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Factors Affecting Sweet
Potato Prices in
Missouri

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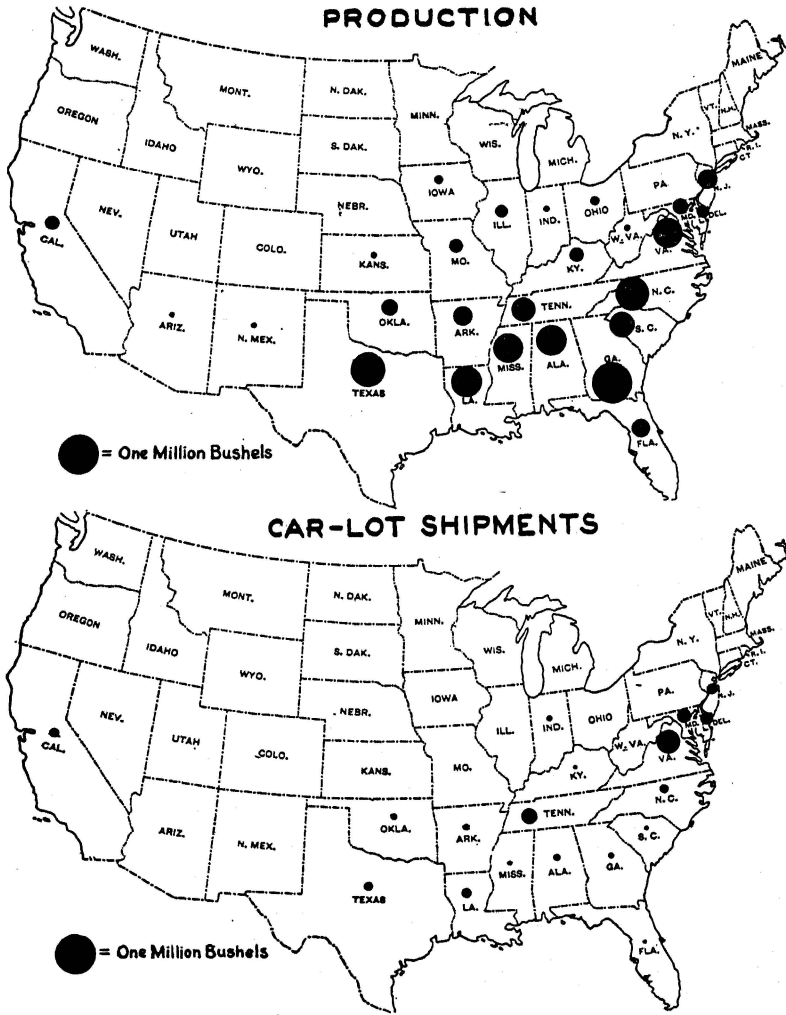


Fig. 1.—Production and Carload Shipments of Sweet Potatoes, 1928.

Factors Affecting Sweet Potato Prices In Missouri

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In the counties along the Missouri River from Kansas City to Dalton, containing relatively large areas of light textured soils, much interest has been shown in the possibilities of commercial sweet potato production. The success of this proposed new enterprise would depend upon: (1) adaptability of the soil and other factors to the production of a high-quality dry-flesh sweet potato at a cost of production per bushel which compares favorably with competing sections; (2) market or price prospects for sweet potatoes of that type from this region.

Production conditions apparently are favorable. Information relating to the growing and marketing of sweet potatoes is available elsewhere. It is the purpose of this publication to answer the second question regarding market or price prospects. In doing so it was found that little definite information on the factors affecting sweet potato prices was available from other sources. Hence it was necessary to make a general analysis of these factors, with particular reference to Missouri conditions. The results are largely applicable to other states. For this reason some of the more technical phases of the analysis, which may not be clear to the non-professional reader, have been included in this bulletin. This will not prevent an understanding of the main points by farmers and others who are not interested in the methods used in their determination.

Producing and Consuming Sections

The states producing sweet potatoes may be divided into two main groups: (1) the southern states, including generally those south of the Mason-Dixon Line except the eastern shore of Virginia and Maryland. These states grow the moist-flesh or so-called yam type varieties (of which the Nancy Hall is best known in Missouri) because of the adaptability to southern soil and climatic conditions, and the preference for this type in the south. (2) The northern states which grow the dry-flesh or so-called Jersey type sweet potato. This group in turn may be sub-divided into the eastern seaboard states of Virginia, Maryland, Delaware and New

*The authors wish to acknowledge helpful suggestions by Messrs. F. H. Frame, C. H. Hammar, O. R. Johnson and J. T. Quinn, of the Missouri Agricultural Experiment Station, and Mr. Ross Silkett of the Wabash Railway.

Jersey, which are by far the more important commercially, and the north central states. California supplies the Pacific Coast region, and may be omitted from consideration east of the Rockies.

Missouri at present falls within the first or southern group of states, as sweet potato production is now mostly confined to the southeast section of the State, where the yam type is prevalent. However, in the proposed commercial section north of the Missouri River the dry-flesh varieties would be grown, and from the standpoint of commercial production Missouri would then be classified with the northern Jersey type states. This distinction, as will be shown, is very important.

While the southern states produce by far the largest proportion of the total sweet potato crop of the United States (84 per cent for the period 1921-29, excluding the Pacific Coast), they are not nearly so important in the carlot commercial trade, as shown by Figure 1. This is due to the very heavy local consumption of sweet potatoes in the south. Frequently, sweet potatoes are used for feed in that section. The principal states shipping the Jersey type, as shown by the chart, are Virginia, Maryland, Delaware, and New Jersey. Indiana is the only other northern state making extensive carlot shipments. Of the southern states, Tennessee is the principal shipping state, and is the main source of competition for sweet potatoes of the moist type in markets adjacent to Missouri.

