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Multiple Cropping in the Western United States[1]

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The land area of the 17 western states totals approximately 468.7 million hectares (61% of the contiguous states). Agricultural censuses have placed this area into four regions, Pacific, Mountain, Northern Plains, and Southern Plains (Fig. 1). About 65% of the area is used for grazing, 15% for crops not including pastures, and an additional 10% is in nongrazed timbered land exclusive of parks, reservations, etc. (Frey, 1973).

When considering the cropping systems of the western U. S., it must be recognized that the native grasslands and mixed timber-grass ranges are important intercropping systems. Range management, silviculture, and wildlife management are specialized sciences that deal with the management of these important natural resources. It should be recognized that approximately one-third of the nation's land is federally owned, most of which is in multiple-use multiple-cropping management to provide forage, meat, timber, and water to the agricultural economy of the region.

Land used for crop production remains about constant in the Pacific and Mountain states, but declined from 1949 to 1972 in the Plains states, especially in the Southern Plains (Frey, 1973). Much of the land taken out of crops was put into pasture and timber-pasture production. In 1974, the trend was reversed and land went back into crop production. This indicates that land use in the Plains depends on economic conditions.

AGRICULTURAL AREAS

The land of the western states has been placed into 14 cropping areas (Austin, 1965) based on general environmental conditions and the major crops or type of farming (Fig. 2).

[1]Contribution of the Agricultural Research Service, USDA. Grateful acknowledgment is given to those providing information through correspondence.

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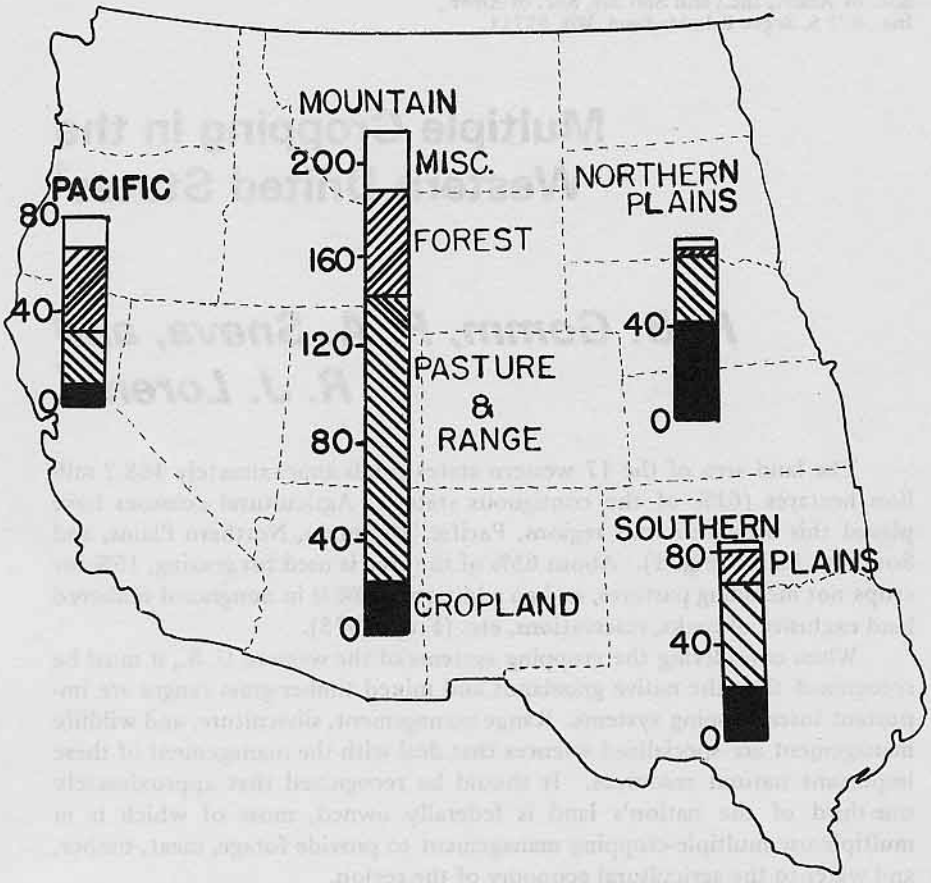


Figure 1. Major uses of land by census regions, 1969 (millions of hectares).

