ECONOMIC ASPECTS OF THE POTATO ENTERPRISE

WITH PARTICULAR REFERENCE TO COSTS

by

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INTRODUCTION

Although potatoes are grown in most countries of the world the pattern of production is largely concentrated in Europe where almost three-quarters of the world's acreage is grown. The Americas account for somewhat over 7 percent of total acreage of which over one-half is grown in the southern continent.[1] In terms of production, this concentration is even more marked with 86 percent of the total coming from the aforementioned areas. Thus it is noted that it is in European countries and these areas of the world largely populated by the descendants of Europeans that the potato finds favor despite the fact that it originated in Peru and was first used by peoples of Asiatic origin as an item in their diet.[2]

World and National Trends in Production and Consumption

On a world scale the crop is grown mainly for human consumption, but some industrial processing, mostly into alcohol and starch, is carried on, principally in Germany and the Netherlands. A substantial proportion of Germany's production is consumed by livestock as a substitute for grains. The highest consumption on a per capita basis

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[1] F.A.O., Production Yearbook, Vol. XVIII, 1964. U.N. Rome, 1965, p. 80.

[2] Radcliffe N. Salaman, The History and Social Influence of The Potato, Cambridge, England, 1949, passim.

is found in Europe in countries such as Ireland, Germany and Belgium.[3] In those countries the pattern of consumption is approximately three times the level of that of the United States, but in Europe as elsewhere, consumption has been steadily decreasing. It is a phenomenon characteristic of the food economies of the western countries that potato consumption tends to decline with advancing economic prosperity and to be replaced by increased consumption of foods with a higher protein content. More than one explanation has been advanced in attempting to explain this downtrend. In the first instance, increased urbanization tends to lead to lower per capita consumption. Secondly, potatoes would seem to be somewhat of an inferior commodity with higher real incomes leading to a lower consumption. Thirdly, an increased diet consciousness has occurred in recent years with people less inclined to consume food of high caloric content. Furthermore, modern civilization demands convenience foods which require little preparation and it was not until recently that the potato industry showed an awareness of this fact. The volume of heavy manual work has sharply declined also and this results in a lower demand for high-energy foods.

The potato has been in cultivation in the United States at least since the early years of the eighteenth century and was first mentioned in the U.S. Census in 1840. It appears that at this time it was not widely accepted as a vegetable and it was not until the latter half of the nineteenth century that a substantial increase in

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[3] F.A.O., Food Balance Sheets, 1957-59 Average. U.N. Rome, 1963, passim.

demand occurred. This coincided with and was probably caused by the great influx of Europeans, whose consumption of potatoes was then and still is above the world average. It has been demonstrated that per capita consumption actually increased between 1870 and 1909 and that the subsequent decline in consumption was caused by the diminishing proportion of foreign stock in the population of the country, who gradually became assimilated into the pattern of living of the native population.[4] This decline was but a part of the general trend in the decreasing consumption of high carbohydrate foods in the developed countries.

Where potatoes are concerned however, processed products may yet arrest the decline in per capita consumption and there is evidence to substantiate this in recent years.[5] Increased processing and merchandising has been taking place in a relatively short period of time. Whereas the quantities used for chipping in 1939 were almost negligible as a proportion of total consumption and amounted to approximately 2.5 million hundredweights, a major expansion occurred in the fifties and in 1964 processed products accounted for a third of the production which was used for food. (See Chart I). The main components of this group are chips, dehydrated products and frozen and canned potatoes. The frozen and dehydrated products have

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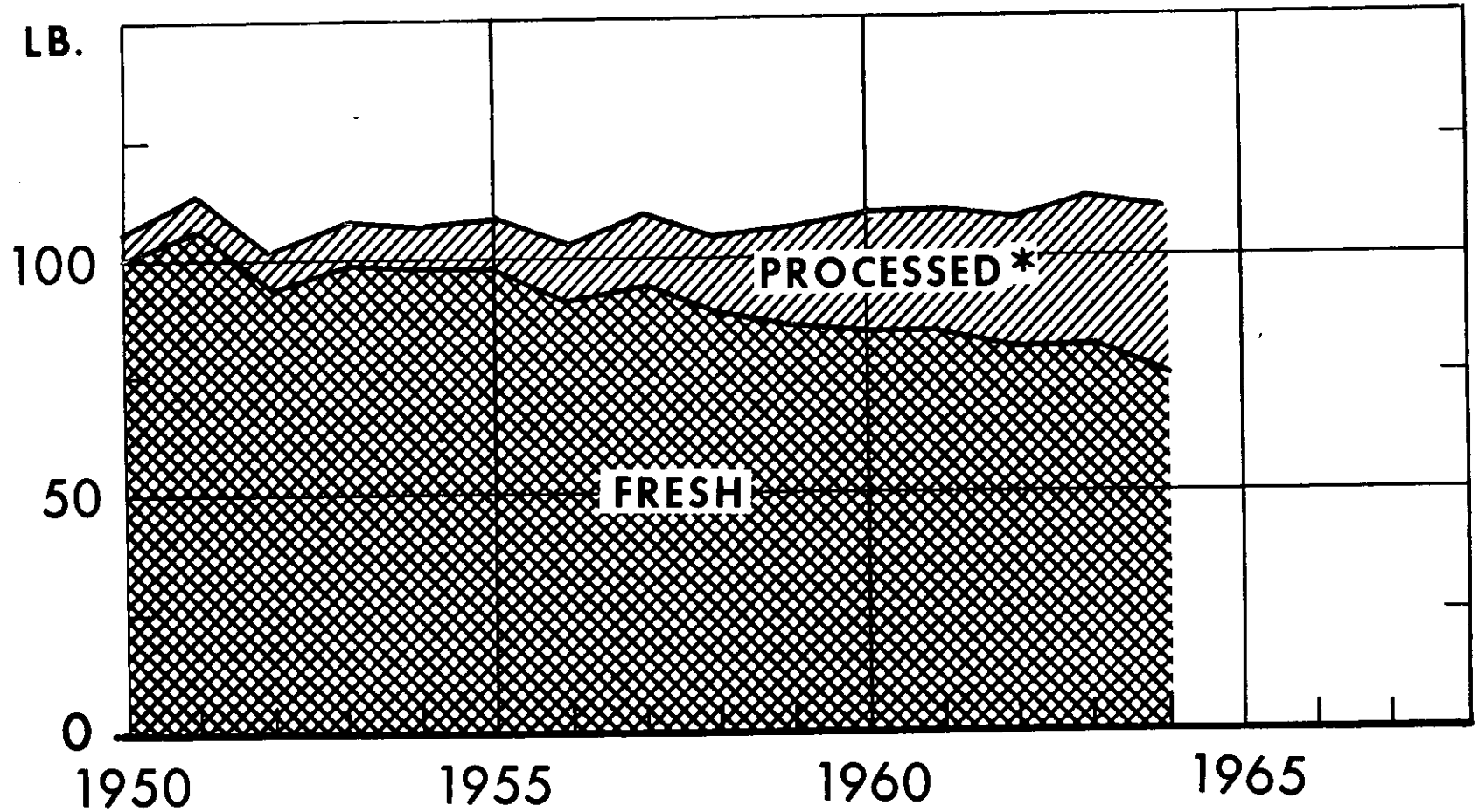
[4]Roger W. Gray, Vernon L. Sorenson and Willard W. Cochrane, An Economic Analysis of the Impact of Government Programs on the Potato Industry of the United States. North Central Regional Publication No. 62. Univ. of Minnesota Agr. Expt. Sta., June 1954. p. 14.

[5]Donald Kuryloski, Vegetable Situation, 1966 Outlook Issue, E.R.S., U.S.D.A., October 1965. p. 22.

Chart 1

POTATO CONSUMPTION PER PERSON



CALENDAR YEAR.
* INCLUDES FRESH EQUIVALENT OF CHIPS AND FROZEN, CANNED AND DEHYDRATED POTATOES.

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made the more dramatic gains recently. (See Table A - Appendix)

The quantities retained for seed and consumption in growers' households have decreased over the years and this has led to a larger proportion of the crop being marketed.[6] (See Chart II) Before World War II only about one-third of seed requirements was purchased from other growers as against two-thirds at the present time. In the third decade of this century 65 percent of the crop was marketed, but in 1964 sales accounted for 90 percent of total production.[7] It is possible that this trend will continue, although it is likely that some quantities will always be retained for domestic consumption and a small proportion of the crop will be unmarketable for reasons of quality.

In the United States approximately 2 percent of the world's acreage of potatoes is grown, with a share in the total production of 4.4 percent.[8] This may give the impression that the crop is unimportant in the total agricultural economy. Yet in selected parts of the country it makes a major contribution, as for instance in Idaho and Maine where it provides 14 and 29 percent respectively of total cash receipts from farming.[9] It comprised 1307.5 thousand acres in 1964 and was valued at $786.4 million. Significant changes

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[6] Ibid., p. 22

[7] Ibid., p. 23.

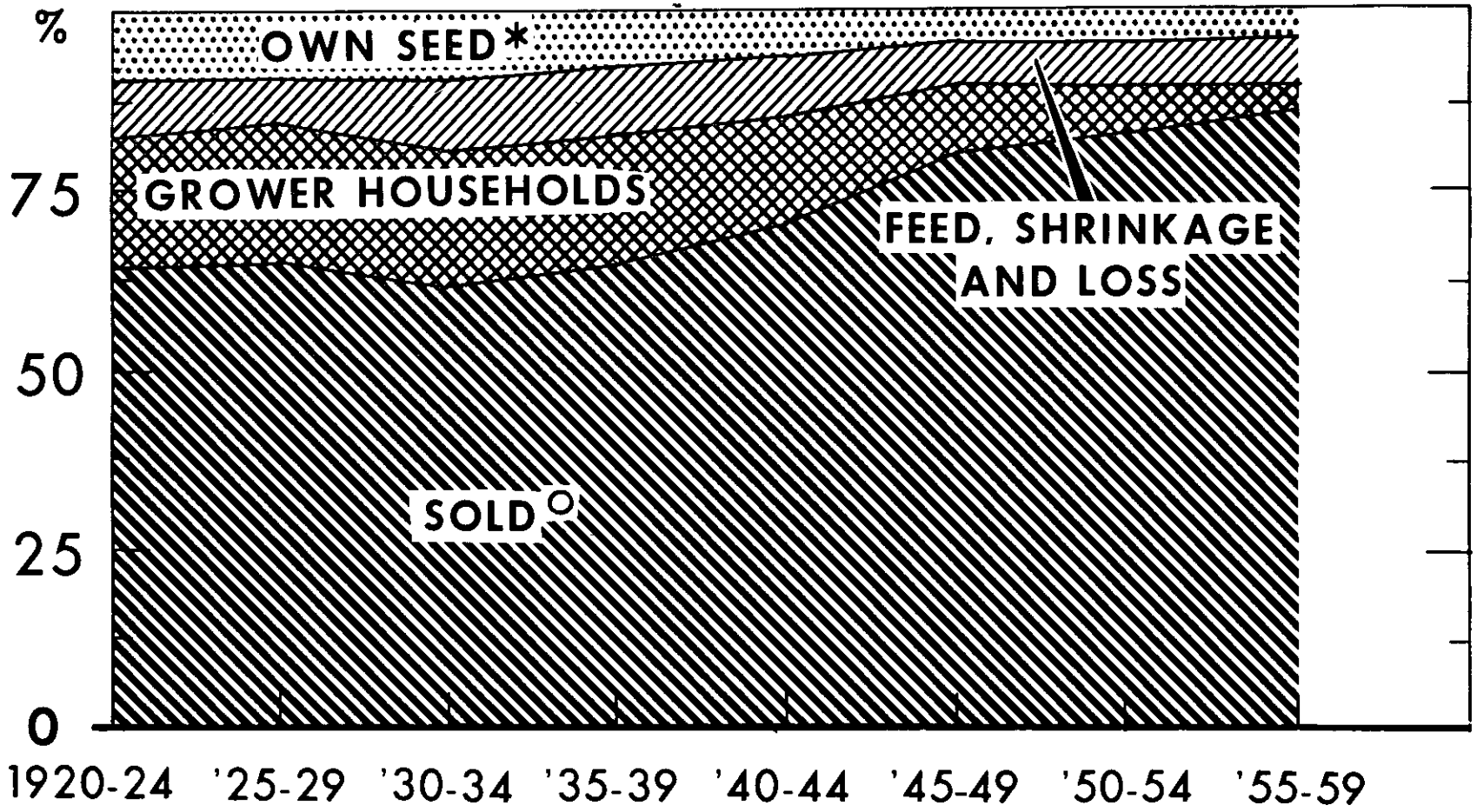
[8] F.A.O. Yearbook, op. cit., p. 78

[9] U.S.D.A., Cash Receipts from Major Farm Commodities by States, Statistical Bulletin No. 262, A.M.S., U.S.D.A., April, 1960, pp. 13-20.

