



The History of UC Rangeland Extension, Research, and Teaching: A Perspective

MELVIN R. GEORGE, UC Cooperative Extension Rangeland Management Specialist Emeritus, Plant Sciences Department, University of California, Davis

W. JAMES CLAWSON, UC Cooperative Extension Rangeland Management Specialist Emeritus, Plant Sciences Department, University of California, Davis

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A scenic landscape photograph of a grassy field. In the foreground, there is a dense field of wildflowers, including purple and yellow ones. The middle ground shows a lush green field with a few large, mature trees. The background is a clear blue sky.

Introduction

This publication documents significant milestones in rangeland extension, research, and teaching in the University of California. This historical overview chronicles the programs, people, facilities, and accomplishments that have contributed significantly to the success of these undertakings.

The Early Years

In 1868 the University of California (UC), located in Berkeley, was chartered as California's land-grant university, with the College of Agriculture as its first department. In 1875 the UC Agricultural Experiment Station, authorized by the Hatch Act, was established. In 1901 the Animal Science Division was started at UC Berkeley, followed by the Agronomy Division in 1904. In 1906 the University Farm was purchased at Davis. By 1909 the Animal Science and Agronomy Divisions moved from Berkeley to Davis. The first students at UC Davis were enrolled in 1908 for short courses that emphasized technical training. In 1922 Arthur W. Sampson joined UC Berkeley as a lecturer in the School of Forestry and as the first range faculty member (app. A)

In 1915 California accepted the provisions of the Smith-Lever Act that established the Agricultural Extension Service and authorized the County Boards of Supervisors to expend funds to support county Extension offices and staff. The first Cooperative Extension director, B. H. Crocheron, required that an organized agriculture group be established in a county before a farm advisor could be placed there (Crocheron 1914, 1915, and 1917). In 1913 Humboldt County formed the first county Farm Bureau, followed by Yolo, San Joaquin, and San Diego Counties. In 1919 the California Farm Bureau Federation was formed, and it took over the establishment of the county Farm Bureaus. More than 150 Cooperative Extension (CE) specialists (app. B) and

advisors (app. C) have conducted range research and Extension programs throughout California since 1915.

Improving rangelands by controlling weeds and brush, seeding, fertilization, and grazing management has been a continuing theme of research by the University of California since the late 1800s. In 1878 Eugene W. Hilgard, Professor of Agriculture and Agricultural Chemistry, and Edward J. Wickson, Professor of Horticulture, both in the College of Agriculture at UC Berkeley, received seeds of a bunchgrass, smilgrass (*Oryzopsis miliacea*), from an experimental grass garden in New Zealand. Over the next 2 years they sent seed of this Asian native grass to farmers for range trials in several parts of California (Kay et al. 1981). In 1912 P. B. Kennedy came to the UC Berkeley Division of Agronomy and initiated trial plots of native and exotic legumes and grasses throughout the state. During this time Kennedy introduced hardinggrass (*Phalaris tuberosa*) from Australia, and it is now widespread in California. While these early programs were small, they were the forerunners of longer-term, well-organized investigations aimed at range improvement.

The beginnings of organized range management research, education, and Extension can be traced back to an address in 1920 by Professor P. B. Kennedy to the California Cattlemen's Association, during which he outlined needed range research within the University to increase range forage production (app. D).

Brush Management and Range Improvement Programs

In 1932 the Dean of the UC College of Agriculture appointed the Committee on Range Management to investigate ways to improve brush ranges (Adams 1984). Recognizing interdisciplinary interests in range management, a multidepartmental committee was formed (chaired by George Hart from the Animal Science Department). It included Ben Madson (Agronomy), F. J. Veihmeyer (Irrigation and Soils), T. I. Storer (Zoology), and David Weeks (Agricultural Economics). Investigations were started and information developed regarding vegetation change following fire and the controversial problems of runoff and erosion. This early research included small watershed studies by F. J. Veihmeyer in Shasta, Tehama, Lake, Mendocino, Monterey, Madera, and Tulare Counties (fig. 1).



FIGURE 1. Remnant of the Veihmeyer flume near Ahwahnee, Madera County, California.

Committee on Range Land Utilization

After World War II agricultural research in California accelerated, including on rangelands. In 1945 the UC Committee on Range Management was reorganized into a policy committee and renamed the Committee on Range Land Utilization. This committee's purpose was to recommend and sponsor sound programs. It included representatives from various divisions of the College of Agriculture, School of Forestry, and Cooperative Extension, with Ben Madison as chair.

The use of fire to control woody vegetation was an important part of UC investigations—but then, as now, there were conflicting views about the use of prescribed burning. Within the UC system there were researchers allied with the agricultural industry, principally at UC Davis, who favored prescribed burning, and there were those on the side of fire protection, mostly at the School of Forestry at UC Berkeley. Disagreement also existed between the pro-burning UC agricultural group and the State Board of Forestry and the California Department of Forestry (CDF). This uneasy relationship is well documented in *State Regulation of Controlled Burning* (Arvola and Wolfram 1986). Eventually these differences were overcome, resulting in a joint agreement on the role of UC and CDF that led to the implementation of the range improvement burning program at the state level. In 1945, after several years of deliberation, the state legislature authorized CDF's Range Improvement Program. With modifications in 1949, CDF was charged with issuing burning permits on privately owned brush-covered lands and handling administrative duties associated with its general fire control responsibilities (Adam 1984). The purpose of this newly created range improvement program was to increase the carrying

capacity of foothill rangelands for livestock and wildlife, reduce fire hazard, and encourage wise use of range resources.

Range Management Advisory Committee (RMAC)

Also in 1945 the State Board of Forestry requested the appointment of a Range Improvement Advisory Committee to improve relations with ranchers. The committee was first established in 1946 by the State Board of Forestry, and it was composed of representatives from the California Cattlemen's Association, the Wool Growers Association, the California Farm Bureau Federation, the California Forest Protective Association, and the UC College of Agriculture's Committee on Range Land Utilization. A primary function of this committee was, and still is, to serve as a liaison between the State Board of Forestry and range livestock producers. In 1966 a major reorganization of the Range Improvement Advisory Committee occurred, in which the industry organizations retained voting privileges but the university and the involved agencies took on a nonvoting consultation role. The Range Improvement Advisory Committee was dormant from 1973 to 1975, when it was reactivated. In 1985 the committee's charter was again modified, and the name was changed to the Range Management Advisory Committee (RMAC). From 1993 to mid-1996 RMAC met on a voluntary basis with no official record of these meetings. In 1996 additional legislation (AB3262) expanded the committee's advisory role to include advising the California Environmental Protection Agency and the California Department of Food and Agriculture, in addition to the Board of Forestry and the Resources Agency.

California Department of Forestry (CDF) Range Improvement Studies

The California Department of Forestry initiated Range Improvement Field Studies in 1947. These brush control studies began at Spring Dell in San

Benito County, followed by the Pine Hill Range study in Nevada County, the Rescue Range Improvement Project in El Dorado County, the Allen Ranch spray plots in Amador County, the Williams Ranch studies in Shasta County, the medusahead studies in Mendocino County, the Mason Ranch study near North Fork in Madera County, and several other small studies. These studies often involved cooperation with the Agricultural Extension Service and the Agricultural Experiment Station.

UC Range Demonstration Project

In 1950 the UC Range Land Utilization Committee of the College of Agriculture initiated a series of brush range improvement demonstrations funded by the state legislature. The Range Demonstration Project was conducted by the UC Davis Agronomy Department, headed by Lowell Myler, and included Bud Kay, Charles Walker, and Jim Street. This project, along with research and extension activities in the School of Forestry at UC Berkeley by Rudy Grah (CE Extension Forestry Specialist), R.K. Arnold, and Harold Biswell, focused on brush control methods and results. Harold Biswell became known worldwide for his knowledge of prescribed burning.

County Range Improvement Associations

In 1951 the Range Improvement Advisory Committee submitted a resolution to the State Board of Forestry recommending that a broad plan be pursued to promote a coordinated brush range improvement program and to organize effective local organizations to implement the program. In 1953 the plan was approved by the Range Land Utilization Committee of the UC College of Agriculture, the Range Improvement Advisory Committee, and finally the Board of Forestry. The Agricultural Extension Service, UC College of Agriculture, and CDF were charged with assisting in the development of effective local organizations that became known as Range Improvement Associations. Initially the program was patterned after

the successful Madera County Controlled Burning Program. In 1964 Les Berry, Range Improvement Extension Specialist, reported that 58 CE advisors and 16 CE specialists (in wildlife, range, forestry, weed control, soils, farm management, irrigation, entomology, and animal husbandry) were actively engaged in some phase of the Range Improvement Program. In the period from 1945 to 1975 there were 9,083 permits used for a total of 2,606,812 acres burned.

Wildland Resources Center

In 1958 there was a transition from the series of UC range management committees to the formation of the Wildlands Research Center (WRC). The WRC was first proposed by Henry J. Vaux in 1954 and was formally established within the Agricultural Experiment Station in 1958. The Center's mission was to promote interdisciplinary research, coordinate wildlands research with-

in UC and other public agencies, and promote extension of knowledge related to conservation, management, and utilization of wildland resources. While the Center was a system-wide unit of UC, it was closely aligned with the Forestry Department at UC Berkeley. Henry Vaux was the first director (from 1958 to 1965) and was followed by John A. Zivnuska (from 1965 to 1974), Rudolf F. Grah (from 1974 to 1978), Dennis E. Teeguarden (from 1978 to 1981), Fred Dickinson for a short period in 1981, and Harold Heady (from 1981 to 1983). Dennis Teeguarden served a second term from 1983 to 1989. Beginning in 1977 several task forces and committees examined the role of the Center. In 1980 Harold Heady submitted a report of recommendations for the Center. In 1983 Robert Callaham was appointed as program coordinator for the Center.