The sources of supply for middle-western markets of interest to Missouri are shown in Figure 2. In this chart the states have been divided into four groups: (1) the eastern dry-flesh producing states; (2) the middle-western dry-flesh states; (3) the states adjacent to Missouri which ship the yam-type potato; and (4) the more distant southern states of less commercial importance.

It will be observed that the different markets vary widely in the proportion of unloads coming from these different sections. The approximate percentages may be read from the scale on the side of the chart. Minneapolis, for example, obtains nearly 80 per cent of its sweet potatoes from the Atlantic seaboard states producing the Jersey-type, while Detroit, much closer to that producing section, obtains from it only about five per cent of its supply. St. Louis and Kansas City both seem to favor the Nancy Hall yam-type sweets more than any other city in this group. Chicago, Missouri's largest potential market, takes about 60 per cent moist and 40 per cent dry varieties. It will be noticed that Chicago, Milwaukee, Omaha, Des Moines and Indianapolis obtain an appreciable percentage of their dry-type sweets from nearby

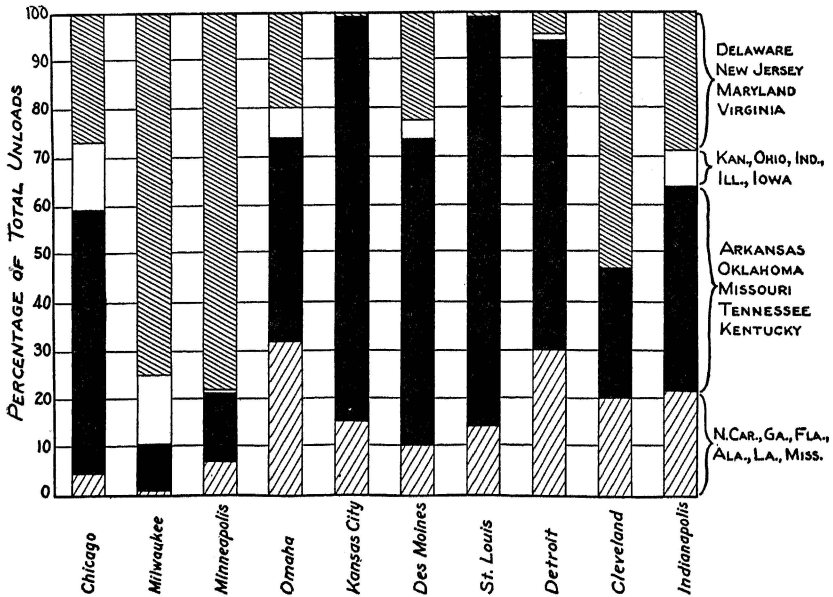


Fig. 2.—Carlot Unloads of Sweet Potatoes by States of Origin, at Ten Midwestern Markets, 1927 and 1928.

states, but in no case is this quantity equal to that coming from the east coast. Many other interesting features are to be found in a detailed study of this chart.

Price Differences by Types

While southern people like the moist-flesh type of sweet potato, consumers in carlot markets of the north, many of whom never tasted a properly cooked delicious candied yam, prefer the dry-flesh Jersey type. This preference, in conjunction with the relative supplies of the two types, has resulted in a very marked price difference in favor of the Jersey type. Since Missouri (north of the River) proposes to grow that type, this price premium is of great importance.

Market quotations in the trade papers and government reports by varieties are not entirely satisfactory, continuous, or even representative, because of the daily range of prices and differences due to grades. But they do demonstrate beyond question that the dry-flesh sweet potato almost always sells for an appreciably higher price. This is shown in Figures 3 and 4, based, respectively, on government and private market news service quotations for 1927

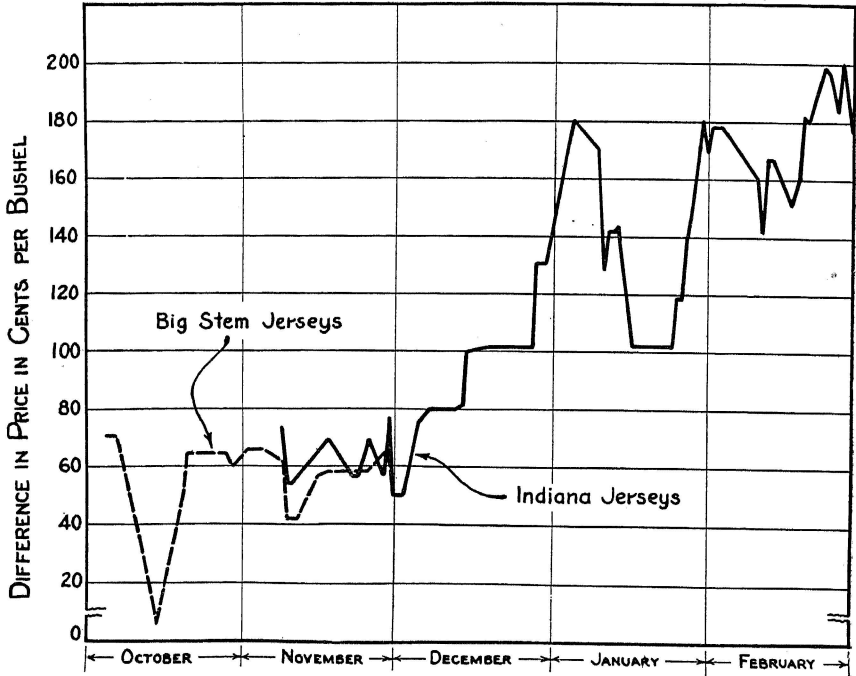


Fig. 3.—Margin in Price of Jersey Type over Tennessee Nancy Hall Sweet Potatoes on the Chicago Market, 1927, by Days. (Based on market news reports of the U. S. Dept. of Agriculture).

and 1930. It will be observed that the margin in favor of the Jersey type at times runs well over a dollar per bushel, and at no time after the middle of October was below 50 cents per bushel.

