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IRRIGATED AGRICULTURE IN THE SAN LUIS VALLEY

By V. M. CONE and ALVIN KEZER

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LOCATION AND TOPOGRAPHY.

The San Luis Valley lies in the south central part of Colorado. An arm of the valley extends a few miles into New Mexico, but is of little importance so far as irrigation is concerned. The eastern rim of the basin is formed by the Sangre de Cristo range, and the western rim by the Conejos mountains, La Garita hills, and the Saguache mountains. The junction of the Saguache mountains and the Sangre de Cristo range closes the valley in the north. The valley proper is about ninety miles long and forty-five miles wide, and is roughly elliptical in shape.

The principal streams entering the Valley on the west are the Rio Grande, Conejos and Alamosa rivers, and La Jara and Saguache creeks. Entering from the east are the Culebra and Trinchera rivers and Cottonwood, Spanish, Willow, Crestone, Rito Alto and Cotton creeks. San Luis creek flows south from the upper end of the Valley. The streams on the east are small and usually lose themselves in the sand a short distance from their canons except when flooded. The streams on the west have much larger drainage areas and carry more water than those entering

This bulletin is based upon results obtained from field investigation and experimental farm work in the San Luis Valley, and is intended to be a popular presentation of those results. The Colorado Experiment Station, in co-operation with the Office of Experiment Stations of the United States Department of Agriculture, has been carrying on experiments and field work in the San Luis Valley for the past three years. Field plat experimental work in crops and irrigation methods have been conducted on the farms of the Costilla Estates Development Company, with headquarters at San Acacio. In this location three farms of forty acres each were divided into plats, upon which crop, soil and irrigation experiments were performed. The authors have spent considerable time upon experimental work and made many trips to various sections of the valley during the three seasons.

The Experiment Station is indebted to the Costilla Estates Development Company for courtesies extended which permitted the collection of much valuable data. In 1912 the experimental plats were taken care of by Mr. Roy Hice. Mr. E. H. Thomas was responsible for the resident work in 1913 and 1914. Much of the general irrigation information was collected by Mr. R. G. Hemphill during the years 1912 and 1913.

from the east. At one geologic period the Valley was the bed of a lake, and all except the recently formed soils were deposited by the waters of this lake. Streams flowing into the lake were laden with this material and deposited it in fan-shaped deltas spreading outward from their canons. Except in a few cases these fans are not apparent to the eye, and the Valley appears to be a flat, treeless plain. The streams flowing into the Valley from the west being larger, but carrying less heavy material, formed deltas more extensive and flatter than those deposited on the eastern side, with the result that the trough of the Valley is considerably east of its north and south axis. Most of the large irrigation systems are located on this western slope. Here the inclination of the land varies from 5 to 30 feet per mile except near the foothills, and is so uniform that canals are usually constructed along section lines either east or north. The Prairie Ditch runs for over 25 miles in a straight line, and it is reported that at no point was an excavation of more than two feet necessary.

The elevation of the Valley is high, its lowest point being over 7,500 feet above sea level. Practically all of the farming land is at an elevation between 7,500 and 8,500 feet. Elevations of some of the principal towns are given below.

Town.	Elevation.	Town.	Elevation.
Villa Grove	7,962 ft.	Del Norte	7,868 ft.
Saguache	7,740 ft.	Monte Vista	7,650 ft.
Crestone	7,871 ft.	Alamosa	7,536 ft.
Moffat	7,568 ft.	Blanca	8,403 ft.
Hooper	7,566 ft.	La Jara	7,597 ft.
Mosca	7,562 ft.	Manassa	7,660 ft.
San Acacio	7,737 ft.	Capulin	7,800 ft.
Jarosa	7,650 ft.		

CLIMATE.

The climate is characterized by almost continuous sunshine, very little rainfall, extremes of temperature, and a high wind movement. The mean annual precipitation is between 8 and 9 inches, varying widely from season to season and at different points, the highest recorded being 18.85 inches at San Luis in 1891, and the lowest 2.88 inches at Saguache in 1896. The heaviest rainfall of the year occurs in July and August at the time when most needed. Usually the rains are of little direct benefit to growing crops, but the streams flooded from rains in the hills afford water for irrigation for a few days.

The mean annual temperature is 42 degrees, the coldest month being January, with a mean temperature of 18 degrees, and the warmest month July, with a mean temperature of 64 degrees. The minimum temperature recorded was 34 degrees below zero, and the maximum 98 degrees above. Frosts are liable to occur any month of the year. Owing to the high altitude and rare air, these extremes of temperature are not keenly felt.

The most disagreeable feature of the climate of the Valley is the high wind, the general direction of which is toward the northeast. In some of the lightest soils the wind does some damage to newly planted crops, since it blows steadily for days at a time.

SOILS.

In appearance the San Luis Valley is a vast plain. To the eye it appears to be level and devoid of hills and irregular slopes. Actually, it is the basin-shaped bottom of an ancient lake, which at present appears as a treeless plain surrounded by high and rugged mountains. The surface slopes are unusually uniform and gradual. Close to the eastern edge, which is the low portion of the Valley, or Valley trough, the slopes are so slight that drainage is very poor, causing considerable areas of seeped land, some swampy portions, and shallow basins filled with alkali lakes.

A large proportion of the soils of the Valley is sand, sandy loams, and gravels, underlaid at from two to four feet of the surface with gravel more or less porous in nature. The soil materials were deposited in large part at the geologic time when the San Luis Valley was occupied by a lake. These materials were carried from the slopes of the adjacent mountains by the torrential streams which flowed into the ancient lake. The so-called recent soils have been deposited by the streams since the drainage of the lake, which occurred when the canon of the Rio Grande was cut thru in past geologic time. This ancient soil material was laid down in alternating layers of clay, sand and gravel. In many places at the present time the surface has been worked over and new material deposited by the streams. Some of this material is known as adobe, being of very fine texture and extremely difficult to work.

These adobe or clay soils are classed as "heavy." As a total area they are comparatively unimportant in the Valley acreage, since they are usually confined to the bottoms and flood plains of the larger streams. Away from the streams, towards the slopes in the foothills, the soils are a little lighter in texture. Most of the heavy soils are comparatively recent stream deposits—that is, they have been deposited by present streams since the drainage of the lake which once occupied the present San Luis Valley.

Quite a large number of soil types occur, many of which have a considerable distribution. The soils deposited as the result of the work of the Rio Grande commence at Del Norte and extend eastward to Mosca, Hooper and Alamosa, and westward to the mountains. Most of these soils are rather porous and gravelly, underlaid by gravelly subsoils. In color they are mostly reddish brown. These soils have been called by the Bureau of Soils the San Luis Series.* In this region are found sands, sandy loams and loams, which the Bureau of Soils has called San Luis Sand, San Luis Sandy Loam, and San Luis Loam, respectively.

The San Luis Sand extends from the face of the mountains to the vicinity of Center and Monte Vista and eastward from those towns in narrow belts as far as the Valley trough. The type is porous and easily worked, being derived from the volcanic rocks on the adjacent mountains. The lighter portions are subject to wind drifting, and frequently form slight ridges or dunes. The subsoil is gravelly and occurs at depths of two to four feet. This soil never becomes sticky when wet, water penetrates it readily and drainage is rapid where the slopes and other conditions permit. Some of the lower slopes, due to insufficient natural drainage conditions, are swampy and alkalized. New lands of this type frequently have a cemented area or layer which occurs at about the depth of the rainfall's penetration. The cemented area has been caused by the washing down of soluble materials from the surface and their deposition in a layer at the bottom of the zone of percolation. Irrigation has dissolved these cementing materials and on old irrigated lands this layer, sometimes called hardpan, is not noticeable.

