

Dry Farming in the Plains area of Montana

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In some of the intermountain valleys of Montana dry-farming has been practiced for a number of years with continued success. Many of the farms in the Gallatin Valley have been dry-farmed for over thirty years, while in the Judith Basin and the Shields River Valley farming without irrigation has been general for from ten to twenty years.

Because of the shortness of the season, grain farming is uncertain in Montana above an altitude of 5000 feet. The greater part of the area of the state having an elevation less than 5000 feet is in the plains east of the Rocky Mountains. This area, comprising approximately sixty million acres, was used primarily as range for cattle and sheep from the time white settlers came west until within

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the last three to ten years. During this time practically all the land which is tillable and adjacent to transportation has been settled upon. The settlers came from various parts of the country and were formerly engaged in many different lines of industry. Because of this condition, farming methods in the newly settled communities lack the stability of the older farming sections, and as a result there is a demand for definite information based on the most successful farming methods.

This circular describes the most successful cultural methods and rotations for ordinary field crops grown under dry-land conditions for that portion of Montana situated east of the Rocky Mountains. The information is based largely on the results obtained at the Judith Basin experiment station during the last nine years and at the Huntley experiment farm during the last five years. The Judith Basin experiment station is located at Moccasin in the Judith Basin, being approximately in the geographical center of the state. The Huntley experiment farm is located in the Yellowstone Valley, seventeen miles east of Billings. The dry-land work at both stations is conducted cooperatively by the Office of Dry Land Agriculture of the United States Department of Agriculture and the Montana Experiment Station.

SOILS

The soils of eastern Montana vary from heavy clay and gumbo to light sandy loam. In general they contain a large amount of clay in the subsoil and are capable of retaining a large percentage of moisture which is available to plants. They contain sufficient available plant food for the growth of ordinary crops. Commercial fertilizers have not increased yields. Some of the lowlands contain so high a percentage of alkali salts that the ordinary crops do not produce a vigorous growth. In certain localities, after the land has been farmed for a few years and the native soil is well rotted, the soil will blow when in a finely cultivated state.

CLIMATIC CONDITIONS

The annual precipitation as shown by the records of the United States Weather Bureau for different places in this area is rather uniform. The larger number of places where records are available show a normal rainfall of between thirteen and fifteen inches for the year. There are a few places where the annual precipitation is below

thirteen inches, and others where it is as high as sixteen inches. Table I shows the annual precipitation for eight towns which are distributed over the plains area of Montana.

TABLE I.—SHOWING MAXIMUM, MINIMUM, AND NORMAL PRECIPITATION FOR EIGHT DIFFERENT LOCALITIES IN EASTERN MONTANA.*

Recording station	Years of observation	Maximum precipitation	Minimum precipitation	Normal precipitation	Altitude
Poplar	25	25.35	7.41	13.74	1966
Glasgow	18	20.20	9.41	12.87	2095
Havre	35	25.67	6.76	13.44	2493
Glendive	25	22.51	9.51	15.44	2069
Miles City	28	20.09	9.14	13.55	2371
Huntley	8	17.54	11.64	14.20	3038
Judith Basin ..	20	23.78	10.42	16.87	4160
Great Falls.....	15	23.73	6.68	15.94	3323

*Figures taken from records of United States Weather Bureau.

Crop conditions are affected largely by the distribution of the rainfall during the growing season. When there is a drought during this season, crops are generally light even when grown by the best methods. On the average, between 60 and 70 per cent of the annual precipitation falls in the five months between April 1 and September 1. Above an altitude of 3500 feet the annual precipitation is slightly less than for the lower sections.

The yearly range in temperature for this region is generally great. During the summer 100 degrees or over is often recorded, while a minimum winter temperature of -40 degrees is not unknown. Throughout the growing season the nights are warmer in the plains area and in the lower altitude than in the localities adjacent to the mountains. The snowfall is lighter and the winters are more open in the plains area than in the mountains.

Evaporation is an important index to the use that crops can make of the rains that fall. Evaporation in this area is less than in the central and southern Great Plains. Therefore an inch of rain should be of more benefit to crops here than farther south as less is lost by evaporation from the soil.

• METHODS OF PRODUCING CROPS

There are two rather distinct phases of production in this part of Montana, namely, production on new or sod lands, and production on land that has been previously cropped. The two are so distinct that they will be discussed separately.

CROP PRODUCTION ON SOD

In a newly settled community there is always a large percentage of the crops produced on sod land. This condition will generally continue for from five to ten years.

The cost of producing crops grown on sod land is higher than on old land. More power is required for plowing and more cultivation is necessary to prepare the seed-bed after plowing. On account of the cost of good preparation crops are often seeded on sod land that is very poorly prepared. This may result in light yields. When crops are grown on sod land that is properly prepared, however, the yields should be equal to those produced on old land.

