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Challenges in FORAGE AND RANGE RESEARCH

Agricultural Research Service
UNITED STATES DEPARTMENT OF AGRICULTURE

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Challenges in Forage and Range Research

Prepared by the Forage and Range Research Branch, Crops Research Division, Agricultural Research Service

Our grasslands are a multiple-use resource. Their development concerns everyone who has an interest in livestock production, in soil and water conservation, or in wildlife and recreation. Grasses and legumes provide grazing and stored feed for livestock; they restore and conserve soil fertility, reduce erosion and silting problems in reservoirs and waterways, and improve streamflow; they provide cover for wildlife and for recreational areas; and they add to the beauty of our homes and our cities and roadsides.

Maintaining and improving our grassland resource requires cooperation among many groups—farmers, ranchers, extension workers, teachers, conservation specialists, turf specialists, economists, engineers, and research workers. These groups working together have made significant gains in the culture and management of some grasses and legumes and in the introduction of new species and productive varieties. But we need to know more.

We need grassland species adapted to environmental conditions that range from sea level to altitudes of more than 10,000 feet; and from desert conditions to areas that receive 100 inches of rainfall each year. We need to know the species best adapted to each environment and use; the seedbed preparation necessary to assure good stands; the most economical measures to control insects, diseases, and weeds; and the management practices that will provide the most nutritious forage or the most beautiful turf.

These are the challenges. Basic and applied research by specialists in many disciplines will provide the technical information to meet these challenges.

BN—29523

Much forage and range research is cooperative between the U.S. Department of Agriculture and State agricultural experiment stations. The stations may provide land, buildings, and facilities. These bermudagrass introduction tests (checked plots in foreground) are used in research at the Georgia Coastal Plain Experiment Station, Tifton, Ga.

N-22107

A geneticist at Tifton, Ga., self-pollinates pearl millet. Selfed lines are used in studying breeding methods and inheritance of specific traits in grasses and legumes.

BN-29537

Alfalfa stem cuttings are rooted in sand. Rapid and effective methods of increasing selections vegetatively are important in grass and legume improvement.

BN-29544

A technician at the U.S. Regional Pasture Research Laboratory, University Park, Pa., crosses white clover selections.

Research on Breeding Methods

Research on breeding methods conducted by Forage and Range Research Branch, Crops Research Division, is limited to selected species among the 90 grasses and 30 legumes that are of importance for hay, pasture, range, turf, and conservation.

Breeding perennial grasses and legumes is a complicated task. Among the factors that make the task complicated are the following:

—Perennial grasses and legumes have more chromosomes than most annuals. The large number of chromosomes increases the difficulty in selecting for specific characteristics.

—Most perennial forage species are cross-pollinated by wind or by insects. Cross-pollinated plants not only produce highly variable progeny but also are difficult to inbreed.

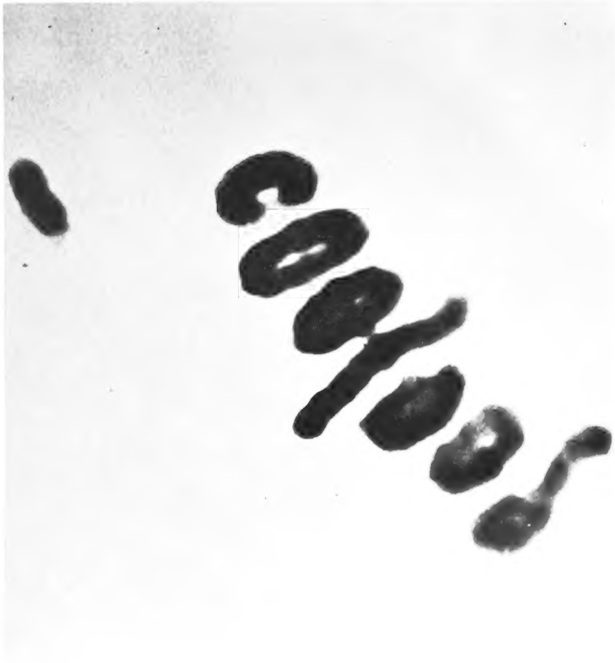
—Perennial grasses and legumes often produce poor seed yields where they are grown for forage or conservation.

—Perennial species take longer and cost more to evaluate than annual species.

—Collections of plant material are difficult to acquire and to maintain.

BN–29545

A plant breeder at the U.S. Regional Pasture Research Laboratory, University Park, Pa., examines white clover introductions.



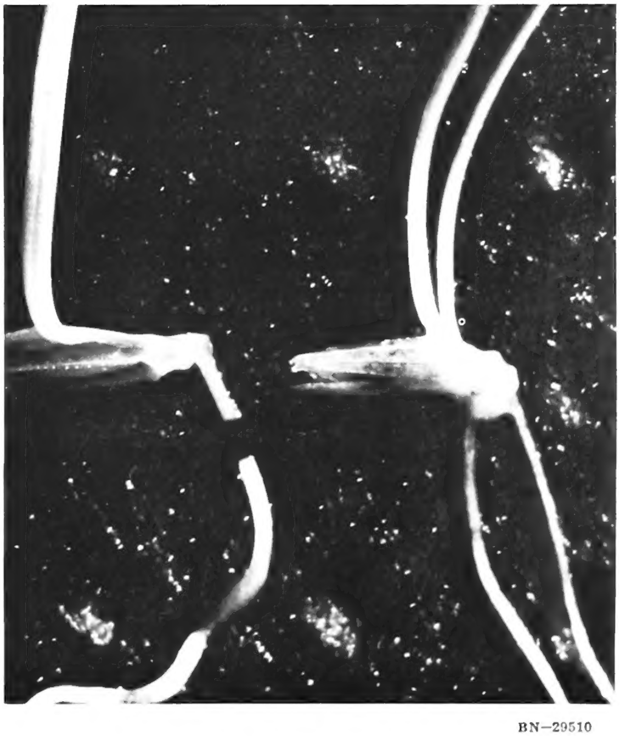
BN–29499

There are 15 chromosomes (seven pairs and a single chromosome) in this plant derived from tetraploid crested wheatgrass (2n=28 chromosomes) at Logan, Utah. Chromosome studies provide a guide to the origin of species and to inheritance patterns.

—Available genetic, cytogenetic, and pathological information does not provide adequate guidelines for breeding.

To improve methods of breeding grasses and legumes, we need more information on—

- Isolating sources of superior lines of plant material.
- Improving techniques for emasculation, pollination, and selfing.
- Clarifying pollination patterns within isolated breeding nurseries.
- Developing efficient testing procedures for field studies.
- Comparing contrasting selection procedures.
- Developing techniques for studying parent-progeny relationships.
- Developing systems for combining lines into varieties.
- Finding systems for maintaining genetic stability of varieties.
- Developing multiplication procedures for new varieties and hybrids.

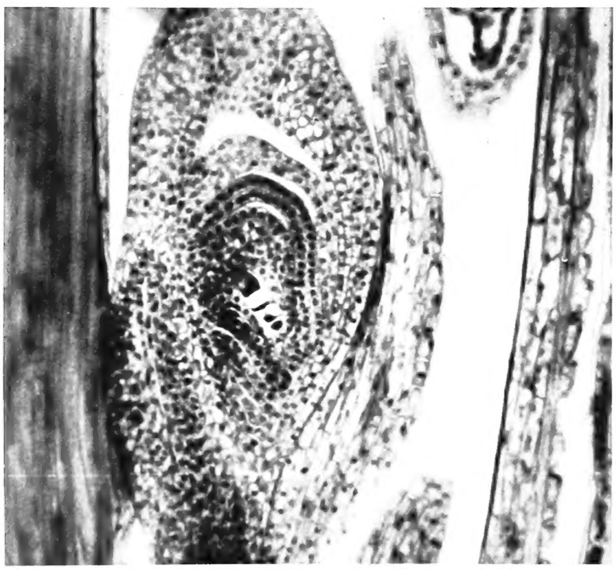


BN–29510

These plants from twin seedlings have different numbers of chromosomes.

N-22105

Colchicine is used in studying the effects of chromosome doubling on plant growth and seed set. Here, a geneticist examines colchicine-induced tetraploid Pensacola bahiagrass (2n=40 chromosomes) at Tifton, Ga. *Left*, Diploid Pensacola bahiagrass (2n=20 chromosomes).



BN-29509

Microscopic examination of embryo sac development is essential in studying reproduction of grasses and legumes. Normal sexual embryo sacs may be supplanted in later stages of development by asexual cells.

- Locating sources of male sterility and incompatibility mechanisms.
- Measuring inbreeding depression and hybrid vigor.