In this area the next most extensive type of soil is the San Luis Sandy Loam. This contains more fine material than the San Luis Sand previously described but is, on the whole, rather coarse and carries considerable gravel. The surface layer is from 18 to 36 inches in depth underlaid by coarse gravelly subsoil. It is quite sticky when wet, especially as there are often streaks of heavier material in the surface. Except in the lower lying districts this type is naturally well drained.

The San Luis Loam occurs in limited patches on the lower rivers and usually upon the low slopes adjoining such areas. The soil is rather heavy and contains a great deal of the finer material carried down by mountain torrents, or washed from higher lying soils. It looks much like San Luis Sandy Loam, but contains a

* Soil Surveys of the San Luis Valley, Colorado Field Operations, Bureau of Soils, 1903. Circular No. 52, Bureau of Soils, 1912.

considerable amount of finer material, thus becoming sticky when wet. Stickiness is probably increased by the presence of alkali salts and by the absence of coarse sand or fine gravel in the surface layers. It is usually underlaid at a depth of two to three feet with sand or sandy loam which grades into the usual gravel underlying most of this region. This soil is very rich. When well drained it will produce heavy crops of grasses, alfalfa and grains, but much of it is not now available for cropping because of seepage and alkali.

The so-called Rio Grande series occurs in narrow belts along the Rio Grande. The series includes Sandy Loams, Loams and Clays, the first-named being the most extensive type. All of these soils are dark brown to black in color and usually have considerable organic matter in their native condition. The surface soils contain very little gravel, but generally at a depth of two feet or slightly over, they are underlaid with the prevailing gravel layer or layers peculiar to this region.

The surface slopes of the Rio Grande types are gentle, favoring irrigation, though they are frequently cut up by old stream courses or banks of gravel. Much of their area is subject to overflow or is flooded to increase the growth of wild hay. If protected from overflow and excessive irrigation, Rio Grande Sandy Loam is one of the best adapted soils for potatoes, alfalfa and truck crops.

The heavier Rio Grande types are also subject to overflow. They are very sticky and puddle easily, and these adverse physical conditions frequently are made worse by considerable quantities of alkali. When worked in just the right way and at the right time they give good crops of grass and wheat. However, their management is difficult as they require artificial drainage, very careful irrigation and plowing and other cultivation at just the right moisture point—conditions difficult to obtain.

The San Luis and Rio Grande Series occupy the western and southern parts of the valley and include the more important agricultural types. The soils of the northern part of the Valley are somewhat heavier in texture—that is, they contain much more fine material. They were probably deposited by slower moving streams as the present grades of the streams are much lower than those in the western and southern parts of the Valley. The lime content of the soils is also less.

The soils in this section are chocolate brown to light brown in color, although occasionally they will be found almost gray in considerable patches. Close to the mountains and on the Valley slopes the soils are gravelly to sandy gravelly loams, but on the flatter Valley floor they run to loams and clays. Rather heavy percentages

of alkali are encountered which is mostly composed of sodium sulphate and sodium chloride. Some magnesium sulphate also occurs.

In the vicinity of the alkali lakes, in the eastern part of the Valley, there is an occurrence of some black alkali or sodium carbonate as well as some sodium bicarbonate. Outside of this small locality the alkalis of the Valley are mostly the so-called white alkalis and are occasionally in sufficient quantities to be injurious to vegetation. They come to the surface when the land is waterlogged or seeped. Probably more damage is done by seepage in many of the wet alkali sections than by the white alkali itself, although the percentages sometimes run high.

With few exceptions, the soils of the Valley are deficient in organic matter, the incorporation of which is one of the big problems of farming and successful soil management.

IRRIGATION.

Probably the first irrigation in Colorado was by the civilization which gave rise to the cliff dwellings still extant in the extreme southwestern portions of the state, but the first modern irrigation was probably in the San Luis Valley. The first development was in the extreme southeastern part of the Valley and was small in comparison with the present irrigated acreage. Some irrigation systems now in use date back as far as the early fifties, but until 1880 development was slow. The ditches were taken out by individuals or by a few farmers associated together. During the period from 1880 to 1890 a majority of the present ditches of the Valley were constructed. Little was done from 1890 to 1905, but since then new systems have been built and many of the older ones improved by the construction of reservoirs and by ditch betterments.

There are at present in the Valley approximately 1,100 ditches with adjudicated water rights. These aggregate an appropriation of 15,873.82 second-feet, while about a hundred other ditches have unadjudicated claims for water. There are about 2,000 miles of ditches and principal laterals. Authorities differ as to the area of the land irrigated in 1914, this being variously estimated at from 500,000 to 790,000 acres. Five hundred thousand acres is perhaps a conservative approximation, having been arrived at by checking up the records of agents in the field during that season. It is believed that the number of acres which can be irrigated is approximately 800,000.

During the early days of irrigation development in the Valley nearly all of the water used was secured by direct diversion from the streams, but during the past few years seventeen reservoirs with an aggregate capacity of over 260,000 acre-feet have been

built, materially increasing the supply of water available during the irrigation season since they store water in flood times and hold it till times of normal slack stream flow.

In the western and southwestern portion of the Valley, there is considerable artesian water. Owing to the very porous nature of the soils small reservoirs cannot be built economically and successfully for storing the flow from these wells. There are between 5,000 and 6,000 of these artesian wells. Roughly, the wells average a flow of 40 gallons per minute. This is much too small for direct application except on small acreages, such as garden patches. Some of the wells, however, have much heavier flows. Despite the aggregate flow of 450 second-feet the acreage irrigated is extremely small, totaling not over 2,000, mostly on gardens and small patches. Owing to the manner in which the wells have been cased—that is, for a short distance only—it is not feasible to cap the wells and stop the flow when the water is not needed for use. Consequently the discharge from these wells has created local swampy areas and has caused considerable trouble without furnishing very much direct benefit except in the way of water for domestic purposes.

Data for 1912 show practically 300,000 acres irrigated by surface flooding. Sub-irrigation is employed directly on about 130,000 acres or approximately one-fourth of the irrigated acreage. The sub-irrigated lands are almost exclusively those irrigated from waters taken from the Rio Grande, there being only about 5,000 acres in other districts which are sub-irrigated. Furrow irrigation is used on 24,000 acres, principally for cultivated crops such as potatoes, beets and other roots, and also on lands too steep for flooding. The border and check methods are used on about 4,000 acres.

As stated above, the acreage watered directly by sub-irrigation methods is approximately one-fourth of the total irrigated acreage. However, there is no way of telling what acreage is indirectly influenced by the sub-irrigation practice. The water level has doubtless been raised over a very much larger area. Near the upper portions of the sub-irrigated belt the water table must be raised from 20 to 30 feet each season to bring it into the root zone. This practice has naturally resulted in an undue rise of the water table in lower lying lands and in seeping and swamping the lowest. Sub-irrigation can hardly be improved upon where ideal conditions of soil and slope obtain, but ideal conditions are very rarely encountered. When only a few farmers were irrigating with sub-surface methods no bad results followed, but when large areas were so irrigated it was found that sooner or later the farmer on the lower land was drowned out. Perfect control of the water level is impossible

to secure so that sub-irrigated fields are usually either too dry or too wet. The rise of the sub-soil water following sub-irrigation has carried up alkali which has accumulated at the surface— in fact, sub-irrigation has produced more pernicious results in this respect than any other method of irrigation practiced. While sub-irrigation is very easy on the irrigator and enables one man to irrigate a large acreage at a cheap labor cost, it is very hard on the land and may be very hard on the crop. Practically all of the land which has been subjected to one system or another of drainage was formerly watered by sub-irrigation, but is now being surface irrigated.

