1973

Recent Shifts in the Location of the Soybean Processing Industry

Charles C. Harper
Eastern Illinois University

PAPER CERTIFICATE #2

TO: Graduate Degree Candidates who have written formal theses.

SUBJECT: Permission to reproduce theses.

The University Library is receiving a number of requests from other institutions asking permission to reproduce dissertations for inclusion in their library holdings. Although no copyright laws are involved, we feel that professional courtesy demands that permission be obtained from the author before we allow theses to be copied.

Please sign one of the following statements:

Booth Library of Eastern Illinois University has my permission to lend my thesis to a reputable college or university for the purpose of copying it for inclusion in that institution's library or research holdings.

Feb. 5, 1973
Date

I respectfully request Booth Library of Eastern Illinois University not allow my thesis be reproduced because_____

_____

_____

_____ _____
Date Author

pdm

RECENT SHIFTS IN THE LOCATION OF THE SOYBEAN PROCESSING INDUSTRY

(TITLE)

BY

CHARLES C. HARPER

THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF

MASTER OF ARTS IN EDUCATION

IN THE GRADUATE SCHOOL, EASTERN ILLINOIS UNIVERSITY
CHARLESTON, ILLINOIS

1973
YEAR

I HEREBY RECOMMEND THIS THESIS BE ACCEPTED AS FULFILLING
THIS PART OF THE GRADUATE DEGREE CITED

1/29/73
DATE

1/29/73
DATE

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

MAPS

FIGURES

LIST OF TABLES

INTRODUCTION

The soybean processing industry within the United States has developed sufficiently to establish the United States as the leading processing country. This development has been unilaterally accomplished with outstanding levels of production and high levels of domestic and international marketing. As the industry developed, changes occurred in production, processing, and exchange.

This study seeks to determine what shifts have occurred in the location of soybean processing plants primarily engaged in the processing of beans for oil and meal in the United States from 1960 through 1970. This investigation will also be concerned with the identification of possible causes of any relocation trends observed. The investigation, therefore, must determine what relocation occurred as a result of variations in the factors that most influence plant location. Specific questions whose answers will be sought in this research include: What trends in the industry directly affect the distribution of processing? What is the interrelationship between soybean production and the location of processing plants? What influence has the increased exportation of soybeans abroad had on the number and the location of processing plants?

Investigative approaches, techniques, and data vary with aspects of this study. Such variations are warranted as different factors influence plant location in different ways. Although adaptations

occur, approaches and techniques used in this investigation are basically cartographic, historical, and mathematical. The data used will be from available published information, computed from statistical compilations, or from direct field inquiries. Information published by the American Soybean Association is used as the basis of most of this study because many processing concerns rigidly control the release of specific data that might disclose their particular locational or competitive advantages. Specific information obtained directly from responding processors was primarily used in formulating research procedures and to verify or clarify general relationships whenever possible.

The design of this study is intended to accomplish two basic purposes. First, the 1960 through 1970 time span was chosen to provide information that would augment and up-date some of the findings of the writer's 1958 research entitled, Missouri and the Soybean Processing Industry. Secondly, the presentation of findings in three major units or chapters is intended to emphasize each block of information and to more clearly identify specific relationships in each unit. This study, therefore, will relate what shifts have occurred, what factors most influence the location of soybean processing plants, and provide an analysis of the locational shifts observed.

CHAPTER I

PLANT LOCATION AND SHIFTS

This section of the study is primarily concerned with the location and changes in location of soybean processing plants and processing levels in the United States from 1960 through 1970.[1] These locations and changes are identified through a series of cartographic and mathematical analyses on a state, regional, and national basis. Information presented in this section will be used to propose answers to the basic questions of where is the industry located and what has been the degree, direction, and over-all pattern of the shifts identified. In answering these questions this section will provide a basis for the interpretation of locational tendencies and shifts later in the study.