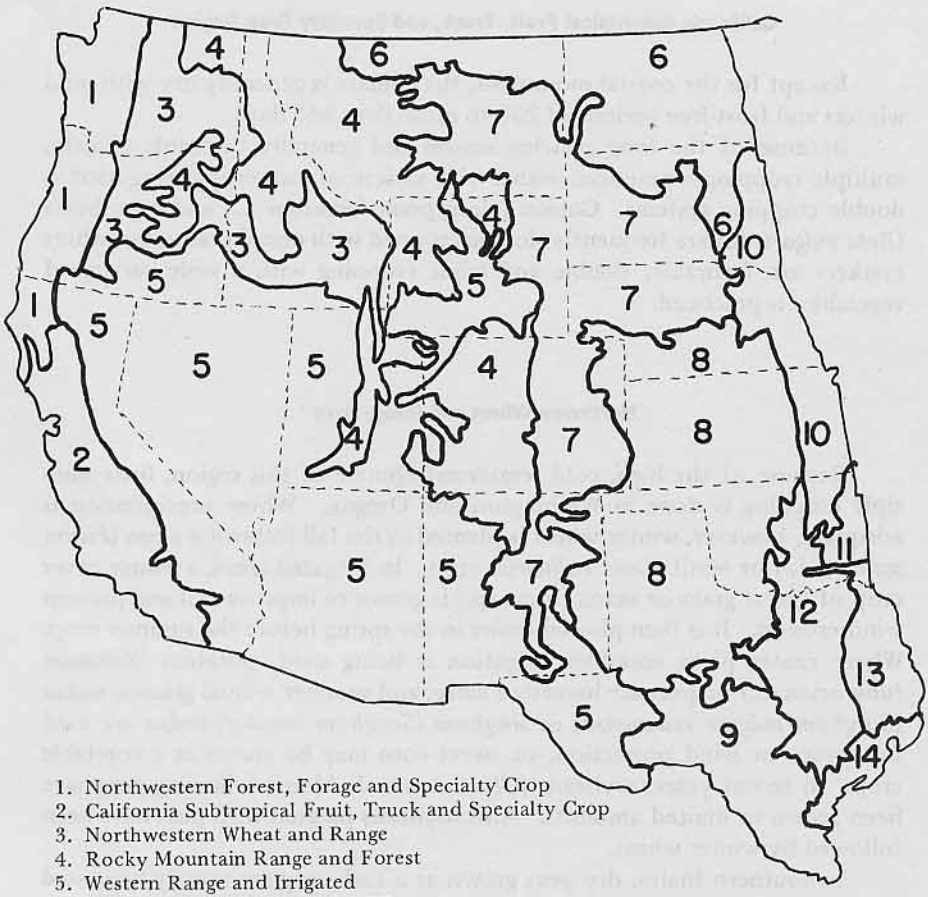
Northwestern Forest, Forage, and Specialty Crop Region

This region, west of the Cascade Range, is humid with cool summers and mild winters, but July and August are dry which makes irrigation advantageous.

The largest multiple cropping practice in the region is intercropping of oats (*Avena sativa* L.) with red clover (*Trifolium pratense*). The oats and clover are planted in the fall. The oats are then harvested as grain or hay. Adverse weather during harvesting can result in killing a large proportion of the clover where windrows remain on the field too long.

In the fruit and nut orchards, small grains or annual forage crops are grown between rows of newly established trees.