To change from sub-irrigation to surface irrigation, it is only necessary to enlarge the supply ditches and build the field laterals closer together. For surface irrigation, especially on the lighter soils which slope, all water should be run across narrow strips of land—that is, the field laterals should be close together. In porous sandy soils the water should be run across the gentlest slope so as to reduce washing to the lowest possible limit. A change from sub-irrigation to checks or borders could be made with equal ease, the only difficulty being the expense of constructing levees. Rectangular and border checks are now being used in several sections of the Valley in alkali reclamation work.

Irrigation, especially on the sandier lands, which do not have a high water-holding capacity, must be rather frequent to give best results. Lands which tend to form a crust should be irrigated prior to the seeding, where it is necessary to "irrigate up" the crop. If this is done cultivation can be given before seeding and the seeding operation itself effects some cultivation which will produce a surface mulch and effectually break up the crust. On lighter soils where a crust is not formed there is a tendency for the formation of a natural mulch. On such soils to "irrigate up" the crop it is best to plant the crop and irrigate after seeding, because the soils will not hold moisture in contact with the seed long enough if they are irrigated first and seeded afterwards.

Until recently very little land has been leveled for irrigation. What leveling was done consisted in running a field float over the surface after plowing. Now, however, considerable land is fairly well leveled with slips and fresnos after plowing. Usually such work pays well because it permits putting all of the land into growing crop.

Clearing land for irrigation was formerly done by burning off the sagebrush or hacking it out with grub hoes. Now the land is usually broken with heavy plows pulled by tractors, and the brush is raked off. Preliminary leveling done and a crop or two planted, the ground will be settled enough for final leveling.

DRAINAGE.

The best evidence available shows that there are approximately three-fourths of a million acres needing more or less artificial drainage. Possibly 25,000 acres are now provided with drainage systems. A large amount of the seeped land is damaged by irrigation—largely sub-irrigation. A small amount has been damaged by the flow of springs and artesian wells.

Owing to the great length of the slopes and their uniform grade drainage systems to be successful will require large districts and community effort. Drainage operations now being carried on are successful enough to warrant the statement that satisfactory drainage presents no seriously difficult engineering features. It does demand, however, widespread community co-operation.

GENERAL FARMING CONDITIONS.

The soils of the Valley have already been discussed specifically. Soil conditions for farming purposes can be summarized by stating what actually prevails. The great majority of the soils are sandy loams and gravels, underlaid by gravel. There are heavy soils in the northern part of the Valley and along the flood plains of the streams in other portions. These heavier soils often present very peculiar local conditions which are difficult to deal with but from the standpoint of the farming of the Valley they are relatively unimportant, because the area is not very great.

The gravelly subsoils where drainage is good, make the moisture situation acute since they usually cause surface soils to dry out readily, especially if the gravel comes close to the surface. Such conditions will require frequent watering in farming practice.

A general lack of organic matter or vegetable matter affects the Valley soils, except the heavier and recently formed soils along some of the stream courses. Farming practice which aims to maintain production and to increase the fertility of these soils must include some scheme for incorporating vegetable matter (commonly called organic matter) with the soil. Owing to the altitude, the seasons are short and the nights cool so that rotting of organic matter is a slow process. This has led to the general impression that manure and other organic matter cannot be rotted in these soils. This is a mistaken belief. If the organic matter or manure be thoroly chopped to pieces with a disk harrow and mixed with the surface soil, it will be well incorporated with the soil when the plowing and harrowing operations are performed. The pulverized organic matter readily rots and mixes.

The general farm practice of the Valley is to plow too shallow. Deep plowing immediately before seeding will usually delay the

maturity of the crop, as it keeps the growth green later in the season, consequently deep plowing should be done at a considerable time before the crop is seeded. Fall plowing on lands intended for spring seeding, or at least very early spring plowing, is necessary where deep plowing is practiced. In certain localities the soils are so light that they blow readily in the prevailing winter and spring winds and it is sometimes necessary to leave such soils unplowed so that they may be protected by the stubble or other summer growth. Likewise, in some sections the winters are normally so dry that the furrow slice will be entirely dried out where fall plowing is practiced and spring irrigation will be necessary to germinate the seed. Prevailing practice differs thruout the Valley, therefore, according to the prevalence or absence of the conditions referred to. In those sections where conditions would permit more fall plowing for spring crops it would cause a better distribution of labor and larger crops.

Altho the San Luis Valley is served by two railway lines, it is necessarily subject to rather high freight rates, as lines must cross mountain passes to get into the Valley. This condition, coupled with the short season which limits the class of crops which can be grown, somewhat affects the most profitable farm practice. Cash crops in excess of local consumption should not be grown except those which will sell for an exceedingly high price on outside markets. Consequently, the best farm management to be followed in general will encourage the production of feed so that the crop is "marketed on the hoof"—in other words, to permit livestock to convert the relatively cheap hay, grain and other feed into relatively concentrated and high-priced animal products. From the standpoint of good farm practice, a great deal of these crops should be fed upon the individual farms in order that the manure may assist in the maintenance of soil fertility.

Large areas of the feed crops of the Valley are now grazed in the field. This is especially true of peas and pea-grain mixtures. Such practice is exceedingly wasteful of feed, since a large amount of it is blown away by the high winter winds and much of it is tramped into the ground. Moreover, during the winter, snow frequently covers the fields for days at a time. Under such conditions animals will often lose more in four or five days than they can gain in twenty, but where the crop is harvested and fed in lots, the waste is largely stopped.

Over a considerable portion of the Valley summer range in the foothills and mountains is available. Such a condition fits in wonderfully well with the production of hay and grains for feed upon the individual farms. It is estimated that 250,000 to 300,000

lambs are fed yearly and if the feeding industry were properly developed the number of sheep, cattle and hogs now sent out of the Valley could be very largely increased. This could probably be accomplished by increasing the amount of stock on the smaller land holdings, rather than by increasing the large herds already in the valley. No one kind of stock holds any particular advantage over the others, altho cattle, sheep and hogs will constitute the chief market for feed crops produced.

Even in sections where livestock feeding is undertaken on a large scale it will be necessary to practice some sort of rotation by which green manure crops may assist in building up soil fertility. The best of management cannot keep the soil in high productivity by reliance solely upon the animal manures available for fertilizing purposes, since the supply of these is, in any circumstances, limited.

Crops capable of cultivation are necessary because of the prevalence of weeds and occasional plant pests and cultivation must be clean to keep down undesired vegetation, simply as a protection of the moisture supply. Incidentally, such cultivation prevents the formation of a surface crust and the moisture losses and poor physical conditions which result from such formation.

ROTATION.

In starting a rotation it must be kept in mind that perennial crops, such as alfalfa, should be seeded only on well-leveled land, consequently, in starting a rotation on new land or on old land which is improperly leveled, annuals should be used at first, thus permitting time being spent for proper leveling of the land for irrigation. Peas is one of the best crops available for the first planting on new land or to start a rotation on old land, is an excellent feed crop, and is also an annual. Alfalfa should never be seeded until the land is well leveled, because poor levelling results in irregular stands and bad conditions for watering—some parts will be killed out because of excess water, and others will do poorly because of a lack of water. Since alfalfa is a perennial and will probably occupy the land for several years it should be put in with that expectation. A rotation may then be practiced on the portion of the farm not in alfalfa, while the latter may stand until its yield commences to weaken. In other words, alfalfa should form part of a long rotation, while the rotation of peas, grain and cultivated crops should be shorter. In the shorter rotation, peas or pea-grain mixtures should be the first crop on the land. Potatoes, if grown at all, should follow peas or alfalfa. Where peas is grown some trouble is experienced with weeds, especially if the crop is grazed. Harvesting the peas takes the weeds off before seeding, permits early

fall plowing, and gives much the same effect as a cultivation, since it cleans the land of weeds and permits an actual cultivation in the shape of plowing.

