Department of Agronomy and Range Science
UNIVERSITY OF CALIFORNIA, DAVIS

RANGE SCIENCE REPORT

Agricultural Experiment Station | Cooperative Extension

No. 12 | March 1987

MANAGEMENT OF HARDWOOD RANGE
A Historical Review

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Executive Summary

The management of hardwood rangelands by livestock producers and rangeland owners is increasingly under public scrutiny. Livestock are unjustly identified as a major factor in poor oak tree regeneration. Increased forage production and other multiple use values have motivated oak tree management decisions in an agriculturally developing state. Livestock producers have managed these rangelands since the 1850's after being forced out of the fertile valleys by intensive agriculture and urbanization.

The University of California's College of Agriculture responded to foothill livestock operators' request for help in 1932 by forming a Committee on Brush Range Management, and has continued research and education to the present. This committee investigated improvement of foothill range and livestock productivity, empahsizing brush and tree control, seeding and fertilization. The University of California, Agricultural Extension, California Division of Forestry, Soil Conservation Service, and other land management agencies cooperated in research and demonstration projects throughout the state. County Range Improvement Associations promoted this research and the resulting management practices.

Oak tree losses have not been adequately inventoried or monitored over time. Therefore, no clear survey of losses or source of losses can be tendered. Losses have occurred due to residential and commercial development, roads, reservoir development and range improvement.

Cooperative Extension has responded to changing demands for information and education programs. In 1985 the Natural Resource Program Area was started by merging existing programs in Range, Wildlife and Forestry. This new unit responded immediately by implementing the Renewable Resources Information System and publishing the Preliminary Guidelines to Hardwood Range Management.

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The multiple benefits that accrue to hardwood range management are well documented in scientific literature and by the experience of resource managers. Selective oak tree removal that improves wildlife habitat, maintains soil stability, increases livestock productivity, maintains aesthetic values and prolongs or stabilizes spring and stream flow can be accomplished if properly planned.

Hardwood vegetation is not all alike. Therefore it is important not to generalize beyond the scope of a local area where a study or management practice is conducted. Some hardwood range landscapes are dominated by dense thickets of oaks and associated brush, while others are open savannahs characterized by scattered trees with a herbaceous understory. Realistically, hardwood range, brush range and grasslands cannot be managed separately. They occur together in management units and are managed together by livestock managers, range managers, wildlife managers and watershed managers.

Introduction

The management of hardwood rangelands by livestock producers and rangeland owners is under increasing public scrutiny. California's hardwood ranges have been utilized since the 1850's with the needs and management objectives changing as the years progressed. In light of today's interest in oak woodlands it is important to understand the historic factors influencing hardwood range management and the response of research and extension programs to the changing needs of this dynamic agricultural-natural resource system.

When reviewing the historical aspects of hardwood range management it is clear that efforts involving brush range (chaparral) must be included, since this vegetation type is often intermixed with the hardwoods and its responses to management practices are often similar. Most of this land is in private ownership and has supported the livelihood of many ranch families. Economic return from the use of these resources has been a primary objective. However, throughout this history concerns for the resources have also been addressed. This paper attempts to highlight management activities throughout the years in light of the times, interests and needs for information.

Increased forage production and grazing on hardwood rangelands is frequently identified as an important reason for oak tree removal and poor oak regeneration. Because grazing is the greatest single use of hardwood rangelands, it is highly visible and may provoke inaccurate conclusions by casual observers.

Response to Changing Needs

Livestock producers began cutting oak trees and burning brush in the late 1800's and early 1900's to increase forage production in the foothills. Originally, range livestock operations grazed California's prairie in the central and coastal valleys, as well as the oak woodland, chaparral and mountain ranges. The development of intensive agriculture and urbanization in the valleys displaced historic ranching operations and blocked migration routes to summer pasture in the mountains. Consequently, livestock opera-

tions were forced to depend on the grass, hardwood and brush vegetation that occurs in the foothills. Livestock management practices were forced to change including increased use of feed supplements, seeding and fertilization to maintain adequate nutrition and more efficient use of forage from these rangelands (Hart et al. 1932, Conklin et al. 1942, Vcorhies et al. 1942, Weeks et al. 1945, Burcham 1957, Wagnon et al. 1959.).

