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Storage of Root Crops on the Farm

Prepared by the Markets Division of the State Committee of Food Production and Conservation.

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Several specialists in the College of Agriculture, University of Minnesota, have made contributions to this bulletin, and their cooperation is hereby acknowledged by the Markets Division.

Minnesota farmers have responded loyally to the call for increased food production. Unusual effort and favorable weather conditions have resulted in the production of large quantities of potatoes and other perishables. It is to the interest of everyone that all of these food products be saved. The use of potatoes and other vegetables as substitutes for wheat and meat will result in the consumption of more of these products than normal. Yet if large quantities are rushed onto the market this fall the price is likely to fall, transportation and terminal storage facilities may be inadequate and as a result producers will lose, food products will be wasted, and food production in 1918 will be discouraged.

Who Shall Store

State and federal authorities who have urged greater food production are now making every effort to insure the efficient handling of the crop. And while there is no available information to enable the Markets Division to advise intelligently all farmers to store their vegetables or to sell at once, it seems wise in view of past experiences to advise that farmers generally make plans for storing so that if prices are unsatisfactory this fall or if cars for transportation are not readily available, perishables may be satisfactorily stored until a more opportune time for shipping. Each individual must be his own judge as to storing, but only by providing storage facilities can he hold his perishable products even if he desires to do so.

Points to Remember

Prices are often, not always, higher in the spring than in the fall. Vegetables shrink in weight when stored. Some or all of them may spoil. One may expect normally a loss of about 10 per cent from these causes. In storing, one loses the interest on the value of the crop; he takes a risk of lower prices or loss; and extra work is involved. Unless one is experienced in handling vegetables, it is safer to accept a fair price at harvest than to store.

Profitable prices are important, but of still greater importance now is the saving of food. For this reason it is a patriotic duty to provide suitable storage facilities so that all food products may be saved.

Other Plans

Advice to provide adequate storage facilities is not all the Markets Division is doing to aid in marketing. Every county is being organized so that every market center will be taken care of. Full information with reference to marketing the perishable products of 1917 will be furnished by applying to your local market representative or by writing to the Markets Division, University Farm, St. Paul, Minn.

CONSTRUCTION OF EARTH STORAGE PITS

The use of this type of pit shown in Figure 1 is recommended to the farmer who has only a few hundred bushels of potatoes to store. If the pit is to be dug in sandy or light soil that will not stand as a perpendicular wall, the oval bottom represented by the solid line is best. The slope of the sides will depend somewhat on the character of the soil in which it is dug. In sandy or very light soil the sides will stand a slope of about 1 foot of base to 1½ feet of altitude. In soils containing more clay the slope can be steeper. This pit can be made any width or depth desired. The cut shows a pit 5 feet deep, and 8 feet wide at the top. The length depends altogether on the amount of potatoes to be stored. A pit made with a rounding bottom, in the dimensions given above, will hold about 16½ bushels of potatoes per foot in length. Thus, if a farmer has 165 bushels of potatoes to store, he will need a pit 10 feet long. A great deal of the digging can be done with horses and a drag scraper, finishing the ends and sides with a shovel.

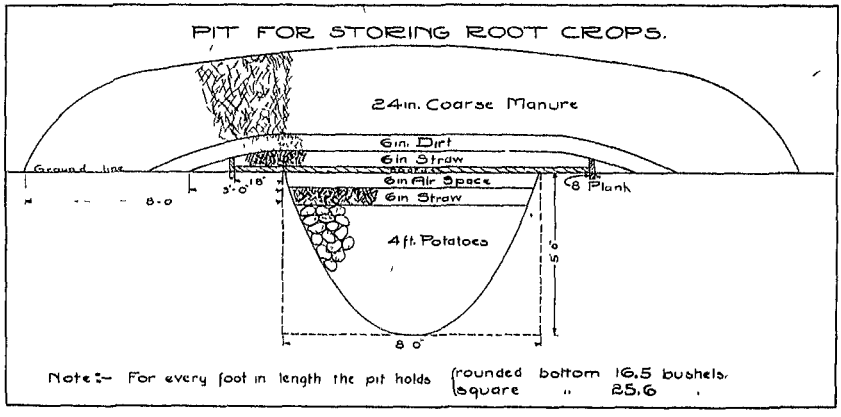

Figure 1. Pit for Storing Root Crops.
For every foot in length this pit holds—Round bottom, about 16½ bushels; square bottom, about 26½ bushels.

