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The Potato Industry of Colorado

By C L. FITCH and E. R. BENNETT

POTATO INSECTS

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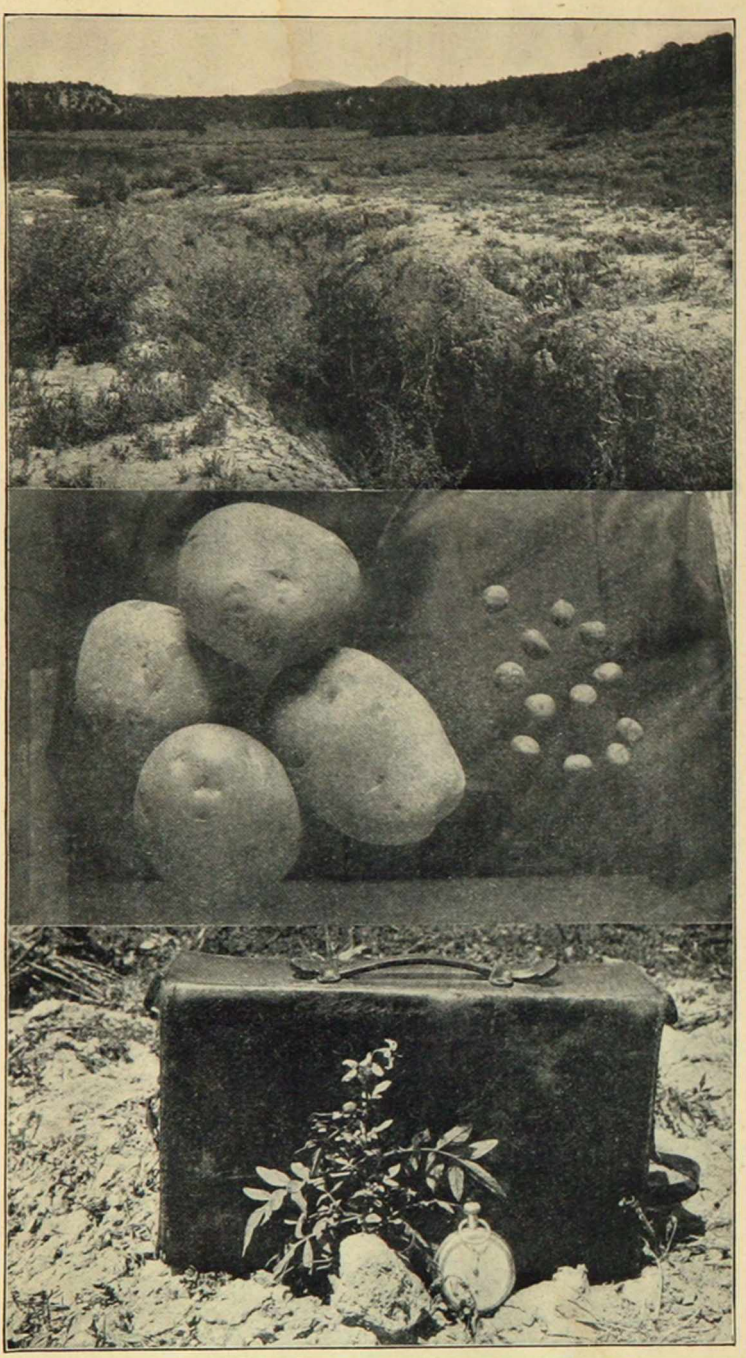

PLATE II.—THE COLORADO WILD POTATO (Solanum Jamesii)
1.—Habitat at Tiffany, near Durango. 2.—Size of Tuber as compared with Rurals
3.—A wild plant with two blossoms and seed ball

THE POTATO INDUSTRY OF COLORADO

By C. L. FITCH and E. R. BENNETT

PREFACE.

When the cattlemen first established their home ranches in our mountain valleys and in the creek bottoms on the plains, they found the dark, sandy, alluvial loams good potato soil, rich with the wash and willow leaves of ages, and large returns were secured for years on these soils. The introduction of alfalfa from Utah and California made the bench lands even more productive, and when farmers learned how to break and handle the alfalfa sod, it proved the greatest factor in the extension of potato growing and of irrigation development generally. The total output was doubled from the same areas in a few years' time and the possibilities of profit woke up the state.

A little later the fine shape and wonderful quality of mountain potatoes became known outside the mining and lumber camps, and railroads saw the possibilities of agricultural freight, and farm development.

Somewhat later the newer districts made so many demands upon the Agricultural College for advice and instruction that the Board of Agriculture secured a potato specialist to work for the growing industry. The attention of growers and of business men generally was called to the geographical position of Colorado with reference to the production and consumption of potatoes and the specialist went up and down through the mountains as an instructor and adviser to the newer potato districts. In connection with the Rio Grande Railroad and the department of Farmers' Institutes, Professor Cottrell took expert potato growers to the newer mountain districts, and later three special institute trains were run by the railroad and the college that were of great use, both to the railroad and to the people along its line.

In 1895 Colorado put in 37,000 acres of potatoes and produced three and one-half million bushels and ranked as the twentieth state in the Union in total potato production. Next year she was twenty-second. In 1900 she was twenty-third. In 1902 Colorado rose suddenly to sixteenth place in the Union. In 1903 she was tenth, and since that time she has held about that position. In 1906 her crop fell to the sixteenth, and in 1909 it rose to the ninth state. This year the August freeze at Greeley has lowered her position again to the twelfth place. The acreage in 1910 was 64,000.

In money value per year her crop in fifteen years has grown from a little over a million dollars to an average, since 1903, of more than four millions of dollars, with the highest total in 1909

of $5,928,000. The production in bushels has risen from three and one-half millions to an average of between seven and eight, with the high point in 1909 of 10,400,000.

As to the future, more acres will be put in to potatoes, and great increases in production are to come from better methods. Better understanding of seed potatoes and the laws of productiveness are to be a big factor. Improved strains and improved varieties will count a great deal, and we are beginning the work of developing such strains and varieties.

It is calculated that improvements in varieties and seed stocks can workably affect a minimum increase in quality and value of five per cent., and associated with it will be an additional yield of at least as large an amount. If we figure only ten per cent. on a six million dollar crop, and another ten per cent. in possible betterments of methods, the economic prize to the state is well worth reaching out after. Colorado has been ambitious for her potato industry and its expansion, and liberal in her provision, that no industry be better served, and that the experience of all be gathered and made available to all, to the end that potato growing shall be nowhere on a higher plane of intelligence, service or profit.

With this brief general glimpse of the potato industry of Colorado, and its relations with the college, we will plunge into a detailed account of potato growing and its problems, designed for the use of Colorado growers, of those interested in the crop commercially, and of high schools in potato districts. To it is appended a report of field work in 1910.

INTRODUCTION.

THE POTATO CROP.

More weight of food is produced by potatoes than by any other crop of the world. In number of bushels the potato far exceeds any of the great cereal crops of the world; wheat or corn or the rice of the Orient are far behind it in total production.

Per Capita Consumption.—While the potato is universally used among American people, the consumption per capita is notably less than in Europe. According to the statistics of the Department of Agriculture, the crop of the United States is not far either way from 300,000,000 bushels per year, or 3½ bushels per capita. Germany, a country that is a little more than twice as large as Colorado, produces 1,600,000,000 bushels, or from five to six times as many as the whole United States. The people of Germany, as well as the people of Ireland, in place of using 3½ bushels of potatoes per year, consume twenty-five bushels per capita.

Where Grown.—By far the larger part of the potatoes of the United States is grown in a few of the *northern* states. In fact Maine, New York, Pennsylvania, Michigan, Wisconsin, and Minnesota produced half of the immense crop of 1909.

While Colorado is the 10th or 11th state in production of potatoes, she is one of the leaders in the investigation and promotion of the industry. A little study of potato prices and possibilities of potato growing will show why Colorado is one of the leaders in this work.

TABLE 1.—Average Yield of Potatoes per Acre, in bushels.
(From U. S. Dept. of Agriculture, Yearbook.)

Year:	1904	1905	1906	1907	1908	1909	Average
Nebraska	120	93	87	73	78	78	88
Wisconsin	126	68	97	91	80	102	94
Michigan	121	67	95	90	72	105	91
Iowa	136	80	95	85	80	89	94
Minnesota	102	87	92	101	76	115	95
*New York	93	70	105	98	82	120	94
Colorado	159	160	125	150	125	160	146

TABLE 2.—Average Farm Value of Potatoes per Acre, on Dec. 1.
(From U. S. Dept. of Agriculture, Yearbook.)

Year:	1904	1905	1906	1907	1908	1909	Average
Michigan	$35.09	$37.52	$32.36	$40.50	$41.76	$36.75	$37.33
Minnesota	29.58	41.00	34.04	41.41	42.46	42.24	38.45
Wisconsin	35.28	42.16	29.10	40.95	48.00	38.39	38.96
Nebraska	31.20	34.41	45.25	51.10	42.90	46.80	41.94
Iowa	38.08	39.20	40.85	46.75	48.00	48.95	43.63
*New York	50.22	49.00	51.45	55.86	61.50	60.00	54.67
Colorado	58.83	91.20	56.25	99.00	75.00	91.20	78.58

*These states are direct competitors of Colorado, with the exception of New York, whose great acreage gives the state a large influence in the potato market of the United States. Maine alone, among the great potato producing states, exceeds Colorado in production per acre, but Maine's geographical position and large costs of production are such as to exert little influence on the Colorado potato industry.

Colorado Yields Compared With Other States.—One half more potatoes per acre are shown by Table 1, to be produced annually in Colorado than in any of the great potato states mentioned. These averages cover the whole state, not only the irrigated parts but a large area in eastern Colorado that does not, and never can be expected to produce the highest yields.

Money Value Per Acre.—Yields per acre do not necessarily mean high money values. Table 2 shows that Colorado not only produces a high average yield of potatoes, but that the value per acre is also more than in any of the states mentioned.

Net Profit.—Again, yields per acre, or values per acre, do not always mean net gains. The cost of growing must be taken into consideration as well as the gross income. In Colorado, by far the greater proportion of the crop is grown by irrigation and it may be claimed that this increases the cost. This is true, but the cost is much more than offset by the fact that practically no fertilizer for growing this crop in Colorado is needed, and that in a large part of the state no spraying is done for either fungus diseases or insect pests. In fact, these two items alone, in many cases, cost more per acre in some of the great potato producing states than the total cost of production in Colorado.

Native Home of the Potato.—While the potato is a native of the tropics, its habitat is at a high altitude. By far the greater part of the potatoes grown in the United States are produced along the northern border and few are produced in the south.

Potato Prices, North and South.—Last year the price of potatoes in Wisconsin, Michigan, New York and other northern states was less than fifty cents per bushel when potatoes were from $1.00 to $1.10 per bushel in South Carolina, Georgia, Florida and Texas.

Colorado's Favored Position.—Colorado is practically half way between the producing and consuming regions. This gives the growers a great advantage over their competitors in these high priced markets. The northern states have the cool climate which adapts them to potato growing, because of their high latitude. Colorado, because of its high altitude, has practically the same summer climate as far as temperature goes.

Dryness and Sunshine.—The northern states have, with their cool climate, a tendency toward humidity and cloudiness that Colorado does not have, and as sunshine is a most essential thing in plant growth, Colorado has a considerable advantage in this respect.

OUR TERRITORY AND ADVANTAGES SUMMARIZED.

Northeastern Colorado.—Until the present time, the major part of the potato production of the state is confined to the Greeley district, which embraces approximately 250,000 acres and will be nearly doubled by ditches under construction. East along the Platte, including the country about Fort Morgan, Sterling and Julesburg, potatoes are being grown more than formerly, and the dry land growers of these regions are taking greater interest in this crop.

The San Luis Valley.—This valley includes an area of 3,100,000 acres of land, which is largely adapted to potato growing and has untold possibilities. In fact if one-tenth of the area of the San Luis Valley were to be planted in potatoes, and should produce 10,000 pounds per acre (which is not a large yield for this district), the valley would produce one-fifth of the present potato crop of the United States.

The Grand, Eagle, and Crystal River Regions, known as the Carbondale and Eagle district, contain many thousand acres of land admirably adapted to potato growing but not yet fully developed.

The Uncompahgre and North Fork Valleys comprise more than one hundred thousand acres of land, the most of which is adapted to the growth of this plant.

Archuleta, Montezuma, Dolores, La Plata, and San Miguel Counties, in the southwestern part of the State, have large areas that are well adapted to this crop but not yet developed to any great extent owing to a lack of direct transportation.

Rio Blanco, Routt and Grand Counties have remained largely undeveloped for the same reason as the last section, although they have many thousand acres as well adapted to the growth of this crop as those districts that have become famous.

A Summary of Advantages: Colorado climate is ideal for potato production, eighty-five per cent. of the days in the year being fair.

Colorado soils need no fertilizer for the growing of this crop out side of the established rotations.

Colorado's geographical position gives a big saving of time and freight in reaching the high priced markets of the United States.

Few of the many potato diseases trouble Colorado growers.

Colorado's production per acre, including a large per cent. of unirrigated lands, is much greater than that of the great potato producing states with which we compete, and the value of the crop per acre is about double that of those states.

The money received for Colorado potatoes is largely net gain to the State as very little money is sent out for fertilizers, etc.

The potato crop at present brings to the growers approximately $6,000,000 a year. Colorado has undeveloped lands enough to make the total output several times what it is at present.

THE BOTANY OF THE POTATO.

Solanum Tuberosum, is the botanical name for the common potato of commerce. It is closely related to the tobacco and tomato and to the nightshade, the egg-plant and the buffalo-bur. Other species of tuber-bearing Solanums have been domesticated in the hope of finding a potato equally as good as *tuberosum,* and one that would be more resistant to fungus diseases. Among these are *Commersonii, Maglia,* and *Jamesii,* the last being a native of the mountains of southwestern Colorado. None of these species have ever become valuable as a source of human food.

What Is a Potato?—Botanically, the potato is a tuber or enlargement in a stem or branch, normally under ground, but sometimes above, even in upper branches when disease or accident has interfered with the formation of tubers below ground. Not infrequently growers speak of the potato as a root, or growth from the root. The tuber has no connection with the root system of the plant. This structure of the potato may be best observed by examining the the plant about the time the blossoms are forming. If the plant is carefully dug, the small stems will be observed growing from the main stem of the potato above the seed piece from which the plant came.

Tuber Stems Vary greatly in length with the varieties. The stem of the Pearl is short, and the tubers are set close in around the old seed piece. The stems and tubers of a Rural New Yorker go more deeply into the soil. The Peachblow has not only a long underground stem, but often the stem continues through the first tuber, so as to have two or even three tubers on the same stem.

Potatoes from Seed.—While the plant is usually reproduced by cuttings of the tuber, it may be reproduced from true seed, as it undoubtedly is propagated in part under wild conditions. Many of our best varieties of potatoes, however, never produce seed balls, nor even perfect blossoms. (For a discussion of this point see Bulletin No. 176.)

The Function and Development of the Tuber.—The plant food, elaborated by the plant during the summer, is deposited in the tuber for the use of coming generations of plants, and a very large part of this food is deposited during the last weeks of the plants' growth.*

*For an explanation of tuber structure see Quality of Potatoes herein.

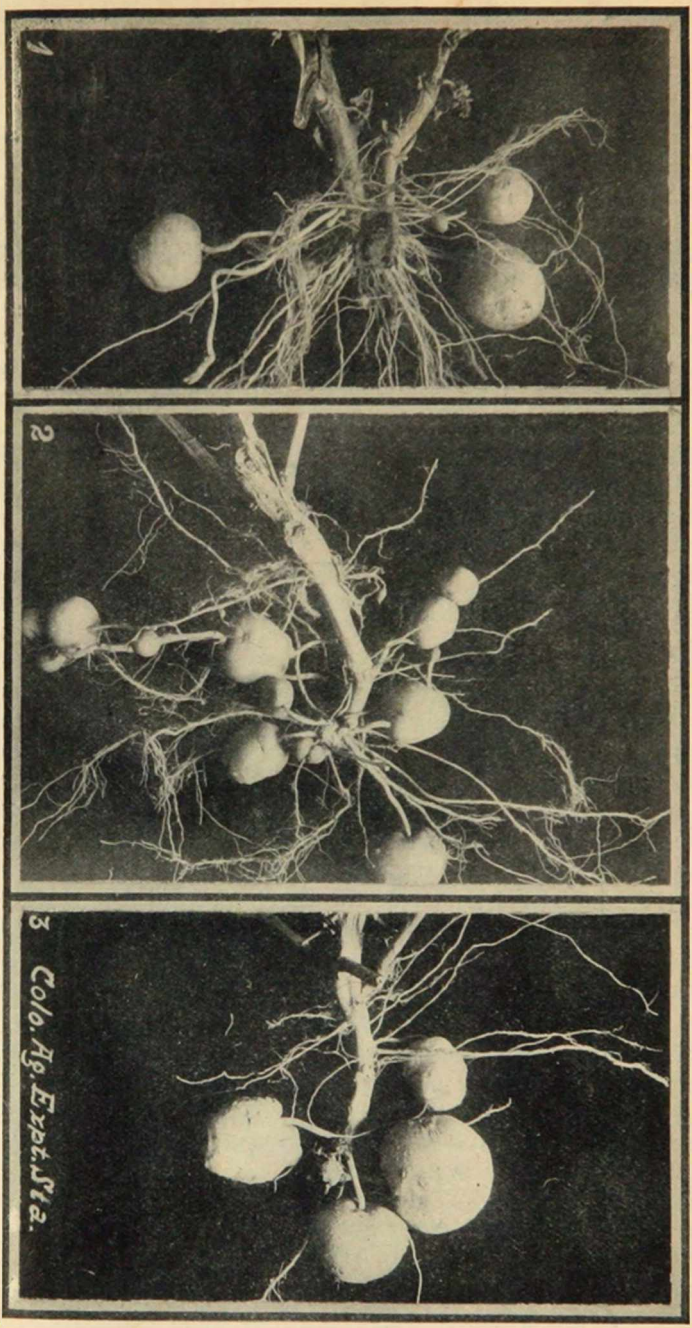

PLATE III.—HABITS OF GROWTH

1. Rural. 2. Peachblow. 3. Pearl

It has been found in several experimnets that where the ground and plants are in good condition when the tubers have set, that a fair yield of tubers may be obtained, even though the top soil be dry so that little more plant food could be taken from the soil. This is an important point, in our irrigated districts, as we believe that entirely too much water is ordinarily given after the tuber-forming season of growth. We believe that where the soil is in fairly moist condition at the bottom of the hills when the tubers are one-third grown, that the yield will be practically as great if no more water is given, as if another thorough irrigation is applied. Those plants that die back to the ground each winter as the asparagus, rhubarb and lily take care of the plant food by storing it in the underground parts. This is also true of the potato except that the food is stored in a different part of the plant. If the potato stem or leaf be examined during the latter part of the season, considerable quantities of starch will be found in the tissue. After the tuber begins to form, this starch is rapidly transferred to the tubers. In a field at Greeley in 1908 four plots were staked out by us, each of which contained 1/100 of an acre and were as nearly uniform as possible. The first of these plots was dug August 25. At this time a few of the tubers had reached the size of six or seven ounces. The plants were in good condition of growth and the soil moderately moist. The tubers dug weighed seventy pounds, or seven thousand pounds per acre. Nine days later the second plot was dug. In the meantime the tubers had very materially increased in size so that many of them weighed more than one pound. The total weight of the plot was one hundred fifty pounds or 15,000 pounds per acre. One week later the next plot was dug, which gave 170 pounds, or 17,000 pounds per acre. If the first plot had been dug two or three days earlier and the second plot two or three days later it would have been found that by far the larger part of the total tuber growth was made in two weeks.

POTATOES MIXED IN THE HILL.

The Botanist and the Farmer.—The botanist knows that potatoes cross or mix in the seed, and not in the tuber. The grower knows, as an actual fact, that he finds different colors and kinds of potatoes in the same hill from the same seed piece, and he often vows that the botanist is a theorist.

Both Are Right.—There is no occasion for bad blood on the subject. There is the highest authority that both are right. Just as Albinos are born in human families, or as peaches and apples sometimes have limbs whose fruit varies from that of the rest of the tree, so white potatoes come in purple hills, or purple in white hills, or round ones among long tubers, by natural variation, or coming up of diverse inheritance.

The Origin of Many Varieties.—By bud variation White Pearl potatoes came from Blue Victors,* White Ohios from Red Early Ohios, and Red Peachblows from the old spotted Jersey Peachblow. Thus, of the above Colorado standard varieties, three came "mixed in the hill," although they did not mix there, and only our Rural came to be what it is without this factor. The Rural came direct from the seed ball and so did the regular Early Ohio—the latter a cross between the Hebron and the Peachblow—"mixed," or crossed in the seed ball.

HISTORY OF THE POTATO IN COMMERCE.

The Potato Was Discovered in 1532 by the expedition of Pizarro near Quito in Peru, where it was cultivated at an elevation, they thought, greater than the line of eternal snow in Europe, and was found growing wild still higher above the tilled lands of the Incas.

Spain, Italy, and France soon saw specimens of the tubers, first as botanical curiosities and then as a possible source of food for peasants. In 1586 the plant was brought to the attention of Queen Elizabeth of England. As late as 1719 the potato was not listed in a garden manual in England which purported to be complete. Somewhat over 200 years ago, interest had been shown by English landlords in the growing of potatoes for food for their Irish tenantry and the crop soon thereafter became important throughout Europe.

Germany, Russia, Austria, and France, in the order named, lead the world in the total production of potatoes. Their use as food for stock, as a source of alcohol for mechanical and household purposes, and as a source of starch for cloth makers and laundries, is now a great factor in the consumption of the potato.

Why Grown.—Climate and the cheapness of the potato as a food (with no process of manufacture needed) among people where cheapness is desired or imperative, together with the small knowledge required for moderate success with the crop, have been the chief factors in the extensions of potato culture. The appreciation of good potatoes as a staple food is a later factor.

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*In a field of White Pearls in 1908 we found in different hills two potatoes which had small purple spots covering eyes. These tubers were planted that winter in the college greenhouse, the purple and white eyes separately. The potatoes grown from these pieces came true in color to the color of the eyes planted, and they were planted in the field at Greeley in 1909, again coming true in color except for some white streaks on the purple variety. This stock was planted in 1910 at Del Norte and again came true each to its color. These are the "White-Eye Pearls," and "Purple-Eye Pearls," noted in the Del Norte Tables.

Corn, Tobacco and Tomatoes have remained to a great degree American crops, the tomato having been the last to enter use on a commercial scale, and that almost entirely in America. Cotton came to us and we lead the world in its production. It has been the reverse with the potato. South America, its home, produces less in total than Colorado, and the potato crop of the United States is insignificant as compared with that of Europe.

The Potato as Freight is important, because it is better economy to grow it in the north, or in the high altitude districts, and transport it south, than to grow it in the uncongenial climate of the south. The weight of the potato crop of the world is nearly half more than the leading grains—wheat or corn—and nearly three times the weight of the world's rice crop. The average crop, in tons per acre, of potatos in Colorado, is about six times that of grain. Fully as large a per cent. of the potato crop is shipped by rail as of wheat or corn, and potatoes pay a higher freight rate.

QUALITY IN POTATOES.

Table Quality in potatoes is an important factor in the development of the industry in the United States. All but a very small per cent. of the potatoes grown in this country are used for human food. When the quality is high the amount consumed per capita is considerably more than in years when the quality is low. Attention on the part of the growers to producing smooth, white fleshed, mealy tubers will increase the per capita rate of consumption.

What Constitutes Quality.—From the American standpoint, the popularity of the potato as a food depends for the most part upon its starch content, because in the United States the consumer demands a mealy potato. In continental Europe, France in particular, a soggy potato is preferred. The amounts of starch and other ingredients vary with the variety and also with the conditions under which the potatoes grow. C. F. Langworthy in the Yearbook of Agriculture gives the average chemical analysis as follows: "The edible portion of a potato is 78.3% water, 2.2% protein, .1% fat, 18.4% carbohydrates (principally starch), 1% ash or mineral matter."

A Thin Cross Section of a potato held to the light will show that the tissue is composed of several different layers or areas. The outside *skin* corresponds to the bark of the stem; inside the bark is the sap wood or vascular tissue which in the potato is known as the *cortical layer.* This is readily distinguished as a layer from one-eighth to one-half inch thick just under the skin and is bounded by a dark line of *fibro-vascular* tissue. Inside this line is another area that is ordinarily of about the same density as the cortical, known

as the *external medullary* area. This corresponds to the heart wood of the stem. Inside this area is an irregular tract of much more transparent tissue. This is called the *internal medullary* area and corresponds to the pith wood of the stem.

Proportions of Each Layer.—The French chemists, Coudon and Bussard, give these different areas that make up the body of the potato in the following percentages, as average, by weight:

Envelope or skin 8.79%
Cortical layer 36.19%
External medullary area 34.17%
Internal medullary area 14.96%

Chemical Composition of Each Layer.—The following table taken from their analysis shows the relative amounts of starch and nitrogenous matter in these different areas:

	Starch per cent.	Nitrogenous matter	Water per cent.
Cortical layer and skin.....	19.42	1.99	74.79
External medullary area	16.29	2.14	77.44
Internal medullary area.....	11.70	2.31	82.16

Thick Cortical Best.—As will be seen the cortical layer is richer in starch than the outer medullary and both of these are very much richer than the pith or inner medullary area. Consequently the potato with the thickest cortical layer contains the greatest amount of starch. It is also true in this table that the per cent. of water and total nitrogenous matter increases from the outside to the center of the potato. This analysis was made from three European varieties which were bred for nitrogen content rather than for starch. Analyses made at the same time, however, show that while the total nitrogen increases from outside to center, the per cent. of proteid nitrogen or that which is digestible, to the total nitrogen decreases from the outside to the center.*

*E. M. East, in a bulletin published by the Illinois Experiment Station, makes the following observations in regard to physical structure and quality in potatoes.