Under Callaham's guidance the Center became active in several areas, including watershed management and oak woodland management. The WRC, in collaboration with state agencies and organizations, was instrumental in securing funding for the Integrated Hardwood Range Management Program (IHRMP). In 1989 Don Erman was appointed director of the WRC. In the 1990s the WRC was combined with the Water Resources Center to form the Centers for Water and Wildlands Resources (CWWR) under the direction of Don Erman. One of the principal activities of the combined centers was coordination of the Sierra Nevada Ecosystem Project that reported on the status of the Sierra Nevada. In 1999 the WRC was separated from the CWWR and directed by Richard Standiford. Declining budgets led to closure of the WRC in 2004.

Rangeland Seeding

In the 1930s livestock producers wanted to improve range feed conditions. When Burle Jones became Cooperative Extension Specialist in Agronomy in 1938, range improvement was not receiving much attention. He initiated an extensive series of grass and legume variety trials that

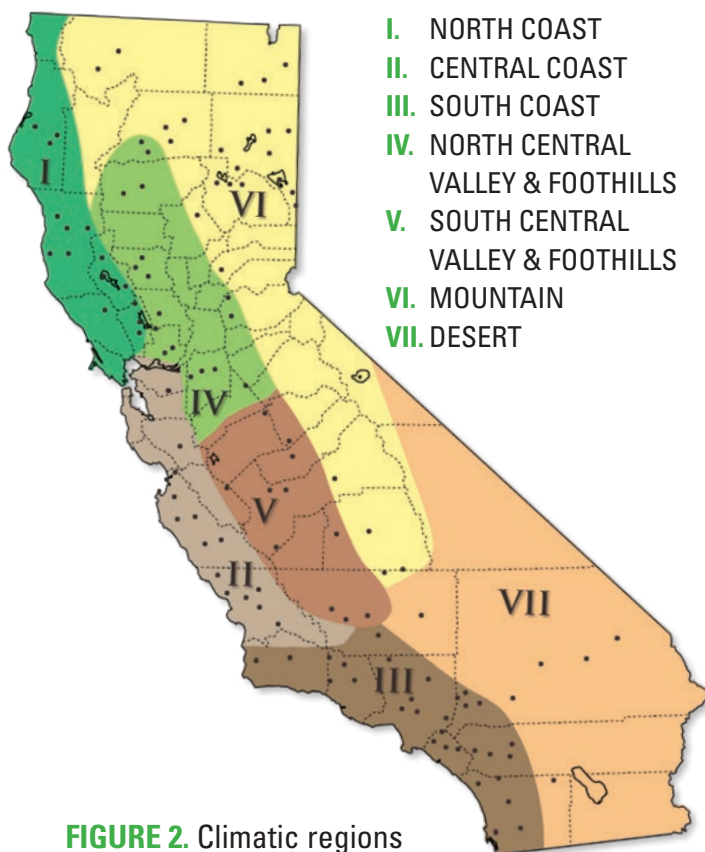


FIGURE 2. Climatic regions and locations of range nurseries and broadcast plots.

eventually included 240 nurseries and broadcast plots in 40 counties (fig. 2). This program was based on

- producer demand for improved feed conditions
- need for improving productivity of privately owned ranges
- benefit payments by the Agricultural Conservation Administration
- the work of the USDA Soil Conservation Service (SCS) on the value of grass cover
- recognition of the need for palatable cover to replace brush

Some of the earliest testing was not very encouraging, but with changes in grazing management and improved field methods recommended by Ben Madson, results became more promising. In 1940 the department hired a young Canadian geneticist, Merton Love, who took leadership of these state-wide trials and addressed key issues in rangeland management. These included rangeland forage production and quality, as well as grazing management practices that were compatible with these new plant materials. The McDonald endowment was established in 1938 for range research, and most of these funds were allocated to the investigation of range grasses and forage plants.

Included in this initial testing program were many grasses and legumes from Australia, including Wimeria ryegrass, several annual medics (*Medicago* spp.), and subterranean clover (*Trifolium subterraneum*). These would play a prominent role in range reseeding recommendations that resulted from this and later programs. After 8 years of testing, it was possible to draw broad lines of species adaptations. Bur clover (*Medicago hispida*), introduced into the state during the mission period, was found to be a promising species for parts of the Sacramento Valley and Sierra foothills. Subterranean clover also looked good in some plots in those areas, as well as along California's north coast. Conspicuously absent from the initial list was rose clover. In the 1940s Merton Love

introduced rose clover, which by the 1960s was widely naturalized to California (Love and Sumner 1952).

Of the 200 forage varieties included in trials from 1937 to 1945, 34 were native perennials. By 1945 it was evident that few perennials were widely adapted. Because of limited adaptation and subsequently low demand for seed, only a few species were recommended for range improvement. During this program purple needlegrass (*Stipa pulchra*, now *Nasella pulchra*) and nodding needlegrass (*Stipa cernua*) lines were selected from test plots at UC Davis, and foundation seed was developed from a blend of 12 superior strains of each of these native grasses (Jones and Love 1947). Restoration of native perennials into California's annual-dominated rangelands is a recurring objective that remains unfulfilled unless the site allows for normal crop production practices, including tillage and weed control. Exotic perennial grasses were also included to extend the green forage season and maintain higher forage quality. By the 1960s only non-native perennial grasses (hardinggrass, smilograss, summer dormant orchard grass [*Dactylis glomerata*], and veldtgrass [*Ehrharta calycina*]) were recommended. In 1945 Burle Jones and Merton Love authored *Improving California Ranges*; and in 1947 they authored *Improving California Brush Ranges*. Both of these publications were the result of these statewide tests, observations, and interviews of stockmen.

Eventually the grass and legume testing that was started by Burle Jones, as well as the testing conducted as part of the Rangeland Demonstration Project, evolved into a field plot testing program conducted by the Agricultural Extension Service (Les Berry and Jim Street) in collaboration with the Agriculture Experiment Station (Bill Williams and Merton Love) (Williams et al. 1957; Murphy et al. 1973). Cooperative Extension specialists in the Agronomy and Range Science Department led this program and conducted county trials with CE advisors throughout much of California. Several

“ *These early years provided a base of long-term data on climate, forage response, and cattle production that continues to the present.* ”

varieties of subterranean clover, rose clover (*Trifolium hirtum*), crimson clover (*T. incarnatum*), and bur clover (*Medicago* spp.) made their way into county seeding recommendations as a result of these county trials. This program worked closely with the seed industry and USDA Soil Conservation Service. Legume inoculation with specific *Rhizobium* strains was a research focus starting in the 1960s that led to specific *Rhizobium* strains being coated on the legume seeds prior to planting (Holland et al. 1969; Phillips and Williams 1987).

While most of the focus was on plant materials for California's Mediterranean-type rangelands, other plant materials, including several wheatgrasses (*Agropyron* spp.), were also tested in northeastern California. Several grasses and legumes were tested on the Likely Table in Modoc County from 1954 to 1988 (Kay 1988). Several wheatgrasses and wildryes (*Elymus* spp.) did well in these studies, but legume survival was poor (Kay and Street 1961).

In the 1970s and 1980s Bud Kay, in collaboration with Walt Graves (Farm Advisor, San Diego County), Jim Young (USDA ARS, Reno), and Catherine Ross (graduate student), conducted germination and establishment studies on about 20 desert plants as part of their efforts to revegetate the second Los Angeles Aqueduct that traversed more than 100 miles of the Mojave Desert from Owens Valley to Los Angeles. The results of these studies were published as *Mojave Revegetation Notes* (Kay 1977).

In the 1980s Bud Kay also conducted seeding trials and developed management practices so

that the California Department of Transportation could revegetate highway road cuts on completion of highway constructions. He also developed seeding recommendations to protect ski slopes in the Sierra Nevada mountain range.

Range Fertilization

In the 1940s J. P. Conrad found that bur clover responded to application of sulfur and phosphorus (Conrad 1950). Later studies by scientists in the UC Davis Agronomy Department found that rose, subterranean, and crimson clovers also responded to application of these nutrients. In the 1950s O. K. Hoglund, H. W. Miller, and A. L. Hafenrichter reported production increases from nitrogen fertilizers and the need for phosphorus and sulfur to be included with nitrogen for the nitrogen to be effective. In the 1950s and 1960s Bill Martin (Extension Soil Specialist) and Les Berry (Extension Range Specialist) established range fertilization test plots and grazing trials with farm advisors statewide. These studies found that addition of nitrogen increased forage and animal production per acre but usually required sulfur or phosphorous (or both) along with the nitrogen (Martin and Berry 1970). Beginning in the 1960s Milton Jones, a soil fertility specialist at UC Hopland Research and Extension Center, began to study soil fertility and plant nutrition on rangelands. He conducted extensive studies of legume responses to phosphorus, sulfur, and other nutrients and grass responses to nitrogen, phosphorus, and sulfur, which he reviewed in Jones (1974). He also conducted nutrient cycling studies, publishing a review of biogeochemical cycling in the annual grasslands (Jones and Woodmansee 1979).

Weed Control

In 1947 one of the first successes in biological control in the world was started with the introduction of the Klamath weed beetle (*Chrysolina quadrigemina*) on the north coast by the UC Division of Biological Control. Klamath weed

was, and still is, an important plant that is toxic to grazing livestock. The release of the beetle was very successful at suppressing Klamath weed and keeping it in check.

Agricultural Experiment Station and Extension Service researchers in agronomy and botany have investigated the biology and control of several rangeland weeds. Beginning in the 1940s medusahead control was the focus of research with studies that investigated palatability and control methods, including burning and grazing (Lusk et al. 1961; McKell et al. 1962). Yellow starthistle control has also been the focus of attention over the years (DiTomaso et al. 2006), and goatgrass control has also been investigated, especially in recent years, when it invaded millions of acres of foothill rangeland (Davy et al. 2008).