The difference in prices received by producers in the several production areas is even more significant, since they reflect, in addition to market prices, differences in transportation costs, quality, local demand, and other marketing conditions. These prices by sections are shown, for the individual years 1921 to 1929, in Figure 5. It will be noted that the mid-western states producing the dry-flesh type were consistently above any other group in prices received by producers.

Missouri Sweet Potato Prices

From the foregoing it is evident that the prices which Missouri producers of sweet potatoes may expect to receive in any given year will depend upon three things: (1) the general level of sweet

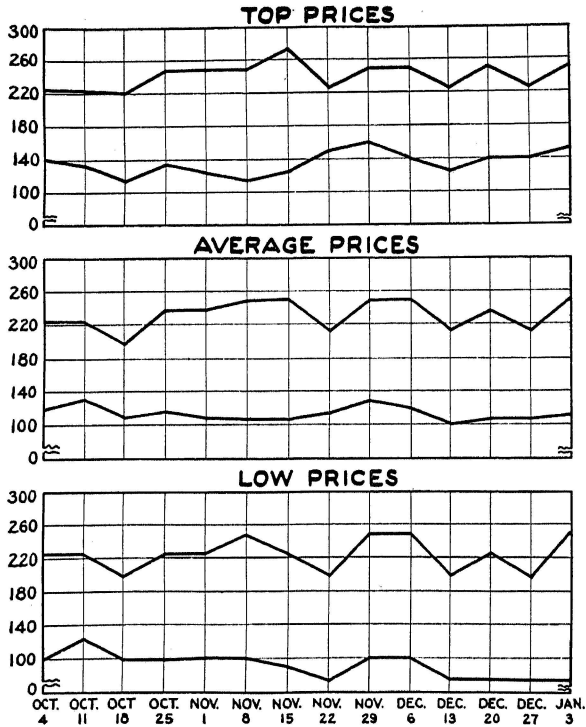


Fig. 4.—Margin in Weekly Prices of Jersey Type Sweet Potatoes Over Tennessee Nancy Halls, at Chicago, Based on Top, Low, and Average Prices (Quotations from the "Kansas City Packer").

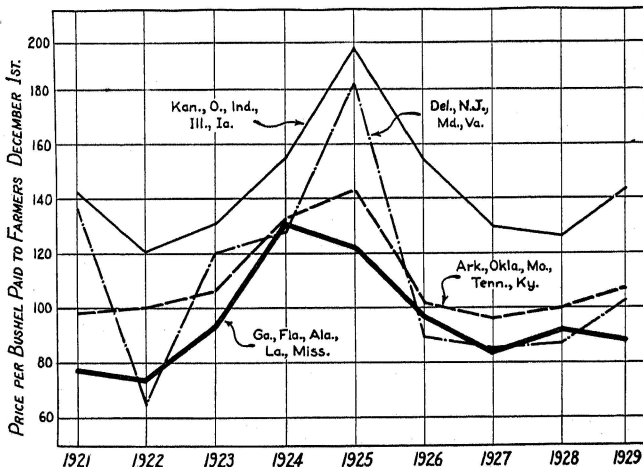


Fig. 5.—Prices Received by Producers for Sweet Potatoes, by Groups of States, 1921-29.

potato prices for the country as a whole: (2) the premium which the dry-flesh or Jersey type potato can command over the moist-flesh type; and (3) the relative advantage which Missouri sweets might have in mid-western markets, because of superior quality or pack, lower freight rates, or other marketing conditions. Since the latter would obtain in one year the same as another, the price outlook for any given year would depend on the factors affecting the general sweet potato price level and those determining the variety premium.

Factors Affecting Sweet Potato Prices

Prices of sweet potatoes in the United States are affected chiefly by the production of sweet potatoes and the price of white potatoes. For the years 1921-29 these two factors combined accounted for 92.65 per cent of the annual price changes.* If the years 1921-22-23 are omitted from the calculation an even higher percentage of the price variations are explained by the two factors, but this would not be justified, since other erratic years like 1923 are likely to be encountered in the future.

The extent to which the annual changes in price during the years 1921-29 were explained by these factors is shown graphically in section 3 of Figure 6, which gives the price as calculated from these factors compared with the actual price. It will be seen that the two were quite close together for most years. Of course, it is entirely possible that in future years a materially different relationship will obtain, just as it did in the war years preceding 1920.

