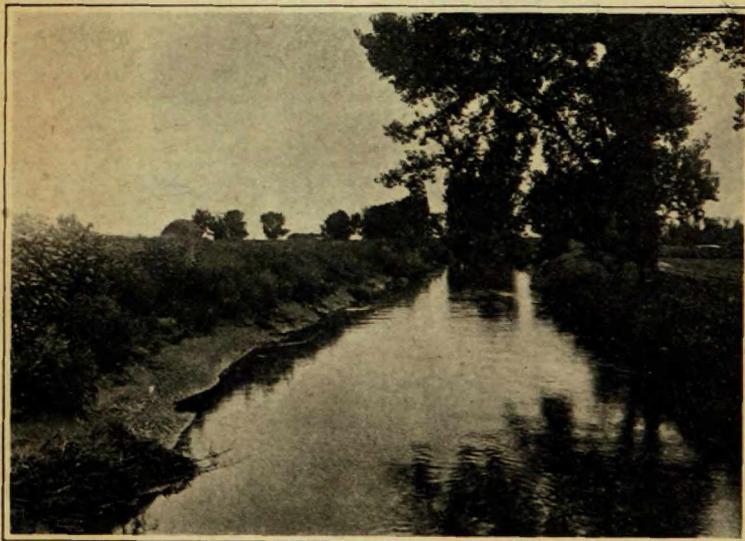


Irrigated Farming IN COLORADO

Being an Authoritative Statement of Facts
About this Method of Farming in
Colorado, Written for the Pros-
pective Settler in the
Centennial State

By PROF. ALVIN KEZER
Head of the Department of Agronomy, Colorado Agricultural College



A COLORADO IRRIGATION SUPPLY CANAL

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Irrigated Farming in Colorado

*By Alvin Kezer, Head of the Department of Agronomy
Colorado Agricultural College*

Irrigation Acreage. Colorado was one of the first states to develop irrigation. In spite of the enormous irrigation development elsewhere, Colorado still maintains first place with respect to acres under irrigation. In fact, California is the only irrigated state which approaches Colorado in the extent of its irrigation enterprises.

At the present time there are about six million acres in round numbers included in irrigation enterprises. Of this acreage, about four million acres receive some sort of irrigation and about three million acres are rather well supplied with irrigation water, so that it constitutes a stable source of wealth in the shape of irrigated agriculture.

More development is under way in a number of sections in the state. There is still possible a great deal of further development. The further development will partly take place through a development and utilization of underground water supplies by pumping, by an increased development and use of flood water from intermittent streams. This later development will necessarily mean the construction of storage works. There is still a small amount of development which may take place on streams where settlement has not yet taken place.

Much of this new development, especially where the construction of storage reservoirs is necessary, will be rather expensive, and will probably be undertaken only when the pressure of population forces prices higher so that the higher prices will justify the increased cost of securing and establishing the water supply.

Where Irrigation is Practiced. Since irrigation is dependent upon a relatively easily and cheaply obtained water supply the irrigated sections of the state are located upon the bottom lands, bench lands and mesas adjoining the principal streams. These may be designated by districts as the northern Colorado district, which is located along the South Platte river and its tributaries, the St. Vrain, Thompson and Poudre rivers. This section is one of the oldest and best developed general farming

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sections in the state. Another region is located along the Arkansas Valley from Canon City east. A very large region is located in the south-central part of the state contiguous to the Rio Grande, which is known as the San Luis Valley. Another is located in the southwestern part of the state, and known as the San Juan basin, a part of which lies along the Animas, La Plata and tributaries of the San Juan river, and a part on the tributaries of the Dolores. In the west-central part of the state is the celebrated Grand Valley, and in the northwestern the valleys of the White and Yampa or Bear. These divisions mark the location of the large irrigation developments.

Numerous small irrigation enterprises are located in different sections of the state, along smaller streams and in shallow water belts where pumping is feasible.

Soils in Irrigated Sections. The soils in irrigated sections are extremely variable. Along the Platte the soils are quite likely to be sands, sandy loams and gravelly loams underlaid with gravel. The tributaries of the Platte, such as the St. Vrain, Thompson and Poudre, have similar soils, although there is a much greater proportion of silts and occasionally even clays. Very little of the land in the Platte drainage, however, is so tight as to be impossible for farming purposes.

The soils of the Arkansas Valley run largely to sandy loams and gravels, yet there are places where the very tightest adobe exists. Such lands require special treatment in cultivation and irrigation in order to get the best production out of them. The soils of the San Luis Valley are somewhat different in formation, since the San Luis Valley is the bed of a prehistoric lake. Most of the surface, however, has been worked over by the present streams. The soils are for the most part sandy to gravelly loams; yet along some of the streams patches of the very tightest adobe are occasionally found.