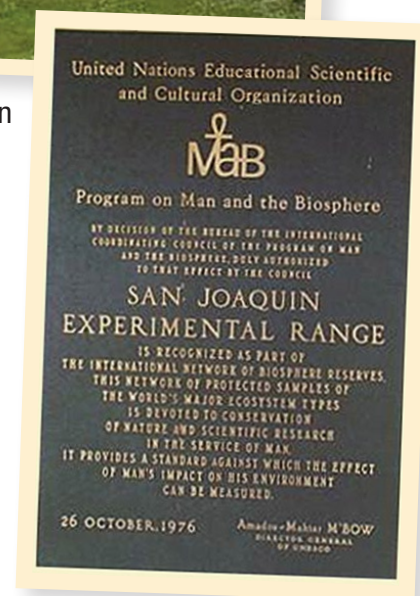
Soil Vegetation Survey

As forestry and range research progressed, it became important to know the capability of the land to support silviculture and range improvement practices. In 1947 the California Soil-Vegetation Survey program was started, with CDF serving as the lead agency and receiving collaboration from UC, USDA SCS, and the USDA Forest Service Pacific Southwest Forest and Range Experiment Station. This survey covered the forests and rangelands (uplands), and the USDA SCS Soil Survey focused on farmland. Rod Shippey, Mendocino County Farm Advisor, developed guidelines for using the Soil-Vegetation Survey to estimate carrying capacity of rangelands. In 1988 the Soil Vegetation Survey terminated due to loss of funds and the retirement of the last CDF (Jim Mallory) and UC (Bob Powell) staff.



FIGURE 3. San Joaquin Experimental Range in Madera County, California.

FIGURE 4. The San Joaquin Experimental Range was designated a United Nations “Man and the Biosphere Reserve” in 1976.



Research Stations

In 1934 the USDA Forest Service established the San Joaquin Experimental Range (SJER) in Madera County, with UC as a partner in beef cattle and zoological research, while the USDA Forest Service conducted range research (figs. 3 and 4). The SJER is approximately 4,500 acres in size and has been grazed by cattle since its beginning. The exception is its Research Natural Area, which has been ungrazed and unburned since 1934. A variety of grazing, animal husbandry, range improvement (fertilization, reseeding, brush control, etc.), wildlife habitat, botanical, and zoological studies have been conducted at SJER. The UC Animal Husbandry Department placed an experimental beef cattle herd on the station to study what was needed to have a

productive, year-round, commercial cattle operation in the foothills. Probably the most important cattle management information that was developed and used as a result of these studies concerned the need for supplemental feed for the cow herd in the fall and early winter and the recognition that a moderate level of grazing was the most productive and economical. In addition, information on cattle grazing behavior, reproduction and survival, equipment, and other general production methods was developed and published.

The UC Davis Department of Zoology was involved with many wildlife studies at SJER, often cooperating with state and federal wildlife agencies. Information on quail, pocket gophers, squirrels, and other animal life, as well as on the impact of wildlife on plant cover, has added to our knowledge of management. Other major UC activities included

- a detailed soil survey by the UC Davis Soils Department
- chemical studies of forage species by the Forestry Department
- revegetation and fertilization by the Agronomy Department
- economic aspects of surrounding livestock operations studied by the Agricultural Economics Department

- advisory committee activities and field days conducted by the Agricultural Extension Service

During this time Forest Service researchers studied the botany of the range, forage management, effect of cattle grazing on the range, and the possibilities of introducing new forage plant species. Studies at SJER led to a better understanding of California's annual rangelands and their use by livestock. Bentley and Talbot (1951) dissected the forage year into the inadequate green season, the adequate green season, and the dry and dry leached season in recognition of the variability and nutritional value of range forage through the year. These designations are still used and taught to range managers today. These early years provided a base of long-term data on climate, forage response, and cattle production that continues to the present. In 1958 the Animal Husbandry Department moved their livestock herd to UC's new Sierra Foothill Range Field Station east of Marysville. In 2009 Neil McDougald (Madera/Fresno Counties Farm Advisor) was appointed director of the SJER with a memorandum of understanding (MOU) with the USDA Forest Service.

Recognizing the need for a permanent sheep production and range research station, in 1951 UC established the 4,637-acre Hopland Field Station, now known as the Hopland Research and Extension Center (HREC), located east of the town of Hopland in Mendocino County. Al Murphy was director of the station from 1951 to 1986. Initially the site of sheep production and brush control studies, HREC would become the site of extensive studies of predator control, range seeding and fertilization, oak woodland ecology and management, habitat management, and, most recently, watershed and water quality research (Meadows 2001). In 1958 UC withdrew from the joint research program at San Joaquin Experimental Range. The beef cattle herd was maintained at UC Davis



FIGURE 5. A field day on Forbes Hill at the Sierra Foothill Research and Extension Center in the 1980s.

and on area ranches until the UC Sierra Foothill Field Station (now known as the UC Sierra Foothill Research and Extension Center, SFREC) was acquired in 1960 (fig. 5). Under the careful administration, stewardship, and advice of UC faculty and staff, which included Lowell Myler, Charles Raguse, Roy Hull, Mike Connor, Dustin Flavel, Bill Frost, and Jeremy James, the station has been the site of research, teaching, and extension projects in many areas. These include beef cattle production and health, oak woodland ecology and management, rangeland improvement practices, weed control, animal behavior, grazing management, watersheds and water quality, and, most recently, ecosystem services (Craigmill and Tate 2010; Meadows 2010).

Undergraduate and Graduate Education

Range management education began with the hiring of Arthur Sampson as the first range faculty at UC Berkeley in 1922 (app. A). Arthur Sampson's association with the University of California began with a lectureship, but in 1923 he was promoted to associate professor, in 1940 to professor, and upon retirement in 1951 he was granted emeritus status. He organized and strengthened the program of graduate study in forestry, and his four textbooks in range management plus many research publications have had far-reaching influence (Parker et al. 1967).

Alan Beetle was an early researcher, with interests in botany and rangelands. He received his PhD from UC Berkeley and was an agronomist in the Botany Department from 1940 to 1946. Beetle was on the faculty of the University of Wyoming from 1946 to 1978 and was instrumental in starting the Department of Rangeland

Ecology and Watershed Management. Harold Biswell was appointed to the faculty of the School of Forestry in 1947, and he retired in 1973. He became a preeminent researcher, teacher, and advocate of fire ecology and management. His pioneering work was a major factor in developing new policies of controlled or prescribed burning. Arnold Schultz joined the faculty at UC Berkeley in 1949. His early research career focused on prescribed brushland and forest burning, quantitative ecology methods, and tundra and desert ecology. Schultz received the College of Natural Resources Teaching Award in 1991 and the University Teaching Award in 1992.

Harold Heady was a range management ecologist at UC Berkeley from 1951 to 1984. In 1951 Heady made a potentially risky decision to vacate a tenured position at Texas A&M, accepting a position in UC Berkeley's School of Forestry as assistant professor. He joined two other former students of John Weaver (Harold Biswell and Arnold Schultz) on the faculty. John Weaver and Fredrick Clements were early grassland ecologists at the University of Nebraska. They are credited with defining succession in prairie grasslands. Most range management graduates can trace their academic lineage to Weaver and Clements. When Heady arrived at Berkeley in 1951, the University had just purchased the Hopland Field Station and was also expanding range management on the Davis campus. This led to many productive research collaborations and years of joint teaching on both the Berkeley and Davis campuses.

“ While range research and extension in UC has focused heavily on range improvement and livestock production practices, researchers have also concentrated on descriptive and quantitative ecology. ”

Merton Love joined the UC Davis faculty in 1940. He developed a distinguished career of research, teaching, extension, and public service and served as chairman of the Department of Agronomy from 1959 to 1970. A satellite program of the UC Davis Agronomy Department was established at UC Riverside in 1964 and staffed by Cy McKell, as a department vice chair, and faculty members Joe Gooden, Vic Youngman, and Bill Isom. In 1968 the satellite program became the Plant Science Department at UC Riverside. In recognition of the importance of range science in the UC Davis Agronomy Department's research, extension and teaching activities, the department was renamed the Agronomy and Range Science Department in 1968. This name endured until a major consolidation of several departments in the late 1990s into the Plant Sciences Department.

The UC Berkeley-UC Davis joint major in rangeland management was first offered in 1953. Faculty for the program included Arthur Sampson, along with recent faculty additions Harold Heady and Harold Biswell from the UC Berkeley School of Forestry; Merton Love, Horton Laude, and Bill Williams from the UC Davis Agronomy Department; and William Weir from the UC Davis Animal Science Department. Arnold Shultz at UC Berkeley and Beecher Crampton at UC Davis also taught in this joint program. Several graduate students also participated in teaching. In addition to range science courses, the curriculum included courses in forestry, soils, agronomy, taxonomy, animal science, and a good breadth in the general sciences and liberal studies (John Stechman, personal communication 2012).

“ *How can Cooperative Extension programs be employed to educate stakeholders and help land managers implement change?* ”

Managing Ecosystems and Impacts

Environmental Policy

While range research and extension in UC has focused heavily on range improvement and livestock production practices, researchers have also concentrated on descriptive and quantitative ecology (apps. A, B, and C). Investigations of hydrology (e.g., Veihmeyer 1951), alien plants (e.g., Robbins 1940), native plants (e.g., Sinclair and Sampson 1931; Beetle 1947), and the California grassland (e.g., Sampson et al. 1951) have been common themes. With new knowledge and new questions, these investigations have expanded. Beginning in 1969, assessing environmental impacts of projects and practices on ecosystems and landscapes became public policy. In response to these policies, ecological and management impact investigations would multiply, and Cooperative Extension programs would change.