If the soil contains enough clay that the walls will stand perpendicularly, the pit can be made square at the bottom, or the bottom may be slightly rounded and the sides made perpendicular. A pit 5 feet deep and 8 feet wide, with a square bottom, will hold about 25½ bushels of potatoes per foot in length, or a pit of this size 10 feet long will hold 256 bushels. It will be seen from the drawing that the pit is filled to a depth of only 4 feet, leaving a foot between the top of the potatoes and the surface of the ground. It is suggested that 6 inches of straw be laid over the potatoes after the pit is filled, and that planks or boards, or, if available, logs or poles be laid across the top of the pit. On top of the logs put 6 inches of coarse straw or, better yet, slough hay, and on this hay 6 or 8 inches of earth. Later on, as the weather grows colder, 24 inches of coarse straw or horse manure should be added.

Be sure that this last covering extends well out over the edges of the pit on both the sides and ends to prevent frost coming in from the side. The drawing shows this covering extending out 8 feet on each side of the pit. If the weather is very cold and the ground is not covered with snow it is a good plan to increase the thickness of the covering to 3 feet and to extend it 10 feet instead of 8 on each side.

Ventilators consisting of an 8-inch flue made of one-inch boards should extend down through the covering to the potatoes. There should be a ventilator for every 8 or 10 feet of length of the pit. In the fall these ventilators should be open during the night so that the roots and tubers dry thoroughly, but should be closed during the day to keep out the warm air. In the early winter the ventilators should be open in day-time and closed at night. When it becomes quite cold, it is necessary to stuff the ventilators with straw to avoid the danger of frost. Wooden caps arranged to keep out rain but let in air are put over the ventilators.

In storing potatoes, care should be taken that the stock is thoroly dry when put into the pit. They should be run over a screen so as to sift out all of the dirt. Before covering the potatoes must be given enough time to become cool. The covering need not be put on the pit until all of the potatoes are in and should be light at first. As the weather becomes colder the covering must be increased. Where possible such a pit should be dug on a hillside facing east or south. Drainage is of the utmost importance, and if the water does not run away naturally it should be led away by ditches around the pit. The main advantage of a pit of this kind is that it is very cheap. It can be built of the waste materials found around the farm, and if properly constructed the potatoes will keep well if they are in good condition when stored.

Such a pit should be constructed with the expenditure of only a day or two of labor. Even when all of the few materials must be purchased new and when the labor must be hired, a very few dollars should cover the total expense. However, it should not be supposed that because this is a very simple storage plant it will not accomplish satisfactory results.

Great care must be observed in opening this type of pit during the winter. But it may be done on any warm day. However, when once opened all of the

