details). The current level of research effort for each ecosystem by subregion is shown in Table 2. About two-thirds of the scientific effort (64 SY) is devoted to the prairie, plains grassland, and the sagebrush ecosystems, that comprise 36 percent of the total rangelands and support 62 percent of the total livestock capacity.

The range research effort for AR scientists was divided into 12 research categories. Table 3 shows the current staff effort in these categories for each subregion. Major effort is being placed on plant improvement (17.7 SY), including germplasm collection, genetics, and breeding new plant varieties. A similar effort is placed collectively upon ecology and control of pests, insects, and disease. This research is complemented by a substantial portion of the remainder in revegetation. A minor effort is placed on complementary pastures, an important aspect of range management systems and range productivity.

The State of the Art and Science of SEA-AR Range Research. In the last 80 to 90 years, since the very inception of range research, progress has been significant in developing scientific and technical bases for range management. Current technology, such as range improvement (brush and weed control, and revegetation) leads to more forage and more stable conditions that in turn will permit greater stocking rates. Yet, although rangeland conditions have improved somewhat in the last few decades, most range scientists believe that rangeland productivity still remains at about one-half of the potential that could be achieved with current technology. Grazing strategies must be developed for each ecosystem, for various levels of range improvements, for maximizing production while maintaining or improving the resource.

While technology for controlling many undesirable plant species has been developed, unwanted plants continue to dominate millions of acres of rangelands. Emerging environmental restrictions continue to require the development of new technology to better control undesirable plants. Although improved forage plants have increased rangeland production for many sites, suitable plant materials for revegetation after mining, overgrazing, or other disturbances are still lacking in many ecosystems. Although revegetation attempts remain a risky operation on most western rangelands, because of present technology the probability of success has increased.

Range fertilization has been proven to be economical in many ecosystems. However, we know little about the full impact of fertilizer practices as a management tool along with distributing grazing and frequency of application in relation to buildup and maintenance of a "fertilizer pool." Consequently, development of suitable N-fixing plant materials compatible with native and improved plant communities is essential.

Availability of water and maximizing its use for plant production, livestock performance, grazing management, wildlife, recreation, and water supplies remain challenges.

Our understanding of energy flow and nutrient cycling of range ecosystems is only in its embryonic stages. Strategies need to be developed for optimal allocation of carbon flow. Domestic herbivores are the prime users of most rangelands; yet, in terms of energy flow, they consume less than 0.5 percent of the total energy captured by range plants. Other herbivores, particularly those belowground, have a significant, although largely unknown, effect on productivity.

RANGE RESEARCH NEEDS

Needs Expressed by Other Than SEA-AR Scientists. Within the last 5 years, several efforts have been made to develop lists or detailed descriptions of research needs on the rangelands of the Western United States.[1/] The results of eight such efforts are summarized in Table 4. Six of these summaries were developed by organizations using working groups or task forces to assemble concepts and needs. The other two consisted of general

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[1/] List of sources of range research needs:

1. Agricultural Research Policy Advisory Committee. 1975. Research to Meet U.S. and World Food Needs, Kansas City, MO, July 9-11, 1975. 326 p.

2. Bureau of Land Management. 1978. Speech presented by R. Keith Miller to Western Directors Association Meeting, Aug. 9-11, 1978. (Copy of speech sent to H C Cox by R. K. Miller.)

3. Great Plains Agricultural Committee. 1976. Range Research Needs in the Great Plains. Great Plains Agricultural Council Publication 79. 60 p.

4. Klemmedson, J. O., R. D. Pieper, D. D. Dwyer, W. F. Mueggler, and M. J. Trlica. 1978. Research Needs on Western Rangelands. J. Range Manage. 31(1):4-8.

5. National Association of Conservation Districts. 1979. Pasture and Range Improvement Report. 38 p.

6. National Cattlemen's Association. 1979. Beef Cattle Research Needs and Priorities. Beef Business Bulletin, 11-2-79.

7. U.S. Department of Agriculture and National Association of State Universities and Land Grant Colleges. 1977. Range and Forage Research Needs for Red Meat Production. National Planning Committee of the Agricultural Research Policy Advisory Committee. 44 p.