Chart 11

UTILIZATION OF POTATO CROPS

Specified Uses as a Percentage of Total Production △



△ ANNUAL AVERAGE FOR PERIODS SHOWN. PRODUCTION AND DISPOSITION DATA ON CROP YEAR BASIS.
* SEED USED ON FARMS WHERE GROWN. ° INCLUDES POTATOES SOLD FOR SEED.

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have taken place in the pattern of production in the past half century and this matter will be examined more fully in Chapter 2.

Government Programs

The potato is notorious for its variability in yield which, together with the market inelasticity of demand, has led to marked instability in prices and hence in income, to producers. In the past this has led to government intervention in the market so as to reduce the variability in income. From 1934 to 1942 purchase and diversion programs were in operation in most years, but they were limited in scope and it has been concluded that their most notable effect was in increasing aggregate income to growers. The price support program which began with the 1943 crop provided for prices at not less than 90 percent of parity. The program comprised two phases - an expansion or nonrestrictive phase (1943-1945) when increased production was encouraged, and a restrictive or contraction phase (1945-1950) when production was discouraged.[10]

The first phase accelerated the movement toward the specialist areas because hitherto, the expansion in production in these areas was impeded by the persistence of small scale producers in the Lake States. Thus, investments by large scale producers were encouraged now that price risk had been largely eliminated. The strong commercial wartime demand meant that program costs were not overly expensive. In the second phase, the existing area pattern of

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[10]Gray et al., op. cit., passim.

production was frozen as a result of efforts to control production, which supposedly was to depend on acreage allotments. But insofar as it failed to achieve its objective and led to surplus, the second phase retarded the trend towards specialized production, which had commenced in the first phase. Consequently, $512 million were spent by the Commodity Credit Corporation in the second period in payment to growers and to cover storage and transportation costs,[11] (as against $40 million from 1943-1945).

The price support program ended in 1950 and producers have not yet made the necessary adjustments in response to the pattern of demand. Only limited arrangements such as marketing orders - in some areas - or the diversion of potatoes to nonfood uses in some years, are now in operation, but they have had little effect on the total quantities marketed from year to year.[12] Thus it appears that stable production at the equilibrium level is the only answer to the large fluctuations in income, however that is to be achieved. This problem is not confined to the U.S. as producers in Europe face a similar situation.

Potato production is a high risk enterprise and is at least as much if not more subject to the vagaries of the elements as any other field crop. Allied to this is the fact that the crop is a labor

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[11] Ibid., p. 114.

[12] Will. M. Simmons, An Economic Study of the U.S. Potato Industry, Ag. Econ. Rpt. No. 6, E.R.S., U.S.D.A., March, 1962, p. 55.

intensive enterprise and this is still true despite the adoption of mechanical planting and harvesting on a large scale. The benefits of technology do, however, require greatly increased investments of a capital nature and where the crop is stored over winter at the farm level, adequate facilities must be made available. The development of processing will tend to obviate the need for farm storage, since most of the potatoes will be hauled directly to processing plants at harvest time.

Spectacular advances have also been made in research into improved and specialized varieties, increased and more efficient use of fertilizer, sprays and irrigation. These facets of research tend not only to enhance yields but also to stabilize annual production. The development of processing may impose an even greater need to develop varieties which are suited to the exacting requirements of the industry and yet retain high yields and other desirable characteristics.

Purpose of the Study

The purpose of this paper is to examine and review the pattern of production and consumption of the potato industry in the United States. Regional specialization in production has taken place to a significant degree and some attention is devoted to the underlying causes of this trend. Chapter 2 includes an examination of the production pattern with special reference to Michigan.

Chapter 3 attempts to analyze some of the factors which have influenced mechanization of the crop. Some hypothetical cases are budgeted to determine the relationship between the acreage grown and the extent to which the crop can be economically mechanized. This

aspect of the industry has attained paramount importance in recent years because of the difficulty in acquiring seasonal labor. The impact of irrigation is also examined to determine under what cost-price relationships it may be profitably employed. These aspects of potato production are increasing in importance due to the tendency towards the large scale production now manifest in the more specialized areas of the country.

CHAPTER II

THE GENERAL PATTERN OF POTATO PRODUCTION IN THE U.S. AND MICHIGAN

There was a persistent decrease in per capita consumption of potatoes from 1910 to 1960 but since then it has tended to remain static. It dropped from 198 pounds per person in 1910 to 102 pounds in 1960, or a reduction of 48 percent. With this pattern of consumption the rapid population growth from 92 million in 1910 to 179 million in 1960 was not sufficient to substantially increase the total quantity demanded by consumers. In actual fact, the total quantity consumed increased by only 24 million from 180 million hundredweight in 1910 to 203.6 million in 1960. Quantities used for human consumption accounted for 83 percent of total production in 1964 and this percentage is increasing as a result of less potatoes being used for animal feed.[1]

National Trends

The production of potatoes in the United States has become a highly specialized enterprise even if the trend has not been as marked as with other crops. Specialization seems to have commenced to some extent with the decline in consumption but the inherent

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[1]Kuryloski, op. cit. p. 23.

characteristics of the crop - its perishability, bulk, adaptability to most soils, and the fact that a major processing industry did not develop until recently have been important adjustment factors.[2] It appears that in the early stages production was collocated with population while transportation remained the limiting factor. Later, production moved away from population as transportation barriers were overcome and as brand promotion increased. It appears that potato production is now concentrated largely in areas which have access to irrigation, have few satisfactory crop alternatives, or certain transportation advantages, but generally there seems to be no factor of overriding importance in determining the present location of the industry.

From 1920 to 1964 the harvested acreage in the country dropped from 3,301,000 to 1,294,000 acres or a reduction of 60 percent. Yet, the almost threefold increase in yield per acre was sufficient to stabilize production, despite some notable fluctuations from year to year. (See Chart III)

Potatoes are grown commercially in every state but a relatively few states dominate production. In 1964, Idaho, Maine, California and New York accounted for 52 percent of total output.

For statistical purposes, the United States Department of Agriculture uses a seasonal classification based on the time when the bulk of the crop is harvested. The seasonal categories are

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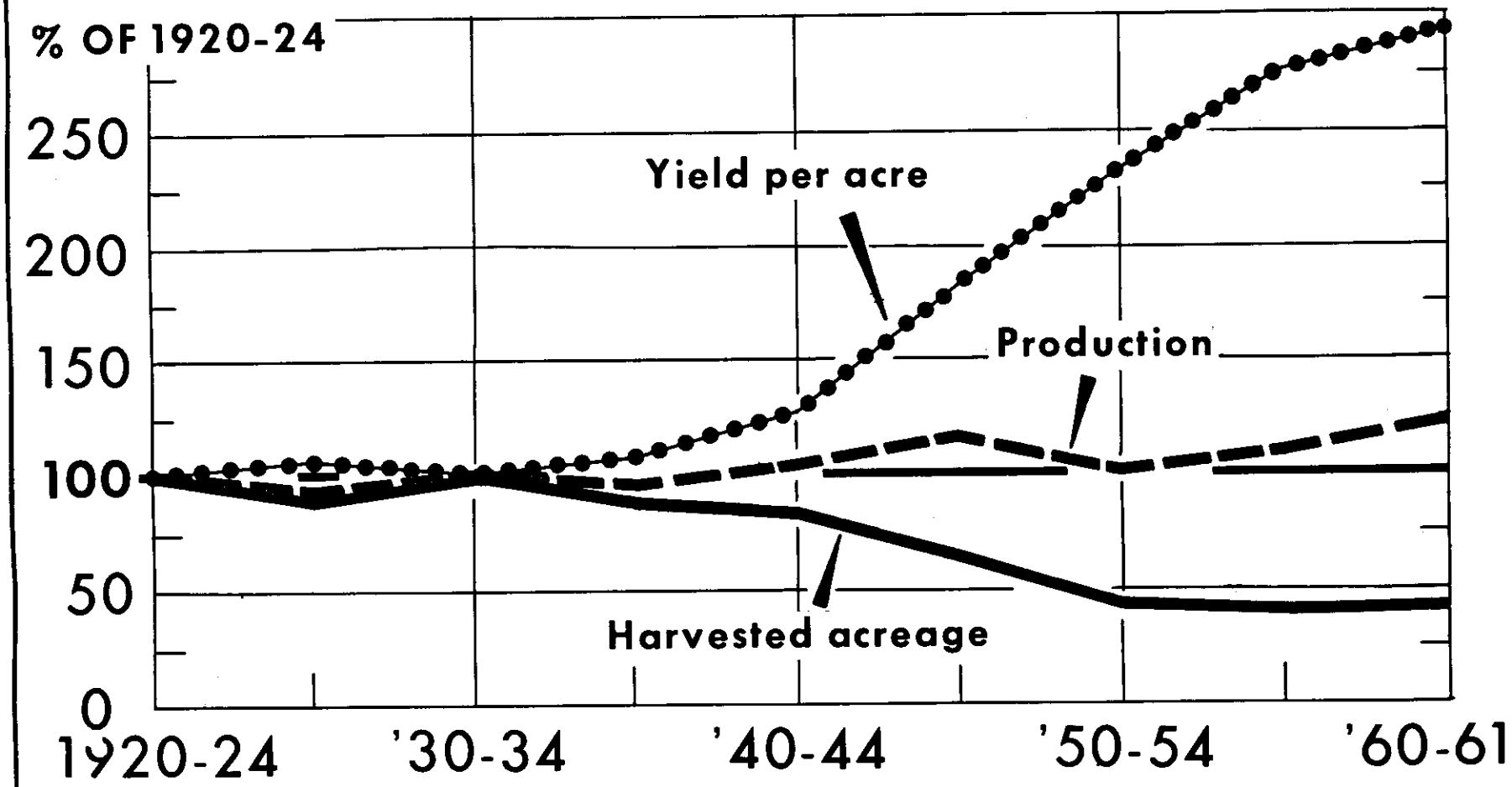
[2]Gray et al., op. cit., passim.

Chart 111

TRENDS IN POTATOES

*Total Acreage, Production, and Average Yield, U. S., 1920-61**



*ANNUAL AVERAGE FOR PERIODS SHOWN; NOTE ONLY 2 YEARS IN LAST PERIOD

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winter, early spring, late spring, early summer, late summer and fall. The percentages of total production accounted for by these categories in 1964 were 1.5, 1.7, 8.5, 4.8, 11.5 and 71.9 respectively. Thus it is evident that the fall crop is by far the most important and hence the greatest determining influence on prices, not only of the fall, but also of the early production of the succeeding year.

There is some evidence to suggest that early production has increased in recent years as a proportion of the total. This is largely concentrated in California, Florida and Texas and usually commands a higher price because of the seasonality in production but its yield is usually below that of later season crops. It is anticipated that the proportion of production accounted for by early potatoes will increase with per capita income. However, because of the limitations imposed by climate it is doubtful if any great changes will occur in the regional production of the crop.

The greater adaptability of the late summer and fall crops to climate, and the technological changes which have developed, permitted the change in the regional pattern of the crop to occur. As these categories account for such a large proportion of total production, it is to be expected that variation in overall acreage and yield of the total crop will be largely influenced by developments in these categories. Late summer and fall crop potatoes are now produced mainly in the northern states especially in the northeast and northwest, so that two loci of specialization may be said to exist.