In 1969 Congress passed the National Environmental Policy Act, followed in the 1970s by the Environmental Quality Improvement Act, Endangered Species Act, Clean Water Act, and Coastal Zone Management Act. All of this legislation had far-reaching influences on the way land was managed. These national policies and additional legislation passed by California changed the objectives and practices for rangeland and grazing management on private and public lands. Research and education topics gradually changed from “how can we economically produce more food and fiber” to questions like the following:

- How do rangeland management practices impact ecosystems, watersheds, and landscapes?

CHANGING PRACTICES

Up into the 1970s oak removal was a practice recommended by Cooperative Extension advisors. Today UC has an active research and extension group attempting to maintain and restore oak woodland ecosystems.

In the past CE advisors actively enabled prescribed burning of foothill brushlands through their collaboration with county range improvement associations. Today air quality regulations and liability issues severely restrict burning.

- How can we change practices so that they effectively maintain environmental quality or reduce proven and assumed impacts?
- How can we assess and monitor management effectiveness?

Although researchers at UC Berkeley and UC Davis had been investigating questions of ecosystem structure and function, more effort would be needed to address the environmental impact questions that became numerous during the 1970s and 1980s and continue today. There were pressures to reduce grazing on public lands and concerns about poor regeneration of oaks in foothill rangelands. Accusations of negative effects of grazing on biodiversity, water quality, riparian habitat, fisheries, and even air quality seemed endless, and some were well founded. In response, UC Division of Agriculture and Natural Resources (DANR) programs began to address some key research and extension questions. Is there really a problem? How is ecosystem structure and function affected? What practices can be employed to reduce or mitigate impacts? How can Cooperative Extension programs be employed to educate stakeholders and help land managers implement change?

Annual Rangeland Management

Taking advantage of existing research and implementing new research and extension programs, UC DANR researchers and educators expanded investigations into ecosystem structure and function, as well as the impact of management on range ecosystems, in several programs beginning in the 1970s.

Some key questions have included

- How does an annual-dominated grassland or woodland understory respond to intra- and interannual weather variation, and can we predict forage production and species composition from precipitation, temperature, and other parameters?
- How are seed banks, germination, and seedling establishment affected by natural influences and management?
- How do grazing and fire affect herbaceous and woody plants and the communities in which they reside?
- How can we document and classify vegetation and soils so that long-term change can be detected in the future (hardwood rangeland classification, ecological sites, state and transitions models)?
- How do woody plant control and grazing affect soil stability and erosion, and what practices can moderate negative impacts?

In the 1970s and 80s researchers investigated the influence of mulch (litter) on annual grassland productivity and species composition (Hormay and Fausett 1942; Bartolome et al. 1980); weather influences on productivity and species composition (e.g., Murphy 1970; Pitt and Heady 1978); and nutrient cycling. As part of the International Biological Program (IBP), researchers in UC and USDA synthesized existing knowledge of the annual grassland ecosystem, reporting on nutrient cycling (Jones and Woodmansee 1979) and developing the Annual Grassland Model (Pendleton et al. 1983). These investigations led

“ *The CE range program was instrumental in disseminating new knowledge and practices that came from investigations of annual rangeland ecosystems.* ”

to important range management applications and education programs in campus classrooms and in extension education.

Residual Dry Matter (RDM) was coined as the term for litter or mulch, and guidelines for RDM were recommended by UC (Clawson et al. 1982; Bartolome et al. 2006) to help managers assess and monitor grazing use. These guidelines were put into use on nearly all of the annual rangelands in California when they were adopted by USDA SCS, USDA Forest Service, and USDI Bureau of Land Management. Over the years they have been adopted by managers of most of the state's 14 million acres of annual rangeland, a major impact of UC's rangeland research and extension education programs.

The Cooperative Extension range program was instrumental in disseminating new knowledge and practices that came from investigations of annual rangeland ecosystems. Initiating the Annual Grassland Management Short Course in 1979, university researchers and educators helped the state's rangeland managers understand the structure and function of annual rangeland ecosystems and practices that could be applied to effectively change species composition and productivity. This short course was repeated and updated many times over the next 20 years and facilitated cooperation with several local, state, and federal agencies. The short course was supplemented with many local workshops.

Public Land Grazing

By the 1970s the effects of grazing on riparian areas and other critical environmental resources became an issue for the public, especially regard-

ing public lands in the western states. During this period UC Cooperative Extension specialists and farm advisors in rangeland management, agricultural economics, and public policy participated in the Western Universities Public Rangeland Coordinating Committee. This committee conducted educational programs focused on the land management agencies' planning process and on monitoring procedures. These programs targeted both ranchers and agency staff. In 1974 Coordinated Resource Management and Planning (CRMP) was formalized in California with an executive committee and technical group representing USDA Forest Service, USDI Bureau of Land Management (BLM), USDA SCS, and UC Cooperative Extension. CRMP was one of the ways that agencies, universities, and public interest groups would attempt to find common ground where management of public lands could be addressed. In 1978 the Modoc/Washoe Experimental Stewardship Program was established as one of three CRMPs authorized by the Public Rangeland Improvement Act of 1978. UC Cooperative Extension county advisors and statewide specialists played an important role in these efforts by providing the organizational skills, knowledge, and opportunity needed for individuals and groups of diverse backgrounds and conflicting positions to come together and address land management issues. These groups were among the first to highlight the need for assessment and monitoring to detect ecosystem change.

Assessment and Monitoring

Monitoring of rangeland vegetation, soils, and grazing has become an important part of modern rangeland management. Over the years UC researchers and Extension agents have contributed to rangeland monitoring by developing the step-point method for estimating cover (Evans and Love 1957), monitoring soil surface litter (see RDM discussion above) and soil erosion (Lewis et al. 2001), and by publishing monitoring guides.

Researchers at UC Davis and UC Berkeley have monitored stream temperature, manure loading, pathogens, sediment, and nutrients as part of rangeland water quality research projects.

Ranch Planning and Grazing Management

By the 1980s it was clear that the Cooperative Extension Service needed to conduct education programs that helped land managers address the entire ranch or rangeland system rather than single improvement practices. Using ranch planning to integrate interdisciplinary and often competing objectives, an interdisciplinary team of Extension specialists organized the first collaboration of Cooperative Extension specialists and advisors in natural resources management in 1982. This was the first of many collaborations that led to the development of the DANR Integrated Hardwood Range Management Program and the DANR Natural Resources Program Area. This was the leading edge of Cooperative Extension's effort to conduct environmental impact education programs for California landowners, managers, and policy makers.

Focusing on grazing and ranch management in the 1980s, Extension specialists and advisors conducted grazing and ranch planning extension education programs that helped ranchers improve profitability while reducing impacts on rangelands and their watersheds. Range management planning and grazing management short courses were developed and delivered locally to help ranchers document their resources, develop goals, and select practices to meet these goals. Monitoring procedures, including RDM, were also demonstrated during these courses. These courses were conducted for nearly a decade starting in 1988. They would eventually be replaced by short courses that would help ranchers cope with water quality issues.

The influence of range livestock distribution on riparian and other critical areas was a significant part of grazing and range management issues

starting in the 1970s. Livestock distribution is the product of grazing animal behavior, terrain characteristics, and placement of stock water and supplemental feeding areas. UC Davis animal scientists have addressed range animal nutrition and grazing distribution since the early 1900s. These researchers identified the need for protein, as well as mineral and vitamin supplementation, resulting in widely adopted supplementation practices that improve animal production. By 2000 strategic placement of these supplements would become important best management practices for modifying livestock distribution and reducing impacts on riparian and other critical areas.

Grazing Behavior Research

Grazing behavior research on small and large scales has been an important part of animal and range science research at UC Davis. On a large scale UC researchers studied livestock distribution beginning with 24-hour observation of beef cow locations and activities by Wagon (1967) at SJER in the 1950s. On a smaller scale researchers have studied animal intake. Torell (1954) developed an esophageal fistula for estimating and characterizing intake, and VanDyne and Heady (1965) characterized the botanical composition of sheep and cattle diets on a mature annual range. UC Davis scientists have contributed significantly to the understanding of intake by quantifying its components, including bite size, biting rate, and grazing time (Demment et al. 1995). More recently UC researchers collaborated with scientists in other states to demonstrate that livestock distribution practices are effective at reducing livestock impacts in riparian areas and other critical areas. In 2011 the effectiveness of these practices was documented in George and Jackson et al. (2011).

Oak Woodland Management

In the 1970s conservationists began to raise alarms about loss of oak woodlands and poor regeneration of some oak species. Bill Weitkamp

(San Luis Obispo County Farm Advisor) and Ted Adams (Extension Wildlands Specialist) were among the first to address these issues with research and extension programs. In the 1980s California's State Board of Forestry, CDF, and the state legislature began to address these issues by supporting research and education. The Integrated Hardwood Range Management Program (IHRMP), initiated in 1986, brought together researchers, educators, and managers from CDF, Department of Fish and Game, and the University of California. Five Cooperative Extension IHRMP specialists (app. B) were hired and placed in the Environmental Science Policy and Management Department at UC Berkeley. Rick Standiford was the director of IHRMP from 1988 to 1999. Several CE advisors were also supported to help IHRMP conduct programs throughout the oak woodlands (app. B). During this program researchers improved our knowledge of natural and management influences on regeneration. They developed practices to improve oak regeneration (e.g., McCreary 2001); studied oak woodland habitat values (e.g., Block et al. 1994); documented and classified oaks and oak woodlands (e.g., Allen et al. 1991); and investigated land owner attitudes about oaks and oak woodlands (e.g., Huntsinger et al. 1997). Through frequent symposia and extension education programs directed at land use planners, land owners, and agency staff, the IHRMP effectively changed practices and attitudes about California's oak woodlands and demonstrated UC ANR's ability to address public policy issues (Standiford and Bartolome 1997). The IHRMP officially ended in 2009, but the UC ANR Oak Woodland Conservation Workgroup continues to address the basic mission of oak conservation within the UC system.