8. U.S. Department of Agriculture, Association of State College and University Forestry Research Organizations, and National Association of State Universities and Land Grant Colleges. 1978. National Program of Research for Forests and Associated Rangelands, Washington, DC. U.S. Dept. Agr. ARM-H-1. 96 p.

summaries of research needs from the National Cattlemen's Association and the Bureau of Land Management. The research needs outlined by the National Association of Conservation Districts were developed from input solicited from eight other groups or organizations, where separate recommendations are also shown in Table 4. The major areas where research is needed are listed along with the appropriate subdivisions.

Needs Expressed by SEA-AR Scientists. Scientists in the 17 Western States identified eight research priorities. Table 5 lists these priorities by subregion in order of decreasing importance. In assigning priorities, SEA-AR scientists considered (1) the importance of each research problem area, (2) the amount of the current effort, and (3) the nature of the disciplines necessary to build effective research teams. The proposed mission of each of the teams suggested as a result of the survey and the suggested disciplines for scientists to comprise each research area are as follows:

Management Systems (Grazing systems, 12; Systems analysis and modeling, 3)[2/]

Mission:

Increase efficiency of red meat production and other multiple uses of rangelands by improving technology for integrated management of the interactions among soil, weather, plant, and animal resources.

Team:

Modeler (Systems Analyst, Bioengineer)
Range Scientist (Ecologist)
Economist
Range Animal Scientist
Agronomist (complementary pastures)
Plant Physiologist
Animal Ecologist
Soil Scientist
Animal Nutritionist

Revegetation (Revegetation, 7)

Mission:

Determine species adaptability to various range sites and methods of seeding to improve deteriorated or disturbed rangelands, to stabilize soils, to protect watersheds, and to improve forage resources.

2/ Item in parentheses refers to the research need and the number of times the need (in comparable terms) was expressed by other than SEA-AR scientists (Table 4.).

Team:

Agricultural Engineer-Hydrologist
Range Scientist
Soil Scientist
Plant Physiologist
Weed Scientist

Brush and Weed Management (Brush and weed control, 6)

Mission:

Develop and evaluate reliable, economical, and safe methods for managing unwanted plants on rangelands so that the forage quantity and quality are improved, the esthetic values are enhanced, soil is protected from wind and water erosion, and animal deaths from eating poisonous plants are reduced.

Team:

Weed Scientist
Entomologist
Range Scientist
Plant Physiologist
Agricultural Engineer

Plant Improvement (Selection and breeding of range plants, 8)

Mission:

Develop superior strains of grasses, forbs, and shrubs for use on rangelands to increase yield and quality of forage, and to stabilize soils.

Team:

Cytogeneticist
Plant Breeder - Geneticist
Plant Physiologist
Range Scientist/Agronomist
Range Animal Nutritionist
Entomologist
Pathologist

Water Management (Soil and water conservation, 7)

Mission:

Develop effective practices for managing surface water and develop methods for quantifying and evaluating the effects of range management practices on water use efficiency, runoff, erosion, and sediment yield.

Team:

Engineer
Hydrologist
Range Scientist
Soil Scientist

Resource Evaluation Techniques (Identification, classification, and inventory of range ecosystems, 7)

Mission:

Develop efficient methods and techniques for measuring the primary characteristics of the range environment.

Team:

Engineer
Remote Sensing Specialist
Physicist
Ecologist
Range Scientist
Soil Scientist

Insects, Diseases, Nematodes, and Other Pests (Impact and management of insects, diseases, and nematodes, 7)

Mission:

Improve rangelands by developing practical, effective, safe, and economical means of managing major insects, diseases, nematodes, rodents, and other pests that limit productivity.

Team:

Entomologist
Nematologist
Pathologist
Range Scientist

Plant-Induced Animal Disorders (Effect and management of poisonous plants, 4)

Mission:

Identify the toxins in poisonous range plants and develop methods to manage plants and animals, neutralize the toxins if ingested or treat poisoned animals.

