

The Agricultural Experiment Station

OF THE

Colorado Agricultural College

**Dry Land Farming In Eastern
Colorado.**

(Information Bulletin.)

BY

H. M. COTTRELL

The Agricultural Experiment Station

FORT COLLINS, COLORADO

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INTRODUCTION.

This bulletin is intended as an aid to settlers, many of whom have been coming into Eastern Colorado, attracted by the prospect of cheap land and the hope to develop homes. While there have been successes on the plains, our duty would not be performed to the proposed settlers nor to the State without a word of caution. The important thing for the plains is not so much a large settlement as the success of those who do come. It should not be forgotten that there are many chances of failure. This is not entirely due to the country, for many are not able, or do not care, to adapt themselves to the conditions. Experience indicates that the best hope of success is to be found in dairying and in poultry growing, with crops as an important adjunct, grown principally for forage.

It is well that each intending settler should see the plains, learn the difficulties, satisfy himself whether he is adapted to them. I would not discourage such, but those who do not understand the conditions, who are not adapted to them, or who do not have capital enough to tide over one or more unfavorable years are apt to meet with bitter disappointment. Sometimes the impression has been disseminated that some newly discovered practice termed "scientific" has overcome the previous difficulties and lessened the dangers or that there has been a change in climate. This is misleading to say the least. No practice lessens the need that plants have for water though there may be better use of what is to be had.

The principles are those of good cultivation everywhere. Aid should be made of every favorable condition, and then there will be years of hardships. The use of irrigation from wells, by pumping, the collection of floods in draws or gulches, the building of ditches to hold the runoff waters and give time for them to be absorbed, may serve as additional aids of considerable value and help to tide over unfavorable seasons.

For those who meet the conditions with patience and intelligence there may be abundant success.

L. G. CARPENTER, Director.

Dry Land Farming in Eastern Colorado

BY H. M. COTTRELL.

Dry land farming is a continual fight against relentless, unfavorable conditions. Success depends upon the man; his courage, his knowledge and judgment, and his persistence. Physical strength and endurance of both men and women is a large factor in this struggle. With the best seeds and methods of tillage there will be some years of total failure and many others of short crops. It is safest to lay plans that will furnish a living with an average of two failures each five years. There have been three consecutive years of no crops followed by as many years of good crops.

Conditions are much more favorable than they were twenty or even ten years ago. There has been no increase in the rainfall, but the methods of storing and holding moisture in the soil are better understood. Today there are dry land plants that will produce crops with limited rainfall and seeds of these crops that have been selected and bred under arid conditions.

Thousands of failures have occurred on the Plains that have been due to other than climatic causes. Men came and used seeds and methods adapted only to humid regions and persisted in the face of continuous failures until they lost their all. Men came without the capital absolutely necessary to carry them over poor years, and their first seasons were ones of severe drought. Men arrived with families, and after paying the freight on their few household goods had no money left. They had not been thrifty enough to save anything in a humid country, where they had been familiar with profitable methods from childhood. They started in an arid climate, penniless, without any knowledge of the methods needed, and with seed, feed and family supplies to be purchased for from six months to two years before any revenue could be expected. Men came with little money to raise grain exclusively. The surest income in eastern Colorado is made from dairying and poultry.

A man unfamiliar with dry land farming should not settle on the Plains unless he has sufficient capital to erect the buildings that are absolutely necessary, to buy the needed teams and implements, and after making these expenditures, have sufficient money left to pay for seed, feed and living expenses for two years.

Men have taken claims in eastern Colorado who had little or

no money, and after years of pinching and hard work have secured a comfortable home and good living. They have been men of dogged perseverance and good judgment, and usually their families have suffered hardships which no man has a right to ask of his wife and children. Thousands of other men have come with little money; their first years were during drought, and after losing their little, moved eastward, often with the help of friends.

After selecting land and erecting a temporary stable, the new settler should either rent a house or live in a tent until he has secured a good well. In many cases comfortable houses and stables have been built and a good acreage broken, all to be finally abandoned and the investment lost because no water could be secured on the farm.

In some places on the Plains the underground water seems to exist in narrow strips with wide areas on each side without water. In other places, the underground water can be secured wherever wells are dug deep enough to tap the sheet water. There is little information that will enable the new settler to form any idea as to what the difficulties in most localities will be in finding water, and as the Plains of eastern Colorado cover an area as great as the State of Ohio, there is a wide variety in conditions. Two neighbors took adjoining claims, and after erecting buildings, breaking ground and putting in crops, hauling all water three miles, started to dig wells. One man put down twelve holes without finding water. The other man found water in his eleventh well, and it was half a mile from his buildings.

After a good well has been secured, permanent buildings may be constructed and land broken and crops planted. The living should be made from dairy cattle and poultry and the methods suggested in this bulletin followed.

The new settler had better break up and seed not over forty acres until he has learned how to farm under dry land conditions, and he should till this thoroughly. Ordinarily, three hundred and twenty acres of dry land will be needed to comfortably support a family. A good arrangement for this is eighty acres in growing crops, eighty acres in summer fallow, or part in summer fallow, and part in crops intensely cultivated, and one hundred and sixty acres in grass. With this amount of land it will often be profitable to rent a winter pasture.

In most dry land counties there are farmers who have lived on their farms for many years, studied local conditions carefully and have comfortable homes with fruit, garden and shade. The new settler should get acquainted with such men at once and should watch and study their operations month by month. The average old settler has not succeeded in making much of a home and usually what he does and says discourages the new neighbor.

The Director of the Colorado Experiment Station, Fort Collins, and the Superintendent of the U. S. Dry Land Experiment Station,

Akron, Colorado, will be glad to furnish any information they or their associates may have and should be consulted often. Reliable books on Dry Land Farming should be thoroughly studied.

Every advantage should be taken of natural conditions. Draws and the lower areas of high uplands can be prepared for garden, fruit trees or alfalfa. Often many acres can be watered from higher prairie lands by running furrows through the sod to catch the storm water as it runs off. It is well to look for such opportunities when selecting a farm. It takes several years to get prairie sod in good condition, but with thorough tillage the tilth and the water-holding capacity increase each year.

THE SYSTEM OF FARMING TO FOLLOW.

Exclusive grain growing in dry land farming has been a failure wherever tried during the past thirty years in Kansas, Nebraska, Minnesota, the Dakotas and Colorado. Yet most of the settlers on the dry lands of eastern Colorado, in the past three years, came with the idea of growing grain only. Many have boasted that they did not even keep a cow for milk.

Hundreds of these grain growers have failed, lost their homesteads and what money they brought with them, and have had to leave the state, sometimes with the help of eastern friends. They made the inevitable failure which was certain to come from their disregard of the experiences of tens of thousands of farmers who had worked under similar conditions. This makes the third time that eastern Colorado has been settled and then almost depopulated.

To many new settlers who are starting in dry land farming on the plains of eastern Colorado, dairying and poultry raising offer a sure income. In the past thirty-four years there have been but few years so dry but that a sufficient quantity of feed could have been raised together with the native grasses to produce a good yield of milk.

Dairying and poultry raising are the profitable lines to follow in dry land farming where the settler's capital is limited, as both give quick and regular cash incomes.

The average annual rainfall on the Colorado Plains varies in different localities from 13 to 19 inches, adequate with good methods, to produce a profitable crop of wheat. In about half the years the rainfall is below these averages, and has dropped as low as 6.93 inches in 12 months, in one section, and in other places to as low as 7.11 to 10.74 inches.

In years of low rainfall, the moisture is not sufficient to produce crops of grain, but there is usually enough for fair yields of forage crops, such as milo maize, sorghum, kafir corn, corn fodder and hay from wheat, oats and barley. These forage crops are not marketable, but become money makers when fed to dairy cows and hens.

Dairy cows and hens, properly selected and handled, will furnish

a comfortable income and enable the farmer to pay cash for his family purchases, no matter how dry the year. Then, the dry land farmer should seed as much land to wheat as he is able to prepare thoroughly with intensive cultivation, and when he raises a crop, the money from it will be surplus cash and will not be needed to pay old store bills, as is the case with the strictly grain farmer.

DAIRYING.

The income in different dairy herds of Colorado ranges from \$12 to \$120 per cow per year, depending upon the quality of the cows kept and the way they are treated. Careful farmers in the dry land section should make good cows give an average return of \$30 to \$50 each per year. Many do not get more than \$12 per year per cow.

The dry land farmer's supply of feed is constantly limited by the sparse rainfall, and for this reason he needs the dairy cow that will make the most from every pound of feed that he can give her. The selection of the cow is of first concern.