Grain for the most part should be grown only for feed or seed. A small amount can be reserved for a cash crop to supply local demands. Where grain is used it should follow peas and pea-grain mixtures, or alfalfa where old fields are being broken up and new stands established.

At present there is a strong tendency to farm larger areas than is advisable with the help and capital available. In most cases a reduction of the size of the farms with better rotations and farm management, would result in large returns.

Sub-irrigation appeals strongly to the average man. In fact, the sub-irrigated districts have been called "the lazy man's paradise." It is the *brag* of some of these "lazy men" that they "can turn on the water and go fishing for three weeks." Sub-irrigation permitted the early settlers to farm large areas, but it resulted in the destruction of the fertility or the seeping of the lands themselves. Surface irrigation, while requiring more work, will *live* much longer and return heavier crops. Sub-irrigation on new lands when first applied will often produce enormous crops, but the yields are certain to run down, except under the most favorable conditions, unless ways of keeping up the fertility are employed. This means that more capital and more labor must be applied to individual units of land to even make profits over most of the districts where bonanza farming formerly prevailed. There has been a noticeably marked change in sentiment on this matter the last few years.

It is fundamentally important that farmers in general raise more of their own living. The hardy garden vegetables do wonderfully well under irrigation and possess a quality scarcely to be surpassed, yet there are not nearly so many gardens as there should be. Every farm should have a good garden and, whether the general farm crops are fed or not, each farmer should have some chickens, a few cows, and a few pigs so that all eggs, butter and meat used in the home will be produced on the farm and small surplus of poultry and dairy products may help reduce the grocery bill.

The leading farm crops in the Valley are wheat, oats, barley, native hay, field peas, and potatoes. Alfalfa has increased remarkably in the last three years, and sweet clover has attained a wide distribution. Sugar beets were formerly grown, but their production has been abandoned, not because they were not adapted to Valley conditions and soils, but because the population was not ready for the intensive garden culture necessary to grow sugar beets suc-

cessfully. Some planning for the future was necessary so that the organic matter in the soils might be built up. Deep plowing and frequent cultivation were needed for success, in addition to a great deal of hand labor. These requirements were not met in the Valley, and the beet industry has been a failure. Disease has made potatoes an uncertain crop. They were formerly staple.

ALFALFA.

It was formerly supposed and quite commonly asserted, that alfalfa could not be successfully grown in the San Luis Valley, but the folly of this belief has been amply demonstrated in the past few years, and it is now known that the crop can be grown practically everywhere in the Valley. Fields of some years' standing may be found in nearly every section at the present time. From Del Norte on the west and Hooper and Mosca on the east; from Saguache and Moffat on the north to Antonito on the south, and San Luis, San Acacio and Eastdale on the southeast, there are successful fields of alfalfa. Many of the failures in the past have been due to a lack of understanding of proper methods of handling the crop and to improper varieties.

The altitude of the San Luis Valley is very high and the extremes of temperature and moisture are consequently great. The southern types of alfalfa and much of the so-called common alfalfa are not likely to prove successful because of their inability to stand the winter climate and the dry cold, windy springs.

Alfalfa is a deep-rooted crop. Where the root room is limited by subsoil water, the common alfalfas will not survive. The so-called hardy or northern types will grow under these conditions, but the reduction of root room causes them to feed heavily upon the surface soil, and all except exceedingly rich soils will soon be exhausted. Alfalfa is commonly supposed to be a soil improver, renovator or fertilizer. Under proper conditions this is absolutely true, but it is also true that of all the crops grown in the Valley alfalfa is one of the heaviest feeders upon soil fertility. It may be expected, therefore, that on those soils where the rise of sub-soil moisture is such as to develop a very heavy shallow root system, the crop will eventually tend to exhaust the soil fertility. Many of the Valley soils, as has already been shown, have sandy and gravelly subsoils. On such soils, when the subsoil water is allowed to recede (if it does recede) the mass of roots in this narrow zone at the surface finds difficulty in securing moisture enough for the plant to subsist upon. Growing upon these porous soils the crop is unable to put roots down into the gravelly layer fast enough to get the water needed for growth and the thick mass of roots in

the surface will soon exhaust the water supply in the limited area of the surface soil. Under such conditions the crop ceases growing and will perhaps wither and die. While proper varieties can be grown where the subsoil water is very close to the surface, they will not make as good development nor produce as heavy tonnages thru so long a period of time as will be the case when the soils are watered by correct methods. Where the farming methods are such as to provide a considerable depth of soil properly moistened, alfalfa sends out an extensive root system which enables it to draw its moisture and food supplies from large areas of the soil and subsoil. These are the conditions best suited for the proper and heaviest development of the crop.

Under best management it is not advisable to seed alfalfa on new land or on old land that has not been properly leveled. Alfalfa is a crop which will remain on the land several years. Improperly leveled land increases the work of irrigation and will often leave pockets which will receive so much water that the alfalfa will be killed. On the other hand, ridges and knolls may be left to which water cannot be supplied in sufficient quantity to keep the crop going. These conditions increase labor and reduce the yield of hay.

An additional reason exists for delaying planting on new lands. When first broken up and put under irrigation, these settle unevenly. They should therefore be irrigated at least one or two years so that these inequalities can be leveled off and settling effected by the use of irrigation water may be finished before the ground is planted to alfalfa. Such practice will do away with the evils which often appear from gopher and other rodent holes before the alfalfa is put on the land.

In San Luis Valley it is seldom advisable to use a nurse crop with alfalfa. Generally only two conditions occur where the use of a nurse crop is advisable, these being found upon the heavy adobe and clay lands which tend to bake and crack at the surface. Here a nurse crop may break up the surface and enable the young plants to appear, which they might be unable to do otherwise. In sandy lands which are subject to plowing, it is sometimes advisable to put in a nurse crop to hold the surface soil. Under practically all other conditions alfalfa will do better and can be more successfully started when planted by itself.

Variety.—Both the costly experience of farmers who have made failures and the direct experiments by the Experiment Station have shown that it is not advisable to plant the southern types of alfalfa in the Valley, and, in general, even common alfalfa is not adapted to the soil and climatic conditions which are found there.

The best varieties to grow are the Baltic, Grimm, and Hardy Turkestan, in the order given considering local preference or comparative value for the Valley conditions. Baltic alfalfa is, in a way, a selection from Grimm, but is somewhat better than the parent variety. Common alfalfa, the seed of which has been obtained from long established fields from which practically all of the non-hardy plants have been killed, can be grown to a considerable extent, but it is not advisable to use common alfalfa for seed if the hardy varieties can be obtained and their propogation effected. Such "naturally selected" common alfalfa will stand the winters very well, but it does not stand the soil water conditions nor the effects of late spring frosts, which are often accompanied with *Black Stem Rot* or *Alfalfa Blight,* as well as do the hardy types.

Preparation of Seed Bed.—One of the first considerations in the preparation of a seed bed is to have the land properly leveled. After this feature has been taken care of, the immediate preparation will depend a great deal on previous cultivation. Relatively new lands should be deeply plowed, preferably in the fall, where alfalfa is to be planted the following spring. Sometimes in preparing a seed bed it is advisable to plow deeply and thoroly for a grain crop and then disk the stubble of the grain in the fall after the grain is removed and the following spring drill the alfalfa in on the land so prepared. This is especially advisable for sandy lands, and will do away almost entirely with any need for a nurse crop. Where land has been plowed it should be worked down thoroly by disking and repeated harrowings until the sub-surface is well packed, with a granulated surface to conserve moisture and to prevent, as far as possible, the winds from blowing the soil.