Cytogenetic Research

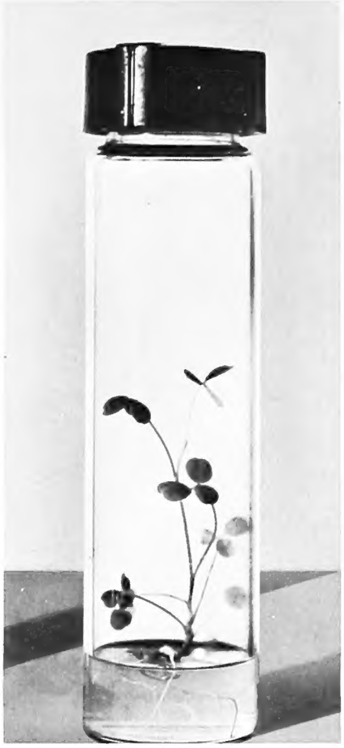
Cytogenetics is the study of heredity at the cellular level—the chromosomes, cytoplasm, and associated elements. Cytogenetic information is used to plan and interpret experiments in genetics, breeding, and hybridization. Without this information, time and effort in breeding work can be wasted. Conversely, cytogenetic research can lead to major breakthroughs in improving grasses and legumes. Examples of contributions from cytonegentic research are: Verification of asexual seed-set in some grasses; doubling chromosome number to improve success in wide crosses among species; and development of information on expected segregation ratios within progenies.

BN–29548

A cytologist at the U.S. Regional Pasture Research Laboratory, University Park, Pa., studies chromosome behavior.

To make better use of cytogenetics in research on grasses and legumes, we need more information on—

- Transferring characters between species and creating new species through hybridization.
- Restoring fertility in sterile hybrids.
- Investigating the effects of chromosomal behavior and cytoplasm on seed-set.
- Determining the effects of genetics and environment on asexual seed-set.
- Determining the origin and inheritance of asexual seed-set and male sterility.
- Establishing the physiological consequences of changing the number of chromosomes.
- Identifying mutagenic agents as well as the types and value of mutations.
- Determining the origin and genetic behavior of natural and induced polyploids.
- Isolating genetic markers for basic and applied studies.

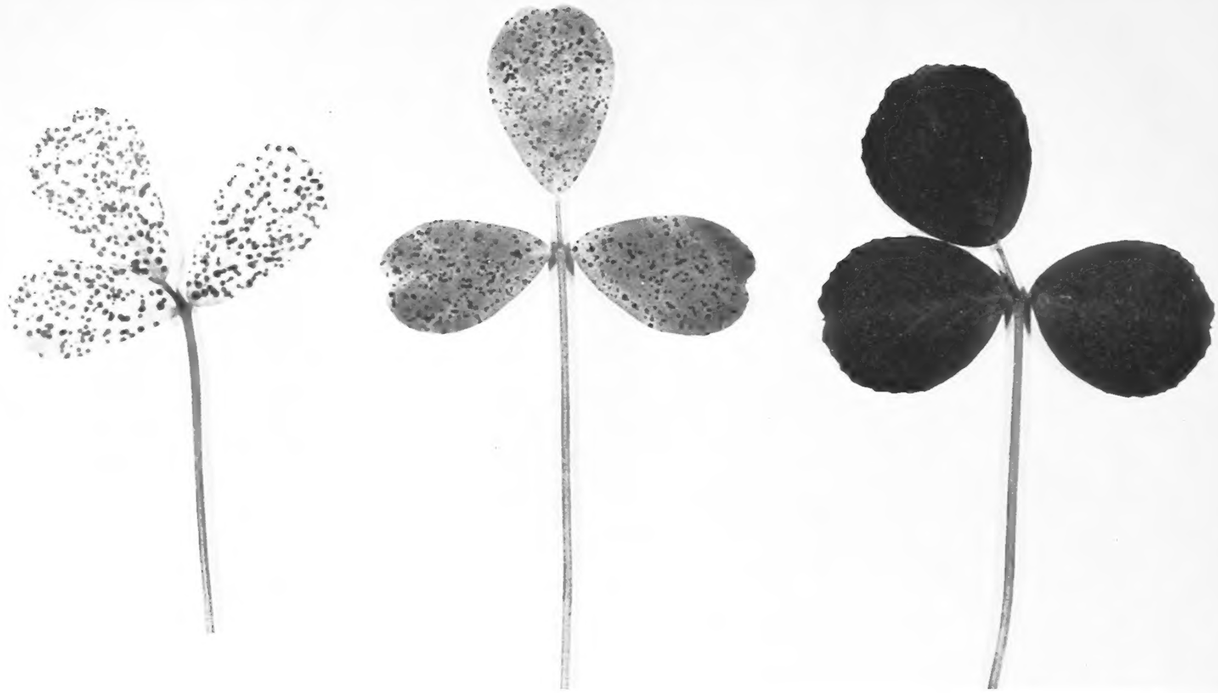


N–13377

Crosses between related species often fail to produce seed. Embryos reared under an agar surface in diffused light and at controlled temperature—like eggs in an incubator tray—sometimes circumvent this problem. This seedling is from a cross made at Lincoln, Nebr., between white and yellow sweetclover.

N–31863

Grass specialists examine Kentucky bluegrass mutants at the Plant Industry Station, Beltsville, Md. Mutations obtained by irradiation and chemical treatments are of value in studying gene action and inheritance in breeding.

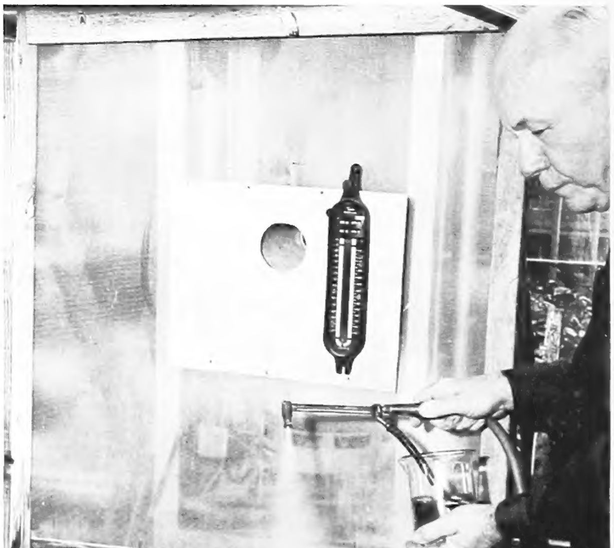


BN-29543

Leaf diseases cause not only direct losses in forage quality but also indirect losses from premature loss of leaves. Resistance to common leafspot is shown in these alfalfa selections. ***Left to right:*** **None, moderate, high.**

N-22101

A plant pathologist at Tifton, Ga., examines bahiagrass for leafspot. Field tests confirm results obtained from laboratory and greenhouse disease-screening studies.



N-31535

A plant pathologist at Stoneville, Miss., inoculates annual ryegrass seedlings with rust. Thousands of plants can be screened in greenhouse and laboratory tests.

BN-29533

Red clover plant *(left)* shows "internal breakdown" disease (dark area in root); *right,* healthy plant. "Internal breakdown," apparently caused by agents other than micro-organisms, is responsible for substantial stand losses.

Research To Develop Disease, Insect, and Nematode Resistance

Diseases, insects, and nematodes reduce stand density, persistence, yield, and quality of grasses and legumes grown for forage, turf, and seed. Diseases alone reduce the total value of these crops by an estimated 11 percent each year. Use of many grasses and legumes is restricted by lack of varieties that are resistant to diseases and insects.

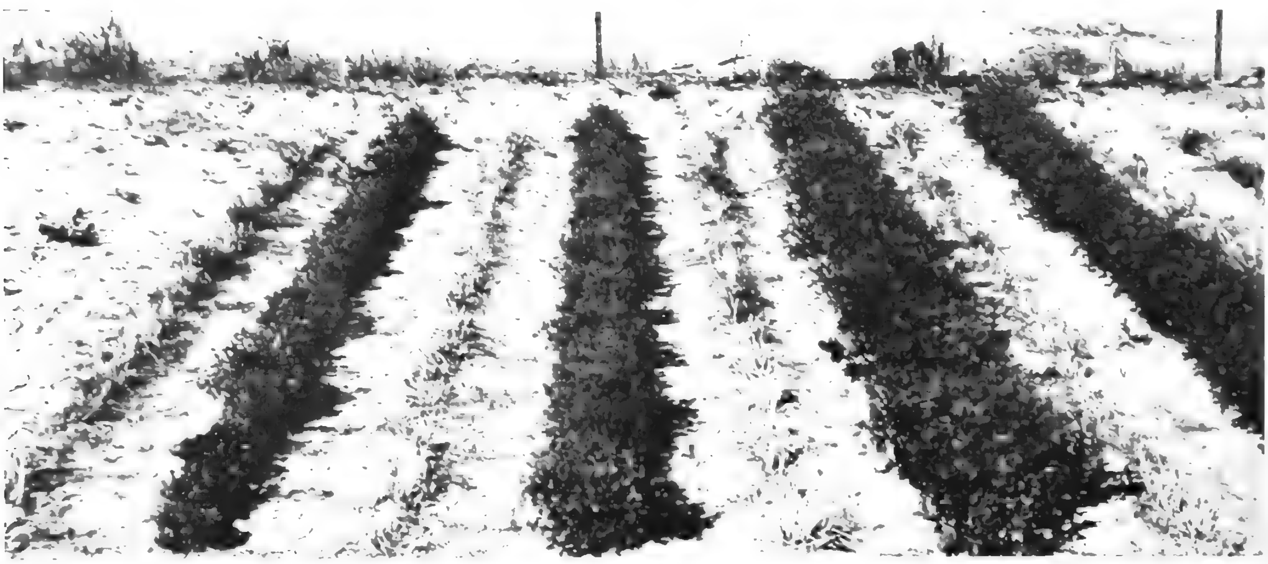
We have made progress. Development of alfalfa varieties resistant to bacterial wilt and spotted aphid has removed two serious threats to the alfalfa industry. Use of varieties resistant to bacterial wilt has increased returns to farmers by an estimated $100 million a year. Efforts are continuing to develop varieties resistant to the alfalfa weevil and to isolate lines with resistance to other major pests.