In the San Juan basin the soils prevail somewhat heavier and tighter. The same is true also of the soils in the bottom lands of the Grand river. The mesas along the Grand river, however, are not so tight. In the northwestern districts where the Yampa and White rivers drainage areas are located, the soils prevail sandy to sandy loams, although on the bottom lands there are frequent patches of extremely tight adobes. The uplands and mesas are usually sandy loams to loams underlaid with gravel. These regions are all more or less mountainous and rock outcrops and patches are frequent.

All of the soils in the irrigated sections are relatively rich in the mineral constituents of fertility, and all of them are relatively poor in organic matter. Everywhere in the irrigated districts it is found that land which has been in alfalfa or sweet clover and which has had a crop plowed under, or where manure has been applied, will yield heavier than the virgin land.

Some of the lands in these irrigated districts are so open that they present some difficulties under irrigation management; some of the lands are so tight that they present just as difficult problems, but problems of an entirely different nature. These extremes, however, constitute a relatively small proportion of the total irrigated acreage.

Cost of Irrigation. The cost of irrigation is extremely variable and runs from as low as \$7 per acre to as high as \$100 per acre. The cheaper costs are to be obtained on ditches which have direct flow and easy construction. Sometimes the water supply in shallow water districts may be obtained by pumping, at prices even lower than this. The higher costs arise in districts where expensive structures, such as reservoirs and expensive canals, are necessary.

According to the United States census, the average cost of preparation of land in 1910 was \$14.50 per acre, which must be added to the cost of obtaining a water supply. The varying cost of irrigation consists in the cost which must be charged to the land for irrigation works, such as canals, ditches, reservoirs, etc., to which must be added the cost of preparing the land for the application of water. The cost of preparing the land for the application of water consists of leveling, often clearing sage brush, other brush or timber, and the construction of farm ditches. As has already been mentioned, the average cost in Colorado for this work is \$14.50 per acre; but in some sections the cost of clearing and leveling will run as high as \$100 per acre. Such high costs are prohibitive except in regions where high priced crops may be produced.

The cost of the water itself will vary from a minimum of \$7 for stream flow conditions to a maximum of about \$100—with a probable average of around \$40 per acre. Occasionally in shallow water pumping districts the supply of water and the necessary pumping equipment can be obtained at a cost as low as \$2 to \$3 per acre, but such instances are extremely rare.

Sources of Irrigation Water. The final source of our irrigation water is precipitation, either in the form of rain or snow. Most irrigation water in Colorado comes from the precipitation in the mountainous regions, largely in the form of snow which gradually melts and finds its way along natural drainage into the streams. From the streams it is diverted by means of diversion works into ditches. It may be applied directly to lands from these ditches, or it may be run into reservoirs which store the supply in times of non-use, or in flood times for use in those periods when irrigation water must be used upon the land.

The reservoir system has been most highly developed in the northern Colorado district. The general practice in a great many of the districts is to use direct stream flow for early spring irrigation and to use flow from reservoirs as well as direct stream

flow for midsummer and late summer irrigation. Many irrigation enterprises depend entirely upon flood waters and reservoirs for their supply of irrigation water. Some of these enterprises are as certain and reliable, though more expensive, than the direct flow systems. In some of them the water supply is more or less erratic, being plentiful in wet years, and apt to be rather deficient in dry years, because insufficient water falls upon the water shed to fill the reservoirs.

The sources of underflow supply are originally the same as the surface flow; that is, the underflow is originally supplied by precipitation. Only in this case the water finds its way through gravels and underground channels so that wells must be sunk and the water pumped to the surface, in order to make use of it. If the underflow or underground supply is adequate and close enough to the surface, it forms just as reliable a source of irrigation water as surface flow. No general rule can be given as to the depth from which irrigation water may be successfully pumped. For the ordinary crops and for ordinary prices, however, it is seldom possible to pump water over fifty feet even where the supply is certain and adequate. If water is to be pumped from greater depths, it must be used to irrigate higher priced crops because of the cost of such pumping.

Water Rights. The right to use the waters is granted under certain legal restrictions by the state. The water itself is the property of the commonwealth. The water rights are assigned by court decree and have value according to their priority, that is, the order in which the decree was given. Thus priority number one has the first right to use water; later priorities do not have the right to use the water unless the early priorities are supplied. On this account it is always wise for new settlers or persons coming into developed irrigated territory from unirrigated regions to familiarize themselves with the water rights, if they are locating under established irrigating systems. Priority number one in a drainage area calling for a cubic foot of water per second might be gilt-edged, while priority number 500 in the same district might supply water only in flood times. Consequently it is always wise for the settler in established districts to ascertain what the value of his water right really is, that is, how much water his water right will really deliver to his land.

As much or more attention should be paid by a new settler to ascertain the water supply of systems being developed, because systems that are under development at the present time may have very late priorities, yet, due to the construction of storage works to hold flood waters, they may have an adequate supply of water. The point is that the settler should ascertain what his supply is, and be sure it is reasonably adequate. A right to a continuous flow of one second foot of irrigation water is sufficient in Colorado to irrigate from 80 to 120 acres in most sections.