Sometimes there is sufficient spring moisture in the soil to germinate the seed and start the crop off. In such cases planting may be done at once. Where the soil holds insufficient moisture, as is often the case after dry winters, it may be necessary to irrigate for seeding. On heavy adobe or clay lands, or even heavy loam lands, it is advisable to thoroly level and prepare the land, irrigate, and then, just as soon as the surface can be worked, plant with a disk drill. If such a tool is not available, it is advisable to disk the surface and follow the disk with a harrow and alfalfa drill or seeder.

In the case of sandy lands it is usually best to thoroly prepare the seed bed, seed the alfalfa and irrigate afterwards, because on sandy land there is no danger of the formation of a crust and sand is not retentive enough of moisture to hold moisture in contact with the seed any great length of time consequently the seed should

be in the ground previous to the irrigation. This process is commonly called "irrigating up."

In the San Luis Valley spring seeding should always be practiced. It is usually advisable to delay seeding until the latter part of April or early in May, as the soil is then warmer and the crop will start up more vigorously if other conditions are right.

Irrigating.—The first year, especially, care should be taken in watering. The object should be to make root rather than top development. To accomplish this there must be water in the subsurface and subsoil, because the roots will not grow downward into a dry soil. Frequently very light irrigations will keep the crop growing, but will not tend to produce root deevlopment. Relatively heavy irrigations, followed by lighter ones, will tend to produce a heavy root growth.

One of the most serious dangers to alfalfa is winter killing or more properly, spring killing, due to the dry, cold windy springs. To reduce this danger, it is advisable to irrigate in late September or early October, so as to have some moisture in the ground upon the approach of winter. A crop so irrigated will start off vigorously in the spring. Irrigation should be such as to keep the crop growing energetically thruout the season. When the spring is dry, early irrigation is necessary. Where considerable winter or spring precipitation has fallen so that abundant moisture is in the soil it is advisable to withhold the early spring irrigation because the water at this season is exceedingly cold and will retard plant growth.

Usually three cuttings may be obtained in a season, or two cuttings and enough later growth to make considerable pasture, the latter often amounting in value to more than half a cutting. For this amount of growth, two or three irrigations will ordinarily be sufficient. On new land which has not been irrigated previously or on land very deficient in vegetable matter, more than one and one-half acre feet of water will probably be needed to produce maximum crops. Under most other conditions, however, one and one-half acre-feet will probably be ample to grow a maximum crop and may be found to be more than is absolutely necessary in the short seasons which prevail in these altitudes. Alfalfa will give heavier yields and will survive much longer if proper methods of surface application of water are followed. It will make better root development, and with better root development is capable of giving better yields. Sub-irrigation frequently used in the Valley holds stagnant water in contact with the subsoil for long periods. Alfalfa roots are killed out in such standing subsoil water, but they will grow to great depths in moist subsoils which do not have sufficient water to stagnate.

Harvesting.—One of the first essentials in growing alfalfa is to know when to cut it. The proper time to cut to get the greatest total yield of hay and feed for the season is when the crown shoots which are to produce the following crop make their first appearance. An examination of the crowns at the soil's surface from time to time will determine this point. The blossoming period is not a safe criterion to follow, because weather conditions markedly influence the time of blossoming. Sometimes the crop will be in full bloom before the crown shoots appear, and sometimes the crown shoots will be out before more than the first blossoms are in evidence. If the alfalfa is allowed to mature too much for any particular cutting it will retard the development of the succeeding crop. While any individual cutting will give a greater amount of tonnage if allowed to go to full bloom, the total weight of cuttings during the year will be greatest and the hay will be of much better quality if the alfalfa is cut upon the appearance of the first crown shoots.

The best method of making hay is to mow after the dew is off in the morning or afternoon; then rake with a side delivery rake very soon after the alfalfa is cut. It should only be allowed to wilt slightly before raking. The cutting process thru which alfalfa must pass is essentially drying. The leaves are the natural organs of alfalfa for getting rid of moisture. If the alfalfa is allowed to lie in the swath until the leaves are dry it takes a long time—several days—to dry the stems out. When thrown into a loose windrow with a side delivery rake most of the leaves are in the shade and will continue to evaporate moisture rapidly so that the curing or drying will take place in a very much shorter time. The alfalfa can be stacked directly from the windrow or may be cocked, depending upon the particular farm conditions. Where the old dump rake is used it is advisable to rake after the hay is slightly wilted, and put the hay into small cocks as quickly as possible, and cure in the cock. When handled in this way, especially where the side delivery rake is used, the hay can be put in the stack from twelve to twenty-four hours after cutting, which very much reduces the work and facilitates the whole process.

Black Stem Rot or Alfalfa Blight.—In the spring of 1914 alfalfa made an unusually good growth early in the season because of favorable weather conditions. A heavy frost, however, struck the Valley May 9th. A few days after this frost many growers noticed that their alfalfa was not growing properly. One of the authors, with Mr. A. C. Cooley, at that time Valley Agriculturist, drove over practically all the western and central sections of the Valley examining fields. It was found that the difficulty was

caused by Black Stem Rot or Alfalfa Blight. This disease attacks the alfalfa following a heavy frost which cracks the epidermis or plant skin on the stems, thus making it easy for the disease to gain entrance. The disease is almost never troublesome except after heavy frosts in the spring time. The only remedy known at present is to mow the hay at once, no matter what the size of the cutting, because the Stem Rot retards or prevents the growth of the crop on the land, especially if very virulent, and it may kill out the crop entirely. Mowing obviates this trouble and prevents injury to succeeding crops.

PEAS.

Field Peas, or Canada Field Peas, is one of the best crops for the Valley. Before it was discovered that alfalfa could be successfully grown field peas was almost the only legume crop successfully and generally planted. While authorities differ somewhat as to the time of introduction and as to the responsibility for the orginal plantings, it is generally conceded that some of the first planting was done in the vicinity of Monte Vista, and it is certain that the value of peas as a crop was first thoroughly established in this vicinity. James A. Kelly was one of the first to put out peas as a crop and to successfully feed it to stock. In 1914 peas constituted the major portion of the feed for something over 260,000 sheep fattened for market, while it is estimated that 18,000 to 20,000 head of cattle and a large number of hogs were also fattened on this crop as the principal feed.

When peas was first introduced the Valley had just reached a period when injury was being felt from continuous grain farming. Peas helped to restore the soil fertility and made a good rotation crop. It is quite probable that peas must be given credit—and a very large credit at that—for saving the agriculture of the San Luis Valley at a time when it was in extreme danger of annihilation because of reduced soil fertility.

The common practice over much of the pea district is to disk peas into the grain stubble and not plow. This method has some advantages, but on the whole is slipshod and will not produce the greatest possible results. Frequently, under the methods of subirrigation prevailing in some localities, this method will give greater returns than better ones, but where proper surface irrigation is employed much more satisfactory yields can be obtained where the land is properly prepared for the crop. To be successful, peas should be planted just as early in the spring as the seed can be put into the ground. In order to accomplish this to the best advantage the land should be plowed in the fall. One of the best reasons for

early planting is that peas is a cold weather crop; that is, the plants grow and make their best development in the cool spring weather. When planted late they are blossoming and developing seed at the most heated period of the season. As a consequence there is a tendency with late planting to a heavy production of vines and a light production of seed.