"Microscopic examination of the structure of the potato bears out the chemical analysis of the different zones.

"The cortical layer, below the first few layers of cells which are removed with the skin, shows a markedly larger amount of starch in the cell than does the internal medullary layer. The starch content of the external medullary layer is also greater than that of the internal. The grains of starch in the cortical and external medullary layer besides existing in greater number per cell are generally of larger average size. The paucity of starch in the internal medullary area causes the cells to be only partially filled with the cooked starch and the cell walls are scarcely ever ruptured. In the cortical layer, on the other hand, the amount of starch is such that in the swelling due to cooking, the cells are filled completely and many of them ruptured causing the mealy appearance so much desired by the consumer.

"It is quite evident then that potatoes having so far as possible a homogeneous flesh and containing as large amount as possible of cortical and outer medullary layers in proportion to the inner medullary layer, should be the finest quality."

Where there is a shortage of starch in the cells the cell walls retain their structure and the water contained in the potato is not all taken up by the starch with a result that the potato is soggy, and not mealy.

A Microscopic Examination of different potatoes shows that the starch granules differ in size with the different varieties. In comparing Snowflake with Pearl it is found that while the Snowflake has a large quantity of starch granules the average is much smaller than in the Pearl. The greater number apparently makes up in this case for the size of the granules so that ordinarily comparatively little difference is found in the mealiness of these two varieties when each is properly grown. In general, it may be said that the Snowflake is finer grained when cooked than the Pearl and very much finer than the Peachblow, probably owing to the difference in the size of the starch granules.

The Degree of Ripeness of the tuber has much to do with its chemical constituents. The unripe potato is usually richer in nitrogen but decidedly deficient in starch content. A high starch content does not necessarily mean a good flavored potato. The German potatoes that are grown for alcohol and starch making, are richer in starch than the better varieties that are used for culinary purposes, but are decidedly deficient in flavor.

What Causes Flavor in a potato is not known. There is apparently the same difference in varieties of potatoes in regard to flavor as with fruits, only to a lesser degree. Freedom from disease of any kind, absence from exposure to light, and mechanical texture, are known to be large factors in potato flavor.

Market Standards are largely set by size and appearance of the tubers. It has been found that a tuber weighing from eight to twelve ounces is the most desirable both from the standpoint of economy in handling and cooking and from the standpoint of quality. Very large tubers are apt to be coarse in texture and frequently hollow in the center as the result of the breaking down of the pith cells. This tendency toward being hollow is a varietal characteristic, but all potatoes are more or less subject to it when overgrown. The large potato is also more apt to be deep eyed than the medium sized tuber.

Loss in Paring.—Few people realize the loss of food material in paring the small, rough or deep eyed potato. The following table shows comparative losses from paring different sized tubers:

	Original weight	Pared weight	Loss	Loss %
Smooth	10½ oz.	8⅞ oz.	1⅝ oz.	15%
Smooth	6¼ oz.	5 oz.	1¼ oz.	20%
Smooth	3¾ oz.	2⅞ oz.	⅞ oz.	24%
Rough	7¾ oz.	5¾ oz.	2 oz.	26%*

*In cracked, very rough, or deeply flea-marked potatoes we find a 40% loss in paring often unavoidable; and in extreme cases this loss may run to 75%.

Loss of Food Value.—The loss in weight is not the only serious part of paring away the tuber. As has been shown, the food value of the area of the potato just beneath the skin is much greater than the center of the potato. Where potatoes are particularly rough it will be seen that not only is one-fourth of the weight of the potato removed but considerably more than one-fourth of the real nutriment of the tuber is lost, and that of the best quality.

HOW TO DETERMINE GOOD POTATOES ON THE MARKET.

Color no Guide.—It is not uncommon to hear consumers say they always use certain colored potatoes as they have found them to be better in quality than some other color. So far as has been determined, there is absolutely no correlation between color and quality. Certain markets demand a certain colored potato to the exclusion of all others simply because they have been educated to that color. In fact, if it were desirable to do so, it would be possible by breeding to change the color of nearly any of our potatoes from white to red or the opposite.

The Appearance of the Skin indicates the quality of the potato. When the skin of a given variety is smooth and more or less transparent with what is called a "baby skin," and the potato has a soft spongy appearance, it is usually deficient in starch and is apt to be soggy. This condition is usually the result of immaturity of the tuber. The tuber should have a russeted appearance due to crackled skin; and it is usually considered a mark of good quality when the potato is well covered with lenticels. The degree of russeting differs with varieties but with a given variety the more russeted potatoes are the better in quality.*

The Amount of Irrigation given to the plants has much to do with the quality. It has been found in Colorado that soils that are well drained, and particularly those soils which are newly broken from prairie or sage brush, usually give better quality than older soils that are more retentive of moisture. Where irrigation is stopped early to allow the potato to mature in a dry soil the quality is greatly improved over those that mature in a wet soil.

Proper Irrigation a Help to Quality.—The growth of the tuber may be controlled under irrigation so as to produce the highest

*Gilmore of the Cornell Experiment Station found that with most potatoes those growing close to the surface were not so good quality as those grown deeper in the soil, doubtless because the deep grown tubers set first and had a longer season with greater ripeness. It has been found also that where plants reached a natural maturity before the vines were killed from disease or frost, the tubers were superior in quality to those from plants destroyed previous to this condition.

quality possible, as water may be given as needed, and in Colorado diseases rarely prevent the plant from reaching full maturity before frost. Where early irrigation can be practiced, and tubers can be set early, they reach fuller maturity and finer quality. The naturally dry climate of our State makes it possible in most seasons to mature potatoes in dry soil.

VARIETIES.

Success or failure in potato growing depends most vitally upon selection of the right variety.

The White Pearl.—This variety, known as Peerless in the eastern states, is adapted to more conditions and soils in Colorado than any of the others that have been grown. At least two-thirds of the potatoes grown in Colorado are of this variety. It is a standard at Greeley and in the San Luis Valley and does well on the West Slope and on dry land farms. The Pearl, in season, is neither early nor late. As this potato is the most common one grown in Colorado we shall use it more or less as a standard by which to compare other varieties.

The Rural New Yorker No. 2.—This standard variety, the leading sort in the United States, is ordinarily a little smoother and more uniform in size and shape than the Pearl, and is from a week to ten days later in season. It is somewhat more subject to diseases other than early blight, and is influenced by adverse weather conditions more than the Pearl. In the Uncompahgre district it seems to be even better adapted to the climatic conditions than the Pearl and gives fully as large yields.

The Peachblow, wrongly known as Red or White McClure, is the potato with which Carbondale has made her name as a potato growing district. This potato is fairly uniform in size and quality but seems to be adapted only to the best environment. At Greeley, this variety quickly degenerates and changes its color and characteristics. It is the excellence of Carbondale conditions for potato growing and not any particular variety that has made the region famous.

The Ohio Family, the leading early potatoes of the United States, are characterized by high quality, extreme earliness, low vitality, and moderate or low yields, with a tendency to poor shape. To this family, all much alike, belong the Adriondack, Six Weeks, Acme, and White Ohio.

Other Varieties.—*The Irish Cobbler is a strong competitor of the Ohios, and is already displacing them to some extent in Colorado. The Charles Downing, a close relative of the Snowflake, is of excellent quality and is desirable in some localities for mid sea-

*See **Early Potatoes** for comments on the Cobbler.

son market. In the San Luis Valley, a potato known as Monroe County Prize, has been grown for a long time and is a desirable, long potato. The Russet, grown in the Carbondale district, is a high quality, early, long potato of great promise in our mountains. See *Field Experimentation* for the undesirability of any other sorts than those mentioned here.

SOILS.

What is a Potato Soil.—In a very general way this question may be answered by saying that potato soil is deep sandy loam, with some sort of under drainage. Potato growing in the Greeley district is on soils that range from light sand to heavy clay. The underlying stratum of most of this district is coarse gravel at a depth of from one to several feet. Some of their best lands are deep medium sandy loams underlaid with porous white clay either above gravel or in connection with a good slope.*

The Character of the Subsoil appears to be more important than the character of the surface soil. In fact some of the heavier soils of the district where underlaid by gravel at two to five feet, are among the best of the potato sections of the district.

In the San Luis Valley, which is an old lake bed, there are considerable areas that are inclined to be gravelly, although the soils there vary from light sand with gravel subsoil to heavy clay or adobe. Some of the best potato soils are those of the river bottoms, composed of river sedimentation and wash from the surrounding hills.

On the West Slope the deep red sand stone soils are among the best adapted to potato growing. The gray wash or till soils from the hills are also good. The Carbondale district and some of the mesas of the Uncompahgre and North Fork Valleys are of the red sand stone character and are particularly adapted to this crop.

Adobe Soils in these districts are often used for potatoes but with constant risk of bad seasons and damage from soil diseases, owing to the tendency of these soils to become puddled. Greater care is necessary in cultivation and in irrigation, and even where the greatest care is used rains frequently compact the soil so as to stop tuber formation. This is particularly true of the soils on the college farm.

Potatoes Unsuccessful on Most Heavy Soils.—We have planted potatoes on this kind of soil at Fort Collins for the past five years. The cultural methods used have been similar to those which give

*Their most common soil is that which is designated by the Government Soil Survey as the Colorado fine sand. Other soils of the same district are those known as the Billings loam, Colorado sand, and Billings clay loam. The soils of the river bottom known as the Laurel sand loam, also grow potatoes.

success in the Greeley district. All these crops but one have been, practically, failures.*

*__The first year__ the cultivation was largely with a shallow cultivator. While the soil was kept loose on the top it was not loosened at a sufficient depth to affect the tubers, and almost total failure resulted.

__The second year__ about two acres were planted on the west college farm and cultivation was given soon after planting. In this cultivation the soil was loosened to a depth below the plowing, or from nine to twelve inches. A second cultivation of the same character was given soon after the plants appeared above the ground. No more cultivating was done but the land was ditched twice with a shovel plow which was equivalent to at least one cultivation. Although this soil is decidedly heavy, these cultivations loosened up the soil below where the tubers were formed. No heavy rains occurred to pack this soil and at digging time the soil was loose as deep as the tubers were set. This year a good crop was secured.

__The third year__ the same ground was again planted to potatoes, making it the second crop after alfalfa, and another plot was planted on freshly broken alfalfa land. The same kind of cultivation was given and the soil kept in the best of condition till the middle of July. At this time the potato tops were sufficiently large to cover the ground and the tubers had reached the size of from one-half to an inch in diameter. Heavy rains following for one week packed the soil to such a condition that a spade was required to dig into the hills. After this packing of the soil there was practically no growth of tubers and although a month elapsed before frost came, and there was no disease of importance to be found, the tubers did not reach marketable size.

The same season a plot of nearly an acre was planted about three weeks earlier than the main crop. Heavy rains followed this planting and caused the soil to become packed and sticky. A good stand of plants was secured but most of the plants became diseased soon after pricking through the ground, and no amount of cultivating could loosen this soil sufficiently to even make a good growth of vines. Almost no tubers were secured from these plots.

__The fourth year__ the same plots were planted again with an additional plot of freshly broken alfalfa land. This year's experience was to a great extent similar to the year previous. Dry weather prevailed during the early part of the season which gave the plants a good start in loose soil; later in the season heavy rains packed the soil about the time that tuber growth commenced. These plants were comparatively free from disease but made very little tuber growth although the vines were of average size.

What tubers were formed in the compact soils during these three years of failures on the college farm, were distorted in form so as not to follow the type of the varieties.

__The fifth season__ (1910) potatoes were planted on another plot of freshly broken alfalfa, with soil similar to the other place. This season heavy rains followed the plowing even before the potatoes were planted. In order to overcome the packing of the soil by the rains a deep cultivation was given this soil before planting. This went far toward putting the soil in better condition but tended toward drying the soil more than was good for the plants. A fair stand of plants was secured, however, and growth was about normal until the latter part of the season when heavy rains again offset the work of deep cultivation. Some marketable tubers were secured but as a whole the crop was a failure.

This experience is not only true of the plots on the college farm, but is the experience of growers for the past twenty years in a large part of the districts along the foothills of the East Slope, and in the Arkansas Valley.

We believe that the character of the soil in regard to being __packed by rains__ in addition to their becoming sticky and so excluding air, during

GETTING LAND READY FOR POTATOES.

Preparing Raw Soils.—It is better for the grower to break raw lands during the summer of the year previous to growing the crop. This puts the soil in better condition for taking and holding water and for culture than where the raw soil is broken in the spring before planting. New land in Colorado seldom produces the maximum yield of potatoes, because it is deficient in vegetable matter and therefore in nitrogen, while the physical condition of the soil can never be gotten in the best shape the first year.

The Best Crop for Subduing Raw Lands in Colorado is undoubtedly the potato, even for soils really too heavy for this plant. No crop puts the land in so good condition for the succeeding crop, or for leveling and getting the land into alfalfa. The continuous cultivation of the potato crop, the irrigation, and then the digging in the fall (which is a far better mulch than a fall plowing), leave an exceedingly favorable physical and chemical condition of the soil.

Various Rotations.—In northern Colorado the most common rotation is, potatoes two years, followed by grain as a nurse crop for alfalfa, then alfalfa as a hay crop two years—a five year rotation. Where diseases have interfered with the potato crop, this is sometimes changed to potatoes one year, grain one year, potatoes one year, grain and alfalfa one year, alfalfa two years, then back to potatoes. Where the canning of peas has become an industry, peas have been grown between the two potato years in the place of grains. On the west slope the rotation for the most part is similar to that in northern Colorado. Sugar beets are often used in place of the second year of potatoes.

In the San Luis Valley the rotation is largely potatoes one year, peas one year, grain one year.

Alfalfa, Peas or Clover used in rotation prepares the land for potatoes by improving its physical condition and furnishing the necessary nitrogen. Experiments made by Paddock and Rolfs in the Greeley district showed that the use of a commercial fertilizer

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the middle of the season, is largely accountable for failures to grow crops in these districts. These soils for the most part are not only heavy at the surface but are underlaid by a stratum of almost impervious clay. In the Greeley district even the heavy soils are for the most part underlaid by a gravel stratum which makes good drainage and which appears to prevent the packing of the soil. At almost no time in our experience in growing potatoes at Fort Collins, has there been a season when it was possible to dig into the ridge where the potato plants were growing, with the naked hand. At Greeley it is usually not difficult to dig the potatoes with the naked hand even where they are from six to eight inches beneath the surface. This, we believe, in a great measure accounts for the differences in soils as to their ability to grow potatoes. However, it is found that in the high altitudes and in some places of the West Slope potatoes are grown in soils that are apparently heavier than that of the college farm.

did not materially increase the yield in potatoes and consequently that the expense was not justified. Where manure is obtainable, the yield of all crops for several years is increased very materially. Where potatoes are grown on feeding or dairy farms the manure has very materially increased the yearly total production per acre.

The Breaking of Alfalfa.—Previous to 1886 it was thought that alfalfa could not be broken for potatoes. Up to that time the yield of potatoes in the Greeley district had been gradually decreasing; since that time much progress has been made in the methods of breaking and handling alfalfa land, and the yield of potatoes per acre has shown a great increase. The rotating or small harrow and the two-way plow with five and six horse hitches mark the highest advancement in alfalfa breaking.

Turning Alfalfa Under.—On heavy soil, plowed and planted late, it is not uncommon to allow alfalfa to grow in the spring to a height of ten or even eighteen inches at the last before plowing. This alfalfa is broken by plowing not less than eight inches deep, with a broad or alfalfa shear longer than the furrow width and flattened to sever the alfalfa root before the moldboard lifts the soil.

Heading Alfalfa is a system of great merit growing in use. The land is plowed in the fall or early spring as shallow as it is possible to cut the alfalfa roots below the crown. Then the harrow follows the plow and brings the severed alfalfa crowns to the surface so that they may be dried out and killed. After the alfalfa crowns are dry and dead, a second plowing is given the land, this time going down eight inches or so. Alfalfa *roots* never send up sprouts so that if the root is cut below the crown and the upper portion is killed ,no further trouble will be experienced. The great trouble with planting on alfalfa ground has been that after the alfalfa is turned over, sprouts start from the *crown* and continue to grow during the season. See *Cultivation.*

Clover and Peas used in place of alfalfa give no trouble of this sort but are not equal in fertilizing value, though the soil is left by either in very fine condition.

Irrigating Before Plowing.—While in northern Colorado there is usually sufficient rain to make it possible to plow during May without previous irrigation, still where water is at hand, both at Greeley and in other parts of the state, where the rainfall is less, it is desirable to irrigate before or after planting, and this is best done before plowing. In any case the plow should be immediately followed by the harrow.

The Smoothing Harrow.—The usual practice is to plow from morning until near noon, then unhitch and harrow what has been plowed in the forenoon before leaving the field. The same should be done in the afternoon. This harrowing establishes a soil mulch

and conserves the moisture which is needed to start the plant, and also warms the ground by preventing evaporation. Before planting, the soil should be leveled and thoroughly harrowed, or disked and harrowed so as to secure an even seed bed, fined to a depth of three or four inches.

EARLY POTATOES.

A Hill of Triumphs.

The Early Potato, a Small Plant.—It is impossible for an early potato to rival in production a larger later sort. An early potato of maximum yield is a seedsman's dream. However, we should study to secure from an early sort its maximum yield. This will be done by growing a large number of plants per acre.

A Good Start, above all things else, is the very foundation stone of early potato growing. This does not mean planting before ground and season are ready, but it does mean good soil fall plowed perhaps and everlastingly spring tilled, and ditching, irrigating and re-levelling before planting if the moisture condition be not right. Mellow surface with moisture both shallow and deep are absolutely required for success.

Close Planting both in the row and between the rows with slope enough to run water in small ditches, rich loose soil, special tools for narrow rows,* small footed and narrow tread horses or mules are needed for success with early potatoes.

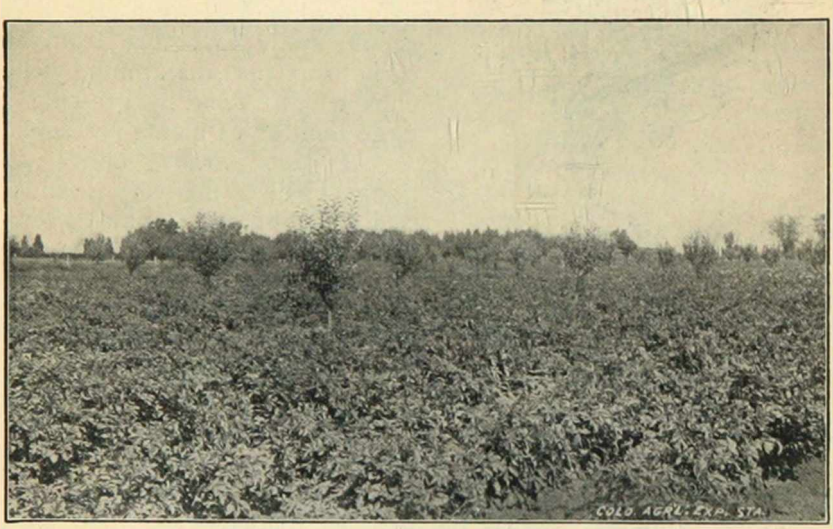
Low Altitutde is not Essential to the growing of early potatoes. It is best done at from 5,000 to 7,000 feet elevation and such regions can supply the market soon after the Kaw Valley, while from 8,000 feet earlies can supply the market all of September. The cool summers, with slope and sunshine, make it possible to force potatoes with water, in ways impossible eleswhere without causing ruinous disease.

Potatoes in Orchards should be of early sorts so that the irrigation, tillage, and digging may be past in time for the new wood

*Funds permitting, in 1911 and 1912 we hope to work out special tools and methods for growing early potatoes in Colorado.

of the trees to mature well before winter; and early potatoes are one of the best crops that can be grown in an orchard.

Varieties of Early Potatoes.—The Ohio, White and Pink, leads all others of the United States in quantity and quality among truly early sorts. The Irish Cobbler is next and has spread from Maine west and south because it is a handsome white potato, free from the knots and cracks that disfigure the Ohio. It is nowhere (we have inquired and tested widely), good eating, except in our best mountain regions, where all potatoes are good. In Wisconsin, Kentucky, Nebraska, and on our own dry lands, it is inclined to be coarse grained, hard, and yellow fleshed. The Bliss Triumph, of which we have a white as well as a red sort, is the leading first



Potatoes in a Young Orchard

early of the south and is among our best earlies. The Russett and later the Downing, come ahead of maincrop and late sorts.

No First-Class Early potato exists. *The White Ohio,* with its fine appearance and perfect quality, would fill the bill, if it did not run to knots and cracks. *The Cobbler* would be everything desirable if it were good eating, and the same may be said of the White Bliss. We are striving to combine the desirable qualities in one potato. It is a long, difficult and uncertain task in which we are greatly interested.

SEED AND ITS TREATMENT.

Type and Source of Seed are as important as variety. Success also hinges upon such care of the seed as shall keep it in vigorous condition till put into the ground. A big yield of tubers must not

be expected when a poor stand of weak plants is obtained. (See in this bulletin the division on the subject of *Stands.*) For Greeley and the San Luis Valley, where potatoes tend to degenerate after two or three years, the best seed is secured from the dry lands of Colorado, Wisconsin or Minnesota or the unirrigated districts in the mountains. This seed, when planted in the Greeley district, produces the most desirable seed for the succeeding year.

Trueness to the Type of the variety in hand is an essential in selecting any kind of seed potatoes. While their previous history and other things* must be considered in determining the value of any lot of seed potatoes, still, examination for trueness to type, tells us what we can learn from the potatoes themselves, just as in buying a horse, examination of the animal is a part of any proper purchase, although other inquiries are not to be omitted.

Seed for the San Luis Valley.—In some parts of the valley there is trouble in securing good stands because of dry weather. In these places whole potatoes are usually planted. This makes it necessary to plant the small tubers. Where the tubers that go through a one and seven-eights screen at digging time are used for seed, the yield from year to year rapidly decreases, and the best practice is to change seed, securing that from the unirrigated lands of the State at least once in three or four years.

Seed for the West Slope.—In the West slope districts, potatoes may be used for seed year after year with little apparent deterioration in the vitality of the plants. In fact no change of seed has been made on some places at Carbondale since the potato growing industry was started thirty years ago.

The Best Home Grown Seed is secured by selecting the tubers from the field at digging time. This should be done from the best hills rather than by selecting the best individual tubers. The characters that are transmitted by the tuber planted, are more apt to follow the characters of the parent plant than of the individual uber. Therefore, we should look to the vitality, productiveness and trueness to type of the whole plant.

Hill Selection.—*The best method for securing seed is to go through the field at digging time with a fork and dig the plants that appear strongest and most productive. If the plant proves to be true to type and has the required number of tubers, with no scab or misshapen tubers, the better potatoes from the hill are saved for seed. If not, the tubers should be covered up to be dug later with the digger. Some skill and knowledge of the variety is necessary for this work. Where incompetent help is to be depended upon

*See Bulletin 176.

*This has not been successful in the Greeley district. See Bulletin No. 176.

it is best for the grower to take three or four men with him so that the work may be readily directed. This way of securing potatoes is somewhat more expensive, but experiments by Goff of Wisconsin, Waid of Ohio, and results in Germany, as well as in Colorado, show it to be time well spent.

Buy Seed in the Fall.—It is a common practice for growers to defer buying seed till planting time in the spring. When this is done the grower ordinarily knows little if anything as to how these potatoes have been grown or stored. It would be better and cheaper if potatoes were secured at digging time so that the grower can know something of the growing and can make sure that these potatoes have been stored in the best possible manner to retain their vitality.

Storage of Seed.—There is an almost universal belief among growers that, if potatoes are chilled in storage, the vitality is decreased, but no actual evidence is at hand to prove this theory. In fact, our experiments tend to the contrary. In all those districts where snow falls before the ground freezes and lies until late in the spring so as to prevent deep freezing of the ground, so-called *volunteer potatoes* that have lived in the ground over winter, come up in the old fields. Where potatoes are left in the ground over winter without freezing, it will be found that tubers are to all intents and purposes in the same condition as at digging time in the fall. In these cases the tuber, while not frozen, must remain at near freezing point during the whole winter season. The condition of storage that most closely approximates this condition must be best so far as vitality of the tuber is concerned.

Sleeping Period.—Experiments have shown that the tubers must have a resting stage before they will grow. When mature potatoes are dug and immediately planted in the greenhouse, or southern grown potatoes are shipped to the north in the spring and planted, they will not grow till they have passed the resting period. The nearer dormant the tubers can be kept during the winter the better chance they have for making a perfect stand when planted in the spring. The danger from chilling is less than the danger to potatoes from heating.

Heating.—This is the generation of sufficient heat in the pits or cellars to lower the vitality, and often follows freezing. Of course if the tuber is frozen so as to cause decomposition of the tissues, or frozen sufficiently to change the starch to sugar, the vitality will be impaired, even if the buds are not killed.