A new intercropping practice in southern Oregon is that of planting wheat (*Triticum aestivum* L.) in areas previously in subclover pastures. Short-



1. Northwestern Forest, Forage and Specialty Crop
2. California Subtropical Fruit, Truck and Specialty Crop
3. Northwestern Wheat and Range
4. Rocky Mountain Range and Forest
5. Western Range and Irrigated
6. Northern Great Plains Spring Wheat
7. Western Great Plains Range and Irrigated
8. Central Great Plains Winter Wheat and Range
9. Southern Plateaus and Plains Range and Cotton
10. Central Feed Grains and Livestock
11. East and Central General Farming and Forest
12. Southwestern Prairies Cotton and Forage
13. Gulf Slope Cash Crop, Forest and Livestock
14. Gulf Coast Lowland Forest and Truck Crop

Figure 2. Land resource areas of the western U. S., adapted from *U. S. Department of Agriculture Handbook 296, 1965* (Austin, 1965).

ly after the wheat is planted, a volunteer stand of subclover appears because of its hard seed characteristic. After the wheat is harvested, a good crop of dry forage remains for summer pasture.

Double cropping is practiced where vegetable crops, bush beans (*Phaseolus vulgaris* L.) or sweet corn (*Zea mays* L.) follow early maturing annual crops.

California Subtropical Fruit, Truck, and Specialty Crop Region

Except for the coastal mountains, the climate is generally dry with mild winters and frost-free periods of 200 to more than 330 days.

Because of the long growing season and generally favorable climate, multiple cropping is practiced with a wide variety of cash crops being used in double cropping systems. Cotton (*Gossypium hirsutum* L.) and sugar beets (*Beta vulgaris* L.) are frequently double cropped with cereal grains, but where markets are favorable, double and triple cropping with a wide variety of vegetables is practiced.

Northwest Wheat and Range Area

Because of the high, cold semidesert climate of this region, little multiple cropping is done in Washington and Oregon. Where precipitation is adequate, however, winter wheat is planted in the fall following a pea (*Pisum sativum* L.) or lentil (*Lens culinaris*) crop. In irrigated areas, a winter cover crop of cereal grain or vetch (*Vicia* sp.) is grown to improve soil and prevent wind erosion. It is then plowed under in the spring before the summer crop. Where center pivot sprinkler irrigation is being used, potatoes (*Solanum tuberosum* L.) or peas are harvested early, and summer annual grasses, sudan (*Sorghum vulgare sudanense*) or sorghum (*Sorghum bicolor*)-sudan are used for forage or wind protection, or sweet corn may be grown as a vegetable crop. In recent years, soybeans (*Glycine max* L. Merr.) following peas have been grown in limited amounts. Also soybeans planted with peas have been followed by winter wheat.

In southern Idaho, dry peas grown as a cash crop are usually harvested about 1 August which leaves the land bare and unproductive for 2.5 more months. Experiments with sudangrass and sorghum following peas have been disappointing, but corn with 16,000 plants/ha produced nearly 7 metric tons/ha of dry matter. Although corn is not a reliable second crop because of early frost danger, it is considered as an emergency crop if the pea crop fails due to an unseasonable freeze or severe hailstorm.

Alfalfa (*Medicago sativa* L.) planted with peas is practiced on the Snake River Plains of Idaho. Turnips (*Brassica rapa*) have also been planted with peas but it is not considered to be a good practice. Occasionally, alfalfa is planted with a crop of canning peas in northern Utah. After the peas are harvested in June or July, the alfalfa may make a crop later in the year.

Rocky Mountain Range and Forest Region

High rugged mountain peaks and ranges dominate this region and influence the climate accordingly. The annual precipitation and length of growing season varies with latitude and elevation.

Multiple cropping is limited to growing multiple species grass-legume pastures, or is used as a relay-companion crop in which perennial pastures or alfalfa are started with a cereal grain. Frequently, a legume companion crop is plowed as green manure. The merits of the companion crop pattern have been debated, and it is generally recommended only for those areas where rainfall is adequate or where irrigation is practical.

Western Range and Irrigated Region

Most of this region is semidesert to desert in nature, and cultivated agriculture is dependent on irrigation.

Except for intercropping of companion grain and forage crops, multiple cropping is largely restricted to double cropping in southern Nevada, Arizona, and New Mexico.

In southern Nevada, cereal grains are planted in the fall for winter and spring use and harvested as green chop, grazed, or as seed. The land is then freed for growing other summer crops. Harvesting small grains in May allows planting of sorghum or corn for silage.