As calculated mathematically by multiple correlation, 93.9 per cent of the price variations during this period of nine years were explained by the changes in sweet potato production and white potato prices.**

Changes in sweet potato production accounted for 60.6 per cent of the variations in sweet potato prices, while fluctuations in white potato prices explained 33.3 per cent.†

From the foregoing it is apparent that the outlook for sweet potato prices is closely related to that for white potatoes. The rea-

*As found by Bean's simplified graphic method of multiple curvilinear correlation (see Figure 6). The index of correlation was obtained by substituting values from curves in the formula:

$$P^2 = 1 - \frac{\sigma_z^2}{\sigma_{x_1}^2} \text{ or } P = \sqrt{1 - \frac{26.454}{360.90}} = .9626$$

This index, however, is conditioned by the small number of observations relative to the number of constants, and should be corrected for these factors. The corrected index of correlation is .9498. The percentage determination, 92.65, was obtained by squaring the uncorrected index.

**R = .969; corrected for number of variables and constants, R = .958. Comparison of the corrected index and coefficient indicates a linear relationship.

†Coefficients of determination.

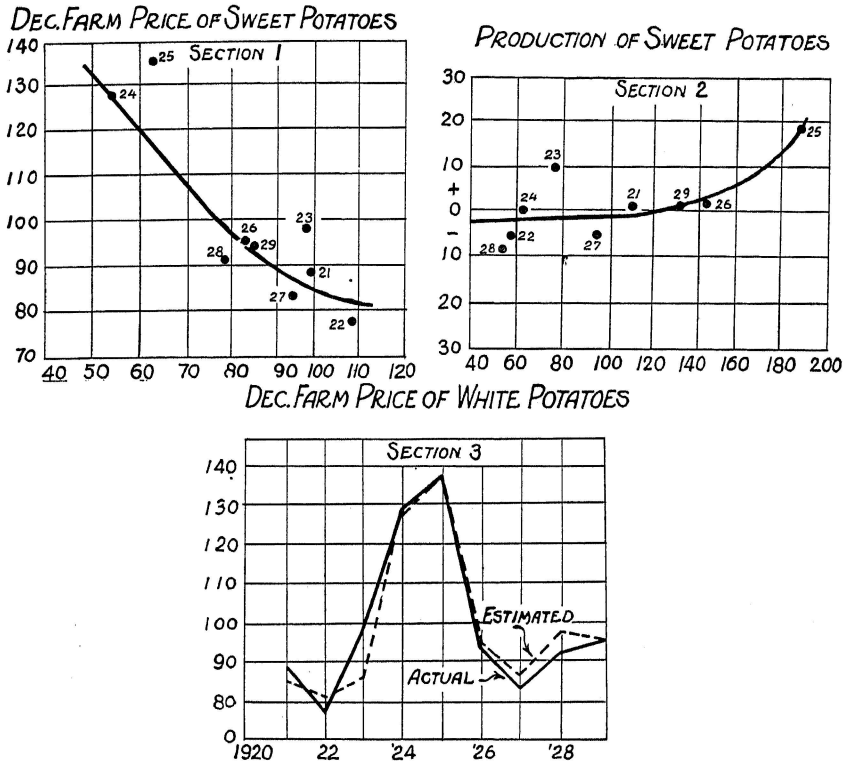


Fig. 6.—Effect on Price of Sweet Potatoes of Sweet Potato Production and White Potato Prices, and Comparison of Actual Prices with Price Estimated from These Two Factors, 1921-29.

son for this is that white and sweet potatoes may be substituted for each other. If white potatoes are low in price consumers are not willing to pay as much for sweet potatoes as they otherwise would, while high prices cause more of them to turn to sweets, increasing the demand for the latter. This relationship is shown more clearly in Figure 7, which includes a much longer period of years (1910-29). It will be noted that the range in price of white potatoes is considerably greater than that for sweets, indicating the greater price stability of the latter.

As a result of this relation between white and sweet potato prices we would expect to find a distinct relation between the production of white potatoes and the price of sweet potatoes. As a matter of fact, white potato production could have been substituted for white potato prices in Figure 6, with satisfactory results, and for

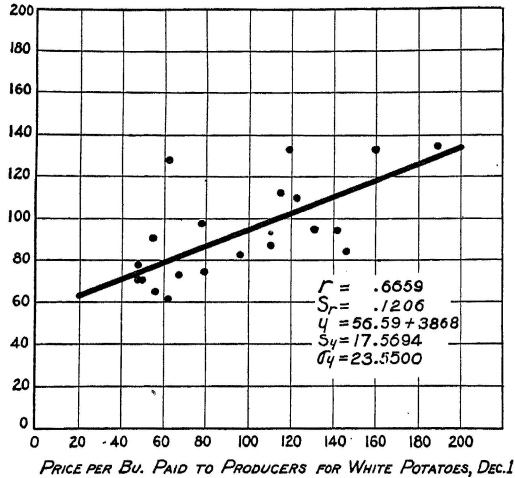


Fig. 7.—Relation between Prices of White and Sweet Potatoes, 1910-29.

the years 1924-29 the production of both kinds of potatoes almost fully accounts for changes in sweet potato prices. Increases or decreases in the production of sweet potatoes within the range encountered during the period included were more uniformly accompanied by corresponding changes in sweet potato prices than were changes in white potato production, the effect of which was more erratic from year to year. Very short crops of white potatoes seem to affect sweet potato prices about as much as proportionately small crops of sweet potatoes, but with crops above somewhat less than medium size, increases or decreases in white potato production have little effect on sweet potato prices.*

For those who find the foregoing discussion too technical, Figure 8 has been prepared. It will be seen that the price of sweet potatoes moved in a direction opposite to that taken by the production of sweet potatoes in six out of eight years. The same was true of sweet potato prices and white potato production, but the two "off" years in which prices and production did not maintain this relation were not the same for sweet potato and white potato production. In other words, in two years (1925 and 1929) the production of white potatoes declined sufficiently to more than offset an increase in sweet potato production, while in two other years (1924 and 1928) the production of sweet potatoes declined

*Based on comparison of supply-price curves, using sweet potato prices and production of sweet and white potatoes.