Rangeland Water Quality

Recognizing that the range livestock industry needed to address clean water issues related to range livestock production, California's Range

Management Advisory Committee—in collaboration with the livestock industry, UC Cooperative Extension, and several agencies—developed the California Rangeland Water Quality Management Plan (CRWQMP). This plan was approved by California's State Water Resources Control Board and appended to the state's Nonpoint Source Management Plan in 1995. The objectives of the CRWQMP were to conduct management activities that would prevent sediment, nutrients, pathogens, and water temperature from exceeding prescribed standards established by California's Regional Water Quality Control Boards.

As the CRWQMP was being developed, Jim Clawson and Mel George (UC Cooperative Extension Range Management Specialists), along with Joel Brown (USDA Natural Resources Conservation Service State Range Conservationist) and in collaboration with state and federal agencies, implemented the Rangeland Watershed Program (RWP). This program offered extension education, technical assistance, and applied research. The RWP conducted a short course on ranch water quality planning throughout the state and helped more than 1,000 rangeland owners develop water quality plans for more than 2 million acres from 1995 to 2004. This short course has been adapted to local needs and continues to be offered as a way to help landowners develop water quality plans that address clean water issues (Larson et al. 2005; George and Larson-Praplan et al. 2011).

In 1992 Mel George, Royce Larsen, and Neil McDougald initiated a study of sediment transport at the SJER, funded by the U.S. Environmental Protection Agency (US EPA) (George et al. 2002). In 1994 a Cooperative Extension Rangeland Watershed Specialist, housed in the Agronomy and Range Science Department at UC Davis, was hired to address water quality and watershed research questions and to join the existing efforts of the RWP. Ken Tate initiated research to understand the fate and transport of waterborne pathogens in collaboration with Rob Atwill, a recently hired

CE Specialist, housed in the School of Veterinary Medicine, specializing in waterborne disease. Collaborating with local water districts, US EPA, and several state and federal natural resource agencies and associations that own, manage, or influence the management of rangelands, Ken Tate and Rob Atwill—along with a multidisciplinary Cooperative Extension-Agricultural Experiment Station (CA-AES) team of researchers—were able to carry out the following accomplishments. They successfully identified management strategies for minimizing microbial contamination of surface and ground water attributable to livestock production systems; characterized the underlying processes of environmental dissemination of microbial hazards; developed monitoring methods for assessing environmental or agroecosystem health; and assessed vertebrate reservoirs of protozoa pathogens. This research positioned this team to effectively address microbial food safety issues when contamination of vegetable crops became a public health issue early in the twenty-first century.

From the beginning this extension and research program was focused on rangeland owners, who collaborated by organizing education opportunities and providing access to their land and herds for many of the research projects in this program. More than 100 ranchers have provided their time, access to their land for water quality data collection, and access to their herds for sometimes invasive sampling procedures. One rancher from Lake County, Russell Rustici, endowed three chairs in CE and AES at UC Davis and UC Berkeley, in addition to leaving a research and extension endowment of nearly \$10 million to the UC Davis College of Agriculture and Environmental Sciences to support livestock and rangeland research.

Professional Service and Achievement

University of California researchers and educators have been very active participants in the profession of range management. UC participation in the Society for Range Management has led to invaluable collaborations with government agencies and opportunities to highlight UC range research. Harold Heady and Harold Biswell were among the charter members of the Society for Range Management. In 1949 Harold Biswell called a meeting of California's Society for Range Management members to organize a local section. Harold Biswell drafted a section constitution and bylaws for a meeting at UC Berkeley attended by 28 members. The first officers elected were Waldo Wood (USDA Forest Service, San Francisco), President; Wayne Austin (USDA/SCS, Berkeley), Vice President; Jay Bentley (USDA Forest Service Research, Berkeley), Secretary-Treasurer; and Councilmen Harold Biswell (UC Berkeley), Merton Love (UC Berkeley), and Joseph Snyder (BLM, San Francisco). In 2002 the California section expanded to include Hawaii and the Pacific, and it was renamed the CalPac Section. Over the years more than 40 UC researchers and educators have served as section officers, and some have been elected to national office. Additionally, many have been recognized for their service to the profession, receiving the Renner, Chapline, Fellow, Outstanding Achievement, and Outstanding Young Professional Awards from SRM and Range Manager of the Year Award from the CalPac Section.

Cooperative Extension: Coping with Change

The role of UC Cooperative Extension has changed over the years. As the outreach arm of a land-grant university, Cooperative Extension is responsive to public needs as well as advancements provided by University research. In the early years the CE range extension program focused on range management that improved livestock production. Early extension work with range improvements was led by Extension agronomists, starting with Burle Jones in 1937. Les Berry was the first to have the title of Range Improvement Specialist in 1954 (app. B). Recognizing the multidisciplinary nature of range extension program needs, the range specialists have often conducted advisor education programs in collaboration with other CE specialists. Evidence of the cooperative nature of range extension can be traced back to 1937, when Burle Jones (Extension Agronomist) and Louis Rochford (Extension Animal Scientist) conducted the first joint livestock and range farm advisor training. Later the range and livestock specialists worked with CE advisors, encouraging participation in statewide field projects and planning educational efforts. Throughout the years it was the CE specialist's responsibility to provide training for farm advisors. Rueben Albaugh, Cooperative

Extension Livestock Specialist, often said that the role of the CE specialist was to make the farm advisors look good.

Today the range extension program continues to collaborate with CE advisors and specialists from other disciplines as it addresses a variety of land ownerships (private, public, easements) with diverse, frequently conflicting management goals that are sometimes pursued with limited knowledge of science and management practice effectiveness. Adaptive management of ecosystem services on working landscapes has become the hallmark of state and local extension programs today. Within this theme Cooperative Extension is currently focusing on water quality, invasive species, grazing impacts, habitat preservation, and ecosystem restoration throughout California. A key component of addressing these diverse issues has been the effort to shift extension education away from single-purpose practice demonstrations; instead, the aim has been to develop extension education programs that face these challenges through rangeland management planning and implementation of effective practices.

External factors have also contributed to changes in UC Cooperative Extension programs. During the past few decades many formerly agricultural counties have been urbanizing, which has resulted in decreased attendance to extension education programs by traditional ranchers. However, urbanization and suburbanization of formerly rural areas has placed more demand on extension education for homeowners and

SOME EXTENSION RULES

Early Extension specialists and farm advisors left us with some good guidelines for successful extension programs:

- If you can't be on time, be early.
- Meetings start on time and end on time.
- You can't get anything done if you only work ten hours per day.
- The formula for a good extension meeting is to have a farm advisor, a specialist, and sometimes a faculty member make presentations and to have a social function after the meeting.

small farms. Another very important change has been the increasing education level of traditional and new clientele groups, who are asking more informed questions as they cope with complex ecological systems and environmental issues.

In the post–World War II era the emphasis of CE education and applied research was on increasing food and fiber production, and ranchers were the primary clientele. By the 1980s the clientele for rangeland CE programs was growing because of increasing needs from other groups, such as managers of public and private forests and rangelands. The environmental movement was the source of part of this change, and small farms and ranches also contributed to a more diversified audience.

The complexity of research questions and education programs increased. No longer were the questions about what herbicide to use or what legume to plant. Now the questions were, how do grazing livestock impact rangeland watersheds, or what are the barriers to successful oak regeneration?

These and other forces have caused Cooperative Extension to change, just like it always has, to adjust to new problems and changing audiences. One thing is still certain: the basic objective of Cooperative Extension is to help people. But today UC Cooperative Extension range programs must help people cope with complex problems, including environmental regulations. ■

Appendix A: Faculty and Agricultural Experiment Station Staff

UC DAVIS

Agronomy and Range Science/Plant Sciences Faculty

- Ben Madson
- William Mackie
- Alan Beetle
- Merton Love
- Maurice Peterson
- John Conrad
- Bill Williams
- Beecher Crampton
- Horton Laude
- Cy McKell (UCD/UCR)
- Joe Gooden (UCR)
- Vic Youngman (UCR)
- Milton Jones
- Charles Raguse
- William Longhurst
- John Menke
- Tag Demment
- Emilo Laca
- Kevin Rice
- Andrew Latimer
- Ken Tate

Experiment Station Specialists and Researchers

- Al Murphy
- Lowell Myler
- Burgess Kay
- Charles Walker
- Jim Street
- Dorran Sumner
- Bob Powell

Other UC Davis Faculty and Researchers

- Frank Veihmeyer (Soils)
- W.W. Robbins (Botany)
- Aldon Crafts (Botany)
- O.E. Leonard (Botany)
- Robert Burgy (LAWR)
- Gordon Huntington (Soils)
- Vic Rendig (Soils)
- Walter Howard (Wildlife)
- Mike Singer (LAWR)
- Randy Dahlgren (LAWR)

UC BERKELEY

Environmental Science, Policy, and Management Faculty

- A.W. Sampson
- Arnold Shultz
- Don Hedrick
- Allen Beetle
- Harold Heady
- Harold Biswell
- William Longhurst
- John Menke
- James Bartolome
- Randy Rosiere
- Barbara Allen-Díaz
- Lynn Huntsinger

Field Station Superintendents

Hopland

- Al Murphy
- Bob Timm

Sierra Foothill

- Ken Wagnon
- Joseph Guild
- Paul Rowell
- Mike Connor
- Art Craigmill
- Jeremy James