The largest returns in Colorado are being secured from cows of the extreme dairy type and of the Holstein, Jersey, Guernsey and milking Short horn breeds. The unprofitable dairy cows are those that convert most of their feed into flesh and yield a good quantity of milk for a few months only.

Most dry land farmers do not have the money with which to buy pure bred dairy cows, and can not give them the necessary care, shelter and feed. Generally the dry land farmer had better secure his cows from neighboring herds of beef cattle, selecting the cows with dairy forms that are usually found in beef herds. Not always, but as a rule, he will find that such cows are grade short horns.

In selecting range cows for dairy herds there are four essential points:

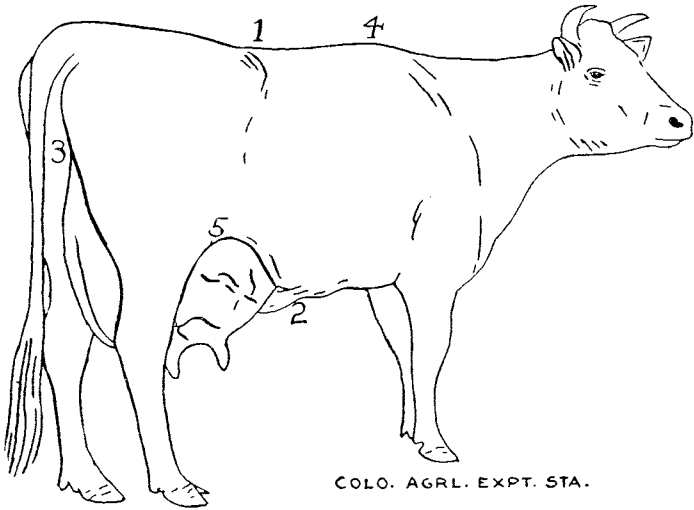
1. *Great Stomach Capacity.* The dry land farmer can feed little grain and his cows must daily eat large quantities of grass or roughage to be profitable. This requires ample room for storage, and to secure it the cow must be deep from back to belly, in front of the hip bones, and broad in the same region. Avoid a round bodied cow whose ribs are short and a flat ribbed cow. The ribs should be long and well sprung, providing for a large paunch.

2. *The cow's back should be sharp* and have little flesh when she is in good condition. When the feed is used to put thick flesh on the back, as is the case with beef cattle, it can not go to produce milk in the udder. The neck, shoulders, rump and thighs should be thin fleshed in the well fed animal.

3. *Ample room for the udder* and a capacious udder when the cow is fresh. The cow should be well cut up behind between the legs so that the udder can extend well up toward the root of the tail. The flank should be well arched, instead of level, as in the beef cow, giving room for the udder, and the udder should extend well forward

and not hang down. The milk veins should be large and the farther they extend forward the better. It is essential that the milk wells, the openings through which the milk veins pass into the abdomen, should be large, as large as the end of one's middle finger. The udder should be loose and pliable, when empty—not fleshy.

4. *The eyes should be large and bright and project out well from the face.* This is a strong indication of the nerve force needed for strong digestion and large milk secretion.



COLO. AGRIC. EXPT. STA.

The dairy cow should be deep and wide from 1 to 2 as this gives her large capacity for rough feed. The back, from 1 to 4, should be sharp, with little flesh, when she is in good condition. She should be well cut up behind so that the udder can extend well up, as at 3. Her flank should be well arched, as at 5, to provide room for a large udder.

Where a farmer has handled beef cattle and is not sure he can recognize these features when he sees them, he should go to town and examine several cows that are known to be heavy milkers and verify each point.

Feeding the Cow.

The native grasses of the Plains are good milk producing feeds when abundant. Where sufficient land can be obtained, it pays to have a native grass pasture exclusively for winter use, keeping off all stock during the summer. In the winter of 1907 a new settler in Elbert county had a good winter pasture of native grass, but no other feed for his cows. He sold through the winter an average of four dollars' worth of cream per cow each month. He could not have done this with scant pasture nor poor cows.

Alfalfa is the best dairy feed and the dry land farmer should get

a field on his farm as soon as he can. Corn fodder raised in the high altitudes of eastern Colorado is a good milk producing feed, entirely different from the coarse product of the corn belt. The fodder from kafir corn and sorghum makes a good dairy feed if cut after the plants have headed, and not later than when the seed begins to harden. A full supply of ripe sorghum seed will soon dry up a cow. All fodders should be cut and cured to keep the leaves as green as possible. Hay from wheat, oats or beardless barley makes a good milk feed. The crop should be cut when the seed is in the thick milk and cured with as little exposure to the sun as possible. If there is a low place on the farm upon which the surface water from the unbroken fields can be carried by a few furrows, plant it with stock beets. Feed 10 to 20 pounds per cow daily. Crushed barley, ground wheat and the grain of milo maize are the dry land grains for dairy feed.

A daily variety in feeding forage crops will secure a larger milk yield than the method of feeding one kind exclusively for several weeks and then another. The most profit comes from feeding all the cow will eat every day. Five cows full fed will yield more profit than ten or fifteen cows sparsely fed. Feeding should begin early in the summer or fall before the cows begin to shrink in their milk.

Handling the Cow.

The cow needs in winter a warm, dry shelter, free from draughts. This can be made of straw, or of sod walls and straw or sod roofs, if lumber can not be afforded. Bales of straw will last for years, when used for stable walls, if the top of the walls are protected from rain. The cows in summer should have a shelter from the sun. This should be placed on the highest point in the pasture and can be made by setting up posts and putting over them a straw roof built so high that the cows can not eat it. Such a shelter will furnish shade and will be cool when the wind blows through it.

About 87 per cent. of milk is water, and the cow, to do her best, must have all she wants easily accessible. Salt should be kept in a box where she can eat it at will. Whatever adds to the comfort of a dairy cow increases the yield; discomfort decreases the yield. Kindness increases the milk yield and costs nothing. The more a milker can make a cow love him, as she loves her calf, the more milk she will give. Petting is profitable. The cow should never be driven faster than a slow walk. All feed should be given after milking as the dust from the feed contains the germs which sour the milk. Feeding and milking should be done at exactly the same hours, morning and night. The cow should be milked ten months each year, and on the Plains it is best to let her go dry through February and March.

It will usually pay the new settler to sell the calves for veal, and give all the feed he raises to the cows giving milk, as this will secure the quickest cash returns. A good calf may be raised on skim milk and either shelled corn, the whole grain of milo maize or crushed

barley. The grain should be fed dry and not mixed with the milk. Calves need plenty of water.

Handling the Cow's Products.

It will pay to separate the cream from the warm, freshly drawn milk with a hand separator. Cleanliness and cold are the necessary means to keep cream sweet. All utensils touched by the milk should be washed clean and scalded. No dust or dirt should be allowed to fall into the milk, as they contain the germs which cause souring. The cow should be milked in a clean place, and her udder and flanks should be clean. Ordinarily cream will keep longer when a covered pail is used in milking. To keep the cream cool, it should be kept either in a pail hung just above the water in a well or else the pail should be covered with a cloth kept wet by having one end dipping into water. Water will rise through the cloth, and constant evaporation will keep the cream cool. The cream should be sold to a creamery.

In May, 1908, the farmers at a point 90 miles from Denver, received nineteen cents a pound for butter fat, while farmers at a point 50 miles more distant received thirty-one cents a pound. The farmers receiving the lower price took the offer made by one firm and did not ask for competitive bids. The farmers receiving the higher price secured prices from four competing buyers. Denver, Colorado Springs, and Pueblo are good cream markets, and the producer should search for the responsible buyer who will pay highest.

Twenty dry land farmers around Elizabeth, Elbert county, made an average of \$50 per cow per year feeding no grain, but with alfalfa hay. Burke Potter, on a 320-acre dry land farm, at Peyton, received \$1,550 in one year for the cream from sixteen cows and six two-year old heifers, and sold veal calves for \$50. He has well-bred Holsteins. He paid \$300 for bran, and grew all the rest of his feed. With well selected range cows, properly fed and handled, the dry land farmer should average from the sale of cream from \$30 to \$50 per cow per year.

POULTRY ON DRY LAND FARMS.

The expert Colorado poultryman who thoroughly understands his business and gives strict attention, obtains an average of \$2 per hen per year above cost of feed. Every dry land farmer should keep from 100 to 400 laying hens. He will not be able to get as much from them, but his expenses will be less, as a large part of their feed without them would be waste. The hens should be cared for by the farmer, and not by his over-worked wife. They should be fed and cared for three times a day, comfortably sheltered, kept free from vermin and the houses cleaned daily. If the dry land farmer will make a business of poultry, they can be made to bring him several hundred dollars each year. Cash, whether there is a drought or not.