TABLE 1

Acreage and percent of late crop production in eastern, central, and western regions, 1920-24 to 1960-64.

Year	Eastern[1]		Central[2]		Western[3]	
	Acres (thousands)	Percent of total production	Acres (thousands)	Percent of total production	Acres (thousands)	Percent of total production
1920-24	768.0	33.3	1,524.2	46.3	479.6	20.4
1930-34	722.9	38.3	1,436.6	32.2	529.3	24.5
1940-44	629.1	37.4	959.6	30.6	467.0	32.0
1950-54	347.7	37.7	364.3	24.0	356.4	38.3
1960-64	301.0	32.9	354.0	23.1	448.2	44.0

[1]New York, Pennsylvania, Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, and West Virginia.

[2]Minnesota, North Dakota, Wisconsin, Michigan, South Dakota, Iowa, Ohio, Indiana, and Illinois.

[3]Idaho, California, Colorado, Washington, Oregon, Nebraska, Montana, Wyoming, New Mexico, Utah, and Nevada.

Source: Crop Production, Annual Summaries, SRS, USDA.

When the trend toward regional specialization commenced however, this was not the case. (Table 1) In the 1920's the central region produced almost one half of the late crop but it diminished in importance to less than one quarter in the period 1960-64, due to a declining acreage and an increase in yield which was not as spectacular as in the other regions. The western region compensated for this decline with a twofold expansion, while production in the east tended to increase slightly in absolute terms, but nevertheless continued to fall as a proportion of total production.

Idaho has had the most significant effect on the industry in the western region. In the period from 1920-24 to 1960-61, Idaho increased its share of regional total from 19 to 57 percent. North Dakota almost quadrupled its proportion of the central region total over the same period but the importance of the corn belt states as potato producers declined markedly. Pennsylvania has had the most dramatic decline of the eastern states but Maine's importance has increased from one third to one half of the region's production over the period. Production in New York has remained more stable except that it has been replaced by Maine as the largest producer in that region.

It is noted that with regard to yield the shift toward specialization was accompanied by a widening discrepancy between specialist and nonspecialist states. When farmers specialize in a product it is reasonable to expect that every effort will be made to increase the use of fertilizer, plant better seed and adopt better

cultivation practices generally. This indeed seems to have been the case as is evident from Table II, which shows that although notable increases also occurred in nonspecialist states, their performance is generally outstripped by the yield pattern in the specialized states.

TABLE II

Changes in acreage yield and production of late-crop potatoes in selected specialist and nonspecialist states, 1920-24 to 1960-61

Item and Unit	Specialist States[1]			Nonspecialist States[2]		
	1920-24	1960-61	percent change	1920-24	1960-61	percent change
Acreage (1000)	522	649	+ 24	1,627	362	- 78
Yield per acre (Cwt.)	93	201	+116	61	174	+185
Production (mil. cwts.)	49	130	+165	100	63	- 37

[1]Colorado, Idaho, Maine, North Dakota, Oregon, Washington.

[2]Michigan, Minnesota, New York, Ohio, Pennsylvania, Wisconsin.

Source: Simmons, op. cit., p. 13.

Relationship of Production to Size of Farm

Among the more significant changes which have occurred, particularly at the farm level in recent decades are:

(1) the large reduction in the number of farmers growing small quantities for home consumption, and

(2) the drastic decline in the number of farmers producing potatoes over the years. But the acreage grown per farm has increased with the result that a small number of farms now produce the bulk of the crop.

TABLE III

Number of farms reporting potato plantings, acres and bushels harvested, for different size categories, 1949 and 1959

Farms with acres harvested	Total Number Reporting		Acres Harvested		Bushels Harvested	
	1959	1949	1959	1949	1959	1949
All	684,853	1,649,906	1,200,431	1,515,283	373,567,119	366,527,787
<20 bushels	843,806[a]	988,320[b]	802[b]	1,136[c]	4,129,803	7,693,333
0 - 2.9	173,115	599,182	64,995	276,083	8,332,045	26,805,945
3.0 - 9.9	7,944	31,165	40,974	158,824	9,624,487	29,771,660
10.0 - 24.9	7,688	17,710	120,522	271,446	37,394,559	70,181,210
25.0 - 49.9	5,828	8,001	205,569	271,448	66,929,913	77,272,543
50 or more	6,492	5,078	767,569	536,296	247,156,312	154,803,096

[a]Harvesting < 20 bu.

[b]Small quantities for which no acreage

[c]By difference

Source: Census of Agriculture: 1949 and 1959.

Table III partly illustrates these trends. The total number of growers producing potatoes fell by 58 percent from 1949 to 1959. The decline was greatest among those growing noncommercially if we assume that all growers having 20 or more bushels are commercial producers. Only the number of farmers reporting 50 acres or more increased and, in the 1959 Census of Agriculture, farms with 50 acres or more comprised less than 1 percent of the total number of potato growers, but accounted for almost 65 percent of the total production. This is in contrast to the corresponding data for 1949 when farmers growing 50 or more acres produced 42 percent of the total quantity. The changes which are taking place in the distribution of acreage among farms, and which are likely to continue, involve larger acreages being grown on individual farms which must necessarily lead to larger capital investments in mechanization and storage facilities.

It is also possible that the trend towards regional specialization would have been more accentuated were it not for the fact that differences in transportation costs favored producers in close proximity to large population centers. For example, in 1960 the freight rate from Caribou, Maine, to New York averaged only $.77 per hundredweight; from Wayland, New York $.50 and from Twin Falls, Idaho to New York City $1.85.[3] Thus it appears that transportation-wise Idaho producers were disadvantaged in the New York City market. Yet, the presence of Idaho products on the market must be attributed

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[3]Simmons, op. cit., p. 52.

to the fact that these producers marketed a specialized product which commanded a premium price and by the fact that these specialized producers enjoyed a production advantage, which enabled them to dispose of their product at a lower per unit price.[4]

Earlier in the century, the larger cities adjacent to potato growing areas were supplied by them. A glance at Chart IV shows that potato production has moved away from populous centers and, in fact, the great population centers of the nation - with the exception of California - are now deficit areas. Of course this has led to increased marketing costs and services as potatoes are hauled great distances from Idaho, Maine and California. Arising from this the producer's share of the consumer's dollar for potatoes has declined in recent years and it is to be expected that as processing increases in importance the share will diminish even further.

Variations in Price and Income

Since the termination of price support programs in 1950, producers must make their own adjustments in response to market prices. Consequently, because of the inelasticity of the demand for potatoes and variations in yield from year to year, producers have had to contend with instability in prices and income. This has been associated with the failure of the industry not to adjust supply in response to low prices.

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[4]Raleigh Barlowe, Land Resource Economics, Englewood Cliffs, N.J.: Prentice Hall, Inc., 1958, p. 248.

With respect to price and income fluctuations, Chart V shows the variation in prices from 1910. With the exception of the years 1943-1950 fluctuations averaged more than 50 percent annually but were reduced to about 20 percent for the period 1943-1950.

The coefficient of variation was used to measure the degree of variation relative to the overall average. Michigan was used as an example to compare the coefficient for potato prices for the period 1955-1964 with prices received by farmers for what might be considered alternative enterprises.

TABLE IV

Measure of variability of prices received for some farm products 1955-1964

Potatoes	Beef	Dry Beans	Corn	Whole Milk
25	13	8	7	3

Source: Michigan Agricultural Statistics.

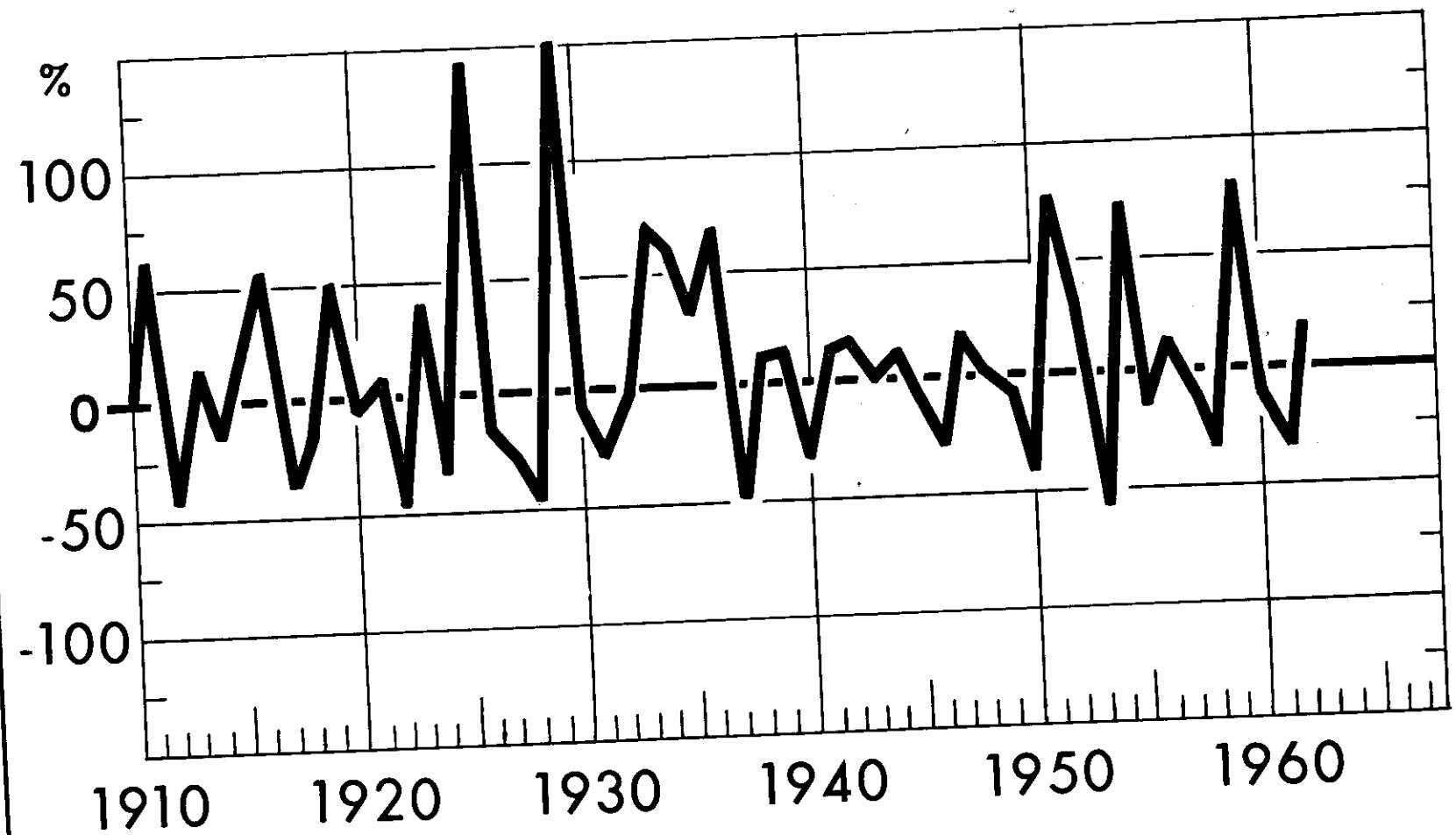
Table IV indicates that of the products chosen the variation in prices received for potatoes is the largest for any enterprise. Furthermore, because of the inelasticity of demand these wide fluctuations in price lead to sharp changes in year to year income. Inelasticity of demand suggests that when the percentage change in price is larger in absolute value than the associated percentage change in quantity then the effect of the price change will dominate and total receipts or income will move in the same direction as price.[5] This means that a

[5]Milton Friedman, Price Theory, Chicago: Aldine Publishing Company, 1962, p. 20.

Chart V

VARIATION IN POTATO PRICES

Year-to-year Percentage Change in Deflated Potato Prices *



* SEASON AVERAGE POTATO PRICE DEFLATED BY INDEX OF PRICE OF ALL FARM PRODUCTS.