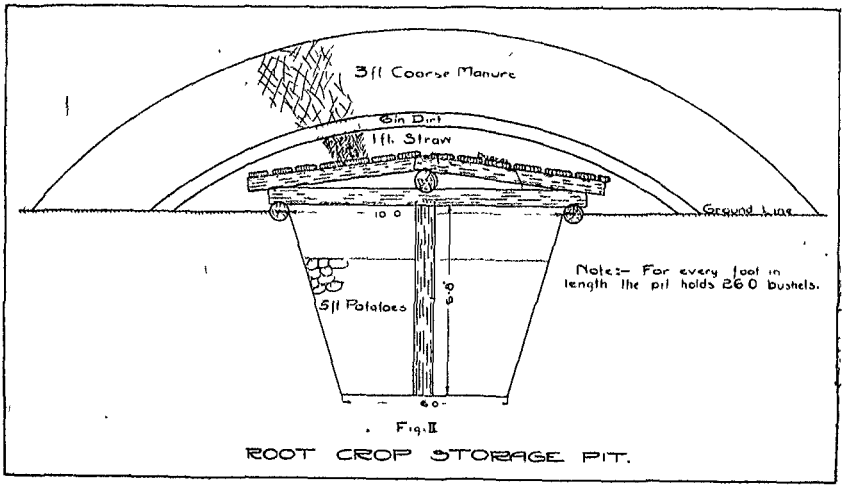

Figure 2. Root Crop Storage Pit.
For every foot in length the pit holds 26 bushels.

potatoes should be taken out. Potatoes stored in this way must be picked out in the spring by hand.

Figure 2 represents another cheaply constructed storage pit for potatoes and other root crops. This pit is 6 feet wide at the bottom and 6 feet high. The advantage of this pit over the one shown in Figure 1 is that it will last several years, and if properly constructed it may be opened at any time during the winter without danger of freezing the contents.

Most of the digging in the construction of this pit can be done with a drag scraper and team, as described in connection with the first plan.

The cut shows logs laid on the surface of the ground at the edge of the pit and another log used as a ridge pole. Where timber is available, all of the wood used in the construction of this pit can be cut from the wood lot. In the prairie section, of course, timber will have to be purchased.

Posts should be set 6 feet apart down the center of the pit to support the roof. These posts can reach from the bottom of the pit to the ridge pole. It is a good plan to put a flat stone under these uprights to prevent them from sinking into the earth. By boarding up one side of these uprights two bins can be made, to provide for two varieties of potatoes. Other cross partitions may be put in if desired to separate carrots, beets, parsnips, and other root crops.

It is a good plan to set the logs or sills at the outer edge of the pit so that their surface comes flush with the surface of the ground.

The slope of the roof can be made to suit the fancy of the builder. The height of the pit above the ground is regulated by the pitch of the roof. A stairway can be built at the end of the pit as shown by the cross-section and should be provided with an outside and an inside door.

The covering of the pit should consist of (1) a layer of old boards, planks, or poles; (2) a layer of straw or coarse hay; (3) a layer of earth; and (4) a layer of horse manure, as shown by the cross-section.

In building a structure of this kind it is a good plan to put in one or two ventilators, depending on the length of the pit. A thermometer can be kept inside

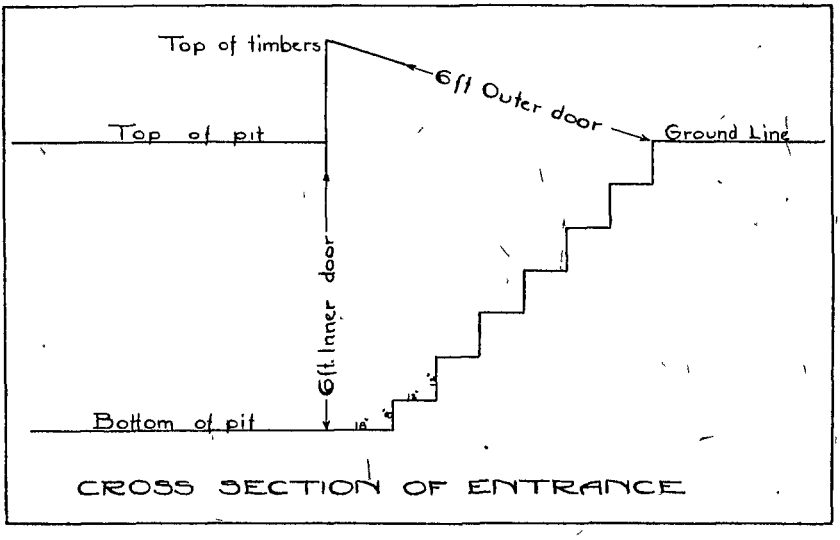

Figure 3. Cross-section of Entrance to Storage Pit.

during the winter, and the temperature regulated by opening or closing the ventilators, as necessary. In extremely cold weather it may be necessary to use a lantern or oil stove. With care, potatoes and roots can be taken from this pit at any time during the winter without endangering the remaining contents.