The most money is in eggs from a special egg producing breed and strain. Egg laying strains of general purpose breeds come next in order for profits.

The average Colorado poultry raiser says that his chickens eat their heads off. His flock is a mixture of all ages, all colors and all breeds. Each breed needs a different treatment. Feed that will make a lazy Plymouth rock fat and worthless will stimulate an active Leghorn to heavy laying. The feed required by a laying pullet to provide for both eggs and growth will ruin a three year old hen.

Severe culling is the first step towards profit. Experts estimate that the average Colorado flock produces an average of sixty eggs per hen each year and that where the poorer half of such a flock is culled out, the average will rise to 120 eggs per hen, per year. Culling is particularly important to the new dry land settler, as he needs to make every ounce of feed return a profit, and he can not afford to feed unprofitable poultry.

In the average flock there are old hens that lay none, or few eggs, roosters that are not needed and usually late hatched or stunted pullets that lay little and eat much. These culls usually make up half or more of the flock, and the good layers have to support them.

Feeding Poultry.

During a considerable part of the year hens on the farm will pick up enough waste feed to supply them, but they should be watched every day and fed whenever the waste supply is short. Wheat should form half the ration for the hens, and the other half can be a mixture of milo maize, barley, corn and oats.

When hens do not get all the worms and insects they want they must be fed meat. Meat meal is the cheapest form in which meat for poultry can be bought. Often rabbits are trapped and fed cooked. Hens need meat in some form daily, but in moderate quantities. Over feeding is shown by looseness of the bowels. It is a common custom to throw the offal at butchering time where the hens can get it and to let them feed on the carcasses of dead cattle. Almost always in these cases, hens will over eat sufficiently to reduce their egg yield, and if they have not had meat for sometime, will gorge themselves to such an extent as never again to be profitable. This meat is likely to taint the eggs and the flesh. Skim milk and curd will take the place of meat.

Poultry should have access at all times to oyster shells and hard, sharp grit. The Maine Experiment Station found that a laying hen consumed four pounds of oyster shells and two pounds of grit a year. Often it is necessary to buy grit on farms where there is an abundance of gravel and sand, but none with sharp, grinding edges.

Poultry should have all the clean, pure water they will drink at least three times a day. A general cause for well fed hens not laying is lack of water. Sixty-five per cent. of the egg and fifteen per cent.

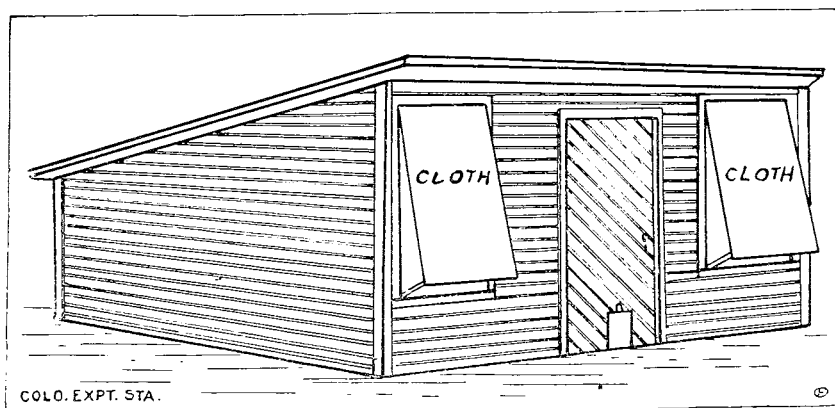
of the hen's body is water, and to lay she must have all she wants, whenever she wants it, and a full supply is necessary in digesting the feed. The chill should be taken off in winter, and the hens watched to see that three times a day they get all they will drink before it becomes frozen. Eating snow is a quick way to stop laying, and walking in the snow will promptly cut down the hen's egg yield.

The hen needs some kind of succulent feed every day; grass, alfalfa leaves, roots, potatoes, cabbage, sprouted grain, or even green sorghum. Too much will make the bowels loose and cut down the egg yield. Just enough should be fed each day to cause the droppings to be similar to those when the hen has the run of a field of grass.

Few good poultrymen feed wet mash. It pays to warm the grain in winter.

The Hen House.

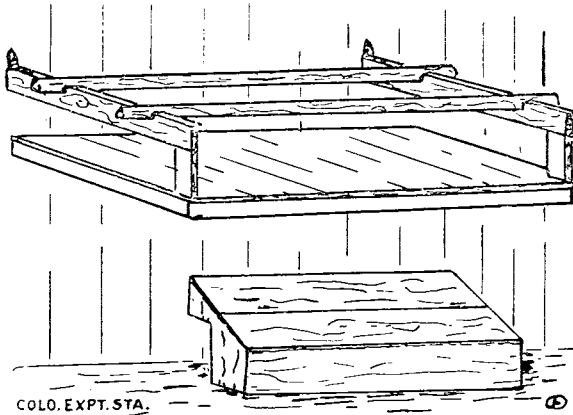
The house for hens should be warm, well lighted, dry and well ventilated without draughts. The dry land farmer can use lumber, sod or straw in building it, and get equally good results from his hens. Good dimensions are four and one-half feet high at the back, seven feet high in front, and fourteen to sixteen feet wide, with a shed roof. It is not best to keep over fifty hens in a house, and thirty to forty hens will give better returns. The length of the house will vary with the number of hens kept in it. If two roosts are used, allow five inches in length of house for each hen. If three roosts are used allow three and one-half inches in length of house per hen. Under this rule a house for 40 hens should be about 16 feet in length if two roosts are used, and 12 feet when there are three roosts.



Poultry house for 40 hens, 14 feet wide, 16 feet long, $4\frac{1}{2}$ feet high at the back and 7 feet high in front. No openings except in front. Window frames covered with cloth and hinged at top so that they may be pushed out at the bottom, on warm days. A small slide door at the bottom and center of the large door permits the hens to pass in and out.

All roosts should be on the same level and should not be over

thirty inches from the floor. The roosts should be about two inches wide and flat on top with rounded edges. A dirt floor, raised a few inches above the ground outside to keep out water, is as good as boards in the dry climate of the Plains. Eight inches below the roosts should be a tight dropping board to catch the droppings and they should be raked off each day into a basket and taken away from the house. The dropping board can be made cheaply from dry goods boxes.



Roosts and Dropping board with nests underneath. The hens enter the nests at the back and when on the nests are in darkness. The top over the nests is sloping so that the hens cannot roost on it and is hinged so that the eggs may be easily reached.

The important point in Colorado is to secure thorough ventilation in the hen house without draught. The average daily change in temperature each twenty-four hours is twenty degrees, and with such a great change it is difficult to ventilate through tubes or open windows without draughts. A draught on a hen is sure to cut down the egg yield, and usually brings disease. To prevent draught, have the house face the south. Make the north side, roof, and east and west ends without openings or cracks of any kind. Use heavy muslin in place of glass for windows. The air will circulate through the cloth without any draught, and light will pass through as well. Arrange the nests so that when the hens are on them, they will be in the dark. Keep the eggs in a cool, dry, dark place.

Hens on the treeless plains need cool shade in summer; sunflowers, trees or any low straw shed open on the north and south sides will supply this.

Lice and Mites.

Lice and mites thrive particularly on the Plains, and a persistent fight has to be made against them the year round. The dropping

board below the roosts should be cleaned daily, and the whole house once a week. The hens should have a good dust bath always ready, and two or three times a year the house should be white-washed inside, and carbolic acid mixed with the white-wash. Insect powder or tobacco dust dusted on and worked down through the feathers to the skin will kill body lice. Applications of boiling water or lice killer to the roosts and to all the woodwork, and particularly in the cracks, will kill the mites. Scald the nests with boiling water, as the lice killer will taint the eggs. Dr. J. W. Downey, one of the best poultrymen in Colorado, makes a good lice killer by crushing moth balls and dissolving them in kerosene. The liquid from this mixture is very inflammable and must not be used where there is a light of any kind. It is as effective as the patent lice killers and much cheaper.

It takes hard, intelligent work to make money from poultry on the Plains, but if the new settler is willing to give the necessary attention, he is sure to have the money with which to buy the family groceries whether it rains or not. Even with every pound of feed purchased, a good poultryman can make money in Colorado, and in most years the dry land farmer can provide most of the feed.

THE DRY LAND GARDEN.