*Greening of Seed.**—If the seed is kept dormant all winter

*During the spring of 1908, a study was made at the Experiment Station of the effects of leaving seed tubers exposed to the light. Several sacks were spread for a month on the ground in a barn where the

by cool storage, excessive spring sprouting may be prevented by greening. This is done by exposing the tubers to the light. The thinner the potatoes are spread out (certainly not over one foot deep) the better, and the oftener they are shoveled over, the better, which should be once a week, at least, for the last month. Of course it must be understood that the tubers are *not cut* previous to this treatment and are *not exposed* to heat and drying. Greening not only toughens the tissues and produces chlorophyll in the bark or skin, but largely destroys the spores of fungus diseases, and makes the seed pieces less liable to rot. For Colorado conditions, greening is preferable to treatment with corrosive sublimate or formalin, which treatments we do not recommend.

*Treatment for Scab.**—For four seasons, experiments have been made both at the Experiment Station and with growers in the Greeley district, with a treatment of seed for scab. In this treatment the seed was soaked two hours before being cut for planting in a solution of a pound of formalin to fifteen gallons of water. No beneficial results whatever were secured.

Cutting Seed.—In planting potatoes it should be remembered that we are not planting the seed but a *cutting* of the old plant. The question of the size of the cut piece is always before us. The bud with a very small piece of tissue may be taken from the tuber and made to produce a plant. It has been found, however, in various experiments that the yield of tubers increases with the size of the seed piece, up to a certain limit. The reason for this is that the new plant must start its growth from the stored plant food in the piece of potato until it has sufficient root system to take care of itself. If the seed piece is too small or becomes dried there is not sufficient plant food to push it along so as to make a vigorous plant: conversely, if there is more plant food in the piece than is essential for growing the plant the excess is wasted. It has been proven in numberless careful experiments that it pays to use pieces as large as two ounces.†

Two-Ounce Potatoes may be planted without cutting. Four ounce potatoes are best cut in two. In order to have the eyes

strong light could reach them. These tubers were somewhat shriveled from being stored in a cellar where the temperature was higher than was desirable and where the air was too dry. Nearly all became green and many lost so much moisture as to be decidedly dry and toughened. At planting time the potatoes had started to grow but the sprouts were only from a quarter to a half inch in length and were green and tough enough to withstand handling. It was thought that the worst of these tubers were too badly dried out to germinate, so they were planted by themselves, but, to our surprise, nearly all produced healthy plants.

*See **Potato Diseases** in this bulletin.

†See in this bulletin the subject of **Stands.**

evenly distributed, the potato should generally be cut legthwise first. Six ounce potatoes are usually cut first lengthwise, then twice crosswise of the tuber.*

Gauging the Cross Cut.—It is best to make the stem-end pieces larger than the bud-end pieces. With the Pearl, this will nearly always insure at least one eye or bud in each or the stem-end pieces.

Hand Cutting is the only practical way. A few potato cutting machines have been used, but these have never come into general use because machines cannot exercise discretion as to the size of pieces and the eyes contained in each.

Cutting Racks.—The rack most commonly used, and which is the most satisfactory, is like the one shown in Plate VI. This is a slatted, sloping-bottom bin, with a frame for holding a sack open and a knife set at the rear side of the sack holder. The advantage in this is that the potatoes, when scooped into the hopper, are always at the hand of the operator, and instead of holding the knife in the hand, both hands are available for work with the tubers. When one is accustomed to using this device, it is found to be much easier and faster than holding the knife in the hand.

The Cheapest Cutting Device is made by driving a case knife into the end of a piece of board so that the operator may push the tubers across the blade of the knife. Many prefer to push the potatoes in any case, and to drop them thus into the basket or sack.

Do Not Cut too far Ahead.—Potatoes are best not cut more than twenty-four to thirty-six hours previous to planting. If they are left for any considerable time, the loss of moisture is so great as to seriously affect the stand. Similarly, cut seed potatoes in dry, warm, or windy weather must be covered on the wagon with a canvas and must not be left in the field or in the planter to dry out. It is found that the seed works better in the planters when the cut surface is allowed to become slightly dried before putting into the machine.

Dusting Seed.—Many growers think that less disease occurs in the fields where the cut seed is treated with flowers of sulphur or air-slaked lime after cutting. Where this is done, a handful of sulphur or lime is scattered onto each basket of potatoes as fast as added to the sack or on the thin layer on the floor. This dries the cut surfaces so they are at least more readily separated and

*Many growers have thought that the "seed end" eyes were not so productive as or differed from the stem end eyes. We find, however, no difference in their value. At the College, in 1909, two sacks of Pearl potatoes were cut so that the eyes from the seed end, the middle and the base of the tubers could be planted separately. So far as the most careful observation could tell, there was no difference whatever, between the lots, either in time of coming up, the per cent. of stand, the time of maturing, or the yield of these plots.

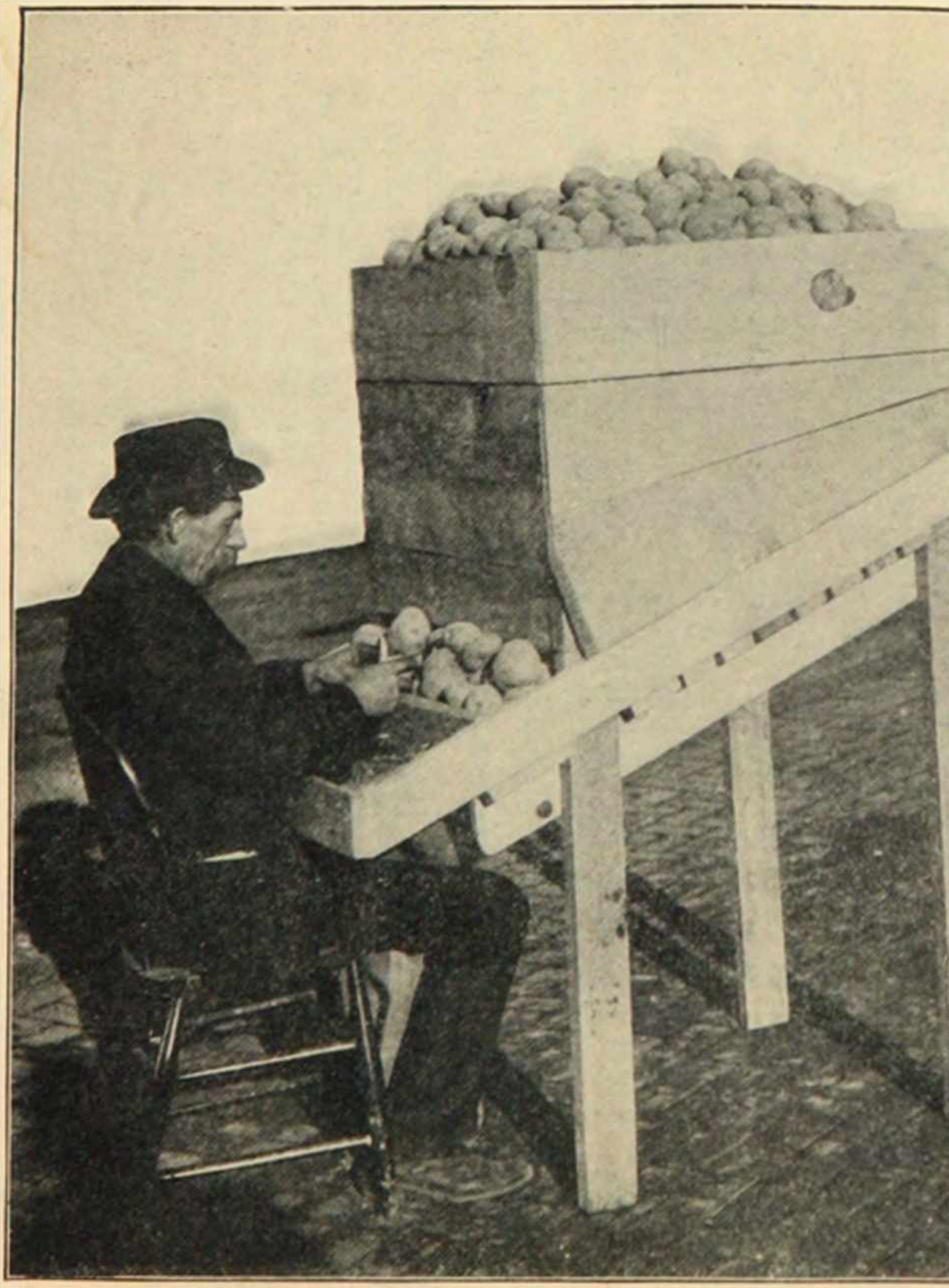
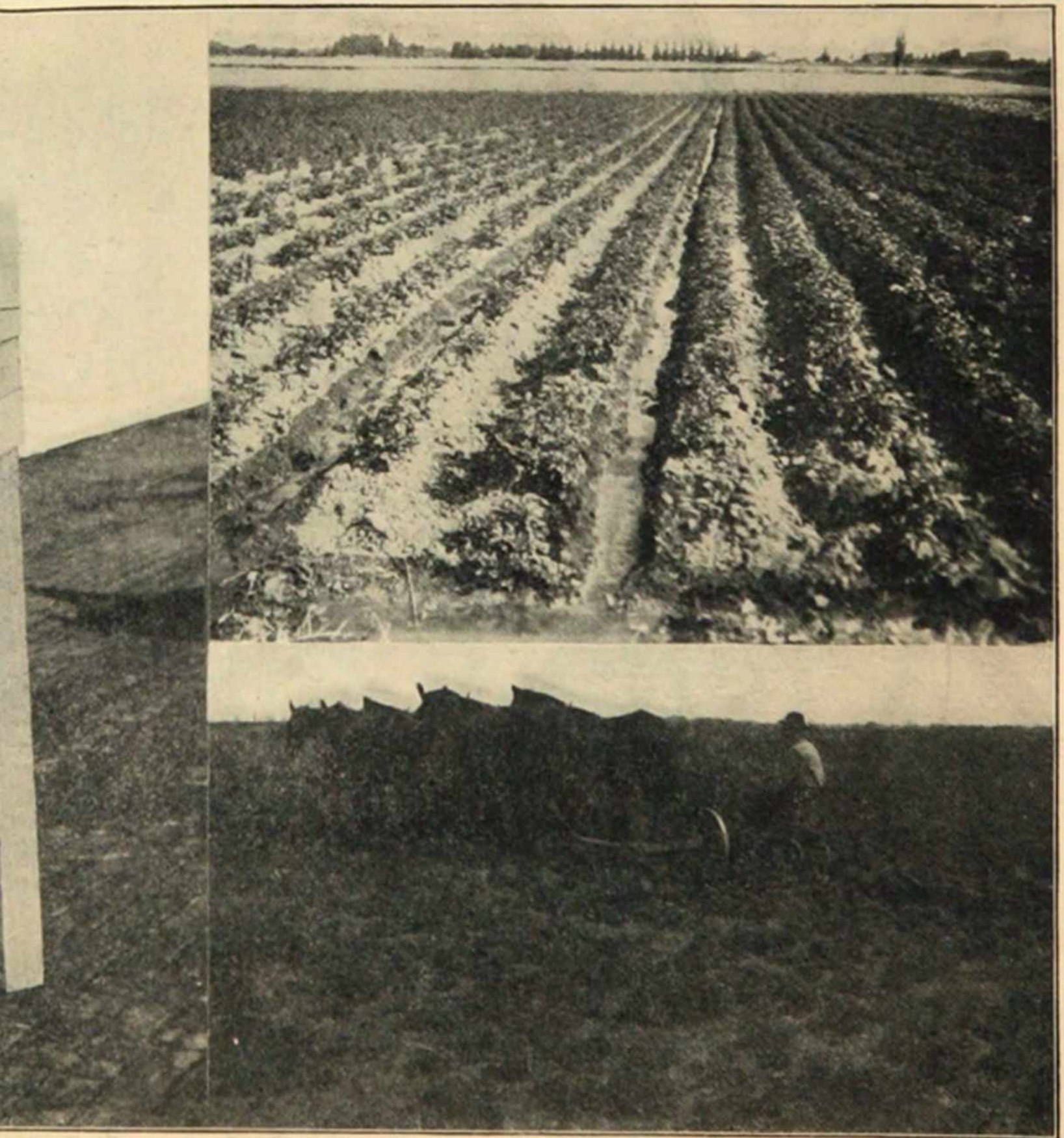


PLATE VI.—1. A Modern Cutter Box.



2. Irrigating every other row. 3. Plowing alfalfa sod.

work better in the machines. It is claimed by some that this treatment reduces the rotting of the seed.*

PLANTING.

Machine Planters are universally used in Colorado. The chief reason for this is that hand planting would be too laborious and expensive to be profitable, but if hand planting were not too expensive, it would not be satisfactory as machines do much better work than could be accomplished by hand. With the planter, the soil is furrowed, the seed dropped in place, and covered, all within a space of three or four feet, so there is no opportunity for the drying effects of the atmosphere to injure the chance for the germination of the plants. Where the plow and hand dropping is used the soil is very liable to become dried, as the planted tuber is in most cases covered with dry soil.

Picker Planters. — The Aspinwall, Evans, Superior, and Eureka are common types of the picker planter, and while each is different in detail, and some have been more thoroughly tried out than others, they all do practically the same work, are all automatic, and only require one man for operation.

Non Picker Type.—The Robbins Planter feeds the seed by dropping from between the spokes of a horizontal wheel and requires a second man to correct the drop, so that in this case the accuracy of the planter depends on the accuracy of the operator.†

Depth of Planting.—No hard and fast rule can be laid down as to the depth to plant potatoes. Much depends upon the moisture and soil conditions, and slope of the land. Ordinarily, where the soil is in good condition so far as moisture is concerned, and danger of frost is passed, two or two and one-half inches beneath the surface level is sufficient depth, while on flat land, in good condition, potatoes are sometimes planted only one inch deep.‡ Where the soil is apt to dry out, or where planting in dry soil, it is necessary to go deep in order to insure moisture. Deep growing varieties do not need to be planted as deeply as more shallow kinds.

In the Higher Altitudes.—Where there is enough fall to keep water below the tuber bed and where the ground is apt to be touched with frost before the potatoes are dug in the fall, it is well to plant

*Any dust will do the same so far as drying the cut surface of the potato is concerned. Dry Bordeaux mixture was also tried, along with other materials, at the Experimental farm in the year of 1907. This mixture did not prove satisfactory, as the copper sulphate in the mixture tended to shrivel the potatoes and apparently decreased their vitality.

†See the subject of **Stands** in this bulletin, and the per cent. of stands obtained by different machines on the 1910 plots. Robbins planters were used at Greeley and Carbondale; Aspinwalls at Montrose and Parshall.

‡In speaking of depth of planting, it is understood that the depth below the surface is meant, and not depth below the planter ridge.

such shallow growing varieties as Pearl, as deep as four inches below the level.

Width of Rows.‡—With most growers of late potatoes the average distance is 38 inches. This gives room for the planter, cultivator, ditcher, and digger to be used without interfering with the growth of the plants.

The Distance Apart of the plants in the rows depends on the variety and the richness of the soil, and varies considerably in different parts of the State. At Greeley, the average distance in the row we find to be thirteen inches on alfalfa land, and where potatoes follow potatoes or a grain crop, the distance is fifteen inches. On the rich lands of the Western Slope, potatoes are planted as close as twelve inches or even eight inches apart in the row, especially for Rurals on alfalfa land.*

In Dryland Districts, the distances apart for potatoes is much greater, as the plants need more space from which to draw moisture. In this case from eighteen to twenty-four inches is close enough, the closer distance being for early sorts.

CULTIVATING.

Packing of the Soil by the horses' feet when planting is unavoidable on our heavier lands, thus leaving the soil in poor condition for holding moisture, and also for the growth of the tubers. These two things, and the tendency of heavy soils to exclude air, have brought about a system of cultivation, particularly in the Greeley district, that differs materially from potato cultivation in the east.

The Greeley System.—It was found that in order to loosen up the soil and also to kill the alfalfa, it was necessary to cultivate deeply soon after planting. Experience soon taught growers that this deep cultivation, not only killed the alfalfa, but to a large extent prevented the development of diseases by loosening and aerating the soil. Where irrigation is practiced, and particularly with heavy and flat lands, the aerating of the soil is one of the important features in growing this crop.

On Sandy Soils, in some districts of the state, the need for this deep cultivation is not so imperative, although we believe that in all soils in Colorado that are to be irrigated, some degree of this deep cultivation is beneficial, at least once.

Special Cultivators which do this work satisfactorily have been made for Colorado trade. These, while similar to the two horse

‡These distances are all given for the maincrop potatoes. See elsewhere in this bulletin a statement of this matter in relation to **Early Potatoes.**

*See in this bulletin reports of close planting at Del Norte, Carbondale and Greeley, and **Stands** herein.

PLATE VII.—CULTURAL OPERATIONS.—1. Furrowing. 2. Digging. 3. Cultivating. 4. Planting

cultivators of the east, are made heavy enough to stand the pull of four big horses and the strain of four shovels penetrating the soil from eight to ten inches.

Cultivation is Begun within a week after planting, or before the sprouts have more than started, the planter having left a ridge which may be followed without difficulty. The cultivator shovels are four inches wide by fourteen inches long, and are moulded and adjusted so as to throw the soil toward the row, and the inside shovels are run so close as almost to throw out the seed.

The Ridge and the Harrow.—After the cultivator is used, the soil is left with a considerable ridge over the row and a depression between the rows. This starts the work of ditching and provides drainage so that heavy rains will not flood the row. The cultivator should be immediately followed with a smoothing harrow, which is run parallel to the rows, for the purpose of making a soil mulch, and breaking down the clods, which are thrown up by the cultivator.

The Alfalfa Roots, or a large part of them, thus loosened and dragged out will be on top of the ground, where they will be dried out and killed.

The Second Cultivation must be delayed ten days or so until the plants are up so that the rows may be followed.

Guards.—In cultivating the second time, it is generally necessary to use guards on the cultivator to prevent the shovels from throwing down and covering the plants.

*Further Cultivation.**—If the work is properly done, these two cultivations will raise a ridge in the land so that ditching is comparatively an easy matter. In many parts of the State these two cultivtions are all that are given, though when the season permits, or when rains are frequent, or in the mountains, between early irrigations and before the vines are too big, it is desirable to cultivate once or twice more. Sometimes the only tool that can be used at last is a small cultivator between the rows. Cultivation of potatoes by the Greeley method is recognized as hard and *skilled labor.*

IRRIGATING.

The Rainfall in northern Colorado for May, June and early July, is usually sufficient to bring up plants and grow them until the tubers begin to form. This is rarely true in the mountains

Irrigation Once Begun must be continued as needed until the crop is developed. Most successful growers hold that in general

*The object of cultivation, rather than any fixed rule, should be kept in mind. If the soil is loose, leave the field alone, do other work against a time when cultivation is needed. One of the best crops we have known of was raised with only one cultivation as there was no rain and the soil staid loose.

too much rather than too little water is used. The number of irrigations required cannot be foretold for any soil or season, and is a matter of experienced judgment based on observing the weather and the actual moisture conditions prevailing under the plant and about the roots, and will vary from two to seven times.* Irrigation must cease before the growth of the tubers ceases, or the potatoes will be coated with dirt, which would have been loosened by the surface motion of growth.

The Per Cent. of Slope affects the methods and amount of water used in irrigating. On the plains, in many places, there is not more than eight or ten feet fall to the mile, while narrow valleys usually have several times this amount. With plenty of slope,

*Some measurements taken on the E. R. Bliss ranch show the amount of water actually used in growing a crop of potatoes, both on alfalfa land and on old potato land. The applications on the potato field, preceded by three years of alfalfa, were as follows: July 25th-26th the water ran 17 hours with a delivery of 4.05 feet per second. August 1 and 2, 27 hours with 1.96 feet per sccond. August 8 and 9, 24 hours at 2.31 feet per second, and August 15 and 16, 30 hours at 2.37 feet per second. This field contained 17.88 acres, and the depth of water used in irrigation was 13.76 inches. The rainfall by months from April till October was: April, 3.04 inches; May, 1.73; June, 1.10; July, 2.24; August, .64, and September, 2.31, or 11.05 inches. The September rain was mostly in the latter part of the month, and probably did little if any good to the potato crop. If the September rainfall is left out, the precipitation that should be counted as contributing to the growth of the crop will be 8.75 inches. The rainfall plus the irrigation gives us 22.51 inches as the total water used on the crop. The field is Billings clay loam with quite a large per cent. of sharp granitic gravel. The soil is about two and one-half feet deep, underlaid with gravel, so it has good drainage. The field was plowed in early May, eight inches deep, harrowed immediately and planted to Pearl and Snowflake potatoes June 1st. The yield of Pearls on this field was above 150 sacks per acre, which is near the maximum for the season.

The field adjacent to this one had grown potatoes the year before, and was watered just previous to the alfalfa potato field. The first run was 14 hours at a discharge of 4.05 feet per second and the second 18 hours at 1.96 feet per second, the third 16 hours at 2.31 feet per second and the fourth 24 hours at 2.37 feet per second. This field had an area of 19.74 acres, and an average depth of water was used over the field for the season of 9.35 inches. The difference in the irrigating water between the old potato land and the alfalfa land was 4.41 inches. This field was planted just previously to the alfalfa field and the potatoes ripened (or the vines died from fungus troubles) about two weeks earlier. The yield was about 130 sacks per acre, as against something over 150 sacks for the alfalfa land. Frequently a greater difference than this results between alfalfa land for potatoes and land preceded by other crops, but it seems that the difference comes not from the amount of plant food in the soil, but from disease: for, after potatoes have been grown on soil even three years, the cereals grown on it will produce heavy crops.

The difference in the amount of water can be attributed to the mulched condition of the old field and to the physical condition of the soil in the two fields. The decaying alfalfa stems and roots make the newly broken land more porous, and the first irrigation particularly takes more water to fill the soil.

deep ditches are not required; and in fact, where the land is steep, shallow ditches are desirable. Neither is such deep cultivation necessary although thorough cultivation gives the best results in all parts of the State. The length of time required to wet the soil by irrigating varies with the per cent of slope. That is, the greater the fall the greater length of time the water must be run.

Sub-Irrigation.—In the San Luis Valley, where the land is level enough and the subsoil will permit, a system known as sub-irrigation is practiced. For this purpose lateral ditches are run at uniform intervals of from 30 to 150 feet across the field. The water from these ditches in a short time fills the subsoil from the ditches to the center of the spaces, then gradually rises to the surface and moistens the soil. This system has an advantage in ease of operation but is open to the objection that usually more water is used than is good for the plants. The valley has a great deal of soil disease, in consequence, among her potatoes.

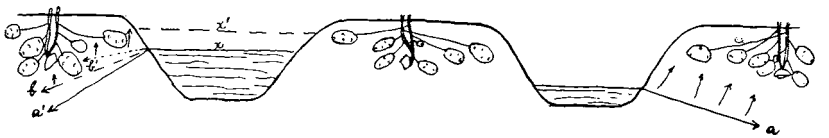


PLATE VIII. *Drawing by C. L. F.*

The Advantage of Sufficient Slope.—Where there is fall enough so the vines or uneven grades do not back up the water in the row at any time, we have the condition shown on the right. The hill space and the dirt about the tubers is not puddled and set, but is moistened like a wick from below as indicated at (a). Ideal slope for all crops including potatoes is about 1 per cent., or 50 feet to the mile.* On much steeper lands, great care is required to prevent heavy washing. However, with good subsoil, record crops of potatoes and grain are grown where the fall is at least 200 feet to the mile.

Flat Lands Not so Good.—Where the fall is slight, very short runs and much labor and skill are required, or conditions will obtain like those shown to the left. With the water level at x, the time must be brief if the soaked portion be confined to the line a', and it is pretty apt to rise to b and b', and the hill surface is sure to be puddled to the level x; while with the water level at x', the whole side hill surface and much of the tuber bed is sure to be damaged.

Accurate Grading of Flat Lands is essential that the existing

*Such slope does not permit of the turning out of large heads at one spot, but requires the substitution of corrugation for flooding, and row irrigation for all fields, to the great benefit of every crop.

general fall may be evenly distributed, and all knolls and hollows are eliminated. A good farm level, a four horse Fresno scraper, with wheelers for long hauls, and infinite labor and perseverance are required for this job, but it pays big dividends in quantity and quality of crop, and in water and labor saved.

FROST.

High Altitude and the close proximity of snow clad mountains make us liable to sudden frosts, both late in the spring and early in the fall. The young potato plants are nipped even in June, early frosts are apt to catch tubers unprotected by a good layer of earth, and our mountain passes render us liable to sudden freezing in shipment.

Growing Potatoes are best protected by water, and air drainage. The bottoms of valleys and such spots as are protected by trees or otherwise from air movement are most liable to frost damage. Recently watered* fields, or fields on which water is running, are least liable to injury by frost. So when a frost is predicted it is wise, other things being equal, to use all the available water, and if the field cannot be all irrigated, to use the water in every third of fourth row.

Protective Ditching and prompt digging are the remedies for frost damage to tubers. The Pearl and other varieties which set shallow, and long or large potatoes or those on long stems which run close to the side of the hill are liable to be nipped by frost. So ditches need to be narrow and straight sided as possible, and the soil taken from the ditch should be spread over the top of the hills. For this purpose there is as yet nothing equal to the Kersey Ditcher† with "side shoves," although we think some of the nearly vertical sweeps may be equipped for this work.

Damage in Shipping is made less liable by putting a false bottom or thick layer of straw on the floor of the refrigerator car and by packing the sides with paper and straw. Salamanders (small stoves) are used to thoroughly warm the cars up to train time, and shippers from northern states are obliged to send men with the cars to tend stoves, but always with a large expense and some losses by fire. In Maine, there is a line of oil heated cars in use to Boston and New York that make shipment safe in any weather. For our use, steam heated cars with thermostats con-

*We might expect the cells of well watered sappy plants to be easiest broken by freezing, but such is not the case with potatoes nor with alfalfa or the leaves of our cottonwoods.