The pit represented by Figure 2 can be made with very little expense except labor. Most of the material is usually found on any farm. Its capacity is 26 bushels per foot of length, and the necessary length will depend, of course, on the amount of vegetables to be stored. This pit, properly built, should last a good many years. The walls may be either perpendicular or sloping, to suit the fancy of the owner. In lighter soils it is recommended that the walls be made sloping, as it will be much easier to construct.

HANDLING

Adequate and properly constructed storage facilities are not alone sufficient. If poorly graded commodities go into storage, poor quality commodities will come out, and poor prices will be the result. For it must always be borne in mind that the trade determines the price offered, not by the best stock to be found in any lot, but by the poorest. It is only too common that a carload of otherwise acceptable potatoes, for example, is discounted 10 or 12 cents per bushel because of a few small or defective potatoes in the car.

Another pamphlet in preparation issued by this Division will give in more detail the exact rules for standards of size and quality for the various root crops which enable such graded articles to receive a preference from the trade. It is sufficient here to note that the first essential to be kept in mind by the grower is that satisfactory conditions can not be obtained in the storage of root crops unless care is exercised throughout the process of storage. Fruits and vegetables will not stand rough treatment. Cut or bruised specimens immediately invite decay, and decay spreads with great rapidity. To be sure, there are other dangers to be encountered in storage, as, for example, diseases in the products that have resulted from improper methods of growing. It is much better to discard fruits and vegetables that have been bruised or cut or sunburned or frosted or injured by diseases or insect pests, than to include them in the so-called commercial products and thus invite serious reduction in price for the uninjured stock.

The way to avoid the necessity of discarding large amounts of roots or fruits in preparation for storage is to exercise scrupulous care throughout each process of harvesting. Potatoes, for example, should not be dug and allowed to lie in the sun for an indefinite time. They should not be thrown roughly from one receptacle to another. In fact, they should be handled the fewest possible number of times, for each handling, however careful, decreases their keeping quality.

After digging or pulling, root crops such as potatoes, carrots, and parsnips should be left in the field long enough to dry the soil that adheres to them. To what extent this is necessary and the length of time required depends on the character and condition of the soil. Root crops heavily encrusted with soil are at once discounted at the central markets, so the producer must choose between exposing his crops to sunburn and shipping them in an attractive condition.

In the Northwest, root crops are for the most part dug and stored by October 15, as after this date the danger of frost is great. Wholesale dealers are of the opinion that it is unsafe to handle potatoes without special protection after the latter part of October. In fact, they claim that more frosted potatoes are received during November and December than during January and February. In the late fall months, farmers will run the risk of shipping without false bottoms in the cars or without devices for heating, while in the months of intense cold they do not take such risks.

Potatoes as a rule are picked by hand, and a picker should average from one hundred to two hundred bushels per day. The use of a wire basket of approximately one bushel capacity is probably the most usual method of picking potatoes, tho the danger of cutting and bruising is greatly minimized by the use of a picking crate made of rounded slats. This eliminates a great deal of decay. Particularly bad is the method of dumping the potatoes into the wagon, redumping into the storage warehouse, reloading into the wagon, and thence into the car. Repeated handlings are certain to reduce greatly the value of the stock on the market and add a considerable sum to the cost.

A mistake that is only too common is the belief that a mechanical grader will properly assort potatoes. It will only grade according to size, while the market insists on grading according to quality also. There are various types of sizing and sorting apparatus which are ordinarily exhibited by local dealers; consequently they will not be described here. Potatoes graded according to both size and quality are those that receive the preference of the trade, and this preference is sufficiently important more than to repay the extra expense of accurate grading and sizing.