STATE BASIS

Based on the number of soybean processing plants, the leading states throughout the 1960-1970 period were Iowa, Illinois, Mississippi, and Arkansas. During this time span, some changes occurred in state rankings as the number of plants changed within most states. Locational rearrangement was perhaps more a result of there being fewer processing

---

[1] Information regarding average processing levels of plants on both the state and regional basis was computed from published state data. This procedure was necessary because information regarding individual plants was not available in published form and too few individual processors supplied volume information in response to direct inquiry. With data limited to averages, shifts and locational arrangements could not be computed using weighted locational analysis techniques.

plants at the end of the ten-year period than through the addition of new processors at diverse locations. The trend toward fewer plants will be discussed in the analysis section of this study.

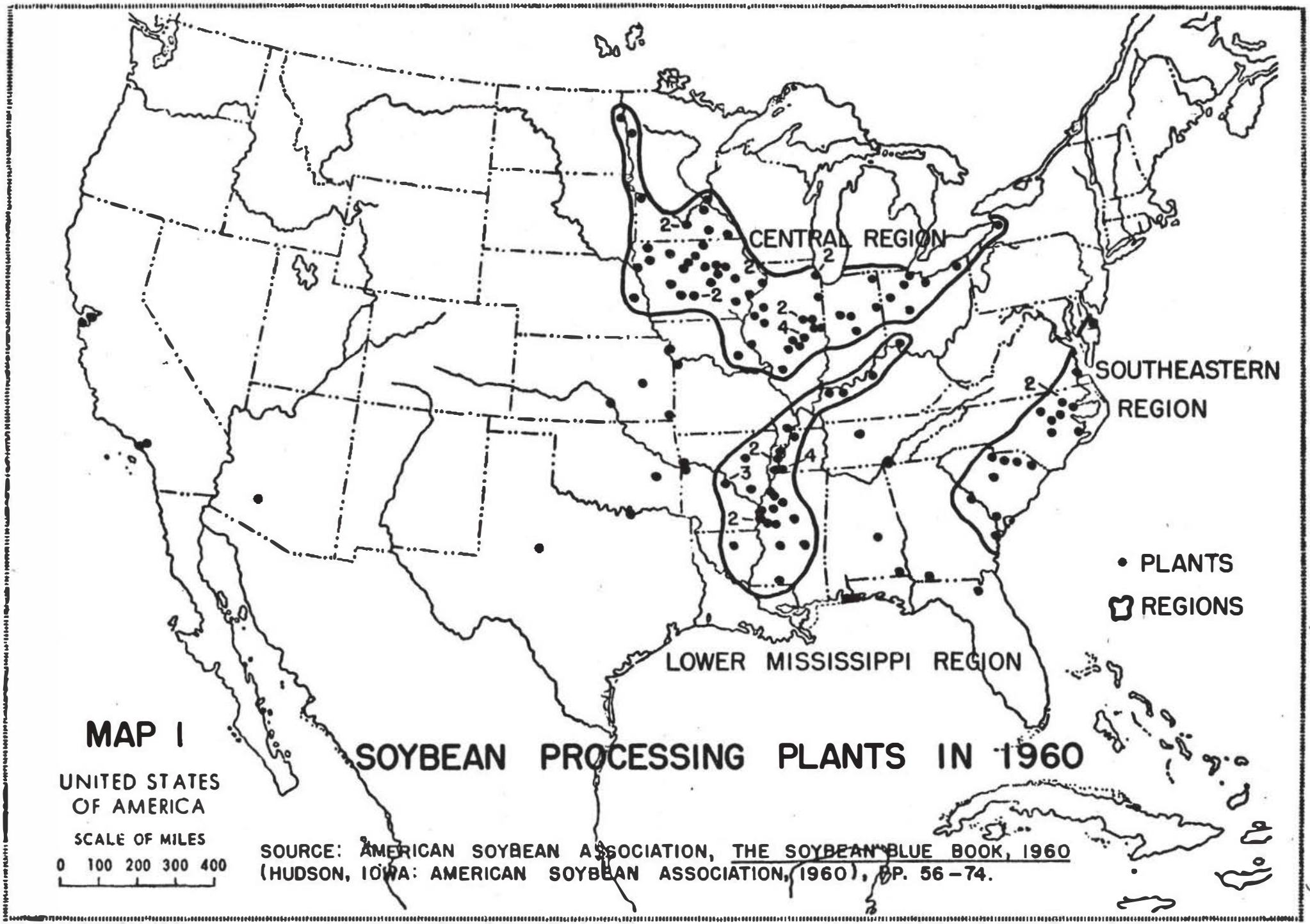
In 1960 there were 141 soybean processing plants located in 25 states.[1] The location of these plants is shown in Map 1. Based on the number of individual plants, the five leading states were Iowa (22), Illinois (20), Mississippi (14), Arkansas (11), and North Carolina (8).