In 1932 in response to requests from foothill livestock operators, the University of California's College of Agriculture formed a Committee on Brush Range Management to investigate improvement of brush range forage and livestock production, brush invasion, runoff and erosion (Madson 1949, Adams 1984). In 1945 the committee was reorganized as the Committee on Range Land Utilization but continued to coordinate range research and extension programs. Meanwhile, in 1938 the income from the McDonald Fund Endowment was made available for the study of range grasses and forage plants and other range problems (Assembly Interim Committee on Agriculture 1951).

Watershed research has been an important focus starting with 24 watershed plots established in 1936 with nine of them on hardwood range (Veihmeyer 1950). At the Hopland Field Station in the 1950's, Watersheds I and II were cleared of oak trees and brush. Later, watershed projects were established at the Sierra Foothill Field Station which included an oak tree thinning project.

A series of range demonstrations were implemented in 1950 by the Rangeland Utilization Committee of the College of Agriculture in cooperation with Agricultural Extension, California Division of Forestry, and range and livestock operators. These demonstrations were used to test techniques and economics of range improvement and to extend new management practices. Many of the demonstrations were restricted to chaparral brushlands. However, the Aldridge Ranch (Shasta Co.) and Manley Ranch (Tulare Co.) included hardwood rangelands along with the brushlands. Burning these hardwood ranges opened up the cover by controlling brush.

During the 1950's and 1960's several demonstrations were conducted in cooperation with C.D.F., Cooperative Extension, Department of Fish & Game and S.C.S. Most of these had multiple use objectives, even though the emphasis was on livestock production. Some included cooperative studies on chemical methods with Dr. O.A. Leonard. The following projects included hardwood range along with the brushlands:

Spring Dell Range, San Benito Co.
Backbone Range Study, Shasta Co.
Ranchita Range Study, San Luis Obispo Co.
Rescue Range Improvement Project, El Dorado Co.
Pine Hill Range Study Project, Nevada County
Rabbit Flat Project, Amador Co.
Allen Ranch Spray Plots, Amador Co.
Williams Ranch, Shasta Co.

The first statewide organized Range Extension program dates back to the establishment of the Committee on Range Improvement in 1932. The activity was the joint effort of the Extension Agronomist and the farm advisors in

cooperation with the Department of Agronomy. By 1940 range improvement projects existed in all but 4 counties (Osterli 1951). These projects included: brush range improvement, oak tree control, seeding trials, soil fertility, water development, grazing management, wildlife management, and economics. Les Berry, Extension Range Specialist in the 1950's, 60's and 70's actively promoted selective oak tree management. According to the Renewable Resources Information System (George, Clawson and Lasarow 1985) the following counties had oak tree thinning trials: Glenn, Tehama, Shasta, Humboldt, Mendocino, Colusa, Yuba, Placer, Sacramento, Amador, Madera, Tulare, and San Diego.

Many counties formed Range Improvement Associations or Committees to promote, organize and conduct controlled burns (Mendocino, Madera, Fresno, Tulare, Kern, Santa Barbara, San Luis Obispo, San Benito, Tehama, Calavaras, Tuolumne, Mariposa, Shasta, Ventura, and Monterey). They were made up of participating ranchers and organized by the farm advisors and C.D.F. In addition to burning these groups promoted selective tree removal, reseeding and fertilization. Even during the late 1960's and early 70's, when burning activity declined, it was these counties that accounted for much of the prescribed burning. In the 1980's these groups and Cooperative Extension played a major part in the development of a broad base of support for legislative action that led to creation of the Vegetation Management Program. In 1986 many of the counties listed above still have active Range Improvement Associations.

The practice of controlled burning reached a peak in the 1954 and decreased in the 1960's due to liability, air pollution and economic concerns. It was during this period that indiscriminate subdivision of rural lands broke up many large land holdings, interfering with the use of fire for land management and with wildlife habitat and migration routes. The California Land Conservation Act of 1965 (Williamson Act) and tighter local land use regulations slowed the rate of rural subdivision. However, ranch land and crucial habitat are still lost annually. During the 1960's selective tree control reached its peak and dwindled, in part due to enviromental concerns about the use of herbicides. In the 1970's we experienced our first energy crisis which led to increased domestic demand for firewood.