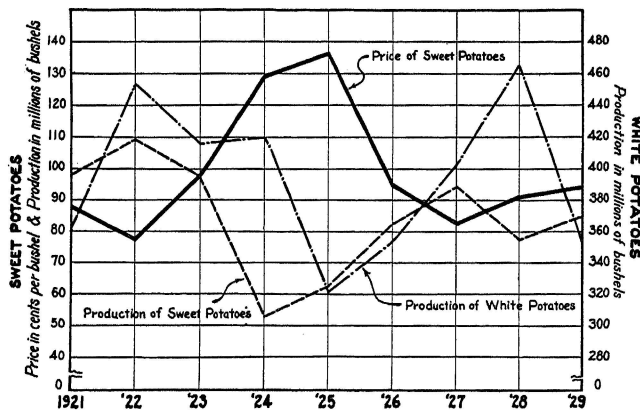


Fig. 8.—Relation between the Price of Sweet Potatoes and Production of White and Sweet Potatoes, 1921-29.

sufficiently to more than offset an increase in the output of white potatoes.

Factors Affecting the Production of Sweet Potatoes

Production, of course, is the result of only two factors, acreage and yield per acre. Since the yield cannot be forecast, the accuracy of any advance estimate of production is limited by the extent to which changes in acreage are responsible for the changes in production. This may be determined for the period of years included in the analysis by calculating what are called determination coefficients. By this means it is found that the net percentage influence on production of acreage and yield per acre, respectively, was 69.0 per cent and 29.8 per cent. The slight discrepancy between the total of these percentages and 100, results from the dropping of decimals and the use of round numbers in calculating total production and the percentages. Thus, it is evident that the more predictable factor, changes in acreage, resulting largely from producers' reactions to price stimuli, is the most important factor affecting variations in production. This naturally leads to the question, what are the factors which determine the acreage planted to sweet potatoes each year?

Factors Influencing Sweet Potato Acreage

The two most important factors influencing the acreage planted to sweet potatoes in the United States each year are the prices received for sweet potatoes and cotton the preceding year.

Cotton prices influence the acreage of sweet potatoes because the latter constitute a substitute crop. If cotton prices are low, southern farmers seek some more profitable outlet for their land and labor, turning to sweet potatoes among other crops. High cotton prices bring greater emphasis of that crop and neglect of alternative enterprises such as sweet potatoes. The influence of cotton prices was strikingly shown in the year 1923, when, despite a good price for sweet potatoes, the acreage was much reduced, as the result of high cotton prices prevailing. Examination of the statistics for individual years indicates that when sweet potatoes are above one dollar per bushel, further increases in price do not have an appreciable influence on acreage.

The combined effect of sweet potato and cotton prices on the acreage planted to sweet potatoes is shown in Figure 9. The two factors accounted for 99.98 per cent of the changes in sweet potato acreage during the period of years included, 1921-27.*

Section 3 of Figure 9 gives striking evidence of the completeness with which changes in sweet potato acreage were explained by these influences. It should be remembered, however, that as in the case of the two other similar charts, this is "back-casting" rather than forecasting, and that the relationship will not necessarily be as close in the future. Forecasts for the years 1928-29-30, based on the relationship existing from 1921-27, were almost 100 per cent accurate in two out of the three years, but the forecast for 1928 was materially off, due to the influence of other factors. This is shown in Section 3 in the portion labeled "forecast."

Forecasting the Average Price for Sweet Potatoes

Thus, it will be seen that we have two factors which in normal years indicate very accurately the prospective changes in sweet potato acreage. It has been previously shown that changes in acreage have accounted for approximately 69 per cent of the annual variations in production, which in turn explain about 60 per cent of the annual fluctuations in sweet potato prices. White potato prices, the other factor influencing sweet potato prices, may be forecast by methods worked out by other investigators. Therefore, by combining the proper values as determined in this manner according to the curves in Figure 6, we could make a quite definite forecast of sweet potato prices each year. This forecast, of course,

*The gross correlation obtained by substituting in the formula previously given was .9999, and after correcting for number of observations and constants, .9995.

