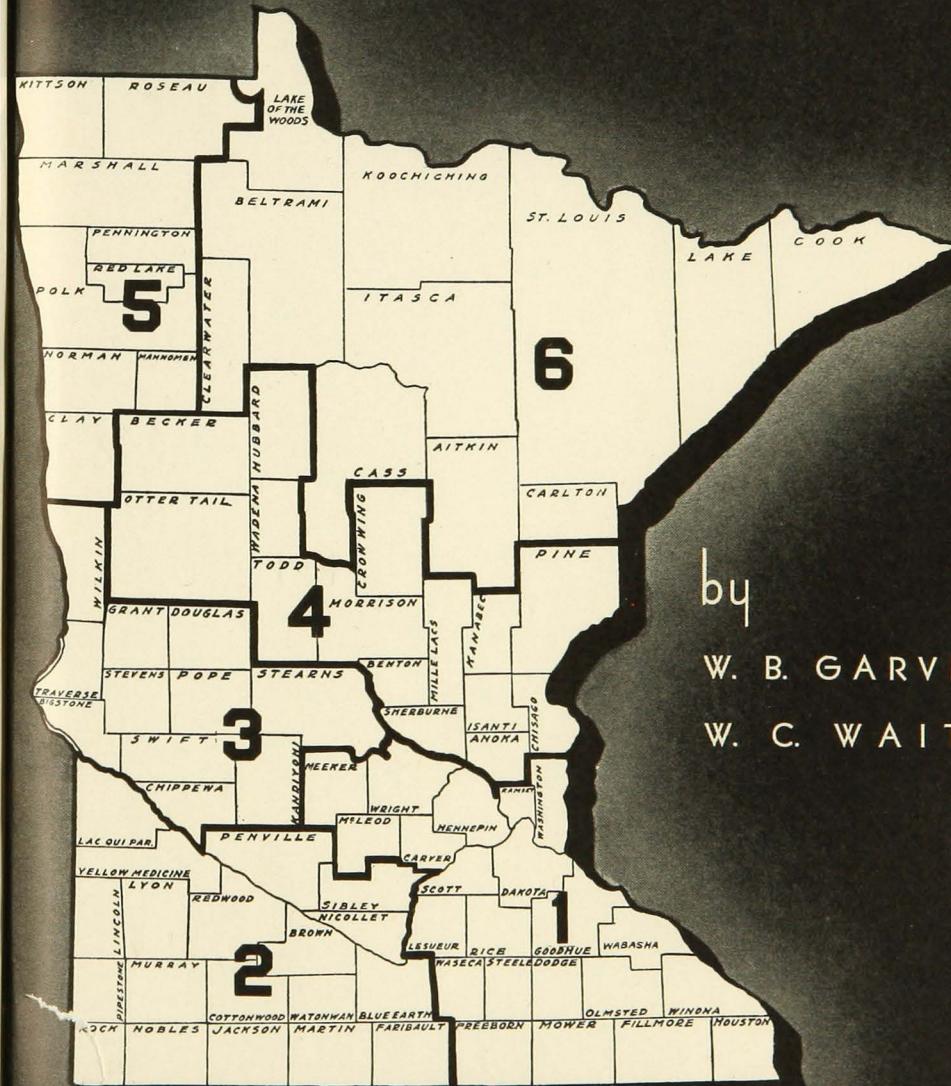


*District Indexes of  
Prices, Quantities and Values  
of Cash Sales of  
Minnesota Farm Products*



by

W. B. GARVEY

W. C. WAIT

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# Indexes of Agricultural Prices, Quantities, and Cash Sales for Six Districts of Minnesota<sup>1</sup>

WALTER B. GARVER and WARREN C. WAITE

The Division of Agricultural Economics for a number of years has computed index numbers of prices of farm products for the state. Because of the size of the state and the diversity of its agriculture, the situation in particular sections differs from that indicated by the state index. These differences have been especially marked during the unusual conditions of recent years. The purpose of this study is to show the variations in agricultural prices in different sections of Minnesota by means of index numbers. The estimates of quantities of sales necessary for weights in these indexes also have permitted the computation of indexes of quantities sold and gross cash income from the sales of the included commodities. The state has been divided into six areas on the basis of agricultural characteristics and indexes prepared for each area.

These indexes include 13 of the principal agricultural products of the state, namely, wheat, corn, oats, barley, rye, flax, potatoes, hogs, cattle, lambs-sheep, chickens, eggs, and butterfat. The prices are those reported to the Division of Crop and Livestock Estimates of the Bureau of Agricultural Economics as received by producers on the 15th of each month. The individual reports from the specified areas have been averaged for the area monthly price and the annual prices are weighted average prices for the year. The quantities are estimates of the marketings by the farmers in the particular areas. The prices multiplied by the marketings give the estimated gross cash sales of the commodity, for the year. The indexes are of the so-called Fisher "ideal" type, in which the price index multiplied by the quantity index yields the value index.

These indexes do not represent the marketings of all agricultural commodities. The 13 included items, however, contributed about 90 per cent of the sales of agricultural products in the state and are all the items for which reasonably adequate data are available on a district basis. A number of minor crops have been omitted, among the more important of which are market milk, hay, calves, clover seed, and fruits and vegetables. In certain areas each is of importance, but for the state as a whole they are relatively unimportant as compared with the income from the 13 included items. The price indexes are probably not greatly different than they would have been if all the omitted items had been included. Most of the excluded items tend to fluctuate in price in a manner

<sup>1</sup> We are indebted to Mr. Paul H. Kirk, Statistician, Minnesota Crop Reporting Service, and the Division of Crop and Livestock Estimates of the U. S. Department of Agriculture for access to the basic data. Completion of the study was made possible by workers supplied on Project 4841, Sub-Project 420, Minnesota Works Progress Administration. Sponsor: University of Minnesota.

similar to the included items; for example, milk for cheese and butterfat and prices of calves and beef cattle. Notation has been made in the subsequent analysis wherever the omissions are thought to be important. No allowance has been made in the estimates of income either for the value of farm products used by the family or for changes of inventory value of livestock or crops.

### VARIATIONS IN THE STATE AS A WHOLE

The level of agricultural prices in Minnesota has varied materially during the last 12 years. Using 1924-1925-1926 as the base, the index of prices declined from 105 in 1929 to a low of 41 in 1932 and subsequently rose to 78 in 1935. The indexes of prices, quantities, and cash

income from sales for the state are shown in Figure 1. The index of gross cash sales follows the variation in the index of prices closely since the total quantities of products sold do not appear to have varied greatly during the period, except for drouth.