Extension has advocated selective tree thinning (Brooks 1958, Bell 1963) and complete removal from small areas with good soils (Bell 1963). Extension recommendations have not advocated large scale removal of oak trees. The University by its actions at the U.C. Hopland Field Station (Watershed I & II) and U.C. Sierra Foothill Range Field Station (Forbes Hill) may have appeared to advocate large scale clearings. However, the large scale clearings were conducted for research purposes. Both cases have contributed to our knowledge of the consequences of large scale removal. In the early 1960's, workshops in Santa Barbara and San Luis Obispo Counties recognized multiple values of chaparral and oak woodland management. Extension range and wildlife efforts expanded to look at recreation opportunities of these resources.

Hardwood Range Management in the 1980's

In 1984 Albin-Smith and Raguse published a report that proposed criteria for assessing and mitigating the environmental impacts of manipulating foothill rangeland to improve its capacity for livestock grazing. The range management methods described are based on extensive experience and research on the benefits and environmental impacts produced by vegetative type conversion and related range improvement activities. They concluded that:

1. Management of range to improve forage for livestock is more beneficial to wildlife and man than range left unmanaged.

2. Significant multiple use benefits can be attained on rangeland by managing for wildlife, aesthetic/recreational and historic values.

3. Adverse environmental effects from rangeland development (soil erosion from road construction and removal of cover, water quality degradation from siltation and loss of wildlife habitat from tree and brush removal) can be mitigated using available technology.

4. Aggregation of trees left on a range in groups or strips is better than solitary trees for soil stability, habitat interspersion and grazing values.

The following guidelines reflect the criteria currently used to guide tree cutting operations at the U.C. Sierra Foothill Range Field Station (Raguse 1986):

1. Leave strips of all woody vegetation in natural drainage ways to reduce erosion.

2. Leave woody vegetation on rocky outcrops.

3. Leave scattered groups or corridors of trees (including all age-classes present) for aesthetic values, wildlife habitat and livestock shade.

4. Use appropriate special conversion measures when specific wildlife management objectives exist.

5. Appropriately modify conversion where the area is part of a visually sensitive landscape.

6. Avoid clearing of slopes in excess of 30-40 percent to minimize erosion hazard, except as needed to aid in livestock surveillance and handling.

7. Completely clear areas of good soils best suited for agricultural operations such as seeding, fertilization agroforestry and irrigation.

Today's Extension Natural Resources Program

In August 1985 the range, forestry and wildlife units were merged into the Natural Resources Program Area. Two years earlier, these units combined animal science and animal health specialists to conduct a multiple use

training program. During the first year of the program area the Preliminary Guidelines to Hardwood Range Management were completed and the Renewable Resource Information System was used to improve program delivery and aid clientele decisions.

The Preliminary Guidelines for Hardwood Range Management have been subjected to extensive review, and they are being used to aid in management decisions on hardwood range. Changes have already been recommended based on these reviews and initial use; additional range management information has been compiled for inclusion in future editions. Research in progress and planned will help to refine the guidelines.

Oak Management vs. Brush Control

University involvement in oak tree management evolved out of two lines of research and development: 1) herbicide research by Oliver A. Leonard, U.C. Botanist, which led to selective tree removal techniques; and 2) Rangeland burning and reseeding research by Drs. A. W. Sampson and H.H. Biswell at U.C. Berkeley, R.M. Love of U.C. Davis and many others contributed to the prescribed burning and seeding techniques used today.

Studies of oak tree control with herbicides were started in the 1950's by Oliver A. Leonard. His primary interest was to reduce the cost and labor involved in the control of trees (not just oaks) through the use of phenoxy herbicides. This research led to the most successful method of controlling trees, the injection of phenoxy herbicides. (Leonard and Carlson 1955, 1959, Dal Porto 1960, Leonard, Carlson, and Bayer 1965). Herbicide injection is more selective than mechanical removal with heavy equipment or aerial application of herbicides.

Aerial chemical applications, burning, and mechanical methods such as the ball and chain, brushland disk, and bulldozer blade have been used to control oak trees and brush. Frequently, retreatment with herbicides is necessary to control resprouting. Observations in Tehema County indicate that many acres controlled in the 1950's and 60's now have new oak tree cover due to resprouting and lack of retreatment with herbicides (Knight, personal communication).

Controlled burning was applied to hardwood range because it frequently had a heavy brush understory or was adjacent to brushlands. Fire research and monitoring of hardwood rangelands has shown that fire frequently opens up the oak tree understory by suppressing brush. Many burns have resulted in an open hardwood rangeland similar in appearance to the oak savannah.