Manner of breaking.—Sod should be broken when there is sufficient moisture in the soil so that a clean, thorough job can be performed. The roots of all vegetation should be cut off. The furrow slices should be even and should be uniformly turned.

Depth of breaking.—The depth of breaking will vary somewhat with the cropping system that is to follow. If the land is to be plowed for the second crop, shallow breaking is to be recommended, that is, not over 4 to 5 inches deep; the second plowing can then be to a depth of 6 or 7 inches. This will turn enough loose soil with the sod so that the sod will not hinder subsequent cultivation. In certain localities where the native sod is very heavy and the lower soil very compact, it is difficult to make the second plowing deeper than the breaking. When this condition is found, the general practice is to break about 6 inches deep and disk the crops in on stubble for one or two years in order to allow the native sod to decay. If the land is left for two or more years before plowing the second time, there is less trouble from native grasses starting second growth when the breaking is to a depth of 6 inches than when it is more shallow.

If conditions will allow, 4- to 5-inch breaking with backsetting after the first crop is recommended. Breaking to a depth greater than 4 inches has given no increase in yields over those obtained from that depth.

Time of breaking.—When conditions will permit, sod should be broken in late spring or early summer, before July 15, and remain fallow during the summer. This is generally known as summer breaking or fallow breaking. In localities where the grasses will not start growth after plowing, the sod should be cultivated soon after plowing. In localities where western wheat grass (*Agropyron smithii*) will start growth, cultivation should be delayed a few days until the furrow slices have at least partially dried out. Western wheat grass starts growth after plowing by means of rootstocks, and the drying of the soil will usually kill these rootstocks. There should be sufficient cultivation of the newly broken ground to prevent weed growth. Sod lands are not ordinarily weedy and one disking while the weeds are small will usually kill them. If the land is to be seeded to winter wheat, the summer cultivation should be more intense than if it is to lie over winter for spring seeding.

When the land is to be seeded to a crop the following spring, only sufficient summer cultivation to prevent weed growth should be given after breaking. One disking and one harrowing just before the seeding in the spring will usually prepare a good seed-bed on land so treated.

On summer breaking any of the grain crops or flax may be seeded. The yields are as heavy as by any other method. Winter wheat will often survive the winter with less injury on summer breaking than on old land that has been fallowed. Some especially heavy yields of flax have been grown on summer breaking.

Immediate cropping of sod lands.—The new settler usually needs quick returns for his labor and can not afford to let the breaking lie fallow through the summer. When this is the case, the land may be broken in the spring and immediately planted to crop; or it may be broken in the fall and planted to crop the following spring. Fall breaking requires more power than breaking in the spring on account of the dry condition of the soil.

Land broken in the fall should be left rough until the following spring. The rough condition during the winter tends to hold the drifting snow and to some extent prevents run-off when the snow melts rapidly. If plowed in the spring, the land should be either packed or disked immediately after plowing, thus packing the sod firmly on the subsoil. When a disk is used, it should be followed

immediately by a harrow. This cultivation prevents the drying out of the seed-bed.

There is no significant difference in the yields of crops grown on land broken in the fall and land broken in the spring. Land that has been broken in the fall has an advantage in that it can be seeded earlier than land broken in the spring.

The small grain crops are uncertain on land that is cropped immediately after breaking. When growing conditions are especially favorable, wheat, oats, or barley may produce small to medium yields. Under ordinary conditions the yields will be very light or perhaps fail entirely. Flax is one of the best crops to grow on newly broken sod. Corn is also adapted to new breaking but is not adapted to a large acreage. Under certain conditions Russian thistles will grow even on newly broken sod land. Where there is danger of weed growth, the sod should be broken to a depth of at least 6 inches and the soil well worked before planting to corn. This gives sufficient loose soil above the sod to allow cultivation of the growing crop. In localities where weeds do not grow on new breaking the depth of plowing may be less and corn can be grown without cultivation while the crop is growing.

PREPARING CROPPED OR "OLD" LAND

Seed-bed preparation.—There are several methods of preparing a seed-bed on land that has been previously cropped. The most common practices are fall and spring plowing, disking corn ground, summer fallowing, and disking stubble land. Fall listing of stubble ground, a method not generally used in this area, has been practiced at the experiment station with favorable results on land that is free from weeds.