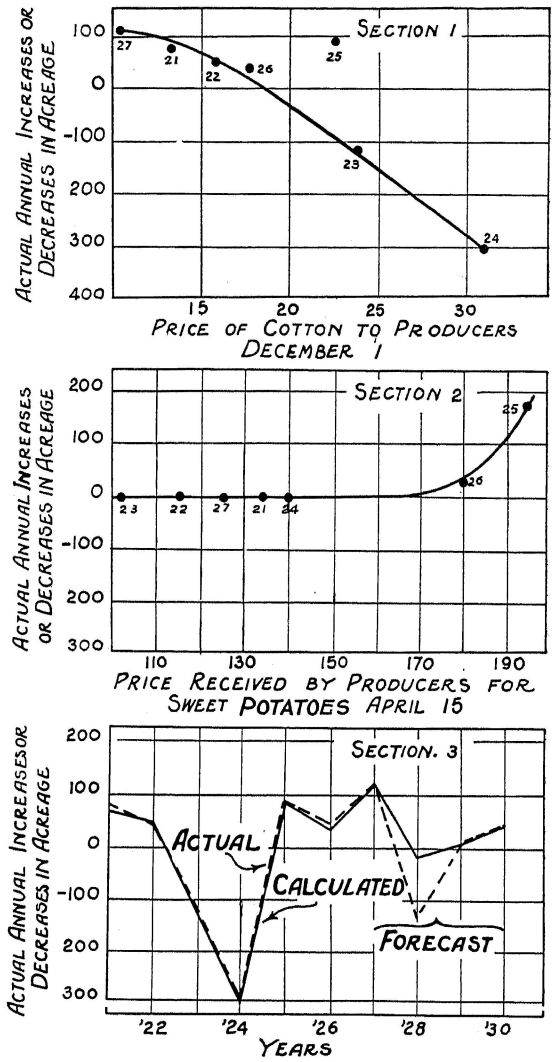


Fig. 9.—Factors Affecting Sweet Potato Acreage, 1921-27, and Three Year Forecast Based Thereon.

would be vitiated to the extent that the yield per acre of white or sweet potatoes deviated from the normal, and its accuracy would be further limited by the tendency for the relative importance of the different factors to change from year to year, and the possibility of new influences being introduced. Similar forecasts for other

commodities have proved unsatisfactory in the long run; hence, our estimate of the price outlook must be a matter of common-sense judgment, which is very materially aided by the knowledge of price-making forces resulting from the quantitative analysis of the factors involved.

Factors Affecting the Margin Between Dry and Moist Flesh Types

Figure 3, 4 and 5 indicated very clearly that an unfavorable outlook for sweet potato prices for the country as a whole would not necessarily apply in the same way to individual sections, such as north Missouri, where the dry-flesh type is to be produced. The expected premium for these varieties would also have to be considered. If this premium were the same from year to year, or in other words, if prices of the two types or in different sections moved up and down in approximate proportion, the general outlook for sweet potatoes would apply equally well to any type or state; but this is not the case. The difference in price received by producers in the southern and northern states varies considerably from year to year (see Figure 5), and hence must be taken into account in connection with the general outlook.

The chief factors which might be expected to influence this difference are: price of white potatoes, total production of sweet potatoes, ratio of production in dry-flesh states to production in yam states, and the ratio of carlot shipments from the dry-flesh states to shipments from yam states. Upon subjecting these and other factors to statistical analysis, it was found that most (97.76 per cent) of the annual variation in margin between the two types was accounted for by changes in the price of white potatoes and the ratio of production in the dry-flesh states to production in the yam states. This is shown in Figure 10. The actual margin and that estimated from the changes in these two factors practically coincide, the largest discrepancy for any one year being less than five cents per bushel, as shown by section 3 of Figure 10*.

The reasons for this marked relationship are fairly obvious. If white potato prices are high the sweets shipped from the dry sections to northern markets encounter less competition than with low white potato prices, and their price tends to be higher. The southern grown sweet potatoes, being shipped out in smaller proportion,

*The co-efficient of gross correlation obtained by substituting in the formula was .9887, indicating that 97.76 per cent of the changes in margin from year to year were explained by these two factors. The gross correlation corrected for number of observations and constants was .9849.

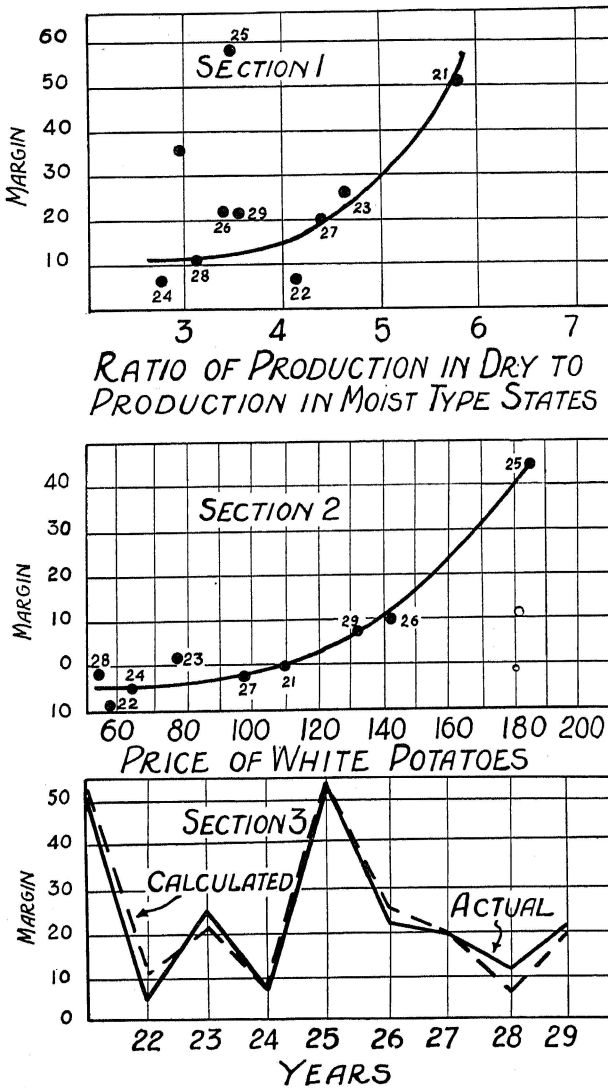


Fig. 10.—Factors Affecting Difference in Price between Dry and Moist Type Sweet Potatoes, with Actual Margins and Those Estimated from These Factors, 1921-29.

and occupying a more important place in the local diet than white potatoes, as compared to the north, are affected to a lesser extent. Hence, the margin between the northern and southern sweets in-

creases. Likewise, when production in the dry states is light relative to that in the southern states the resulting relative scarcity of the dry-flesh varieties on northern markets causes the margin to increase.