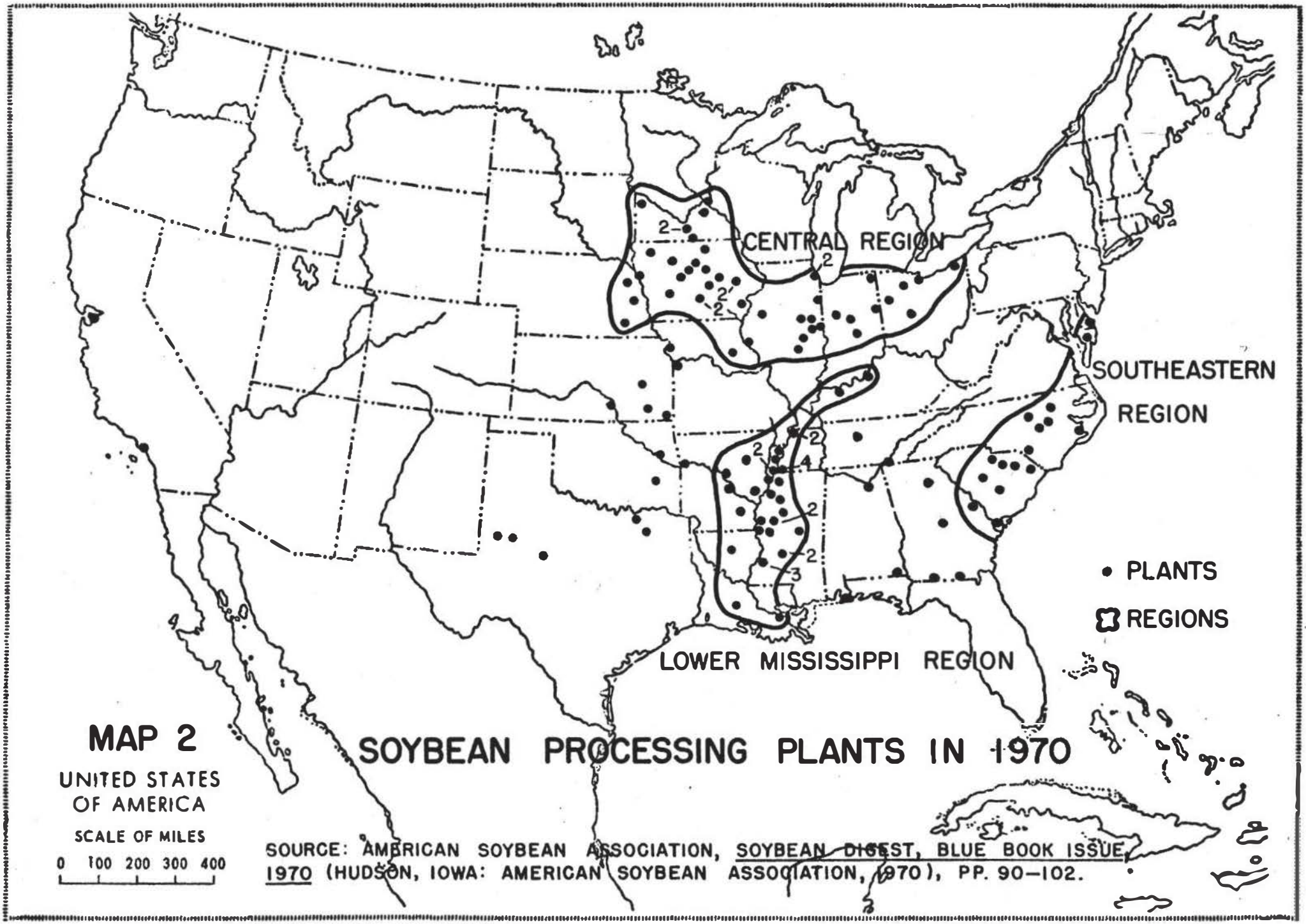
Ten years later, in 1970, the number of processing plants had decreased and the sequence of leading states had changed. As shown in Map 2 there were 123 plants located in 22 states in 1970. This is a decrease of 18 plants and 3 states from the 1960 level. Based on the number of plants, the five leading states in 1970 were Iowa (16), Mississippi (15), Illinois (12), Arkansas (11), and Tennessee (8). This new alignment of leading states was the result of Iowa losing only 6 plants while Illinois slipped from contention with a loss of 8 establishments. At the same time Arkansas held steady in the number of plants and Mississippi and Tennessee each gained one establishment. These data indicate a shift in the location of successful processing operations from the Iowa-Illinois area to the Mississippi-Arkansas-Tennessee area.