Plowing and cultivation.—Where old land is to be plowed, either in the spring or fall, it should be done when there is sufficient moisture in the soil to permit good work. The plows and hitches should be so adjusted that the plows will run straight and with as little side draft as possible. Furrows should be close enough to turn all the soil. Excessively deep plowing has not, on the average, increased yields while, on the other hand, in some cases yields after deep plowing have been less than those obtained from ordinary plowing. Generally 5 to 7 inches is deep enough. Emphasis should be placed on plowing when soil conditions are favorable and to a

depth sufficient for completely turning under weeds and trash rather than on plowing to a depth exceeding 7 inches. This depth is ordinarily enough to eradicate growing vegetation.

The cultivation after plowing will depend on the time of plowing and the crop that is to be grown. Fall plowing, unless seeded to winter wheat, should be left rough during the winter. This rough condition prevents soil from blowing and to a considerable degree tends to catch and hold drifting snow. Loss of moisture by run-off is less on ground left in this state than on smooth land. As a drill will not entirely eradicate weeds that may have started growth, cultivation just before seeding is recommended on weedy land. Cultivation following spring plowing should be done as soon as possible in order to prevent the loose soil from drying out. Unless the plowed ground is soon packed and worked down by means of disking, harrowing, or some other equally good method, the loose soil will in many cases quickly dry out to the depth of the furrow. When this occurs it may retard the germination and early growth of the crop seeded. A double disking or packing followed by a double harrowing, if done when conditions are favorable, will form a good seed-bed on land that has been either spring or fall plowed.

Land that has been in a cultivated crop the previous season and has been kept free from weeds need not be plowed for a small grain crop. Experiments show that as much small grain can be produced on disked corn land as on plowed corn land. On corn stubble one double disking followed by one double harrowing will usually form an excellent seed-bed.

Land that is to be fallowed should be plowed in essentially the same manner as for producing an immediate crop. This should be done when the soil is still moist enough to turn well and before vegetation has made much growth on the land to be plowed. Bearing in mind that the chief loss of soil moisture is through growing vegetation, it is obvious that the greatest benefits from summer fallow can be expected only when weed growth is kept down. Cultivation to accomplish this end will vary with different localities. Land to be summer fallowed should usually be plowed before July 1. Double disking shortly after plowing ordinarily leaves the soil in good fallow condition. The rough surface which is formed by disking is preferable to a finely mulched surface; the former will not puddle or wash

as much as the latter when subjected to torrential rains. Weed growth which starts later in the season can be eradicated by a spike-tooth or a spring-tooth harrow. When fallow land is to be seeded to winter wheat the surface should be in somewhat finer tilth during late summer than when it is left for spring seeding. The additional cultivation forms a fine and firm seed-bed, which is a condition favorable for the germination and early growth of winter wheat. When fallow land is to be seeded to a spring crop, the land should be disked or harrowed just before seeding in order to kill any weeds that may have started.

Should it be deemed advisable to grow two grain crops in succession without plowing for the second crop, a common practice is to double disk and possibly double harrow the stubble just before seeding the second crop. This method should be followed only on land free from weeds. Under ordinary circumstances a crop thus grown should not be expected to produce a heavy yield. In certain parts of the plains area of Montana, winter wheat drilled in grain stubble shows less winter-killing than when seeded in any other manner. This is probably due in large part to the protection afforded the young plants by the standing stubble.

Fall listing of stubble land as a substitute for plowing has been practiced at the experiment stations and has resulted in favorable returns from crops sown thereon the following spring. The ground is listed out in furrows 3 to 4 feet apart and to a depth of 5 to 7 inches. Rain and drifting snow are held in the furrows and surface run-off is retarded. In the spring, shortly before seeding, the ridges are cultivated down and the surface leveled by harrowing until a good seed-bed is established. The advantages of this method are that it is cheaper and more rapid than plowing and that a maximum amount of precipitation is retained. The disadvantages are that it does not eradicate weeds on land where they have already become well established, and that the leveling off of the seed-bed requires a greater amount of labor than is needed in the preparation of a seed-bed after ordinary plowing.

As the amount of work necessary to produce a good seed-bed will vary with local conditions, the recommendations here given regarding cultivation are more or less general. However, the following points are considered essential in the preparation of a seed-bed. (1)

The surface soil for 2 or 3 inches should be in such a state of tilth that the seed when planted will be covered to a uniform depth. (2) The lower soil should be sufficiently moist so that germination will not be retarded, and firm enough so that it will not dry out quickly, thus injuring the early growth of the plant. (3) The seed-bed should be free from weed growth. With these points in mind cultivation should be conducted under the various conditions so as to bring the ultimate seed-bed as near the ideal as possible.

CROPS FOR OLD LAND

The crops generally grown on old land are spring wheat, winter wheat, oats, barley, flax, and corn. Other crops may be grown, but economically those mentioned are the most important. A separate discussion will be given for each crop, giving the leading variety, the rate and date of seeding, and the methods of seed-bed preparation that have brought the best results.