In order to plant early and properly it is necessary to plow in the fall or exceedingly early in the spring. The seed bed should be worked down until it is fairly compacted. The peas should be drilled in. The amount of seed per acre to give the best results will vary widely in different localities. On new lands, especially, more seed is required than on land that has grown peas for a number of years. This is due partly to soil fertility and is partly a question of inoculation. On new lands the soil is not inoculated for peas. When peas has been grown on the land for several years there is plenty of inoculating material present so that a smaller amount of seed will produce a larger number of plants.

Probably sixty pounds of seed peas per acre will be sufficient unless the crop is to be raised on new lands, where it may be advisable to plant as much as ninety pounds per acre. On many of the richer old lands which have been growing peas for a number of years, as low as thirty-five pounds per acre is amply sufficient.

Varieties.—There is an exceedingly large number of varieties of field peas, but despite this only a comparatively few have received very wide distribution. The two varieties most widely grown are the so-called San Luis Valley Stock Pea or "Mexican," and the White Marrow Fat, or Colorado White. The so-called Mexican pea is not a pure variety, but consists of a large number of mixed sorts, and for adverse conditions, is probably the best one to plant. Where conditions are good for pea growth, the White Marrow Fat will make heavier yields.

Numerous other varieties have been tried, some of which give considerable promise, but there is a large opportunity for improvement by seed selection. Considerable work has been done by individual farmers and a little work by the Experiment Station. This has not yet resulted in many new sorts, but it has been carried far enough to show that there is possibility of heavy increases thru selection breeding. The Warshauer-McClure Sheep Company of Antonio has been hand-selecting a variety. They have obtained a large white pea which matures at least two weeks earlier than the common peas. It does not make as heavy a vine growth, but pods very heavily. Farmers who have hand selected their peas claim that they have obtained heavy increases in yield over those not hand selected. The selection of high yielding individual plants to become

the mothers of varieties will probably give quick and much heavier results than any hand bin-selection that could possibly be made. In this way only high yielding plants would be kept to start the variety, while with bin-selection a certain type of seed is obtained, having both high and low yielding plants, which does not give the greatest possible increases.

Peas should be planted with a drill—preferably a disk drill. Being large seeded they can be planted from two and one-half to three inches deep, which will insure the seed moist soil, if proper care has been taken in the preparation of the seed bed. A common practice in drilling peas is to stop up every other drill hole. Thus with a drill having the shoes or drills eight inches apart the peas would be drilled sixteen inches apart where every other hole is stopped. In experimental work the past two seasons in the Valley it has been found that practically as good, and sometimes better results can be obtained by leaving all the drill holes open. For new lands, to leave all the drill holes open is better practice and for most old lands it is just as good as the other method.

The type of drill with the so-called revolving cup feed should be used for pea planting, as it will not break the seed. The fluted roller type of feed will crack a large proportion of the peas and thus be very wasteful of seed.

Irrigation.—Enough water should be present in the soil to start the crop in the spring even if irrigation must be practiced in order to put the water there. Any irrigation made should supply sufficient water for continuous unchecked growth until the time of blossoming. To produce the heaviest grain yields, irrigation should be shut off at this time. Heavy supplies of soil water after the plants are in blossom will keep the crop growing and blossoming clear up until frost. It will increase the yield of vines, but will reduce the yield of peas. The water can be handled much better and controlled much more easily if surface irrigation is used and heavier yields of both peas and vines may consequently be obtained. With sub-irrigation there is danger of getting too much water which is liable to be held on the land too late to make the best development of peas. The reason why peas disked into stubble land have apparently done better in many instances than peas planted on plowed land, has been largely due to sub-irrigation, the stubble land having prevented some of the effects of excessive moisture which usually accompanies sub-irrigation.

Harvesting.—The common practice in the Valley in the past has been to graze stock, either hogs, sheep or cattle, on the peas in the field. In general this practice is wasteful. In the first place, many of the leaves dry up and blow away, causing an actual loss

of feed. A quantity of the peas themselves is lost by tramping into the soil. There is another disadvantage: A five days' snowstorm quickly burying the peas in the field may cause more loss to the animals than they could gain in twenty days' grazing. Sooner or later all growers must practice cutting their peas, because, if for no other reason, they can get very much more feed off the same acreage where the peas are cut and properly taken care of than when they are grazed in the field. Another very decided advantage exists in cutting. Pea fields are often very weedy, especially with sunflowers, so that the crop following peas is liable to be troubled with weeds. Where the peas are cut and stacked this difficulty is not important, as cutting gets rid of the weeds, also leaving the land in shape so that it may be plowed and prepared for spring crops.

Pea-Grain Mixtures.—What has been said in regard to the preparation of the seed-bed and irrigation for peas applies equally well to pea grain mixtures. Mixtures which have been used extensively consist of pea-oat; pea-barley; pea-oat-barley; pea-wheat and pea-wheat-barley. One of the advantages of planting grain with peas is that the peas more or less thinly occupy the land and some other growth will be present anyhow, consequently the grower might just as well harvest a desirable feed by planting some of these grains with peas. Peas make a nitrogenous feed stuff and consequently make a very narrow ration, but when planted with grain mixtures a feed is harvested which is much more nearly balanced. Thus not only the tonnages are increased, but a better feed is produced.

For pea-oat mixtures on new lands, heavier amounts of seed will be needed than on land which has been growing peas for some time. A mixture of about forty-five pounds of peas with twenty to twenty-five pounds of oats; forty-five pounds of peas to twenty pounds of barley; forty-five pounds of peas to fifteen pounds of oats and fifteen pounds of barley; forty-five pounds of peas and twenty pounds of wheat; forty-five pounds of peas and fifteen pounds of wheat and fifteen pounds of barley are about right for new lands. On old lands, thirty to forty pounds of peas should be used with fifteen to twenty-five pounds of oats; fifteen to twenty pounds of barley, and fifteen to twenty pounds of wheat.

Early seeding is as important with pea grain mixtures as it is with peas alone. Oats may be killed out by frosts on exceedingly early seedings, but usually barley and wheat will withstand frosts. This has been the experience in experimental work with such mixtures.

The pea-grain mixtures should be harvested in the same manner as peas, and should be either stacked or put into the silo. The

pea plants, especially if the growth is rank, often become very much tangled and are difficult to cut. This difficulty can be very greatly decreased by the use of pea guards on the mowing machine sickle bar. These raise the peas up so they are cut off squarely. Where stacked it is necessary to rake or at least cock the peas for curing.

Harvesting should be done at a time when the greatest quantity of peas may be saved. There are always some pods which ripen later than others and cutting should take place at a time when the greatest possible number of developed pods may be obtained. The peas and grain mature to the proper stage for cutting at practically the same time.

When put into the silo peas are allowed to mature to about the same stage, cut, raked, and taken immediately to the silo. Even then, it is often necessary to run some water in with the peas to make them keep successfully.

WHEAT.

Wheat as a crop has a place on practically every farm in the Valley, as it fits in well with rotation and will make a feed or cash crop almost every year. It has been amply shown, however, by past experience in the Valley that wheat should not be grown as an entire crop. In some sections wheat has done exceedingly well, and was planted extensively and often the entire acreage of not only one farm, but of hundreds of farms, was planted exclusively to it. Naturally under such management the soil productivity declined. Wheat cannot be grown continuously on any soil in any climate. Without a rotation of some sort disaster will arrive sooner or later. However, as a crop occupying part of the farm acreage and a place in the rotation, wheat has a great value.

Winter Wheat.—Winter wheat has not been grown extensively in the Valley. It might be utilized to a greater extent. The only varieties worth considering at present are those belonging to the Turkey type, Turkey Red and Kharkov being the best. Land for winter wheat should preferably be plowed in July or early August. Plowing should be deep. Frequently it would be advisable to follow the plow with a disk harrow. Seeding should be done the last half of August, while successful plantings and successful crops are often made with much later seeding; but the practice is not advisable in the length of season which prevails, as it will result in failure many times when earlier planting will be successful.