Appendix B: Extension Specialists

RANGE SPECIALISTS

- Burle Jones Extension Agronomist (1937–1947)
- Milton D. Miller Extension Agronomist (including Range) (1946–1949)
(and again, 1955–1964, as Extension Agronomist)
- Victor Osterli Extension Agronomist - Forage (1949–1954)
Range Improvement Specialist (1959–1965)
- Lester J. Berry Range Improvement Specialist (1953–1957 and 1964–1972)
- Art Haig Extension Technologist - Range (1955–1962)
- Jim Street Extension Technologist - Range (1959–1978)
- Ted Adams Extension Wildlands Specialist (1972–2001)
- W. James Clawson Extension Range Specialist (1972–1992)
Extension Range Specialist Emeritus (1992–present)
- Melvin George Extension Rangeland Specialist (1978–2012)
Extension Range Specialist Emeritus (2012–present)
- Kenneth Tate Extension Range Watershed Specialist (1995–present)

LIVESTOCK SPECIALISTS

UC Berkeley

- Louis Rochford
- B.T. Bachelder
- Vard Sheppard
- Sedge Nelson
- Horace Strong

UC Davis

- Horace Strong
- Rueben Albaugh
- “Pat” Pattengale
- Jim Elings
- Glenn Spurlock
- W. James Clawson
- Ken Ellis
- John Dunbar
- Glen Ufford
- Rich Benson
- Steve Berry
- Jim Oltjen
- Diane Meyer
- Frank Mitloehner

VETERINARY EXTENSION SPECIALISTS

- Alex Ardans
- Bob Bushnell
- George Crenshaw
- Ed Loomis
- Ben Norman
- John Glenn
- John Maas
- Art Craigmill
- Rob Atwill

IHRMP DIRECTORS, SPECIALISTS, AND ADVISORS

- Rick Standiford (Director)
- Jim Bartolome (Director)
- Robert Logan
- Doug McCreary (Director)
- Bill Tietje
- Tom Scott
- Robert Schmidt
- Adina Merelender
- Bill Frost
- Neil McDougald
- Sheila Barry
- John Harper
- Greg Giusti
- Royce Larsen
- Morgan Doran
- Sabrina Drill

OTHER SPECIALISTS WORKING ON RANGELANDS

Soils

- Bill Martin
- Roland Meyer
- Toby O'Geen

Weeds

- Bill Harvey
- Jim McHenry
- Steve Radosovich
- Joe DiTomaso

Wildlife and Animal Damage Control

- Maynard Cummings
- Terry Salmon
- Dick Teague
- Lee Fitzhugh

Farm Management

- Phil Parsons
- Doyle Reed
- Ed Yeary
- Fisk Phelps
- Bert Burlingame
- Kent Olson
- Steve Blank
- Karen Klonsky

Resource Monitoring

- Maggi Kelly

Fire

- Max Moritz

Pest Management

- Art McCain
- Carl Koehler
- Matteo Garbelotto

Forestry

- Woodbridge Metcalf
- Rudolph Grah (later a faculty member)
- Jim Gilligan
- Ed Gilden
- Jim Laacke
- Richard Standiford
- Thomas Robson
- Gary Nakamura
- William Stewart

Appendix C: County Livestock, Range, and Natural Resources Advisors

Alameda

Earl Warren, Jr.
Stan Coats
Walt Johnson
George McNeely
Holly George
Larry Forero
Sheila Barry

Amador

Bob Plaister
Donna Herschfelt
Del Farnham
Bill Frost
Scott Oneto

Butte

Henry Everett
Al Mitchell
Bob Willoughby
Glenn Nader

Calaveras

Dan Irving
Ken Churches
Scott Oneto

Colusa

Milt Miller
Glenn Eideman
Russ Helphinstine
Monte Bell
Josh Davy

Contra Costa

Joe Bordon
Paul Lamborne
Holly George
Larry Forero
Sheila Barry

El Dorado

Jack Graves
Barry Leeson
Lou Bilger
Bill Frost
Scott Oneto

Fresno

Lloyd Stoval
Dick Jones
Aaron Nelson
Neil McDougald

Glenn

Milt Miller
Glenn Eideman
Russ Helphinstine
Monte Bell
Sheila Barry
Marc Horney
Josh Davy

Humboldt/Del Norte

Doug Pine
Coop Cooper
Charlie Lawrence
John Dunbar
Gary Markegard
Alan Bower
Jeff Stackhouse

Imperial

Harold Thurber
Jim Burgess
Don Addis
Juan Guerrero

Inyo/Mono

Dean Smith
Rhonda Gildersleeve
Rick Delmas

Kern

Horace Strong
Walt Emrick
Roy Parker
Ralph Phillips
Julie Finzel

Kings

Herb Etchegary
Carol Collar
Julie Finzel

Lake

Willard “Mose” Lusk
Dale Cannon
John Harper
Greg Giusti

Lassen

Stan Brown
Alton Young
Sam Thurber
Carl Rimby
Glenn Nader
David Lile

Los Angeles

Chet Perry
Sabrina Drill

Madera

Ed Garthwait
Walt Emrick
Bill Haight
Bill Hambleton
Neil McDougald

Marin

Win Engvall
Don Brittsan
Ellie Rilla
David Lewis
Stephanie Larson-Praplan

Mariposa

John Anderson
Wain Johnson
Gary Hickman
Fadzayi Mashiri

Mendocino

Russ Foot
Bill Brooks
Rod Shippey
John Harper

Merced

Don Peterson
Jim Farley
Fadzayi Mashiri

Modoc

Jack Hays
Pat Pattengale
Norm Nichols
Tom Bedell
Carl Rimbey
Cecil Pierce
John Robinson
Don Lancaster
Rick Delmas
Melissa Metcalf

Monterey

Rueben Albaugh
Marion Stanley

Napa

Irving Grover
Morgan Doran

Orange

Max Corry

Placer/Nevada

Walt Johnson
Jack Herr
Bill Helphinstine
Harry Dasher
Roger Ingram

Plumas/Sierra

Alton Young
Art Scarlett
Carl Rimbey
Holly George

Riverside

Don Addis
Jim Sullins
Juan Guerrero

Sacramento

Jim Elings
Al Moore
Gary Vesperat

San Benito

Rocky Lydon
Sergio Garcia

San Bernardino

Jim Oliver
Jack Davidson
Jim Sullins
Royce Larson

San Diego

Vic Brown
Herb Wiselight
Walt Graves
Valerie Mellano
Carl Bell

San Joaquin

Al Moore
Bill Helphinstine
Bill van Reit
Theresa Ward

San Luis Obispo

Parker Talbot
Russ Helphinstine
Cecil Pierce
W. James Clawson
Bill Weitkamp
Wayne Jensen
Royce Larsen

San Mateo

H.A. Sandlin
Hank Scaroni
Bill Weitkamp
Ann King
Sergio Garcia

Santa Barbara

Dan T. Batchelder
Ray Geiberger
Lin Maxwell
Wayne Jensen

Santa Clara

Bud Beckley
Holly George
Larry Forero
Sergio Garcia
Sheila Barry

Santa Cruz

Joseph Rodriguez

Shasta

Don Smith
Les Berry
Walt Johnson
Larry Forero

Shasta/Lassen

Sam Thurber
Walt Spivey
Dan Marcum

Siskiyou

Sedge Nelson
Daniel Drake

Solano

Art Swenerton
David Pratt
Morgan Doran

Sonoma

George Bath
George Stanley
Doc Adams
Lloyd Harwood
Stephanie Larson-Praplan

Stanislaus

Victor P. Osterli
Wayne Hanson
George H. Bath
John Anderson
Bill Helphinstine
Sam Thurber
Bill van Riet
Bill Mason
Franz Rulofson
Theresa Becchetti

Sutter/Yuba

Merl Collins
Bill Klamm
Ben Ramsuar
C. J. Sullivan
Chuck Wilson
Glenn Nader

Tehama

Ben Madson
Don Smith
Les Berry
Lyn Maxwell
Ken Ellis
Ron Knight
Sheila Barry
Josh Davy

Trinity

Joe Borden

Tulare

H. C. Jackson
Ralph Worrel
Bob Miller
Jim Sullins
Ralph Phillips
Julie Finzel

Tuolumne

Harry Hinkley
Don Appleton
Franz Rulofson
Jay Norton
Scott Oneto

Ventura

Bob Brendler
Erv Bramhall
Sabrina Drill

Yolo

Carl Schoner
Gary Veserat
Morgan Doran

Appendix D. “The Range Problem in California”

(Address to the California Cattlemen’s Association by P. B. Kennedy of the University of California, as reported in The California Cattleman, December 1920)

“There is general concern among cattlemen over the present and future carrying capacity of their ranges. The daily question put before me is: ‘How can I increase the forage on my range?’”

I must ask you to put yourself in my place and consider how recommendations can be made when no experiments have been carried on in California by which one is able to base an opinion. If I were a Sir Oliver Lodge I could invoke the spirit world to aid me in recommending an infallible method for renewal of the ravages consisting of a multitude of varying conditions of altitude, rainfall, temperature, exposure and types of soils. But I have little imagination, or I would be a poet. There is no poetry left now in the range business, however popular pastoral poetry may have been in the days gone by.

Many people who write to me and come and consult me are amazed that after a few descriptive terms of their range, I am not able to take up a pencil and pad and write out a prescription in the same deft and wise appearing manner as the average physician. But the physician has the results of centuries of intelligent and controlled experiments back of him on which to base an opinion. Therein lies the difference.