SPRING WHEAT

Spring wheat is generally adapted to this area. The acreage grown is larger than that of any other crop. Kubanka and Pelissier, belonging to the durum group, have been the highest yielding varieties. While the durum wheats yield well and are more resistant to disease than the common wheats, the market for durum has fluctuated more than for the common wheat. Marquis and Fife are the most generally grown of the common wheat varieties and mature almost as soon as winter wheat. The milling qualities of both Marquis and Fife are excellent.

Spring wheat should be seeded early. This should be done before the middle of April if possible and should not generally be attempted after May 15. While fair results are sometimes obtained when the seeding date is as late as June 1, the late-sown wheat usually produces only a small yield. Oats, barley, or flax will be more profitable than wheat for late seeding. When the ground is in good shape the seeding rate should be 40 to 60 pounds of clean wheat per acre.

At the Judith Basin substation the yields of spring wheat grown under different methods of soil preparation do not vary greatly. The average yield after small grains has been 20.8 bushels per acre. On corn ground the average yield has been 22.3 bushels and on fal-

low, 21.8 bushels per acre. At the Huntley field station there is no significant difference in yields on spring and on fall plowing after small grain. The average yield after small grain has been 14.5 bushels and after corn, 21.8 bushels per acre. Fallow has given an average yield of 24 bushels per acre, an increase of 2.2 bushels per acre over corn land. The largest profits per acre are produced on disked corn land.

WINTER WHEAT

In the eastern half of the plains area of Montana, winter wheat is uncertain because of winter-killing. When the crop survives the winter it generally produces heavier yields than spring wheat. It matures earlier and for this reason often escapes summer drought.

Kharkov and Turkey Red, two closely related varieties of the hard red or Crimean group, have been the most hardy and have given the heaviest yields. Winter wheat is usually seeded between August 15 and September 15. Later seeding in some cases has been found to be better. In certain localities farmers have made a practice of seeding just before the ground freezes up in the fall. In the winter wheat district the time of seeding will depend on soil and climatic factors. When the soil is in good condition in September, seeding at that time is usually the best. If it survives the winter, wheat sown at this time will mature a few days sooner than late seeding. Winter wheat is usually seeded at the rate of 3 to 4 pecks per acre.

Because of the range in adaptability of winter wheat, seed-bed preparation and resultant yields vary to some extent. In sections where winter-killing is not severe, wheat has given especially heavy yields when grown on fallow land. There is, however, less winter protection for the plants when grown on fallow than when grown by other methods. Winter survival is often greater when the crop is drilled into stubble. When this practice is followed, the stubble should be free from weeds. The late summer is generally so dry that the soil is in poor condition to plow for winter wheat, hence this practice is seldom followed. The yields of winter wheat have been almost as heavy when seeded on corn land as on fallow, and the cost of production is less on corn land. There is more protection for winter wheat if the corn stalks are left standing during the winter. The disadvantage of this practice is that the seeding in stand-

ing corn has to be done with a one-horse drill. At the Judith Basin substation winter wheat on corn land gave an average yield of 30 bushels, while the average yield on fallow was 29.6 bushels. The average yield at Huntley has been 22.9 bushels on corn ground and 31.1 bushels on fallow.

OATS

Oats grow well in this climate. The crop in Montana is more dependent upon the local market than wheat and is consequently subject to relatively greater fluctuations in price.

Sixty-Day and Kherson, two closely related varieties of early oats, have given the highest yields. Swedish Select and Danish, mid-season varieties, yield about as heavily when the precipitation during the growing season is above normal.

Early seeding is surest for dry lands. There is little danger to the crop from spring freezing when seeding is done after April 1. Seeding is sometimes done quite late, however, so that the date of maturity will be late in August or early in September. This late seeding exposes the crop to greater danger of injury from drought and early frost than does early seeding.

The rate of seeding will vary with the sizes of the kernels. Small oats should be sown at about 5 pecks per acre, while varieties with larger kernels may be seeded as heavily as 6 to 7 pecks.

There has been but little difference in yields on spring plowing and on fall plowing when oats are grown after small grains. When following small grain the average yield for Judith Basin has been 42 bushels and for Huntley, 28 bushels. Summer fallow has averaged 57.1 bushels and corn ground, 51.9 bushels at Judith Basin. At Huntley the yield of oats on fallow land has been 58.5 bushels, while oats grown on corn land have averaged 48.1 bushels per acre. At both stations disked corn ground has been the most profitable method of production.