BN-29534

Weevil on crimson clover. Insect damage is severe on many forage crops. Cooperation with entomologists has helped to identify sources of resistance. (Photo courtesy of Mississippi Agricultural Experiment Station.)

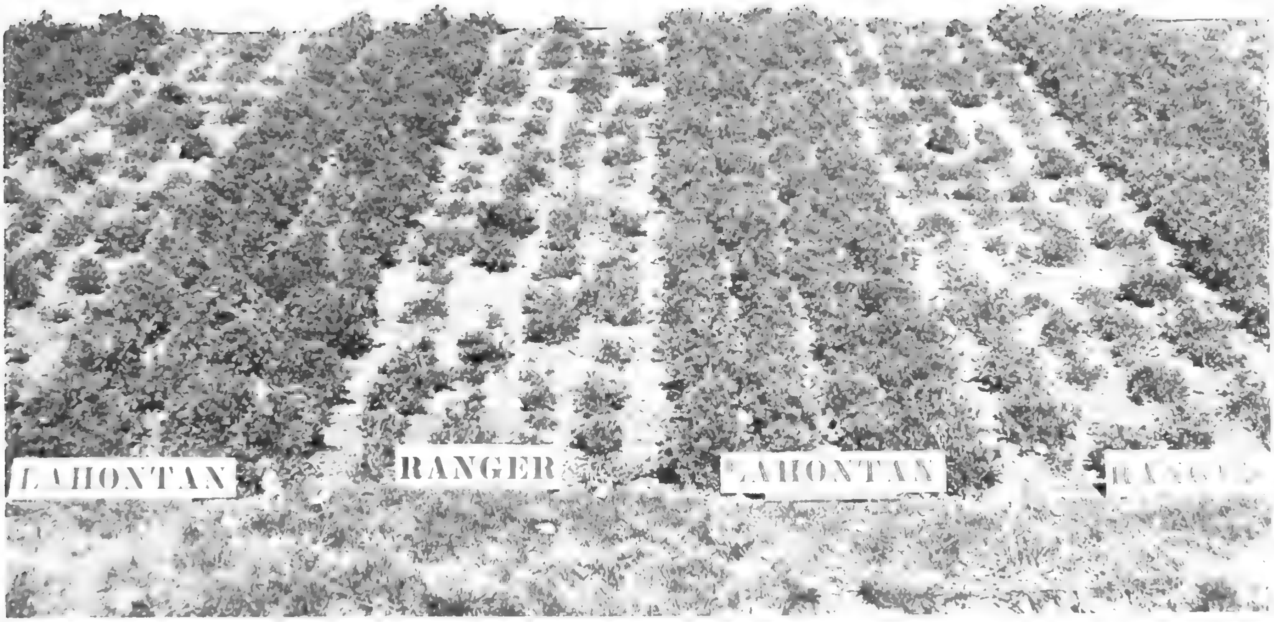
BN–29529

White clover selections at the U.S. Regional Pasture Research Laboratory, University Park, Pa., inoculated with a crown rot fungus. Effective inoculation techniques are needed for many economically important diseases.



BN–29528

Alfalfa breeding lines resistant to the spotted alfalfa aphid show good growth; damaged rows were planted to a susceptible variety.



BN–20526

In this test at Reno, Nev., the stem nematode *Ditylenchus dipsaci* damaged the susceptible alfalfa variety Ranger. Lahonton had been bred for resistance.

To develop resistant varieties we need new or additional research on—

- Nature and extent of losses from specific diseases, insects, and nematodes.
- Pathogenicity and life cycle of disease organisms.
- Identification of races within pathogens.
- Techniques for culturing pathogenic organisms.
- Transmission of diseases and effective artificial inoculation procedures.
- Development of rapid and reliable techniques for isolating resistant stocks, or for devising other disease-control measures.
- Response of plants to various combinations of diseases, insects, and nematodes.
- Mechanism of resistance to diseases, insects, and nematodes.
- Inheritance of resistance.
- Development of lines with multiple resistance to diseases, insects, and nematodes.

Research on Tolerance or Resistance to Environmental Hazards

Environmental hazards cause seeding failure and slow growth of grasses and legumes, and loss of mature plantings. Environmental hazards also increase losses

BN–20527

Factors influencing plant survival are studied in the laboratory, the greenhouse, and the field. In this field experiment at Clemson, S.C., the lifespan of individually marked white clover stolons is recorded.

BN-20522

Field basins maintained at different levels of salinity at Logan, Utah, are used to measure the relative salt tolerance of grass selections.

BN-22816

The creeping rooted characteristic of alfalfa is an important adaptive mechanism in certain environments.

SCS-80903

Millions of acres of unproductive grasslands could be improved by a better combination of livestock management and seeding to species that will tolerate heavy grazing and drought.

from diseases and insects. We need varieties that are tolerant or resistant to drought and extreme temperatures. And we need forages that will do more to stabilize and restore lands where production is now limited by excessive erosion, low fertility, and salinity.

To develop varieties that are tolerant or resistant to environmental hazards, more information is needed on—

- Improving techniques for measuring drought resistance.
- Finding better procedures for evaluating tolerances to low and high temperatures.
- Determining resistance of species and varieties to saline conditions.
- Measuring grazing tolerance and proper season of use as related to persistence.
- Identifying morphological and anatomical characteristics associated with resistance and susceptibility.
- Establishing the association between seeding and mature plant behavior.
- Isolating species that have promise for use on difficult sites.
- Selecting varieties with improved adaptation to environmental hazards.

BN-29511

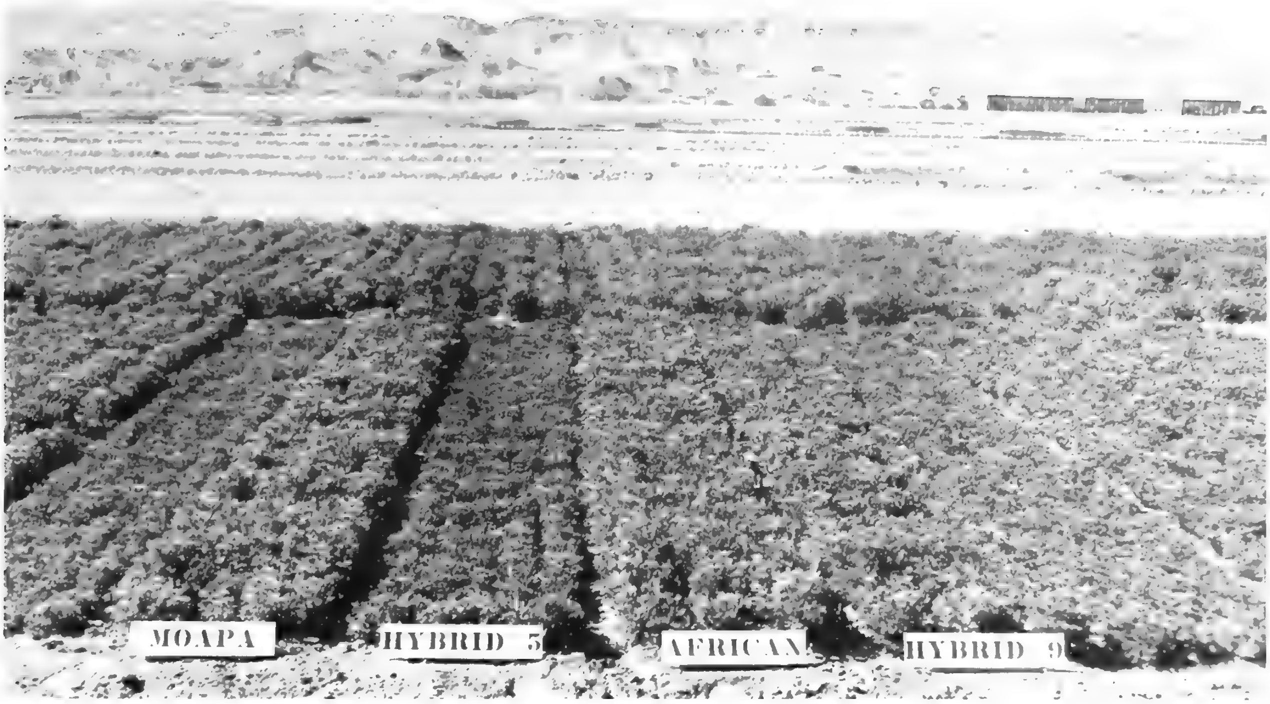
Information on the adapted characteristics of species, varieties, and experimental selections is obtained from field experiments. Here, a geneticist plants a clover test in Colorado.