Corresponding indexes have been computed for each of the three principal groups of products included in the total index, namely, crops, livestock, and livestock products. The crop index includes wheat, corn, oats, barley, rye, flax, and potatoes. The livestock index includes hogs, cattle, and lambs-sheep. The livestock products index includes butterfat, chickens, and eggs. These indexes are shown in Figure 2. The individual indexes of quantities sold show some striking changes in the character of agricultural production in the state. The quantity

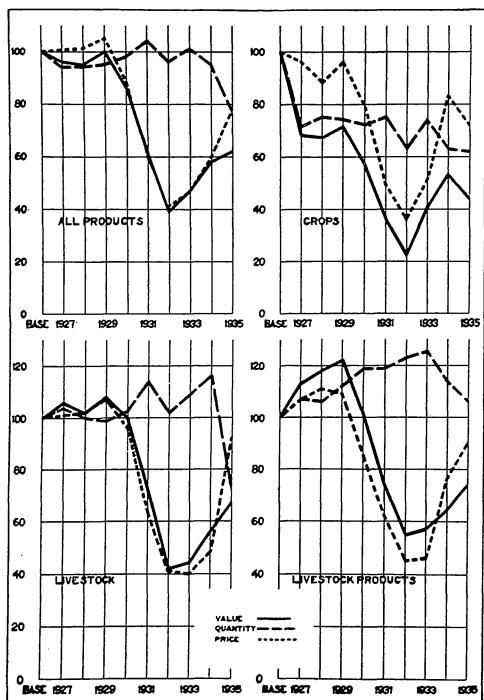


FIG. 1. STATE INDEXES OF AGRICULTURAL PRICES,  
QUANTITIES SOLD, AND VALUES OF SALES  
FOR ALL PRODUCTS AND VARIOUS  
CLASSES OF PRODUCTS,  
1924 TO 1935

index of crop sales was below 75 for the period from 1927 to 1935. The quantity index for livestock sales increased considerably following 1930. The quantity index of livestock product sales increased throughout most

of the period, especially during the early part. It reached 124 by 1933, but declined to 106 for 1935, due to the drouth. The index of crop prices was somewhat lower between 1926 and 1932 than the indexes of livestock prices and livestock product prices. The decline in prices in each group was sufficient to reduce the income greatly. The decrease in the quantity of crops marketed and the relatively larger decline in crop prices combined to result in a greater decline in the income from crops than from either livestock or livestock products. In 1932, because of smaller marketings and lower prices, the income from crop sales was only about 22 per cent of that in the base period. The income from livestock sales in the same year was 42 per cent of that in the base period, and for livestock products, 55 per cent.

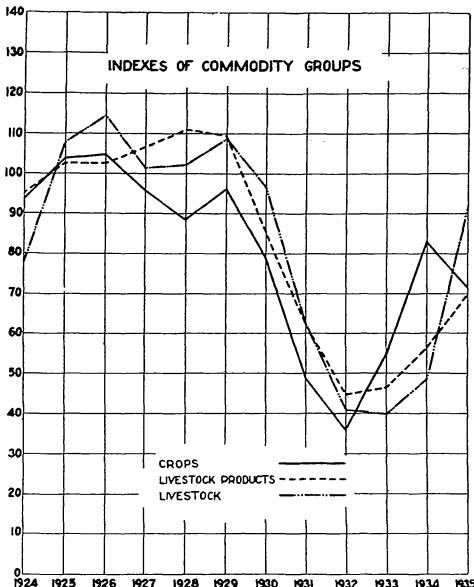


FIG. 2. STATE INDEXES OF PRICES OF CROPS,  
LIVESTOCK, AND LIVESTOCK PRODUCTS,  
1924 TO 1935

### CHARACTERISTICS OF THE DISTRICTS

District indexes of prices, quantities sold, and value of gross cash sales of the 13 agricultural products have been computed for six districts or areas of the state. The division of the state into these six districts is shown by the map on the cover of the bulletin. Some of the differences in the agricultural characteristics of the districts are shown in Table 1, which gives the proportion of income derived from each of the three groups—crops, livestock, and livestock products—for the period 1924 to 1935.

District I includes 22 counties located in the southeast section of the state. About four fifths of the value of sales in this district were from livestock or livestock products and one fifth from the sales of crops. The inclusion of income from market milk would have made the relative importance of livestock products even greater than it appears. Crop sales were fairly evenly distributed among the small grains. District II includes 19 counties in the southwest section of the state. This region is one of the most important livestock areas of the state, nearly half of the income of the area coming from the sale of livestock. Sales of cash grain

are also important, accounting for over one fourth of the estimated income. District III includes 11 counties in the west central part of the state. In this area the sales are fairly evenly divided among the three groups of products. District IV contains 15 counties in the north central part of the state. In this area livestock products are of predominant importance, constituting over half the income and relatively more than half if allowance were made for market milk income, which is important in this district. District V contains 9 counties in the Red River Valley area in the northwest section of the state. Here crop sales are of great importance, furnishing over half of the income. District VI contains 11 counties in the north and northeastern section of the state. Livestock products are the major source of income, furnishing close to three fifths of the income. In general, the proportion of income from the sale of crops is greater in the western half of the state than in the eastern half, although it constitutes more than one third of the income only in the northwest. A relatively larger proportion of the income is from livestock products in the eastern half of the state than in the western half, and livestock are a relatively more important source of income in the southern than in the northern half of the state.

**Table 1. Proportion of Gross Cash Sales of 13 Principal Agricultural Products Derived from Crops, Livestock, and Livestock Products in Six Districts of Minnesota, 1924-1935**

District	Proportion of total estimated income derived from—		
	Crops	Livestock	Livestock products
I .....	per cent	per cent	per cent
I .....	18	44	38
II .....	29	48	23
III .....	32	37	31
IV .....	20	27	53
V .....	54	21	25
VI .....	15	28	57
State .....	27	40	33

Not only do the proportions of the district incomes derived from these groups vary, but the proportion of the income from each commodity contributing to these groups varies among the districts. The greatest variation was in the case of crops. This is shown in Table 2 and in Figure 3.

**Table 2. Relative Importance of Seven Crops in Gross Cash Crop Sales in Six Districts of Minnesota, 1924-1935**

District	Proportion of income from crop sales derived from—						
	Wheat	Corn	Oats	Barley	Rye	Flax	Potatoes
I .....	per cent	per cent	per cent	per cent	per cent	per cent	per cent
I .....	34	8	11	12	6	12	17
II .....	16	34	20	10	3	16	1
III .....	35	9	15	11	4	21	5
IV .....	23	1	6	3	12	6	49
V .....	39	0	10	11	5	16	19
VI .....	9	0	5	2	3	8	73

Wheat was an important cash crop in all districts except VI during this period and was the most important single cash crop in Districts I, III, and V. Potatoes constituted the major source of crop income in Districts IV and VI, and were also of some importance in I and V. Sales of corn were of importance as a source of crop income only in District II, where they constituted about one third of the sales of crops. Flax is of importance in all except the two districts, IV and VI. Barley supplied as much as 10 per cent of the income from the sale of crops only in Districts I, III, and V, and rye only in District IV.