†This ditcher was developed in a district where there is very little fall and is there popular because of its clean large straight sided ditches. It is cheaply made by the local blacksmith and in sizes needed for the slope or variety raised on the particular farm.

trolled by air pressure from the air brake system would be preferable.‡

Danger Dates.—Corn growers and even beet raisers have more time to complete their work in the fall than has the potato farmer, because they are more independent of frost.

The experience of years has established dates past which it is dangerous to leave potatoes in the ground subject to heavy frost losses. Waiting for potatoes to ripen is not wise; it is better to devise ways to ripen them earlier another season and save what is in hand this time.

At 7,000 to 8,000 feet altitude, October 1st is the danger line.

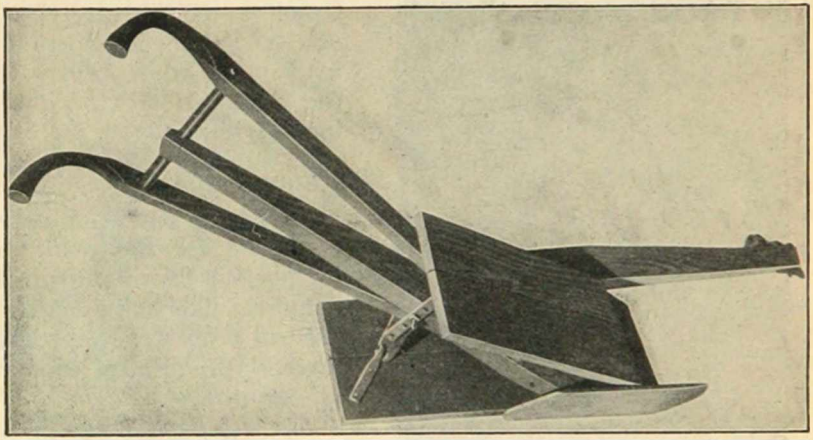


PLATE IX.—The Kersey Ditcher

At Greeley, the leases used to read Oct. 20th, but growers feel safer to be done several days sooner, as damage has occurred on the 16th. Lower still, about Julesburg, for instance, Oct. 20th is quite safe.

Old growers recognize these limits of safety. New ones will do well to adopt them.

CARING FOR FROSTED POTATOES.

When to Sort Them.—The third week after storing is the time

‡The cost of equipping cars in this way is not more than $100 each. Colorado people stopping at at least one hotel in Denver will find this system in use in all rooms, and very quick to respond to a five degree change in the dial. The Burlington Railway is experimenting with a system of this sort, and the Colorado Agricultural Experiment Station, funds permitting, will gladly co-operate with the growers, dealers, and railroads in working out a system to do away with frost losses in shipment. A system of this kind would be particularly useful between the San Luis Valley and Pueblo.

to care for potatoes that have been touched with frost in the ground. The first ten days after the storing, the frozen ones cannot be detected nor sorted out with speed. Frosted potatoes can be told at any time by thumbing the nose of every potato. After the third week they are likely to be semi-liquid rots and to smear the mass past remedy.

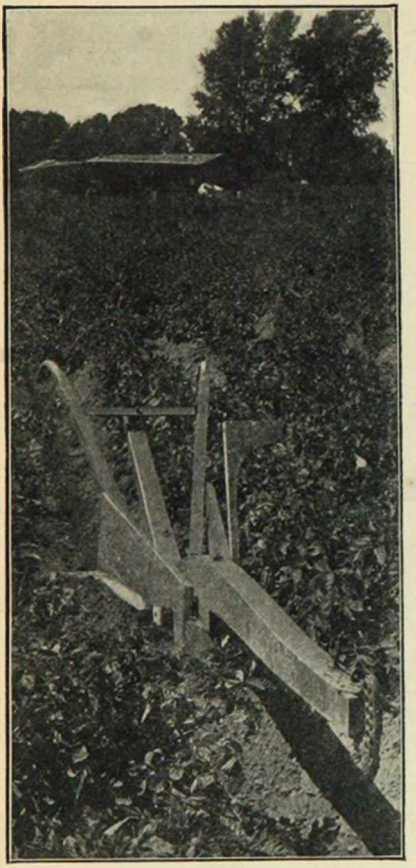


PLATE X.—Kersey Ditcher with "side shoves."

Good Light.—Good light is required and cannot be counted upon from open doors or windows at the right time because of the likelihood of storm and cold. Gasoline mantle, acetylene, or electric light is sometimes available. Some cellars in the Greeley district, including the new one at the college, have facilities for skylights in cold weather. Daylight is the best and none too good for the work of sorting out the rots. Frosted potatoes, like balky horses, are bad property. Never buy them. We all have enough of our own.

Sorting from Pits.—This practice always is dangerous, because some years there is no weather that allows the pits to be opened before the long steady cold spells. Most seasons this is a very good way to handle frosted potatoes for storing or selling in November or December. The man who stores frosted potatoes and *does not sort,* deserves scant sympathy.

POTATO DISEASES.

Diseases Differ from Those of the East.—Work done in the East on this subject is of comparatively little value to Colorado potato growers. Every station in the eastern potato growing states has put out from one to a dozen studies on this subject. Nearly

all of these diseases come under the common name of "potato blight," and are caused by various species of fungi that work on the outside of the foliage or stem of the potato above ground.*

Late Blight.—The disease most talked about and which probably causes more trouble to potato growers of the East than any other is that known as late blight, or *Phytophthora infestans.* This fungus came to the United States from northern Europe, its native home†, being the home of the potato in South America. The first we hear of this disease causing trouble to any great extent was at the time of the famine in Ireland during the forties of the last century. The ravages of this disease in destroying the potato crop of Ireland, resulted in the death of 300,000 people in one year from starvation, and brought to a crisis the political agitation and the emigration from Ireland that is only now being abated. This fungus did its first damage in the United States in 1843 and has gradually spread from the eastern states, west, as far as the humidity of the climate would permit its growth.‡

Late Blight Described.—Where this disease is prevalent, it may be seen in early fall, on the lower side of the leaves as a fine mould. When the seasons are comparatively dry with little humidity, the plants seem to withstand the disease, so it will not be noticeable, except that the plants appear to mature earlier than where the disease is prevented by spraying. We found at the Connecticut Experiment Station, that while unsprayed plots showed no particular signs of disease, the foliage appeared to ripen off so that the plants were dead two or three weeks before frost, while sprayed plants were still in good condition until frost struck them.

Damage of Late Blight.—Not only does the fungus kill the vines or injure them so as to reduce the yield, but in seasons when the weather conditions favor the development of the fungus, the tubers decay in the ground, or if infected tubers are taken to the cellar many of them will decay later. This loss by decay is sometimes as great as fifty per cent. of the crop of a whole district. It is not uncommon for this disease to destroy the plants over a large part of a state within three or four days from the time the effect of the fungus is first seen on the plants.

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*For this reason the old, almost universal remedy has been the fungicide **Bordeaux mixture.** It is not uncommon to find Colorado potato growers planning to spray their potatoes for diseases which have never been known in this State.

†**The Potato,** Samuel Fraser.

‡It is not probable that the disease will visit Colorado, for as the fungus lives over winter in the tubers it certainly must have been brought to the State and planted many times in the last ten or fifteen years. Therefore, we may conclude that as the disease has not been found in the State our climate is not favorable to its development.

Early Blight.—Another leaf fungus is that known as early blight, (*Alternaria Solani*), often found in our mountains and less often at Greeley. This disease may be distinguished by black areas with concentric rings on the foliage of the plants in early July or August. It seldom causes rot of the tubers, and is injurious, simply because of its injury to the leaves of the plant. It is impossible to know what per cent. of injury is caused by this fungus as compared with other troubles. In the east, where plants are sprayed with a fungicide, they always give larger yields than where not sprayed, as the result of controlling early blight and the prevention of the ravages of insects and of fungi other than *Alternaria.*

Early Blight Damage in Colorado ordinarily amounts to but little. During the summer of 1909, in early August a storm occurred over Colorado that brought the conditions of humidity that are common to the east; that is, there were some days of almost continuous cloudiness with occasional rain. Early blight developed as a result in nearly every part of the State. In some fields it was so prevalent as to nearly defoliate the plants. If it were possible to know when these conditions were to occur it would be profitable to spray Colorado potato fields.

The Colored Plate illustrates young potato stems affected with the fungus diseases, *Rhizoctonia* (No. I), and *Fusarium* (No. II). Note the plant stems on the left are girdled with *Rhizoctonia.* The stem on the right is affected with *Fusarium* which started by rotting the cut surface of the seed tuber, then followed the vascular system of the plant up the inside of the stems, and killed the smaller sprouts before they got out of the ground.

Rhizoctonia.—Until the last two or three years it was thought that nearly all the fungus troubles of Colorado potatoes were due to *Rhizoctonia.** This disease affects the plant by girdling the stem or root stalk, so as to prevent the food from going from the tops to the roots and tubers, or by cutting off the tuber stems. See the Colored Plate.

Fusarium or Dry Rot.—We have found many fields of potatoes seriously diseased, though the bark of the stem from the old seed to the surface of the ground was clean and free from disease. The leaves, however, were turning yellow, and stopping growth. In some districts this was so serious that many plants died before reaching the surface of the ground. Others grew a few inches above ground and succumbed to the disease. The trouble started principally from the cut surface of the seed piece and followed through the tissues of the old tuber, into the stem of the plant.

*Since publishing Bulletin No. 117, on the Colorado Potato Industry, we have found that a great deal of fungous trouble is not due to this disease.

When the plant stem was split lengthwise, it was found that the sap wood or vascular tissue of the plant was discolored from the base of the stem to some distance above the ground line. The plant was often blackened from the vascular tissue out and in some cases it was rotted off at the base. Investigation was made of this disease and it was found that it was caused by a fungus known as *Fusarium*. In the cross section of the potato stem showing the

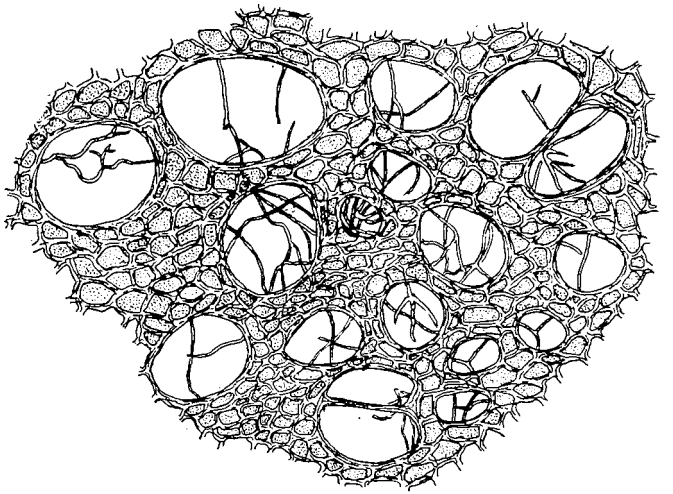


PLATE XII.—Fusarium Hyphae in the Ducts

vascular structure of the stem, the hyphae of this fungus are shown growing across the cell spaces. Apparently this fungus acts on the circulation of the plant, much as roots of cottonwood, willow or alfalfa do in a tile drain.†

†It is probable, also that the fungus does other damage to the plant as well as stopping the circulation. A careful examination of fields in all parts of the State show that this disease is almost always present, more or less. If growers will go through fields in August they will occasionally find plants that appear to be maturing early. They are turning yellow and showing signs of dying. If these stems are pulled up and split, you will nearly always find the yellow discolored area running up the stem just outside the pith tissue. This disease is most noticeable when the plants are young, and in fields where potatoes follow potatoes. In fact it is quite probable that the difference between yields where potatoes follow potatoes, and alfalfa ground in the Greeley district is largely due to the ravages of this fungus. No remedy is known for this disease. Two preventative measures may be adopted: First, that of rotating the crops so that potatoes will not follow potatoes; and the second, cleaning the seed by exposing to the light and air, so that the spores of this fungus will be largely killed, and the tubers made resistant. The planting of a whole seed is always desirable where this disease is liable to occur. The development of the disease is favored by wet soils and high temperatures. Where soils are porous and not too wet, little trouble has been experienced from this disease.

Dry Rot in Potato Tubers is also chiefly caused by the fungus, *Fusarium,* and is most common on bruised or cut tubers and where the potatoes are stored in unventilated or warm cellars, or where dealers and town people keep potatoes in warm places. As stated, the use of such seed is very apt to infect the new plant, to the serious damage of the stand and yield. This matter of dry rot is exceedingly important especially to the growers of Rural and Ohio potatoes and to the consumer. The dealer's warehouse and the out-of-the-way, little-visited farm cellar, set in the field or in some side hill, are great sources of infected seed, poor crops, and unsatisfactory table potatoes.

Internal Brown Spot is a disease affecting, in our region, the tubers of the Early Ohio potato almost exclusively, and though it occurs from California, Idaho and Montana to Texas, we have not known of a case of this trouble under the ditch. It* is thought not to be of bacterial or fungous origin but to be a physiological matter, the death of some of the cells. The cause is supposed to be drouth, and the remedy is the raising of other varieties than the Ohio, and better dry farm methods† that shall supply water enough for the plant.

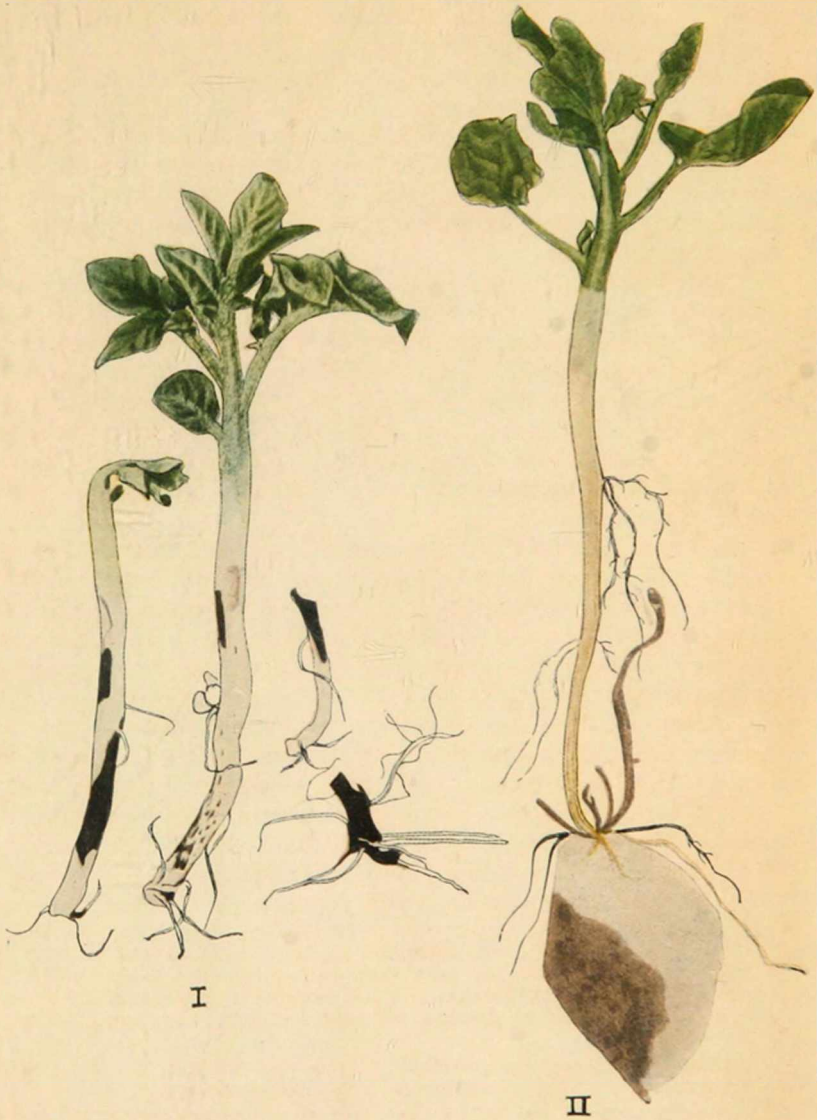
Internal Brown Spot does not destroy the tuber nor hurt its outside appearance nor preclude‡ its use as seed; but the spots do prevent its sale and as found by the potato specialist in Nebraska and Colorado, seriously damage the odor, flavor and appearance. In close competition, we have found the odor and flavor in samples where the spots could not be seen.

Potato Scab.—This disease occasionally makes its appearance in every Colorado potato field. In the east nearly all writers have thought that scab was caused from a fungus, *Oospora scabies.* German pathologists have proved that several other fungi may cause scab, and in Colorado Professors Rolfs and Paddock found that much potato scab was caused by the *Rhizoctonia* stage of *Corticum vagum.* More recently we have demonstrated that this is true.

*Nebraska is a leading producer of Ohio potatoes and without irrigation, and the disease has been very serious in that State. Dr. E. M. Wilcox of the Nebraska Station and his assistants have spent an immense amount of time on this disease, without isolating any organism as the cause.

†Summer tillage the previous season and summer or fall plowing, with thorough shallow tillage up to and after planting.

‡Sutton & Sons, the well known British seedsmen, performed in 1906 an experiment as to whether tubers affected with this spot were good seed. They found with two varieties that the healthy seed produced a larger crop by one-fourth to one-half but that there was not more brown spot from the affected than from the unaffected seed. In fact there was far less from the affected seed, doubtless because it grew less rank and used less water and suffered less from drought, which in Great Britain, as with us, is thought to be the cause.



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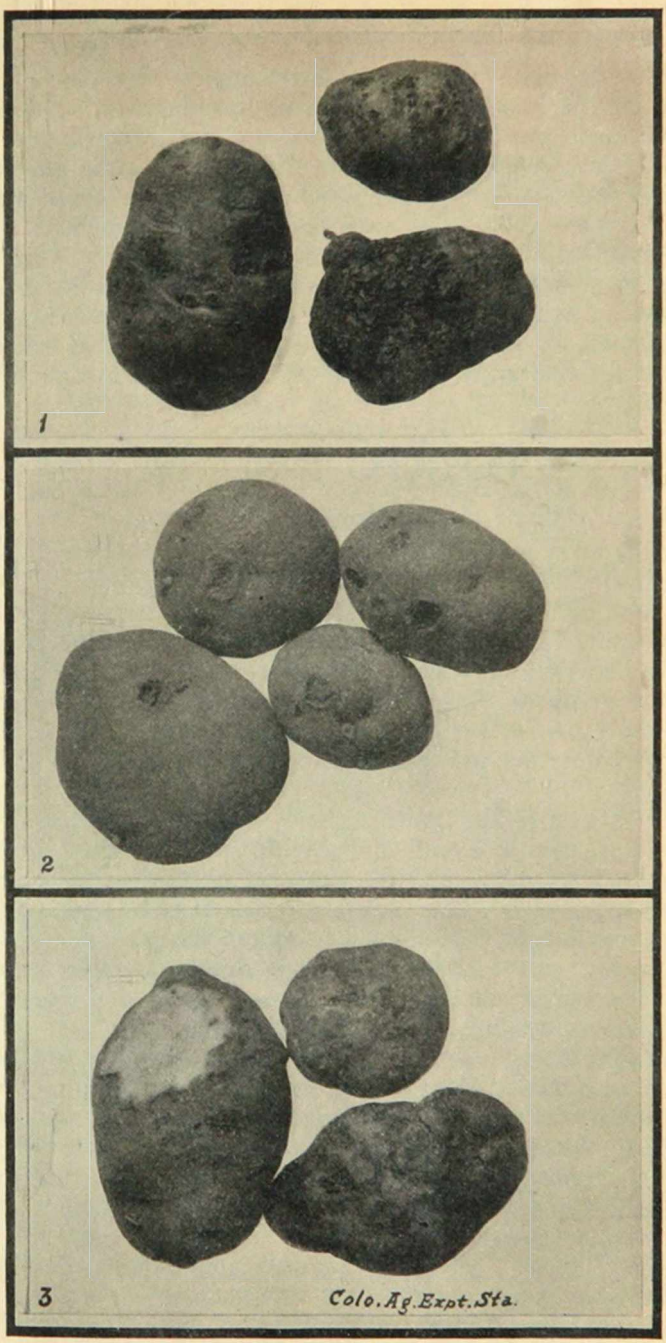


PLATE XIII.—Scab of Potatoes
1. Surface Scab. 2. Deep Scab. 3. Apparent Scab—work of the Beetle.

Tubers treated with formalin solution so as to preclude any chance of planting the fungus with the tubers, have been grown in pots of soil that were sterilized with steam, and the plants watered with boiled water. When the tubers formed in these pots part of them were inoculated with the fungus Rhizoctonia and typical scab was produced, while the checks were perfectly free from scab. As we know that scab may be produced from a fungus, Rhizoctonia, present in all our soils, we cannot hope to eradicate scab by any treatment of the seed. Rotation of crops with good drainage and cultural methods are the only preventive measure that can be recommended. See under *Seed and Its Treatment*, a report of field trials.

POTATO INSECTS

By S. ARTHUR JOHNSON

THE COLORADO POTATO BEETLE, (*Leptinotarsa decemlineata.*)

Native Home and Food.—This insect is a native of a strip of country which lies just east of the Rocky mountain range and includes eastern Colorado. In its native state the beetle lives upon the wild weeds of the potato family. The chief of these is the buffalo bur, but the beetle is quite a general feeder on plants of this group including not only potatoes, but tomatoes, egg plant, tobacco and pepper.

The Insect.—The adult beetle is oval in shape, about three-eights of an inch in length and a trifle narrower than long. The ground color is yellow and the wings are marked by ten black lines running lengthwise. There are also black markings on the thorax. The eggs are bright yellow when fresh and are generally laid on the under surface of the leaves in patches containing from ten to fifty each. The young are dark red or brown grubs with black heads. The color becomes lighter as the grubs mature.

Life History.—The adult beetles live over winter usually in the ground at a depth of from four to six inches. Where the ground is loose they frequently go much deeper. When the ground becomes warmed by the spring sun, the beetles emerge and seek food plants on which they may feed and lay eggs. They are more or less abundant every year and do considerable damage to early potatoes. The late crops in Colorado generally escape because most of the adult beetles die off before the potatoes appear above ground.

The eggs hatch in from four to eight days depending on the temperature. The larvae feed at first on the surface of the leaf where they hatched, but soon migrate to the top of the plant and eat the tender young leaves which are just unfolding. The young

reach full growth about three weeks later. Soon eggs are laid again and the second generation hatches. Ordinarily two broods are all that we may expect.

Remedies.—The best and most practical remedy is spraying with some arsenical poison. In commercial fields the best machine is a power sprayer drawn by horses. In garden patches a hand sprayer does very good work. *Arsenate of lead,* altogether the best poison, is a white paste which must be carefully mixed in a little water before it is poured into the spray machine. It should be strained through a fine screen in order to remove all lumps which might clog the nozzles. Apply the poison at the rate of six or eight pounds to a hundred gallons of water. The proper time to spray is when the young grubs begin to appear at the tops of the stems. Arsenate of lead does not kill as quickly as Paris green, but it sticks to the leaves much longer and the benefits can be seen for weeks even after rains. *Paris green* is the old standby, is cheaper for a single application, and is still the most used. This poison is mixed with water at the rate of a pound to seventy-five or one hundred gallons. There is danger that this substance will burn the foliage of the potato, and to avoid this, it is well to add the milk from two pounds of slaked lime to each hundred gallons of water used. While spraying either of these poisons the contents of the spray machine should be kept well agitated. Sometimes the pest is confined to small areas. In such cases the insects are often controlled by the use of dust sprayers, which either blow the Paris green out in fine clouds, or dust out the same poison when it has been mixed with flour or carefully screened air slaked lime.*

THE POTATO FLEA BEETLE, (*Epitrix cucumeris.*)

The Insect.—When tomatoes are first set out or potatoes first come up there may often be found on them tiny black beetles which jump when alarmed. They are called the flea beetles because of this habit, though they are not closely related to the flea.

Injuries.—The adult insects live over winter and appear during the latter part of May and first of June. They get their living by eating tiny holes in the surface of the leaves of plants of the potato family, and often attack cucumbers and beans. The insects very often congregate in such numbers that the leaves of the plants appear almost black with them. Newly set tomato plants and young potatoes frequently have their leaves so badly eaten that they

*The suddenness of scourges of potato beetles should be remembered. At Greeley, they had not been very serious for many years, but in 1909 $50,000 was spent in fighting them. In 1910, everybody was ready with poisons and sprayers, and almost no beetles appeared. These beetles are liable to be serious in districts where growers have not noticed any harm from them. The first beetle seen should be a warning to be ready the next year.—C. L. F.

shrivel, and the tomatoes may die. Ordinarily the stand of the potato crop is not seriously injured in this way. Their greatest damage to potatoes in Colorado is done by the larvae which live underground. These larvae are tiny white grubs which attain a length of about a quarter of an inch. The first brood is to be found during June or early July. They frequently cut into and destroy the young tuber stems of the potatoes, thus preventing a regular setting of the crop. The second brood of larvae appear during August and September. This brood bores into the flesh and under the skin of the potatoes, causing a pimply or scabby development, which may cause great waste in preparing the tubers for the table and seriously depreciate their market value.

Remedies.—No satisfactory remedy for this pest is known. The leaf injuries to young potatoes and tomatoes may be largely avoided by spraying the leaves thoroughly with Bordeaux mixture to which Paris green is often added. The insects appear to avoid the parts of the plants covered with these disagreeable substances and to seek fresh tissues upon which to feed. It is not certain where the insects hibernate, but they are often found in the fall in large numbers feeding on stray potato plants or pieces of tubers which have been left in the fields. It is well to clear up the fields immediately after the crop is gathered. These insects are seldom, if ever, found on new ground and are much worse where potatoes are planted in succession.