BN-29517

Stand failures are frequent on poor seedbeds such as this one in the Southern Great Plains. Improved seedling vigor and increased tolerance to drought and temperature extremes would reduce losses; however, elimination of competing vegetation is essential for successful seeding operations on arid land.

BN-29530

Hybrid vigor has been recorded in many forage species. The vigorous plant *(center)* is a hybrid produced by crossing sand bluestem *(left)* and big bluestem *(right)* at Lincoln, Nebr.



BN-29494

Alfalfa varieties tested in Nevada show differences in growth. There is an urgent need for grass and legume varieties that will utilize moisture and minerals more efficiently, yield well over the entire growing season, and produce high-quality forage.

Research To Improve Seed Quality, Seedling Vigor, and Yield of Forage and Seed

Nordan crested wheatgrass, released on the basis of improved seed quality, seedling vigor, and seed yield, has become the accepted variety of crested wheatgrass throughout the Northern Great Plains and intermountain region. Superior yields of grasses and legumes are being obtained with the proper combination of variety, environment, and management. However, we need varieties that respond better to fertilizers and moisture and that recover rapidly following grazing or mowing. Improved seedling establishment, persistence, and yield would reduce seedling losses and increase returns from forage in both humid and arid regions.

Many potentially useful varieties are little used now because of low seed quality, low seedling vigor, or low seed yields.

Investigations are in progress or are needed on—

- Determining the relation between forage and seed yields.

SCS-81524

Birdsfoot trefoil is a valuable forage and soil-conserving plant, but seed losses can be very high as a result of shattering. Resistance to seed shattering is needed in this species and in many other useful forage species.

BN-29540

Uniform growing conditions are essential in identifying selections possessing good seedling vigor. In this experiment at Beltsville, Md., vigorous birdsfoot trefoil seed lines are selected from sand cultures.

BN-29511

A geneticist examines pearl millet lines at Tifton, Ga. *Left*, hybrids; *right*, an inbred line. Cytoplasmic male sterility is now available for producing hybrid pearl millet varieties. Superior hybrids have increased seedling vigor and improved yields and possess a wider range of forage adaptation.

- Identifying factors that control seed-holding capacity.
- Selecting for improved seed set, seed yield, and seedling vigor.
- Separating the genetic and environmental effects that control seed dormancy and seedling vigor.
- Developing varieties with increased vegetative growth.
- Developing chance and controlled hybrids.
- Understanding trends in plant vigor in successive generations of seed increase.
- Determining the response of varieties to different levels of soil fertility, moisture, and other variables.
- Finding shattering resistance in some species.

Breeding for Improved Quality

There is a tremendous opportunity to improve the quality of grasses and legumes and to increase the yield of nutrients per acre. In the past, little attention was given to improving forage quality except by selection for late maturity, disease resistance, leafiness, or the absence of toxic substances. Recognition of energy limitations in animal feeding and of the effect of environment and disease on plant composition has stimulated interest in research on breeding to improve quality.

BN-29508

The hoofs of a dairy cow suffering from "fescue-foot." This comparatively rare disease is of concern in regions that rely on tall fescue pastures. The origin of the disease has not been determined.

N-22111

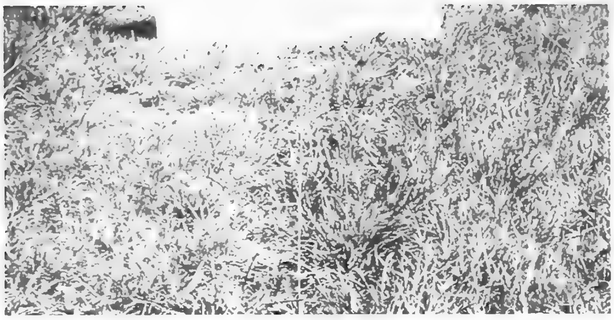
New bermudagrass hybrids are higher in total digestible nutrients than the Coastal variety. These hybrids could increase animal performance even though forage intake remained the same. Additional increases could result from increased consumption of better quality bermudagrasses.

M-2064

Excellent progress has been made in developing sweet lupines for forage. The sweet characteristic has been combined successfully with improved disease resistance and cold hardiness. Similarly, low-coumarin sweetclovers have been developed.

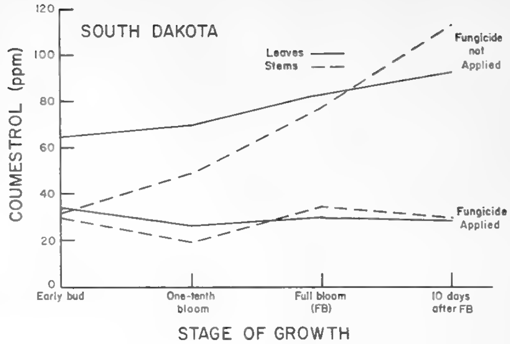
BN-2

Quality investigations are conducted on harvested forage as well as on forage under grazing. Harvesting of field plots has been mechanized whenever feasible.



BN-20504

In some experiments, grazing animals have been used to identify palatable plants and lines. At Lexington, Ky., dairy heifers grazed the tall fescue progeny on the left while avoiding the variety on the right.



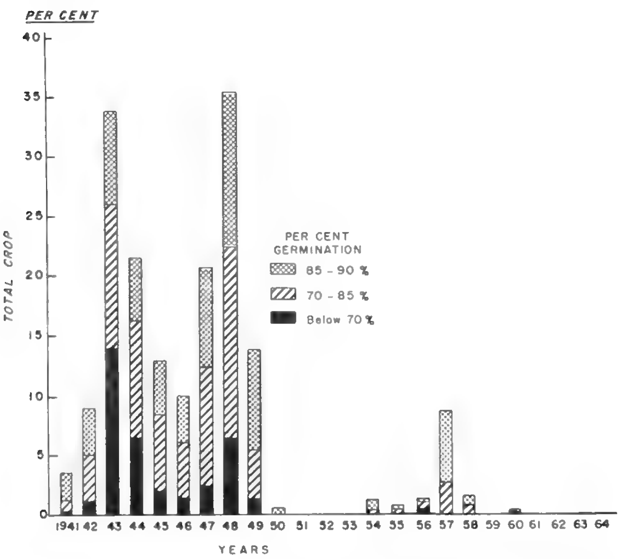
Plant diseases influence plant composition. In this experiment, control of leaf diseases with fungicides lowered the coumestrol content of alfalfa.

BN-20402

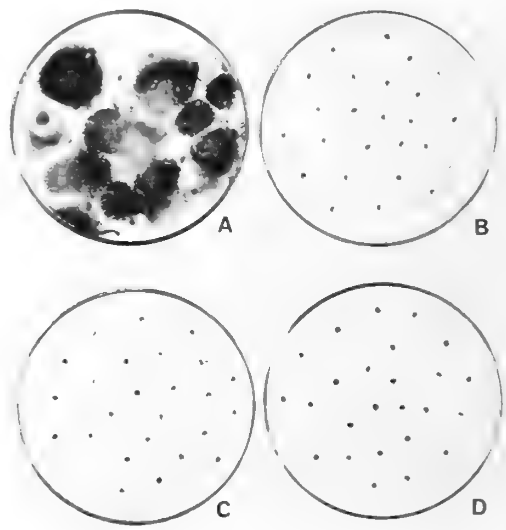
Part of test plots at Prosser, Wash., used in research on the seed yield potential of grass and legume varieties. Genetic change attributable to environmental conditions and management practices are studied in these experiments.

BN-20403

Cages at Prosser, Wash., isolate insect-pollinated experimental lines. A hive of bees is provided in each cage for pollination.



Research at Corvallis, Oreg., on burning to control blind seed disease led to this remarkable improvement in seed quality. Between 1941 and 1949 (before burning to control this disease), from 3 to 36 percent of the total perennial ryegrass crop had a germination below 90 percent; afterward, this fraction of the crop ranged from 0 to 9 percent and essentially none of it was as low as 70 percent.