The composition of the income from the sales of livestock in each district is shown in Table 3. Hog sales are of greatest relative importance in the southern part of the state and gradually decline and are replaced by cattle toward the north. Hogs made up two thirds of the livestock income in Districts I and III and nearly three fourths of the income in District II. The income from cattle and hogs was about equally divided in District IV, and cattle furnished the major portion of the livestock income in Districts V and VI. Sheep were relatively unimportant in all the districts, exceeding 10 per cent of the livestock income only in Districts V and VI.

Table 3. Relative Importance of Hogs, Cattle, and Lambs-Sheep in Gross Cash Sales of Livestock in Six Districts of Minnesota, 1924-1935

District	Proportion of income from livestock product sales derived from—		
	Hogs	Cattle	Lambs-Sheep
I	65	32	3
II	73	25	2
III	63	34	3
IV	46	47	7
V	34	50	16
VI	27	59	14

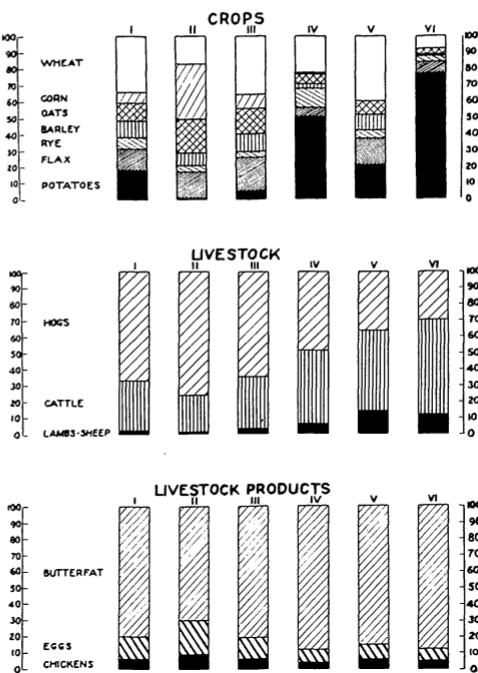


FIG. 3. RELATIVE IMPORTANCE OF PRODUCTS AS A SOURCE OF INCOME IN VARIOUS DISTRICTS OF MINNESOTA, 1924 TO 1935

In the income from the livestock products considered, butterfat predominates in all the districts, ranging from 69 per cent of the total from livestock products in District II to 88 per cent in Districts IV and VI. These data are given in Table 4.

**Table 4. Relative Importance of Butterfat, Chickens, and Eggs in Gross Cash Sales of Livestock Products in Six Districts of Minnesota, 1924-1935**

District	Proportion of income from livestock product sales derived from—		
	Butterfat	Chickens	Eggs
I .....	78	6	16
II .....	69	9	22
III .....	81	6	13
IV .....	88	4	8
V .....	85	6	9
VI .....	88	5	7

An analysis of the probable importance of other items in the cash sales of the various districts indicates that the items included in the index constitute over 90 per cent of the total income of Districts II, III, IV, and V. In District I, where market milk and truck crops are of importance, the included items still constitute more than 80 per cent of the total income, and in District VI about 75 per cent of the income is accounted for by the included items, much of the balance coming from the sale of forest products.

The distribution among the six districts of the income from sales of the 13 commodities, by groups, is shown in Table 5. Almost two thirds of the income from the 13 commodities was produced in Districts I and II. Each of these districts is nearly as important as a source of income as the remaining four districts of the state. Districts I and II accounted for nearly three fourths of the total income from livestock sales.

**Table 5. Relative Importance of the Six Districts in the Total Estimated Income from Sales of 13 Commodities, 1924-1935, by Groups**

District	Crops	Livestock	Livestock products	Total, 13 commodities
	per cent	per cent	per cent	per cent
I .....	19	31	32	28
II .....	37	42	24	35
III .....	15	12	12	13
IV .....	10	9	21	13
V .....	17	4	6	8
VI .....	2	2	5	3
Total .....	100	100	100	100

### DISTRICT PRICE INDEXES

The district price indexes are shown in Table 6 and in Figure 4. The general broad movement of prices in all the districts is much the same. There was a marked decline from 1929 to 1932, with a subsequent

rise. There were, however, some important differences between districts, occasioned largely by the difference in products sold. As is indicated in Figure 2, the index of crop prices for the state was considerably lower between 1927 and 1932 than the state indexes of livestock and livestock products. In consequence, in the districts where a large proportion of the sales are of crops, we find the indexes low relative to the districts in which a large portion of the sales are from livestock and livestock products. For example, the index for District V, in which over 50 per cent of the sales were of crops, was the lowest district index in the period from 1928 to 1932, while the index for District VI, in which 85 per cent of the sales were of livestock and livestock products, was the highest of the district indexes from 1928 to 1932. The difference between the indexes in these two districts amounted to 15 points in 1928 and did not change greatly until 1932. The increase in grain prices relative to livestock and livestock product prices carried the index of District V above that of District VI in 1933. The range in the index is greater in Districts IV and V than in the other districts.

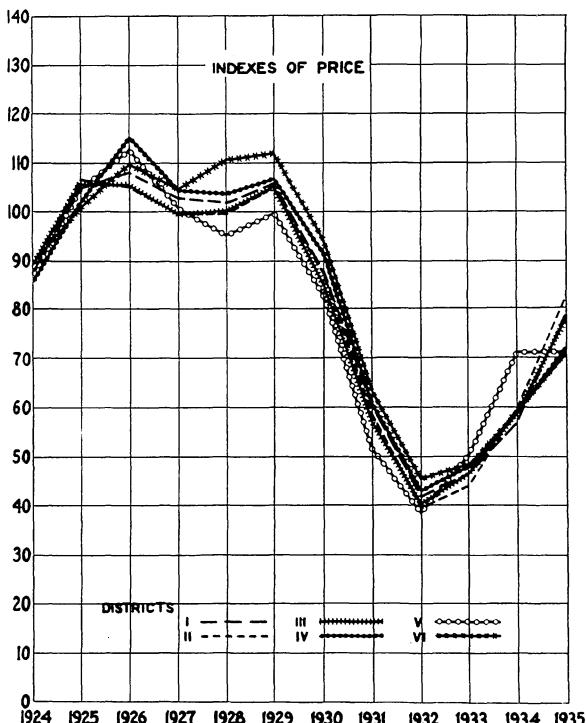


FIG. 4. INDEXES OF AVERAGE ANNUAL AGRICULTURAL PRICES  
FOR SIX DISTRICTS OF MINNESOTA, 1924 TO 1935

Using 1924-1925-1926 as a base for the districts and considering the weighted average price in this period as 100 for each district does not mean that the prices in all districts were the same. There are well defined differences in prices in various areas of the state arising from such things as differences in transportation costs, qualities of products, and whether the area is a surplus or deficit region for the particular product. These differences have been described in some detail in Minnesota Bulletin 303, "Local Prices of Farm Crops in Minnesota," and Bulletin 316, "Local Prices of Livestock Commodities in Minnesota."