Seeding should be done with a drill, preferably and on most lands with a disk press drill, using sixty pounds of seed per acre.

On very heavy lands it is sometimes not advisable to use the press wheels, but cover with chains or other devices. Under other conditions the press drill is to be preferred.

Spring Wheat.—Practically all of the spring wheat grown has been Defiance. The famous Marquis wheat has been tested. This variety matures in a season from ten days to two weeks earlier than Defiance and has a better quality of grain, but under good cultural conditions does not yield nearly so heavy a crop, consequently, for most conditions Defiance is the preferred variety.

Spring wheat should follow peas, or cultivated crop in the rotation. Where the soil moisture is such as to permit fall plowing without undue blowing by winds during the winters the land should be fall plowed so that early spring seeding may be done. Seeding should take place quite early in the spring, in March and April, if possible, injury by early frosts being little to be feared.

Preparation of Soil.—Land for wheat should be plowed rather deeply a considerable time previous to planting. Fall plowing accomplishes this for spring wheat, altho following dry winters land fall plowed may be rather dry for seeding in the spring. This is really the only objection that can be offered where winds do not need to be considered with a specific soil. Prior to seeding, land should be well compacted by disking and harrowing so as to provide a firm seed bed. The preparation of land for wheat, oats, barley, spring emmer and other spring small grain crops should be much the same. Spring wheat should be seeded at the rate of about ninety pounds per acre for most irrigated conditions of the valley. If a smaller amount is used, the stand will be so thin that weeds will take partial possession; if more is used, the stand will be so thick that the grain itself will act as a weed and reduces the yield by undue competition.

In general the care of seed thruout the valley is extremely lax. Seed is often mixed with barley, oats, peas, wild peas and other impurities. More care directed to screening and grading the seed would result in much more satisfactory crops.

Irrigation.—In the spring if the ground holds moisture enough to keep wheat growing, it should not be irrigated. An irrigation should be given, however, just as soon as water is needed. In other words, the wheat should be kept growing continuously. Irrigation should stop at the blooming period and in no case should water be applied after the grain has reached the soft dough stage, except on almost pure gravel patches. Late irrigation deteriorates the quality of the grain and prevents proper ripening.

Proper surface irrigation will return heavier yields than sub-irrigation, because of the better aeration of the soil and increased root room which this method will give.

Harvesting.—Occasionally a wheat crop will be caught by early frosts so as to render it unfit for milling purposes. Under such conditions it is sometimes advisable to harvest for hay. Wheat cut in the soft dough stage and cured makes an excellent quality of very palatable, nutritious hay. When not caught by frosts wheat should be cut in the yellow ripe stage. Stacking is advisable unless thrashing out of the shock can be done within one or two weeks of harvest.

After the wheat is removed there will usually spring up many weeds, especially on the older lands. To prevent the seeding of these weeds and to preserve moisture and fertility it is well to disk the stubble and plow.

OATS.

The cool climate of the Valley is especially favorable to oat production where soils have been kept up in proper fertility. The straw, after the grain is thrashed, makes very good feed, almost as good, in fact, as a great deal of hay grown in lower altitudes.

The preparation of land for oats is much the same as for wheat. Oats should be seeded a little later in the spring than wheat as it is more liable to injury from spring frosts. It is safe to seed in April and even as late as early May if seasonable conditions warrant. The order of planting with most of these crops should be barley, wheat, emmer, oats, as oats will stand the least frost of any of the crops.

What has been said in regard to irrigation for wheat will also apply for oats.

Varieties.—The two varieties that give the greatest promise for the Valley are the Colorado Number 37 and the Kherson. Colorado Number 37 is a Swedish type. The original selection from which it was originated was made by the Colorado Experiment Station in the San Luis Valley and the variety is consequently well adapted for Valley conditions. Kherson is the earliest maturing variety grown in Colorado. It has given very good results and heavy yields of grain. The production of straw, however, is very much less than in the case of Colorado Number 37, but either of these varieties is good.

Growers should follow community growing to a considerable extent—that is, a neighborhood should grow either one or the other of these varieties in order not to have mixed seed or mixed grain. The Colorado Number 37 will probably do best on the

heavier lands. As the soils commence to get lighter Kherson will be the preferred variety. Kherson will do better at the higher altitudes.

Many other varieties of oats, such as the New Market, the Big Four, the Swedish Select, all do fairly well. It would be best, however, for valley growers to confine their selection to the Colorado Number 37 and the Kherson, the two best adapted varieties. Oats are excellent feed and also make a very high quality of hay if cut for that purpose.

Seeding.—The amount of seed to use per acre will depend somewhat upon the variety. Large plump seeds require heavier seeding than smaller ones, but about eighty pounds of seed per acre is the average amount to plant. With very large seeded Colorado Number 37, it will sometimes be advisable to sow as much as ninety pounds or even more to get proper results, because the larger sized seeds run fewer to the pound.

BARLEY.

During the past few years barley has been more or less an uncertain crop in the Valley, altho in general it has been very well adapted to the soil and climatic conditions. However, barley is easily affected by changes in soil and soil fertility, and in recent seasons very deficient barley growths have been secured. The liability of the recurrence of this trouble is the strongest objection that can be urged to barley as a feed crop, but owing to this objection barley will probably be found most valuable as a crop to plant with peas. For this purpose the so-called beardless barley is to be recommended, as the absence of beards is very desirable in feeding hay or straw to animals.

All of the bearded varieties, Hanna, Oderbrucker, and California do well and produce in normal seasons rather heavy yields of thrashed grain.

Seeding.—Barley can be seeded as early in the spring as peas without probable danger of injury from frosts. The earlier planted barley seems, in fact, to make a better growth and to be less injured by seasonal conditions than that planted later. This has been true on experimental plats near San Acacio for the past three years. Barley may be planted in late February or early March if seasonal conditions permit. When planted alone, about ninety-five pounds of seed per acre is required for all of the hulled varieties. Where the berry is exceedingly large, more pounds may be needed, and where exceedingly small a slight reduction in the amount of seed can sometimes be made profitably. With the hulless varieties less seed is required, seventy-five to eighty-five pounds being usually sufficient.

Irrigation.—Barley is more sensitive to changes in the water supply than any other of the small grain crops. A lack of water just at the proper time will always stunt the growth and irrigation should be such as to permit a vigorous continuous growth.

Harvesting.—Barley is sometimes harvested as a hay crop. When the bearded varieties are so harvested they should be cut relatively early. If they are allowed to mature until the stiff dough stage, the beard is liable to be a serious obstacle to successful feeding. The beardless varieties can be cut anywhere from the soft dough to the stiff dough stage and made into good hay.

When cut for grain they should be allowed to get to the yellow ripe or well past the stiff dough stage before cutting. Except in years of short straw growth, barley will be cut with the binder or header. When conditions are such as they were in 1913, when a very short growth of straw was produced, much barley can be harvested only with a mowing machine.

EMMER.

Experience with winter emmer in the Valley is not sufficient as yet to justify its recommendation for general planting. Difficulty seems to be encountered in getting soil conditions such as will prevent severe spring killing. With the soils dry and with windy weather in the spring, spring killing is almost a certainty. Conditions have not been sufficiently favorable to warrant recommending the crop except in favorable locations.

Spring Emmer.—Spring Emmer gives promise of being a strong rival of barley as a grain feed crop. Emmer belongs to the wheat family. The hull, however, sticks to the berry when the grain is thrashed, this peculiarity distinguishing it readily from the common wheats.