Overseeding of dormant bermudagrass (*Cynodon dactylon* L.) with small grains produces forage nearly the year around. Alfalfa is frequently planted in bermudagrass in October. The next season the grass is crowded out.

Approximately 70% of Arizona's farmed land is located where double cropping might be considered. At the lower elevation in southeastern Arizona, barley (*Hordeum vulgare* L.) and wheat are harvested in May or June. Sorghum is planted as the second crop to be harvested in the fall when cereal grains are again planted. Full season hybrid sorghums are planted in April and May without double cropping. Safflower (*Carthamus tinctorius*) which is planted on dates similar to the cereal grains, is harvested in July and August, depending on elevation. Using conventional crops, double cropping with safflower has not been popular, but double cropping with winter season vegetables has good potential, especially at low elevations.

Double cropping in central Arizona is practiced on a small scale with sorghum following sugar beets. Sugar beets are grown for 6 to 10 months depending on elevations. The growing season at higher elevations is too short to recommend double cropping.

The feasibility of using cotton in double cropping with cereal grains is being studied (Scott Hathorn, Jr., and B. Brooks Taylor. University of Arizona, Agric. File Q-131). It appears that late-planted cotton and narrow-row cotton are more profitable crops than sorghum grain in a double cropping system.

Photoperiodic sorghum varieties have been used to essentially grow two crops of sorghum from a single seeding. The photoperiod sensitive varieties, growing under short day lengths, mature grain when 1.25 to 1.50 m high. Combining is easy. Later, under the long day period, the same plant will grow to 2.5 to 3 m tall before maturing grain. It can then be cut for silage (Stith & Voight, 1962).

As in Arizona, New Mexico producers are double cropping the lower irrigated valleys, and researchers are attempting to develop earlier maturing cottons and barleys in an attempt to grow these two crops in a 12-month period (Arden A. Baltensperger, New Mexico State University, personal correspondence). This is being done using a semidwarf cotton strain, 'Acala', that is 12 days earlier but fully equivalent to standard varieties in fiber quality; also being used is a barley variety that matures extremely early and is quite frost resistant.

Northern Great Plains Spring Wheat Region

The growing season is too short and precipitation is insufficient for much double cropping in this region. It is possible, however, to produce a crop of early barley and then an oat crop for hay, silage, or sometimes seed. Sudangrass following barley has been tried with irrigation, but the practice is not considered feasible. Greater returns are expected with a single crop of grain, corn, alfalfa, soybeans, potatoes, dry beans, or sugar beets.

Western Great Plains Range and Irrigated Region

The climate of this region is milder than the Northern Great Plains, but because of unfavorable soils, steep slopes, and undependable moisture, dry farming is uncertain.

The summer fallow system with small grains is practiced extensively throughout the semiarid wheat producing areas. One of the prime interests at present in Montana is the search for alternatives to this system because of "saline seep". It is believed that the practice of summer fallowing for two or three decades has caused saline seep in the glacial till soils which contain high concentrations of salts (Kurt C. Fellner, Montana State University, personal correspondence).

In Wyoming on irrigated farms, intercropping with a cereal grain and alfalfa as companion crops is a common practice. The season is too short for double cropping; per se, except that a cereal grain crop may be harvested early. The stubble is then used as a seedbed in which a legume or grass is seeded. The late season precipitation is too low for this to be a good practice under dryland conditions.

With sprinkler irrigation, some farmers have broadcast alfalfa seed at the last cultivation of corn. This allows the alfalfa to become established before winter but must be done on clean land.

In north central Nebraska, rye (*Secale cereale* L.) is seeded in some of the irrigated sandy corn fields by airplane in the standing corn to provide fall pasture, but this seeding is primarily to control wind erosion. Research has shown that alfalfa can be seeded in irrigated corn and avoid a season's delay, but farmers have not adopted the practice (D. G. Hanway, University of Nebraska, Lincoln, personal correspondence).

Central Great Plains Winter Wheat and Range Region

Although precipitation is generally low, temperatures are warm enough to permit some double cropping. In south central Nebraska, wheat is sometimes followed by sorghum, or corn is followed by fallow in nonirrigated areas.