Water in reservoirs is frequently measured by the depth to which the land is covered with water; that is, it is frequently spoken of as an "acre foot," or 18 "acre inches" in depth, as the case may be. In the northern Colorado districts two and one-half acre feet of water is considered an adequate supply, except on very porous soils. Two and one-half acre feet actually delivered to the land is probably a sufficient supply, but often measurement is made at the reservoir or ditch intake, and the users on the systems always stand their proportional share of the losses by evaporation and canal seepage. For most northern Colorado districts, in fact for most Colorado districts, a supply of eighteen acre inches actually deliverable on the land, if used with proper methods of cultivation, should be sufficient except on the most open and sandy lands.

Developed Irrigation Farms. - New settlers coming into an irrigated region come in contact with two types of irrigated farms—those which are already developed and which have their water rights, necessary clearing, land leveling, farm laterals, etc., completed or partially completed. Such lands are usually already in active production. Such farms in good neighborhoods, with good water rights, are capable of being judged as to their value as producers. Usually, however, such lands, if good, command relatively high prices, because they are already in a producing condition and do not require a great deal of extra development work before they commence to bring in returns. In purchasing a developed farm, a new settler should spend some time investigating the farming industry of the community, the probability of production, and prices of different crops, and thus be able to judge as to the reasonableness of prices asked. A little time expended in such investigation is well spent. Many of the developed irrigated farms which might be purchased are worth all that is asked for them and often more. But there are cases where too high a price—land, water rights, location and productive capacity considered—is asked.

Undeveloped Irrigated Farms. In locating upon undeveloped irrigated farms, two principal questions should be satisfactorily answered. These call up of course many subsidiary questions. Two of the most important questions to ask are: (1) Is the land good? and (2) Is the probable water supply adequate, and what is its cost of development?

In taking up undeveloped irrigated lands, it must be remembered that the land must bear certain expenses, first of which is the cost of obtaining the water. This will vary with the source of supply which is or may be available. It will often run as high as \$40 to \$60 per acre. The second item of expense will be that of clearing. Nearly all undeveloped irrigated land is covered with some kind of vegetative growth which must be removed—sage brush, scrub oak, trees and other brush are often on the raw

lands. This extra vegetation must be grubbed out, piled and burned before other operations can be carried out. Probably the cost will vary for such clearing from a minimum of around \$3 per acre to a maximum of as high as \$75 to \$100 per acre where there is much timber or timber and stone to be removed. Sage brush is removed in various ways, sometimes heavy plows are used which turn out the brush which is afterwards raked and burned. Special grubbers are on the market and many home-made grubbing devices which successfully pull or grub the brush are in use. In any case where machinery is used there will probably be small patches of large brush which must be removed by hand grubbing. Trees are usually removed by pulling. Sometimes the stump puller is assisted by the use of dynamite. In a few cases the timber from the land will pay the cost of removal. In many cases it has no value outside of its fuel value. After the extra vegetation has been removed there still remains a considerable amount of work to be done to put the surface of the land in shape for applying irrigation water. This work is ordinarily called leveling. If the land is naturally in a fairly smooth condition, a home-made plank leveler of sufficient length and power may be all that is necessary to give the surface a uniform grade. Where there are considerable knolls and bumps, scrapers such as the fresno, buckscraper and slip must be made use of to carry the large quantities of earth from high points to low points. In any case the last leveling should be made by float or box leveler, sometimes called a plank leveler. All of these operations are expensive, especially if much work must be done to accomplish the result desired, namely, a surface having uniform slopes for the distribution of water. Where the land surface is naturally in a very smooth condition, requiring nothing but the heavy plank leveler, the cost may be less than \$1 per acre, and where much work has to be done it may rise to \$50 or even more per acre. The cost for leveling largely depends upon the amount of dirt which must be moved to get the desired surface. The grading costs on new land are not considered unusual where they amount to from \$15 to \$30. Many lands do not require near this amount, and many require more.

✓ **Irrigation Methods.** Water is applied to the land in different ways. When distributed by flooding from field laterals it is called flooding or wild flooding. The flooding method is used almost entirely for grain crops and hay crops in the northern Colorado districts. It is used somewhat in the northwestern districts, slightly in the western districts, and to some extent in the southern districts. It has some advantages and many disadvantages. One of the great advantages of the flooding method is the rapidity with which water may be spread by an experienced irrigator. The disadvantages are the tendency to waste water, to over-irrigate portions of the field and under-irrigate others, and to lose much water by waste overflow and by seepage.

The furrow method of irrigation is used exclusively in some sections for all crops, and is used in nearly all sections for cultivated crops such as beans, potatoes, sugar beets, corn, etc. When the furrow method is used the water is run in small furrows spaced at suitable distances. In this method the water is not allowed to cover the entire surface of the ground, but wets the soil by percolating downward and sidewise. Of course, care must be taken to have the furrows so placed on the land slopes that there is fall enough to move the water and not enough fall to severely wash the land. The furrow method is economical of water if correctly used, and is the only method that should be used on tight adobe lands and on many rough lands which are likely to wash. The heads carried in the furrow method are always small in the individual furrows so that "washy" lands are more easily watered with less danger of serious washing. The furrow method is used almost entirely for rowed crops in all districts, and is almost exclusively used in the San Juan basin and certain sections of the Grand Valley.