Team:

Animal Scientist
Veterinary Pathologist
Plant Physiologist
Range Scientist
Veterinary Toxicologist
Veterinarian
Weed Scientist

Generally, SEA-AR scientists and several groups, identified in Table 4, agree concerning which research needs are high-priority items. Undoubtedly, these needs differ among ecosystems, a fact which must be considered in implementing range-research programs. Also, no projected view of the future can forecast all potential effects. A specific insect or disease can suddenly seriously reduce productivity or cause range managers other problems. With a background of broad-based range ecosystem research, including the modeling of predicted responses to management or manipulative treatments, the anticipated effects of these catastrophic events can be better predicted and evaluated, and alternate corrective strategies developed and applied.

SEA-AR ROLE IN FUTURE RANGE RESEARCH

SEA-AR's contribution to future technology development for managing the renewable rangeland resources should be based on its strengths (expertise of its scientists, historical data base, research facilities and locations), and its ability to operate across physiographic or political boundaries. Also, SEA-AR's research can address problems on a long-term basis blending basic and applied sciences from the necessary scientific disciplines.

Its present scientific expertise should be complemented to form range ecosystem management and utilization research teams at strategic locations.

As funding permits, SEA-AR's rangeland research programs should be increased to complete all research teams that are currently in various stages of staffing.

Implementation Strategy. About 56 additional SY's are needed to address the range research problems envisioned in this report. But, where do we begin in filling the voids? In what regions or resource area are the SY needs most critical? Which of the scientific disciplines should be filled first? In what priority should the others be added? And at what rate should the SY's be added?

First Priority. To build on SEA-AR's strengths, the strategy should be to fully staff research teams at locations where scientists are productive and at locations where scientists can utilize historical data bases. These Range Management Systems research teams should be staffed so they can begin to function as soon as possible. These locations should be fully staffed with scientists with expertise in the basic disciplines to include the soil-plant-animal-climate areas. Modelers should be added to synthesize the existing data base and to formulate working models that can be used by each team in the regions in which they are located. Other scientists should be added to complement the differing emphases of research at each location. A total of 28 additional SY's are needed to complete these research teams.

Second Priority. Four additional areas of SEA-AR research should be strengthened as soon as possible: (1) revegetation, (2) brush and weed management, (3) plant improvement, and (4) water management. The most critical need is in the area of revegetation.

Brush- and weed-management research related to revegetation problems will continue to be an important need. Additional scientists should be added to research programs with expertise in biological control of undesirable plants and both the biological control and the engineering aspects of revegetation. Plant improvement teams are functioning well at most locations, but needs exist in the areas of improving native species; adaptation of introduced species; introduction of new germplasm, particularly legumes; and continuing testing of new chemicals for efficacy and safety.

Third Priority. Some aspects of the three remaining areas of research, resource evaluation techniques, insects and other pests, and plant-induced animal disorders need strengthening--particularly identifying toxic compounds, predicting potentially hazardous introductions, and identifying the role of management systems in reducing losses from poisonous plants.

These recommendations reflect the current situation and reasonable plans for the near future. As programs change, other State and Federal agencies will initiate, expand, or decrease programs, and AR's research effort will need to be continually evaluated to ensure that it complements the total range research effort. For each of the three priority rankings, first priority should be given to locations with historical data bases that can be further analyzed and synthesized; to locations representing the most productive (currently or potentially) and widespread range types; to locations which are unique to a particular range type; and to locations where SEA-AR can share staffs with other agencies, including SAES and USFS. At locations with similar range types where SEA-AR operates more than one staff, or a SEA-AR location and another agency operate separate staffs, consideration should be given to combining staffs and forming single (multiagency) research teams.

The goal of 56 additional SY's seems large relative to the present base of 96.5 scientists. However, these additional SY's would be added over a 5-year period, or longer, to the existing program. Also, considering that these scientists would be added to eight major research areas at about 20 locations, the number per location, although small, would make a significant contribution to individual research teams and to a national range program.