Where irrigation of soybeans following wheat is possible in central Kansas, double cropping can be successful. Some producers and researchers propose to aerially seed soybeans into the wheat crops about 1 May and then keep the soil moist with irrigation until the soybeans are well established. Others prefer to plant soybeans in May or June and then follow with wheat because the soil is mellow and seedbed preparation is minimal following soybeans. Sometimes, however, wet conditions in the fall prevent planting of wheat. Grain sorghum (short season variety) is grown only on a limited scale following wheat.

Multiple cropping is also widely used in Oklahoma but is primarily limited to cropping in bermudagrass sod. The lack of rainfall at critical periods is the most limiting factor.

In the Texas highlands, cotton and sorghum have been grown in alternating four row blocks across a field perpendicular to the prevailing wind. This system was to have provided protection to the younger crop, but the practice was never widely accepted. In the peanut (*Arachis hypogaea* L.) producing area of Cross Timbers and Rio Grande Plain, this practice is used.

Southwestern Plateaus and Plains Range and Cotton Region

The climate of this southern extension of the Great Plains is generally warm with mild winters.

The semitropical lower Rio Grande Valley has the greatest potential for multiple cropping in the region because of the 330+ days of growing season. Vegetables and field crops are grown in a multiple of relay, double, and intercropping combinations, depending on market prices.

Central Feed Grains and Livestock Region

The part of this general region which falls within the western states includes the eastern portions of South Dakota, Nebraska, and Kansas and a small part of Oklahoma. Temperatures are conducive to permit some double cropping.

In South Dakota, intercropping by growing corn and soybeans together in the same row is commonly done to increase protein content when the crop is cut for silage. A modified alternate strip form of intercropping with corn and legumes has been investigated, but results indicated that it was not a feasible method. The system omitted every third row of corn, leaving a 2-m (7-foot) spacing to which alfalfa was planted. The next year, two normally

spaced rows of corn were planted in the legume sod, again leaving the 2-m space previously in corn to be planted to legumes (Fred E. Shubeck, South Dakota State University, personal correspondence). In northeastern Nebraska, oat is grown as a companion crop when establishing alfalfa, but this practice has declined in recent years.

For double cropping to be feasible in South Dakota and Nebraska, it would be necessary to develop short season crops with low moisture requirements.

Double cropping is a widely accepted practice in southeastern Kansas where soybeans are frequently planted as a double crop following wheat. To do so, however, soil moisture must be adequate and seeding of soybeans must be done by early July. If conditions are favorable, yields of 680 to 777 kg (25–30 bu) are possible. To prepare the seedbed, some producers burn the straw and disk; others prefer to plow the soil, but no-tillage is gaining interest. Moisture loss becomes a problem when the soil is cultivated.

East and Central General Farming and Forest Region

Although the climate is generally mild enough for double cropping, summers are relatively dry. The terrain is not favorable for cultivated crops and farms are small. Where the land can be cultivated, interplanting of legumes with small grains or with corn has potential for forage and feed production, but little multiple cropping is practiced.

Southwestern Prairie Cotton and Forage Region

Except for the hot dry winds which blow during the summer, the region has a mild climate, and the potential for double cropping is good where irrigation water can be applied. Cotton is the main cash crop which could be followed with small grains.

Interplanting of legumes with small grains has been successfully used in Oklahoma and Texas for winter, spring, and summer grazing. The cropping sequence of multiple cropping and rotation has been shown to be important from the standpoint of fertilizers required. Oat does not do well following sweetclover (*Melilotus indica*) or cotton.

Gulf Slope Cash Crop, Forest, and Livestock Region

This area has mild winters and a long growing season but because of the high evapotranspiration rate and low water holding capacity of the soil, crops are often limited by moisture. Where soils are deep, cotton is the main cash crop which is occasionally followed by double cropping with grain sorghum.

Gulf Coast Lowland Forest and Truck Crop Region

The climate is subtropical with up to 330 days growing season. The potential for multiple cropping in this region is good where cultivation is practiced.