The check method of irrigation is used in a few localities. By this method small borders or checks are thrown up, usually by machinery, and water is run into the check and left there until it soaks away.

In a very few localities a combination of the check and flooding methods is used. Low dykes or checks are thrown up which confine the water to definite strips; water is then flowed between the checks on these definite strips. Where the land can be arranged for this method it is extremely saving of the irrigator's time.

Sub-irrigation. Sub-irrigation is practiced in a few sections. However, in most of these sections its use is pernicious and should be abandoned for some type of surface application. The greatest sub-irrigated district is located in the San Luis Valley. This district has made sub-irrigation unduly popular. However, only about one-fourth of the irrigation used in the valley is done by this method.

Water Losses. The irrigation water supply suffers certain losses. A part of these occur before the water ever reaches the farm to be irrigated. Such losses are known as reservoir and canal losses, and consist of loss by seepage from the canals or reservoirs and evaporation from canals and reservoirs. Canals almost never deliver as much water to the land as is diverted for the service of the canal, either from reservoirs or from the direct flow of streams. Water loss by seepage from canals and reservoirs is often troublesome, because it frequently flows into or onto lands, injuring them—sometimes rendering them useless for agricultural purposes.

While such damage and losses occur, of course it affects a relatively small area, with respect to the total irrigated acreage.

Yet it is a factor which must be considered in irrigated regions. All the loss of water, however, is not canal loss or reservoir loss. Much water is lost or wastefully used on the land itself. If too much irrigation water is used, much of it passes into the subsoil entirely beyond the reach of plant roots, and is thus lost by percolation. Unless care is used in irrigating, the water may be lost as surface run-off or wastage. These two types of loss are capable of a great deal of control. They can be reduced to a low minimum and often entirely stopped by a skillful and competent irrigator. Canal losses may often be reduced by simple expedients, but usually such losses require concerted action on the part of the canal users. The losses on the farm itself, however, are chargeable directly to the farmer, because they are dependent upon the skill or lack of skill of the individual irrigator.

IRRIGATION OF CROPS

In irrigating crops it must be remembered that irrigation in Colorado is practiced because the climate is semi-arid or arid and that the irrigation supply is provided to supplement a deficient precipitation. If this point is kept in mind, irrigation water will be more efficiently used than will be the case where the idea prevails that the water should be poured into the land indiscriminately.

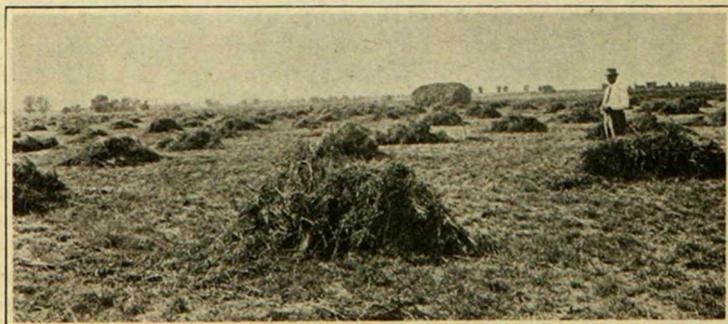
No absolute rule as to the time and amount of irrigation application for crop production can be laid down. This is due to the fact that natural precipitation conditions vary widely in different localities. In some localities it is necessary to irrigate crops up, while in many localities natural precipitation will be sufficient to germinate and start the crop. If the supply of water were adequately available at all times, the ideal method would be to keep the soil in that condition of moisture which is best for the growth of plants, but oftentimes the supply of water is intermittent as to season and even then is delivered in rotation to users. Thus there are times when it is necessary to irrigate when the water can be obtained, simply because to wait until it could be next obtained would ruin the crop, altho application at that time may not be the very best for desirable crop growth. The aim should be, however, to irrigate as near as possible at the time that will keep the soil in the best condition of moisture for crop growth.

In a few localities there is a good flow of water in the fall, but a deficient flow in other seasons of the year. In many such localities fall irrigation may be profitably practiced, because it fills the soil with moisture, which when supplemented by the natural summer precipitation, will produce fair yields. Even in such districts, however, it would usually be wiser to provide storage facilities if such are at all feasible and store such fall and winter flow in reservoirs for summer use.

Irrigating Alfalfa. Alfalfa possibly has a larger acreage in Colorado irrigated agriculture than any other one crop.