BARLEY

Barley has proved itself generally adaptable to the plains area of Montana. Because of its short growing period it can be one of the last small grain crops seeded in the spring. Late seeding, however, is not to be recommended. When sown early, about the second week in April, barley matures and can be harvested before the other grain crops. As compared with other grain crops, barley will gen-

erally yield more pounds of grain per acre than either wheat or oats. In feeding value it is nearly equal to shelled corn and is more adaptable to all kinds of live stock than oats. This feature alone should assure a place for barley in the general farm rotation, especially in localities remote from a railroad.

The two main types of barley are the naked or hull-less and the hulled or brewing barley. Both general types contain two and six-rowed varieties as well as bearded and beardless varieties. All are good for feeding purposes, but if the crop is to be harvested by hogs one of the beardless varieties should be used. The variety that has proved best adapted to the plains section of Montana is the White Smyrna. This is a bearded, two-rowed variety and one of the earliest to mature. Its ability to withstand severe drought conditions makes it especially adapted to dry-farming. The chief objection to this variety is the shortness of the straw, which in a dry season makes harvesting difficult. This may be overcome somewhat by early seeding, which allows the crop to make its growth during early summer when growing conditions are normally more favorable than later in the season.

Of the naked varieties the Nepal or "White Hull-less" is commonly grown. This is a six-rowed, beardless variety, yielding somewhat less grain than White Smyrna and maturing a few days later. It is a variety that may be grown for hay or for hogging-off. In the higher valleys the Guy Mayle, also a hull-less variety but bearded, has proved one of our best yielders.

The usual rate of seeding is 5 to 6 pecks per acre for the hulled varieties and 4 pecks for the naked varieties.

The highest barley yields generally have been obtained from summer fallowed land or disked corn land. The average for summer fallow at Judith Basin has been 27.8 bushels per acre and at Huntley, 39.8 bushels per acre. Corn land averaged 26.3 bushels at Judith Basin and 39.8 bushels at Huntley. At either station there is little difference in the yield of barley on spring and on fall plowing. When grown after a small grain crop comparatively satisfactory returns have been received. At Judith Basin barley after a small grain crop has given an average of 22.7 bushels per acre and at Huntley, 22.9 bushels per acre. The most economical method of producing this crop is by disking it in on corn stubble.

CORN

The acreage of corn in this area is much less than that devoted to any of the small grains. Corn is generally used by the farmer who grows it as feed for his live stock. The crop will produce forage practically every year unless destroyed by hail or pests, and in extremely dry years it will yield more feed per acre than any other crop. Through the northern portion of the state the early flint varieties will usually mature. Some of the semidents and early dents will produce a seed crop only when conditions are most favorable. In eastern Montana, along the Yellowstone Valley, satisfactory results have been obtained each year with the early dent varieties, which have always produced feed and generally a fair grain crop.

Only the early varieties of corn should be grown in Montana. Dakota White Flint and Gehu Flint have produced the highest yields. They are early and will make more growth during cool weather than the later varieties. These early flints are too short to be harvested by machinery and are especially adapted to pasturing off in the field. Northwestern Dent, a semident variety, has been quite generally grown. There is a wide range in the character of growth of the different strains of this variety. Some of them are low growing, very similar to the early flints, while others grow taller and with less tillering. The taller-growing strains can be harvested by machinery and are adapted for use as ensilage. Northwestern Dent usually produces mature grain in the Yellowstone Valley. The early dents, such as Brown County and Rustler's, and the tall-growing flints, Triumph and Longfellow, are best adapted for localities with a long growing season. They grow tall enough to be harvested with machinery and the ears are high enough so that husking may be done in the field. Varieties should be selected according to the use that is to be made of the crop. For hogging-off, the heavier yielding varieties should be used. If the crop is to be harvested either for dry feed or for silage, the taller varieties should be grown if possible.

Corn may generally be planted during the first half of May. When planted later than May 20, it is apt to be damaged by the first frosts in the fall.

From 8 to 12 pounds of seed per acre is the amount generally required when the crop is drilled in by means of a corn planter. If

the check-row method of planting is employed, the amount of seed required is less. If possible seed should be secured from the locality in which it is to be planted or from a locality with similar climatic conditions.

Corn should be grown on either spring or fall plowing after a small grain crop. Yields have been slightly heavier on spring plowing than on fall plowing but the difference is not considerable. Growing corn on fallow is not recommended as the yields are not enough greater than yields produced after small grain to pay for growing the crop by the former method. Land that has been fallowed and properly cultivated should be cropped to small grain or flax rather than to corn. Planting in listed furrows has given greater yields at Huntley than has surface planting, while at Judith Basin listing has not given as high yields as surface planting. The cultivation of listed corn is facilitated by special machinery, and this method should not be used extensively unless this special machinery is available.