Table 1. Rangeland types, areas, condition, and stocking in the 17 Western States[1/]

Ecosystem	Area (mil. acres)	Condition (%) Good	Fair	Poor	Very Poor	Grazed (%)	Stocking Rate (AUM/a)	Total Stocking[2/] (1,000 AUM's) Present	Potential
Sagebrush	129.9	12.3	36.1	35.0	16.6	89	0.182	24,641	77,770
Desert shrub	81.2	17.4	36.4	31.5	14.7	70	0.041	2,809	8,070
Southwestern shrubsteppe	43.2	10.5	14.8	41.5	33.2	92	0.084	3,775	17,140
Chaparral-mountain shrub	15.5	11.8	24.0	37.9	26.3	95	0.125	1,612	8,300
Pinyon-juniper	47.3	9.1	28.6	44.4	17.9	88	0.073	2,393	12,040
Mountain grasslands	26.9	17.5	36.2	31.2	15.1	97	0.319	16,597	29,020
Mountain meadows	3.3	32.4	38.8	21.1	7.7	79	0.613	822	4,220
Desert grasslands	24.7	8.4	24.7	50.5	16.4	93	0.091	2,998	8,220
Annual grasslands	10.2	13.2	5.0	36.7	45.1	96	1.095	10,649	64,010
Alpine	6.8	42.8	27.1	28.7	1.4	70	0.045	216	460
Shinnery	4.7	16.5	27.7	40.5	15.3	97	0.406	1,848	6,780
Texas savanna	28.4	16.4	23.5	45.9	14.2	99	0.428	16,493	43,660
Plains grasslands	175.2	14.7	34.2	39.6	11.5	98	0.294	54,325	168,560
Prairie	41.0	14.0	34.2	38.1	13.7	95	1.090	45,145	148,680
Douglas fir	38.5	--	--	--	--	52	0.049	1,000	2,000
Ponderosa pine	33.7	--	--	--	--	74	0.059	1,617	3,230
Western white pine	0.6	--	--	--	--	48	0.234	50	100
Fir-spruce	113.4	--	--	--	--	51	0.028	418	840
Hemlock-Sitka spruce	19.8	--	--	--	--	0	0.000	173	350
Larch	2.8	--	--	--	--	41	0.147	178	360
Lodgepole pine	21.2	--	--	--	--	56	0.011	527	1,050
Redwood	0.8	--	--	--	--	55	0.063	28	60
Hardwoods	39.8	--	--	--	--	56	0.059	1,222	2,440
Longleaf slash pine	0.3	--	--	--	--	96	0.200	55	110
Loblolly-shortleaf pine	5.4	--	--	--	--	37	0.011	22	40
Oak-pine	3.3	--	--	--	--	48	0.105	147	290
Oak-hickory	7.6	--	--	--	--	28	0.253	531	1,060
Oak-gum-cypress	2.8	--	--	--	--	3	2.490	191	380
Elm-ash-cottonwood	1.6	--	--	--	--	10	0.213	51	100
Wet grasslands	3.5	17.0	27.6	20.7	34.7	79	0.663	4,304	8,610
Desert	7.5	76.6	11.5	6.5	5.4	45	0.001	3	10
Total	940.9							194,840	617,960

1/ Partially obtained from and based on "An Assessment of the Forest and Range Land Situation in the United States" (Forest Service FS-345, 1980).

2/ Potential stocking was calculated by assuming that good, fair, poor, and very poor range conditions produced 80, 50, 30, and 10% respectively, of potential. Based on the ecosystems for which we had condition data, we assumed that the potential stocking for the remaining ecosystems could be approximately doubled.

Table 2. SY's in research in each ecosystem in the 17 Western States

Subregion	Ecosystem[1/] A	B	C	D	E	F	G	H	I	J	K	L	M	N
Northern Great Plains	0.8	16.0	0.8											
Central Great Plains	0.9	10.9	1.5										0.1	0.1
Southern Great Plains	5.5	10.0		2.8	5.4	1.5	0.1	0.5	0.2					
Southwest			0.3			3.2	6.4		2.4	0.8	0.1	0.1	0.2	0.4
Great Basin and Northwest	—	—	17.2	—	—	—	0.3	—	1.2	1.8	0.2	1.1	3.7	—
Total SY's	7.2	36.9	19.8	2.8	5.4	4.7	6.8	0.5	3.8	2.6	0.3	1.2	4.0	0.5
						Grand Total			96.5 SY's					

[1/] Ecosystem Type: See map attached to the back cover.