Permanent damage to oaks rarely occurs in these burns. Brush burns are usually planned and conducted with as little damage as possible to the oak trees (Green 1980). Minnich (1973) reported that oak vulnerability to fire is directly related to the distribution of brush around the oaks.

Fire is a normal factor in the hardwood range environment, and oak trees are adapted to periodic fire. McClaren (1986) indicates that pre-goldrush (1681-1852) the mean fire interval in the oak woodlands at the U.C. Sierra Foothill Range Field Station was 25 years, and after the gold rush to 1948 it was seven years.

Shrubs in the woodland-grass understory include manzanita (Arctostaphylos spp, poison oak (Toxicodendron diversilobum), buckbrush (Ceanothus cuneatus) and California coffeeberry (Rhamnus californica). The herbaceous component is dominated by annual grasses such as soft chess (Bromus mollis), ripgut brome (B. diandrus), wild oats (Avena spp). Much of the hardwood range consists of open stands with little shrub growth, but in some places the brush is dense and impedes forage production and reduces habitat value for some wildlife. In six Sierra foothill counties more than 70% of the woodland area was found to have brushy growth sufficient to interfere with grazing (Sampson and Burcham 1954, Wieslander and Gleason 1954).

Why Have Hardwoods Been Removed

The rancher's primary motivation to remove oak trees and brush has largely been to increase range livestock productivity by improving access, plus improving range forage quality and yield. Those were perfectly valid objectives for a developing agricultural state. The livestock industry and The University of California have had a major role in successfully increasing productivity on these lands.

While increasing forage production is the primary motivation, most livestock producers receive benefits as well as monetary income from the multiple uses that accrue to good ranch and resource management, such as:

- Improved deer habitatfrom planned brush and tree removal
- improved forage for wildlife due to seeding and fertilization
- reduced erosion due to improved cover from seeding
- habitat improvement from stock water developments
- improved fish habitat due to increased summer streamflows
- reduced wildlife predation
- reduced fire hazard from fire breaks and recent controlled burns.
- improved control of grazing from fencing
- critical habitat protection with fencing and grazing management
- improved summer forage from irrigated pasture development
- improved access for recreation and fire protection from road construction

Many of these practices have been recognized as important conservation practices and have been or are qualified as conservation practices from ASCS.

Oak removal is judiciously limited by ranchers because oaks provide shade for livestock, stabilize soil, provide aesthetic pleasure, add to property values and provide their homes with firewood (Fortmann and Huntsinger 1986). Some recent large scale clearings have been motivated by firewood prices and poor economic conditions in the livestock industry, in some cases to literally save the ranch!

Oaks that are economically accessible are of interest to the woodcutter for firewood. Due to high labor and transportation costs woodcutters prefer trees that are on gentle slopes and near roads.

The Extent of Tree Removal

Accurate estimates of oak tree removal during the last 40 years do not exist. The recent report to the Board of Forestry entitled "Status of Hardwood Resource of California" (Mayer et al. 1986) uses the results of a recent unpublished survey by Bolsinger (in press) to determine the decrease in area of hardwoods on hardwood rangeland. Bolsinger reports that he found evidence of cutting on 773,000 acres of woodland, or about 14% of the existing hardwood rangeland. Of this, about 300,000 acres of woodland have experienced cutting in the last 5 years (He defines cutting as any loss, from 1 tree per acre to 90 % stand reduction). This estimate represents acres cut but not acres that have been lost to development or type conversion. Bolsinger further reports that from 1945 to 1973, hardwoods on rangeland decreased about 1,185,000 acres. He says the major cause of this decline in woodland area before the 1970's was rangeland clearing.

Unfortunately, Bolsinger had to extrapolate these estimates of clearing from activity summaries that did not list acreages cleared by vegetation type. His methods to estimate clearing relied on extrapolations from narrative reports on a few projects. Bolsinger went on to say that residential, commercial, road and reservoir development contributed to the total loss of hardwood rangelands.

The Bolsinger report provides preliminary information, but more precise studies are needed. Because thorough and accurate records of oak tree removal have not been maintained, it will be difficult to accurately assess hardwood range management activites. Policy decisions should be based on thorough and accurate resource inventory and monitoring programs. Historical changes in canopy cover on old and new aerial photographs might give a more accurate estimate of historic stand reduction and regeneration following incomplete control.