GRASSHOPPERS.

The Insects.—There are many kinds of grasshoppers, but the species that become injurious have life histories which are very much alike. The eggs are laid in the fall in packets in the ground, containing from thirty to a hundred eggs. Their position is about an inch below the surface of the soil. The insects appear to select places which are comparatively dry in which to deposit the eggs, and we have found most of them this year in patches of weeds and grass under fences, and along ditch banks and roadsides. The young hatch rather late in the spring and do not become full grown until mid-summer or later.

Injuries.—Grasshoppers frequently injure potato fields by invading them from the borders, but this is not one of their favorite food plants. The most serious relation of grasshoppers to the potatoes is indirect rather than immediate. Potato growers depend on alfalfa to renew and enrich the soil. The presence of grasshoppers in the fields newly sown to alfalfa is disastrous, for they quickly destroy the little plants and it is impossible to obtain a stand. This prevents a proper rotation of crops.

Remedies.—The best remedy to employ during the fall and spring is the destruction of the eggs. The first step in this work

is to locate the eggs. Inspection should be made everywhere in the surface of the soil for the pods of eggs. When the infested areas have been located, they should be plowed deeply to bury the eggs, or disced or harrowed very thoroughly to break up the pods so that they will be exposed to the ravages of birds and other animals or dried out before they have time to develop. The earlier in the fall that this remedy can be applied the more satisfactory will be the results. It is better not to trust to one treatment, but to work over these places several times at short intervals. When young, or even when full grown, grasshoppers may be caught successfully in a hopper pan. If this is set on wheels a few inches above the surface of the ground and driven over the alfalfa when that is a few inches high, great numbers may be caught. The best time to do this is in the early morning when the hoppers are on the tops of the stems and somewhat numbed with the cold. A third remedy is that of arsenic-bran mash. This substance is made by mixing white arsenic with bran at the rate of one pound of arsenic to twenty of bran. After the substances are thoroughly mixed, add sufficient water to make a sticky, but not too sloppy material. Some add a little anise or syrup. The mixture should be scattered late in the afternoon or early in the morning so that the hoppers will get it before the hot sun has dried it up.

In the Greeley experiments of 1910 the potatoes were sprayed with Bordeaux mixture to test the value of this substance as a repellant to grasshoppers. The results appeared to be favorable as to keeping off grasshoppers, but indecisive as to the prevention of flea beetle injuries to potato tubers. See *Greeley Notes.*

TO SELL OR TO STORE POTATOES?

A SYSTEM

Selling from the Field.—To sell always from the field is as well as *always* to store. The wise grower will sell out of the field when the year's production is greater than the average yearly consumption of three and one-half bushels per capita; and in such a year he will keep selling whenever any one will buy, no matter what the market, because in such a season the price will show no general rise. It is folly to hold for a price for which the grower thinks he can afford to sell.

When to Hold.—The wise grower will hold, particularly following a low price season, whenever the yield of the country is short of the average need, especially if quality be good and consumption likely to be large.

Crop Estimates.—The Crop Reporter, published by the U. S. Department of Agriculture, which is our best basis for judgment, is

sent free to all who ask it, and arrives about the 20th of each month with estimates made on the 1st. Sometimes in error on single states, the "Reporter" is said to have been wrong in its general conclusions for the country only once in fifteen years.

Importation.—Potatoes pay a protective tariff of twenty-five cents per bushel. In 1909, 8,000,000 bushels were imported into the U. S., and when domestic prices reach a high level, the crop in Europe must be considered. Otherwise Colorado growers should consider the general crop of the country paying no attention whatever to the crop prospects in our own state, and but little to the crop in our group of states. Until the Panama canal is finished, Colorado growers must look out for an excess on the Pacific coast, as it must compete direct with us now for outlet.

Good Marketing and the Community.—Public welfare is served by *steady* movement of produce to the consumer. Dealers, transportation companies, consumers and producers, *as a body,* are benefited by regular shipment. Good facilities for shipment over our mountains, and accurate crop information, that the price may at all seasons reflect the supply and demand, are therefore matters of public concern.

STORAGE IN ITS RELATION TO MARKETING.

No Fixed Rule can be laid down for the selling of potatoes. Constant study is essential to success. The prices and the best markets vary from year to year, according to the relation of supply and demand in different places. While the demand for potatoes is a constant one in every city, town and hamlet in the United States, the supply varies, and some regions are supplied locally one year and the next year have to ship in potatoes; while the cities and the south are supplied with potatoes that are grown many miles distant during at least a part of every year.

The Northern States produce most of the potatoes and have on hand at digging time ordinarily a sufficient quantity to supply, not only the local demand, but the large markets of the country until the early potatoes from the south take their place in the spring.

Commercial Methods.—If the growers were to place the whole product on the market at digging time it would necessitate the storing of from fifty to seventy-five per cent of the crop each year in the local warehouses in the growing districts. As direct shipment to consuming centers is essential to economy, storage at jobbing points is out of the question, while storage at southern consuming points is too warm or too expensive.

Storing a Large Part of the crop in the districts where the potatoes are grown and shipping as demanded for consumption is better from every economic standpoint; and the temperature in potato growing states favors the plan of storage on the home farm

or local warehouse. In those districts where the winter climate is particularly severe, and where it is difficult because of cold weather or bad roads to take the potatoes from store house to market there is more of a tendency to sell potatoes direct from the field regardless of price at digging time, and in districts where the rainfall is excessive there is also the objection that storage houses are not so easily kept dry as in the arid regions of the West

In Colorado there is seldom a time when potatoes cannot be taken from the farm to the market. As a result our potato growers have taken advantage of the favorable conditions for storing and a characteristic and unique system of storing has been developed. Our growers thus avoid glutting the markets during the digging period in the fall, and take advantage of any brief bulge in the price during the winter. The history of this system shows that it is not an invention but a gradual growth from the idea of storing in pits to the perfected ventilated potato cellars that are found in Colorado today. This system we consider one of the great features of the Colorado industry and is well worth the careful study of all potato producers who do not already understand its principles.

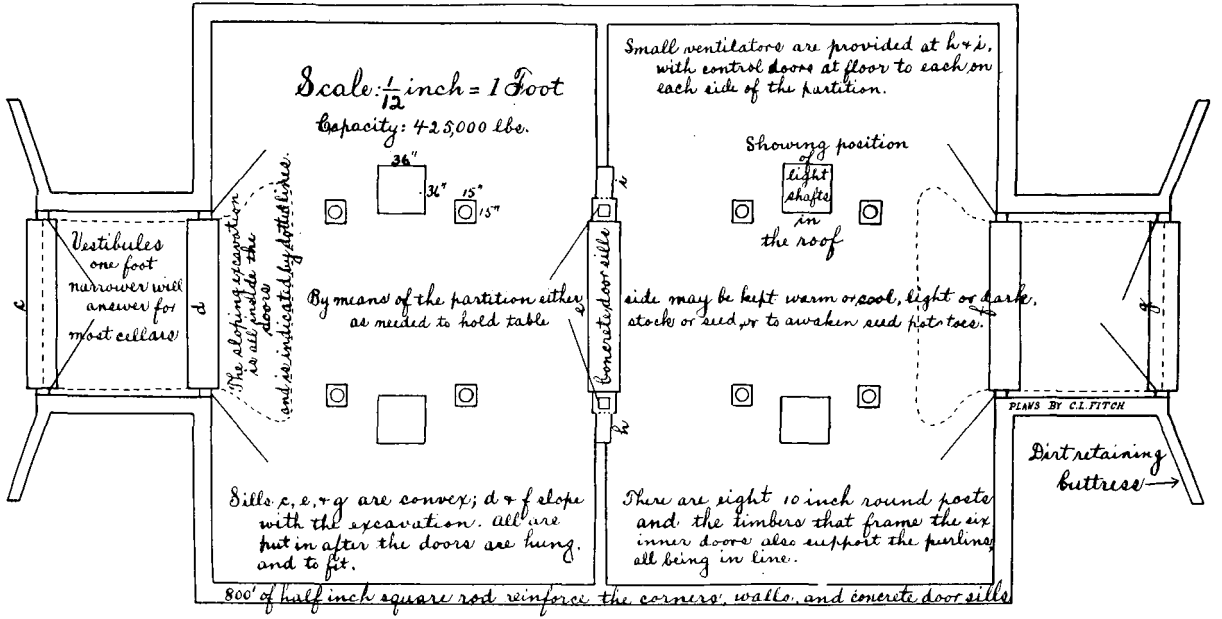
POTATO CELLAR CONSTRUCTION AND MANAGEMENT.

Cost of Construction per Hundred Weight of Potatoes.—This, in the best grade cellars, is about 20 cents. With a permanent roof over the dirt roof, the cost will be at least 5 cents more, and if a grower wishes to provide for seed potato storage, and have a handsome cellar for sales purposes, he may spend as much as 30 cents per hundred weight of potatoes to be stored. On the other hand, with cheap construction, without much regard to permanence, and with the use of farm labor, as little as 7 cents per hundred weight on a large cellar may provide good safe storage. Interest and sinking fund on this basis make the cost of cellar as a minimum one cent per hundred of capacity per year.

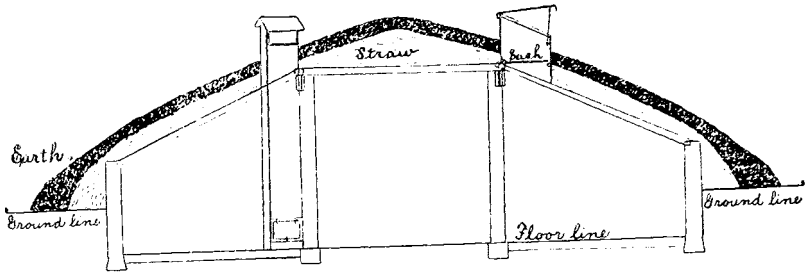
Size of Cellars.—Each square foot of floor space within a cellar will carry 200 pounds of potatoes, piled five feet deep, or 240 pounds per square foot six feet deep. Thus a cellar 50x100 feet will hold one million or one million two hundred thousand pounds of potatoes, with the driveway filled. It is wise to have a cellar large enough to care for the crop if piled four feet deep.

Driveways and End Doors.—A large cellar should have a driveway clear through it, with doors at each end. This saves backing into the cellar, or makes the potatoes at each end accesible, when the cellar is full. It also makes quick and complete ventilation easy. At the same time driveways take space, and the extra bulkhead and double doors are expensive, and let in cold, so that small cellars are often built with only one doorway. Such cellars should be arranged, however, so the center at the rear can be emptied early

PLATE XIV.


Scale: 1/12 inch = 1 Foot
Capacity: 425,000 lbs.
36"
36"
15"
15"
Vestibules one foot narrower will answer for most cellars
The sloping excavation is all inside the doors and as indicated by dotted lines.
By means of the partition either side may be kept warm or cool, light or dark, as needed to hold table
Concrete door sills
Small ventilators are provided at h & i, with control doors at floor to each on each side of the partition.
Showing position of light shafts in the roof
stocks or seed or to awaken seed potatoes.
PLANS BY C.L. FITCH
Dirt retaining buttress
Sills c, e, & g are convex; d & f slope with the excavation. all are put in after the doors are hung. and to fit.
There are eight 10 inch round posts and the timbers that frame the six inner doors also support the purlins, all being in line.
800' of half inch square rod reinforce the corners, walls, and concrete door sills

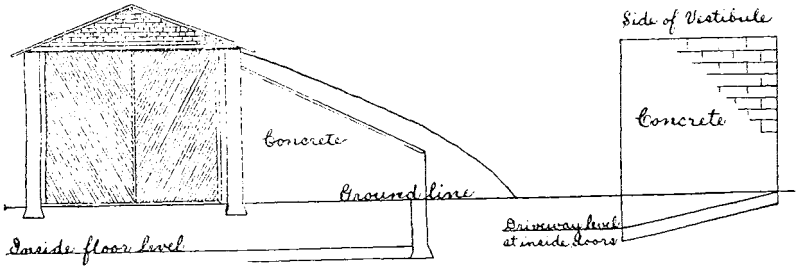
Scale: $\frac{1}{12}$ inch = 1 Foot

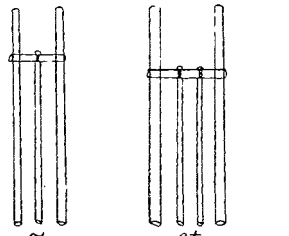


A FARM POTATO CELLAR WITH PARTITION AND ARRANGED FOR LIGHT, DARK, COOL & WARM STORAGE

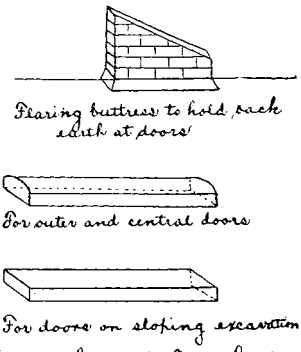
PLANS BY C. L. FITCH.

DETAILS OF CONSTRUCTION





Framing Details



Reinforced Concrete Door Sills

PLATE XV.

in the spring, because it is at this point that most heating and sprouting occurs.

Side Chutes vs. Inside Unloading.—Wide cellars require driveways; narrow ones do not, unless for ventilation. Inside unloading means a vast deal of lugging and stowing away, which in practice involves tramping upon potatoes and rough handling of sacks. By arranging an inclined driveway about over the side walls, chutes may be used, that, with a considerable saving of labor, will permit cellars up to 40 feet wide to be filled quickly from above. Such chutes should be square, about 15 in. x 15 in., set at an incline, and fitted with a slip-over cover of wood, iron bound, but unhinged. If sacked potatoes are to be stored for a time, chutes 22 inches square are required, smooth inside, with a smooth inclined trough below and a table to receive the sacks and of height convenient for the man who piles them up.

Unloading through Chutes.—The wagons should drive within two feet of the chute. A tapering trough, with slatted bottom made of large quarter-round running lengthwise is leaned against the wagon, and is made to fit against the top of the chute. Two men on the wagon handling half sacks of potatoes from the field can keep a continuous stream of potatoes going down into the cellar.

Removing Dirt from Potatoes is important both for appearance and because dirt stops the inter tuber spaces, prevents ventilation and so causes heating, sprouting and rot. Sorters used in the field are the quickest way to sack potatoes, separate the small ones and remove the bulk of the dirt. The slatted trough removes a further per cent., but there will still be some left. When potatoes are dumped inside from sacks, the dirt is well distributed.

Use of a Canvas.—When chutes are used, ten to twenty-five feet of irrigation canvas can be used to let potatoes down without bruising them. The outer end brought up through the chute is turned over and fastened with laths and shingle nails, while a man holds the other end to ease down and distribute the stream of potatoes.

The Leveling of the Top of the potatoes over the whole cellar can be done largely by the canvas. This leveling is best because the projecting parts of uneven piles condense so much moisture upon them, and the top potatoes become so much discolored in the best of cellars, that a perfectly level top is desirable, to have the least possible exposed surface, consistent with proper depth.

Ventilation of the Pile of potatoes is sometimes promoted by using a heavy false bottom of 2x4's with half-inch cracks between the pieces. Others take two 8-inch boards and nail cleats across them close together thus making air shafts for use in the parts of the potato pile deepest or farthest from the side walls.

Dirt Floors Rot Sacks that rest on them if left for more than a week or two, no matter how dry the floor. Therefore floors other than dirt are required for storage in sacks.

Excavations for Cellars should be made deep enough so that sufficient dirt is secured for use about the bulkheads, sides, and roof. Three feet will usually supply this dirt, and this depth makes the slope of the driveway about all that can be covered by the vestibules. Where water comes too close to the surface, cellars must be built upon the surface and dirt found elsewhere to cover them, or sods and adobe brick are used. The cost of excavating the station cellar with the use of day help and teams was 13-8/10 cents per cubic yard, including the piling of the dirt about the hole where it would be handy for covering the roof. A farm level should be used to level the floor of the excavation.

A Knoll is the Best Place for a potato cellar, where available, as the cellar can be placed well into the earth, and still have the slope away from the doors, for surface drainage. Situations should be avoided where water may collect and run into a cellar; and a porous soil without floor is desirable to quickly let away any chance water in the cellar. The worst possible place for a cellar is secured when it is set into a side hill, and especially if set in endwise. If a knoll is not available, the level ground without shelter is the best place.

Side Walls of Cellars are usually required. Some soils stand up firm enough to use for walls without reinforcement, and will carry the plate and rafter ends. Caveins of side walls are disastrous, however, to cellar, crop and life, and it is seldom wise to trust to the earth alone. The cheapest practical construction requires good posts set deeply next the side and carrying the plate on the tops. Planks on the outside of these posts next the dirt are an improvement usually essential, or poles may be laid in. Reinforced concrete is the most permanent side wall, and appeals to those who can afford the best.

*Light is Important,** and ventilators should serve also the purpose of windows. Darkness is demanded for table stock, because greening by light develops the acrid taste characteristic of exposed potato tissue. On the other hand, light combats disease in seed potatoes, toughens the skins, and is a check to excessive sprouting. Cellars should have light in the spring without warmth.

Vestibules should be long enough to leave no sloping driveway outside. Some of the slope can be run within the cellar if required. A good roof and double doors well fitted are needed. A bar will keep out stock when the doors are open, or half doors can be used for this purpose. With good door sills, it is best to fasten the doors

*See elsewhere in this bulletin the discussion of **Greening of Seed.**

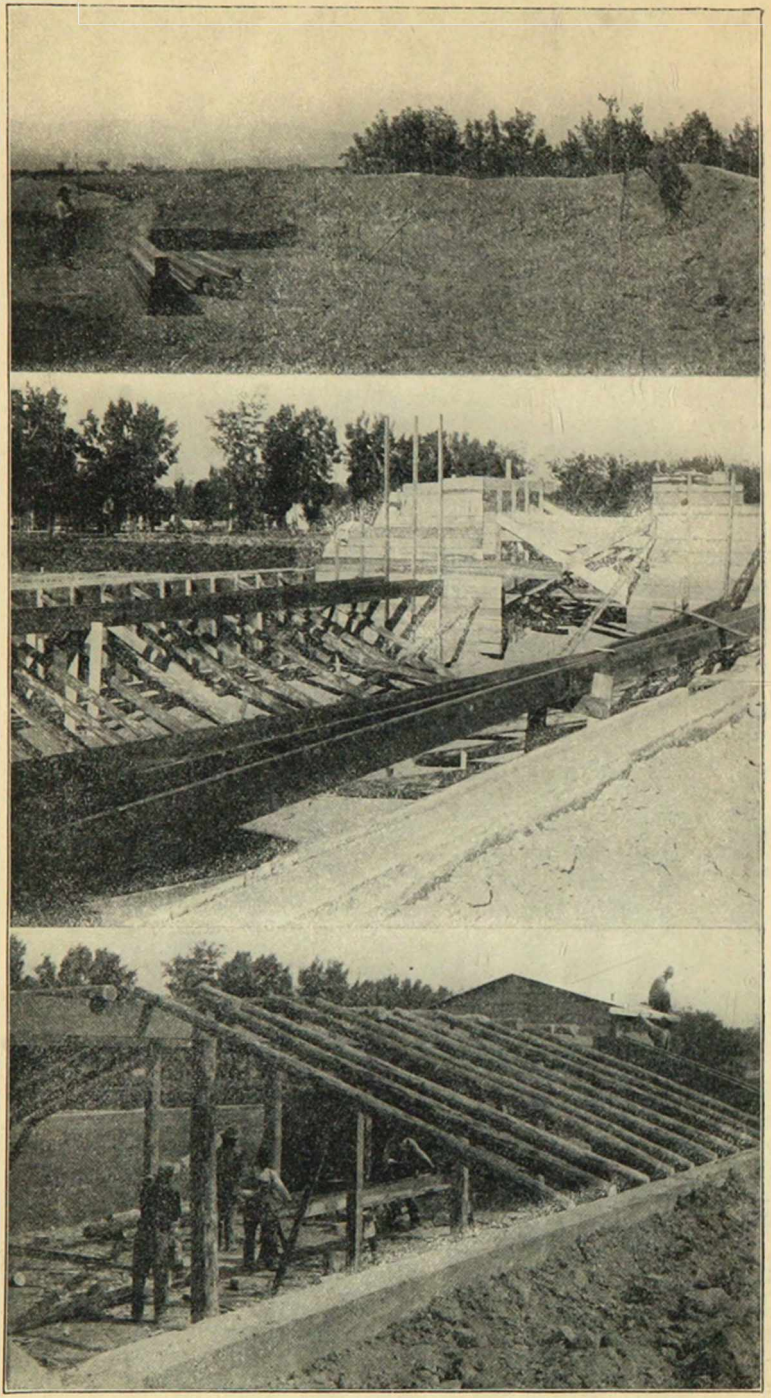


PLATE XVI.—The Station Cellar. Excavation. Braced Concrete Forms. Framing the Roof.

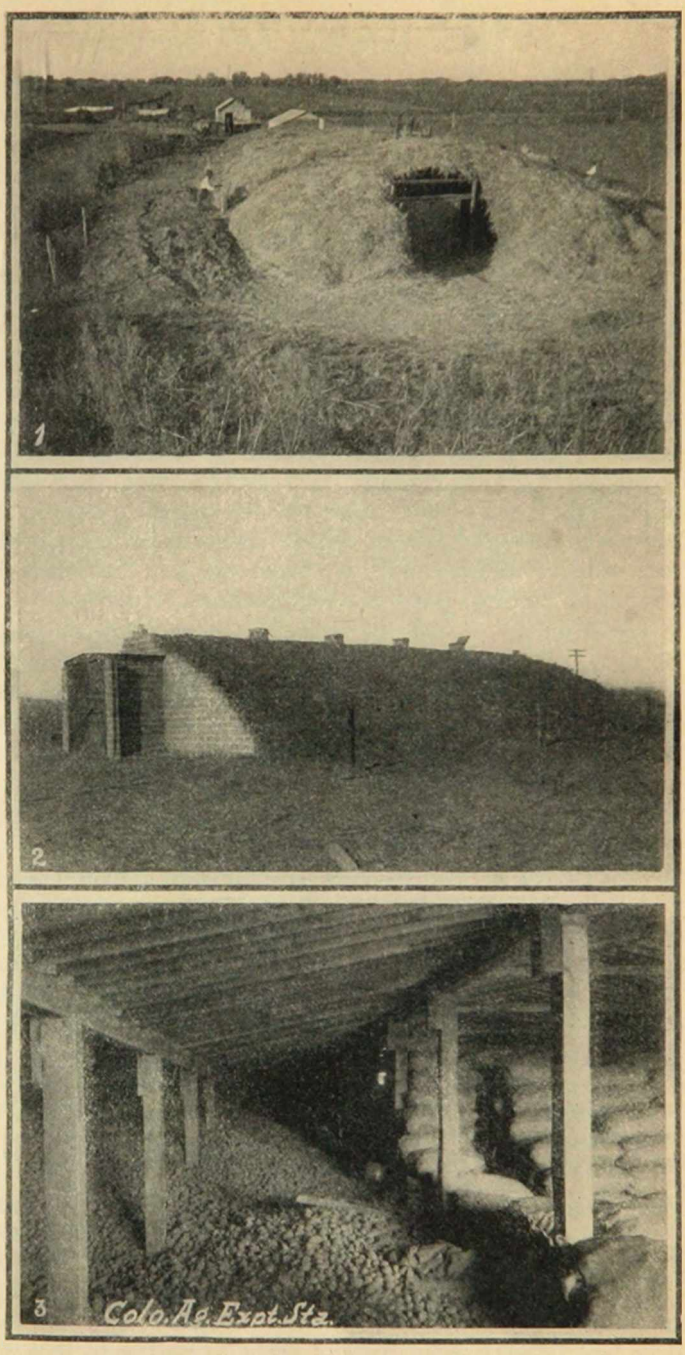


PLATE XVII.—Potato Cellars
1. Strawing. 2. Exterior. 3. Interior.

with top and bottom bolts rather than to a cross bar. Chains or straps and staples and pins should be provided to hold doors safely when they are to be left ajar; and some provision should be made to hold all doors securely open or shut to protect them from damage by wind and wagons.

The Roof is best made of dirt and straw, not alone for cheapness but because of their superiority as insulating material. In a rainy country a tight roof over the dirt might be required, although our dirt-roof cellars when in good shape leak only during prolonged and heavy storms. Even where concrete construction is used for the walls, it seems wise, as yet, to make a temporary roof, and to expect to renew it once in ten or fifteen years.†

Framing the Roof.—Rafters should be sound poles 4 inches at small end, set 15 inch centers, or 2 x 12 sawed stuff. Purlines should be built up of two or three 12-inch planks. Posts should be not more than 10 feet between centers at the most and should be at least 8 inches at upper end. Two rows are sufficient in a 36 foot room, but four lines of posts are required in a wider cellar.

Good Foundation for the posts and walls is required. The roof is extra heavy at times of rain when the foundation soil is liable to be soaked. Gravel or cobble stone bottom is firm but clay subsoils are often semi liquid when soaked, and on such foundation the largest flagstones are required beneath the posts and side walls.

Cost of the Experiment Station Cellar.‡—Gravel, 61 loads, $76.50; poles, $73.15; lumber, cement and paint, $315.30; hardware, $59.85, including square rods for reinforcing; sash, $7.40; contract work for erecting forms, mixing and putting in concrete at $3.25 per cubic yard, $191.00; working foreman at $4 per day and railroad fare from his home, $87.20; straw, $6; labor, $332.85.* Total: $1,149.25. See Plates XIV, XV, XVI, XVIII.