Preparation of the land and irrigation are the same as for wheat. Emmer can be seeded as early as wheat, about ninety-five pounds of seed per acre being used. It may have some value as a hay crop in occasional years, but if grown at all it should be for a grain feed.

RYE.

Winter rye gives promise of being valuable as a feed crop both for the straw and grain. It should be planted on land prepared the same as for wheat and at about the same time. From 60 to 70 pounds of seed per acre should be used. Irrigation should be about the same as for winter wheat. The larger proportion of the small grains production in San Luis Valley is for feed. Except to raise seed and to have a grain feed to be used separately, the most of the

plantings may well be in pea-grain mixtures, to which reference has already been made.

SUGAR BEETS.

Sugar beets have been declared a failure for the San Luis Valley. The factory built at Monte Vista and operated for a short time is now idle, partly because of financial conditions, but largely because of the inability of the factory to get beets. The sugar beet crop must be looked upon and treated as a garden crop if successful and profitable yields are to be produced. There is no fundamental reason why beets should not do well in the Valley, but to produce them profitably it is necessary to put the soils in proper tilth and a high state of fertility. The Valley soils contain abundant mineral constituents, but for the best production the soils must also have incorporated in them organic matter in considerable amounts. With the proper incorporation of organic matter, deep and thoro plowing and proper cultivation and irrigation, sugar beets might be a successful crop, but with present methods of management the yields generally will not be heavy enough to induce growers to produce them.

Upon many farms it might be desirable to grow some sugar beets, or preferably stock beets or Swedish turnips, to help out the winter supply of succulent feed. Sugar beets, stock beets and stock turnips all do well on land properly prepared and cultivated. Until a larger proportion of the community is willing to adopt the methods necessary, these crops should be planted in very small acreages, as they are expensive of time and labor.

POTATOES.

In the past potatoes have been considered an excellent crop for the Valley conditions. Some world's record potato yields have been produced. In the past few years, however, blight and other diseases not yet understood have made yields very uncertain. Potatoes make a very poor crop for new lands. When grown at all they should be planted on lands which have been under cultivation for some time—preferably lands which have produced several crops of peas or been in alfalfa or sweet clover.

Potatoes as a market crop are only adapted to the more sandy lands. On such soils as have had their fertility built up by proper rotation of peas, alfalfa or sweet clover, potatoes are still a good crop when prices are good and diseases absent. Whether or not they should be grown is a question for each farmer to settle for himself because of the general uncertainties of production and marketing. Owing to the short season, potatoes should be planted early, preferably early in May. Under Valley conditions, whole

seed should be used. The varieties which are best adapted to conditions are not always the best market varieties, but the Pearl, the Charles Downing, and the Irish Cobler, are among the best varieties.

Potatoes should never be irrigated by sub-irrigation methods, because such soil treatment tends to increase the ravages of potato diseases. Land for potatoes should be in a high state of fertility and deeply plowed. Irrigation should be by the furrow method after the potatoes have been ridged. Small streams of water should be used and great care taken not to over-irrigate. The Colorado Experiment Station has published complete bulletins on potato culture which can be obtained when more detailed information is desired.

FLAX.

Flax does remarkably well on the soils and under the climate of the Valley, but existing freight rates render it inadvisable to grow the crop with the expectation of selling the seed in outside markets as prices are not usually high enough to cover the necessary freight charges and leave a profit to the grower. Flax is an excellent crop to use sometimes as a supplementary feed for livestock. For dairy and pure bred herds especially, a small amount of ground flax added to the rations will give tone and quality to the animals. For such purposes it is sometimes advisable to grow flax. For a cash crop prices usually make it unprofitable.

Land for flax should be prepared as for the small grains. It should be seeded very early in the spring, preferably in April, twenty to twenty-five pounds of seed being used per acre. Flax is subject to a disease known as flax wilt. To reduce the dangers of this disease to a minimum, all seed should be severely fanned to blow out all light seeds. The remaining heavy seeds should be treated with formaldehyde so as to kill all of the wilt spores adhering to the seed.

Irrigation.—Flax does not require heavy irrigation, but it should be kept growing continuously with light or moderate applications of water. The last irrigation should be given not later than the beginning of the blooming period. Late applications of water tend to keep the crop green, thus preventing proper filling and maturing of the seed.

Harvesting.—Flax may be harvested with a binder in the same manner as small grain. The bundles should then either be shocked or allowed to dry until cured. In many seasons flax can be harvested best with a self-rake or an ordinary mower having bunching attachments. When the straw is thoroly dry, it may be stacked or thrashed with a common grain thrasher.

SWEET CLOVER.

Sweet clover has usually been looked upon as a noxious weed. Stockmen and farmers are finding, however, that under proper conditions it is capable of making nutritious pasture or valuable hay. During the past three years the acreage in sweet clover has been greatly extended thruout the Valley, the discovery that it was valuable for feed coupled with the fact that the crop would grow on many of the alkali or partially seeped lands which would not produce other crops, has assisted in its wide distribution.

The two varieties of sweet clover are distinguished by their yellow and white flowers. For Valley conditions the yellow flowered variety is to be preferred because it is the earlier maturing, and will produce good crops of seed as well as hay. Sweet clover seed is almost exactly the same size and very similar in shape to alfalfa seed.

Land for sweet clover should be prepared the same as for alfalfa. The seeding can preferably be done in the spring by exactly the same methods as those used for alfalfa seeding. Eight to fifteen pounds of the hulled seed is sufficient. If the unhulled seed is used, twenty to twenty-five pounds must be planted to produce approximately the same stands.

Irrigation should be the same as for alfalfa. When intended for hay, sweet clover should be cut before the stems have become unduly woody. To accomplish this it is usually wise to cut when the crown shoots for the next crop appear. The first cutting after seeding should be made with the cutter bar of the mower set rather high, and may be begun when the first bloom appears. It is usually unsafe to cut earlier than this, as earlier cutting may result in killing the crop and necessitate reseeding. Methods of hay-making are the same as for alfalfa.

Probably no crop will prove more beneficial as a soil improver than sweet clover. In the short seasons of the Valley it is probably destined to considerably wider use than it now enjoys, both for hay and for pasture.

RODENTS.

Rodents such as prairie dogs and kangaroo rats do an enormous amount of damage to new lands as well as old lands which have uncultivated sections lying adjacent. The damage is two-fold. Prairie dogs and kangaroo rats dig deep holes in the fields, increasing the difficulties of irrigation and sometimes starting very severe soil washing. Unless their numbers are kept down they are also very destructive to crops. In some places it is almost impossible to start any of the garden crops or alfalfa because of the depredations

of these rodents. Frequently they will cut off the roots a few inches below the surface of growing alfalfa, thus killing the crop out so that it has to be reseeded.

These rodents can be destroyed if sufficient effort be made, or with less effort they can be so reduced in numbers that injurious effects from their activities will be relatively light. Probably poisoning is the cheapest means for disposing of them. To be effective, the poisoning must be done in the spring before green growth starts, as the prairie dogs and kangaroo rats will eat poisoned grain at this time, but will not touch it after green things become abundant. The State Entomologist and his assistant have worked out successful methods of poisoning these rodents, and will furnish methods of making up the poison upon request. Poisoned wheat will be sold at practically the cost of preparing it.

A recently devised method of killing off these small animals is by the use of dynamite. When this method is used, a piece of dynamite about an inch long is attached to a fuse long enough to let the dynamite well down into the hole. The dynamite is then lowered into the hole and earth is securely patted around the fuse so as to hold it firmly and stop up the hole at the same time. The fuse is then lighted. The dynamite burns without explosion, giving off poisonous gases which quite effectually kill any animals in the burrow. Most of the dynamite salesmen will supply printed directions for this method of exterminating rodents.