1. Because the continued success of irrigated agriculture is largely dependent upon this crop as a rotation and soil building crop. The land for alfalfa, if possible, should be leveled with extreme care, as alfalfa being a perennial crop is likely to remain on the land for several seasons. Poor leveling increases the work of irrigation and may seriously reduce the yield of the crop. In the northern Colorado sections, alfalfa is almost uniformly irrigated by the flooding method. In the San Juan basin, many places on the western slope and in the Arkansas Valley, it is irrigated by the so-called furrow method or corrugated method. Water should be applied to alfalfa so as to get the best production. In northern Colorado, in ordinary seasons, one irrigation should be given about one week to ten days before the first cutting comes off. In dry seasons it may be advisable to irrigate early and give the second irrigation about one week before the crop is ready to cut. The object in irrigating at this time is to have sufficient water in the soil to force the vegetative growth and also to start the growth of the following crop quickly. On deep sandy loam, silt loam, loam and adobe lands one irrigation for each cutting will normally be sufficient, but on very sandy lands, especially if they are shallow and have gravelly subsoils, one to three irrigations are required for each cutting. Thus, in northern Colorado on the tighter soils, three irrigations are usually all that are given to secure three good cuttings of alfalfa, while on the sandy lands some five to seven irrigations are given to get the same results. It is usually best to apply the irrigation a week to ten days before cutting. Water can be controlled better at such a time, evaporation losses are lower, and the soil is put in good condition for the growth of the next crop.

The average yield of alfalfa on Colorado irrigated lands as given by government statistics is slightly less than three tons per



A TYPICAL COLORADO CROP OF ALFALFA ON IRRIGATED LAND

acre per year. Except on the sandier lands mentioned, 18 acre inches of water actually applied to the land should be amply sufficient to produce even greater tonnages than this. Often, however, much larger amounts are used without materially increasing the yields. This is due to improper use. Irrigation water tends to pack the land. Consequently, on many of the tighter lands, it is advisable to cultivate the surface early in the spring after the second year. This is to loosen up the crust where there is a tendency for its formation, thus permitting water to enter the soil more easily. It also brings about a better aeration of the soil, which seems to promote growth under irrigated conditions. Alfalfa on irrigated lands is frequently allowed to stand for years. Except where alfalfa hay is the principal source of income, it would probably be very much better if alfalfa were allowed to remain on the land only from three to five years. When it is plowed up in the rotation, one cutting should be plowed under for green manure, in order to get the full benefits of the fertilizing value of the crop.

Sugar Beets. Sugar beets constitute probably the greatest cash crop of irrigated regions available to transportation and sugar factory facilities. Owing to the great amount of expense necessary in the production of sugar beets they should be put in on the best land, prepared in the best way, because a high tonnage is necessary to produce profitable yields. It costs from \$40 to \$60 an acre to produce sugar beets. Consequently, a tonnage of from 9 to 12 is necessary to pay cost of production. The profits are made by producing much more than the average. To get this high production, sugar beets should be grown not only on the best land, but land in a rotation in which alfalfa or some other legume is used and upon which manure is used. On most farms alfalfa production is necessary not only for its rotation value, but to furnish hay for feeding operations thru which manure is produced.

Land for sugar beets under irrigation should be prepared by deep plowing. Preferably sugar beets should follow a grain crop. When alfalfa is broken up it usually would be advisable to put in wheat. Manure the wheat stubble and plant sugar beets after wheat, using not over two crops of beets in succession upon the same land. Sugar beets are normally planted in rows twenty inches apart. In the northern Colorado districts it is very seldom necessary to irrigate beets up. If the land is properly handled the natural precipitation is almost always sufficient to start the crop. Sugar beets, however, produce best yields and the best sugar content where they are kept growing constantly from the time of germination up to the ripening period. Irrigation should be used so as to accomplish this purpose. Comparatively light, frequent irrigations always followed by cultivation, produce this result with the greatest certainty, but often labor, water

supply and other conditions are such that heavier and less frequent irrigations must be used.

Sugar beets are always irrigated, or should be, by running water in furrows between the rows. The furrows are made by ditch openers provided on the cultivating machinery. Sometimes home-made furrow openers are used, which accomplish the results better for peculiar local conditions. It is very seldom necessary in northern Colorado districts to irrigate sugar beets before well along in May, and often not necessary until June. Very little is ordinarily gained by irrigating after the first of September, altho individual seasonal differences will make some variation from these general rules. In the Arkansas Valley it is often necessary to irrigate the beets up. On the lighter lands it is usually best to furrow the land, plant the beets, and then irrigate. On the heavier lands or tighter lands, however, it is usually best to irrigate first, giving a cultivation and final leveling just as soon after irrigation as the land can be worked, and then plant. The same precaution should be taken in other districts where it is necessary to irrigate the crops up.