Farm Costs of a Similar Cellar.†—The cash expenditure on a farm for such a cellar will be reduced from the above by omitting charges for horse labor, by the use of efficient farm help, by the substitution of old digger chains for boughten reinforcement, and in

†Reinforced concrete over dirt and straw would make a permanent job, but is in the experimental stage, and is too expensive for trial by individuals.

‡The potato specialist built the cellar rather than let a contract, so he could keep an account of costs. For administrative reasons, the construction was delayed into potato harvest, and he was compelled to hire a competent foreman.

*This includes carpenters and painters at union rates, and team work at $4 per day.

†The best farmers reckon cost of teams as well as of wear and tear on wagon and tools, cost of board and value of their own time, in calculating such a job.

other ways. A clever hard working farmer can put up such a cellar for a cash outlay of about $900; or if he omits the doors, vestibule, and bulkheads at one end, as he may very well do on a cellar of this size, his expenditure need not exceed $750.00. He may erect such a cellar and add a permanent water tight roof for about $900 cash out of pocket.

It Pays Best even with present prices of material to build strongly but cheaply, expecting to build over again when required. This is the business view: but a permanent structure like the station cellar appeals to the man who can afford it as a part of his farm home, for his own and his family's satisfaction.

Ventilation of Cellars is important, but is usually secondary to correct temperature and is ordinarily sufficiently accomplished in connection with air movement secured in proper temperature control.

The Cellar is for Cold Storage, and should be regarded as a place for maintaining proper and even temperatures. In the fall the ground is warmer than the night air, and this night air is our source of cold. In the spring, the ground is colder than the air except in the cool of the night and early morning, and at these hours we must get what ventilation and increase of coldness we can.

Late Evening and Early Morning attention is a requisite. On many fall and winter days doors need to be left open or ajar until, bedtime, and in the spring, doors must be kept tightly shut all day and cannot be opened until bedtime, and should be closed soon after sunrise.

Potato Cellars Close to the House are therefore much better than cellars in the field. The house, where possible, should be at the point nearest the shipping station, which is usually the trading town, in order to save any back haul of the heavy tonnage per acre produced by potatoes. The saving in time of grower and workmen in going back and forth to the cellar in the winter and spring, and the better control of temperature thus possible, more than offset in most cases the economy of team labor at harvest time effected by field cellars.

Correct Temperature for a potato cellar is just above freezing. Good management can hold it within two degrees above or below a standard of 34° F. all the main part of the winter; can get down to this standard quickly in the fall, if the cellar be close to the house; and can fight off the spring rise in temperature for a long time, but late evening and early morning attention are indispensable.

Thermometers Correct at 32° F. by test in slush of snow or chopped ice and water are required for this work, and should be tested before purchasing. The cheapest makes are all right, if so tested and found correct. Three at least are needed—one or more

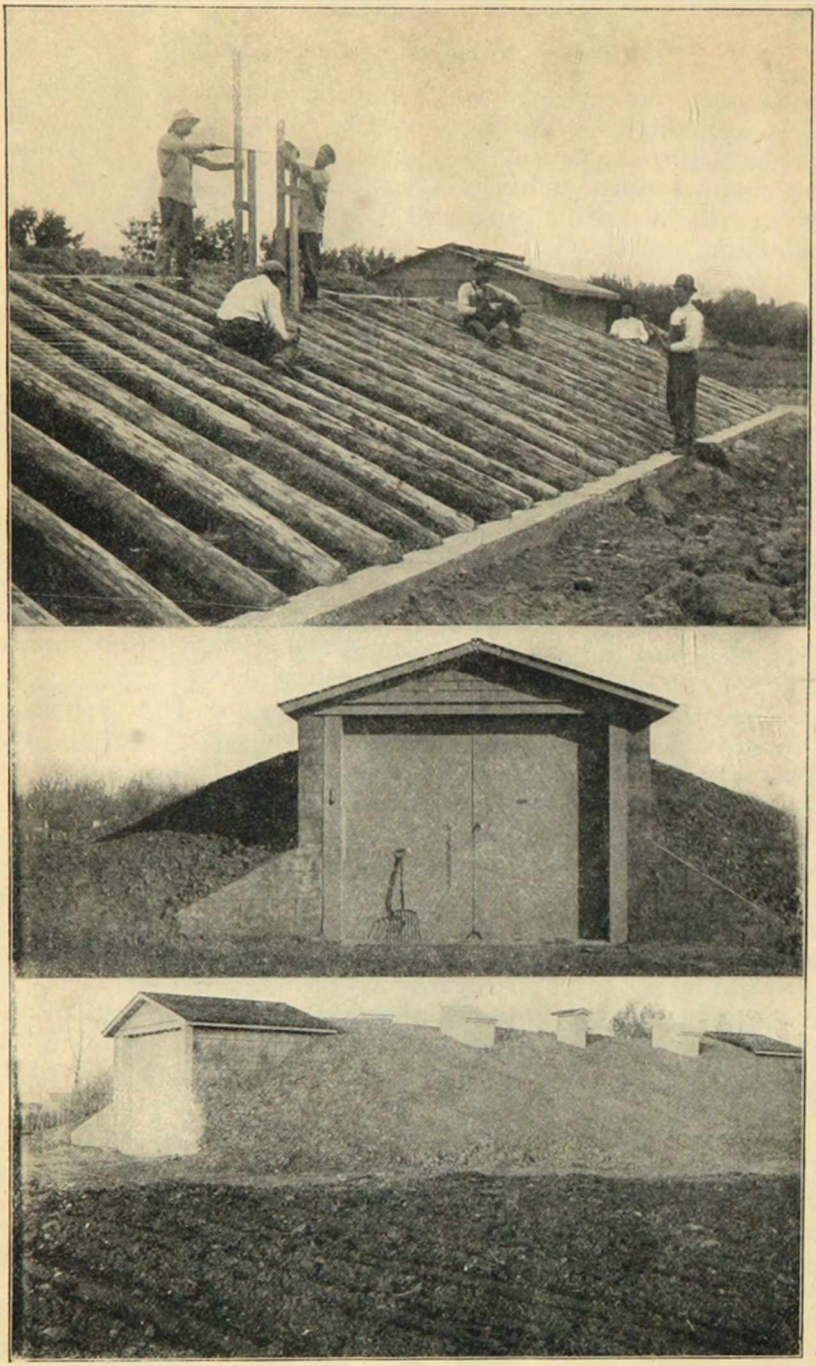


PLATE XVIII.—Getting the Station Cellar Ready for Straw. End and Side Views of Completed Cellar. Photo by Sackett.

in the cellar, one outside at the cellar, and one on a post near the house.

MARKET STANDARDS: POTATO SHOWS.

A Higher Standard for Size prevails in Colorado than on the Chicago market. There a screen 1½ inches in the clear was standard until recently a 1¾-inch was adopted; here a screen 1⅞ inches in the clear is required, and a 2-inch screen is sometimes used.

Poor Sorting Bad Policy.—While it may pay the individual grower for the time being to sell poor and small potatoes and dirt, it does not pay the individual grower in the long run nor the district at any time. The general rate of consumption depends upon satisfaction and quality, and the market and price for any particular district depends very directly upon good goods and reliability.

Inspection Systems have been devised by dealers* for their protection, and by the Weld County Farmers' Club for the good of the Greeley potato district. While there are delays in getting any of these plans put into use, because the progressive element cannot lead the conservative element too rapidly, inspection is as sure to come as were pure food laws and the prohibition of chemical preservatives in canned goods.

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*The grades for potatoes in force under the Chicago Produce Reporter System are as below:

"Fancy Potatoes" shall be known as: One variety true to name, ripe, sound, smooth, clean, bright, free from disease, scab and second growth, uniform run of medium to large size, correct shape for the variety quoted, with none but would run over a 1¾-inch screen, and not over 5 per cent that would run through a 2-inch screen for round varieties. For long varieties there may be 20 per cent that would run through a 2-inch screen.

"Choice Potatoes" shall be known as: One variety, with not over 10 per cent mixture, but all of one color, ripe, sound, not over 5 per cent scabby, diseased and second growth, fairly clean, good color, medium to fair size and shape for variety quoted, with none but would run over a 1½-inch screen, and not over 10 per cent that would run through a 1¾-inch screen for round varieties. For long varieties there may be 20 per cent that would run through a 1¾-inch screen.

"Good Potatoes" shall be the same as Choice, only there may be a 30 per cent mixture of same color, or 10 per cent mixture of any color and variety, fairly well matured, according to season shipped, and not over 15 per cent scabby, diseased and rough, fair to dark color, fair size, with none but would run over a 1-inch screen, and not over 15 per cent that would run through a 1¼-inch screen, with not over 2 per cent unsound.

"Field Run Potatoes" should be practically sound, but unassorted.

Dockage, when loading potatoes.—In cases where the percentage of dirt, small, inferior, green, etc., potatoes, exceeds the allowance in above grades, inspectors may make said stock equal to the grade quoted, or purchased, by such dockage as they consider equitable.

The section from which the potatoes are quoted, and the general quality of that season's crop in that section, should always be considered in connection with grades; not as really changing above definitions, but in close cases inspectors should favor the shipper if that season's general

One of the Systems for Dealers is operated by a house which also publishes a produce paper and a book of commercial ratings. Where shippers agree to put the system in force at their point, all produce is inspected as loaded by the inspecting company, while its adjusters also operate in the consuming territory, so that unreliability and trickery are largely eliminated. The curbstone shipper and the shortsighted grower who sells to him are the hindrances to the success of this system.

The Weld County Farmers' Club Scheme, in force for the crop of 1909, and considered unnecessary because of the fine quality of their 1910 crop is this: The Club does the work and hires a chief inspector at $100 per month, and sub-inspectors at each loading station, paid by the car. The dealers' association, which receives the first benefits in reliability of goods handled, pays the expense. Certificates are furnished for each car inspected.

Potato Shows should be so arranged that the judge does not know the name or location of the exhibitor.‡ Potatoes should be shown in wire baskets in two tiers. To each basket a tag should be fastened bearing the number of the entry and the name of the variety. On each basket should be laid a card with name of exhibitor and all particulars. Until after the potatoes are judged, this card should be sealed in an envelope bearing the number only on the outside, in addition to the score card, if used, printed thereon.

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crop is not up to the average quality, or favor the receiver if as good or better than usual.

MARKET GRADES: The Weld County Farmers' Club

Fancy Potatoes.—One variety, ripe, sound, smooth, clean, bright, even run of good size, true to type, not over 5 per cent but would run over screen two inches in clear.

Choice Potatoes.—One variety, ripe, sound, not over 5 per cent scabby, wormy or knotty; fairly clean, bright and even in size; not over 10 per cent but would run over screen two inches in clear.

No. 1 Grade.—One variety with not over 5 per cent mixture of same color, or 2 per cent of other color; fairly ripe for date of shipment; not over 15 per cent scabby or wormy; not very knotty or muddy, fair size, run over screen 1⅞ inch in clear.

No. 2 Grade.—Not over 50 per cent scabby, wormy, knotty or green. Not over 5 per cent unsound or that would go through a screen 1⅞ inch in clear.

Disqualifications for show or first three market grades. Screen less than 1⅞ inches in clear. Many knots. Very deep eyes or very irregular shape. For show, any mixture of varieties; for market more than 5 per cent of same color or 2 per cent of different color. Color mottled, splashed, blue or purple. Muddy. Over 15 per cent scabby or wormy or 1 per cent unsound. One-fourth hollow. Sacks not neat, strong, uniform in size. Sacks not securely sewed with standard sack twine.

Trueness to name and type required. No red potato to score as high on color as a white variety; no deep-eyed or long potato to be scored as high on shape as round and smooth.

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‡This is best in any case, and is the only system under which the potato specialist will act as judge.

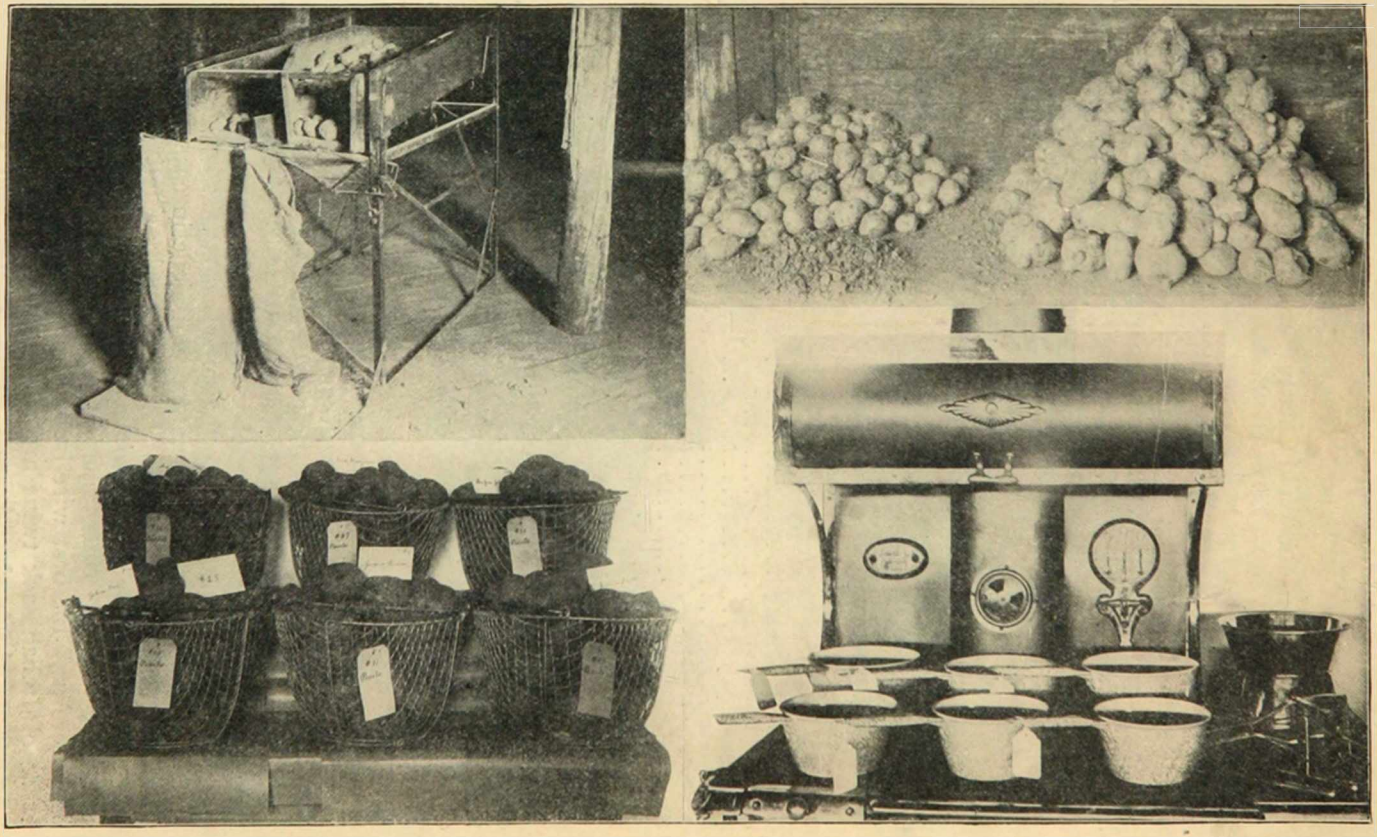

PLATE XIX.—A POTATO SORTER; and an unsorted sack—one-third smalls and dirt.
ARRANGEMENTS FOR A POTATO SHOW, with cooking tests for sweepstakes.

The Score Card of the Weld County Farmers' Club is as follows:

I. Dealers' Scale.

Size 20	Too large	4
	Too small	10
	Not even	6
Shape 10		10
Skin 40	Not bright	10
	Dirty	10
	Scabby or wormy	20
Quality 30	Unsound	10
	Brittle or spongy or green	20
		100

II. Final Purchaser's Scale

Smoothness	5
Pares thin	10
Flesh white	5
Sound and not hollow	10
Cortical thick	10
Centers small and not watery	10
	50

III. Consumer's Scale

Quickness of cooking	5
Potatoes cook alike	5
Mealiness	10
Whiteness	10
Grain (mashed)	5
Flavor	15
	50

Total Score (perfect 200).

Cooking Tests should always decide the sweepstakes prizes. Growers and the potato specialist alike owe this to their own interests and that of the consumer. Six uniform white enamel pots tagged or numbered, and gas or gasolene stoves to boil six lots at once, together with paring knives, basins, a potato ricer or fruit press, and one or two capable assistants are required for doing this work with dispatch.

EFFICIENCY OF LABOR IN POTATO HARVEST.

Labor Costs More in New Regions.—We have been struck by the low efficiency of labor in the potato harvests of our newer regions as compared with our established potato districts; a difference almost as great as between the labor cost of shoes made by a cobbler and by a factory, and for much the same reasons.

This slowness is a disadvantage, not alone in cost of production, but in increased danger of being caught by a fall freeze.

System and the Best Equipment are Cheapest.—For economy and speed the best sorters must be used; and solid sacks—"Liverpool Returns," the best wire baskets, the best needles, and a high grade of Italian sack twine are none too good. Standard potato wagons are absolutely necessary to the grower who would make most money.

The work should be systematized, and each man have his job. The digger man should feed and clean his horses, and then have his breakfast while others harness the horses, so the digger can run at daylight.

A Day's Work.—In potatoes yielding 12,000 pounds per acre, each picker should put on the sorter not less than 8,000 pounds per day, of nine or ten hours. Where the yield is larger and made up of big potatoes, 12,000 to 15,000 pounds are sometimes picked by a good man; and the grower should be willing to see such a picker in such potatoes make $5.00 a day. It pushes the deal along, and is worth the price, being often cheaper than day labor at $2.00 or $2.50.

In cutting potatoes, 1500 pounds well cut is a good day's work, and 2500 requires a remarkable pace. In planting, four to seven acres should be put in with one planter per day. In sorting up and

PLATE XX.
Three Tons is a Standard Load of Potatoes for a Standard Potato Wagon

sewing good potatoes in the cellar, fifty sacks or 6000 pounds is a fair day's work per man, although expert crews have done three times that amount.

HORSES FOR POTATO FARMING.

Some Farms Can Use Heavy Horses.—The size of the draft animal for a potato farm is set by the work to be done. While 1,600 to 1,800 pound horses are very desirable for breaking alfalfa and for hauling big loads, such animals are a damage in cultivating and digging, and are undesirable on long hauls because they cannot be trotted on the return road and last. Such horses are the thing for the grower close to the railroad switch, who plants wide. Aside from other considerations the smallness of mules' feet and their

narrowness of tread recommend them, especially in the heavier weights, in preference to horses, for potato growers.

An Active 1500-pound Animal the Best.—Horses of not too blocky type, weighing from 1,400 to 1,500 pounds, are the choice of most experienced growers. Five or six such can break alfalfa anywhere; four such can pull a digger all day, if required; and a pair of them can handle three tons of potatoes for the regular load on good roads. This is the standard, net load, at Greeley.

Power Units.—An eighty-acre potato farm should have five horses of this size, and a 160-acre farm, eight. It is cheaper to have them good, and to have only this number; and it is wise to adopt a standard of size, action, color, and harness, and to have only such animals and harness, in order that the units of power may be interchangeable, and make up into two, three, four, five or six-horse teams, of like strength and speed.

The Manufacturer has long considered such items as these in the efficient conduct of his business; farmers have commenced to apply the same principles to their business.

FIELD EXPERIMENTATION

Variety Trials have been continued by the station since 1906 and before. All promising sorts of this country, Great Britain, and of continental Europe have been tried. We feel that we know absolutely the best sorts for Colorado. This work is therefore finished to date, and will be continued only as new sorts arise. It is greatly to the economic benefit of the potato industry to have such work done by the state, and the facts established by clear cut public experimentation rather than by widespread, indefinite and costly private experience.

Seed Changes and Sources are now pretty well understood. The principles involved have been largely fixed, and are formulated in Bulletin 176, and such work as is carried out in the future along this line will be only by way of working out these matters more definitely.

Some New Terms have been adopted in Bulletins 175 and 176. From England we have appropriated the term **ware**, which we think a more useful term than **saleables** or **table stock**, both of which it can well replace. We have used also the English word **maincrop** instead of our indefinite term **late varieties** as opposed to **early varieties**. For instance the Pearl potato is our leading **maincrop** sort, but it is not a late potato. Among variety names we have attempted to establish the better and more appropriate names, always favoring the old as opposed to any new name. The **Peachblow** should not be called McClure; the **Cobbler** is not properly called Eureka; and **Russet** we believe to be most appropriate for the promising new sort which has carried the indefinite names White Beauty and Russet Burbank. Parts of tubers are more definitely named than heretofore, in Bulletin 176.

Future Field Work should be in the development of varieties and strains; in obtaining further knowledge as to the reasons for yield and for running out of seed stocks; in carrying along up to date each year variety trials that we may always have the best; and in the promotion of dry land potato growing for the benefit of the entire potato industry and for the general good of dry land agriculture. Funds permitting, a demand for fertilizer trials at Greeley and Carbondale should be heeded in 1911 and 1912.

One One-Hundredth Part of an Acre is in nearly all cases the basis for the yields given herein. The rows for weighing were in most instances taken alongside each other, and are believed to afford correct and fair bases for judgment of the points in question.

The Potato Specialist, primarily the technical servant of potato growers and consumers, like an engineer to other industries, is used also by the

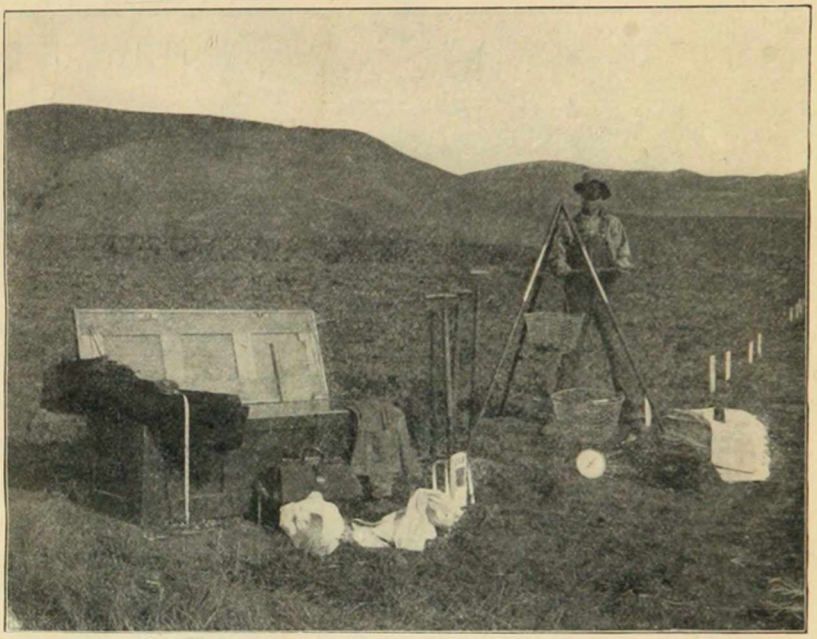

PLATE XXI.
Assistant Chisholm and Harvesting Kit at Parshall up the Moffat Road.

state as a counselor in person and by correspondence in the development of its newe· districts. While not a teacher, his work is best managed by the Agricultural College. He is a gatherer of information and experience for the benefit of all growers of potatoes, and as such he is a worker in farmers' institutes, where as in bulletins he renders his reports. The far sighted policy in Colorado that has made this work possible, going hand in hand with our natural advantages, must result in a leading position for Colorado among potato states.

STAND

How to Count Stand.—Count 100 hill spaces, as near as can be estimated, including both present and absent hills. Count the skips back and deduct the number from 100. The result is the per cent. of stand. This method is both simpler and as accurate as to measure with a tape the calculated distance for 100 hills and to count the hills present therein as the per cent. of stand.

Causes of Poor Stand.—There are six main causes in Colorado for loss of stand of potatoes: (1) Dryness of seed bed. (2) De-

fective seed or seed asleep. (3) Disease or rot. (4) Defective planting. (5) Large and uneven or poorly cut seed. (6) Cultivation.

1. *Dryness of Seed Bed.*—The upper picture Plate XXII shows a potato field the near part of which had been used for a sheep feed lot the second winter previous and was cleaned up only in time to plow. The pens had been hard tramped and thoroughly dried down deep, while the bents had been well mulched with the litter of the hay, and were in good moisture condition. Potatoes will *sprout* without moisture, but they will not *root* unless moist earth touches the seed piece. Therefore, summer fallowing, fall plowing with spring tillage, or irrigation before plowing, or ditching and irrigation before or after planting, are absolutely necessary to be sure of stand. Potatoes must be planted deep enough for the moisture level to remain in touch with them even if the surface dries after planting.

2. *Defective Seed or Seed Asleep.*—Seed that is slow, from drying, heating, over sprouting or disease may rot before it roots well, so that the little plant loses the impulse of the food in the seed piece. Late varieties may partially recover from such a set back but early sorts cannot. Seed potatoes should be held asleep by cold storing but should be awakened in time to be ready to grow when planted. In moist soil five days from planting we have noted on potatoes that had stubby sprouts when planted, roots three inches long, while similar seed that had not started or had had the sprouts broken off showed roots only 1 to 1½ inches long. *

3. *Disease or Rot.*—Potatoes affected with *Fusarium* will often rot completely before the plants get a good start, or before they start at all. This is particularly true if the seed bed be dry and rains come *after* an interval. And such plants as do start are often killed by the disease soon after or even before they come out of the ground. †

4. *Defective Planters and Planting.*—Not less than 15 per cent. loss in stands the state over is due to this cause, and for the most part to the sort of defective pickers shown in the right of the illustration, Plate XXII, which let go the seed piece in the hopper, instead of holding it, as do those to the left, until the seed piece is

*The greenhouse picture Plate XXII shows one row of Pearls in pots that had been held warm long enough to wake them up ready to grow, and two rows of pots with the same kind which were still dormant when planted on the same date. The plant that establishes itself quickly is much surer to grow and to do well.