A = Prairie
B = Plains Grassland
C = Sagebrush
D = Oak-Hickory
E = Texas Savana
F = Southwestern Shrubsteppe
G = Desert Grasslands
H = Shinnery
I = Desert Shrub
J = Pinyon-Juniper
K = Annual Grasslands
L = Mountain Meadows
M = Mountain Grasslands
N = Chaparral-Mountain Shrub

Table 3. SY's in each range research category in the 17 Western States

Subregion	Research Category[1/] I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Northern Great Plains	0	2.8	1.6	4.5	1.6	0.7	0.8	1.5	1.8	0	2.2	0.2
Central Great Plains	0.1	2.0	2.4	1.3	1.6	0.7	1.1	2.3	0.3	0	1.1	0.7
Southern Great Plains	0.4	6.5	2.8	4.6	0.9	0.8	0.2	1.1	0.8	0.4	4.2	3.2
Southwest	0.9	1.8	1.6	2.2	1.2	0	0.3	2.8	0.8	0.1	1.9	0.2
Great Basin and Northwest	1.1	4.6	1.2	4.4	0.9	0	0.6	4.2	4.7	0.4	2.3	1.1
Total SY's	2.5	17.7	9.6	17.0	6.2	2.2	3.0	11.9	8.4	0.9	11.7	5.4
						Grand Total		96.5 SY's				

1/ Research Categories

I = Inventory and Classification
II = Improved Plants
III = Revegetation
IV = Ecology, Damage and Control of Pests, Insects, and Disease
V = Other Manipulative Treatments
VI = Complementary Pastures
VII = Grazing Systems
VIII = Effects of Practices III-VII
IX = Livestock
X = Wildlife
XI = Basic Research
XII = Models

Table 4. Range research needs expressed by other groups and organizations

Research Needs	National Cattlemen's Association (1979)	Klemmedson et al. (1978)	Agricultural Research Policy Advisory Committee (1975)	Great Plains Agricultural Council (1976)	Bureau of Land Management (1978)	U.S. Department of Agriculture (1977)	U.S. Department of Agriculture (1978)	Pasture and Range Improvement Report-National Association Conservation Districts (1979): Forestry Organization	American Forage and Grassland Council	Farmer/Rancher Group	Research Groups	Society for Range Management	Soil Conservation Group	Wildlife and Environmental Groups	Other	NACD Summary	Number of Times Need Expressed
Improvement of Rangeland for Increased Productivity and Stability	X	X	X	X		X	X		X	X	X	X	X	X	X	X	14
1. Revegetation			X	X		X	X			X	X					X	7
2. Brush and Weed Control (Management)	X		X	X							X			X		X	6
3. Impact and Management of Insects, Diseases, Nematodes	X			X		X	X			X	X					X	7
4. Impact and Management of Poisonous Plants	X			X		X					X						4
5. Burning			X	X			X							X	X		5
6. Improvement of Tillage, Fertilizer and Other Means				X			X										2
7. Economics of Improvement Practices						X	X			X		X	X				5
Identification, Classification, and Inventory of Range Ecosystems		X	X	X	X		X					X				X	7
1. Uniform Inventory Procedures			X	X								X				X	4
2. Range Suitability Criteria					X												1
3. Range Conditions and Trend Criteria																X	1
4. Site Potential		X															1
5. Remote Sensing			X				X										2
Grazing Systems	X	X	X	X	X	X	X				X	X		X	X	X	12
1. Integration of Range and Pasture	X		X	X		X	X					X				X	7
2. Energy Efficiency of Converting Forage to Protein by Animals							X									X	2
3. Nutrient Quality of Forage	X		X	X		X											4
4. Effects of Silvicultural Systems of Understory Forage							X										1
Selection and Breeding of Range Plants		X	X	X		X	X				X				X	X	8
1. Biological N-Fixation (Legumes)		X	X	X		X					X					X	6
2. Increased Efficiency for Yield, Water Use, Pest Resistance, Quality			X			X	X				X					X	5

Table 4. Range Research Needs Expressed by Other Groups and Organizations (continued)