The garden should be located where it can be irrigated from the well or where storm water from the prairie can be brought onto it by means of furrows. The patch should be small and should be given much cultivation. In most soils a garden can not be irrigated by taking water directly from the pump to the ground. A few square feet of ground will absorb water as fast as an ordinary windmill can deliver it. The water must be collected in a tank or earth reservoir, and then turned on in a considerable sized stream that will flow the entire length of the rows.

When ready to irrigate, open a narrow furrow along the entire length of the row and a short distance from it. Pull a straight round post through this ditch, to smooth the ground, and then run the ditch full of water. Apply the water after sundown, as it will do more good then, and the next morning thoroughly cultivate the soil, making a good earth mulch.

Mr. J. E. Payne, Superintendent of the U. S. Dry Land Experiment Station, Akron, Colorado, recommends that all garden crops be planted in rows and thoroughly cultivated. He recommends planting the usual small truck and a good patch of Mexican beans, early cow peas, sweet corn, potatoes, pumpkins, squashes, melons, and Pearl or Queen's Golden pop corn. He recommends planting seven varieties of sweet corn: Cory, Black Mexican, Perry's Hybrid, Stowell's Evergreen, Country Gentlemen, Mammoth Evergreen and Egyptian. He plants all varieties the same day, often near the last of May, and has had roasting ears from July 26th to September 26th. "Sweet corn can be dried; the ripe grains parched are a luxury, as is popcorn

and milk. Poultry will keep the grasshoppers down, and potato and squash bugs may be killed by a club. A constant fight against them is necessary."

Early Richmond Cherries resist drought well and the fruit ripens while supplied with spring moisture. Set them 20x20 feet apart. Prof. B. C. Buffum recommends horse radish and rhubarb as among the strongest drought resisters. Mr. Payne states that gooseberries, native currents, plums and cherries are reasonably sure to produce good crops if given special care.

RAIN FALL IN COLORADO.

Records furnished by Prof. L. G. Carpenter, Director, Colorado Experiment Station, Fort Collins.

TOWN AND COUNTY	No. Years Record Kept	Average Inches Rain-fall 3 Winter Months	Average Inches Rain-fall 3 Spring Months	Average Inches Rain-fall 3 Summer Months	Average Inches Rain-fall 3 Fall Months	Average annual Rain-fall, Inches	No. of Years Rainfall was below average	Least Rainfall in One Year
Rocky Ford, Otero	19	1.13	4.10	5.50	2.11	12.84	11	6.93
Denver,	39	1.62	5.53	4.27	2.53	13.96	18	8.48
Hamps, Elbert	15	0.91	5.21	6.15	1.69	13.96	10	7.62
Fort Collins, Larimer	25	1.37	6.24	4.63	2.63	14.87	13	7.11
Cheyenne Wells, Cheyenne	15	0.93	5.27	7.88	2.35	16.43	6	8.41
Le Roy, Logan	19	1.46	6.06	6.72	2.44	16.68	11	7.34
Yuma, Yuma	18	1.70	6.05	7.63	2.41	17.79	8	10.34
Wray, Yuma	14	1.09	6.43	8.29	2.85	18.66	5	10.74

HANDLING THE SOIL.

Only the principles of handling the soil can be given. Their application will vary each year on every farm and with each crop. The dry land farmer's success will depend upon his skill in applying them to each individual crop.

The best soil for dry land farming is a sandy loam, then a light clay loam, and next a sandy soil. An adobe soil is to be avoided, as is also one with a coarse gravel subsoil.

The soils of the Plains are rich in mineral plant food. Often the subsoil, to a depth of thirty feet or more, will produce good crops when brought to the surface. The yield of the crop is determined by the quantity of available water which passes through the plant. Often when the rainfall is ample for a full crop, none is raised because the soil is in such condition that the rain can not be absorbed and the water runs off into the streams. Frequently when the soil has absorbed a plentiful supply of moisture to produce a good crop, the yield is unprofitable, because a soil mulch has not been provided, and the water is lost through evaporation.

WATER USED BY CROPS.

Prof. F. H. King concludes from his researches and from those of other investigators that an average of three hundred and twenty-five pounds of water must pass through the plants, and be evaporated by them, for each pound of dry matter which they produce. The weight of an inch of rainfall on an acre is one hundred and thirteen tons. In a crop of wheat grown on dry land, there is about the same weight of dry matter in the straw as in the grain. On this basis, one inch of water passing through the plants is sufficient for about five bushels of wheat per acre.

Under fair dry land conditions, at least three-fourths of the annual rainfall evaporates from the surface and runs off into the streams, with most skillful management this leaves not to exceed one-fourth of the rainfall to be absorbed by the plants. An annual rainfall of twelve inches, falling at the right time, and carefully conserved, would, under most favorable circumstances, furnish three inches of water to be actually used by the plant—sufficient to produce fifteen bushels of wheat.

It is evident that the production of fifteen bushels of wheat per acre, or the equivalent in other crops, from an annual rainfall of twelve inches, hangs on slender chances. Where the ground is hard or has been plowed too shallow to absorb water well, the run off is large. In some seasons the total rainfall is ample, but does not fall during the growing season, or it comes in heavy, driving showers, so fast and so hard that even mellow, deep soil can not absorb it as rapidly as it falls. The earth mulch may be carelessly maintained, and then the evaporation from the surface of the soil may amount to much more than three-fourths of the rainfall. The seed may be shiftlessly put in, the plants so thick in places that a good supply of moisture is insufficient and so thin in other places that they can not use all the moisture.

On the other hand, the plowing may be so deep and the soil kept in such good tilth that under ordinary conditions much less than one-fourth of the rainfall will run off and a greater proportion left in the soil available for the plant.

Four things are necessary to secure profitable crops with the limited rainfall of eastern Colorado:

1. Storage of rainfall.
2. Retaining moisture in the soil.
3. Reducing the effects of the wind.
4. Drought resisting crops from seed grown under dry land conditions.

STORING RAINFALL.

Much of the rainfall runs off the surface of the compact, unbroken prairie of the Plains. The earliest need is to put the soil in such tilth that it will absorb a large part of the rainfall, even when it comes

in dashing showers. To do this it must be broken and porous, to a depth of at least a foot, and in granular condition—neither loose nor puddled, and with no large air spaces. The surface must be kept corrugated. A soil in this sponge like condition not only absorbs water well, but allows a wide spread of the roots, giving to each plant a large water-supplying area.

The raw prairie is broken the first time at any depth from three to nine inches, depending on the power available and the toughness of the sod. It should be gradually deepened until the practical limit of the ordinary plow is reached. All the land should be plowed, no cutting and covering, and the furrow should be turned over flat and pressed firmly down on the unbroken soil to promote quick rotting. If the plow is followed with a disc harrow, running lengthwise of the furrow, the rotting of the sod is hastened. The soil gets into condition most quickly when the prairie is broken after the grass has started well in the spring and while it is still growing.

One of the cheapest ways to deepen some soils is to take advantage of the effects of frost. Just before the ground freezes in the fall, list it, going as deep as the lister will work and making the rows not over three feet apart. The furrows will soak up all the moisture that falls and the ground will freeze deeper than it would if left level. On warm days the large surface of exposed soil will thaw and in cold nights freeze. This alternate freezing and thawing granulates the soil, putting it in the best condition for absorbing moisture.

The listed ground must be leveled and protected with a soil mulch as soon as the frost is out, as the evaporation from the large surface made by listing will be much greater than with level land.

In twenty-one years of observation on the Plains the writer has never seen any increase in yield with any kind of crop from subsoiling land. The soil does not stay loose long enough after being subsoiled to be benefited. Where a farmer thinks that subsoiling will help his land, he should first test it on a small scale.

Using deep rooted plants, such as alfalfa, brome grass and sweet clover, is a cheap method of deeply loosening hard soils and thereby improving their water-holding capacities.

Decayed plant and animal matter increases the water-holding power of the soil, and the dryer the season the stronger its influence. This material gives the soil a dark color and is very deficient in the soils of the Plains. The more the decayed roots of plants and the material from rotted manure is incorporated into dry lands soils, the greater will be the proportion of rainfall that is absorbed.

It is specially important for storing moisture in dry land farming that every pound of manure produced on the farm should be spread on the fields, and yet most dry land farmers find that when they manure the land, the crop is reduced, sometimes for several years. When coarse manure is plowed under, it cuts off the connection between the

plowed and the unstirred soil, making a mulch that prevents the water from rising through the plowed land, and it creates large air spaces in the soil. These tend to dry out the soil rapidly and to weaken the plants growing in it.