† Some experiments indicate that the rotting of seed may be partially controlled by the use of lime on the seed. This is a matter which we hope to take up thoroughly in 1911 and 1912. Rotting of seed already reduces our potato output in Colorado at least $200,000 yearly.

dropped into its place in the ground. We find 95 per cent. of perfect work quite obtainable from our leading planters of either type. The best picker type requires one man who absolutely knows his business. The other type requires a good driver and a faithful, quick and everlastingly patient man or boy behind. We find that one planter crushes the seed about the same as the other, and that one can do as good work as the other. The choice should be made according to the help available. Compare the stands obtained on Pearls at Parshall and Montrose with a picker planter, with those at Carbondale and Greeley, where the other type was used. The annual loss, about a quarter million of dollars, due to defective planters, largely a matter of easy repair, is twice the first cost of the 2,000 planters in use in Colorado.

5. *Large and Uneven Seed.*—Very large seed does not drop as well and is more subject to rot and always results in poor stands. It pays to screen seed to even size in two or three lots, and to cut evenly and carefully, to secure even dropping by the planter. A few large pieces in the hopper are a continued source of lost stand while they remain. It goes without reminder, that seed should not be sliced long but cut as nearly square as possible and always with good eyes in each piece. It pays to use seed weighing as much as two ounces to the piece, and the best stands are always obtainable by using whole seed of this size.

6. *Cultivation.*—The close, deep cultivation required in our heavy and flat lands to combat disease is a frequent cause of large loss in stand, especially in new regions where employers do not realize that potato cultivation demands a high grade of skilled labor and the best tools, as well as accurate planting and straight rows evenly spaced.

ACTUAL LOSSES BY POOR STAND.

Part of Loss Offset.—The following table shows just how much of the loss in hills missing is made up by the hills to each side of the empty place. We find the weight made up much less than some growers have supposed. The first hill on one side of a skip, we call *Firsts*. The next hills we call *Seconds*, *Thirds*, and *Fourths*.

How Affected by Distance in Row.—When the best distance in the row has been decided upon for the variety and soil, the loss by defective stand appears to be independent of the distance used in the row.

CONCLUSIONS.—From the weight of these 802 hills dug by hand and carefully weighed, as summarized above, we may conclude:

1. Skips in some varieties affect stand to the second hill to

each side, and large skips sometimes affect more than do single skips.

2. Small plants (early varieties) cannot make use of much extra root space; and loss of stand with them gives an almost equal loss of yield.

3. Deep rooting plants like Rurals and Carmens may or may not make use of extra space. There seems to be no uniformity as to the effect of stand on per cent. of culls.

4. If the weights of the thirds and fourths be taken to repre-

Weights of hills dug by hand bordering skips in stand.
Pounds and tenths.

Place	Variety	Sets of hills	Average Firsts.	Average Seconds	Average Thirds.	Remarks. Screen 1⅞ in.
Del Norte	Sunlight	20	2.3	1.7	1.7	Planted 10x36 inches.
	Six Weeks	20	1.4	1.3	1.02	Firsts 10% culls, others 16% each.
	Noroton	10	1.12	1.14	...	6% and 19% culls.
	E. Ohio	10	1.2	1.1	.92	Uniform 6% culls.
	Cobblers	10	1.7	1.4	1.2	Firsts & thirds same 6% culls.
Skips of one hill	Pearls	10	1.4	1.9	1.4	Culls 10%, 5% and 6%.
Skips of 2 or more	Pearls	10	2.2	1.5	1.2	Culls 10%, 10% & 11%.
	Carmen III	10	1.8	1.6	1.5	Fourths 1.5. Culls 10%, 6%, 19% and 20%.
Montrose	Rural No. 2.	30	2.3	1.8	2.0	Fourths 2.1.
Skips of 2 or more	Same	30	2.5	...	...	Planted 12x39 inches.
Kersey	Pearls	20	2.3	2.3	2.1	A yield of 24,000 lbs.
Greeley	Carmen III	18	1.4	1.7	1.1	Fourths 1.3 lbs.
	Carmen III	15	2.0	1.6	1.3	Fourths 1.2. Planted 15x38.
	Blue Victors	20	1.6	1.3	1.3	Fourths 1.1. Yield 14,200.
	Rural No. 2.	15	2.0	1.6	1.3	Fourths 1.2.
	Average of 248 sets of 3 & 4 hills..		1.8	1.6	1.3	Fourths 1.4.

sent the average yield per hill in a perfect stand, then the firsts and seconds recover together an average of .35 pounds, or about ¼ of the loss of one hill.

5. A similar amount is made up on the other side of the skip.

6. *The hills on either side of a single skip make up one half the loss.*

7. *The skips of more than one hill are positive losses of yield except for the weight of one half of one hill.*

STANDS IN GROWERS' FIELDS.

Average Stands 70 to 75 Per Cent.—An extensive examination of stands in fields over the state, in growers hands, convince us that among Pearls and Rurals which constitute nine-tenths of our output, 70 or 75 per cent. is an average stand. An examination of stands secured with these varieties on our plots will convince the reader that a stand of 85 to 90 per cent. is attainable in field prac-

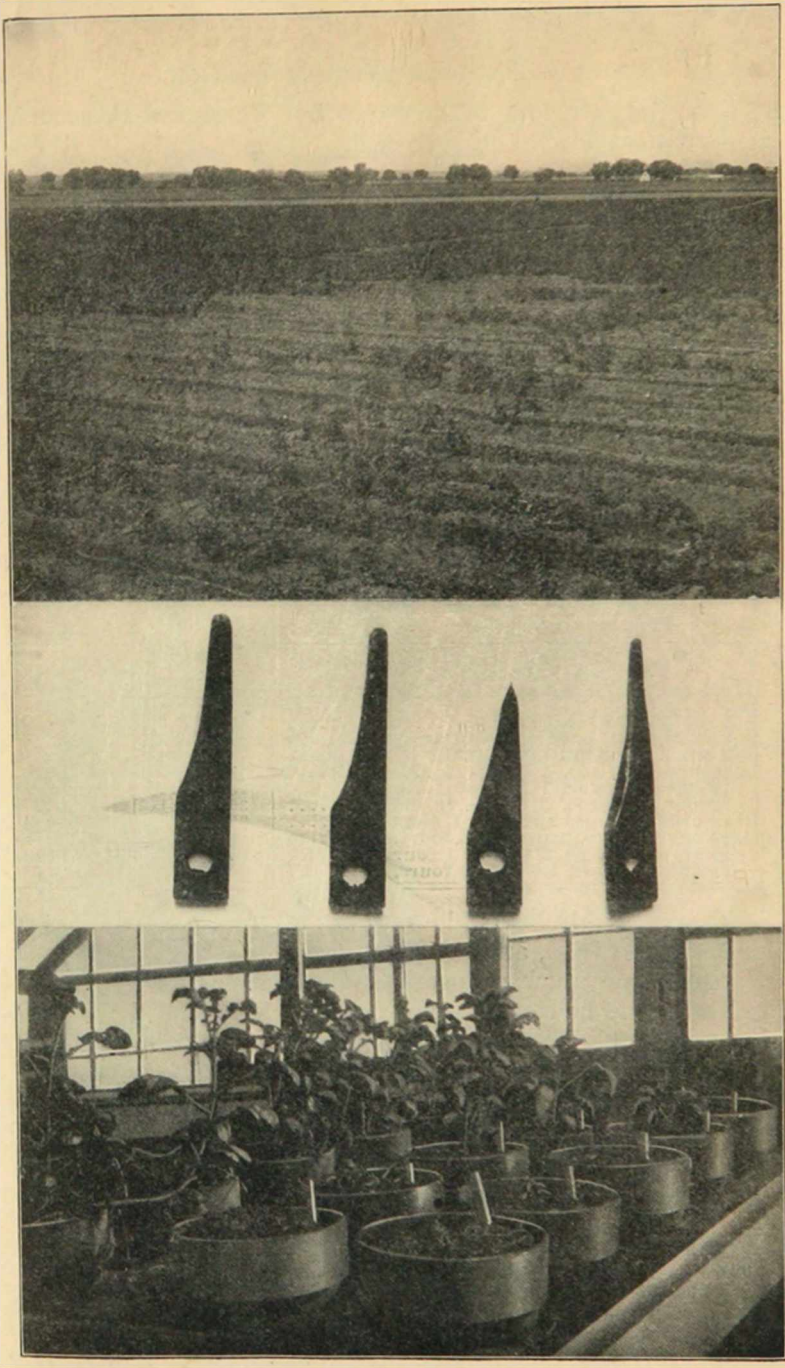

PLATE XXII.—Some Factors Affecting Stands.
1. Condition of Seed Bed. 2. Picker Points Good or Bad. 3. Seed Awake or Dormant.

tice. Growers have told us they had fine stands, when accurate count showed as low as 70 per cent.

One-Fifth Colorado Crop Lost.—Thus there is a loss of about one-fifth of our crop annually by poor stand, or *half at least of the profits.* The Colorado crop has a minimum value of over $4,000,000. One-fifth this amount is $800,000.

Possibilities of Economic Benefits.—If there can be saved, by educational work and by accurate statement of the facts, one-eighth of this $800,000 for one year, or $100,000, the interest on the saving for a single year, at 5 per cent. annually would support permanent technical work for the potato industry. If one-fifth this loss can be saved annually, it would support the agricultural college in all its branches.

LOSSES BY DEFECTIVE STAND

In per cents of whole crop for stands running from 50% to 95%.

Per cent. stand	Typical skips for each stand stated in left hand column. For every skip ½ hill is made up at sides, the rest is absolute loss.	Stand lost, per cent.	Basis of 100% stand or 100% crop.	Crop lost—per cent on crop secured. 90% standard.	85% standard.
95	5 of one hill each	5	3	0	0
90	8 of one hill each and 1 of two hills	10	5	0	0
85	9 skips of one hill each and 3 of two each.	15	9	4	0
80	10 ones, 2 twos, 2 threes	20	13	9	5
75	13 ones, 3 twos, 2 threes	25	16	13	8
70	12 ones, 4 twos, 2 threes, 1 four	30	21	20	15
65	12 ones, 4 twos, 2 threes, 1 four, 1 five	35	25	27	21
60	14 ones, 1 two, 2 threes, 2 fours, 2 fives	40	30	36	30
55	10 ones, 11 twos, 3 threes, 1 four	45	33	42	36
50	14 ones, 5 twos, 1 three, 2 fours, 3 fives	50	37	51	44

With very early sorts, loss of stand means nearly a proportionate loss in yield, and is much more than is above shown.

Figuring how much he loses by a poor stand, a grower should decide what stand he should secure: 85 or 90 per cent. Then take the line of the table where he finds at the left the stand he actually secures, and in the columns to the right, under his standard stand, he will find his loss in crop, on the basis of what he secures. He will thus be able to figure how much expense he can afford to incur to care for seed and seed bed and to repair old or buy new planters.

DRYLAND POTATO GROWING: Points of Difference from Other Potato Culture

Cheyenne Wells 1910.—The yields here represent the minimum of what need be secured on suitable soils in the plains region. The land was native sod in 1894. It has been farmed each year since, without manure or rotation with peas, nor has it been summer tilled or fall plowed. The natural conditions both of soil and of season could hardly have been worse than in 1910. First class care and tillage with first class seed made a yield that would at least supply food, to a farm home, on the plains.

Rotation with Peas, Beans and Alfalfa.—The results at Julesburg hold out a promise of large yields to the grower who will rotate with

legumes and summer till for potatoes. Pea and oat hay is good hay to produce milk, and if planted early on rightly managed land is a sure crop. Mexican beans are a paying dryland crop. The great interest in good alfalfa seed is sure to result in profitable growing by drylanders of special varieties of alfalfa for seed purposes. And rotation with peas or beans and with alfalfa when it has to be plowed up will increase all the farm crops on the plains. See **Julesburg 1910, herein.**

Plowing for potatoes will be done the summer before; or, after summer tilling, will be done in the fall. Spring plowing is a gamble. Fall and spring tilling will be universal. Summer tilling will promote good shape in the potatoes grown the next year.

PLATE XXIII.- Planting 2 acres a day with a planter costing 98c Chicago. $1.25 Denver.

Planting is well done deep on the dryland and is one of the things upon which good shape, early set, and good seed depend. It is not advisable to plant with a plow. Use a horse planter or plant as deep as possible with a hand planter.

Cultivate Shallow following cross harrowings. Do not cultivate when it is not needed, but keep out all the weeds and break every crust.

Machine Diggers of the four horse elevating type are often too expensive for dry land neighborhoods while plows are too wasteful of potatoes. The double beam rod shaker digger shown in the cut is a good compromise, as it is cheap and works well on small or mature vines when the ground is loose and not wet.

DEL NORTE

The Good Yields secured at this point commend the soil and care in a year below average for the yields of the valley as a whole. The blights and diseases which in 1910 hurt the earlier sorts, even including Pearls, left our Rurals by far the heaviest yielding class. The yield of the Dewdrops (Stake 150) maturing with Pearls we discard because of the undesirable shape of the tubers. The net weight of the Cobblers and the gross weight of the Ohios were about the same, and both were here of fine table quality, and were ready the first of September. All varieties were dug September 21, and at this date Rurals though thin skinned were mealy and white fleshed.

The Productiveness of Sports such as Red Ohios from White, White from Red, Blue Pearls from White, or White from Blue is illustrated at Stakes 169 and 170.† This has been specially noted with Pearls, and we

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*One of the representatives in our present legislature cites his experience that potatoes planted in the furrow that dries out over Sunday give very poor stands. The same is true to some extent of all furrow planting.

†See herein **Mixing in the Hill.**

often hear growers say that they wish they could raise Blue Pearls because of the yield. Sports of this sort afford a good starting point for improved strains, but we do not find the increased yield is long maintained of itself. We have secured here, at Greeley and at Montrose, from dry land Blue Victors, by means of good conditions and the liberal use of manure and artificial fertilizers to induce variation, about 150 pounds of new White Pearls, to be used at Carbondale in starting an improved strain of Pearls.

Close Planting on deep soils here results in great increase of yields and most desirable uniformity of size. Note the yields secured from stakes 200 to 190. Deep rooting sorts like the Rural respond the best to this practice. Note that the use of double the seed, or 1000 pounds more per acre, is more than doubly returned in the small seed secured in the crop, and a profit in the ware averaging, on the six lots of Rurals 3049 pounds per acre, for the five inch instead of 10 inch planting. The much more saleable uniform crop is also to be remembered.

Source of Pearl Seed for the San Luis.—Note the difference in the same pedigreed stock of White Ohios, one lot kept the last year at Greeley and the other lot at Pagosa Springs. The ware yield of the latter is double the former. Note the same with Pearls the sixth year at Greeley on the same farm (176) or that the sixth year at Pagosa (175), and compare again with 173, changed to another farm at Greeley the last year before coming to Del Norte, and with (200) the yields of big Del Norte grown seed which gave a very poor stand. Compare also the yields from first, second, and third year Greeley Pearl seed, remembering that of this seed secured in the same neighborhood the "first year" was much the poorer.

CHEYENNE WELLS—1910

May 7-9: Planted 24x36.

Stake	Variety and Source	Total
37	Pearl—Divide	1403
38	Pearl—3 yr. Greeley	1422
39	Pearl—2 yr. Stove P.	2848
40	Pearl—1 yr. Greeley	1564
41	Pearl—10 yr. Stove P.	1754
42	Pearl—Montrose	1228
43	Cobbler—Akron	1020
44	Cobbler—Maine	1709
45	Cobbler—Mancos	1719
46	Carmen I—Maine	1916
47	Peachblow—Flagler	2455
48	E. Ohio—Maine	2286

These were planted by hand, under excellent conditions, and the stand was practically perfect, except for damage in cultivation.

San Luis Valley Profits in potato growing **depend on the seed** secured. First year Greley seed is much better than that longer at Greeley; seed grown at Pagosa or Del Norte from Greeley or (presumably) from dry land or Wisconsin seed is much better still. By the results with Rurals, a strong presumption is raised that Pearl seed raised by close plantings of the best Pearl seed brought to Del Norte will run enough to seed size so that the rest of the valley may well look to Del Norte as a source of seed, provided only and always that the parentage of the seed offered be known.

Conditions and Parentage: not Place alone are to be considered in the matter of seed changes. To no potato growers of Colorado are the principles underlying these matters more important than to those of the San Luis. See Bulletin 176.

DEL NORTE YIELDS PER ACRE*

In Pounds.

Screened over 2-in. screen and corrected by 3 per cent. estimated difference to 1 7-8 basis.

Stake	Variety and Source	Total	Ware	Culls	Stand
147	Sunlight—Maine	11460	10270	1190	84
157	Six Weeks—Maine	10975	9107	1868	88
151	Bovee—Maine	12240	11136	1104	63
192	Noroton—Maine	5790	4971	819	59
150	Dewdrop—Maine	20740	19661	1079	81
148	Burpee—Maine	12260	11186	1074	73
152	Ohio—Minn.	11088	8562	2526	88
153	Ohio—Divide I	10220	8734	1486	81
158	Cobbler—Maine	12080	10266	1814	75
159	Cobbler—Minn.	12414	10427	1987	83
205	Ohio—Divide II	9540	8385	1155	76
154	W. Ohio—Pagosa	13271	10217	3055	85
155	W. Ohio—Greeley	10350	5174	5176	82
191	White Victor—Del N.	14594	13736	858	..
169	White Eye Pearl—	22806	22404	402	..
170	Purple Eye Pearl—	20700	19251	1449	..
160	R. Seedling—S. Prairie	8100	7323	777	80
161	R. Seedling—Greeley	9540	8386	1154	81
162	R. Seedling—Carbondale	8600	6658	1942	83
163	R. Seedling—Divide	7400	5622	1778	78
168	Russet—Carbondale	7740	6112	1628	..
164	Snowflake—Greeley	9480	6604	2876	89
167	Challenge—Greeley	8040	3301	4739	87
180	People's—Greeley	9440	7953	1487	91
166	W. Prolific—Pagosa	6640	5159	1481	77
172	G. Mtn.—Greeley	8400	5692	2708	88
202	P. of Canon Valley	9600	7168	2432	81
171	Wells'—Wheatland	4680	3434	1246	83
165	Peerless—Greeley	14240	11267	2973	88
176	Pearl—6 yr. Greeley	8240	5927	2313	86
175	Pearl—same, Pagosa	13600	12728	872	78
181	Pearl—1 yr. G. sod	11440	8703	2637	88
179	Pearl—2 yr. Greeley	10080	7742	2338	87
174	Pearl—3 yr. Greeley	9760	7642	2118	89
177	Pearl—1 yr. Greeley	9960	8258	1712	84
173	Pearl—6 yr. Ped.	9280	7398	1882	79
178	Pearl—1st. yr. Ft. Collins	11360	9340	2020	91
182	Pearl—Wisconsin	12320	11249	1071	81
	Same	12800	12384	416	..
200	Pearl—2 yr. Del N.	18000	16210	1790	65
	Same, poorer soil	12550	11776	770	..
	Same, next row 2x10	14700	12241	2459	..
189	Carmen III—Wis.	12840	11295	1545	74
	Same, 2x10	17760	13512	4248	..
188	Rural—1st. yr. Ft. Collins	13080	11192	1888	75
	Same, 2x10	15480	12464	3016	..
187	Rural—1st. yr. Greeley	12240	9967	2273	81
	Same, 2x10	19680	14990	4690	..
185	Rural—Greeley, sod	19920	15178	4742	..
	Same, 2x10	17980	16039	1941	..
183	Rural—Wisconsin	16502	.....	....	75
	Same, 2x10	17710	15931	1779	..
184	Rural—1st. yr. G., alfalfa	17958	14437	3521	71
	Same, 2x10	22965	19721	3244	..
186	Rural—Greeley, station	15625	13593	2032	82
	Same, 2x10	19800	18234	1566	..
190	Peachblow—Greeley	15000	12810	2190	75
	Same, 2x10	21000	16520	4480	..
156	E. Ohio—Parshall	10800	9564	1236	82
206	Triumphs—1st. yr. Del N.	15240	14017	1223	75

* The planter used here caused a loss of stand of about 10 per cent.

MONTROSE: BOSTWICK PARK

Planted: Earlies 12x39. Late Varieties 10x39.

Stake	Variety and Source	Total	Ware	Culls	Stand
	Earlies on sage brush land in orchard.				
64	Dewdrop—Maine	4550	4300	250	95
56	Noroton—Maine	1600	1300	300	60
66	E. Ohio—Red River	3300	2600	700	95
57	Triumph—Carbondale	4800	4300	500	76
58	Same—Salzer's E.	.....	.....	....	76
59	W. Bliss—Maine	4000	3600	400	72
65	Perfection—Maine	5300	4700	600	63
67	Bovee—Maine	4300	3700	600	67
63	Burpee—Maine	5000	4500	500	45
62	Cobbler—Mancos	5700	5200	500	90
61	Cobbler—Red River	5500	4100	1400	77
	On four year old alfalfa sod.				
84	B. Victor—Nebraska	15800	15500	300	95
87	Cobbler—2x10	7000	5500	1500	..
70-a	Duplicate	7550	6050	1500	..
69	Snowflake—B. P.	15000	14000	1000	100
68	Snowflake—Greeley	16300	14300	2000	96
77	"La Follette"—Wis.	13250	12750	500	93
70	Pearl—Pedigreed	12200	11700	500	94
73	Pearl—Stove P.	15300	13700	1600	77
71	Pearl—B. P.	13100	12500	600	91
72	Pearl—Carbondale	9600	9300	300	87
76	Pearl—1 yr. G.	10600	9700	900	94
75	Pearl—1 yr. G. sod	13300	12300	1000	94
74	Pearl—Del Norte	16000	15700	300	94
81	Rural—B. P.	13700	13100	600	96
83	Rural—Eaton	16400	15800	600	95
80	Rural—Greeley	14700	13700	1000	98
82	Rural—W. Sprout	17000	15000	2000	93
79	Carmen III—Wisconsn	18600	17400	1200	92
78	Downing—Montrose	12500	11600	900	95
85	Peachblow—Greeley	12000	9500	2500	93
86	Peachblow—Carbondale	14100	11100	3000	88
87	Russet—Carbondale	12900	10400	2500	93

Earlies here had a poor start due to deeply dry soil and, as at Greeley, to drouth. And early potatoes cannot make up for lost time, as is noted under the division of this bulletin **Early Potatoes.** The excellence of the Triumph and the Cobbler are corroborated, and on the alfalfa sod increased yields were obtained from close planting of Cobblers.

Maincrop Potatoes suffered severely not from a poor start, for they had a good one, but from the breaking of the ditch and dryness in midseason. The large yields of both lots of Snowflakes as compared with others is a feature, while the Downings and Russets again give good yields as secondary sorts.

Among the Pearls, note the capacity of the Stove Prairie dryland seed to give a good account of itself in hard conditions, as was shown with dryland seed Pearls at Greeley. This same idea applies to the Bostwick Park sage brush land Pearls,† the Greeley sod Pearls, and possibly to the Del Norte pea land Pearls as compared with those grown on alfalfa land at Greeley and Carbondale, and it is a general principle, that good seed does better when taken to richer conditions than those under which it grew.

†See results with Bostwick Park sage brush land seed at Julesburg and Greeley, and of Parshall sage brush land seed at Greeley. Sandy land with enough slope and the early irrigation possible at high altitudes, we believe to be factors in the success of this sage brush land seed.

Among Rurals, note that all imported stocks exceed the home seed, and that a Rural seedling, Carmen III, Wisconsin grown, leads them all, while seed, pear-shaped, grown at Eaton near Greeley comes second. This seems to argue for change of seed stocks in this locality.

White Sprouted seed is found among all the Rurals of the Montrose district that we have seen, and their white blossoms are conspicuous among the purple in the fields. This is a serious defect to the eyes of a potato man in the otherwise wonderful Rurals shipped from the Uncompahgre, and we thought to find that a selection of the white sprouted sort at planting time would show a lower yield. Such is not the case. They exceeded the Rurals from the same lot by 3300 pounds gross per acre and by 1900 pounds net. Their shape is, however, inferior and is still worse in poorer conditions.* The white sort is doubtless Carmen I. See its yield at Greeley.

CARBONDALE

Record Yields for unmanured, unfertilized field culture were here obtained on our plot. Such was the uniformity of yield at the upper and lower ends of rows and from one side of the field to the other, that we believe that the whole piece would have gone the same as any part if planted to the same sort.

Early Sorts.—Note the 2800 pound increase in the Cobbler yield by the 5½ inch planting (A and B) and that at stake 128 the very earliest sorts were made to yield 20,000 pounds per acre by planting in 20 inch rows and cultivating with a beet cultivator.† The excellence of the Russet as an early potato is here as elsewhere strongly indicated. (Stakes 129 and 130). Note also that it responds here strongly to seed selection. The more oval seed produced 6257 pounds more ware per acre than the slim seed.

The Snowflake has been a famous potato. Believing that the great work done by Carbondale growers with the Peachblow and the Triumph could be repeated with the Snowflake, we sorted over a large quantity of Greeley Snowflakes, and planted the best, to be hill selected here, and then grown on the dryland, to be thence supplied in 1913 to all the State, as a home favorite potato. The yield (S. 126) promises success.