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relatively small change in production results in a much larger change in price. For potatoes, it has been estimated that a 5 percent change in production was associated with an opposite change of 25 percent in prices received by growers.[6]

Variation in output is the other major determinant of the fluctuations in income received from potato production. These arise from decisions of producers and factors usually beyond their control such as natural phenomena. About 60 percent of the year to year variation is due to change in acreage and 40 percent to changes in yield.[7] Variations in acreage arise directly from decisions of producers in the aggregate, but differences between acreage planted and harvested are probably due to weather or disease and pests. In estimating the supply elasticity for the total late crop, Olson concluded that it lay between 0.16 and 0.13 or less than the price elasticity of demand.[8] This would suggest a converging situation with respect to supply and demand and a tendency to adjust towards equilibrium but when data on prices and acreages planted in succeeding years are observed adjustments along these lines are not the order.

Despite unfavorable prices there is a persistent tendency towards overproduction as indicated by acreage planted and surpluses. Low prices have not resulted in the expected reduction in planting

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[6]Simmons, op. cit., p. 35.

[7]Robert E. Olson, Economics of Potato Utilization, Fourteenth National Potato Utilization Conference Report, ARS, USDA, November, 1964, p. 16.

[8]Olson, op. cit., p. 16.

in succeeding years. Thus it appears that the more efficient producers find potato production a profitable enterprise. Perhaps areas where specialization is now taking place have fewer alternative opportunities and so potato production is adhered to, but a more plausible explanation may be found in the fixed asset theory.[9] The analysis developed in this theory suggests that where a dual pricing of acquisition and salvage prevails, there is a range of falling prices over which the farm will not contract output and will not do so until the marginal value productivity of the asset becomes less than the salvage value. It would appear that as more and more capital is invested in the potato industry then, in fact, the tendency towards overproduction may be perpetuated.

Potato Production in Michigan

Michigan's importance as a potato producing state formerly ranked much higher in the nation than it does at present. In the second and third decades of the present century it fluctuated in rank from first to third but it has been steadily falling in rank since that time. In 1964 it was ninth in the nation in acreage and eleventh in production and accounted for approximately 3.4 percent of the acreage and 3.3 percent of the production. The contribution of the crop to the agricultural economy of the state cannot be described in the aggregate as of great significance, as only 2 percent of cash

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[9]Glenn L. Johnson, "The State of Agricultural Supply Analysis," Journal of Farm Economics, Vol. 42, No. 2, pp. 441 et seq.

receipts from farm marketings was accounted for by the crop and yet in a few counties, the economy is heavily dependent on potatoes. Total value of production amounted to $27 million in 1964 but this was above the previous three year average by about $11 million due to the abnormally high prices received in that year.[10]

The trend which has taken place in the United States, and particularly in the North Central or Lake States area, is well illustrated by Michigan which has had a very spectacular decline in acreage, especially since the third decade of the century. Chart VI indicates that acreage has been falling almost consistently since the 1921-25 period with the exception of 1931-35 when on the average 253,000 acres were harvested and a record of 323,000 acres was attained in the years 1934 and 1935.

In the last five years an average of 48,000 acres were harvested and a low of 45,000 acres was reached in 1964. The erection of a new processing plant in Montcalm County resulted in an increase of approximately 7,000 acres for 1965. The period over which the largest decline took place in the state approximately corresponded with the great emphasis in regional specialization over the nation as a whole.

Yields on the other hand, have shown a marked contrast to acreage, more than tripling in the period 1926-30 to 1961-63. The trend has been even more marked in the last decade and has been

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[10]Michigan Agricultural Statistics.

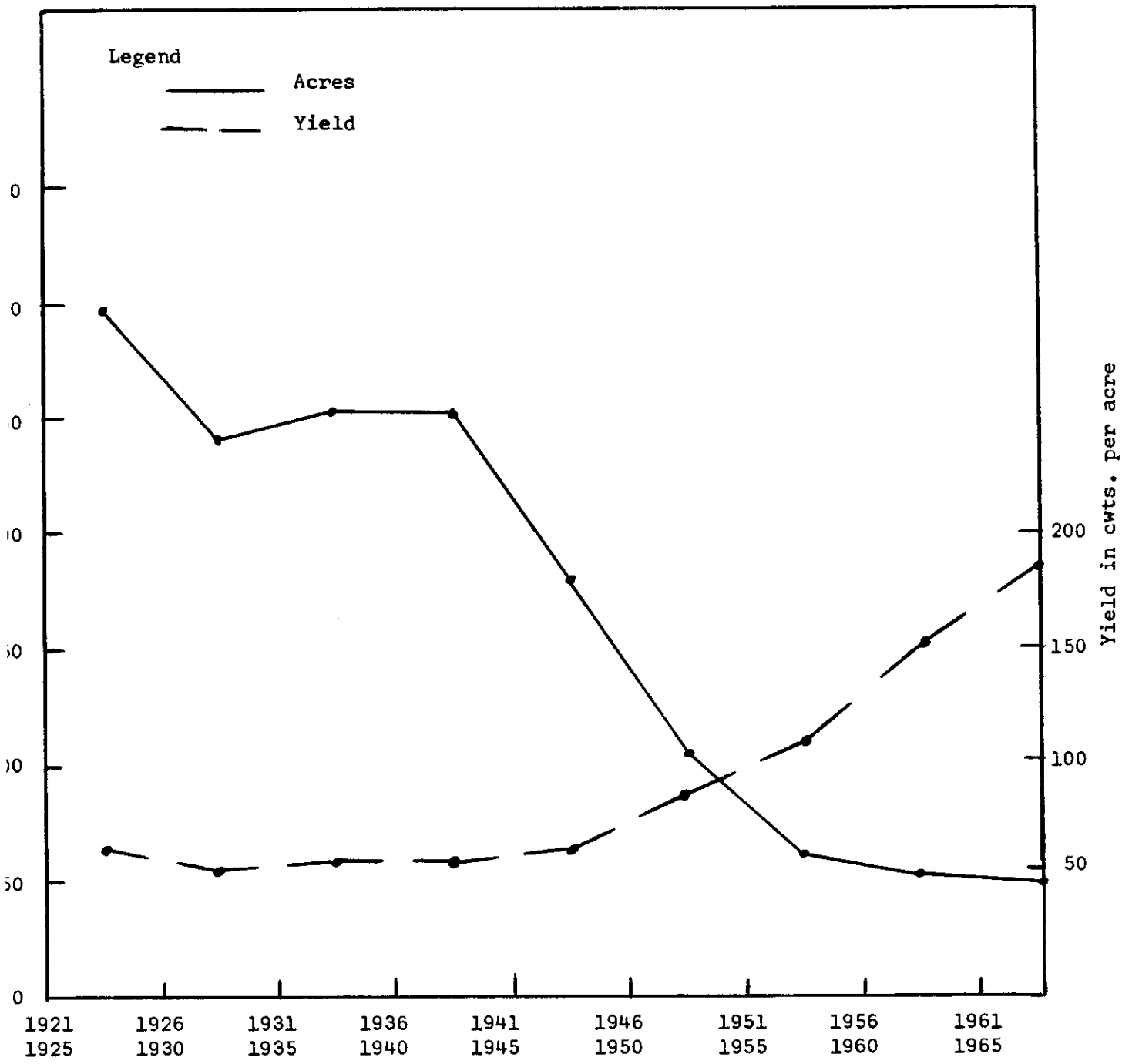

Chart VI. Acreage and Yield, Michigan Potato Crop, Five Year Averages, 1921 - 1965.

attributed to improved varieties, better production practices, a more liberal use of fertilizer and increased use of irrigation. Were other variables to remain constant the anticipated increase in irrigation alone would almost certainly encourage some expansion in production in the years ahead. Despite the very favorable situation with respect to yield, it was not sufficient to offset loss of production due to rapidly declining acreage. There was an overall decrease in total production of 41 percent from 1926-30 to 1961-63. If the assumption is made that the average population of Michigan over the last five years was eight million then, using the national per capita consumption, there was little difference between production per annum on the average and the requirements of the state in terms of food. However, some quantities of the state's production are sold out of state and others are fed to livestock or used for seed and losses occur from shrinkage and disease. In 1960, Michigan was included among those states which had a deficit of four million hundredweights or over.[11] This deficit has in large measure been filled by imports from Maine and Idaho which usually command a higher price at the retail level than the produce of the state.

County Changes

The Michigan Crop Reporting Service estimates, on a county basis, of acreage, yield and production of potatoes are available

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[11]See Chart IV, Supra, p. 21.

for the period 1943 to 1963, and the pattern of distribution of the crop over that period follows the overall pattern of the nation. Whereas in 1944-48 the six counties with the largest acreage accounted for 27 percent of the state total, in 1959-63 the top six counties grew 47 percent of the acreage. This trend marks the extent to which the crop has become specialized area-wise in its production. The six counties which in 1963 were the most important in this respect were, in order, Bay, 7700 acres; Montcalm, 6500; Presque Isle, 3600; Allegan, 2100; Lapeer, 1800 and Monroe, 1200 acres. Because the potato is adaptable to most soils and in view of the lower land values one would expect that the crop might have potential in the Upper Peninsula, but the acreage has declined there almost to the same extent as for the state as a whole. Little specialization among the counties seems to have occurred in the Upper Peninsula. Whereas Houghton County was one of the six most important in the state in the last decade, it has now dropped out of this category.[12] This is difficult to explain but it is probably due to a combination of poor resources, small farm size and differential transportation costs relative to the more intensive areas within the state. These areas on the other hand have more favorable soils and are in a more advantageous location relative to the new processing plants in the state.

How the industry will meet the challenge of the future is

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[12]Michigan Agricultural Statistics.

difficult to predict. Project '80 projections for potatoes anticipate that if Michigan maintains its present share of the fresh market by 1980, 30 percent more potatoes will be produced, with little change in acreage expected, but a marked increase in yield is expected. It is probable that the decline in acreage in areas further removed from the present areas of concentration will be offset by increases in acreage arising out of the location of new processing plants in the state.

CHAPTER III

THE NATURE OF COSTS

Mechanization of the Potato Enterprise

One of the most significant changes in American agriculture is the degree to which mechanization, or the substitution of power and equipment for labor, has taken place. This is typified by the shift from farm produced to purchased mechanical power. In 1910, virtually all power used on farms was produced on farms, but the transition from farm produced to nonfarm produced power progressed rapidly after 1940, and in 1957 only about 10 percent of the power was of the non-mechanical variety as measured in terms of 1947-49 constant dollars.[1]

Arising from the substitution of mechanical for farm produced power was a concomitant increase in the use of purchased equipment adaptable to the new source of power. Hence, increased mechanization permitted the mobility of agricultural labor to nonfarm employment and acted as a boost to the economy as a whole. The relative shortage of labor in agriculture in recent times has accentuated this trend and furthermore, since 1960, retail prices of farm machinery and motor vehicles have increased at an annual rate

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[1]Ralph A. Loomis, and Glenn T. Barton, Productivity of Agriculture, United States, 1820-1958, Tech. Bul. No. 1238, ARS, USDA, April 1961. p. 16.

of 2 percent, while over the same period the farm wage rate increased annually by 4 percent.[2] It is hardly surprising then, that increasing emphasis is being given to the development of labor-saving techniques in all aspects of production. Improved machinery has permitted a saving in other inputs as for example in the case of a more accurate drill, where a substitution for seed or fertilizer is possible.

Mechanization is generally output-increasing and because of the substitution factor involving a smaller labor force, output per worker is also enhanced. Production per man increased about 140 percent from the Civil War to World War II and has made a more rapid increase of greater than 50 percent since that time.[3] Another advantage of mechanization is timeliness--the ability to carry out critical operations in a relatively short period of time, or to take advantage of favorable weather or minimizing effects of unfavorable weather. Allied to this is the possibility for improvement in the quality of produce such as hay, where the period of time when the crop is exposed to the weather is shortened. Other, but nonetheless important, advantages of mechanization are of a nonmonetary nature, such as more leisure time, or the elimination of drudgery.