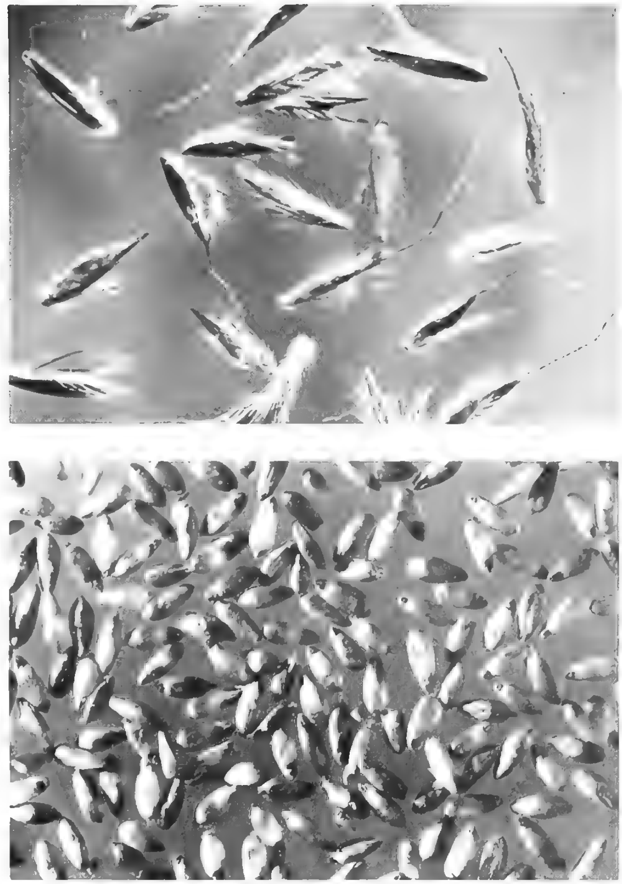


BN-20521

Fungi carried inside seeds reduce stands and are a source of infestation to new seed crops. In research at Corvallis, Oreg., aerated steam has shown promise of eliminating these fungi. A, untreated cabbage seed; B, cabbage seed held at 130° F. for 20 minutes. Similar results were obtained with seed held at 130° for 40 and 60 minutes, C and D.

BN–29495, BN–29496

Differences in maturity among red clover varieties can be controlled, in part, by their reaction to day length (photoperiodism). Varietal characteristics can be identified by subjecting plants to various environments in growth chambers. *Top,* three varieties of red clover remained vegetative when grown for 5 weeks at 30° C. under 12-hour days; *bottom,* the same varieties responded differently when grown in the same way under 16-hour days. One produced numerous flowers; another, elongated stems; and the third, no change.



BN–29497, BN–29503

Indiangrass seed: *Top,* unprocessed; *bottom,* processed. Indiangrass is representative of chaffy-seeded grasses that are difficult to process and to evaluate for germination. Additional problems are encountered in harvesting, cleaning, storage, and seeding.

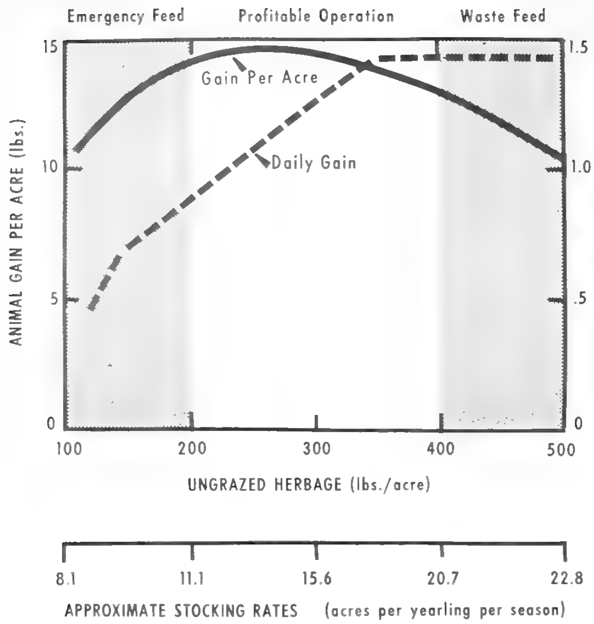
We need to know more about the—

- Effect of plant maturity, environment, and management on the chemical composition of forage varieties.
- Changes in composition induced by diseases and insects.
- Identification and study of alkaloids and other toxic substances.
- Use of isogenic lines and populations in evaluating quality.
- Selection for improved palatability, leafiness, and improved energy content in forages.
- Inheritance of specified plant constituents.
- Isolation of lines with either high or low levels of specific constituents.

Research on Seed Production

In the United States, seed production has become a highly competitive, specialized industry in regions where the environment is favorable for high yields of good-quality seed. Although this development has increased efficiency within the seed industry, it has also created serious problems.

Grass and legume seed is harvested annually on more than 300,000 farms—most of it thousands of miles from where it is used. New varieties developed for forage in seed-consuming areas may produce low seed yields. Also, when seed is multiplied in a different environment, type and forage characteristics may change significantly. And disease and insect problems usually differ in seed-consuming and seed-producing areas.



Good grazing management requires information on desirable stocking rates. These data were obtained at the Central Plains Experimental Range, Nunn, Colo.

BN–29500

Steers are weighed individually every month during grazing experiments on the Southern Great Plains Experimental Range near Woodward, Okla.

BN–29501, BN–29516

Stocking rates can affect profits: *Top,* Cows grazed yearlong on 12 acres of sagebrush range near Woodward, Okla., weaned an unprofitable 80-percent calf crop with calves weighing an average of 410 pounds. *Bottom,* Cows grazed yearlong on 17 acres weaned a 92-percent calf crop with calves weighing an average of 480 pounds. In this experiment, overgrazing was indicated better by weight and condition of the calves than by forage utilization.

BN–29502

Detailed vegetation surveys are required before grazing studies are initiated, as well as during the course of the experiment.

BN-29532

A range scientist at the Central Plains Experimental Range, Nunn, Colo., obtains herbage yields. Measurements of production and estimates of herbage utilization are essential in grazing experiments.

BN-29506

Grasses and legumes are evaluated in terms of animal products. Desirable grazing systems vary with species, varieties, and mixtures of plants and with classes of livestock.

To increase the efficiency and competitiveness of domestic seed production, we need better information on—

- Controlling diseases and insects that attack seed crops.
- Improving germination and purity of chaffy-seeded species.
- Identifying genetic and environmental factors that control the amount and time of flowering.
- Determining factors that limit pollination, including nectar production and quality and attractiveness to insect pollinators.
- Characterizing varieties and species as to pollen production, distribution, and viability.
- Improving isolation standards for wind- and insect-pollinated species.
- Developing effective cultural, management, and disease control practices for seed crops.
- Finding effective procedures for maintaining and restoring the productivity of old seed fields.
- Eliminating contamination when replacing seed fields with new varieties of the same species.
- Determining the effect of climatic factors on genetic changes within varieties.

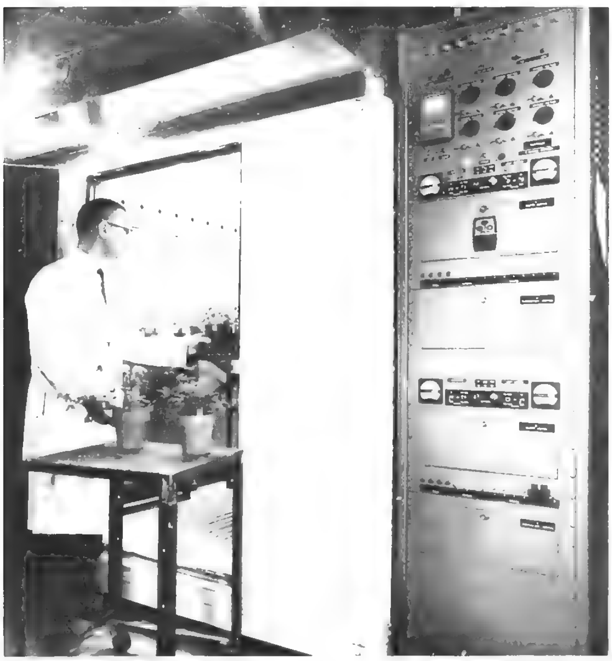
Research To Develop Better Grazing and Management Systems

Half of the land in the United States—a billion acres—is grazing land (pasture and range). In the Great Plains, more than half the land is used only for grazing. In the southeastern States, more than 100 million acres of woodland and range is used for grazing.

Better grazing and management systems will result in more efficient use of feed resources, increased animal gains, and improved reproduction rates. Better management will reduce deterioration of seeded pasture and range and at the same time reduce loss of soil and water. In many parts of the United States, returns from properly managed seeded pastures compare favorably with returns from cultivated crops.

SCS-C-8764

Factors controlling plant competition for light, moisture, and nutrients require detailed study.