Haphazard and unintelligent experiments should be discouraged as they only lead to indefinite conclusions and failures not to mention the money wasted. Besides it discourages others and retards whatever might be done to increase the productiveness of the range. Range experiments therefore must be conducted under the supervision of a highly trained scientific man who under-

stands the problem and is in hearty sympathy with the practical side of the question. Whether this is to be done under the Forest Service, the University of California, the state Department of Agriculture at Sacramento, or by a Range Research staff of your own Association, is not for me to say.

Certain it is that the research should be carried on without any political influence. Those chosen to do the work should have your hearty cooperation, reasonably paid and well financed. The selection of such person or persons should be done only after a search of all the available material has been thoroughly investigated. The work is of such proportions and requires such a broad knowledge that it could not be done by a recent graduate of a college, but must be by a man of experience, and one who knows plants and their needs like a good cattleman knows the points of a prime steer.

No advance will be made towards a solution of the range problem if it is attempted on a cheap scale. If it cannot be carried on right, then leave it alone.

What are the arguments in favor of its being done right! To my mind, they are many.

The State has approximately 160,000 square miles of territory, or about one hundred million acres. Sixty million acres are mountains and desert, not subject to cultivation, and forty million are adapted to possible cultivation. Of these possible forty million acres of land that might sometime be put under cultivation, only five million acres are actually in crops, while Kansas, Iowa and Illinois have twenty million acres each. Even much of the five million acres in crops are utilized for the feeding of stock or grazing, as in grain stubble, bean, straw, sorghum, alfalfa, etc.

Of the twenty million acres in the National forests, large areas within the boundaries of these

forests are of as great importance for grazing as for timber production. Of the twenty-one million acres of privately owned deeded lands belonging to large stock companies, lumber companies, railroads, etc., much of it is utilized for grazing.

The fifty-four million acres of unappropriated land consists of free range controlled by owning the water supply, inaccessible lands, and lands too dry for the use of cultivated crops now known. The greater part of this area is not suitable for the plow, and is now, and probably always will be used for grazing purposes. Of the one hundred million acres of land in California, you will see that a very large part of it is utilized for grazing in one form or another.

It is evident from the above that we must know how to handle this vast area of grazing lands, so that they may be a permanent asset to the State. In order to be able to advise concerning carrying capacity, range deterioration, range restoration or renewal, maintenance, and the relation of grazing to the forest, and to water power and development, a systematic study of all the fundamental factors involved is necessary.

This is argument number one.

The cattle industry in California represents a business of great magnitude. Quoting from one of our leading agricultural papers, I find:

Ninety million dollars is conservatively estimated to be the value of beef cattle in California, and this figure does not include the investment in land and equipment. Probably the total value of cattle, land, and equipment amounts to over \$350,000,000, and certainly an industry of this magnitude needs an organization back of it to further its interests.

A large share of the above cattle land and equipment must be represented by this Association. How a cattleman could seriously read the purposes of the Association as set forth in the articles of incorporation, and then not immediately become a member, is beyond my conception.

The articles of incorporation include many valuable principles, such as prevention of theft,

branding, breeding, marketing, etc.; but after all, is it not a fact that none of the above mentioned could function if we did not keep up and perpetuate the range which is the foundation of the cattle industry!

One of your articles of incorporation reads: "To procure the enactment of legislation beneficial to the cattle industry." Now, nothing could be more beneficial to the cattle industry than to find out the following:

1. The extent, distribution and food value of the plants now growing on the California ranges.
2. What period of rest is necessary to bring back areas that have been over-grazed in the past?
3. To what extent and how are ranges injured by premature grazing?
4. What are the species of foreign grasses obtainable on the market at a reasonable price that can be profitably introduced on the ranges, and when and how must the seed be planted?
5. What are the species of native grasses worthy of introduction?
6. How should seed of desirable species be multiplied and distributed?
7. What worthless brush lands can be profitably turned into pasture without danger from erosion and floods, and to irrigation and water systems?
8. When, where and how should burning be practiced! What is the best method of burning to clear land for range? What are the species that are killed outright by burning, and what are those that come back vigorously from the root and in a few years return the land to an impenetrable brush again?
9. What are the best crops that should be grown on the farm to supplement the range?

These are only some of the things concerning which we have no adequate knowledge.

I take it for granted that it is desirable to maintain and increase the amount of forage on the ranges, both as to quality and quantity, and that the methods adopted must not cripple the livestock industry. Let us look back, and try to determine what has been the development of the ranges of California.

Before the days of the missions in California, there existed on the hills and valleys, a great abundance of the most excellent kinds of grasses and other forage plants. Of the grasses alone, there are 261 different kinds which belong to California, and have been here since pre-Spanish occupation. We can still find representatives of them all, but in greatly diminished quantities. At that time certain of the outstanding and most valuable and best liked species covered sections of land that can now only be found as individuals on places that have been peculiarly protected by railroad rights-of-way, or for one cause or another.

It is also particularly true with the native clovers (and by this, I do not include the Spanish clovers, the burr-clovers, or melilotus). California has perhaps ten times the number of species of clovers (*trifolium*) as that of any other state.

In addition, there were myriads of wild flowers of every form and color, blending with the grasses and clovers, and forming an immense continuous pasture field from San Diego to Redding.

The first encroachment on this large supply of forage in California was due to the establishment of the missions, up and down the Coast. In connection with the missions, there were maintained at least one flock of sheep, which was used by the inhabitants for many purposes, such as making of clothing, tallow for lighting purposes, and for meat. These sheep were shipped around the Horn, the first flock being brought to San Diego in 1773. By 1815, they were numerous, and by 1825, it is estimated that the seventeen missions from San Diego to San Francisco owned over a million head, with outside ranchers, perhaps, owning a similar

number. The flocks kept increasing rapidly, until we find them reaching the peak seventy-five years later in 1880, with about four millions in round numbers. Then there was a gradual decline to about two millions in 1900, and a million and a half in 1910, where the number has remained about the same for the last ten years.

Now, what happens when sheep traverse a country, aside, of course, from the enormous amount of vegetation they consume! They pack along in their wool large numbers of seeds which are deposited particularly on the bedding grounds, thus extending the area until these plants are found growing wherever the climatic conditions will permit. This left us then, seed of the native species, wherever they were fortunate enough to be allowed to go to seed, mixed with the seed of the introduced species from the Mediterranean region. At once there was set up a competition between the native and the introduced species. These introduced species having left their enemies and competitors for space behind them found themselves, as it were, in a free country, and being aggressive, soon occupied much of the land that was already becoming over-pastured. As the flocks increased, the area utilized for pastures was greatly extended, until we find in a few decades of years that the entire coast, hill and much of the valley country, was entirely changed from its original character of plants. The native plants to a large extent disappeared, and their place was taken by the more aggressive introduced ones. As examples of these introduced plants, we might mention the alfalfarias or "filarees," of which there are several, and the well-known burr-clovers, which are not native, as is generally thought, but introductions from Europe.

It has been exceedingly fortunate for the livestock industry in the past, that we have been able to introduce these above mentioned very valuable plants.

But the golden fleece was not able to discriminate between the seeds of good and bad plants for California uses on the range, and so we find there was a number of weedy grasses introduced, such as the bronco grasses, poverty grasses, squirrel tail

grasses, hair grasses, and other worthless species now altogether too abundant on our pasture lands. In many instances, these have crowded out the "filaree" and bur-clovers, and being much less valuable and nutritious than the latter, are greatly responsible for the poor carrying capacity of much of the range country today. These weedy species are of some value in the early Spring, but when dried up are practically worthless.

The high mountain pastures have been saved from extermination only by reason of the climatic barrier. You do not find the burr-clover in the high Sierras, neither do you find the worthless weedy introduced species. The seed has been carried there, but the rigorous climate is too much for them.

There is another group of plants which might be called both good and bad, according to their state of maturity. I refer to the foxtails, or wild barleys. Up to the present time, stockmen have been unable to find a grass which will grow without cultivation during the cold winter, rainy season. As foxtail is very nutritious in its earlier stages, we are not surprised that it is a favorite at that season of the year. Later, however, when it produces its spiny creeping beards, which cause sores in the mouths of stock, it is very much disliked.

The wild oats, too, is another introduced plant that was exceedingly important, and still furnishes large quantities of hay and pasture for stock. But the wild oats is an annual, and must be permitted to go to seed.

Until a few years ago, very little thought had been given in California to the amount, or methods of production of food for livestock. There was plenty of forage for all the animals then on the range. More recently, however, with the more strict observance of fence laws, and the settling up of large areas which were at one time public lands, the area has been reduced to a very large extent. This, together with the change of the forage plants, in many cases from perennial, nutritious species to annual introduced weedy, worthless ones, is the reason we hear the cry from all sides that the range does not produce either

the amount or the quality of feed that it once did, and requests are being made to remedy this condition, because the demands for stock raising are becoming greater each year as the country develops.

This is the real problem of the cattleman, and indeed of the State, because as the lands deteriorate in productive capacity, the producer and the consumer, and therefore the State, suffers a great loss. The question therefore for the State to decide is whether the stock industry should be fostered and provision made to find out what can be done so that definite recommendations, based on actual proven experiments can be given out.

This is argument number two.

For the present, we must content ourselves with giving only general suggestions, more or less theoretical.

Perhaps the first and most important is that so far as we are able, we must try to conserve the good forage plants, whether native or introduced, and exterminate those worthless ones, which now occupy the land, but which are of little value to us from a forage standpoint. In order to encourage the good ones, we must be sure that they go to seed abundantly, so that they may have at least an equal chance with their worthless competitors. There is a tendency for stock, as in humans, to eat the food they like best. In this way the good forage plants are eaten up and over-grazed, and not permitted to produce seed, whereas those that are only moderately liked, or perhaps even disliked are left alone, and permitted to produce seed abundantly, finally occupying the range almost exclusively.