Seasonal Price Variations

It frequently happens, in connection with fruits and vegetables, that average prices for a season or the general price outlook for a commodity mean very little to individual producing sections, because of the marked seasonal variations encountered, and the varying times at which different areas come on the market. That seasonal price changes are important in the case of sweet potatoes is shown in Figure 11. The price normally starts to decline in September, and continues sharply downward until November or December, after which the trend is upward until the new crop starts moving. This price movement is largely the result of inverse changes in monthly shipments of sweet potatoes from producing sections.

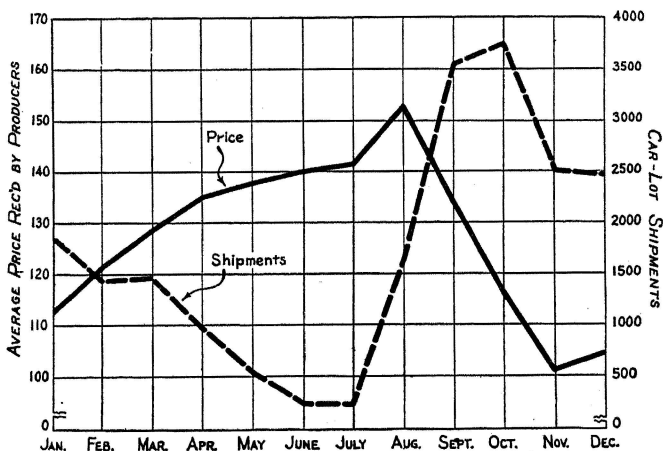


Fig. 11.—Seasonal Variations in Price and Shipments of Sweet Potatoes in the United States, 1921-29.

Since it has been contemplated that Missouri shipments be made immediately after harvest in the "green" state, this seasonal price movement is particularly important, although it applies to all sections with respect to the price advantages to be gained from storing. The Missouri crop, harvested from about the middle of September into November, under this method of handling would

reach the market during the peak movement for the country as a whole, and the months of low prices.

Because of the large proportion of total carlot shipments which originate in the Jersey type states on the east coast, the seasonal variation in weekly shipments by that group corresponds very closely with that for the country as a whole, as shown by Figure 12. The southern states can get on the market considerably earlier in the summer, as shown by the shipments from Tennessee. The latter state, principal shipper of the moist-type sweets

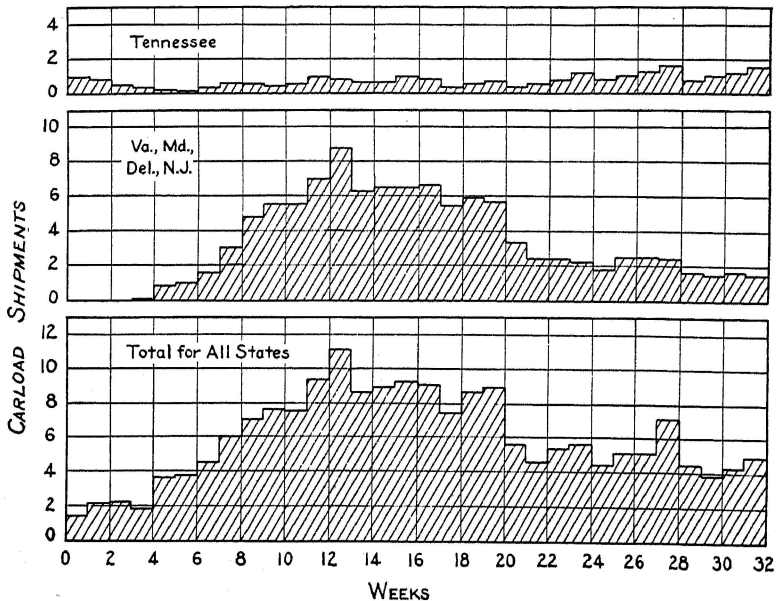


Fig. 12.—Weekly Shipments of Sweet Potatoes, July 2, 1927, to February 11, 1928, by Groups of States.

to northern central markets, has a relatively uniform distribution of shipments throughout the year, owing to the utilization of storage. Thus, Missouri would find itself in direct competition with other dry-flesh producing states during the fall months. Figure 3 indicates that the price margin of the dry over the moist flesh varieties is lowest during the fall months when Missouri's shipment, if made in the "green" state, would be greatest.

Since much of the output of the dry states is sold in the east, it is desirable to analyze the seasonal distribution of receipts at markets within reach of Missouri. This is shown in Figure 13.

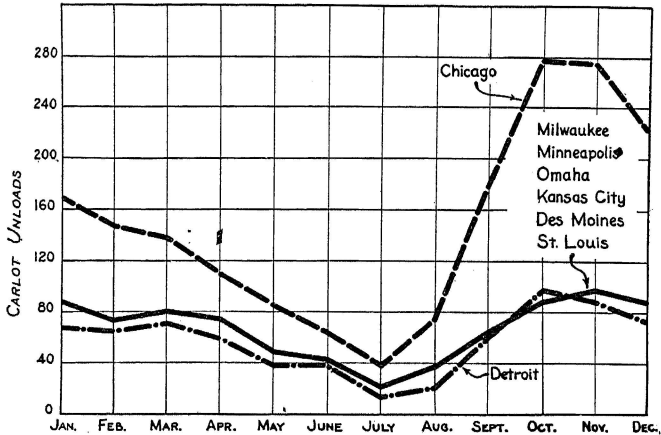


Fig. 13.—Seasonal Distribution of Sweet Potato Unloads at Leading Mid-western Markets, Average of 1927 and 1928.