Irrigation of Grain. The irrigation of wheat, barley and oats is so similar, that a description of handling these crops will suffice almost for any one or for all of them. In irrigated regions the wheat acreage is largely spring wheat, because potatoes and sugar beets enter into the rotation and often prevent fall seeding. Occasionally, however, winter wheat is grown. Where winter wheat is grown, it is sometimes necessary to give one irrigation in the fall in order to have water enough in the soil to germinate and start the crop. This is especially true in the regions of most deficient rainfall, such as the Arkansas Valley and the San Luis Valley. In northern Colorado if the grain stubble is disked immediately after harvest, so as to break up any surface crust which may have formed and to kill weeds and other vegetation, a seed bed may usually be prepared having sufficient moisture to start the crop. In the case of spring grains on the heavier lands, the soil should be prepared by fall plowing wherever possible. If the spring grains follow beets or potatoes, the fall plowing will necessarily be late. Some lands are so light that it is inadvisable to fall plow on account of the danger of blowing. Spring plowing where done should be done as early as possible. The plow should be followed immediately by the disk and harrow, and the land should be leveled prior to seeding. The annual leveling which is done as a part of the process of preparing a seed bed is done by the plank leveler. This process differs from the first leveling of land in degree only. The object is to produce a surface of uni-

form grade in order to facilitate the easy distribution of water. Most of the tillage operations such as plowing, disking and harrowing leave smaller or larger depressions. The leveler equalizes these, leaving a surface of fairly uniform grade. In the northern Colorado districts, it is very seldom necessary to irrigate small grains up. In the Arkansas Valley and often in the San Luis Valley natural precipitation is so deficient that it is necessary to irrigate in order to have water enough to start the crop. On the tighter lands where this is necessary the land should be irrigated, then disked, leveled and harrowed as soon as cultivation is possible, planting operations following this preparation. On light, sandy lands it is better to plant and irrigate after planting because sandy lands dry out at the surface so quickly. If there is moisture enough in the soil to keep the crop growing, there is no need of irrigating until about the time the crop commences to head. The crop, however, should not be allowed to suffer for water, even if it is necessary to irrigate prior to this time. On the tighter lands in northern Colorado one irrigation for small grains is usually amply sufficient. On the sandier lands two or three irrigations will be necessary to produce the same results. In those sections where it is necessary to irrigate crops up, two irrigations on the tighter lands are sufficient and usually three irrigations on the sandier lands. Heavy irrigations at the time the crop is developing straw tend to increase the straw growth without materially increasing seed production. If the crop is growing rather vigorously, showing no need of water, the heaviest seed production can be obtained by irrigating when the grain is in the flower, or just a trifle later, that is, just as the grain is heading out. There are certain critical periods in the development of grain crops when water is absolutely necessary. The first of these is when the crop is germinating. The second at the stooling period, the third at the jointing period, and the fourth in the heading stage. Barley, especially, is very sensitive to a shortage of water in the jointing and heading stages. However, the actual amount of water which the crop will use in these stages is very slight compared with the amount used from the heading period on. The amount of vegetative matter produced is very small during the stooling and jointing stages, and is very large from the heading stage to maturity. Little or nothing is gained by irrigating after the grain is in the milk and often losses are caused by delayed ripening and lodging.

Of the winter wheats grown in the district, Turkey Red is the most generally adapted. It should be seeded under irrigated conditions at about 60 pounds per acre. Of the spring wheats the wheat most generally adapted for irrigated conditions is the De

fiance, a wheat originated in Colorado. In dry, sunshiny seasons Defiance will far out-yield any other spring wheat, which is adapted to our irrigated conditions. In cloudy, wet seasons, however, there are some other spring wheats that are superior to it. Owing to the fact that the dry, sunshiny seasons predominate, Defiance is more generally adapted.

Barley is the great feed grain of the irrigated sections. Barley in Colorado irrigated sections will produce a greater amount of feed per acre than will corn in the corn belt. A large number of varieties are adapted. Part of these are the so-called brewing barleys, and part are feed barleys. Of the feed barleys the California or Coast type is probably the best. Of the brewing types Oderbrucker, the so-called Scotch Frow and Hanna are among the best.

For irrigated conditions, about three varieties of oats may be recommended. For feed purposes on the farm Kherson is one of the best for all irrigated conditions. As a market oat, probably the best is the Colorado 37, a selection from Swedish Select. This is to be preferred on account of its color. The Great Dakota, a New Market type, does unusually well in the cooler, irrigated sections where the altitude is above 7,000 feet. The Kherson oats can be grown at higher altitudes than any other oat grown, and is the best one to use in regions having elevations from 7,000 to 8,500 feet.

Corn. Corn is not generally grown as a grain crop under irrigation. This is due to several factors: (1) Most of the irrigated regions, owing to altitude, have very short seasons. As a consequence full development is impossible except with the very short season corns, for most irrigated districts. (2) More grain feed may probably be produced with other crops at a lower cost. However, the increase of the dairy industry in irrigated regions has caused a very large increase of corn acreage for silage. Along with this development of corn as a forage crop has come some development as a grain crop. This has been especially true in the Arkansas Valley, where the seasons are hotter and longer than in other irrigated sections of the state. Whether the crop is to be produced for forage or grain, the preparation of the land, irrigation and cultivation is the same. The only difference is a thicker rate of planting is used for corn intended for silage, than for corn intended for grain production. Preferably land for corn should be fall plowed. Where this cannot be done for any reason, spring plowing should be done as early as possible. Corn under irrigated conditions should always be surface planted. Care should be taken to so place the rows