Where rice (*Oryza sativa* L.) is grown, it is followed by planting cereal grains, flax (*Linum usitatissimum* L.), or pasture species directly into the rice stubble. Rotation of rice and pasture has increased both beef and rice production and has controlled undesirable grasses and weeds.

Where cotton is the principle crop, it is generally followed by corn or grain sorghum. Winter legumes are also grown in double cropping patterns in rotation with row crops.

GENERAL OBSERVATIONS

In the final analysis, in the western U. S., little double or relay cropping is done north of latitude 37°N., or above 600 m elevation. The short growing season restricts the planting and maturing of soybeans or sorghum after harvesting small grains, and rainfall is usually inadequate to permit germination and establishment of a second crop. Even with irrigation, the season is normally too short to permit effective double cropping as a common practice. Good managers, however, may recognize seasonal weather patterns in an occasional year when they can take advantage of a double cropping system.

Fallowing to increase soil moisture and intercropping with companion crops during the establishment of a permanent pasture or legume crop can be used effectively in many of the western states, but again, inadequate rainfall late in the growing season is often the limiting factor.

The only areas normally suited for double cropping with present agronomic crops and varieties are those having growing seasons longer than 200 days (Fig. 3) and which have adequate irrigation water. Because of the variability in soils, climate, and evapotranspiration requirements (Fig. 4) it is not possible to relate multiple cropping success to precipitation pattern except as it occurs locally from year to year. It would appear, however, that areas where double cropping is practiced without irrigation must receive more than 75 cm of annual precipitation (Fig. 5). Intercropping, especially in the northern latitude, is successful where precipitation is greater than 50 cm.

RANGE AS A MULTIPLE CROPPING SYSTEM

By its nature, physical characteristics, and resultant multiple species forage crop, the western rangelands provide food for man only when harvested by grazing animals, and because these lands cannot profitably produce cul-

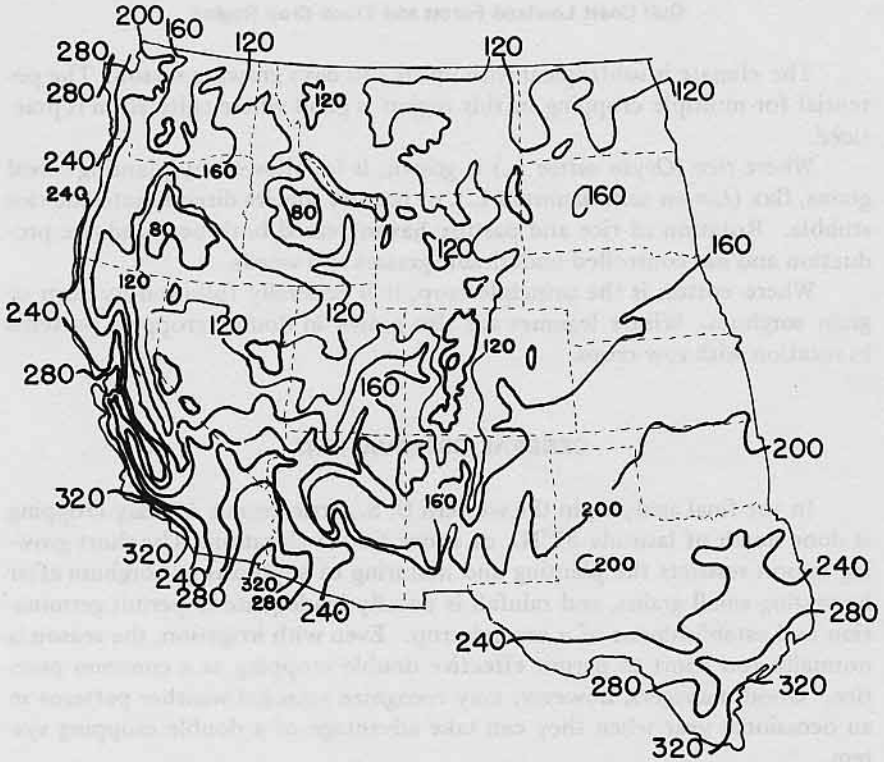


Figure 3. Average length of frost-free period (days), adapted from *Climate and Man Yearbook of Agriculture* (USDA, 1941).

tivated crops, they will continue to produce rough forages. Nevertheless, much is being done to improve, harvest, and manage this natural intercropping system.