BN-29524

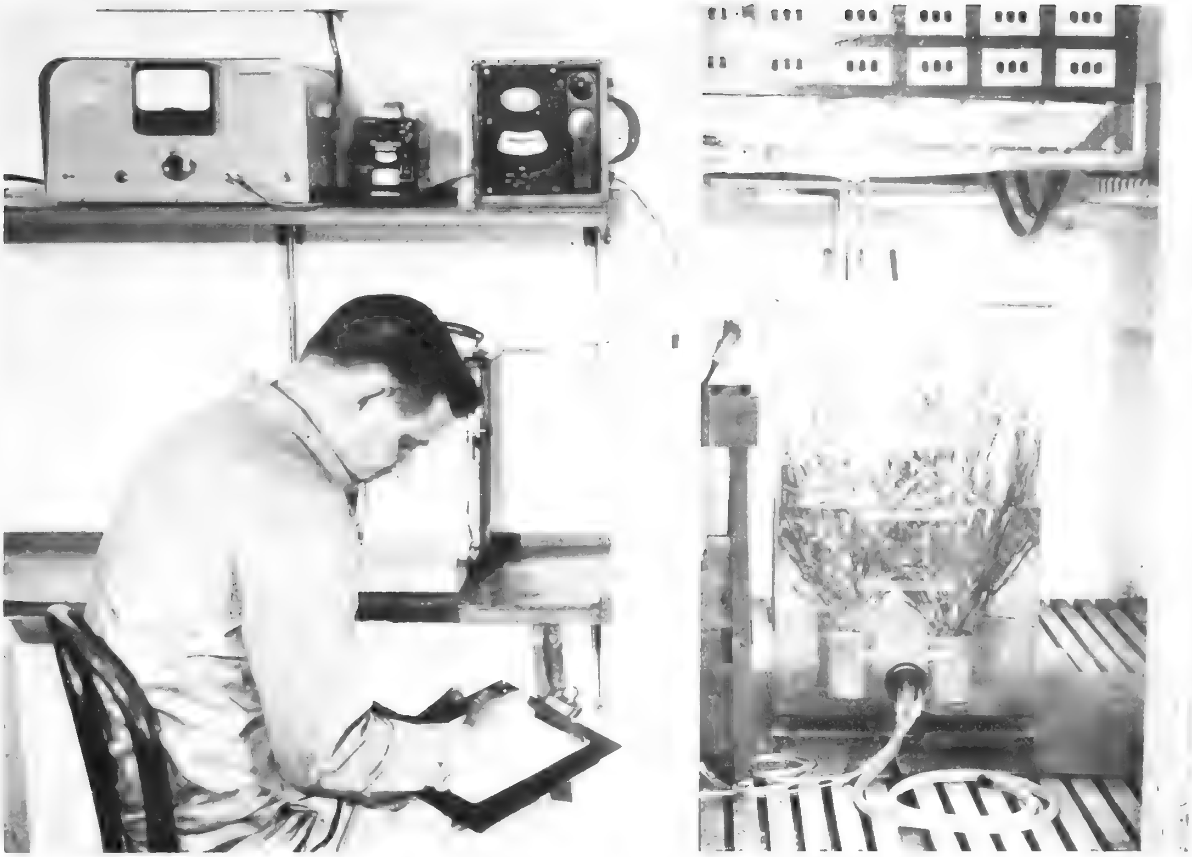
A plant physiologist examines red clover plants in a growth chamber at Lafayette, Ind. In controlled experiments, critical information can be obtained on the interaction of day length, light intensity, and temperature on vegetative and reproductive development of grasses and legumes.

N-28644

Information on the physiological behavior of forage plants is obtained from comprehensive field experiments. Measuring the amount of light reaching grass grown under shade cloth is part of the procedure used at Tifton, Ga., to determine the effect of light on yield and composition of Coastal bermudagrass.

BN-29535

Environmental factors are partially controlled in a greenhouse study at the U.S. Regional Pasture Research Laboratory, University Park, Pa. In this experiment, plant competition for nutrients supplied from a common reservoir is investigated while competition for space and light is eliminated by growing grass and clover in separate pots.



BN–20536

Use of light within a community of plants is studied in the photosynthesis laboratory, Beltsville, Md.

More information on the following subjects will help us develop better grazing and management systems:

- Prediction of herbage production and development of improved procedures for measuring yield.
- Evaluation of grazing systems, including deferment of pasture and range.
- Carrying capacity and quality of seeded species and mixtures and native range.
- Importance of grazing pressure in measuring herbage yields and quality.
- Changes in botanical composition of pasture and range under grazing.
- Integration of grazing with supplementary feed supplies.
- Differential grazing behavior of breeds and classes of livestock.
- Use of mixed animal species on pastures and range.
- Interrelationship of palatability, digestibility, and intake.
- Environmental factors, including shade and pest control, that influence animal performance in grazing studies.

Research on the Physiology of Plant Growth and Development

We need knowledge of the physiology of hay and pasture plants if we are to manage and improve our Nation's grasslands intelligently. More information on the physiology of plant growth and development will increase the scope and value of field tests; will help us develop improved management practices for pasture and range and for green chop, silage, hay, and seed production; and will give us sound objectives for breeding improved forage varieties. For example, we need to know why results obtained in grazing and forage-production studies in one environment have only limited application in a slightly different environment. And we need more information on the physiological factors that limit vegetative development and seed production of grasses and legumes.

To provide answers to these problems, we need knowledge on—

- Response of plants to the total environment, including variation in microclimatic conditions.
- Characteristics of roots in mature plants.

BN–29539

A plant physiologist checks instruments for measuring and recording microclimatic data at University Park, Pa. Microclimatic information is essential in establishing the relationship of climatic variables to germination, reproduction, and persistence of forage species.

M–1986

Nonmowed pasture (*left*) and mowed pasture show beneficial effect of mowing at the proper time on grass improvement and brush control near Woodward, Okla. Physiological research can provide information for developing superior grassland management practices.

TEX-49991

Chaining is one of several methods used to control undesirable brush on rangelands. Areas subjected to either mechanical or herbicidal treatments must often be seeded to restore the grass cover.

- Competition among plants for light, moisture, and nutrients.
- Nutrient requirements of various species and varieties of grasses and legumes.
- Nature of tolerance to temperature extremes, including diurnal fluctuations.
- Efficiency of photosynthesis in relation to location and age of leaves.
- Effect of day length, light quality, and light intensity on forage and seed yields.
- Storage, location, and form of reserve carbohydrates.
- Relationship of leaf area, reserve carbohydrates, and other variables to regrowth following grazing or clipping.
- Energy requirements for the synthesis of carbohydrates, fats, protein, and nucleic acid.
- Action of subcellular particles in protein synthesis.
- Effect of environment on biologically active constituents.

Research on Seeding Methods

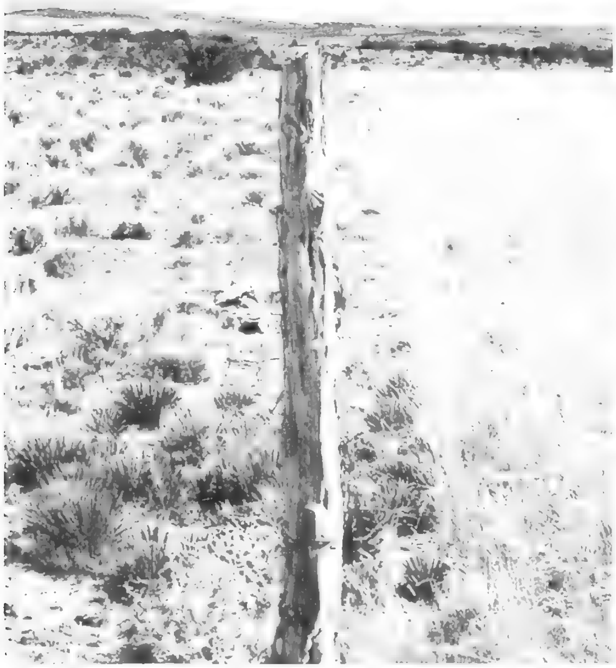
In most areas, methods for seeding grasses and legumes are based either on farm practice or on limited tests. Although these methods have much to commend them, seeding failures occur too frequently in both arid and humid regions. In arid regions, better seeding methods will reduce seeding failures of forages used for revegetation; in humid regions, better methods will increase the use of forages in rotations on cultivated land. Basic research information accumulated from problem sites will have broad application in improving seeding methods.

To improve methods of seeding forages, we need more knowledge on—

- Development of instruments for measuring plant response.
- Microclimatic relationships on problem sites.
- Germination of forages under various stress conditions.

BN–29538

Counting seedlings in a method-of-seeding experiment at Fort Collins, Colo.



BN–29517

The field on the right was cleared of sagebrush and seeded to crested wheatgrass and other grasses in 1950. This 1958 photograph shows little usable forage on the unimproved, native sagebrush range. The elevation at this Colorado location is 7,500 feet and the annual precipitation is 12 inches.

BN–29525

Band seeding of tall fescue and ladino clover at Beltsville, Md. *Left,* seed and fertilizer broadcast; *right,* seed banded in 8-inch rows with fertilizer banded 1 inch below seed. This experiment included rate of seeding and rate of applying fertilizer.

BN–25028

Heat lamps simulate hot rangeland conditions in laboratories at Las Cruces, N. Mex. Survival ability of many different grasses planted in small plastic containers can be determined in a single test.

BN-29531

Management is the key to maintaining a good cover of desirable range plants. Returns from grass seedings on abandoned farmlands and depleted range also depend on good range management practices.