The Pearls, especially the locally developed Pearl, called Valley Prize, gave remarkably high net yields, without knots, cracks, hollowness or other defects. Stake 134 had a net yield over 1⅞-inch screen of 598 bushels, and the next highest net yields were of Pearls from Pearl seed grown in the valley at Carbondale, and at Greeley, and from Messrs. Sweets' Peachblows and Gold Coins.

That Rurals were Omitted from the Carbondale lists is one of the oversights of a strenuous season. This variety now leads all others in the United States. From what it does at Del Norte and Montrose and in private hands at Carbondale, we do not hesitate to recommend it for planting beside the Peachblow as a **late sort.** It will doubtless lead all other white potatoes in yield, uniformity, beauty,‡ and high quality at Carbondale. For **medium,** the Pearl will be standard. For **early** the Russet and the Cobbler promise to be standard. We would not at Carbondale go outside this list. It has been a misfortune that all varieties do well here.

Close Planting will be the thing for Rurals, as close as four inches perhaps. At 124, note that the Peoples gave a good profit on using twice as much seed, and that when three times as much seed was used it returned in the crop. This 3-2/3 inch planting also gave a much increased percentage of seed size. Compare also Pearls so planted at stakes 138 and 139, where the closest planting reduced the yield but produced more seed. See also Del Norte for close planting of Rurals and Peachblows.

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*The new sage brush lands of the Uncompahgre should develop a trade for seed Rurals but will find that pure seed will be demanded.

†See **Early Potatoes,** a division of this bulletin.

‡Rurals come out of the ground clean because of their smooth skin.

CARBONDALE—1910

Planted 11x38. 1 3-4 Screen used and corrected to 1 7-8 basis by addition of 2% to culls.

Stake	Variety and Source	Total	Ware	Culls	Stand
A	Cobbler—11 in.	18100	15928	2172	93
B	Cobbler—5½ in.	20900	.....	....	93
C	Sunlight—Maine	28600	.....	....	97
D	Dewdrop—Maine	31600	.....	....	100
E	Perfection—Maine	17789	.....	....	90
128	Earlies—11x20,Noroton	22040	17632	4408	..
	Triumph	18810	15048	3762	..
121	Late Ohio—S. P.	20700	.....	....	85
122	R. Seedling—Carbondale	26642	.....	....	91
123	R. Seedling—S. P.	24200	.....	....	91
124	People—Carbondale	27785	.....	....	96
	Same, 2x11	32393	.....	....	..
	Same, 3x11	33529	.....	....	..
126	Snowflake—Greeley	24600	19434	5166	97
127	F. Snowflake—Maine	34200	.....	....	96
129	Russet—Carbondale	28484	25353	3133*	89
130	Same, slim seed	21700	19096	2604	91
131	Up-to-Date—Carbondale	29464	.....	....	93
132	Peerless—1 yr. G.	29400	.....	....	86
134	Pearl—Valley P.	38000	35340	2660	..
133	G. Coin—Carbondale	30900	28737	2163	100
136	Pearl—Carbondale	32500	28925	3575	95
135	Pearl—Wisconsin	30100	26789	3311	91
137	Pearl—1 yr. G. sod	33200	28884	4316	98
138	Pearl—Del Norte	29900	26312	3588	97
139	Pearl—mixed, planted 2x11	32592	.....	....	..
	Same, planted 3x11	30400	.....	....	..
140	Peachblow—Ault	36300	.....	....	97
141	Peachblow—Carbondale	35700	.....	....	98
	Duplicate	37500	.....	....	..
142	Peachblow—Flagler	37800	.....	....	90
143	Peachblow—Greeley	30600	.....	....	89
144	W. Peachblow—G.	28000	.....	....	94

* Estimated at 11%, following test of 12% on slimmer stock.

PEACHBLOW CULLS AND CRAX

The per cents of smalls, crax and extreme slims were taken on the three highest yielding Peachblows. ("Crax" is the trade name for cracked potatoes).

Stake	% Smalls	% Crax & Slims	% Ware	Yield Ware
140	8	23*	69	25047
141	7	16	77	28875
142	8	26†	66	24948

* A large per cent. here of slims.
† Almost all crax.

PARSHALL 1910

Our Plot in Middle Park on the Moffat road was a sandy brown mesa loam several feet deep, with lighter colored and heavier subsoil on cobblestone drainage, an excellent potato soil. This was the third crop from sage brush, the previous ones having been grain and turnips. Conditions were very fine when planted on May 6 and 7. The plot did not receive water early enough, and was late when the freeze came on August 25, which destroyed $1,000,000 worth of potatoes elsewhere, and was

the record early freeze at the Experiment Station. Potatoes must have rotation with clover, alfalfa, or peas; and Middle Park is no exception; and such rotation regularly practiced will bring amazing results with all crops grown. This region, especially with a James Peak tunnel, will be the closest mountain potato section to the Denver markets. Early potatoes can be ready at 8,000 feet by September 1. In 1909, our yields of Pearls —a medium late sort—were about 12,000 pounds per acre, on sage brush land at this point.

The Seed Grown on Sage Brush Land, at high altitudes, if watered early, we find good seed for the Greeley district. See Montrose, Greeley, and Julesburg.

The Pearl—first year Greeley or dry land seed—is the best main-crop potato for the Park. Rurals might be better on the heavier soils but are pretty late in maturing. For earlies the Cobbler and the Ohio are the ones to plant.

YIELDS AT PARSHALL

Planted 15x38.

Stake	Variety and Source	Total	Stand
108	Pearl—6 yr. Greeley	3168	95
106	Pearl—2 yr. Del Norte	5040	88
116	Pearl—1 yr. Parshall	5760	93
104	Pearl—1 yr. Greeley	5904	88
120	Pearl—1 yr. G. Sod	5616	95
105	Pearl—2 yr. Greeley	5184	94
107	Pearl—3 yr. Greeley	6048	95
119	Peachblow—Flagler	6348	89
110	Downing—Carbondale	3816	72
102	Challenge—Greeley	5184	88
101	Snowflake—Greeley	3024	70
115	F. Snowflake—Maine	6984	86
109	R. Seedling—Stove P.	3096	48
113	E. Ohio—Red River	2664	94
112	Six Weeks—Maine	2736	95
111	Cobbler—Maine	2160	75
103	W. Ohio—2 yr. G.	1584	95
114	N. Beauty—Maine	1018	70
117	E. Rose—Parshall	3876	74

JULESBURG 1910

Our plot here was an old alfalfa field, a gray loam, deep, with heavy but porous subsoil. It was irrigated early, plowed 8 inches deep, harrowed, leveled, rained upon and harrowed before planting on May 4. There are few soils better than this type at Julesburg. The reservoir of the Julesburg Irrigation District broke its dam early in the season, and the potatoes were never irrigated, while the rainfall was below normal. The potatoes were harrowed before and after they came up, and this was of great benefit. Potatoes intended to be harrowed should be planted deep, so as not to be harrowed out.

Boxing is a British title applied to potatoes sprouted in crates and set out by hand. Quicker growth and better yields are claimed for the practice. The early season was dry and unfavorable for this test. Our conclusions here, at Greeley, and Montrose are that better results are obtained by the use of stubby, sprouted, just started, or greened seed potatoes, in planters.

Wisconsin Seed tested here proved to be 78% Pearls and 22% mixed Rurals and other sorts. Such mixtures are not tolerated in established Colorado potato regions.

Dryland Possibilities.—The most significant result of the work in 1910 at Julesburg and one of the most important facts in Colorado agriculture, was brought out because the reservoir broke, and the plot became a dry land experiment. The yields of 10,000 pounds per acre on the

standard sorts is proof of what can be done on loamy lands with good subsoil, without irrigation, if properly rotated with alfalfa, beans and peas.

Dryland Rotations.—If peas are used they should be planted in the earliest spring time in rows for cultivation and on packed fall plowing or summer tilled stubble. Two years of peas are recommended, the first season cutting for hay, and the second plowing under the crop and summer tilling for potatoes to follow in the third and fourth years, returning to grain for the fifth year and then repeating. By this means all dry land crops will be vastly increased, and the irrigated potato regions greatly benefited by an adequate seed supply. The irrigation given the Julesburg soil before plowing we do not consider superior to summer tilling.

Varieties and Seed Sources.—We have much evidence here as elsewhere that those regions which buy Greely seed should buy if possible first year seed, and this is of added importance if the stock is again to be used for seed. The excellence of the sage brush mountain seed from Parshall and Montrose and the Cobblers from Mancos is affirmed in the yield of Rural, Pearl and Cobblers, and the desirability of dry landers' planting both early and late sorts is again illustrated. The Cobblers did fine and were beauties. We can only wish them equal in table quality to the Ohio. We do not favor for Julesburg any varieties but Rural, Pearl, Cobbler, and Ohio. We believe that this region with good knowledge of type and varieties and the facts of Bulletin 176 can maintain its seed stocks somewhat longer on its deep lands than can the Greeley district.

COOPERATIVE DRY LAND TESTS AT JULESBURG

Four Tableland Farm families* cooperated with us in tests of varieties for dryland growing, and gave most hearty and much appreciated

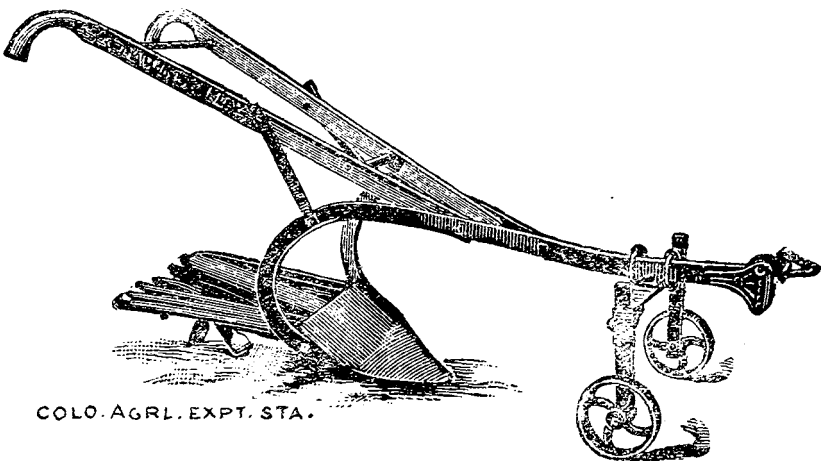

PLATE XXIII.

The Doublebeam Shaker Digger Handles Early Potatoes and Ripe Vines Very Well, and is Much Better than a Plow. Cost, $10.50 Chicago; $12.50, Denver.

aid in this work. On land carefully cultivated but not summer tilled or falled plowed in any case nor that had grown peas, beans or alfalfa, it was proven in this bad season, that dry landers can grow as a minimum 50 or 60 bushels or even more of potatoes. This year Pearls did by far

*We say "families," rather than "farmers," because the women and young folks in the tableland farm homes take their full share of work and interest in these things.

the best, as the moisture came late. Other years, especially with summer tilled land, early sorts like the Ohio will do better. Thus it pays to plant both early and late sorts to hit the season at one end or the other.

Summer Tilling and better early conditions will make better shape and better seed as well as increased yield. See under **Dry Land Potato Growing,** and **Julesburg 1910.**

YIELDS ON THE STATION PLOTS AT JULESBURG

Planted 14x38.

Stake	Variety and Source	Total	Ware	Culls	Stand
22	E. Ohio—boxed	10400	6200	4200	..
25	Triumph—boxed	7360	3840	3520	..
23	W. Ohio—boxed	5409	2254	3155	..
27	Cobbler—8 in.	12831	8554	4277	..
24	Cobbler—8 in.	10692	7026	3666	..
28	Cobbler—8 in.	10450	8250	2200	..
30	Perfection—8 in.	8250	5500	2750	..
3	Cobbler—Mancos	11100	9200	1900	..
4	Perfection—Maine	5600	4500	1100	..
1	N. Beauty—Maine	7900	6300	1600	..
2	Cobbler—Maine	11200	9600	1600	..
14	Pearl—3rd. yr. G.	9700	8300	1400	77
6	Ohio—Red River	9000	6500	2500	..
5	Ohio—2nd. yr. J.	10100	8000	2100	..
26	Pearl—boxed	6700	5600	1100	..
13	Pearl—2nd. yr. G.	9100	7200	1900	86
31	Pearl—2nd. yr. J.	9900	8400	1500	67
17	Pearl—Parshall	11300	9900	1400	84
19	Rural—Montrose	13100	11300	1800	..
12	Pearl—1st. yr. G.	11700	10200	1500	81
16	Pearl—Montrose	10100	8600	1500	70
15	Pearl—Stove P.	10000	8700	1300	80
18	Rural—1st. yr. G.	10800	9200	1600	..
20	Rural—Wisconsin	9800	8500	1300	..
9	Peachblow—Flagler	8700	6400	2300	..
10	Peachblow—8,000 ft.	8100	6100	2000	..
11	Peachblow—Carbondale	8700	6800	1900	..
7	Peachblow—Julesburg	7200	5900	1300	..
8	Peachblow—Greeley	8000	6400	1600	..

FORT MORGAN.

On June 9 we planted one acre at Fort Morgan with about 1/20 acre, one row, each of the following as a test of sources of seed potatoes of standard varieties for Fort Morgan:

Rural—Seed from four sources.

Pearl—Seed from ten sources.

Other Varieties—Three.

Grasshoppers practically destroyed the field. None of us realized how serious this pest would be here in 1910, or a long narrow field between grain and alfalfa would not have been chosen. A right good fight was put up when we realized the situation, but we could not have won unless we had had the special sprayer and arrangements used at Greeley.

Greeley Rules.—These will apply here, as to change of seed, deep cultivation, late planting, late watering, rapid harvest, as set forth elsewhere in this bulletin. In the vicinity of Brush heavy yields were secured, of excellent quality, both of Rurals and Pearls.

Varieties for Morgan County will be the Rural, Pearl, Ohio, and Cobbler. First year Greeley seed will do well, as will dry land seed which shows no signs of running out. Sage brush land potatoes from the mountains will do well, as will Wisconsin seed.

Morgan County dryland potato growers will find their problems discussed elsewhere herein.

GREELEY NOTES

All Yields at Greeley, especially of early potatoes were greatly reduced by serious shortage of water and holding it off too long early in the season. Water was so high in price that we could not require the rental of water extra to that normally sufficient.

The Largest Yields, in the order named were secured with Carmen

GREELEY YIELDS

Planted 15x38.

Stake	Variety and Source	Total	Ware	Culls	Stand
321	Rural—Divide, return	9810	7630	2180	72
322	Epicure—England	6750	5250	1500	80
323	Carmen I—Aroostook	16974	15744	1230	74
324	Pearl—Divide, return	13755	12838	917	..
325	Peachblow—8,000 ft.	10800	8800	2000	60
327	Carmen I—Penn.	11305	9282	2023	82
326	Abundance—England	10115	7735	2380	75
336	People—Carb.	10200	9400	800	83
337	Carmen III—1st. yr. G.	7000	5500	1500	87
338	People—Montrose	9500	8500	1000	70
339	Peachblow—Flagler	12400	10000	2400	77
341	Peachblow—Carb.	11900	9900	2000	75
340	Downing—Carb.	5500	3700	1800	88
330	Old's No. 116—Ohio	10920	9360	1560	90
334	Ninety-fold—England	7739	6540	1199	70
333	Banner—Red River	12102	10810	1292	90
328	B. Crawford—Ohio	13180	11680	1200	82
278	Pearl—1st. yr. G.	6700	4800	1900	..
348	Russet—Carb.	11900	10200	1700	92
349	Rural—Montrose	9300	8600	700	85
350	Rural—Del N. (big)	4200	3800	400	29
351	Rural—1st. yr. G.	6300	5700	600	81
331	Peachblow—Ohio	8000	6500	1500	82
332	Up to Date—Vermont	10865	9840	1025	66
335	Snowflake—Aroostook	9064	8038	1028	84
342	Pearl—Divide	13500	12200	1300	96
343	Pearl—S. P. (L)	9400	7900	1500	92
344	Pearl—Grover (N)	12800	11300	1500	90
345	Pearl—Grover (S)	14800	13300	1500	97
352	Snowflake—Stove P.	7000	6000	1000	45
353	Pearl—1st. yr. G. sod	12500	10700	1800	93
354	Carmen III—Plateau V.	10100	9300	800	86
346	People's—1st. yr. G.	7500	5700	1800	88
347	G. Mt.—1st. yr. G.	11600	9500	2100	97
355	Carmen III—P. V.	10000	9300	700	..
357	Carmen III—Wis.	15500	14000	1500	95
356	Carmen I—	11600	10600	1000	80
358	Pearl—1st. yr. G. (S)	12100	11000	1100	88
359	Prolific—Pagosa	13300	12400	900	75
360	Pearl—Montrose, G.	12000	10400	1600	97
361	Dewdrop—Maine	12100	11300	800	76
364	Pearl—S. P. (S)	10800	9800	1000	64
363	People—2nd. yr. G.	11800	10700	1100	86
362	Pearl—1st. yr. G. (D)	14300	12700	1600	89
365	Pearl—Limon (N)	16900	15100	1800	91
369	Pearl—S. P. (L)	14300	13400	900	74
370	Pearl—S. P. (L)	9400	8400	1000	48
371	Pearl—4 yr. Montrose	11900	10700	1200	85
372	Pearl—Wisconsin	13900	13100	800	68
	Same	14200	13000	1200	..
	Same	12800	11900	900	..
373	Pearl—S. P. (L, 8)	11600	10500	1100	..
	Same, 8.	13000	11900	1100	..
374	Pearl—S. P. 3x15	14600	13300	1300	..
366	Pearl—Parshall (W)	10900	10300	600	71
367	Pearl—Parshall (C)	13500	12500	1000	71
368	Pearl—S. P. (R)	8500	7900	600	51
380	Rural—Eaton	.....	.....	....	85
379	Rural—1st. yr. G. sod	11100	10200	900	78
378	Peerless—1st. yr. G.	10600	7900	2700	68
377	Pearl—Foothills (N)	11600	10000	1600	85
376	Peerless—1st. yr. sod	7700	6100	1600	60
375	Pearl—S. P. small (L)	11000	10300	700	68

I from Aroostook; Pearls from Limon, Colorado; Carmen III from Wisconsin; Green Mountains from Wisconsin; Pearls from near Grover; and Stove Prairie Pearls planted with three times the regular number of seed pieces (3 in each spoke). The Carmen I and the Green Mountain are of a shape unsuitable to Greeley conditions. The significant point is that no first year seed is in the first seven lots this year.

Close Planting of one lot of Cobblers increased the yield one third as did a double row of the same lot, while close planting of a first year Cobbler resulted in the lowest Cobbler yield. Close planting of Stove Prairie Pearl seed resulted in good yields at a cost for seed that would

GREELEY YIELDS

Planted 15x38.

Stake	Variety and Source	Total	Ware	Culls	Stand
241	B. Victor—Kimball	14200	12500	1700	92
243	B. Victor—Plateau V.	10900	9700	1200	85
242	B. Victor—P. Valley	.....	.....	....	73
244	Noroton—Maine	3600	2700	900	80
246	R. Seedling—Carb.	11600	9900	1700	89
245	E. Rose—Haxtun	11000	9700	1300	87
247	E. Ohio—Parshall	6000	5300	700	84
248	R. Seedling—S. P. (V)	5900	5700	200	58
249	Cobbler—Maine	4100	3400	700	73
250	Cobbler—Scotts Bluff	4500	3800	700	89
254	Same—double row	6100	4500	1600	89
253	Cobbler—S. B. 2x15	6000	4400	1600	84
251	Cobbler—Mancos	6600	5200	1400	86
252	Cobbler—Red River	6000	4800	1200	69
256	Cobbler—1st. yr. G. 2x15	3100	2100	1000	79
255	W. Ohio—Pagosa	4200	2700	1500	93
257	W. Ohio—Red River	3100	1800	1300	94
258	W. Ohio—Red River	3900	3000	900	87
259	E. Rose—Red River	9500	7900	1600	80
260	Six Weeks—Red River	4600	3600	1000	96
261	Thorburn's Early—	7740	6192	1548	80
262	Noroton—Sapinero	2992	1936	1056	93
263	E. Ohio—Sapinero	6698	4334	2364	93
264	E. Roser—Red River	6600	5300	1300	..
265	Triumph—Red River	4580	2748	1832	75
266	Cobbler—Akron	3658	2714	944	..
271	Bovee—Aroostook	7544	5576	1968	88
267	Cobbler—Aroostook	3825	2390	1435	98
268	Sunlight—Aroostook	4182	2706	1476	90
269	Perfection—Aroostook	5973	4525	1448	95
270	Dewdrop—Aroostook	7800	5980	1820	90
272	Noroton—Aroostook	.....	.....	....	50
273	E. Ohio—Aroostook	5713	4334	1379	98
274	Six Weeks—Aroostook	5900	4800	1200	87
275	Burpee—Aroostook	2900	1900	1000	100
287	Peachblow—Greeley	9400	7200	2200	..
286	Triumph—Boxed	7786	6412	1374	..
289	Rural—Boxed	11700	10200	1500	..
292	W. Peachblow—Boxed	12513	9288	3225	..
291	Pearl—Boxed	8930	6000	2930	..
290	Rural—Boxed	8316	6264	2052	..
276	"Pearl"—Maine	8200	6500	1700	86
277	Pearl—Del N.	11800	10700	1100	85
280	Pearl—1st. yr.	11000	9400	1600	94
283	Carmen III—Plateau V.	11300	10300	1000	78
284	G. Coin—Wis.	9700	8400	1300	79
279	Pearl—Carb.	12600	11400	1200	91
281	Pearl—Montrose, G.	9400	8000	1400	93
282	Pearl—Pagosa, G.	12500	11000	1500	87
293	G. Mt.—Wis.	15300	14000	1300	..
294	G. Mt. Jr.—Wis.	14900	13600	1300	88
295	E. Ohio—Wis.	5500	4300	1200	91
296	Thorburn's Early—	14178	12638	1540	94
297	State of Maine—Wis.	12204	10735	1469	85
302	Pat's Choice—Wis.	8500	7500	1000	45
314	Downing—Montrose	9180	7140	2040	75
315	Rural No. 2—Wis.	13800	13000	800	94
316	Carmen I—Maine	12528	10692	1836	91
318	Taft—Ohio	5848	5440	408	..
319	Snowflake—Ohio	7837	6462	1375	71

often pay. See Del Norte and Carbondale notes on close planting.

Other Points that may be cited are the promise of the Russet as a secondary early, borne out on the other plots: that Pearls first year Greeley from Montrose sage brush lands did as well as any Pearls the first year from dry land. This seed we have tried out for three years with the same result.

Changes of Pearl Seed.—All lots taken to the Divide, to Pagosa, to the plains, to the foothills, to Stove Prairie, when returned have this season done better than local seed. There is no exception save the one where run-out Greeley Pearls went to Montrose and returned. We find elsewhere that the tendency to run out may be held in check so far as yield is concerned, by changes, but will return at once, or after a season, with ruinous results when the seed is brought back to the old conditions, as often occurs with irrigated sod seed, at Greeley.

Stove Prairie seed continues to give good type and good yield per plant but very poor stands. We have shown that it paid this season to plant this seed thick in the row. Many tubers of seed size make up a good yield, although they appear small. We brought down in November 1909 several lots of Stove Prairie Pearls and had them carefully stored at Greeley. The stands were improved by this careful storage only five or ten per cent. During the winter of 1910 and 1911 we are securing Stove Prairie seed of different history to be tried in soils on hand from Fort Collins, Greeley, Del Norte, and Stove Prairie. Professor Sackett, our pathologist, has twice visited Stove Prairie with us to try to find some clue as to the cause of this rot. We regard this as one of the most important and most puzzling problems we have on hand.

SPRAYING FOR GRASSHOPPERS AND FLEA BEETLES

Bordeaux Mixture* applied with a twelve nozzle four row sprayer which covered the whole plant was used by Mr. Atkinson five times on the whole plot of four acres, and on the Atkinson, Badger and Emerson farms, to test the great value of Bordeaux as a repellant to grasshoppers and flea beetles, as reported in Vermont and on Long Island. See **Potato Insects** herein.

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*Potato growers will find our arrangements at the Greeley plots for preparing Bordeaux mixture very convenient. A platform is required some six inches higher than the top of the strainer used on top of the spraying machine, and the water supply should discharge quickly into barrels standing on this platform. Four barrels are required: Two called **dilution barrels,** with hose attached to empty them into the 100 gallon tank of the spraying machine; while two barrels are used for **stock mixtures.** In one, 50 pounds of blue stone or copper sulphate suspended in a sack is dissolved in water and made up to fifty gallons. In another lime is water slaked in like proportions, one pound to the gallon. A box strainer with a bottom of common wire netting is then set over the dilution barrels, and into one with a gallon dipper made of galvanized iron, five gallons of the stock copper sulphate solution is poured out and made up with water to fifty gallons. Into the other barrel, after stirring well the stock solution of lime, five gallons containing five pounds of lime are strained and made up to fifty gallons. At this point equal quantities of each solution are put into a wide mouthed bottle and after being mixed by shaking, the mixture is tested with a drop of potassium ferrocyanide solution made from ten cents' worth of the drug. If a brown color results, the mixture will burn the leaves, and more lime from the stock barrel must be added to the dilution barrel until the test no longer shows brown. Then the two dilution barrels are emptied simultaneously into the sprayer strainer, the hose being regulated as to height so that the barrels empty evenly. Common blue stone costing about seven cents per pound in barrel lots, and the best of stone lime are used. Freshly slaked lime or that carefully covered with water and otherwise kept from the air is required. In some places lime contains magnesium impurities which are of no use in Bordeaux mixture.