This is the condition of the foothills on the western side of the Sierra Nevada Mountains from north to south, and on much of the coast lands that I have visited.

In order to make certain that the plants go to seed, it is very necessary that a system of rotation be early recognized in the plan of procedure. The area, whether great or small, should be divided into at least two and perhaps better, four, distinct areas, moving the stock from one pasture to the

other, so as to treat the different areas in a way that will best conserve the forage. The rotation of pastures so that one part at least may be allowed to seed abundantly, before allowing the stock to graze on it, is one of the first essentials of a permanent and satisfactory carrying capacity.

The condition of the ranges in the higher mountains is somewhat different. There, owing to climatic barriers, as previously stated, there are no introduced, worthless species competing with the native species. All they ask is to be given a chance, and they will make good. So it is largely a matter of management along these lines. Here we have an area that has never been subjected to the same severe treatment, summer and winter, as the foothill and valley lands. Fortunately for posterity, large areas in this great central mountain chain have been set aside by the Federal Government and called National Forests. These, in reality, are in many instances as much grazing as forest reserves.

It is the aim of the Forest Service to do all that it can for the stockman by making the grazing regulations liberal and yet of such a nature that the range may be perpetuated for future use. But they too are handicapped by lack of definite knowledge as to just what is the best manner of utilizing the forage. They are constantly at work on the problem and I feel sure that with your hearty cooperation they will bring to light many facts which will aid in solving the range forage problem.

During the frenzy of war times when pressure was brought to bear from within and without to increase the meat supply, many ranges were overgrazed even by the Forest Service.

Arizona has set us an example which we might well follow. A report by Dr. R. H. Williams, animal husbandman, of the University of Arizona, tells us that in 1904, under the direction of the Forest Service, an area comprising fifty sections was fenced in. At that time it required sixty acres to support a cow. At the present time (1919), twenty acres will feed a cow in better shape than sixty did when it was first fenced. During this time, it has been

exceedingly dry. The surrounding neighbors have lost cattle, but mighty few have died inside the reservation. The calf drop inside the reserve has been increased greatly over that secured on surrounding ranges, and last year they sold their calves at \$5.00 a head more than other outfits in the districts. The proper management of the ranges in Arizona will easily make it possible to double the number than can be maintained in the state.

So much for Arizona; but Arizona is not California!

They frequently have abundant rains in July and August.

Nevada is able to afford a man at the University who devotes all his time to range feed problems, and has no teaching duties.

This is argument three.

The secret of success in mastering the subject of grasses and forage plants lies in one's being thoroughly familiar and conversant with the structure, life, habits, food value, and adaptation of the plants that enter into the composition of our meadows, pastures and ranges. Just as the storekeeper must classify the materials that go to make up his stock, so must the man dealing with range plants classify his material. It is not sufficient to say that a range has such and such a percentage of grass, weeds, and browse. A range might be covered with poverty grass and be of little value, or it may contain large quantities of bunch blue grass and be very valuable. There are weeds on the range, like wild carrot, that furnish excellent feed, while others, like golden rod, may be worthless. The same may be said of browse. If the browse consists of a large percentage of what you call sweet birch, a species of wild lilac, it is valuable. On the other hand, if it is mostly manzanita, it is time to pack up and go.

The Forest Service is doing a very great service to us in the accumulation of data along this line, and I take every opportunity to spend all the time on the ranges that my duties will permit. My so-called vacation period each year has been on the ranges of California or Nevada for many years past.

But this most important work must be greatly

accelerated if we are to be able to base recommendations on facts.

This is argument number four.

What are the possibilities of finding a grass, seed of which can be scattered from horseback on the range without cultivation, and make good forage!

Owing to our different climatic conditions it is not likely that any one grass could fill the bill. Filaree, wild oats and burr-clover are introduced plants and have made good. Why can we not find others!

The velvet grass (commonly called mesquit grass), abundant on the coast from Point Reyes north, is an introduced grass. All it requires is a light soil and plenty of fog and if reasonably pastured, seeds and spreads abundantly without cultivation. It is known in Great Britain as Yorkshire Fog. It is a perennial and drought resistant. But, from reports we receive, we judge it is not as palatable as it might be, due to the dense covering of soft hairs, giving it the feeling and perhaps the taste of velvet. Yet, by analysis, it is a nutritious grass.

Now, there are 4,000 species of grasses in the world, and I would not be willing to give up until we tried out all the likely ones. This indicates the need of experimentation along these lines on the ranges, and is argument number five.

As time goes, on, it will be more and more necessary to supplement the natural pastures and ranges with cultivated grasses and other forage plants. We have already stated that there are 261 native species of grasses in California. In addition to these, we have 83 introduced species. Some of these like Johnson grass, Bermuda grass, sweet vernal grass, barnyard or water cress, millets, timothy, red top, velvet grass, tall meadow oat grass, crab grass, orchard grass, Kentucky blue grass, Russian brome grass, the rye grasses, meadow fescue, sheep's fescue, crested dogs-tail grass, and wild oats, are all of the same value from a forage standpoint.

Included in this group of introduced species are a number of aggressive species of little value, like the hair grass (*Aira*), five species of weedy annual brome grasses, more commonly spoken of as bron-

cho grasses, three species of weedy fescue, called squirrel tail grasses, or poverty grasses, three fox-tails or wild barleys, nit grass (*Gastridium*), beard grasses (*Polypogon*), sand burr grass (*Cenchrus*) and a number of others of more local distribution.

Some of the more recently introduced species are Sudan grass, Dallas grass, Natal grass, Smilo grass, Harding grass, Rhodes grass, elephant grass or Napier fodder, African millet, Kikuyu grass, Japanese sugar cane, Russian wheat grass, Wallaby grass, Guinea grass, rescue grass, Para grass, Texas blue grass, false brome grass, St. Augustine grass, and molasses grass.

We have tried out most of the old well-known grasses, introduced originally from northern Europe, like red top, timothy, blue grass, meadow fescue and others, and find that they are very much restricted as to their usefulness under California conditions. Near the northern coast or in the regions of the northern counties where they have summer rains, or practice irrigation, or in the higher mountain meadows of the Sierras, they may be utilized and sometimes increase materially the supply of forage. But for the great bulk of California valley and foothill lands, they have been tried and found wanting.

We recognized this soon after our arrival in California some six years ago from Nevada. From that time, we have been seeking grasses from other parts of the world where the climate is more like our own, in South Africa, South America, Australia, and the Mediterranean region. In this we have had the hearty cooperation of the United States Department of Agriculture.

We have growing now hundreds of species in a small way in rod rows including those which I have already mentioned, and have a number of promising varieties. What we need is facilities for increasing the seed from these trial plots, so that a sufficient quantity will be available for practical experiments on a larger scale in different parts of the State, with money for chemical analysis, feeding tests, and experimental pastures where stock

may be turned into them under control methods. Then, when you come to us for information and recommendations, we will have them. This is argument number six.

We have already stated that there are 261 native species of grasses that have been in California, no doubt, for thousands of years and originally grazed upon only by wild animals. These have withstood the rigor of the climate, whether heat or cold, valley or mountain. They have become depleted by reason of overstocking and other causes. We believe that a considerable number of these native original species would be valuable forage grasses to re-seed the ranges, if seed were only available at reasonable prices. Australia now utilizes a number of their Native species to counteract the troubles brought about by overstocking and offers seed on the market. Why can we not do the same. This is argument number seven.

We have included in our discourse only the true grasses, but there are a host of other plants among the sedges, rushes, legumes and shrubs which enter into the forage composition of the ranges, all of which should be studied.

France knows the ingredients or the plant population of their native pastures, which are quite extensive, the percentage of each species in the different types, and the food value of each.

I will not take up your time in discussing the necessity of placing good animals on the range. A scrub cow or steer eats as much as a well-bred animal, and yet produces a very much less number of pounds of beef, or milk per acre.

Proper methods of salting, healthy and convenient watering places, the grazing of the right class of stock on the type of range best suited to the animals, and many similar well-known principles [sic].

In conclusion, therefore, I wish to state that you have neglected to take care of your interests. Where there is one man employed by the State in the interests of the stock industry, there are one hundred employed in the interests of the fruit industry."

During the reading of his address Professor Kennedy referred to various grasses on exhibition

in the convention hall, and at the conclusion of his address said:

"I want to call attention again to the grasses, and will be very pleased if you will examine them. A good many of them have been brought up all the way from Los Angeles by Mr. Musser, and they illustrate a number of interesting things. Here is the elephant grass, blooming, from Los Angeles. That is the wrong way to grow it, of course. The thing to do is to cut it when it is about six feet and let it grow three times to a height of six feet, than to let it grow once to a height of twenty-four feet or more. There are many things about the grasses that I should like to tell you, but I thank you for being so good as to listen to me so intently." (Applause.)

[Association] President Bixby: "I have gone into this grass business comparatively carefully, and I am going to plant the Smilo grass and some Harding grass. I have those two picked out. I am scattering them in the hills and canyons to find out whether that stuff is any good or not--it won't do any harm--and we tried it with clover. I planted 1200 acres of clover. It was the best thing I ever did. But, I have picked out Smilo and some Harding grass. Now then, if there is any chance at all to do that I am anxious for you to take this business up. It is Mr. Musser who is the man that has been experimenting with the matter. He is the man that can furnish you with a little seed. I don't know anything about the price, but being acquainted with Mr. Musser, it will be plenty high.

We have another speaker, Professor Heeke, State Director of Agriculture.

He is not on the program, but I am quite sure you will be very interested to hear him. I want to say with reference to Professor Kennedy's address that it is one of the best things I ever heard. We are greatly indebted to him for his specific recommendations. I am particularly interested in this development of grasses which we can sow broadcast from the saddle."

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