The type of animal used to harvest the forage, whether cattle, sheep or big game, is determined by the physical environment and species growing there. The availability of forage also may determine the class of animal that will be managed. Some ranges are suitable only for wildlife habitat, but generally they would be most productive if managed in a dual-use system with livestock so as to balance the species of grazing animals to their most efficient use of the available forage.

Because of the destructive use of range around the turn of the century, about 238 million hectares were seriously depleted (USDA, 1936). Improvement and renovation practices can restore much of the rangeland to a highly productive level by changing the species composition and by proper management (Vallentine, 1971, p. 301-317).

With proper management, crested wheatgrass (*Agropyron cristatum*) ranges can be used for spring and fall grazing in the same season, and essentially produce two crops of high quality forage (Hyder & Sneva, 1963).

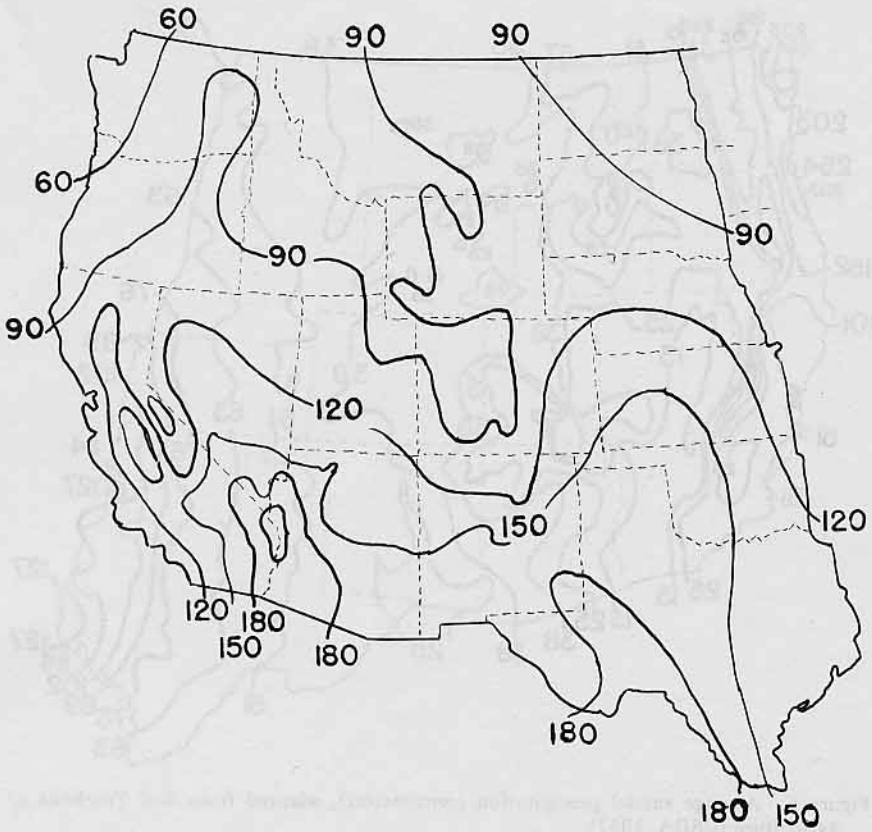


Figure 4. Mean annual evaporation (centimeters), adapted from *Water Encyclopedia* (Todd, 1970).

The removal of nonedible plants with herbicides or by mechanical means has permitted good forage species to recover and increase in production. Water wastage and the decline in forage production has been well documented in brush infested areas in the southwest and Texas. After brush control, the feed supply from these ranges is more than doubled (Herbel et al., 1973, Schultz et al., 1959). Similar results have been obtained by removing dense stands of piñon (*Pinus edulis*)-juniper (*Juniperus* sp.) and sagebrush (*Artemisia* sp.) in the intermountain areas (Clary, 1974). Improving these ranges not only increases forage production there but also allows more efficient use of the summer mountain ranges and the winter desert ranges (Cook, 1966).