Based on the volume of soybeans processed, there is a concentration of processing activity in the Illinois-Iowa area. Although

---

[1] The location and number of plants used in this study are based on the annual listing of processors by the American Soybean Association with adjustments made from direct contact with processors. In the past few years when field reports verify that soybean processing has ceased at a particular location, that information has been forwarded to the Association. As this count basis is different from the general "significant production" requirement used by governmental agencies, the number of known plants in this study will not agree with the number of plants listed in some statistical references.


CENTRAL REGION
SOUTHEASTERN REGION
LOWER MISSISSIPPI REGION
• PLANTS
REGIONS
MAP I
UNITED STATES OF AMERICA
SCALE OF MILES
0 100 200 300 400
SOYBEAN PROCESSING PLANTS IN 1960
SOURCE: AMERICAN SOYBEAN ASSOCIATION, THE SOYBEAN BLUE BOOK, 1960 (HUDSON, IOWA: AMERICAN SOYBEAN ASSOCIATION, 1960), PP. 56-74.


CENTRAL REGION
SOUTHEASTERN REGION
LOWER MISSISSIPPI REGION
• PLANTS
REGIONS
MAP 2
SOYBEAN PROCESSING PLANTS IN 1970
UNITED STATES OF AMERICA
SCALE OF MILES
0 100 200 300 400
SOURCE: AMERICAN SOYBEAN ASSOCIATION, SOYBEAN DIGEST, BLUE BOOK ISSUE, 1970 (HUDSON, IOWA: AMERICAN SOYBEAN ASSOCIATION, 1970), PP. 90–102.

processing levels are not known for all states, most of the processing in the United States is accounted for in Table 1. As shown in this table, Illinois is clearly the leading state processing about 24 percent of the 737.5 million bushels processed in the United States in 1970.[1] This is about twice the volume of second-ranked Iowa and over three times the other major processing states of Arkansas, Indiana, and Tennessee.

Although the processing of soybeans has increased in the United States and in all states listed in Table 1, processing has increased more rapidly in some states than in others. As shown in Table 1, the leading states of Illinois and Iowa did not increase at the national rate; therefore, they processed a smaller percentage of the national total in 1970 than in 1960. Also shown in that table, processing in Arkansas, Mississippi, and North Carolina exceeded the national rate; thus, these states processed a larger portion of the United States total in 1970 than they did in 1960. This information further substantiates that there has been a locational shift in the processing industry with less emphasis on the Illinois-Iowa area and more emphasis on the Arkansas-Mississippi area.

REGIONAL BASIS

Throughout the study period most soybean processing plants in the United States appeared to be arranged in three major groupings with the remaining plants occurring in a more diverse arrangement. These groupings, regarded as regions in this study, are shown in

---

[1] American Soybean Association, Soybean Digest, Blue Book Issue (Hudson, Iowa: American Soybean Association, 1971), p. 66.