on the land as to take advantage of the slope, so that irrigation water will run with the rows, with sufficient and not too much grade. Corn in its early development requires very little water, so that if the soil contains moisture enough to start the crop off and keep it growing, irrigation early is unnecessary. If there isn't water enough in the land to do this, irrigation should be given. Very little water is needed by corn up until tasseling and silking time, but the light demand must be met or the tonnage of forage or yield of grain will be reduced. Corn in irrigated farming should never be planted until the soil is thoroly warm and all frost danger past. This will usually be about May 20th, in most districts where corn may be grown. Corn for grain might be produced in most localities having an elevation of not greater than 5,000 feet. Corn for forage may be grown under irrigation from 1,000 to 1,500 feet higher than for grain. For grain a variety must be obtained which will ripen in the short seasons. Of the native varieties the Swadley dent, Parson's High Altitude corn, some of the native calicos, the so-called Farmers' Reliance varieties will meet these requirements. Of the imported varieties for grain production Minnesota No. 13, Wisconsin No. 7, and U. S. Selection No. 133, have given excellent promise. Any of these corns may be used for forage or silage, and in addition to them Iowa Silver Mine, Leaming, and St. Charles White may be used at altitudes lower than 5,000 feet. These varieties at these altitudes will mature to the dent stage, which is sufficient for silage purposes. Occasionally, however, an especially short season may catch them before they are sufficiently matured, even for silage.

Miscellaneous Crops. In addition to the crops described above, there are a large number of common farm crops which are used in certain localities, or may fit into the irrigation system. Of these may be mentioned sweet clover, which in some sections of deficient irrigation water supply may be used as a good hay and seed crop, alfalfa for seed production in many sections of deficient irrigation water supply, stock beets, stock turnips, field peas in the higher altitudes, alsike and timothy for meadows in the higher altitudes, pinto beans, and quite a large list of other crops which are occasionally grown. Of these crops, beans are rapidly becoming a staple. They yield well under irrigation, even where the water supply is insufficient to produce maximum crops of grain, alfalfa and sugar beets. Pinto beans under irrigation should be planted in rows about 28 inches apart. Thirty to forty pounds of seed are required per acre. Usually two irrigations are sufficient, in fact two irrigations at the proper time on all but the very sandiest lands would probably produce heavier

yields, if proper cultivation is used, than will heavier irrigation.

In the higher altitudes, especially in the San Luis Valley, field peas are very extensively grown as a rotation and feed crop. They are best planted in drills using a drill having a revolving cup type of feed in preference to the fluted roller type. The revolving cup type of force feed in the drill does not damage as much seed. Land for peas should be prepared in the fall or very early spring, as early planting is highly essential to heavy seed or grain production. In regions where field peas have been grown for a number of years, 20 to 35 pounds per acre are sufficient. In regions where they have never been grown, heavier seeding is desirable, probably 60 pounds will constitute an average.

For permanent meadows in the higher altitudes, timothy, alsike, clover and brome grass are the best meadow crops. Three to four tons per acre in good high altitude irrigated conditions are not unusual yields from timothy alsike mixtures. These crops also make very excellent pastures in the higher regions.

Pasture Crops. With adequate water supply, pastures under irrigation are possible and often desirable. Probably the best general pasture mixtures are those made up of brome grass, timothy, orchard grass, meadow fescue and either alsike clover or sweet clover. A good irrigated pasture with an adequate water supply ought to grow feed enough to carry two full grown animals per acre for a period of 4 to 5 months where the altitude is not higher than 5,000 feet.

Management of Irrigated Farms. Irrigated farming is the highest type of farming in American agriculture. It requires an adaptability, information and aggressiveness greater than farming in any other American region. Irrigated farming in Colorado is always under arid or semi-arid conditions. The water is, or should be, put onto the land to supplement and make the best use of the meager natural precipitation supplies. It is necessary for the farmer to know how and when he must irrigate his crops. So important is knowledge and alertness that the difference of a week in the time of irrigation will often spell the difference between a good success and almost abject failure. In most humid sections the difference of a day or two in a farming operation makes little difference, but in irrigated sections it often means the difference between success and bankruptcy. It is not unusual where inexperienced irrigators are applying water for the first time, to find spots in the field where the water was not applied. Often a border line can be distinguished between the points where water was intelligently used and where it failed to reach, good

crops prevailing on one side and the unirrigated spot yielding nothing.

We have already mentioned the fact that irrigation water was intended primarily to supplement natural precipitation. If this is done to the greatest degree possible, it means that for all cultivated crops cultivation will be given just as soon after irrigation as possible until the crop reaches a stage where cultivation will produce injury, or where the growth of vegetation is sufficient to shade the surface. Cultivation in irrigated sections saves water by preventing the formation of a crust and by keeping down weeds and other undesired vegetation. Cultivation will make a small water supply go further and will get more out of an adequate supply. There is always a tendency for irrigation water to puddle and pack the surface. Cultivation breaks up this tendency, reduces water losses to a minimum and thus gets higher efficiency out of the water in the land; besides, it is better for the land to use as little irrigation as can be done and get results in crop yields. Intelligent cultivation with irrigation accomplishes this desired end.