**Table 6. Annual Indexes of Agricultural Prices for Six Districts of Minnesota, 1924-1935 (1924-1925-1926=100)**

Year	District						State
	I	II	III	IV	V	VI	
1924 .....	88	89	89	85	87	90	88
1925 .....	105	106	105	101	104	101	105
1926 .....	108	105	105	115	112	110	108
1927 .....	103	100	100	104	101	104	101
1928 .....	102	100	100	104	95	111	101
1929 .....	106	105	105	107	100	112	105
1930 .....	88	88	85	92	83	94	88
1931 .....	60	59	57	61	52	63	59
1932 .....	42	39	40	43	39	45	41
1933 .....	47	44	46	48	50	48	46
1934 .....	57	60	59	59	71	59	60
1935 .....	79	83	78	72	71	71	78

The district average prices for the years 1924-1925-1926 are shown in Table 7 for the various commodities. These differences are in general typical of most of the years of the period covered by the indexes, except for potatoes, which vary widely in the different years.

**Table 7. District Weighted Average Prices for 13 Agricultural Commodities for Six Districts in Minnesota, 1924-1925-1926**

	District					
	State	I	II	III	IV	V
Wheat .....	\$ 1.34	\$ 1.32	\$ 1.34	\$ 1.36	\$ 1.34	\$ 1.34
Corn .....	.69	.76	.68	.70	.72	.85
Oats .....	.36	.38	.36	.36	.36	.34
Barley .....	.59	.62	.58	.59	.59	.57
Rye .....	.85	.86	.85	.85	.84	.85
Flax .....	2.26	2.28	2.25	2.26	2.26	2.26
Potatoes .....	.86	1.05	1.02	.91	.83	.79
Hogs .....	9.95	10.30	9.92	9.74	9.38	9.13
Cattle .....	6.05	6.27	6.67	6.14	4.80	5.39
Lambs-Sheep .....	11.12	11.08	11.10	11.12	11.14	11.16
Chickens .....	.17	.18	.17	.16	.15	.15
Eggs .....	.25	.26	.25	.24	.25	.24
Butterfat .....	.44	.45	.42	.42	.45	.41

In ordinary years reported prices of grain tend to be somewhat higher in the eastern part of the state than in the western part and are usually relatively high in District VI, which is largely a deficit area. Thus, Districts I and VI are likely to be relatively high and Districts II and V relatively low. The differences amount to around 5 to 10 cents in the case of wheat, corn, rye, and flax, around 5 cents for oats, and 10 cents or more for barley. Potatoes vary widely between years, with differences as large as 50 cents a bushel, but usually Districts I, II, III, and VI are above IV and V in price. The differences in hogs and cattle are more marked. Hogs show a variation of from 80 cents to a dollar, with prices relatively high in District I and low in Districts IV and V. Cattle may vary by as much as \$2 with the highest prices generally reported from District II and the lowest prices in Districts IV, V, and VI. These differences are largely occasioned by types of animals sold. The variation is small in the case of sheep, usually amounting to about 10 cents. With chickens and eggs the differences amount to 5 cents or less, with Districts I and VI relatively high-priced. Butterfat varies by about 4 cents or less per pound, with the highest prices usually reported in Districts I and IV.

**Table 8. Annual Indexes of Physical Quantities of 13 Agricultural Commodities Sold in Six Districts of Minnesota, 1924-1935 (1924-1925-1926=100)**

Year	District						State
	I	II	III	IV	V	VI	
1924 .....	101	103	107	100	107	97	103
1925 .....	100	99	104	102	101	99	100
1926 .....	99	99	89	96	91	102	97
1927 .....	100	92	87	101	86	108	94
1928 .....	95	95	88	100	85	104	94
1929 .....	97	100	84	96	81	102	95
1930 .....	104	103	90	93	82	99	98
1931 .....	106	106	95	102	100	115	104
1932 .....	100	98	85	98	87	112	96
1933 .....	110	109	74	95	94	113	101
1934 .....	100	102	51	91	121	131	95
1935 .....	78	78	59	87	90	118	78

It is impossible to state precisely the influence of these differences in price on the cash income of farmers in the various districts. If, however, we assume that all farmers throughout the state had sold commodities in the same proportion as the state sales in the base period and that their total sales had been equal to the average farm sales for the state, the price differences in the base period would have been sufficient to result in a maximum spread of about \$150 in the yearly cash sales per farm between districts. Farms in District I would have had the highest income and those in District V the lowest. The other districts would have been very close to the state average.

Such marked variation in the quantities sold in the different districts necessitates further examination. In Tables 9 to 11 are given indexes for each district for the three principal categories of sales: crops, livestock, and livestock products. In general, the directions of the trends are the same in each district, but there is a marked difference in the rate of change.

The most marked tendency was the decline in the quantities of crops sold, occurring throughout the period from 1924 to 1935. This decline occurred in all districts but was especially marked in Districts III and IV.