While the pattern of the past is not necessarily a blueprint for the future, the assumption of relatively stable conditions in

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[2]USDA, The Farm Cost Situation, 1966 Outlook Issue, ERS, November, 1965, p. 11.

[3]Lawrence A. Bradford, and Glenn L. Johnson, Farm Management Analysis, New York: John Wiley and Sons, June, 1962, p. 296.

the economy would not suggest that the opportunity cost for labor in nonfarm employment will decline relative to the agricultural wage. Taking Michigan as an example, Project '80 projections indicate that the rural farm population may represent only 3 percent of the total population in 1980. If production is to be increased despite this expected trend, then one important factor which will contribute greatly is the more efficient use of fewer farm laborers operating larger and better tractors and machinery, and the integration of various crop operations.[4] Indications are that the utilization of more machinery and equipment will proceed rapidly in the coming years, particularly for such labor-intensive enterprises as fruit and vegetable production, for which labor may account for 40 percent or more of total costs. Recent legislature in the state which may seriously affect the supply of seasonal labor will accentuate and hasten the need for highly refined, specialized equipment for handling fruit picking and vegetable harvesting - operations which were hitherto achieved through the employment of migrant labor.

Effect of Price Stability on Mechanization

The desire to invest in mechanization may be inhibited for crops exhibiting wide fluctuations in price and consequently a high price risk. For example Gray et al.[5] found that the introduction of price supports for potatoes in 1942 and the greater price certainty

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[4]Michigan Agricultural Experiment Station, Project '80 Phase III, Machinery and Equipment, March, 1965.

[5]Gray et al., op. cit., p. 6.

which accompanied them induced specialized potato growers to apply more capital in the form of machinery, equipment and overhead irrigation, more rapidly than would otherwise have been the case. Therefore, price risk may slow down the development of a favorable economic climate for mechanization and the least cost combination of inputs per unit of output may not be achieved, despite the fact that the overwhelming trend seems to be in favor of a greater substitution of capital for labor.

Importance of Labor in Potato Production

Labor is one of the major factors of production in commercial agriculture, particularly where the potato crop is concerned. An analysis of potato production costs from certain experimental stations provide some insight into the importance of labor in production. In a central Aroostook County study in Maine, Pullen and Tuthill found that labor cost was the largest item in growing, harvesting and storing the crop and amounted to $137 per acre or 33 percent of total costs for all farms. When the two-row conventional digger was the dominant type of harvesting equipment used, machinery and equipment charges were calculated at $47 per acre, or 15 percent of all costs.[6]

A Cornell study allocated $87 per acre to labor costs in growing and harvesting the crop. This accounted for 28 percent of the cost of production of which $48 per acre was charged to machinery

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[6] Winston E. Pullen, and Dean F. Tuthill, Cost of Producing Potatoes, Bul. 635, Maine Agr. Expt. Sta., Orono, Maine, May 1955, p. 43.

and equipment. Storage and marketing were assessed at a cost of $97 but no breakdown of the components of this cost is given.[7] Here again, only one quarter of the growers in this study had either self-propelled or tractor-propelled harvesters.

In a September, 1964 report on potato production in the Red River Valley area of North Dakota, Maier and Leftsgard arrived at a figure of $16.80 for labor costs on an acreage basis for all farms in their survey, which was conducted to investigate the cost of producing and harvesting the crop. This represented 16 percent of all costs and it appears that the relatively low figure can be attributed in part to the fact that 92 percent of the crop was harvested by the direct method. Consequently, machinery and equipment usage accounted for a higher proportion of the total costs and amounted to $30 per acre - 28 percent of all expenses.[8]

Withers analyzed potato production costs in two separate areas of Idaho and on the basis of one study concluded that $38.25 was spent on labor to grow the crop. This accounted for 18 percent of all costs, while machinery and equipment costs amounted to 31 percent or an average of $64.25 per acre. The crop was harvested by the direct method and irrigation equipment expenses also formed

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[7]C.D. Kearl and D.P. Snyder, Costs and Returns in the Production of Potatoes, A.E.R. 160, Cornell Agr. Exp. Sta., Ithaca, New York, January, 1965.

[8]Melvin G. Maier and Laurel O. Leftsgard, Potato Production - Costs and Policies in the Red River Valley, Bul. No. 457, Agr. Exp. Stz., North Dakota State University, Fargo, North Dakota, September, 1964, p. 25.

a significant proportion of the outlay.[9]

No empirical data are available for Michigan in order to arrive at comparable costs of production, but the foregoing analysis does imply that labor is a more important factor in some areas than in others, due primarily to the nature of the factor mix. The data from Maine are characterized by the seemingly disproportionate amount of labor costs, both in an absolute and relative sense. It can be postulated that low opportunity costs for labor both within the farm among enterprises and in the nonfarm sector in the area could, conceivably, result in an irrational use of labor, which if valued at the standard rate would lead to an overstatement of its importance. Low opportunity costs, therefore, for this input will tend to inhibit the adoption of labor-saving techniques on some farms. Of course, this is true for agriculture as a whole, where in the absence of out-migration labor may retard necessary production adjustments. It follows, ceteris paribus, that the opportunity cost of any labor which is saved by the substitution of machinery should be at least as great as the cost involved in mechanization to justify its adoption.

The Seasonal Nature of Labor Requirements for Potatoes

Allied to the absolute importance of labor in potato production is the difficulty imposed by the stringent requirements

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[9]R.V. Withers, Potato Production Costs, Bul. No. 447, Idaho Agr. Expt. Sta., Moscow, Idaho, August, 1965, p. 12.

of its seasonal distribution. Peak periods occur at planting but primarily at harvesting time and whereas the timing of the former may be delayed by unfavorable weather conditions, the duration of the harvesting period is of critical importance due to the danger of early frosts seriously affecting the quality of the crop. In Maine, for instance, the number of suitable harvesting days ranges from 20 to 25 days so that the mobilization of labor and machinery for this purpose must be achieved in that period.[10]

Chart VII shows the seasonal distribution of labor requirements for each month as a percentage of the total. This includes both hired and unpaid family labor; the data being derived from an average of Maine and Red River Valley estimates. It is assumed here that methods of planting and harvesting have little influence on the seasonal labor requirements. Over 50 percent of the total labor is required for harvesting and storage, which points up the seasonality of the crop. Consequently, concentrating on one enterprise which imposes such restrictions in terms of labor will leave this factor, or at least the proportion that is permanent, largely unemployed over a long period of the year. This is undesirable from a profit maximizing point of view and supplementary enterprises could be added to absorb excess labor. An enterprise of a livestock nature, such as a cattle-feeding project, could be profitably employed in

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[10]Winston E. Pullen, New Potato Harvesters Cut Digging Costs, AEE Rpt. No. 105, Department of Agricultural Business and Economics, University of Maine, Orono, Maine, September, 1962, p. 2.

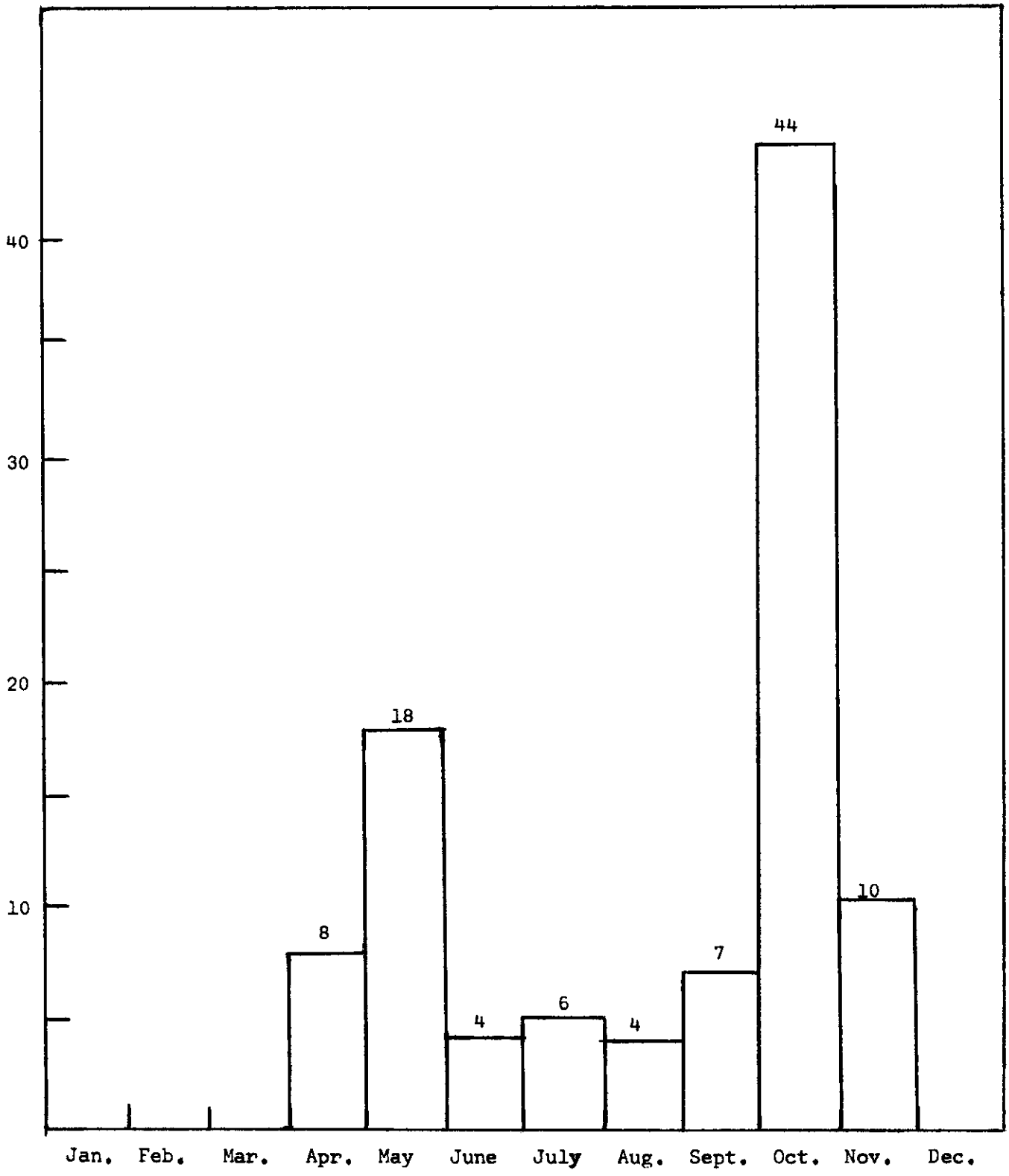

Chart VII. Percentage Distribution of Labor Inputs By Month

this respect, particularly in winter, or advantage could be taken of off-farm employment, if available during the slack season.

While mechanization will tend to substantially reduce labor costs and requirements in an absolute sense, it cannot affect its seasonality except insofar as the introduction of irrigation will enhance the use of labor during the summer months, but minimum tillage will require less in spring and early summer. It appears that harvesting will continue to be the most demanding operation in terms of labor. Few sizable operators could hope to deal with this restriction by relying on a permanent labor force. Even allowing for a modest degree of enterprise supplementality, the operation of the modern harvester requires 6 to 8 men to handle the harvesting and storage of the crop. Operators must then resort to casual labor to ease the bottleneck or else face the consequences of extending the harvesting in both directions, with its attendant disadvantages. In such circumstances, least cost criteria may be difficult to implement but this problem may be overcome in the future with new technology.

The Nature of Costs in Potato Production

Before attempting to outline the conditions necessary to justify particular investments at the farm level, and to use budgetary techniques to point out the relationships between size of the enterprise and needed investment using hypothetical output and input data, we briefly discuss here the nature of the costs in the production of potatoes and the assumptions underlying the budgets used.