All manure used in dry land farming should be applied as a light top dressing to grain, grasses or alfalfa. It then acts as a mulch, helping to retain moisture in the soil. The finer particles are imperceptibly absorbed by the soil, the harrowings required by these crops slowly work the manure into the soil without making air spaces and the manure becomes as great a help as it is a detriment when plowed under unrotted.

RETAINING MOISTURE IN THE SOIL.

When dry land soil has been loosened to a good depth to form a reservoir, and it is porous and fine grained, the water from a rain slowly moves downward through it until absorbed, and each minute grain of earth becomes covered with an invisible film of moisture.

When these minute grains of soil are in close contact with one another, there is a constant movement of the water in the film surrounding them, the water flowing from a wet grain to a dryer one. After a rain the sun and the wind dry out the surface soil and carry away the moisture contained in it. Then the water from the damper soil below moves upward to wet the surface grains and is in turn evaporated. This movement continues in land not cultivated and extends to a depth of many feet, often, in a dry time, taking out of the soil, in a week moisture equal to more than an inch of rainfall.

When the surface soil is stirred after a rain, the tiny grains are separated so that the water does not easily pass from one to another. The movement of the moisture is checked and evaporation is greatly reduced. Such shallow cultivation is called an earth mulch, because it has a similar effect in holding the moisture in the soil, as that effected by a mulch of straw or a covering of boards.

The dry land farmer's supply of moisture for his crops depends upon his skill and judgment in maintaining an earth mulch over his cultivated fields. No set rules can be given. He should study the principles governing the absorption and movement of water in the soil, as here given, until he thoroughly understands and appreciates them. Then he can intelligently conduct the farm operations for maintaining the earth mulch.

The deeper the earth mulch, the better it will prevent evaporation from the soil. For cultivated crops a general rule, with many exceptions, is to keep the mulch three inches in depth. With trees, four to six inches is better. Seeds must be planted below the earth mulch so that they will be in moist soil and the mulch must not be so deep as to prevent the young plants from coming up. With growing wheat and other grains, the mulch must not be made so deep as to put the roots in dry soil.

A good rain packs the loose surface soil and destroys the earth

mulch. It is necessary to pulverise the ground quickly after every such rain to restore the earth mulch, as a week's delay may mean the loss of water equal to an inch of rainfall. Light showers do not usually destroy the mulch.

On account of the winds, evaporation is very rapid just after the frost goes out of the ground in the spring and an earth mulch should be established as soon as the ground is dry enough to work. Evaporation is very rapid from stubble fields after the grain has been cut, and an earth mulch should be made with a disc harrow as soon as the grain is shocked.

Where the surface is hard, the earth mulch will have to be made with a disc harrow; where the surface is mellow, a spike toothed harrow will pulverize the soil sufficiently. A four-horse disc harrow should be used for economy of time. A man having five horses attached to a twenty-four foot spike tooth harrow can put a mulch on thirty to sixty acres a day.

When the annual rainfall drops much below twelve inches and the rainfall during the growing season below five inches, it is difficult, and often impossible, to raise a profitable crop. The land can be fallowed one season and cropped the next, the one crop having the use of what moisture can be stored from two years' rainfall. During the season that no crop is raised an earth mulch must be maintained, and to do this it is usually necessary to till the surface about every ten days, and always after any considerable rain.

In many seasons paying crops may be secured by this system, where, if an attempt is made to grow crops every year, the failure will be total for both years.

With this system the dry land farmer who has one hundred and sixty acres under cultivation will each year have eighty acres in crops, and eighty acres which he will have to till regularly, but upon which nothing will be growing. In Logan county a farmer has been quite successful in following a modification of this plan. He raises three crops in four years. The first season no crop is grown, but the land is kept thoroughly cultivated. In the fall, winter wheat is sown. After harvest the ground is immediately disked, and, as soon as convenient, plowed and harrowed. The following year corn is planted and well cultivated, the cultivation in part having the same influence as a summer fallow. The following year wheat is grown, and the next year the rotation is started again with a summer fallow for the whole season.

Weeds act as pumps constantly at work taking the water needed for the crops out of the soil and evaporating it into the air.

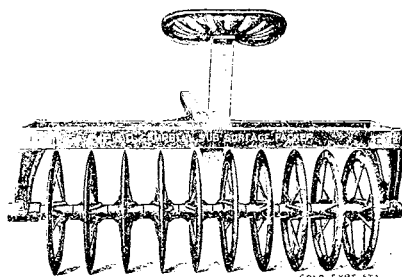
SUB SURFACE PACKING.

Usually on the Plains when soil is turned over with the plow, it is so dry that an imperfect connection is made with the unstirred ground beneath, and the soil that has been broken up by the plow

acts as an earth mulch and prevents the moisture rising above the bottom of the furrow. Unless rain comes, the ground that has been turned by the plow soon becomes so dry that plants will not live in it. It is a good system to thoroughly disk ground just before plowing. The surface turned under will then be fine and will better form a good connection with the soil below.

Dry soil, clods, trash and coarse manure, when turned under by the plow, will make air spaces in the pulverized soil. The air in these spaces dries out the soil and increases the losses from evaporation.

To retain the moisture in the pulverized soil, to bring it up from below to the roots of the plants and to drive out the excess of air, freshly plowed soil must be firmed until a compact but mellow condition is secured. The best implement so far devised with which to do this is the Sub Surface Packer originated by Mr. H. W. Campbell.



The sub surface packer consists of a number of sharp rimmed iron wheels, twenty inches in diameter, placed five inches apart on a strong shaft mounted in a suitable frame. The packer follows the plow, going lengthwise of the furrow. The sharp wheels fine the soil near the surface where the seed is planted and firmly packs the earth against the bottom of the furrow and around the trash and manure,—just the condition needed for a good seed bed and for the best control of the moisture.

The writer considers the sub surface packer one of the most indispensable implements for dry land farming, and would not attempt dry land operations without it. One hundred and sixty acres were plowed for wheat, eighty acres prepared as thoroughly as could be done by harrowing and eighty acres fitted by packing. The yield on the harrowed ground was eighteen bushels per acre, on the packed ground forty bushels.

Whenever the soil is sufficiently moist to settle quickly, it is not necessary to use the packer, but it should be at hand for use when needed. It is heavy in draft, an eight-foot machine requiring four good horses.

Sub surface packing can be fairly well done by setting the disks straight on a disc harrow and weighting the machine to cut deeply.

A corrugated roller is a fair sub surface packer, though not nearly so effective as a machine with sharp rimmed wheels.

With good management in storing the rainfall and in holding it in the soil, the earth will be kept moist from the bottom of the mulch to a depth of 8 to 9 feet.

REDUCING THE EFFECTS OF THE WIND.

A dry land country is always a land with much wind, and the dryer the season the steadier and the harder the wind blows.

The first principle for reducing the damaging effect of the wind is to keep the surface of the ground corrugated. Engineers, in measuring deep mountain streams, often find that where the water is moving so swiftly on the surface that a man can not stand against it, there is almost no current at the bottom, where the velocity is checked by stones. It is on the same principle that the surface of dry land should be kept corrugated; the unevenness impedes the motion of the wind.

When freshly plowed dry land soils are rolled with a smooth roller, the wind moves as fast along the surface of the soil as it does at the height of a man above it, and will often sweep the soil off the field as deeply as it has been plowed.

The sub surface packer leaves the ground more deeply corrugated than the grain drill. The packer wheels have iron spokes, and while the rim fines and packs the soil, making a good seed bed, the spokes bring small clods to the surface, and packed ground has both the corrugations and the clods to retard the wind. The writer has many times seen a highwind blowing across a field that had just been treated with a sub surface packer, and a little fine dust only would be sifting around the clods and across the low ridges, while from adjoining fields, left smooth, the dust was rising in clouds.

All grain should be drilled in with the furrows running at right angles to the prevailing winds.

Deep fall plowing, left rough, will carry land through the winter with reduced losses from blowing, especially if the lower soil that is turned up is a little heavy. An earth mulch must be made on fall plowed ground as early in the spring as it can be worked to save the moisture.

The dry land farmer will find it profitable to start wind breaks and shelter belts around his buildings and garden as soon as his farm gets on a living basis. It sometimes pays to have them on the north, west, and south sides of the farm to check the wind's force. Professor Longyear, of the Colorado Experiment Station, recommends using two year old seedling trees, planting them eight feet apart each way. The two outer rows to consist of Russian olive, the third and fourth rows of black or honey locust, the fifth and sixth rows of ash, the seventh and eighth rows of American Elm or Golden Russian willow, and the two inner rows of cottonwood or Carolina Poplar.