The grower sometimes believes that he is able to deceive the trade by including small and defective stock with good. He usually deceives only himself. The wholesaler almost invariably discovers that the shipment needs re-grading. He charges the amount discarded to the account of the producer; and the costs indirectly, if not directly, fall upon the farmer. These costs are always greater when the grading or re-grading has to be done at the city markets than when it is done on the farm. Besides, the grower loses his reputation with the trade, and this is of no minor importance at a time when quality and reliability with increasing frequency reflect the difference between a profit and a loss.

Storage on the farm has other advantages. It is found that potatoes that are shipped at once from the field are usually in worse condition than those that are retained for later shipment. This is due to the fact that at the harvesting season the work must be rushed as rapidly as possibly with little time for grading and standardizing. The price at the crest of the harvesting season also is ordinarily lower than at any other season of the year. The figures for these conclusions are given on a later page. When potatoes are put into storage sufficient time is allowed for defective stock to appear before shipment and be eliminated.

Other vegetable crops, such as onions, should be topped and allowed to remain for a short time under proper shelter to mature them before going into storage. Cabbages should have the outer leaves removed and the stalks cut to about one inch in length. During all of these processes particular care should be taken that the product is not affected by frost.

Imperfect apples should never be stored. If decay once develops its spread is rapid. Apples should be carefully packed in barrels and boxes and securely covered. The open package does not yield satisfactory results. The longer the time after apples are picked before they go into storage, the worse for the fruit. They should be put into storage within twenty-four hours from the time of picking. Yet they should cool gradually so that moisture does not accumulate, as this is fatal to their keeping qualities.

In a storage warehouse containing several kinds of fruits and vegetables, the proper temperature is from 34 to 36 degrees, Fahrenheit. To make this more specific, the following table is presented. The proper temperatures for cellar storage are:

Fruits:	Degrees Fahrenheit
Apples	32 to 36
Cranberries	34 to 36
Dried fruits	35 to 40
Canned fruits	35

Vegetables:	Degrees Fahrenheit
Cabbages	32 to 35
Carrots	33 to 35
Onions	34 to 40
Parsnips	32 to 35
Potatoes	34 to 40
Squash, early storage	60
Squash, late storage	36 to 40

All of these facts concerning careful handling, avoidance of frost, elimination of earth and small stock, suggest one important point of dissension between farmers and middle men. The farmer is often at a loss to understand why the wholesaler or retailer sells potatoes, for example, at such a large increase over the price paid. The answer in many cases is that the fault lies with the grower. When stock arrives in such condition that it must be re-graded, when many frozen or blighted or decayed potatoes must be rejected, it is only reasonable that a greater price will have to be obtained by the wholesaler, or from the consumer by the retail grocer, in order to cover these expenses and losses. It should not for a moment be assumed that the same number of bushels of potatoes arrives on the retail market that is delivered to the wholesale market. Therefore the price per bushel received by the farmer does not accurately determine what price the wholesaler should receive or the consumer should be expected to pay. If farmers would so standardize and grade their crops that re-grading would be unnecessary, and would keep out small and poor specimens so that the rejection of important percentages is unnecessary on the part of wholesalers and retailers before they can offer them to the public, they would find less difference between their own price and the price charged to the consumer.

THE PRICE MOVEMENT IN POTATOES, 1907 TO 1917

In order to determine the possibilities of storage in effecting more uniform and better prices, the price movement in potatoes for the last ten years, 1907 to 1917, was studied.[1]

[1] Bull. of U. S. Bureau of Labor, Nos. 75, 81. 93, 99.
Bull. of U. S. Bureau of Labor Statistics, Nos. 114, 181 and 200. Wholesale Prices Series, Nos. 1, 4, 5.

The prices quoted are wholesale prices of the Chicago market for white potatoes of quality varying from good to fancy and from ordinary to fancy. The wholesale price quotations for 1907 to 1912, inclusive, were furnished by the secretary of the Chicago Board of Trade; those for 1913 to 1915 were taken from the Daily Trade Bulletin. The wholesale prices for 1916 were obtained from the 1916 Yearbook of the Department of Agriculture. The Chicago Packer was consulted for market quotations from Jan. 1, 1917, to date.