The factors which influence production response in the static

theory of production are (1) the production function or the relationship between resource and output, (2) prices of products and competing products, and (3) costs of inputs or resources.[11] Discussion is limited in the remainder of this chapter to the third factor because the operator has much greater influence on costs and resource combinations, than he has in either of the other two areas. In fact, with reference to potatoes the Michigan growers can be said to be "price takers" because of the small proportion of the market which they supply. In the real world, uncertainty, fixed factors, capital rationing, nonmonetary goals, multi-product farms, complementary and supplementary relationships seriously complicate the model, which assumes profit maximization, so that in reality marginal productivity theory, while ideal under conditions of certainty, is difficult to adhere to.[12] Therefore, in planning, estimates or predictions of the future cannot be formulated with accuracy and there may be no unique way or basis for assigning probabilities to future events. In this particular instance, farmers often rely on their own judgement, and decisions are made on the basis of the confidence which they place in their estimates. The wide fluctuations in potato prices are no cause to inspire great confidence in price estimates, but with the growing tendency to plant potatoes on contract, farmers should be in

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[11] E.O. Heady, "Use and Concepts in Supply Analysis," Agricultural Supply Function, in Heady, E.O., et al., Ames, Iowa, Iowa State University Press, 1961.

[12] Robert Alton Young, "An Economic Study of the Eastern Beet Sugar Industry," (unpublished Ph. D. dissertation, Dept. Agr. Econ., Michigan State University), p. 7.

a better position to utilize their resources more efficiently in the future.

Factors of production in potato growing, as in many other enterprises, fall into three categories and the relationship between input and output can be expressed in the following equation:

$$Y = f(X_1 \ldots Xd/Xd+1 \ldots Xg/Xk+1 \ldots Xr$$

The first category of inputs $/X_1 \ldots Xd_1/$ is variable for the farm as a whole and is perfectly priced, i.e., acquisition and salvage values are equal - these are best represented by fertilizer, seeds and hired labor. The inputs /Xd+1...Xg/ are fixed for the farm as a whole, but variable among enterprises and the relevant costs are their opportunity costs. Farmland, tractors and cultivating equipment would come under this heading. The third category is fixed for each enterprise in potato production and includes planters and harvesters. Here, the relevant prices are the marginal value productivities of the inputs which are bounded by their acquisition and salvage prices. The greater the relative level of factors of production in the third category the more committed the farmer will be to the system of farming to which these investments are specific. Once investments are made in specialized inputs, the operator will tend to employ them as long as their marginal value products exceed their salvage values. It may be argued that an irrigation system for potatoes would fall into this category but it does have alternative uses which sometimes entitles it to be placed in the second category. With potatoes it is highly possible for the marginal productivity of an input to be less than its salvage value in certain years, but on the average, it

must be greater for the operator to stay in production.

In a given situation and for a given output there are two principal methods of increasing profitability, namely higher prices or lower costs. Unfortunately, in public debate on agriculture, the former approach seems to be aired more frequently and undoubtedly it is a far less troublesome way of achieving the desired goal. In the production of potatoes it may be to the advantage of the producer to seriously examine the nature of his costs, as his power in influencing prices is limited.

For many of the inputs, such as seed and fertilizer, fungicides and sprays, the costs are given to a large extent. Labor, power and equipment costs, on the other hand, usually constitute from 45 to 50 percent of the total and it is in this area that most economies can be effected through the use of the substitution principle. If one were to study the extent of mechanization in agriculture, it is probable that under - rather than over - mechanization is the more prevalent, particularly with respect to the more labor-saving equipment. Furthermore, many obsolete methods which contribute to production could be found which not only lower prices but also result in earnings below expectations.[13] This is particularly true on farms where the labor is a fixed factor and may be earning less than its marginal product but it can also occur in a

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[13]Glenn L. Johnson, "Implications of the IMS for Study of Response to Price," A Study of Management Processes of Midwestern Farmers, in Johnson, Glenn L. et. al., eds., Ames, Iowa State University Press, 1961, p. 168.

situation where casual labor is used. The prevalence of this situation may be attributed to imperfect knowledge or to the difficulty involved in acquiring new capital. Purchase of new equipment is also one of the most important factor-purchase problems because of the fact that overinvestment may lead to capital losses. Although there is almost always a lag in the adoption of new technology, it will be greatly influenced by the relative costs of what is to be replaced and the new substitute. Expansion in acreage, per se, will almost certainly encourage mechanization because both planting and harvesting periods are restricted in terms of time to a relatively short span. Factor substitution among other inputs in the production function is rather limited at the farm level. Land values do influence costs, however, from area to area. For instance because of the limited range of alternate uses, land values in the Upper Peninsula are much lower than those in the southern part of the state and for moderately productive soils the respective values are 75 and 225 dollars per acre,[14] but, of course, this advantage is offset to some extent by increased costs of transportation.

It is also possible that many farms are operating over the decreasing cost range of the average short run cost curve and that cost per unit of output may be diminished by an increase of acreage not necessitating any increase in the fixed factor input mix. To illustrate, the author has spoken to farmers who have admitted that

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[14]Lynn J. Maish,"The Economics of Beef Cow Herds in Michigan," (unpublished M.S. thesis, Dept. of Agr. Econ., Michigan State University), p. 112.

their present irrigation system was not utilized to capacity. Obviously, this practice is hardly consistent with the concept of efficiency which relates output to input, and this applies to labor or to any other variable factor. Reduction of costs may also be, and often is achieved by an increase in scale of the enterprise. This is one of the obvious reasons why enterprises are enlarged to take advantage of economies of scale. Studies which have been referred to earlier bear out this point, that the size of an enterprise is an important factor in potato production efficiency. Furthermore, a large volume is necessary because of the narrow range between costs of production and product prices.

In the production of potatoes, few examples of perfect substitutability or complementarity exist, except perhaps in the case of labor and machinery where respective price relationships are important. Some replacement of fertilizer for land can also occur but to what extent this is consciously practiced is unknown. With respect to complementarity some examples may be cited, which though not always put into effect are at least recommended. For instance, farmers who plant certified seed might be expected to apply adequate amounts of fertilizer while growers with irrigation equipment are urged to plant more seed and add more plant food to take advantage of the extra water.[15] In a broad sense good production practices are complementary to the inputs in attaining a desired output, under

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[15]A.E. Kehr, R.V. Akeley and G.V.C. Houghland, Commercial Potato Production, Ag. Handbook No. 26, ARS, USDA, July, 1964, p. 36.

the assumption of equating marginal cost with marginal revenue.

Unquestionably, soil type is an important factor in production and has been responsible for a major share of the regional specialization which has now taken place. Among the best soils for potato growing are well drained, sandy gravelly and shale loams richly supplied with organic matter and other plant nutrients.[16] It is assumed that better quality soil will be used for potato production in Michigan by 1980 than at present. This should also lead to a greater efficiency in production as many marginal dairy farms are located on soils that are capable of producing good quality potatoes with high yields.[17]

Cooperative ownership of machinery and equipment of the planting and harvesting type is another possibility in reducing costs. Little is known of the extent to which this practice is in existence but it is at least deserving of some attention. One or other or a combination of the foregoing items are worthy of serious consideration by the operator who is anxious to continue in potatoe production. Concentration on prices alone is not a sufficient approach to a proper operation of the business of any enterprise. Apparently the problem resolves itself into one of better management, with a constant review of expenditure at all stages of production.

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[16] Ibid., p. 22.

[17] Project '80, op. cit., passim.

The Partial Budgeting Approach

With the foregoing discussion serving as a back-drop, attention is now turned towards a consideration of the capital investments involved in meeting the requirements of operations of different sizes. Investments necessary for potato production are much larger, on the average, than for most other field crops and this may prove to be somewhat of a deterrent to new growers. Partial budgeting techniques are employed to determine the magnitude, and to examine the effect of price in relation to these investments. Data are essentially of a hypothetical nature but are reasonably rooted in reality, as a consequence of contacts with growers, extension personnel, specialists and retailers. Special emphasis is being given to irrigation which is looming large in importance with the rapid expansion in acreage now taking place in Westcentral Michigan.

Partial budgeting is employed because the consequences of a shift in resources from other enterprises are not taken into consideration. The usefulness of the estimates is a function of the accuracy of the physical and financial data employed. It must be remembered that partial budgeting assumes the input-output coefficients to be constant, and their variances zero, or that the production function is linear and homogeneous.

While it would possibly be more desirable to approach these questions using survey data and to obtain information from farms with different organizations, it is often better to wait until a certain number of farmers have "provided their own guidance" and

have adopted a new organization or practice.[18] In such cases, partial budgeting used in estimating outcomes does provide some predictions and therefore can be of help to farmers contemplating changes in their operations or entering a new line of business. This is of particular importance when the investment is of a very specialized nature and where little room for flexibility is allowed.

Estimates arrived at in partial budgeting will be repeated in practice purely by chance, as every farm situation is unique in some respect. Thus, consequences of different actions are likely to follow a normal distribution and it is hoped that budgeting will give the operator, what will in all probability be a mean of the distribution of possible consequences for each action. It is not possible to make general recommendations which are to be followed by operators as farms vary with respect to acreage farmed, crops grown, capital availability, etc., but the shrewd operator should be able to interpret its results to fit his peculiar situation. For one, economies may be affected by cooperative ownership of machinery, for another, it may not be possible to acquire more capital to attain a desired level of output.

Assumptions for the Budgets

The partial budgets are based on the assumptions developed below. As previously mentioned and as is implicit by definition,

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[18] E.O. Heady, Budgeting and Linear Programming in Resource Productivity, Returns to Scale and Farm Size, Heady et. al., Eds., Iowa State College Press, 1956.

only that part of the farm organization which is concerned with potato production is examined. The objective is mainly to emphasize the role of capital investments for the specialized equipment requirements of potato production, particularly in an irrigation system, in the production of 100, 200 and 400 acres of potatoes.

Planting equipment poses no real problem in terms of investment as there appears to be no economic alternative to the automatic planter. The two row planter is assumed adequate to handle 100 acres of potatoes; one four-row planter is deemed necessary for a 200 acre operation; while one two-row and one four-row would be required to handle 400 acres over the optimum planting period. Fertilizer and systematic insecticide attachments are assumed to be incorporated into the planter.

Harvesting equipment is of a more diversified nature. The two-row conventional digger seems to be uneconomic in harvesting 100 acres, as is illustrated in Table IV, where a simple comparison is made between it and a one-row harvester, using data from Maine. Harvesters are either tractor drawn or self-propelled and one-row and two-row models are equally common on the market. On the basis of experience in Montcalm County, Michigan, the one-row harvester was quite capable of handling a 100 acre operation, while a 200 acre operation and multiples thereof, would require a complete two-row direct harvester per unit.

Investments in an irrigation system vary greatly between farms because of differences in costs of drilling wells or of possibilities of obtaining a surface source of water. Because of

the uncertainty of obtaining a surface source of water such as a pond or river on a farm, it was assumed that a well capable of supplying 1100 to 1200 gallons per minute would be the source for irrigation water. This does not imply that a natural supply of water might not be used, on the contrary, where an adequate supply was available it would prove to be much less expensive than a supply from a well.

We further assumed that no dry holes were struck as this increases the cost of the investment significantly, and that the costs of installation of a system were independent of the acreage over which the water would be used. Hence a well which was drilled could theoretically be employed to supply sufficient water ranging from zero to 200 acres, Two wells with the above capacity per well, were considered adequate for 400 acres and the cost of pipings, fittings and sprinklers were assumed to be a linear function of acreage.

Operators who irrigate will be expected and well advised to increase the use of other inputs because of the positive interaction which exists between these and water. The removal of water as a limiting factor opens up numerous possibilities for the increased utilization of other inputs, which would yield a zero or negative return in its absence. Hence, additional expenses on fertilizer and seed to the extent of 25 percent were budgeted. Extra expenses arise because of increased labor costs for operating the irrigation system itself and for handling the expected increase in volume of potatoes; for harvesting and hauling; for power costs and for depreciation and interest charges on investments.