Milwaukee, Minneapolis, Omaha, Des Moines, Kansas City, and St. Louis have been grouped together because of the relatively small number of unloads at those points, which about equal those for Detroit alone. It is noticeable that receipts at Chicago increase much more rapidly during the fall than is the case in the other markets. The movement to these mid-western cities is somewhat behind that of the country as a whole, not reaching a peak until October and November, during the two years included in the averages. This would give Missouri some chance of getting on the market with a portion of its crop before the peak load of receipts. Of course, the difference between these markets in receipts does not necessarily reflect similar differences in seasonal price variations on these markets, since prices at any one point are more or less governed by those at other markets.

Under these circumstances, it would seem advisable for Missouri growers to consider seriously the advisability of drying and storing a portion of the crop for marketing later in the season when prices are more favorable. If storing should be practiced, price forecasts based on the foregoing factors would be helpful in determining the best time to do so.

Differences in Freight Rates

The net prices received by sweet potato growers in north Missouri depend mainly upon the price at the market, but also upon

the cost of transportation. That Missouri producers would enjoy a considerable advantage in this respect over east coast producers is shown by a comparison of the rates to mid-western markets from representative points in Missouri, New Jersey and the eastern shore of Maryland and Virginia, given in the table below.

Freight Rates Per Hundredweight on Sweet Potatoes from Missouri and Competing States to Representative Mid-western Markets

| TO | FROM | | |
|-------------|-------------|----------------|--------------------|
| | Orrick, Mo. | Salisbury, Md. | Camden Jct., N. J. |
| Chicago | 33½ | 53½ | 54½ |
| Milwaukee | 33½ | 53½ | 54½ |
| Minneapolis | 35 | 75 | 76 |
| Detroit | 58 | 41 | 42 |
| Cleveland | 59 | 37 | 38 |
| Omaha | 26 | 96 | 97 |
| St. Louis | 26 | 63 | 64 |

Missouri has an advantage in shipments to all points west of Chicago, but would be at a disadvantage in Cleveland and Detroit, the latter an important sweet potato market. The difference in the rate to Chicago is roughly ten cents per bushel, while for markets west of Chicago it is greater. Such a differential might mean the difference between profit and loss for the producer, yet it might easily be overshadowed by other factors such as quality and time of coming on markets.

Summary and Conclusions

(1) A favorable outlook for the development of a commercial sweet potato industry in certain sections of north Missouri is indicated by a study of markets and prices, providing production conditions prove satisfactory.

(2) Sweet potatoes are of two general types, distinguished by their dry (Jersey) and moist (Nancy Hall, etc.) flesh. The southern states, growing the moist-flesh type, have the greatest production, but much of the crop is consumed locally, and carlot shipments are greatest from four dry-type states on the east coast. It is proposed that the dry-flesh type be produced in north Missouri.

(3) A distinct preference for the dry-flesh or Jersey type of sweet potato was found to exist in North Central markets, resulting in a material price premium for this type over the southern, or so-called yam-type varieties.

(4) The price received by Missouri growers would depend upon: (a) the general price level for sweet potatoes in the United

States, (b) the premium paid for the dry-flesh type, (c) freight rates, quality, and marketing efficiency.

(5) While over a period of years Missouri growers should enjoy a relatively favorable market situation, this would not exempt producers from the effects of supply and demand, and it is entirely probable that there would occur years of unsatisfactory prices, just as with any other commodity. Producers contemplating this enterprise should be familiar with the factors affecting sweet potato prices.

(6) The principal factors affecting sweet potato prices in the United States are the production of sweet potatoes and the price of white potatoes, which together accounted for 93.9 per cent of the annual price variations, the individual percentages being 60.6 and 33.3 per cent respectively. Changes in acreage and yield, respectively, were responsible for 69.0 and 29.8 per cent of the annual fluctuations in production of sweet potatoes, on the average. Variations in the acreage of sweet potatoes were explained almost completely (99.98 per cent) by producers' reactions to changes in sweet potato and cotton prices.

(7) By relating the factors responsible for price and acreage changes it is possible to make definite forecasts of sweet potato prices for the United States, but since the relative importance of the various factors may be materially altered for any one year, and it is impossible to forecast yields, the outlook must be based on a common sense interpretation which is greatly aided by a knowledge of how these forces have operated in the past.

(8) The price margin between the dry and moist flesh types was almost completely accounted for (97.76 per cent) by the price of white potatoes and the ratio of production in the dry type states to that in the moist type states. This margin practically always is in favor of the dry type, but varies considerably from year to year, and is highest in the late fall and winter.

(9) The seasonal variation in sweet potato prices is opposite to that of shipments. Prices generally start to decline in September, reach bottom in November or December, and rise gradually thereafter until the new crop begins to move. Shipments of "green" sweet potatoes from Missouri would reach the markets during the peak movement from other sections, suggesting the possible advantage of curing and storing.

(10) Missouri has an advantage over the principal Jersey type producing sections in freight rates to cities west of Chicago, but not to Detroit and similarly located markets. The advantage in the case of Chicago amounts to about ten cents per bushel.