Benefits of Oak Management

Oak tree thinning and removal to increase range forage production is well documented in published and unpublished research reports (Johnson 1958, Kay et al. 1956, 1957, 1958, 1980, Div of Forestry 1960, Heady and Pitt 1979, Nichols Adams, and Menke 1984, George et al., 1985). Furthermore, thinning and removal are frequently economically feasible (Johnson 1958, Kay et al. 1956, 1957, 1958, McCorkle et al. 1964, Olson 1984). Although many studies have demonstrated improvement of forage production and quality with tree removal, several researchers also have noted higher forage production and longer green seasons under isolated blue oaks than in the open grasslands (Duncan and Reppert 1960, Holland 1973, 1980, Holland and Morton 1980). Further caution against the universal application of a complete clearing treatment was expressed by Heady and Pitt (1979) because of the seasonal nature of the increased forage. They stressed that most of the increase in forage accrues during the spring when forage is in greatest supply. To use this forage would require more stock that would have to be supplemented during the dry season or shipped to mountain pastures at great expense. This very fact is a strong reason why ranchers would not clear extensive portions of rangeland as feed supplements and transportation are among their greatest expenses.

Tree removal has also been demonstrated as a means of increasing surface and ground water through reduced interception and evapotranspiration. Hydrologic studies have been conducted in Placer, Mendocino, Madera, Shasta, Tehama, Lake and Monterey Counties (Lewis and Burgy 1963, Veihmeyer 1950). Veihmeyer (1950) reported that on plots where brush was replaced by herbaceous vegetation all of the soil profile was not reduced to permanent wilting point and water was left in storage in the soil in the fall. On plots that were not burned the brush exhausted the soil moisture.

On Watershed II at Hopland Field Station formerly intermittent streams have been permanent since 1960, following brush and tree removal. Watershed II is a sealed watershed so water was unable to percolate out through fractured bedrock. This kept the water in the watershed, contributing to prolonged and increased stream flow but also contributing erosion and soil slippage. Watershed I has had minimal soil slippage because the bedrock is fractured, allowing water to drain out of the watershed (Burgy and Papazafiriou 1974, Pitt, Burgy, and Heady 1978). Lewis and Burgy (1964) also found that oak tree roots extend to depths of 70 feet. Findings on these two watersheds led to the recommendation to leave streambank vegetation to stabilize soils. However, experience on other soil types indicates that not all soils are prone to slip.

The benefits to wildlife of oak tree management can be significant. Nichols and Menke (1984) have recently reviewed wildlife responses to burning chaparral. Many of the principles discussed would apply to management of deer on hardwood range, especially where oak thickets and brush invasion have reduced herbaceous vegetation (Longhurst, Leopold, and Dasmann 1952). Salwasser (1976) reported that in general, both nutritional and cover needs for deer can be satisfied by managing for mixed-age brush stands and creating habitat interspersion. If brush and trees are left on a range in a block or mosaic pattern to create an "edge" between grassy areas, wildlife diversity is greatly enhanced.

Elimination of any given type of vegetation can have severe detrimental effects on wildlife diversity. Many wildlife species are critically dependent on trees and brush for habitat. These include hawks, squirrels, owls, and jays, all of which nest in oak trees. Quail and deer are most abundant where open and densely-vegetated areas alternate (Plumb 1980). Overextending the use of vegetative type conversion could eliminate habitat for species that are important to normal foothill food chains.

Much of the state's good deer habitat was once in large ownerships by the livestock and timber industry. Subdivision of large land holdings and subsequent reduction of prescribed fire has significantly affected the quality of deer habitat (Longhurst et al. 1976). Maintenance of a healthy livestock industry is one way to maintain large tracts of land that can be managed for deer and other multiple use values, at little or no cost to the public.