Full directions for the planting and after treatment of forest trees may be obtained by writing to the Director of the Colorado Experiment Station, Fort Collins.

CROPS FOR DRY LAND FARMING.

It is imperative that the seed used on the Plains should be grown under arid conditions. It is best to use seed that has been grown in the neighborhood where it is to be planted. If this is impossible, the seed should be grown under as dry conditions as will be met by the growing crop.

This fact can not be emphasized too strongly. Even a small increase in the amount of moisture will lessen the power of plants to withstand severe drought. In a dry year in the "nineties" the writer inspected a field of corn on a farm where the line fence was on the State line between Colorado and Kansas. The stalks were green and well eared, while for over one hundred and fifty miles east, corn was generally a failure. The seed used was a local strain that had, by selection, been developed to yield well under local dry conditions. The grower stated that every time he had tried seed from even only one hundred miles farther east, the crop had been poor.

It is the common practice for new dry land settlers to bring their favorite seeds with them. The Iowa man brings seed corn, the Indiana man oats, and the Michigan man potatoes. With seasons of average or lower rainfall, the planting of these eastern seeds guarantees a failure. The root development of plants from eastern seed is not sufficient to enable them to spread far enough in dry land soil to gather enough moisture, and often the too great growth of foliage evaporates too much moisture.

Only those grain crops that mature early, before drought and hot winds come, and before the spring moisture is exhausted, should be grown. Wheat, barley and speltz are such crops. The surest forage crops are those like sorghum, milo maize and kafir corn that live and stand still through a drought and then mature quickly when rain comes. Seed should be selected from plants whose large root systems give them a broad area from which to draw moisture.

Every season it is likely that conditions on the Plains will be unfavorable before the season is over. This condition demands seed with strong vitality that will transmit vigor to the young plants as soon as they start. Heavy seeds, as a rule, give strongest growth and the thorough use of a fanning mill with plenty of air is a great aid in securing a crop.

Dry land farmers are usually careless about seed and use a mixture of heavy, shrunken and cracked grains, weed seed, chaff, sticks and dirt. There is much loss from seed that has been heated.

Thin seeding is necessary. Where there is moisture enough to mature one plant only, if two occupy the space, the crop is a failure.

When in doubt about the quantity of seed needed, use one-half the amount customary for humid sections.

The following pounds per acre are suggested, but the amount should vary with the size of the seed and the condition of the soil:

Wheat, 30 to 40.	Milo Maize, for grain, 5 to 8.
Barley, 35 to 50.	Corn, single seeds, 15 to 18 inches apart.
Speltz, 45.	Dwarf Essex Rape, 3 to 5.
Flax, 20.	Brome Grass, 20.
Millet, 10.	Alfalfa, for hay, 12 to 20.
Sorghum drilled for forage, 25.	Alfalfa, cultivated for seed, 2 to 3.
Kaffir corn, drilled for forage, 25 to 30.	Sweet Clover, 20 to 25.

Early seeding should be the rule, so as to take advantage of the moisture released when the ground thaws out and from that furnished by early rains. The development of the native vegetation is a good guide to the time for seeding.

Broadcasting has no place in dry land farming. It is a sure method of wasting seed and of producing many weak plants. Some seed is certain to be put in too deep and more too shallow. All seeds should be drilled and great care should be taken that single seeds are placed at equal distance apart. In careless drilling, where seed is bunched, there is not enough moisture to develop the plants, and the moisture in the bare spots is wasted. The writer has examined fields of corn in dry land sections where in every row there were spaces between stalks of from 5 to 13 feet, and other places where the corn was in bunches too thick to amount to anything. Wheat is often seeded as carelessly, and such planting insures a serious reduction in the crop no matter how favorable the season.

It is self-evident that a good seed bed is essential in dry land farming, and yet it is common practice to put seed in cloddy, dry and loose soils.

Sorghum is the surest drought resisting crop. The yield is from nothing to seven tons per acre, depending upon the condition of the soil at planting, the character of the seed and the rainfall. Early Amber is generally used. The seed may be put in with a grain drill, at the rate of 25 pounds per acre, or listed shallow, six pounds of seed per acre, and cultivated until the furrows are level full. It grows very slowly at first and should not be seeded until the ground is warm, usually May 10th to June 15th. Seeded earlier the weeds get ahead of it. Sorghum should not be cut until the seeds begin to harden. When cut before it heads, sorghum is chiefly water and some vegetable fibre, and while very appetizing, furnishes little nourishment to stock. In years of plenty, sorghum can be stacked and kept until needed in times of drought. A cheap but rather wasteful way for harvesting it is to turn the cattle into the sorghum field when the seeds have become firm. Such a method of fall feeding will hold dairy cows up well in their milk. The cows should be well fed before being turned into the sorghum and left only one hour the first day,

two hours the second day and so on. Sorghum makes a fair pasture for hogs during the summer. A dairy cow fed all the ripe sorghum hay she will eat, and no other feed, will soon go dry. It is a fair dairy feed when supplemented by other fodders.

Kafir corn, the surest dry land grain crop in Kansas and Nebraska, does not mature anywhere on the Plains of Colorado except in Baca county. The high altitude makes the nights too cool and the seasons too short for kafir corn as a grain crop. It is planted for forage the same as sorghum.

Dwarf Milo Maize has the same habits and characteristics as kafir corn, but will ripen in a shorter season, and is probably the surest grain crop for the dry lands of eastern Colorado. It should be tried by every farmer, as it will probably fill the same place in dry land farming that corn does in the corn belt.

On ground well filled with moisture it may be planted with a grain drill in rows thirty-two inches apart, dropping single seeds four to six inches apart in the row. In dryer land it may be listed after the ground becomes warm, from May 10th to June 15th, dropping single seeds the same distance as above. The drill and the lister should be followed with a press wheel to pack the soil over the seed. Milo maize is a sorghum without sugar, the strength of the plant going to produce seed.

The seed should be kept in the head until just before planting. Threshed seed stored in bins or in sacks, even when kept dry for a year, is likely in a few damp days to become sufficiently heated to badly injure its germinating power. Where not over forty acres are to be planted, the heads may be held on a sloping board in a wash tub and the seeds scratched off with a common curry comb. The ripest and the most vigorous seeds will shell off first, and when half the seeds have been rubbed from a head, it may be thrown aside and fed to stock. With this method, only the best seed is secured. It should be cleaned free from stems and chaff before planting.

Milo maize should be given frequent shallow cultivation, the same as corn. When ripe it should be cut and shocked like corn. This may be done either by hand, with a corn sled or with a corn binder. In winter the fodder with the heads may be fed to cattle and horses and the scattering grain picked up by either hens or hogs. Fattening hogs do better when the grain is threshed and fed to them either soaked or ground. Work horses fed milo maize can do as much heavy work in the spring and summer as they can on corn. It is best to top the fodder and feed the grain to work horses in the head. When eating milo maize in the head, the little stems that hold the seeds compel the horse to eat slowly and chew the grain well. When threshed grain is fed, the horse is likely to bolt his feed.

One hundred pounds of Milo Maize have a feeding value equal to ninety pounds of corn, and a fair yield is forty bushels an acre, equal in feeding value to thirty-six bushels of corn. The objection

to milo maize as a feed is that it is constipating and stock after a few weeks feeding on it suffer in consequence. This may be overcome by feeding some alfalfa or flaxstraw, the oil in the few seeds left in the straw acting as a laxative.

The plants of sorghum, kafir corn and milo maize develop large root systems, much larger than corn. This enables each plant to secure moisture from a comparatively large area. When a drought comes, these crops live but stand still for weeks, and if late rains come, start quickly and mature seed.

Millet gives a fair yield in seasons where the rainfall reaches the average or above. It is a cheap crop to grow and to harvest and on this account is liked by many dry land farmers. The German millet is the best yielding variety when the rainfall is good. The Broom-corn millet withstands drought best. Millet should be cut as soon as it comes into head, as the ripe seeds are detrimental to stock.

Early cut millet makes a fair feed for cattle, and its laxative effect is beneficial to cattle being fed sorghum, kafir corn or milo maize. Millet hay containing ripe seeds will quickly dry up a dairy cow. Millet, no matter at what stage it is cut, is a dangerous feed to give horses. If fed long, it will stiffen horses so that they will never recover, and often causes their death.

Corn. In years of average rainfall corn is a valuable forage crop in eastern Colorado, and when moisture is abundant, yields a moderate crop of grain. On account of the altitude, the seasons are too short and the nights too cool for large crops. Corn fodder raised at this high altitude is an excellent dairy feed, entirely different from the coarse product of the corn belt.