Fertilization of native grasslands has also been used to change species composition and to increase production of desirable forage plants (Rogler & Lorenz, 1957).

Interseeding and pitting have been widely used on the western range with varying degrees of success. Interseeding (row intercropping) with yellow sweetclover was used successfully in South Dakota to increase forage

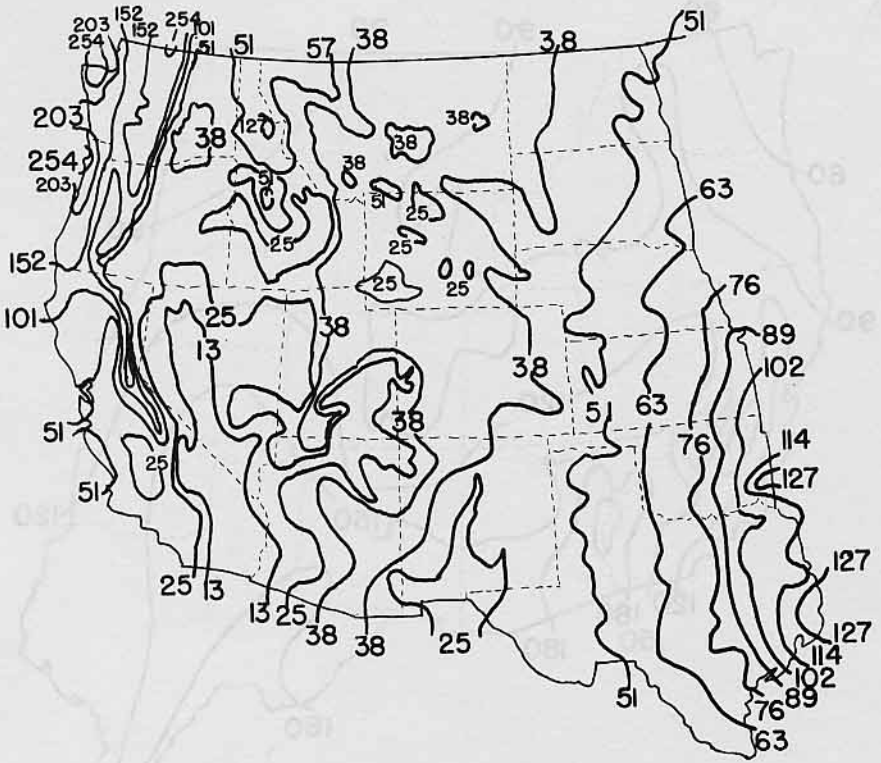


Figure 5. Average annual precipitation (centimeters), adapted from *Soil Yearbook of Agriculture* (USDA, 1957).

production (Nichols, 1969). In Wyoming, pitting increased forage production for two and one-half decades (Rauzi, 1974), and in Montana, both pitting and interseeding with cool season grasses increased production on shortgrass ranges when precipitation was normal or above normal (Ryerson et al., 1970; Wight & White, 1974; J. E. Taylor, 1967. Range pitting and nitrogen fertilization on mixed prairie rangelands in northern Montana. M.S. Thesis, Montana State University). Interseeding with browse and forbs into perennial grass stands is also recommended on intermountain game ranges (Plummer, 1968).

Nature's preferred way is to have a mixed species multiple crop. Ecologically, it is the most productive in terms of total biomass because the resultant community is closed. It is using all of the resources available for plant growth. The only opportunity an invading species has to enter the community is if the factors to which it is tolerant are not fully occupied by another species.

Mixtures provide two additional major advantages to consider when planting: (i) they are better suited for the diverse conditions of soil, topography, and microclimate that might occur within the planned seeding; and

(ii) mixtures provide variety in the animal's diet and might be used more effectively in meeting the animal's needs on a year-long basis.

Since animal species have differing preferences for plant types, care must be used in managing so as not to eliminate the desired species. A well-managed range in the intermountain area might rotate periodically between cattle and sheep to keep the grasses and forbs in better balance. The presence of big game animals adds other dimensions to forage management problems.

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