- Characteristics of grass and legume seedlings as related to emergence and establishment.
- Effect of disease and insect pests on germination and seedling survival.
- Modification of environmental conditions by cultural treatments.
- Contribution of fertilizer placement, compaction, and various mulches to establishment.
- Evaluation of seeding practices with and without weed control.
- Ecological relationships in new seedings.
- Guidelines required to measure the potential value and need for seeding rangelands.
- Effectiveness of seeding practices in terms of improved feed resources, water supplies, and soil conservation.

Measuring the Nutritive Value of Forages

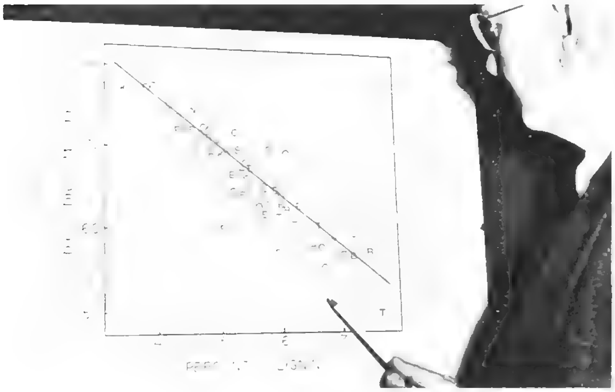
At present, the usual method for determining the nutritive value of forages is by digestion trials. To develop meaningful information, rate of intake must be combined with digestibility. The forages are then evaluated in terms of animal performance.

BN-29546

Chemical treatments may be of value in preserving quality in range plants. In this experiment at the Squaw Butte-Harney Experimental Range, Burns, Oreg., crested wheatgrass (sprayed and not sprayed) was the test plant.

BN–29513

Efficient forage utilization begins with nutritious varieties and sound cultural practices. Green-chopped and pelleted samples of alfalfa like these are used in studies on nutritive value and feeding response.



BN–29512

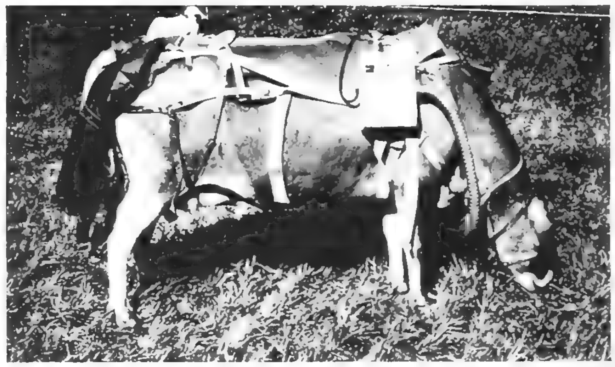
A chemist at the U.S. Regional Pasture Research Laboratory, University Park, Pa., describes findings on the relation between the chemical component lignin and the digestible dry matter of several forages. These and similar findings are used to predict forage quality.

BN–29519

Collecting rumen samples to study intake and digestibility of range forage at Las Cruces, N. Mex.

BN–29507

A physiologist at Lafayette, Ind., uses the in vitro method to estimate forage digestibility.



BN–29512

Detailed information on intake and digestibility of forage and on animal behavior is being obtained on this cow for use in evaluating specific forage plants.

BN–29520

Experiments have shown that beef graded "USDA-Good" can be produced on high-quality grasslands.

M-4118

A familiar scene in many urban areas. This Maryland lawn shows the effect of poor management.

BN-29518

Preliminary data on disease and turf characteristics of new selections are obtained from small plots at Beltsville, Md.

We need rapid, reliable tests for measuring forage quality. Chemical procedures are promising. But these procedures need to go beyond proximate feed analyses, which are not closely correlated with animal performance.

Research is being conducted on several of the following subjects; all deserve attention.

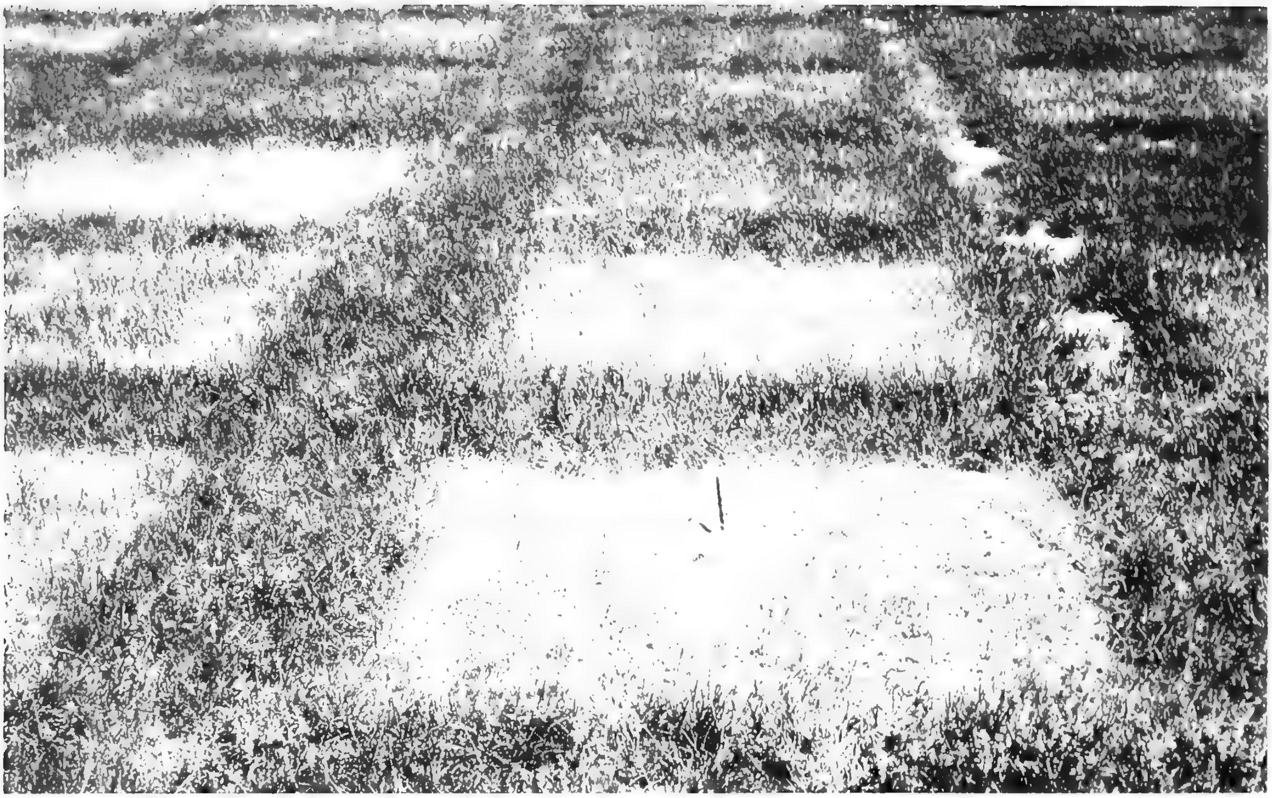
- Identification of factors controlling palatability.
- Anatomical characteristics as related to quality.
- Isolation and study of hemicelluloses, lignin, and other carbohydrate fractions that influence forage value.
- Kinds of plant proteins, their accumulation and value.
- Development of efficient laboratory procedures for measuring digestibility.
- Development of effective indicators for measuring forage intake.
- Differences in quality attributable to maturity, plant parts, and season of use.
- Influence of soil fertility, management, and environment on quality.
- Quality characteristics of species and varieties.

Improving Turfgrasses

Turfgrasses occupy more than 16 million acres in the United States. Maintaining these grasses costs an estimated $3½ billion each year.

Limited studies are being conducted on improving turfgrasses for home lawns, roadsides, cemeteries, and airports; and for parks, playgrounds, golf courses, and other recreational areas. Turfgrasses may fail to become established on these areas or they may deteriorate because of disease, insects, nematodes, drought, overwatering, poor drainage, heavy traffic, unfavorable temperatures, weeds, low soil fertility, soil acidity or alkalinity, mowing too frequently or too closely, not enough light, or improper use of fertilizers, herbicides, or other chemicals.