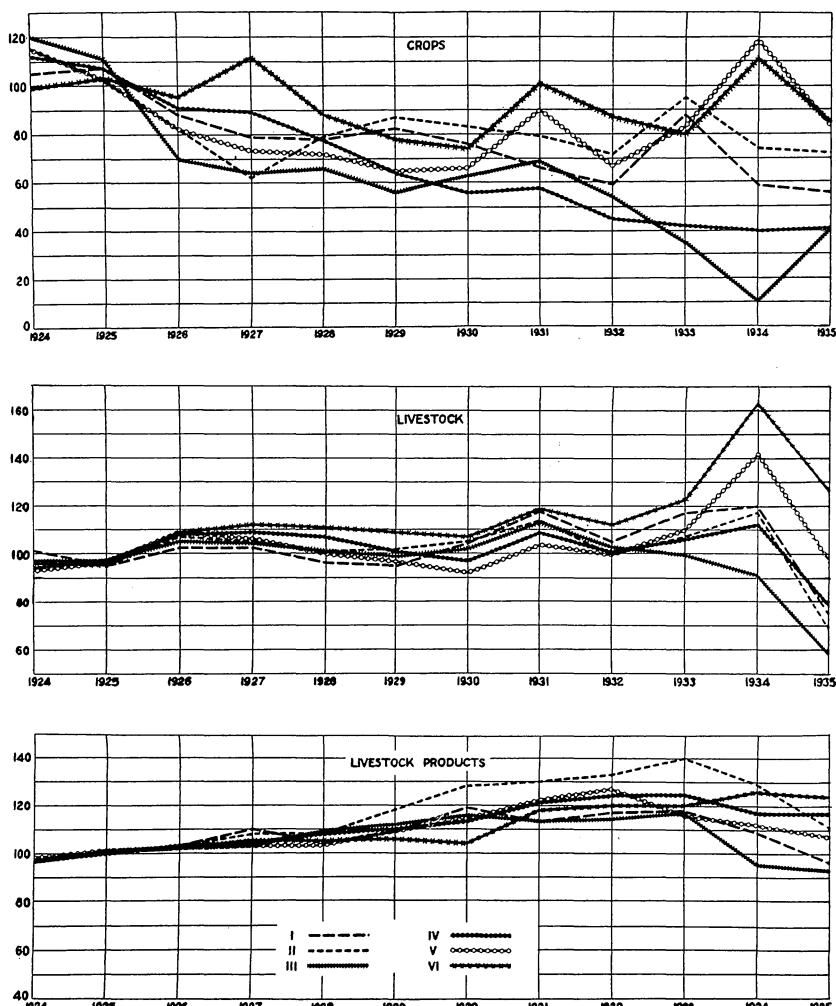


FIG. 5. INDEXES OF ANNUAL QUANTITIES SOLD OF GROUPS OF PRODUCTS IN SIX DISTRICTS OF MINNESOTA, 1924 TO 1935

In these districts 1935 quantities were little more than 40 per cent of the 1924-25-26 averages, in large part occasioned by drouths. Production of wheat declined in all districts, especially in III and IV, but there was somewhat of an upward trend in Districts V and VI between 1930 and 1933. Sales of corn appear to have been less in all districts than in the base period during the years from 1927 to 1932, but the better crop of 1933 raised the quantity sold in Districts I and II above the base period. The quantity of oat sales fell in all districts, as did that of flax. The quantities of barley sold, on the other hand, increased greatly in District II after 1927 and were maintained at about the same level as in the base period in the other districts, except in District IV where a considerable decline occurred. The quantity of potatoes sold in Districts III, IV, and V declined to about 50 per cent of the base period during the years from 1930 to 1935, but in general, except for fluctuations in individual years, remained about the same in Districts I, II, and VI for the entire period.

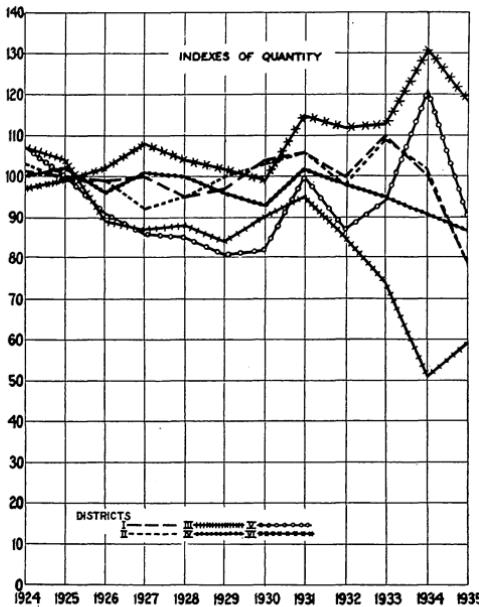


FIG. 6. INDEXES OF ANNUAL QUANTITIES OF 13 PRINCIPAL AGRICULTURAL PRODUCTS SOLD IN SIX DISTRICTS OF MINNESOTA, 1924 TO 1935

Table 9. Annual Indexes of Physical Quantities of Crops Sold in Six Districts of Minnesota, 1924-1935 (1924-1925-1926=100)

Year	District						State
	I	II	III	IV	V	VI	
1924	105	115	120	112	115	99	113
1925	107	102	111	107	102	103	105
1926	88	82	70	91	82	95	81
1927	79	62	64	89	73	112	71
1928	78	79	66	78	72	88	75
1929	82	87	56	64	65	78	74
1930	76	83	63	56	66	74	72
1931	66	79	69	58	90	101	75
1932	59	72	54	45	67	87	63
1933	88	95	36	42	83	80	74
1934	59	74	10	40	119	111	63
1935	56	72	41	41	83	85	62

The indexes for the physical quantities of livestock sold in the various districts are shown in Table 10 and Figure 6. There was a tendency for the quantity of livestock sold to increase in all the districts during the period from 1924 to 1934. The greater increases in the indexes occurred in Districts VI and I. The quantity of hogs sold appears to have increased in Districts I and II, which are the principal hog-raising sections, but to have declined in Districts IV, V, and VI. The quantity sales of cattle were somewhat higher in Districts VI and IV toward the close of the period than in the base period and about the same in the other districts. Cattle sales tended to decline in all districts between 1926 and 1932. The greatest change occurred in the sales of sheep and lambs which increased greatly in all districts, these sales having increased about twofold in all districts.

**Table 10. Annual Indexes of Physical Quantities of Livestock Sold in Six Districts of Minnesota, 1924-1935 (1924-1925-1926=100)**

Year	District						State
	I	II	III	IV	V	VI	
1924 .....	101	96	97	94	93	96	98
1925 .....	95	96	97	97	96	95	96
1926 .....	102	107	105	108	109	109	105
1927 .....	102	105	104	109	106	112	104
1928 .....	96	101	101	107	100	111	100
1929 .....	95	102	99	101	97	109	99
1930 .....	104	105	102	97	92	107	103
1931 .....	118	114	113	109	104	119	114
1932 .....	105	100	103	101	100	112	102
1933 .....	117	107	100	106	110	123	109
1934 .....	120	117	91	112	142	163	116
1935 .....	75	69	58	79	98	127	73

The indexes for the physical quantity of sales of butterfat, eggs, and chickens in the various districts are given in Table 11 and Figure 6. These sales have shown a tendency to increase in all the districts throughout the period. The largest increase appears to have been in District II.