In humid regions such as Michigan, irrigation may be more profitable in some years than in others. This depends on the amount of summer rainfall and its distribution in any particular year. Irrigation almost always increases yields and quality whenever the soil moisture falls below 50 percent of the soil waterholding capacity. Care must be taken, however, to avoid oversupplying the crop with irrigation water beyond its optimum moisture capacity.[19] The expected average increase in yield will determine the question of whether to irrigate or not. In Michigan, this increase will vary from year to year and from farm to farm. For this study three levels of production responses were used, namely 30, 60 and 90 hundredweights per acre. In 1965, increases in yield of 90 hundredweights or more were frequently reported as a result of irrigation. Therefore, it is well within the realm of possibility to assume a response of this magnitude. The expected price structure will also be a prime determining factor in the profitability of irrigation. Consequently, three price levels were suggested, which when used in combination with the levels of production response, gave nine different net income situations for each size of operation. The lowest price of $1.50 per hundredweight closely approximates that which is received for potatoes used in processing. The median figure of $1.75 has been received by growers and in 1963 potatoes were sold for $1.65 on the average.[20] Most farmers would expect to

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[19]Kehr et al., op. cit., p. 36.

[20]Michigan Agricultural Statistics.

Calculations suggest that the two-row conventional digger is uneconomic on a 100 acre operation. (Table IV) What is of concern to growers is the question of whether investment in a deep well irrigation system is worthwhile, and if so, under what conditions. An increase in yield of only 30 hundredweights over the range of prices used would fail to cover all costs by approximately $25 to $10 per acre (Table V). An increase of at least 60 hundredweights per acre is necessary to justify irrigation at the price of $1.50 per hundredweight. Thus, the breakeven point would be roughly a production response of this magnitude at this price. Indeed, no negative returns were produced by either a 60 or a 90 hundredweight response irrespective of the three prices used, and this was so for both the 200 and 400 acre operations. In consequence a response of 30 hundredweights was not sufficient to justify an investment in a deep well system of the order of magnitude suggested in Table V.

The 200 Acre Operation

An investment of $40,200 was required to handle 200 acres of potatoes in accordance with the tenets of recommended practices. On an acreage basis, this was $2 less per acre than for the 100 acre category because of decreasing average costs, but it is doubtful if a larger operation could be handled with this investment, as in normal circumstances this scale would tax the capacity of both the irrigation system and the harvester.

Fixed costs per acre are also substantially lower. A charge of $26 per acre was made for depreciation, interest on investment and insurance, and this amounted to a decrease of 20 percent

per acre by comparison with the smaller acreage--the major saving occurring in fixed costs associated with the irrigation system.

In reviewing the changes in net income arising out of irrigating the crop, the pattern corresponds rather closely to that for the 100 acre operation. The difference in per acre terms is closely related to the different cost structure in the fixed cost category. Here again all changes in net income resulting from an increase of 30 hundredweights per acre were negative or, in other words, irrigation with this production response was not profitable even at a price of $2 for the produce. The median response was of significant importance even with the lowest price structure and amounted in value to $2,320 in absolute terms, while the high response was profitable at all prices. There is no questioning the profitability of irrigation, even with a modern production response, at fresh market prices, which are assumed to be in the neighborhood of $1.75 to $2.00 on average. Of course, this seemingly favorable situation will be discounted to some extent by increased storage and packing costs. Irrigation of a 200 acre operation can therefore result in a loss of $3,980 to a gain of $18,220, or -$2 to +$91 per acre, depending on the production response and price level.

The 400 Acre Operation

Growing and harvesting an operation of this scale requires an investment in specialized capital equipment of $78,000 or $196 per acre. In absolute terms, this would equal the total investment of many Michigan farmers; thus potato production on this scale is

extremely capital-intensive. No data are available which might suggest how many operations of this size are in existence in the state but field trips did indicate that growers engaged in producing for processing were anxious to scale up the size of the enterprise if they were not already doing so. This is because the margin between costs and price is narrow, and volume is important.

Fixed costs per acre were practically identical with those for the 200 acre operation, with the exception of a small saving in planting costs due to the fact that the extra 200 acres could be handled with a two-row planter. (Table VI) Hence, changes in net income on an acreage basis were almost equal to the corresponding entries for the median operation. With the range in price and production levels given, expected changes in net income could range from -$7,960 to +$35,240. The breakeven point at a price of $1.50 per hundredweight would necessitate an increase of approximately 44 hundredweights per acre so that yield increases above that level were profitable given the magnitude of the operation. It is expected that the majority of the 400 acre operators, at least in Montcalm County, would be suppliers to the processing industry, and if the farmers were to receive both a high response and reasonable prices, the justification for irrigation would be beyond question.

Reflections on Investments for the Potato Enterprise with Particular Reference to Irrigation

Plans to invest in a business or enterprise depend upon current prices, expectation of future prices, opportunity cost of the investment and on the willingness to bear risk. An increased

willingness to bear risk will therefore be represented by a change in expected prices in favor of the planner; investments are made either to add to the output of an existing business such as irrigation, or to increase the size of the business itself such as purchasing more land. Oftentimes the business must be of a particular scale to justify further investment of an output-increasing nature, as for instance in the case of a complete harvester in potato production.

The major justification for investment in an irrigation system is, of course, to increase net income. This is mainly achieved through increased yields, but it is well known that quality may also be improved--although no data seems to be available to investigate the economic aspect of this factor. Year to year variations in production and income may also be reduced and this may encourage farmers to adopt other and more efficient production techniques.

When irrigation of potatoes was first introduced it was largely confined to the more arid regions of the country where little if any production could take place in the absence of water. Surface or furrow irrigation was more common in these areas at that time. When it was realized that the distribution of rainfall was also important, apart altogether from the absolute level, supplemental irrigation was adopted in the growing of potatoes and other high-value crops, in the humid areas of the country--the Eastern and Midwestern states. In these areas the use of portable overhead sprinkler irrigation is the more common but solid systems, which require less labor, are also being introduced. In an economic sense

CHAPTER IV

SUMMARY AND CONCLUSIONS

Summary.

The purpose of this study has been to investigate some economic aspects of the potato industry on a national basis and to enquire into the nature of costs associated with the production of the crop. Whereas a thoroughly comprehensive investigation would necessarily fill volumes, the main emphasis in this paper has been to try and relate consumption and demand to production and to try and pinpoint the adjustment processes which are presently taking place and which are likely to continue at an increasing rate in the years ahead.

Potato consumption has rapidly declined since the beginning of this century due to increased urbanisation, higher incomes and diet consciousness, a growing demand for convenience foods and a reduction in the volume of heavy manual labor. The first impetus was given to this trend by the decreasing proportion of foreign stock in the population since 1910. However, since 1950, this down-trend has slackened and this has been attributed to the increasing availability of processed potato products on the market, which now account for one third of the production used for food. From 1910 to 1968, acreage dropped by 60 percent but yields tripled.

Highly fluctuating yields, a strong market inelasticity of demand, and large fluctuations in income received by producers characterise the potato industry. Extensive government programs which had been in existence from 1943 to 1950 failed to contract production of the crop and retarded the trend toward specialised production which had commenced earlier. At the moment, only limited arrangements are in operation, but they have little effect on the total quantities marketed annually.

The regional pattern of production was collocated with population in the early part of the present century as transportation remained a limiting factor. Later it tended to move away from population centers as this barrier was overcome, and it is now located mainly in areas which have access to irrigation or which have few satisfactory crop alternatives. A relatively few states now dominate production. In 1964 Idaho, Maine, California and New York accounted for 52 percent of total output.

Among the more significant changes which have occurred at the farm level are the large reduction in the number of farmers growing small quantities for home consumption and the drastic decline in the number of farmers growing any quantity of potatoes. In the 1959 census of agriculture farms with 50 acres or more comprised less than 1 percent of the total number of growers but accounted for 65 percent of total production.

Because of the wide fluctuations in production and the inelasticity of demand growers face marked price and income instability from year to year. The coefficient of price variability

showed that changes in potato prices are greater than for alternative enterprises in Michigan. It has been estimated that the inelasticity of demand is -0.2 while the elasticity of supply is between 0.16 and 0.13. While this would suggest a converging situation with respect to supply and demand and a tendency towards equilibrium, this has not been the case as there has been a persistent tendency towards over-production. This may, perhaps, be partially explained by the fixed asset theory which states that resources will be retained in production as long as their marginal productivities exceed their salvage values.

The declining importance of the Lake States as producers is well illustrated by Michigan, which is now only ninth in the nation in acreage and eleventh in production. Potato production in the state accounted for only 2 percent of cash receipts from farm marketing in 1964, and within the state six counties grew 47 percent of the total acreage. The processing industry which is becoming established in the state may concentrate production even further.

Potatoes are expensive to produce and the crop is a relatively labor intensive enterprise. Studies in Cornell, Maine, North Dakota and Idaho suggest that labor may account for from 18 to 33 percent of total production costs and is negatively correlated to the extent of mechanisation of the crop. The demand for labor is particularly heavy at planting and harvesting time and over 50 percent of the total is required for the latter operation. This creates many difficulties not only in acquiring seasonal labor but also in providing alternative employment for labor in the remainder of the

season. As a consequence, increasing emphasis is being given to the economics of mechanisation in potato production, as it appears that one of the more obvious economies in production can take place in the substitution of machinery for labor.

Partial budgeting was employed to determine what economies could be effected in the production of the crop by mechanisation and to relate this to the size of the enterprise. More particularly, the impact of irrigation was examined with special reference to Michigan and the investments which might be required towards an efficient adoption of this practice were determined. It was assumed that a deep well system was the source of water and that inputs which are supposed to interact positively in production would be increased in use to take advantage of complementary water.

Using three levels of production response and three price situations it was found that a response of 30 hundredweight per acre was not sufficient to justify investment in an irrigation system even at a price of $2 per hundredweight. This was true for all sizes of operation for which budgets were employed. Even a median response of 60 hundredweights per acre at a price of $1.50 per hundredweight did not produce significantly more than a break-even point. With a low price level it becomes apparent that a high response is necessary to justify investment in an irrigation system; and it would appear that a modern single-well irrigation system should be employed to handle not less than a 100 acre operation and preferably in the region of 150 to 200 acres.

Conclusions.

The trend towards large scale production and specialisation in all phases of agriculture is presently proceeding at a very rapid rate and small scale producers are either enlarging their scale of operations or seeking employment in the non-farm sector. Potato production is no exception in this regard as is evident from the pattern of production in recent decades. It is extremely unlikely that any significant overall increase in demand will take place for potatoes in the years ahead, except insofar as this may be achieved by a rapidly growing population. Hence, production efforts will be restricted to filling this demand, as little scope will be available to expanding it. As of now, the industry is dominated by a large number of small scale producers who nevertheless produce only a small proportion of total output. It is to be expected that as large operations are necessary to justify large capital investments, an increasingly larger proportion of total output will be forthcoming from fewer farms.

More stable income from potato production can only be achieved either through Government intervention in the market of more stable production through efforts of growers. The record of the 1943 - 1950 programs would suggest that heavy government expenditure might be necessary to achieve this purpose unless it were accompanied by supply management; and it appears that this course of action would be unpopular with producers. On the other hand more stable production does hold out some promise as some of the more recent production techniques such as irrigation, and more timely harvesting, tend to

bring production more under the control of the operators. With an increasing proportion of the crop being produced by these methods, it would appear that production might more nearly approximate requirements, even in the absence of price supports, and hence lead to more stable prices.