From a careful analysis of diagrams constructed from these statistics, annual, recurrent high level of prices is noted. This was not the case in 1915 and 1916, apparently, because of abnormal conditions in the supply of potatoes and the market. The maximum is reached between April and August,—some time in late spring or summer. May was the month of highest prices in potatoes in 1907 and 1909; April, in 1912; July, in 1911 and 1913; and August, in 1910. December was the month of highest prices in 1915, and second highest in 1916, with November leading for the year with a 2 cents per bushel margin. It was noted before that 1915 and 1916 did not show the normal price movement. The crest in 1917 seems to have been reached in May with an average of $2.89 for the month, and there is every indication that 1917 will show the same general characteristic movement as in the period from 1907 to 1914.

Between the annual crests there are, of course, annual troughs, that is, intervals of low prices. It is difficult to determine the months which inaugurate these periods and the months in which prices begin to ascend. It seems that the ascent in some years is more rapid than the descent; in other years this condition is reversed. In general, the time of low prices extends from August, September, or October to March or April. In some years this period is advanced one or two months, and in other years it is retarded by the same number of months. Again, it seems that the annual interval of low prices has a slight trend upward for the crop seasons of 1907, 1908, 1910, 1911, and 1913, and a trend downward for those of 1909 and 1912, with that of 1914 more or less stationary. It is hard to predict with certainty that higher prices will prevail at the end of a period of storage than at the beginning. During 1915 and 1916 prices showed a steady upward trend throughout the year. Thus spring prices were greater than those prevailing during the preceding autumn.

By computing an average monthly price for the entire interval from 1907-1917, it is found that June, with a ten-year average of 97 cents per bushel is the highest month of the year. May is second at 90 cents. The average for October, the principal harvest month for northern potatoes, is 63 cents. It is the lowest month of the year, the price being 34 cents per bushel under the average June price. November and December averaged 64 cents and 65 cents per bushel respectively, during the period from 1907 to 1917. By the following January an average of 71 cents was reached, while in April the price was 85 cents for the ten years under consideration. It can thus be definitely stated that over a long period of years the prices ruled lower in October, November and December than in the remaining months. Individual years, as shown above, will show some divergence from this general price movement. Figure 4 gives graphically the ten-year average wholesale price, per bushel for potatoes by months on the Chicago market.

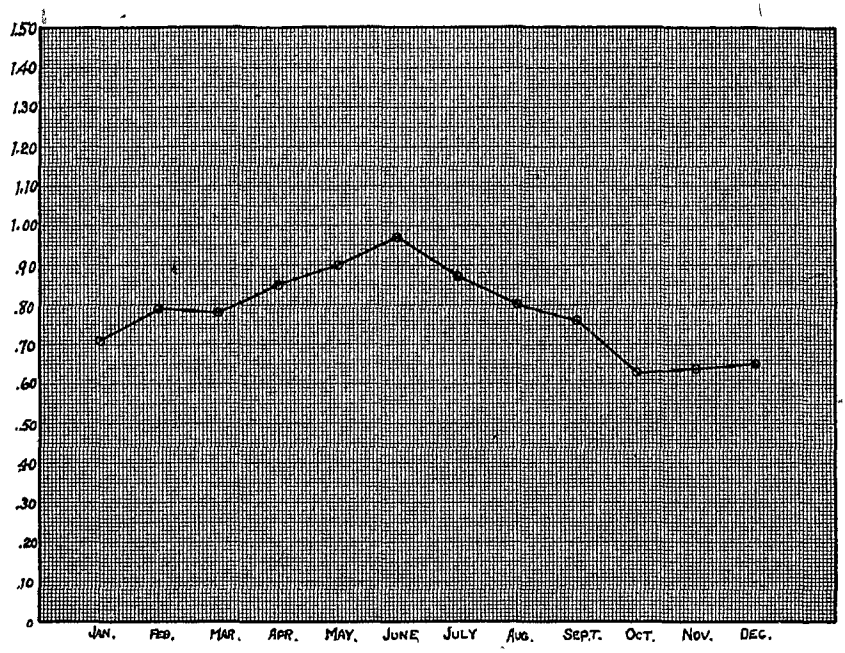

Figure 4. Wholesale Price of Potatoes by Months; Ten-year Average, 1910-1917, Chicago Market.