**Table 11. Annual Indexes of Physical Quantities of Butterfat, Chickens, and Eggs Sold in Six Districts of Minnesota, 1924-1935 (1924-1925-1926=100)**

Year	District						State
	I	II	III	IV	V	VI	
1924 .....	97	97	97	97	98	97	97
1925 .....	100	100	101	100	101	100	100
1926 .....	103	103	102	103	102	102	102
1927 .....	110	108	103	104	103	105	107
1928 .....	104	108	109	108	103	105	106
1929 .....	109	118	112	110	109	106	112
1930 .....	119	128	116	113	114	104	119
1931 .....	113	130	113	121	122	118	119
1932 .....	117	133	114	124	127	120	123
1933 .....	118	140	117	124	116	120	124
1934 .....	109	129	96	117	112	126	114
1935 .....	97	111	93	117	107	124	106

The index follows quite closely the changes in butterfat sales, which is the predominant item in all districts. The quantities of butterfat sold increased between 10 and 20 per cent in most of the districts during the period from 1924 to 1933. The quantities of eggs and chickens sold appear to have increased considerably during the same period, the index of sales of these commodities being over 150 in 1933 for both commodities in nearly all districts. In 1934 and 1935 there were reductions due to the drouth.

### DISTRICT INCOME INDEXES

The changes in prices and quantities sold in the various districts shown by the indexes of price and quantity combine to produce changes in the value of the cash sales of these 13 products in the various districts. The indexes of the value of sales are shown in Table 12 and Figure 7. Between the base period 1924-1925-1926 and 1929, the value of sales of these products appears to have been about maintained in Districts I, II, and IV. The index for District VI had risen about 15 per cent

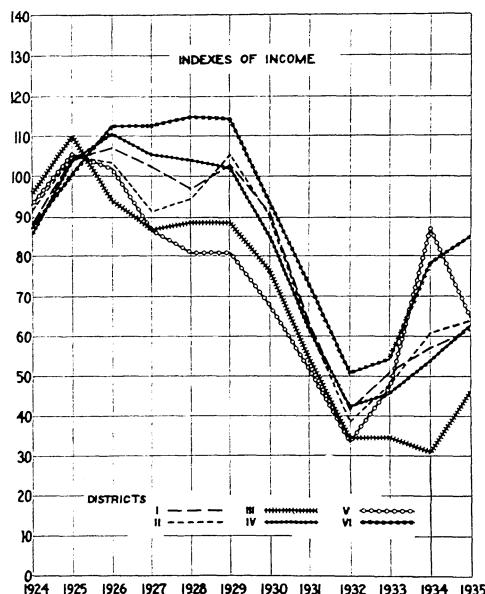


FIG. 7. INDEXES OF ANNUAL INCOME DERIVED FROM THE SALE OF 13 PRINCIPAL AGRICULTURAL PRODUCTS IN SIX DISTRICTS OF MINNESOTA, 1924 TO 1935

Table 12. Indexes of the Income from Gross Cash Sales of 13 Agricultural Products in Six Districts in Minnesota, 1924-1935 (1924-1925-1926=100)

Year	I	II	III	IV	V	VI	State
1924	100	100	100	100	100	100	100
1925	104	105	107	103	105	107	105
1926	107	103	99	104	105	102	104
1927	103	92	94	111	102	96	96
1928	97	95	86	105	86	113	95
1929	103	105	89	102	81	114	100
1930	91	90	76	85	68	94	86
1931	63	62	54	62	52	73	61
1932	42	39	34	42	33	51	39
1933	51	48	35	46	47	54	47
1934	57	61	31	54	87	78	58
1935	62	64	46	63	65	85	62

above the base period. In contrast, the indexes of income in Districts III and V had declined 10 to 20 points below the base period. Between 1929 and 1932 income declined markedly in all districts. A rise began in 1933. In general, Districts I, II, and VI maintained a somewhat more favorable position during the period between 1926 and 1935 than the other districts.

### METHOD OF CONSTRUCTION OF THE INDEXES

These district indexes represent changes in the prices, quantities sold, and value of sales of 13 of the principal agricultural products of the state.<sup>2</sup>

The base period is the average of the three years 1924-1925-1926. This base period is the same as that used for the regularly computed indexes of agricultural prices for the state as a whole. A three-year period is taken rather than a single year, since any individual year selected might be expected to have special characteristics, and a more usual situation with respect to prices and sales is found with a three-year average. A post-war base is chosen, partly because of the greater reliability of the data as compared with that for the pre-war period and partly because a recent base period, in general, furnishes a more reliable basis of comparison than an earlier period.

The prices entering into the index of each district are weighted according to their relative importance in the district. Different weights are necessary because of the variation between districts in the relative quantities of the various commodities sold. The only means of judging the importance of a price is by the amount of the commodity sold at that price. A formula<sup>3</sup> has been employed which combines the weightings of the quantities sold in the base period with the quantities sold in the current period. This is the same procedure as is used in the regularly published state index of Minnesota agricultural prices.<sup>4</sup> Variable weights have the advantage over constant weights of taking at least partial account

<sup>2</sup> These commodities are: wheat, corn, oats, barley, rye, flax, potatoes, hogs, cattle, lambs-sheep, chickens, eggs, and butterfat. Hay, calves, and milk which are included in the regularly published state index are omitted. While these products do not include all the products sold by Minnesota farmers, they nevertheless represent the major portion of the sales in all districts and with the exception of corn are products which are important throughout the state. As previously noted, the items included account for about 90 per cent of the total cash income, and some of the excluded items fluctuate similarly to some of the included items. They are thought, in consequence, to permit comparisons between districts of considerable reliability.

<sup>3</sup> The formula is as follows:

$$\sqrt{\frac{\sum [p_t \cdot q_0]}{\sum [p_0 \cdot q_0]}} \times \frac{\sum [p_t \cdot q_t]}{\sum [p_0 \cdot q_t]}$$

Where  $p_t$  = price in the current month

$q_t$  = quantity marketed in the current month

$p_0$  = average price in corresponding months of 1924-25-26

$q_0$  = average quantity marketed in corresponding months of 1924-25-26

This is a form of the so-called "Fisher Ideal" formula.

<sup>4</sup> The reasons for the choice of such an index are stated in Minnesota Technical Bulletin 72, "Minnesota Agricultural Indexes of Prices, Quantities, and Cash Incomes, 1910-1927," pp. 8-10.

of the special circumstances in particular years. The importance of high prices due to short crops, for example, would be overemphasized with constant weights. In agriculture, where quantities marketed vary widely from year to year both in amount and time, an index with variable weights is thought to be especially desirable.

The quantity index represents the volume of products sold by the farmers in the district and is not an index of changes in agricultural production. It is constructed by methods similar to those used in computing the price index.<sup>5</sup> In these indexes the quantities sold are weighted by the price per unit. The importance of the quantity of a commodity sold is judged by the price.

The indexes of cash incomes from sale are the products of the price index by the quantity index for the corresponding period. This is a distinct advantage of the type of index formula chosen for the construction of these indexes and is not possible with indexes employing constant weights.