Many farmers have had difficulty in keeping land that is in corn free from weeds. Russian thistles have been especially troublesome. The early growth of weeds can be controlled by plowing the land just before planting the corn and harrowing once or twice before the plants have reached a height of 6 inches. Cultivation with a corn cultivator should start as soon as the plants are large enough to permit cultivation without covering them. Three cultivations before August 1 will generally keep weed growth down. The importance of early cultivation is emphasized. If the corn is drilled in rows, the cultivator should be so adjusted at the time of the last cultivation that it will throw the soil into the corn row. By this method small weeds in the corn rows can be killed by covering them with soil. Check-row planting, which permits cross cultivation, can usually be kept cleaner of weeds than drill planting. Well-tilled corn land is a valuable substitute for fallow. The cultivation that the crop requires through the season keeps down weed growth and leaves the ground in shape for the planting of small grains with the minimum amount of labor for seed-bed preparation.

At the Judith Basin substation corn has produced an average yield of about $2\frac{1}{2}$ tons of fodder per acre but ear corn seldom ma-

tures. At Huntley the average yield has been 27.1 bushels of ear corn and 1970 pounds of stover per acre.

FLAX

In 1916 one-fifth of the acreage of flax in the United States was grown in Montana. The average acre-yield for ten years has been higher for Montana than for any other important flax-growing state. Climatic and soil conditions are generally favorable for this crop. The acreage is greater in the eastern and northern part of the state than in the southern.

The yield per acre is less for flax than for small grains, but the market price per pound is higher. Because of the relatively small bulk and hence less expense for hauling, flax can be economically grown at a greater distance from market than can the small grains.

Flax has been grown mostly on new land. It is one of the surest crops on breaking. When grown after flax or small grains, there is no significant difference in the yields on spring and on fall plowing. Spring plowing is the best some years while fall plowing leads in others. The yields are generally high on sod land that has lain over summer. On old land that has been fallowed, flax is not generally as profitable as some of the small grains. Disked corn land makes an excellent seed-bed for flax. Small grains can be profitably followed by flax on either fall or spring plowing.

Flax should not be grown on the same ground continuously as it is apt to become infested with disease.

Under ordinary conditions flax may be seeded from the middle of April to the middle of May. Early seeding has generally given the best yields. The seeding rate is 20 pounds per acre. When less than this is sown the danger of the crop's becoming weedy is increased. Care should be exercised to prevent the seed from being planted too deep and thus hindering the growth of the young plants. Under most conditions seeding to a depth greater than 1½ inches is not desirable.

The average yield of flax on corn ground has been 11.9 bushels and on fallow 10.9 bushels at the Judith Basin station. At Huntley corn ground has given an average flax yield of 10.7 bushels; fallow, 16.3 bushels; and a rotation of small grain and flax, 9.5 bushels per acre.

ROTATION

From the results of the different crop rotations at the experiment stations and from those systems which are in general use in the older farming sections of the state, the following crop rotation is at this time recommended:

Corn on spring plowing, followed by grain—either wheat, oats, barley, or flax—on disked corn land, followed by summer fallow, followed by wheat. In the winter-wheat section that grain can be grown and in the other sections, spring wheat.

In this four-year rotation there would be no early spring plowing for small grain. The land to be sown to spring grain could be seeded as soon as the disking and harrowing had been completed. After the spring grain had been seeded, plowing could be done for corn. If conditions were favorable in the fall, the land for corn could be plowed at that time without materially affecting the yield. After the corn is planted the land to be fallowed should be plowed. While this is being done corn could be cultivated once or twice. The cultivation of corn and of fallow land would occupy the time until harvest. After harvest, winter wheat should be seeded.

A part at least of the corn crop should be cut for silage. The remainder could be either cut for dry feed or hogged-off in the field.

The advantages of such a rotation are that the grain crops, which are the cash crops, are grown on either fallow or corn land; ample feed is furnished for live stock; and the labor is distributed throughout the season.

PASTURE AND FORAGE CROPS

With the rapid settling of the farming regions in the plains area of Montana the amount of free range has been greatly diminished. This is especially true of localities near the railroads and in regions having a high percentage of tillable land. Under these conditions the farmer is often at a loss to find suitable pasture for his stock. The problem of producing hay or other forage for winter use is also one that the dry-land farmer has to meet. Ordinarily some portion of a farm is set aside for pasture. This land may be too rough or otherwise unfitted for plowing and producing grain crops, or it may be entirely tillable and used for pasture because less desirable land is not easily available for the purpose. In either event the question will arise whether or not the land so used is

serving this purpose to the best advantage. Most of eastern and central Montana is covered with native grasses that from a range standpoint are excellent feed. Chief among these are the gramma grass (*Bouteloa gracilis*), western wheat grass (*Agropyron smithii*), and buffalo grass (*Bulbilus dactyloides*). From the standpoint of the farmer whose pasture is often small in area, there is danger from overgrazing and eventually reducing the vigor of the plants or even killing out a large part of the native grasses. Where conditions will permit, the native grasses may be supplemented by seeding some domestic crop that can either be grazed along with the native grasses or pastured separately.