TABLE 1

Utilization of the United States Potato Crop, 1956-1964

Item	Crop Year								
	1956	1957	1958	1959	1960	1961	1962	1963	1964
	mil. cwts.								
Fresh Food									
Table stock sales	146.1	148.4	148.9	149.1	149.2	153.3	150.9	146.5	127.0
	9.3	8.2	7.3	5.9	5.4	5.2	4.8	4.5	4.0
	155.4	156.6	156.2	155.0	154.6	158.5	155.7	151.0	131.0
Processed Food									
Chips, etc.	14.6	17.3	17.0	20.1	21.0	22.7	24.1	26.7	28.8
Dehydrated	3.2	3.8	5.9	7.7	10.1	8.5	9.3	9.9	10.8
Frozen	4.7	4.8	8.3	9.9	15.1	18.1	18.4	22.4	23.6
Canned	2.3	2.6	2.9	2.4	2.8	2.8	2.9	3.2	3.2
Total	24.8	28.5	34.1	40.1	49.0	52.1	54.7	62.2	66.4
Total Food	180.2	185.1	190.3	195.1	203.6	210.6	210.4	213.2	197.4
Starch, flour	18.3	12.7	18.4	7.7	10.2	20.5	11.3	11.8	3.0
Feed Sales	7.7	9.0	18.9	6.6	5.4	20.4	7.9	10.1	5.6
Feed on Farms	4.1	2.7	3.9	3.1	2.9	4.2	3.4	3.1	1.8
Total	11.8	11.7	22.8	9.7	8.3	24.6	11.3	13.2	7.4
Seed sales	13.4	13.6	13.1	13.6	14.8	13.8	14.3	14.2	14.2
Seed on farms	6.8	7.6	7.1	7.2	7.7	7.5	6.1	6.1	7.5
Total	20.2	21.2	20.2	20.8	22.5	21.3	20.4	20.3	21.7
Shrinkage, loss	15.3	11.8	15.2	12.5	12.8	16.6	13.3	13.2	9.9
Total production	245.8	242.5	266.9	245.8	257.4	293.6	266.7	271.7	239.4

Source: Vegetable Situation, 1966 Outlook Issue, E.R.S., U.S. Department of Agriculture, October, 1965.

TABLE II

Potatoes: Acreage, Yield, Production and Price, United States, 1930-1964

Year	Acreage Harvested (1,000 Ac.)	Yield Per Harvested Acre (cwt.)	Production (1,000 cwt.)	Prices Received Per cwt. (dollars)	Year	Acreage Harvested (1,000 Ac.)	Yield Per Harvested Acre (cwt.)	Production (1,000 cwt.)	Prices Received Per cwt. (dollars)
1930	3138.9	69.7	206,290	1.47	1948	1980.8	136.3	269.937	2.53
1931	3489.5	66.1	230,590	.75	1949	1755.3	137.3	240,950	2.10
1932	3568.2	63.0	224,815	.63	1950	1697.9	152.6	259.112	1.50
1933	3422.6	60.2	205,922	1.34	1951	1348.5	145.2	195,776	2.68
1934	3599.2	67.7	243,889	.71	1952	1397.4	151.1	211,095	3.21
1935	3468.8	65.5	227,337	.98	1953	1536.4	150.8	231,679	1.31
1936	2959.9	65.6	194,373	1.87	1954	1412.6	155.4	219,547	2.15
1937	2054.9	73.9	225,869	.84	1955	1405.0	162.1	227,696	1.77
1938	2870.1	74.4	213,509	.89	1956	1371.0	179.3	245,792	2.02
1939	2812.8	73.0	205,423	1.16	1957	1359.4	178.4	242,522	1.91
1940	2832.1	79.9	226,152	.85	1958	1428.4	186.9	266,897	1.31
1941	2692.6	79.3	213,418	1.31	1959	1336.3	183.9	245,799	2.27
1942	2670.8	82.9	221,339	1.90	1960	1396.9	184.3	257,435	2.00
1943	3239.0	85	275,332	2.10	1961	1495.9	196.3	293,594	1.36
1944	2779.8	82.9	230,356	2.40	1962	1376.5	193.8	266,733	1.66
1945	2664.3	94.4	251,639	2.30	1963	1360.8	202.5	275,541	1.77
1946	2526.6	115.7	292,389	2.02	1964	1293.8	185.0	239,403	3.50
1947	2001.3	116.6	233,391	2.67	1965	1403.4	206.0	288,927	N.A.

Source: Agricultural Prices and Annual Crop Services, S.R.S., US Department of Agriculture.

TABLE III

Potatoes: Acreage, Yield, Production and Prices, Michigan, 1930-1964

Year	Acreage Harvested (1,000 Ac.)	Yield Per Harvested Acre (cwt.)	Production (1,000 cwt.)	Prices Received Per cwt. (dollars)	Year	Acreage Harvested (1,000 Ac.)	Yield Per Harvested Acre (cwt.)	Production (1,000 cwt.)	Prices Received Per cwt. (dollars)
1930	232	37.8	8,769	1.40	1948	97	90.0	8,730	2.30
1931	261	57.0	14,877	.51	1949	92	100.0	9,200	2.08
1932	291	69.0	20,079	.43	1950	85	108.0	9,180	1.66
1933	311	46.8	14,555	1.23	1951	64	107.0	6,848	3.25
1934	323	67.2	21,706	.50	1952	60	112.0	6,720	3.40
1935	323	52.2	16,860	.83	1953	65	112.0	7,280	1.53
1936	275	57.0	15,675	1.70	1954	59	123.0	7,257	2.19
1937	278	61.8	17,180	.80	1955	58	97.0	5,626	1.67
1938	250	72.0	18,000	.80	1956	52	154.0	8,008	1.36
1939	250	58.2	14,550	1.10	1957	50	133.0	6,650	2.54
1940	214	49.2	10,529	.95	1958	52	171.0	8,892	1.50
1941	182	66.0	12,012	1.40	1959	53	144.0	7,632	2.31
1942	169	58.8	9,937	2.08	1960	46	158.0	7,268	2.22
1943	213	63.0	13,419	2.22	1961	49.1	186.0	9,133	1.49
1944	170	64.8	11,016	2.65	1962	40.7	184.0	8,593	1.89
1945	164	66.0	10,824	2.30	1963	46.2	171.0	7,893	2.00
1946	143	75.0	10,725	2.08	1964	45.9	177.0	7,965	3.39
1947	107	62.0	6,634	2.80	1965	52[1]/	010.0[1]/	10,920[1]/	N.A.

Source: Michigan Agricultural Statistics.

1/ Estimate

TABLE IV

Fixed and Variable Costs Per Acre, Associated with Alternative Harvesting Systems[1/]

	Two-Row Conventional Digger $900			One-Row Tractor-Drawn Harvester $7,500			Two-Row Self-Propelled Harvester $13,000		
	Acreage			Acreage			Acreage		
	100	200[2/]	400[2/]	100	200	400	100	200	400
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Fixed Costs									
Depreciation[3/]	1.13	----	----	9.37	4.68	2.34	16.25	8.12	4.06
Interest on Investment	0.27	----	----	2.25	.12	0.56	3.90	1.95	0.97
Taxes, Insurance	0.09	----	----	0.75	0.37	0.19	1.30	0.65	0.32
Sub Total	1.49			12.37	6.17	3.09	21.45	10.72	5.35
Variable Costs									
Repairs, etc.	0.27	----	----	2.25	1.12	0.57	3.90	1.95	0.96
Labor[4/]	54.00	----	----	29.00	29.00	29.00	25.00	25.00	25.00
Tractors, fuel Truck[5/]	10.00	----	----	10.00	10.00	10.00	10.00	10.00	10.00
Total Costs of Harvesting	65.76	----	----	53.62	46.29	42.66	60.35	47.67	41.31

1/ Assuming a yield of 250 cwts. per acre. Investments and costs based on 1966 prices.

2/ Not considered.

3/ Depreciation based on 8 years of life and no salvage value.

4/ Based on data from Maine study.

5/ Assuming trucking and hauling and fuel costs independent of acreage.

NOTE: Limitations are set to use of one-row harvester by acreage which it can handle in harvesting period.

TABLE V

Investments, Costs and Returns Associated with Irrigating 100, 200, and 400 Acres of Potatoes at Three Levels of Response and Price

Increase in yield cts/ac.	100 Acres			200 Acres			400 Acres		
	Low Response	Median Response	High Response	Low Response	Median Response	High Response	Low Response	Median Response	High Response
	30	60	90	30	60	90	30	60	90
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Investments[1]									
Pump & Motor	3,600	3,600	3,600	3,600	3,600	3,600	7,200	7,200	7,200
Water Supply	4,200	4,200	4,200	4,200	4,200	4,200	8,400	8,400	8,400
Sprinklers	800	800	800	1,600	1,600	1,600	3,200	3,200	3,200
Pipes & Fittings	7,000	7,000	7,000	14,000	14,000	14,000	28,000	28,000	28,000
Total	15,600	15,600	15,600	23,400	23,400	23,400	46,800	46,800	46,800
Per Acre	156	156	156	117	117	117	117	117	117
Additional Costs[1]									
Depreciation & Insurance	1,376	1,376	1,376	1,978	1,978	1,978	3,956	3,956	3,956
Investment Interest	468	468	468	702	702	702	1,404	1,404	1,404
Power Costs	800	800	800	1,600	1,600	1,600	3,200	3,200	3,200
Fertilizer	1,000	1,000	1,000	2,000	2,000	2,000	4,000	4,000	4,000
Seed	800	800	800	1,600	1,600	1,600	3,200	3,200	3,200
Labor	1,350	1,500	1,650	2,700	3,000	3,300	5,400	6,000	6,600
Harvesting & Haulage	1,200	2,400	3,600	2,400	4,800	7,200	4,800	9,600	14,400
Total	6,994	8,344	9,694	12,980	15,680	17,780	25,960	31,360	36,760
Per Acre	69.9	83.4	96.9	64.9	78.4	88.9	64.9	78.4	91.9
Additional Receipts									
at $1.50/cwt.	4,500	9,000	13,500	9,000	18,000	27,000	18,000	36,000	54,000
at $1.75/cwt.	5,250	10,500	15,750	10,500	21,000	31,500	21,000	42,000	63,000
at $2.00/cwt.	6,000	12,000	18,000	12,000	24,000	36,000	24,000	48,000	72,000
Change in Net Income[3]									
at $1.50	-2,494	+ 656	+3,806	-3,980	+2,320	+9,220	-7,960	+4,640	+17,240
at $1.75	-1,744	+2,156	+6,056	-2,480	+5,320	+13,720	-4,960	+10,640	+26,240
at $2.00	- 994	+3,656	+8,306	- 980	+8,320	+18,220	-1,960	+16,640	+35,240

1/ Based on Maine Agr. Expt. Sta. data and previous work on irrigation by Prof. C.R. Hoglund, Dept. of Agr. Econ., Michigan State University

2/ Based on useful life of 13 years for water supply, 10 years for pump and motor, 8 years for sprinklers, pipes and fittings.

3/ Additional receipts minus additional costs.

TABLE VI

Summary of Expected Investments and Annual Fixed Costs in Specialized Equipment in Potato Production

Investments	100 Acres=		200 Acres		400 Acres	
	Total Dollars	Per Acre Dollars	Total Dollars	Per Acre Dollars	Total Dollars	Per Acre Dollars
Irrigation System						
Pump and Water	3,600	36	3,600	18	7,200	18
Water	4,200	42	2,400	21	8,400	21
Sprinklers	800	8	1,600	8	3,200	8
Pipes and Fittings	7,000	70	14,000	70	28,000	70
Sub Total	15,600	156	23,400	117	46,800	117
Harvesting Equipment						
Basic Unit	4,600	44	7,100	35.5	14,200	35.5
Digger Split	---	--	1,200	6	2,400	6
Bulk Loader & Rock Eliminator	1,570	15.7	1,800	9	3,600	9
Rubber Table	---	--	1,000	5	2,000	5
Vine Eliminator	830	8.3	1,500	7.5	3,000	7.5
Miscellaneous Items	500	7	400	2	800	2
Sub Total	7,500	75	13,000	65	26,000	65
Planting Equipment (Inc. Duster-Sprayer)	2,000	20	3,800	19	5,800	14.5
Total Investments	25,100	251	40,200	201	78,600	196.5
Annual Fixed Costs						
Irrigation	1,844	18.44	2,680	13.4	5,360	13.40
Harvesting	1,237	12.37	2,144	10.72	4,288	10.72
Planting	260	2.60	394	1.97	754	1.88
Total Fixed Costs	3,341	33.41	5,218	26.09	10,402	26.00

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