There are two important limitations to these index numbers as computed. First, they are limited to only 13 commodities and do not, in consequence, cover all farm sales; second, it has been necessary to make a number of estimates in their construction, particularly with reference to the quantities sold. The limitation to 13 commodities probably does not impair the significance of the price indexes to any great extent, since these commodities constitute the majority of the sales in all districts and because comparisons are made more properly on similar items. The restriction of commodities is probably of more importance in the case of the value indexes, since the proportion of special or local crops not included varies from district to district.

### ESTIMATES OF QUANTITIES SOLD

There are no complete enumerations of sales by farmers, so it has been necessary to estimate the quantities sold. These estimates have been made by a variety of methods, and the procedure for each commodity is explained briefly in this section.

Three steps have been involved in these estimates. It has first been necessary to estimate the sales for the state as a whole. The same quantities are used as are employed in the state indexes of prices, quantities, and cash incomes. The methods by which these quantities are estimated are explained in detail in Minnesota Technical Bulletin 72, "Minnesota Agricultural Indexes of Prices, Quantities, and Cash Incomes, 1910-

<sup>5</sup> The formula used is:

$$\sqrt{\frac{\sum(q_1 \cdot p_0)}{\sum(q_0 \cdot p_0)}} \times \frac{\sum(q_1 \cdot p_1)}{\sum(q_0 \cdot p_1)}$$

Where  $q_1$  = quantity marketed in the current period

$p_1$  = price in the current period

$q_0$  = average quantity marketed in the corresponding period of 1924-25-26

$p_0$  = average price in the corresponding period of 1924-25-26

1927," and in consequence are only briefly outlined here. It has next been necessary to assign to each district its probable contribution to these total sales. There are virtually no data with respect to district sales, and in consequence it has been necessary in most cases to assume that sales were closely related to the production in the area. Except for minor differences, this is believed to be essentially true for the commodities included in the study. Finally, an estimate has been made of the seasonal distribution of sales in the districts. For butterfat, hogs, cattle, and potatoes it has been possible to make separate estimates for the various districts, but with the remaining products it has been necessary to assume the same seasonal distribution in all districts. Some inaccuracies are involved in this procedure, but in view of the dominance of the commodities for which separate estimates are made they are not thought to be large. The methods for each commodity are briefly described below.

**Wheat.**—The estimates of the quantities of wheat sold by farmers in the entire state were made by two methods. For the years 1924 to 1929, they are assumed to be the production reported for the state by the United States Department of Agriculture, less a seed deduction of  $1\frac{1}{2}$  bushels for each acre planted the following year. For 1930 and the following years the amounts of wheat shipped from local elevators and warehouses as reported by the State Railroad and Warehouse Commission were used.

The sales by districts were assumed to be in the same relative proportion that the "estimated amount available for sale" in the district was to the state total. This has been computed by totaling the production in the counties of the district as reported in the published reports of the State Statistician and deducting  $1\frac{1}{2}$  bushels for seed for the acreage planted the following year. The proportion which each district is of the total of the six districts constitutes that district's share of the estimated total marketings for the state. The state total of "estimated amount available for sale" is identical with estimated sales in the early period, but differs in the later period.

Since these estimated sales are normally sold during the 12 months following harvest, the sales have been allocated to particular months by the same proportional distribution as the receipts of wheat at Minneapolis.

**Corn.**—The estimates of the marketings of corn are intended to include only the amounts which farmers sell for cash. For the years 1924 to 1929, the estimate of the amount shipped out of county where grown was applied to the reported production in the county to get the estimated sales. The estimates of shipments out of county where grown are made by the United States Department of Agriculture on the basis of reports by farmers. The counties have been totaled for the district sales. For 1930 and the following years the amount shipped from local elevators and warehouses as reported to the State Railroad and Warehouse Commission is used as marketings for the state. These have been allocated

to districts, according to the proportions determined by the same method as was used for the earlier period.

The distribution of marketings by months was assumed to be in the same proportion as the receipts at Chicago. This larger market was believed to be more representative of sales than receipts at the Minneapolis market.

**Oats.**—The same general methods have been used in estimating the annual state and district marketings of oats as were employed for corn. The distribution to the months has been made on the basis of Minneapolis receipts.

**Barley.**—The annual state and district marketings of barley have been estimated in the same manner as for corn and oats. The distribution of sales by months for the years 1924 to 1929 were made on the basis of the combined receipts of barley at Milwaukee and Minneapolis and for the years 1930 and later on the basis of Minneapolis receipts alone.

**Rye.**—The estimates for the marketings of rye have been made in the same way as those for wheat.

**Flax.**—Only one method has been used for estimating the marketings of flax for the entire period. The sales in each district are assumed to be the total production in the district as reported by the United States Department of Agriculture less one-half bushel for seed for each acre seeded the following year. The marketings were distributed by months on the same percentage basis as the receipts at Minneapolis.

**Potatoes.**—The estimated quantities sold for the state are the reported carlot shipments from Minnesota, assuming 600 bushels per car, plus an estimate of the production trucked into the cities.

The proportion of these estimated sales to be allotted to each district was made as follows: From the reported production for the crop year two deductions were made, one of 12 bushels of seed per acre harvested the following crop year, and an estimated home consumption for the district. This net figure for the district was averaged for the preceding and current crop year to secure a calendar year figure. The district calendar year figures were added to secure the state total and the percentage of each district to the state total computed. This percentage applied to the state calendar year sales, as previously estimated, gives the estimated sales for the district.

The monthly distribution of sales in the various districts was made on the basis of reported carlot shipments by counties.

**Hogs.**—The quantities sold are estimated in hundredweight. The number of head received monthly at stock yards and packing plants from Minnesota have been reported to the United States Department of Agriculture. The average weight per head at South St. Paul has been multiplied by these numbers to secure the total hundredweight sold.

These sales were allocated to the districts on the basis of an average of the number of hogs reported on farms on January 1 of the current and following year. The per cent of the district to the state total number

of hogs on farms as thus computed was applied to the annual sales for the state to estimate the district sales.

The monthly distribution of sales in District I was made in the same proportion as the monthly sales reported by farmers in eight counties in the district who are cooperating with the Division of Agricultural Economics in keeping farm records. The marketings from District I were then deducted from the reported state monthly marketings, and the monthly percentage distributions of the remaining marketings were used as indexes of the seasonal marketings for the other districts.

**Cattle.**—The state sales of cattle were estimated in the same manner as for hogs. The average weight of cattle at South St. Paul was multiplied by the number of head of Minnesota cattle received monthly at stockyards and packing plants.

The sales were allocated to districts on the same basis as that used with hogs. An average was computed of the January 1 reported number of cattle on farms for the current year and the following year as an indication of the mid-year number. The percentage which each district constituted of the state total was applied to the estimated hundredweight sales for the state to give the district sales.