BROME GRASS

Awnless brome grass (*Bromus inermis*) has given satisfactory results as a permanent pasture grass. For the best results land to be seeded to brome grass should be plowed as for a grain crop and cultivated to kill native vegetation and form a suitable seed-bed. The crop may be sown with a grain drill. When this is done it is necessary to have an extra man on the drill to constantly stir the seed in the hopper to keep it flowing into the feed openings. Brome grass may be seeded at the rate of 15 pounds to the acre. Care should be taken not to plant it too deep; 1 inch is deep enough, provided there is sufficient moisture at that depth to germinate the seed. Early seeding will give a better stand than late seeding, and the young plants will become more firmly established and hence better able to withstand the heat and drought of the summer months. As the young grass grows quite slowly the pasture will usually become weedy during the first season. The weeds can be prevented from forming seed by clipping them with a mower when they are in bloom. Generally the second year will find the brome grass well established and ready for grazing. It will be green and attractive earlier than the native vegetation and stock will ordinarily devote themselves to it almost exclusively during the early part of the season. This will give the native grasses a chance to make a good growth during the spring and so provide a better pasture through the summer months. If planted in some low place in the pasture lot where it will receive the benefit of run-off, brome grass will usually stay green throughout the season. Where not so favorably located, the grass will usually dry up during the summer

months. Fall rains will often revive it sufficiently to produce a good pasture until winter. The crop is perennial and after becoming well established will usually produce good feed for several years. A brome grass pasture started at the Huntley experiment farm in 1914 by the method just described has furnished excellent grazing during the four years since that time.

WINTER RYE

In some instances winter rye has been seeded for pasture. Though this crop furnishes a desirable feed it lacks the permanence of the brome grass pasture.

It should be seeded at the rate of 50 to 70 pounds per acre.

ALFALFA

The acreage of alfalfa grown on the dry land in Montana has been small. During the past five years this acreage has increased. When the quality of hay is considered it is one of the best crops for forage.

Alfalfa should not be seeded until the native sod is well rotted and the wheat grass entirely killed out. When wheat grass becomes established in a field of alfalfa it will materially decrease the yield of alfalfa and in time may kill it out.

Alfalfa should be seeded, if possible, on land that receives more than the ordinary amount of moisture, either through run-off or from subirrigation. On most farms there are bottom lands or swales where water does not stand too close to the surface that could be utilized for alfalfa. When seeded in these favorable locations alfalfa will usually produce a larger tonnage if planted with a drill the same as small grains than if seeded in intertilled rows. On the ordinary bench land seeding in cultivated rows from 3 to 4 feet apart has given the heavier yields, especially in dry years.

Alfalfa should be seeded after a crop of small grain on either spring or fall-plowed land. Seeding without a nurse crop is the surest method. A satisfactory stand may be secured with a thin stand of grain in a wet season, but under ordinary conditions the young alfalfa plants will die during the first year. When seeding in ordinary drills the rate of seeding should be light, not more than 6 to 8 pounds of good seed per acre.

Alfalfa is usually grown for the production of a hay crop, but experience has shown that it can be used advantageously for pastur-

ing also. Under conditions where a second cutting of hay can not be produced, it frequently makes enough growth to permit grazing in the late summer and fall. When pastured care should be taken to see that it is not grazed so closely as to injure the crowns or increase the chances of winter-killing by the removal of all protection.

It is necessary to use care in pasturing cattle and sheep on alfalfa to prevent their bloating.

SWEET CLOVER

Sweet clover may be raised to some extent in place of alfalfa. It will tolerate a greater amount of alkali in the soil and so can be grown in some places where alfalfa can not. It is doubtful if it is any more hardy than alfalfa or if it will actually stand any more drought. It is a biennial, making comparatively little growth the first year and coming to full growth and completing the life of the plant the second year. Because of its small growth the first year, it often has a reserve of water in the soil upon which to draw in its second or productive year. It may thus produce a crop when an established alfalfa field does not. In order to have a field to harvest each year a field must be sown each year. With limited rainfall there is no certainty of getting a stand when sown with a grain crop. When seeded alone there is the loss of the use of the land for a year to be considered in connection with the other expense of establishing a stand.