As in any other line of farming, size of business affects the income from irrigated farms. The number of acres in cultivation is not always a sign of size of business, because on small acreage expensive and valuable crops may often be produced, hence no general rule may be given for the number of acres which should constitute an ordinary irrigated farm. But from investigations already made, it would seem that about 120 acres was as small an acreage as should be used for general irrigated farming.

On general irrigated farms in the sugar beet, potato and sugar beet-potato sections, high priced crops may be successfully grown. On such lands the main sources of income are likely to be sugar beets or potatoes or a combination of the two crops. Under irrigation heavy crops are possible, consequently the draft on the land is extreme. For this reason extra measures must be used to keep up the productive capacity of the lands. To keep up this productive capacity, it is necessary to follow a rotation in order to get a leguminous crop on the land, and also to furnish roughage for live stock feeding in order to produce manure.

In most moderate altitudes alfalfa is the great leguminous rotation crop.

Probably a good general subdivision of the acreage would be one-seventh to one-fifth of the total irrigated acreage in sugar beets or potatoes or both, about two-sevenths to two-fifths in small grain and the bulk of the rest of the acreage in alfalfa. The rotation should be planned so that alfalfa occupies the land

at least three years. In concluding the rotation one cutting at least of alfalfa should be plowed under for green manure. Most Colorado irrigated soils are very rich in the mineral elements of fertility, and most are rather deficient or low in organic materials. Consequently, plowing under a green crop of alfalfa or applying manure, materially increases productivity.

Plans should be made by every irrigated farm owner to keep enough live stock to use up the low priced products of the farm, such as straw, alfalfa hay, beet tops and crowns. Often it will be advisable to construct silos and make a portion of the acreage under cultivation produce corn for silage. By managing land in this way a considerable amount of manure is produced which will materially help in keeping up profitable yields on the high priced cash crops such as beets, potatoes and in some districts beans.

In regions of good water rights and heavier soils, some pasturage can profitably be included as a regular part of the farm. With live stock and the crops mentioned two to three main income producing enterprises can be sustained. If dairy animals are kept, as will be profitable in some localities, dairy products will furnish an additional source of income. By combining these enterprises so as to distribute the work thru the year, the farm income may be materially increased.

In practically all irrigated farming one decided element of success will be to so farm and so irrigate as to produce heavy yields. The overhead expenses of interest on capital and water costs are large, so that large yields must be obtained to justify irrigation as a farming institution.

At present in many irrigated sections live stock is almost unknown, if work stock is excluded. This is poor management because in ordinary times at ordinary prices live stock will make extremely good use of what would otherwise be waste product. Certain sections in irrigated districts have gained a reputation for specialized forms of live stock feeding, as for instance, the Fort Collins district has become famous as a sheep feeding center, 500,000 to 800,000 lambs being fed annually in the Fort Collins section. The San Luis Valley is acquiring a similar reputation for hog feeding, altho considerable numbers of cattle and sheep are likewise fed in that locality. (Often irrigated farms lie adjacent to rough and cheap pasture land. Where such is the case a combination of farming with stock ranching materially increases the farmer's income.)

Irrigated farming in the higher altitudes is nearly always associated with some form of stock farming, because the crops which may be grown at altitudes from six to eight thousand feet

for the most part must be marketed thru live stock in order to obtain profitable sale. Many such farms are so situated as to profitably make use of live stock because they lie contiguous to forest reserves in which grazing privileges may often be leased. Many of these high altitude farms are at considerable distances from transportation facilities. With live stock they often make quite profitable incomes. Without live stock the crops can scarcely be marketed. A few of these high altitude regions are potato districts, and when this is the case potato growing as one principal source of income in connection with grain, field peas and meadow crops, constitutes rather a good organization.

Newcomers Should Get in Touch with the Colorado Agricultural College

Persons coming to Colorado with the intention of engaging in any of the various agricultural pursuits should immediately get in touch with the Colorado Agricultural College. Through co-operation with the United States government, the Colorado Experiment Station, located at the college, is constantly engaged in experiments and investigations the aim of which is to make more successful and profitable the agricultural industries of the Centennial State. Bulletins containing the results of these experiments and other information on agricultural subjects are mailed free to all residents of the State who request them. Through the Extension Service, also maintained in co-operation with the United States government, twelve county agricultural agents are now aiding the farmers in eighteen counties of the State, specialists in animal husbandry, farm management, demonstrations, markets and marketing and home economies are helping the farmers and farm women, and many valuable publications are being issued. To obtain Experiment Station bulletins, simply write stating your request, to the Director, Colorado Experiment Station, Colorado Agricultural College. For information from the Extension Service, address the Director, Extension Service, Colorado Agricultural College. The College is located at Fort Collins, Colorado.

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