Livestock and Regeneration

Livestock have been imputed a major cause of poor regeneration of oaks on hardwood rangelands. No one would deny that livestock consume acorns or seedlings, but review of the pertinent literature suggests that livestock may be less important than several other consumers of acorn and oak seedlings including deer (Longhurst et al. 1979, Griffin 1971, White 1966), rodents (Fitch & Bently 1949) and insects (Griffin 1971, Adams, personal communication). This is further supported by the fact that oak regeneration has not occurred in livestock exclosures at the Hastings Reservation (White 1966), U.C. Sierra Foothill Range Field Station, U.C. Hopland Field Station or Sequoia National Park (McClaren 1986). McClaren (1986) concluded that the removal of livestock will not guarantee blue oak regeneration and the presence of livestock does not guarantee regeneration. McClaren makes a good case for a combination of favorable events including abundant acorn production and escape from large and small herbivores, sufficient rainfall and protection from dessication for initial seedling establishment, limited competition for light and water from neighboring plants; and protection of seedlings from browsing livestock, deer, rodents and insects. Any of these factors can act as a limiting factor during much of the transition from seedling to sapling (Griffin 1971, Longhurst et al. 1979, Anderson and Pasquinelli 1984).

Hardwood Vegetation

This report reviews range improvement practices on 7.4 million acres of hardwood rangeland. However, oak woodlands are not all alike. Therefore, it is important to not generalize beyond the scope of a local area where a study or management practice is conducted. Some hardwood range landscapes are dominated by dense thickets of oaks and associated brush, while others are open savannahs charactarized by scattered trees with a herbaceous understory. However, because brushlands are adjacent and intermixed with hardwood range and because some hardwood range has an understory of brush species the techniques used to clear brushlands have also been used on hardwood range. Realistically, hardwood range, brush range and grasslands cannot be mangaged separately. They occur together in management units and are managed together by livestock managers, range managers, wildlife managers and watershed managers.

Fundamental plant community differences within hardwood ranges may lead scientists and managers to conflicting conclusions about appropriate management practices. For example, conclusions drawn from oak woodland studies at San Joaquin Experimental Range may not have application on the central coast or in the denser hardwood rangelands of the Mother Lode counties because of different site factors (e.g. soil, rainfall, aspect, canopy cover, etc). Forage production charactaristics under oak canopies at the U.C. Sierra Foothill Range Field Station are not similar to those under the canopy of the more open savannah at San Joaquin Experimental Range. Clearly, management practices must developed on a site specific basis. But because there are so many different sites in California's hardwood range we must rely on fundamental principles to guide management decisions since it is impractical to try all methods or to measure all attributes on all sites.

Dense stands of oaks with high canopy closure are commonly targets of ranchers who wish to increase forage production. They may reduce these stands by burning or selective cutting or other means. These dense thickets of oaks and associated brush are subject to burning under the CDF Vegetation Management Program or under the older fire permit program for a variety of reasons (fire hazard reduction, wildlife and fisheries habitat improvement, water yield, air quality protection and forage production).

Open oak savannahs are less likely to be cleared to increase forage. However, even here control of encroaching brush may at times require burning or other control measures. A good way to determine the potential increase from such clearing is to compare the yield from beneath the trees to the yield on nearby grasslands. If the grasslands yield considerably, an increase in forage can be expected when the trees are removed. On the other hand the apparent increase in forage beneath the few scattered oaks at the San Joaquin Experimental Range illustrates the desirability of leaving a few trees per acre. These few trees will not reduce forage yields and will provide livestock shade, are aesthetically pleasing, and will improve relations between the range manager-livestock operator and the public (Kay, 1982).

Conclusion

Livestock operators historically pride themselves on their independence and ability to manage their ranches without interference. Today's world challenges this independence as people with a variety of interests and concerns have influenced public land policy and regulations affecting manment of private lands. Neither the individual rancher nor the range livestock industry can hide from these pressures in hopes that they will go away.

Ranch profitability is dependent on a healthy economic climate and good management. Good management can no longer be achieved by purchasing a new bull or planting a new grass. Total management requires that range and ranch managers plot long-term strategies for developing products and services from the ranch's land, livestock, labor, physical and financial resources. Cooperative Extension can aid ranchers in setting objectives and selecting the proper mix of practices, products and services for a sustainable and productive future. In recent years, public policy increasingly influences the ability of rangeland owners to remain productive and profitable. The University of California and Cooperative Extension have a long history of extending new technology to increase agricultural productivity and now offer research-based information for use in policy decisions.

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Acknowledgements:

The author wishes to thank the following for identifying historical activities and review: Les Berry, Al Murphy, Walt Johnson, Bud Kay, Ted Adams, Rick Standiford, Jim Clawson, Norm Dal Porto, Grover Roberts, Marvin Dodge, Ron Knight and Monte Bell.