A very firm seed-bed is necessary to get a good stand of sweet clover. The seeding should be at the rate of 14 pounds of hulled seed per acre.

Though fewer instances of bloat are reported when live stock is pastured on sweet clover than when pastured on alfalfa, care must be exercised in pasturing it.

CORN

From the standpoint of a desirable crop to grow for winter feeding the dry-land farmer can usually rely on corn. This crop will ordinarily produce an abundance of fodder, and in the southern and eastern portions of the state mature corn can usually be harvested. The general type of corn grown in this region readily lends itself to feeding purposes. It is usually fine-stemmed and leafy and is very palatable to live stock. Being comparatively short, it is not as difficult to handle, whether in bundles or loose, as it is when coarse,

tall stalks are produced. Climatic conditions are usually such in the fall that the stover can be cured in the stock. When silo facilities are available, the entire crop may be stored in this manner.

HAY

Under favorable conditions of moisture and temperature, brome grass, alfalfa, and sweet clover may produce good crops of desirable hay. It is seldom that more than one cutting of them can be expected. Therefore sufficient acreage should be devoted to these crops to enable the one harvest to yield the winter's supply.

Oats, rye, barley, and wheat are sometimes grown for hay. When grown for this purpose beardless varieties of barley and wheat should be used. All the small grains make good hay when cut while still green and with the seed in the soft-dough stage. In the southern part of the Montana plains area the early sorghums, millet, and Sudan grass have been grown for feed with more or less success.

SUMMARY

Outside of the mountain valleys, in some of which dry-farming has been successfully practiced for years, the land in Montana suitable for dry-farming lies in the plains area east of the Rocky Mountains below an altitude of 5000 feet. The precipitation of this area varies from about 12 to 17 inches. The most commonly grown crops are spring wheat, winter wheat, oats, barley, corn and flax.

Prairie sod, if broken in the fall or early spring, may be seeded to spring-sown crops with a degree of success largely dependent upon the season. The best results are obtained by breaking in the spring or early summer to a depth of 4 to 5 inches and allowing it to lie fallow over the season.

A seed-bed may be prepared on old land by plowing in the fall or in the spring, by summer fallowing, by disking either corn or grain stubble, or by listing. The essential points of a good seed-bed are: (1) A state of tilth of the surface soil that permits uniform covering of the seed; (2) sufficient moisture in the upper soil to germinate the seed and enable the plant to make a vigorous growth; (3) freedom from weeds. The greater the quantity of available water in storage in the soil the better is the opportunity of the crop to withstand drought.

The leading varieties of spring wheat are Pelissier and Kubanka

of the durum group and Marquis and Fife of the common wheats. The seeding rate is about one bushel per acre. Seeding should be early, before April 15 if possible. At the Judith Basin and Huntley substations the greatest profits per acre have been obtained on disked corn ground but the highest yields have been obtained on fallow. There is little difference between the yields on spring and on fall plowing.

In the eastern half of the plains area of Montana winter wheat is uncertain because of winter-killing. When the crop survives the winter it generally yields more heavily than spring wheat. The method yielding most heavily is summer fallow but this does not in all sections increase the yield sufficiently to make its practice profitable. The greatest degree of winter protection is obtained by seeding in grain stubble. Such ground should be clean and free from weeds. The yield on corn ground is in some sections as high as on fallow and the cost of production is less.

Oats are well adapted to this section. Early and mid-season varieties are better than late ones. Early seeding at a rate of from 5 to 8 pecks per acre should be practiced. There is little difference in the yield on fall and on spring plowing. Yields following corn are higher than following small grain, and higher on corn ground than on fallow.

Barley is well adapted to this section and should be a valuable feed crop. While summer fallow and disked corn ground have given slightly the highest yields, comparatively satisfactory returns have been obtained on either fall or spring plowing following small grains or flax.

Early varieties of corn will mature over the greater part of the plains area of Montana. Fodder can be produced even where the grain does not mature. Not only is the crop a reliable source of valuable feed but its growth and cultivation provide one of the best preparations for a crop of small grain.

Flax is especially adapted to new breaking. It also does well after corn and after small grains, but in comparison with other crops it is relatively not profitable on fallow.

A general crop rotation recommended for the plains area of Montana is corn on spring plowing, followed by small grain or flax on disked corn ground, followed by summer fallow, followed by

wheat—preferably winter wheat where this can be grown. This rotation provides feed for live stock, cash crops grown by the surest methods, and distribution of labor throughout the season.

Native grass, brome grass, and alfalfa are the best permanent pastures.

Alfalfa, brome grass, sweet clover, and small grains all make good hay. In the southern part of the area sorghums, millet, and Sudan grass have been successfully grown for feed.