To maintain a pleasing, uniform grass cover requires use of adapted grass varieties plus good management. Unfortunately, adapted turfgrass varieties are not available for many regions, and management systems



BN-29514

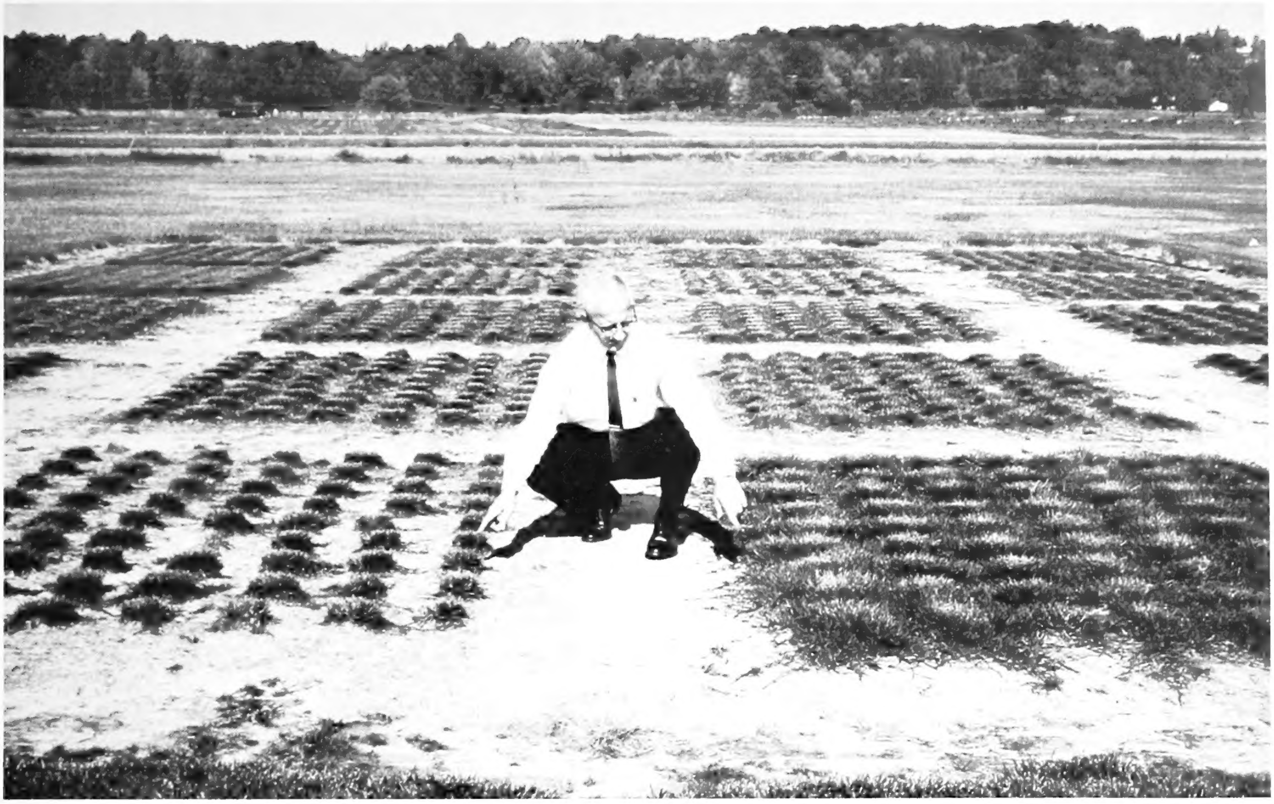
Kentucky bluegrass selections at Beltsville, Md., show differences in disease resistance. Light-colored plots have been severely damaged.

N-15684

Plot being prepared for planting vegetative cores of Meyer zoysia. Many critical questions on the growth and development of turfgrasses remain unanswered.

N-17964

Problems in commercial sod production receive too little attention in turf research programs.



BN-29515

A turf specialist examines zoysia selections at Beltsville, Md. Selections differ in rate of spread, texture, growth pattern, and color retention.

have not been developed either for maintaining new turfgrass varieties or for restoring damaged turf. We urgently need varieties that are adapted to problem soils, and these varieties should have growth characteristics that will help in reducing soil and water losses.

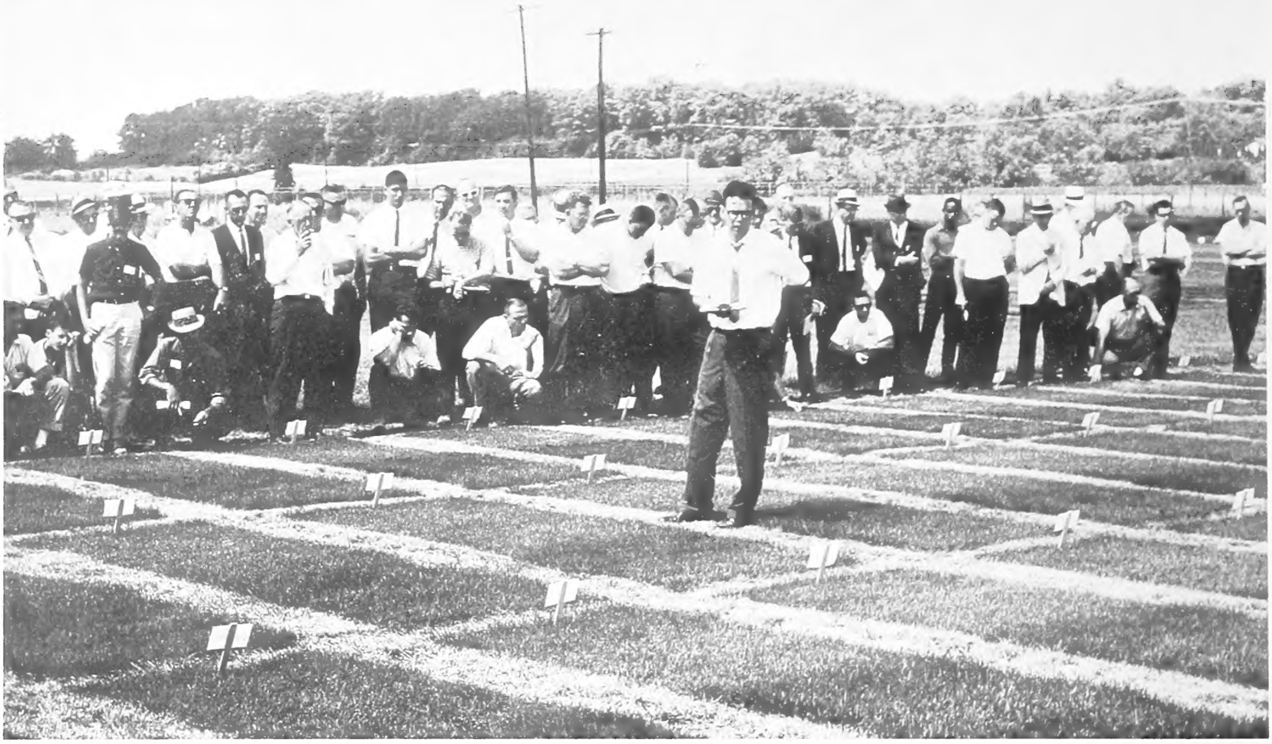
Current research and pressing needs include attention to—

- Development of effective techniques for isolating pest-resistant plants.
- Development of lines and varieties that possess multiple pest resistance.
- Vegetative propagation of sterile hybrids.
- Nature and improvement of root and rhizome development.
- Location and mobilization of reserve carbohydrates.
- Mineral requirements of species and varieties.
- Ecology of turfgrasses and associated weeds.
- Management systems needed to maintain specific varieties.
- Growth characteristics of native and introduced species.
- Adaptation of species and varieties to problem turf areas.
- Response of turfgrasses to herbicides and pesticides.

Forage and Range Research Involves Many Organizations . . .

The Forage and Range Research Branch of the Crops Research Division conducts cooperative research with many organizations, as follows:

- With 38 State agricultural experiment stations.
- With other branches of the division: Crops Protection (weed and nematode control) and New Crops (plant introduction).
- With other research divisions of the Agricultural Research Service: Animal Husbandry, Engineering, Entomology, Soil and Water, and Utilization.
- With other agencies of the U.S. Department of Agriculture: Forest Service and Soil Conservation Service.



BN-29505

An agronomist discusses turfgrass research at a Beltsville, Md., Field Day. People are interested in answers to a wide range of turfgrass problems.

- With the U.S. Department of the Interior: Bureau of Indian Affairs, Bureau of Land Management, and Bureau of Reclamation.
- With private industry.
- With independent research foundations.

The Forage and Range Research Branch is responsible for the U.S. Regional Pasture Research Laboratory, University Park, Pa.; the Southern Great Plains Field Station, Woodward, Okla.; and experimental range units near Las Cruces, N. Mex., and Nunn, Colo.

The Branch shares responsibility with the Oregon Agricultural Experiment Station for the Squaw Butte-Harney Experimental Range, Burns, Oreg.

Research is also conducted in Federal facilities at the Agricultural Research Center, Beltsville, Md.; and at Flagstaff and Tucson, Ariz.; Berkeley and Shafter, Calif.; Miles City, Mont.; Mandan, N. Dak.; and Logan, Utah.

States provide financial assistance or facilities or both, to cooperative programs at Tucson, Ariz.; Fort Collins, Colo.; Gainesville, Fla.; Tifton, Ga.; Lafayette, Ind.; Manhattan, Kans.; Lexington, Ky.; St. Paul, Minn.; State College and Stoneville, Miss.; Columbia, Mo.; Bozeman, Mont.; Lincoln, Nebr.; Reno, Nev.; Las Cruces, N. Mex.; Ithaca, N.Y.; Raleigh, N.C.; Stillwater and Woodward, Okla.; Burns and Corvallis, Oreg.; University Park, Pa.; Clemson, S.C.; College Station, S. Dak.; College Station, Tex.; Logan, Utah; Blacksburg, Va.; Prosser and Pullman, Wash.; and Madison, Wis.

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