								Pasture and Range Improvement Report-National Association Conservation Districts (1979)									
Research Needs	National Cattlemen's Association (1979)	Klemmedson et al. (1978)	Agricultural Research Policy Advisory Committee (1975)	Great Plains Agricultural Council (1976)	Bureau of Land Management (1978)	U.S. Department of Agriculture (1977)	U.S. Department of Agriculture (1978)	Forestry Organization	American Forage and Grassland Council	Farmer/Rancher Group	Research Groups	Society for Range Management	Soil Conservation Group	Wildlife and Environmental Groups	Other	NACD Summary	Number of Times Need Expressed
Multiple Uses of Rangeland		X		X	X	X	X	X					X	X	X	X	10
1. Wildlife Benefits (Including Riparian Habitat)		X		X	X		X							X	X	X	7
2. Biology and Censusing of Wild Horses and Burros					X												1
3. Water Production, Esthetics, Recreation, etc.				X			X										2
Soil and Water Conservation		X	X		X						X			X	X	X	7
1. Improved Water Quality			X														1
2. On-site Water Management (Increased Efficiency of Water Use by Range Plants)		X	X								X						3
3. Livestock Water Supplies															X		1
4. Erosion Control															X		1
Increasing Productivity of Rangelands	X	X	X	X	X	X	X				X						8
1. Production in Relation to Phenology				X	X												2
2. Ecology and Physiology of Individual Species		X	X	X		X	X				X						6
3. Nutrient Cycling				X													1
4. Plant-Animal-Soil-Climate Interactions		X															1
5. Processing and Preservation of Range Forages	X		X														2
Importance of Rangelands (Role of Range Management)		X						X	X			X	X				5
1. Influence of Economic, Social, and Political Restraints		X															1
Improved Efficiency of Animal Production on Rangelands			X														1
Systems Analysis and Modeling			X	X		X											3
Other																	
1. Inadequate Information Dissemination and Communication								X	X	X		X	X		X		6
2. Alternative Financial Incentives for Range Improvement									X	X			X		X		4
3. Range Equipment Development			X														1

Table 5. Scientific effort (SY's) present and needed to complete research teams, by priority, in the 5 subregions of the 17 Western States

Priority	Northern Great Plains[1/]		Central Great Plains[2/]		Southern Great Plains[3/]		Southwest[4/]		Great Basin and Northwest[5/]		Total	
	SY's on Hand FY 1979	Add'l. SY's Needed	SY's on Hand FY 1979	Add'l. SY's Needed	SY's on Hand FY 1979	Add'l. SY's Needed	SY's on Hand FY 1979	Add'l. SY's Needed	SY's on Hand FY 1979	Add'l. SY's Needed	SY's on Hand FY 1979	Add'l. SY's Needed
Management Systems	7.5	7.0	4.5	4.0	4.3	6.0	4.9	6.0	10.0	5.0	31.2	28.0
Revegetation	1.5	2.0	4.0	2.0	1.5	3.0	1.9	2.0	0.7	0	9.6	9.0
Brush and Weed Management	0	0	1.0	0	6.6	2.0	2.6	2.0	2.0	0	12.2	4.0
Plant Improvement	3.8	0	2.0	0	6.7	0	1.0	4.0	5.0	1.0	18.5	5.0
Water Management	1.0	1.0	2.0	1.0	4.6	0	3.0	1.0	4.0	1.0	14.6	4.0
Resource Evaluation Techniques	0	0	0	1.0	2.2	0	0.4	2.0	0	1.0	2.6	4.0
Insects, Diseases, Nematodes, and Other Pests	4.0	1.0	0	0	0	0	0	0	0	0	4.0	1.0
Plant-Induced Animal Disorders	0	0	0	0	0	0	0	0	3.8	1.0	3.8	1.0
Total	17.8	11.0	13.5	8.0	25.9	11.0	13.8	17.0	25.5	9.0	96.5	56.0

Grand Total, present - 96.5 SY's

Grand Total, needed additionally - 56.0 SY's

[1/] Northern Great Plains = Montana, North and South Dakota
[2/] Central Great Plains = Colorado, Kansas, Nebraska, and Wyoming
[3/] Southern Great Plains = Oklahoma and Texas
[4/] Southwest = Arizona, California, and New Mexico
[5/] Great Basin and Northwest = Idaho, Nevada, Oregon, Utah, and Washington

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