It is difficult to tell when to sell products, and it is extremely difficult in the case of a commodity which shows such fluctuating values as potatoes. The most that can be said is that for an average of years the price movement will be upward from harvest-time until the following spring. Some years, notably 1909 and 1912, have shown a decrease. If farmers could afford to hold potatoes one or two months longer and realize a market at the annual recurrent crest for the year, which occurs some time in late spring or early summer, considerably more profit could be realized from the potato crop. Against this, however, must be balanced the inferior condidition of potatoes, the loss through shrinkage, decrease in quality, rots, and frozen and sprouted stock. Considerable labor is also involved in storing and later hauling to market under perhaps unfavorable road conditions.

Again, the preference expressed for new potatoes by consumers who are willing to pay a premium for them largely results in increased prices which do not necessarily represent the market for old stock. Both new and old potatoes are arriving on the principal produce markets in June and July, and a composite price representing the prevailing market conditions will be appreciably above quotations on old stock.

However, farmers must not make the mistake of thinking that storage is unnecessary and that because prices year after year do not rule very considerably higher in the spring than in the fall there is no need for storage. On the contrary, if it were not for storage, prices in the past years would have been abnormally low at harvest and abnormally high in the spring. With additional storage facilities the now fluctuating price movement in potatoes can be much smoothed out. If sufficient potatoes could be held over for use in early summer, the annual recurrent crest would be largely eliminated. In this way potato growers would receive a higher average price for their product throughout the year, while consumers, on the other hand, would not be obliged to pay relatively high prices for potatoes in spring and early summer.

Wholesale Price of Potatoes on the Chicago Market, U. S. Bureau of Labor Statistics 1907-1917

	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	Avg. 1907-1917
Jan.	$0.39	$0.59	$0.70	$0.45	$0.42	$0.97	$0.47	$0.65	$0.40	$1.05	$1.76	$0.71
Feb.	0.42	0.67	0.82	0.38	0.44	1.03	0.46	0.65	0.41	1.05	2.38	0.79
March	0.41	0.68	0.85	0.34	0.40	1.25	0.44	0.62	0.37	0.93	2.38	0.78
April	0.43	0.67	1.00	0.22	0.53	1.43	0.40	0.68	0.40	0.80	2.79	0.85
May	0.63	0.66	1.06	0.25	0.49	1.37	0.48	0.72	0.42	0.95	2.89	0.90
June	0.51	0.96	0.83	0.19	1.20	1.20	0.65	1.00	0.34	1.08	2.76	0.97
July	0.36	0.92	0.66	0.44	1.28	0.77	0.78	1.20	0.44	0.85	1.88	0.87
Aug.	.....	0.76	0.50	0.79	1.21	0.74	0.73	0.78	0.47	1.27	.....	0.80
Sept.	.....	0.69	0.54	0.74	0.86	0.65	0.77	0.73	0.40	1.48	.....	0 76
Oct.	0.56	0.61	0.45	0.52	0.68	0.50	0.61	0.46	0.49	1.45	.....	0.63
Nov.	0.54	0.64	0.34	0.41	0.75	0.51	0.65	0.41	0.56	1.60	.....	0.64
Dec.	0.52	0.67	0.38	0.38	0.84	0.47	0.61	0.36	0.73	1.58	.....	0.65
Avg.	$0.49	$0.71	$0.68	$0.42	$0.77	$0.91	$0.61	$0.69	$0.45	$1.17	.....	$0.78