Seed developed on the Plains must be used; that from the corn belt will not yield much grain in years of heaviest rainfall and in dry years often does not even produce fodder. Frequently new settlers from Iowa and Illinois will send back for seed for three or four years, and every year have a failure before they are willing to accept this fact.

The Plains bred corn has a short rather sturdy stalk, limited in foliage, and the ears grow close to the ground. The Mexican corn stands the drought best. The ears start at or below the ground, and the variety is objectionable on this account. The White Australian Flint is generally preferred. It is a local variety, bred to withstand drought well, and the ear is similar in character to the eight rowed flint corn of New England. The grain is very hard and needs to be soaked or ground for feeding. The Swadley Dent and the Colorado Yellow varieties have ears similar in size and type to the Pride of the North Corn of Minnesota. They are prized in many localities.

A fair crop of corn on dry land is from 10 to 25 bushels per acre, and this yield is considered profitable on account of the high price of corn in Colorado and the low expense of raising a crop.

Corn and Milo Maize need similar methods of planting and

cultivation, and when the dry land farmer can afford the teams and the implements, one man can handle large areas and reduce the cost per acre for raising so low that even a small yield is profitable.

One man and three heavy horses with a single lister can prepare the ground and plant eight acres a day. Following the lister with a smoothing harrow has never seemed to the writer to be profitable, although generally recommended. About all the harrow does is to drag trash on to the rows.

For the first three cultivations, one man driving four heavy horses on a disc harrow can cultivate twenty acres a day, straddling alternate rows, and each cultivation straddling the row that was on the outside the previous cultivation. Guards are needed to protect the corn when small. One man driving four heavy horses to a three-row lister cultivator for the first three cultivations can handle well thirty acres daily. With both the disc harrow and the lister cultivator, the corn should be laid by with an ordinary corn cultivator. The crop can be harvested at the rate of seven acres a day with a three-horse corn harvester.

Wheat is the cash crop of the Plains, but fails too often to be depended upon to meet living expenses. It is safe to calculate on at least two failures each five years. Sometimes there will be failures for two or three years in succession, and then as many paying crops. It is probable that in many sections the greatest profit could be made by alternating summer fallow with years of cropping.

The ground should be plowed early for wheat, and each half day's plowing harrowed before the teams leave the field. After plowing, the land should be worked with a sub surface packer and then harrowed frequently. Wheat needs a shallow firm seed bed, very mellow above the seed.

Turkey red is the variety preferred for fall seeding, and Kubanka Durum for spring seeding. Early seeding is usually necessary to secure a good yield. The seed should be heavy and well graded and sown with a drill.

In the spring, if the ground is loose, run over it with a sub surface packer. If the ground is firm so that many plants are not loosened, harrow across the drill rows. Begin harrowing as early as the ground will work well, and continue, at intervals of ten days, until the plants shade the ground.

When wheat, after heading, begins to burn up from drought, it may be cut for hay and makes a good feed for horses and dairy cows.

Barley requires a short season and a good supply of moisture for early growth. It should be seeded with a drill as early in the spring as the danger from severe frosts is over. Barley is more sensitive to frost than either wheat or oats, but if the ends only of the leaves are killed, the plants are not hurt. Often the moisture released when the frost goes out of the ground is nearly sufficient for barley up to heading time, when the seed is sown early.

A large share of the failures in growing barley come from late seeding. The seed is sown after the moisture held by the frost has been lost, making the early growth weak. The barley then heads too close to the ground to harvest.

Two varieties are used for dry land farming; California Feed barley, and the Bald. The Bald barley is one of the best drought resisters, but the straw is weak near the head and with a good yield much of the grain falls down. California Feed barley is the best yielding variety in seasons of good rainfall.

Oats is a poor dry land crop; very uncertain in yield. Many farmers sow oats, and if the drought is so severe at the time of heading that the heads will not fill, the crop when in bloom is cut for hay. The hay is excellent for horses and dairy cows. Kherson and Sixty Day are the varieties usually recommended.

Speltz, or Emmer, as it is correctly called, looks like a cross between barley and wheat. In threshing, the chaff remains attached to the grain. It is a strong drought resisting plant, and the grain is a good feed for horses, cattle and sheep. The grain contains too much hull to be a hog feed. Sow with a drill, the same time as for barley, using forty-five pounds of seed per acre.

Flax, so far as tested, has proved to be a good dry land crop when the rainfall reaches an average, and a total failure in years of severe drought. In Lincoln county, in 1907, in large fields, the yield on sod was nine bushels per acre, and on summer fallow, twenty-two bushels per acre. In the same locality, in 1908, much of the acreage was not worth harvesting.

It is one of the best crops for putting sod in mellow condition for the crop which follows it. It should be sown early as it needs abundant moisture to push the young plants. Sow with a drill using twenty pounds of seed per acre.

Flax straw is a good cattle feed as it contains some seeds and the oil in them is needed to balance the deficiency in fat found in most dry land crops.

Dwarf Essex Rape has been described as a cabbage that keeps growing, but never forms a head. It stands cold and drought well, if sown as early in the spring, as the ground can be worked. Late seeding is a total failure in dry years.

Sow in rows twenty-four inches apart, using three to five pounds of seed per acre. Cultivate frequently. It is the next best pasture to alfalfa for hog feed. The hogs should be turned on the field when the rape gets eight to ten inches high. It is best to divide the field into two lots and change the hogs from one to the other as they eat the crop down.

Potatoes, if given special attention, can be grown most seasons on dry land farms where the soil is not heavy. In 1908, in a section of Kiowa county that produced no marketable grain, a farmer grew one hundred bushels of potatoes per acre on two acres. The patch

was on high land at the foot of a slope where it received the storm water from over twenty acres of prairie. The land was plowed about twelve inches deep, and furrows arranged to catch the surface water from the land above. The soil was thoroughly pulverized before planting and repeatedly harrowed and cultivated. A farmer in Phillips county reports good yields for eight consecutive years. He harrowed and cultivated the potatoes at least twelve times each year, and his fields received the surface water from land above.

Potatoes on dry land require early spring planting, strong seed covered firmly with moist soil, and repeated cultivation. Early Ohio and Rose Seedlings are the varieties generally recommended.

When potato bugs are too numerous, Prof. C. P. Gillette, of the Colorado Experiment Station, recommends the mixing of one pound of Paris green with fifty pounds of flour. Place the mixture in a sack of cheesecloth and shake the sack over the vines when the leaves are damp.

Stock Melon is a large citron, with firm flesh, that keeps well into the winter if protected from freezing by straw or earth. It is a passable substitute for roots and furnishes a much needed winter succulent feed for cows, hogs and poultry. It withstands drought well and a moderate quantity should be grown by every Plains farmer. Plant and cultivate the same as for watermelons.

HAY CROPS.

Wheat, oats and bald barley cut when the seeds are in the milk and cured with as little exposure to the sun as possible make good hay for horses. *Fodder* from corn and kafir corn will take the place of hay for work horses, care being taken not to have it dusty when fed. Horses will stand heavy work such as breaking prairie, when fed grain and fodder, but fodder is disagreeable to handle in mangers.

Brome Grass (Bromus inermis) is the most satisfactory drought resisting grass that has been tested on the Plains, and is generally recommended by those who have given it a careful trial under dry land conditions.

Most of the seed on the market has been heated, and but a small per cent. will germinate. The writer has always sown twenty pounds per acre, and has never yet secured a good stand nor seen one from seeding made by others. Brome grass spreads from the roots, and if the stalks are not over one foot to eighteen inches apart when first seeded, the stand will thicken to a good sod in a few years.

Select low land which receives storm water from land above and have the soil deeply plowed, thoroughly pulverized and well settled before seeding, with a good supply of moisture stored in it. Seed with a drill. The seed is chaffy and is very difficult to sow, requiring two men, one to drive and one to see that the seed works down steadily.

Keep down the weeds and wait with patience until the stand

thickens to a good sod. Brome grass furnishes good hay until the sod gets too thick and then will stand heavy pasturing. It gives early and late pasture and is often dormant in midsummer.

Alfalfa should be tried on most farms on the Plains. Select a low spot or a place at the foot of a long slope where surface water from the rains can be carried to it by furrows. Do not plant on sod. Raise other crops until the sod is thoroughly subdued.

Plow the ground deeply. Thoroughly pulverize and pack it and do not seed until the soil is moist to a depth of seven to nine feet, if you have to wait two or three years. While waiting, work the soil often and collect in it all the moisture you can from land above.