The monthly distribution of sales has been estimated on the basis of rail receipts of cattle at South St. Paul. It was found that District I was served chiefly by the Milwaukee Railway, District II by the Northwestern, District III by the Soo Line, and Districts IV, V, and VI by the Great Northern. The seasonal distribution of receipts of cattle via these roads at South St. Paul was taken tentatively as the distribution for the respective districts. In some districts truck shipments are of great importance, but it has been impossible to obtain a seasonal distribution of truck receipts by districts. When the quantities for the districts are distributed by this method and summed, they result in a somewhat different distribution than the known actual seasonal marketings. Each month, in consequence, is adjusted by the ratio of actual sales to the tentative distribution. This results in the total marketings monthly by districts checking in total with the known state marketings, yet it gives effect to the differences in districts in their probable seasonal marketings.

**Lambs-Sheep.**—The total state marketings of lambs and sheep are determined in the same way as for hogs and cattle, and the quantities allotted to districts in a similar manner. The monthly district distributions were the same as for the state sales.

**Chickens.**—The total sales for the state are the sum of two items—the receipts of Minnesota poultry at Chicago, New York, Philadelphia, and Boston, and an estimate of consumption by the urban population of the state. The former are data reported by the Bureau of Agricultural Economics. The latter estimate was made by reducing the urban population of the state to adult male equivalents by the approximate weights used by the United States Bureau of Labor Statistics and using an estimated consumption of 6.85 pounds per annum for each adult male equivalent.

The proportion of the total state sales made by each district was assumed to be in the same ratio as the number of hens reported on farms January 1 in the district was to the number of hens reported on all farms in the state at the same date.

For 1931 and the following years these quantities were distributed monthly on the basis of receipts reported by the Land O' Lakes Co-operative Creameries, Inc. For the years prior to 1931 the distribution was made on the basis of the monthly receipts at the four eastern markets from Minnesota, adjusted by the average difference between the receipts at these markets from Minnesota and receipts at Land O' Lakes Creameries during the period 1931-1932-1933.

**Eggs.**—The number of eggs produced on the farms of the state as a whole was estimated from the number of chickens on farms as reported for January 1 and the number of eggs per chicken interpolated from the U. S. Censuses of Agriculture. An estimated consumption on farms is subtracted from these production figures for the estimated quantities sold.

The sales in each district are assumed to bear the same relation to the state sales as the reported number of chickens on January 1 in the district bears to the total number of chickens reported for the state. Monthly sales are assumed to be distributed through the year similarly in all districts and to vary in the same way as the receipts of eggs from Minnesota at Chicago, New York, Philadelphia, and Boston.

**Butterfat.**—Butter quantities for the state as a whole were taken from the State Department of Agriculture, Dairy and Foods report of creamery butter manufactured monthly. Deduction was made for resale to farmers, and the remainder multiplied by 0.8, to allow for overrun, to determine the probable butterfat quantities. Since these reports were available by counties, district totals were computed and an index of production prepared on a 1929 base for each district. The amount of butterfat sold in cream in each district was determined from the 1929 U. S. Census and the percentage of the district to the state total computed. This proportion was then multiplied by the index of butterfat production to give the proportion of the total sales in the state arising in each district. This procedure was thought necessary to eliminate the possibility of a district receiving allotments of butterfat which it carried in manufacturing reports but which were manufactured from butterfat shipped from another district. These district proportion figures were applied to the state total in order to estimate the district total. The 1924 and 1925 reports of manufacture were unavailable and the 1926 distribution was used for these years.

The quantity sold during the year in each district was assumed to vary in the same manner as the reported butter production in the district. For 1924 and 1925, when these monthly reports were unavailable, the three-year (1926-1927-1928) average percentage difference between the Land O' Lakes distribution and the state manufacturing distribution was applied to the Land O' Lakes distribution in 1924 and 1925 to secure the estimated marketings.

## SUMMARY AND CONCLUSIONS

The decline from 1929 to 1932 in the prices received by Minnesota farmers for products sold and the subsequent rise produced an almost identical fluctuation in the income from the cash sales of the principal agricultural products. The only outstanding exceptions occurred in 1934 and 1935, when drouth curtailed production and sales. While there were changes in the importance of individual commodities in the total sales, the total physical volume of sales does not appear to have changed greatly during the period.

Individual agricultural products had somewhat different price movements. The prices of crops fell earlier and further, and later rose more rapidly than the prices of livestock and livestock products. In consequence, the general level of agricultural prices in districts deriving a larger portion of their income from the sale of crops had a wider swing than the level of prices in districts where the larger portion of the income was from the sale of livestock and livestock products. During the period of low prices the indexes were about 5 points lower in the districts where crop sales were of most importance. This means that the incomes on average farms in the crop-selling districts declined \$100 to \$150 more than in the districts where livestock production is of greater importance. In general, the proportion of the farm income derived from the sale of crops is greater in the western than in the eastern part of the state.

Throughout the state there was a tendency during the entire period for the quantity of crops sold to decline. The decline was especially marked in the west-central parts of the state where, accentuated by drouths, sales of crops in 1933-1935 were less than half those of the base period 1924-1925-1926. For 1934, District III was only 10 per cent of the base. Farmers depending largely on the crop sales for their income thus suffered not only from greater price declines but from a smaller volume of commodities for sale. However, District V, comprising the Red River Valley, appears to have gained materially from the drouth situation of 1934. This region escaped most of its ravages. As a result it had large crops of wheat, oats, barley, and flax to market at the abnormally high prices resulting from the drouth. For 1934 its index of physical quantities of crops marketed was 119, one-fifth higher than the base period, while for the same period the adjacent districts, III and IV, had indexes of 10 and 40, respectively. Indexes of income from sale of crops was 98 for District V as contrasted with 8 and 30 for Districts III and IV, respectively. Livestock and livestock product sales increased in all areas in the state, but somewhat more rapidly in the eastern half. Hogs tended to decline in importance in the north, and cattle to increase, while the reverse occurred in the south. There was a considerable increase in the sales of lambs and sheep throughout the state, but especially in the north. Butterfat sales increased steadily at a rate of about one per cent a year in the state as a whole, but with a larger increase in the western part. The quantities of eggs and chickens sold increased in all

districts, the total increase for the period amounting to over 60 per cent.

The variation in type of agriculture among districts of the state has been sufficient to result in considerable differences in the changes of income during the last 12 years. In general, the income from crop sales appears to vary more widely from year to year than the income from livestock and livestock product sales, both because of a greater fluctuation of prices and because of variation in volume of production. Livestock production has a tendency to run in cycles of several years' length. If the general conditions in agriculture remain unstable in the coming decade, a considerable variation in the level of agricultural prices and farm incomes in the various districts of the state may be expected.