Alfalfa will usually fail when sown in freshly plowed land. Plow deep but get the soil well settled before seeding. Sow with a grain drill, using twelve to fifteen pounds of seed as early in the spring as the danger from severe frosts is over. Use no nurse crop.

Use seed grown on dry land. Seed from irrigated land is certain to bring a total failure, and a great proportion of the failures in eastern Colorado have been assured from the start by the use of seed from irrigated fields.

Prof. W. M. Jardine, U. S. Department of Agriculture, told the writer that in Utah a dry land strain of alfalfa had been developed that with an average annual rainfall of eleven inches yielded an average of two tons of hay per acre. Seed grown under such arid conditions finds eastern Colorado most congenial.

When one year old, alfalfa should be harrowed early in the spring and again after each cutting.

When two years old, and every year thereafter, alfalfa should be thoroughly cultivated with a disc harrow set to cut two to three inches deep. The alfalfa should be disked early in the spring and after each cutting.

Alfalfa should be cut as soon as the first blooms appear. It will live many years longer than if left until in full bloom before cutting. Alfalfa must not be pastured so close as to have the crowns eaten off; when this is done, the plants die.

Usually when alfalfa is seeded on dry land for the first time, it dies out in three or four years. The land should then be plowed and planted to another crop that can be thoroughly cultivated. At the end of one year reseed to alfalfa, using the same methods as employed for the first seeding. The second seeding usually thrives for many years as the first sowing has prepared the land to a good depth for the easy growth of the second seeding.

Prof. P. K. Blinn, of the Colorado Experiment Station, has made a special study of alfalfa and has prepared the following statement for this bulletin:

RAISING ALFALFA FOR SEED IN DRY FARMING.

If a farmer on the dry plains has a well that will furnish just enough water for fifty head of stock, it would be absurd for him to

try to keep sixty or seventy-five head on the same supply of water; and it is equally ridiculous for him to attempt to crowd plants in soil where the moisture is limited.

Some plants may develop with less moisture than others, but alfalfa is not one of these plants; on the other hand, it is conceded by all western farmers that an abundance of moisture is the key to success in growing alfalfa for hay.

When it is well established, alfalfa will endure long droughts and still revive when water is applied; to that extent, it is adapted to "dry farming," and its deep rooting tendency may enable the crop to grow without irrigation, if the roots can penetrate the moist soil.

There are some localities on the Plains where the run-off from heavy showers could be collected and diverted by ditches upon soil suited to alfalfa. Often in a draw, where moisture from the surrounding prairie is inclined to center, good encouragement for seeding to alfalfa is offered.

The number of plants to the acre that can be maintained in the dry farming district has not been determined; but at Rocky Ford, Colo., in 1908, an alfalfa nursery plat, without irrigation for eleven previous months, produced at the rate of two and three-fifths tons per acre the first cutting; and then made a second growth, equally as good, that was left for seed. The plat had been seeded, in 1907, to Turkestan alfalfa, and thinned to single plants twenty inches apart each way. It received one irrigation and was thoroughly cultivated that year. In 1908 the growth was made from the moisture that was stored and conserved in the soil; but such phenomenal yields can hardly be expected without irrigation. In the favored spots, before mentioned, alfalfa can certainly be grown if once established and properly managed.

The growing of alfalfa seed offers great opportunities to the farmer on dry lands, because the fact has been well demonstrated that alfalfa yields seed best when the plant makes a slow, dwarfed growth, when it really lacks for moisture, but has enough to set and fill the seed.

Seed grown under dry conditions has more vigor and vitality than seed produced with an excess of moisture, and it is usually free from dodder and other noxious weeds, if the field has had any cultural care. There is a demand for dry land alfalfa seed that far exceeds the supply.

In establishing alfalfa for seed production, under dry conditions, it is recommended to sow in rows eighteen or twenty inches apart, with two or three pounds of good seed per acre. A thin, uniform stand is absolutely necessary, even to thinning, as in beet culture, but the stand can usually be regulated by the amount of seed sown.

It has been found that plants twenty inches apart will support each other and not lodge or lay on the ground, as in thicker or thinner stands. With a good stooling variety like the Turkestan, plants six

to twelve inches apart in the row are thick enough. If all the seed would germinate, one pound per acre would be ample, but it is difficult to sow a small quantity uniformly in the row, and for seed production, it might pay to space and thin the plants.

The row system is essential, as it permits inter-tillage to eradicate weeds, and to conserve the moisture, and also allows deep cultivation to absorb winter storms, affording an opportunity to furrow out the rows and direct or divert any surface water that may or may not be needed. It is the only system that will allow the tillage that is so essential in all dry farming.

The four-row beet cultivator, with its weeding knives and other attachments, is an ideal tool for cultivating the crop. A four-row drill, adapted to sowing alfalfa seed, is needed to complete the equipment, but the ordinary beet drill, with the addition of an alfalfa or grass seeder attachment, can be modified to suit the work.

The seed should be sown shallow, not over an inch deep, and good results have been secured with the common garden drill by marking out the ground with the rows gauged in sets of four, to correspond to the four-row cultivator.

Where there is an opportunity to use flood water for irrigation the field should be ditched in every other row, and the furrows logged out with a sled made of short logs, eight to ten inches in diameter, and from three to four feet long, spaced to fit two furrows, so that the water may run through as quickly as possible, for the alfalfa crop for seed will need only a small application of water. A short rush of water after a sudden shower can be delivered over considerable ground if the field is properly ditched.

IMPLEMENTS AND POWER.

The yield under average dry land conditions is low and a large acreage must be handled per man in order to make a living. This requires a number of heavy horses and implements of large capacity. A man with two horses will hardly average plowing two acres per day. The same man with five or six horses and a gang plow can plow an average of five or more acres a day. The returns from his labor are two and a half times greater with the larger equipment. Riding implements are always preferable because with them a man does not get so tired that he can not think.

A breaking plow for sod should have a mould board either solid or of rods. A disc plow does very poor work in sod.

The mould board plow is preferable for old ground, except when the soil is so dry that it plows up in clods. A disc plow will turn over land very dry and hard without making clods. Extra shares should be purchased with each plow, as sharp shares save power.

The lever smoothing harrow should be twenty-four feet wide, in four sections, with the coupling bars so arranged that two, three or four sections can be connected as desired. With five or six heavy horses on a 24-foot harrow, a man can till thirty to sixty acres a day.

A riding attachment adds little to the draft and much to the comfort of the man.

A disc harrow is essential. It should cut at least seven feet wide and be operated with four horses. The disc harrow can be used to pulverize sod; cultivate corn, milo maize and sorghum; put a mulch on alfalfa fields, on stubble fields after harvest, and on ground in the spring. It makes a fair sub surface packer when weighted and the disks are set straight.

A four-horse sub surface packer is the most economical.

A lister is needed for planting corn, milo maize and sorghum for grain. With three horses and a single lister, a man can plant an average of seven to eight acres daily.

The most economical grain drill sows either eleven or thirteen feet. It should have single discs and easily removable press wheels that are coupled in pairs, each pair working independently.

The two-horse corn cultivator should have both broad and narrow shovels. The one-horse cultivator should have at least nine reversible teeth and be narrowed and widened with a lever.

A home made float is very useful when land is cloddy. A wagon and hay rack, a mower and a two-horse hayrake and small tools are needed. The grain binder and corn harvester can usually be hired to advantage. One good fanning mill is sufficient to grade the seed for a neighborhood.

GRASSHOPPERS UPON THE PLAINS.

Grass hoppers are often a serious pest. When the native grasses become dry, a cultivated spot of green plants attracts them from every direction. Many failures have been due to this cause alone.

A large flock of turkeys affords a good protection. One turkey per acre for the entire farm where half is under cultivation, will save the crops. The birds are herded on the fields during the day time and shut up in a wolf-proof enclosure at night. In the fall they are closely confined while being fattened.

Prof. C. P. Gillette, of the Colorado Experiment Station, advises remedies in press bulletin 38. This may be had on request of the Director.

"One of the simplest and often a very effectual remedy is to grow plenty of chickens or turkeys to range over the infested grounds. Wherever coyotes abound, however, precautions must be taken to protect turkeys and chickens at night. Turkeys are very profitable, if raised with proper care, as they protect the crops from destruction, forage nearly their whole living, and sell at a high price in the fall or winter.

"Hopper 'dozers' or pans are also very successful where they can be used. Anyone wishing directions for making a good hopper pan should write the experiment station for a copy of Bulletin No. 112."