TABLE 1

PERCENT OF UNITED STATES SOYBEANS PROCESSED IN THE UNITED STATES BY KNOWN STATES FOR 1960 AND 1970[a]

State	1960	1970	Change
Illinois	30.0	24.0	- 6.0
Iowa	17.4	13.2	- 4.2
Arkansas	2.5	7.0	+ 4.5
Indiana	9.0	6.9	- 2.1
Tennessee	8.0	6.5	- 1.5
Minnesota	7.3	5.4	- 1.9
Mississippi	2.5	4.8	+ 2.3
Ohio	8.9	4.4	- 4.5
Missouri	3.7[b]	3.7	0.0
North Carolina	1.2	1.3	+ 0.1
All Others	9.5	22.8	+13.3

[a]Computed from: American Soybean Association, The Soybean Blue Book 1962, (Hudson, Iowa: American Soybean Association), p. 36 and Soybean Digest, Blue Book Issue 1972, p. 62.
[b]Estimated from 1959 processing information.

Maps 1 and 2. The establishment and general delineation of these regions are based on a combination of: distance between processing establishments, general alignment of plant locations, logical arrangement, and the general contribution made toward the simplification of pattern or locational analysis. The Central Region is somewhat crescent-shaped. The greatest density of plants occurs in the Iowa-Illinois area with lower densities eastward through Ohio and northward into Minnesota. The Lower Mississippi Region is basically linear and is generally aligned to lowland areas associated with the Lower Mississippi and the flood plain along the lower Ohio River. The Southeastern Region consists of a series of clustered and somewhat isolated plants predominantly in the Atlantic Coastal Plain and Piedmont Regions of the United States.

Each of the three designated processing regions has distinct characteristics. These regions and scattered locations are considered individually with regard to the number of plants and processing levels in 1960 and 1970. This procedure is intended not only to demonstrate areal shifts but to provide a basis for interpreting locational changes later in this presentation.

The Central Region

The Central Region is the most significant processing region in the United States despite the changes that occurred from 1960 to 1970. Based on information in Tables 2, 3, 4, and 5, there are some distinct aspects of processing that characterize this region. The Central Region leads in the number of plants and the volume of processing. At the same time, the region also leads in the relative shrinkage of processing plants. Processing in the region increased by about 118 million bushels from 1960 to 1970. National processing levels increased in far greater proportion thus causing the region's total processing to diminish from 74 percent in 1960 to 55 percent of the United States total in 1970. This 19 percent reduction in the national total established the Central Region as the only region with diminishing national significance from 1960 through 1970. As to the number of plants, the Central Region lost more individual processing establishments than any other area with the number of plants diminishing from 65 in 1960 to 48 in 1970. This reduction of 17 plants represented a 26 percent change within the region and accounted for about 90 percent of the net United States reduction in plants. This region therefore experienced a percent change in the number of processing plants that was twice as great as the nation as a whole.

TABLE 2

NUMBER OF PLANTS AND PERCENT OF UNITED STATES TOTAL BY REGIONS[a]
(By Regions in 1960 and 1970)

Processing Region	1960		1970	
	Number	Percent	Number	Percent
Central	65	46	48	39
Lower Mississippi	33	23	36	29
Southeastern	18	13	16	13
Other Areas	25	18	23	19
Totals	141	100	123	100

[a]Computed from data shown in Maps 1 and 2.

TABLE 3

NET CHANGE IN NUMBER OF PLANTS[a]
(By Regions 1960 to 1970)

Region	Number Change	Percent Change
Central	- 17	- 26
Lower Mississippi	+ 3	+ 9
Southeastern	- 2	- 11
Other Areas	- 2	- 8
United States	- 18	- 13

[a]Computed from data in Table 2.

TABLE 4

REGIONAL PROCESSING BY VOLUME AND PERCENT OF UNITED STATES TOTAL[a]
(1960 and 1970)

Region	1960 Million Bushels	1960 Percent	1970 Million Bushels	1970 Percent
Central	300.4	74.0	418.9	55.1
Lower Mississippi	55.1	13.6	153.5	20.2
Southeastern	5.3	1.3	19.8	2.6
Other Areas	45.1	11.0	168.0	22.1
Totals	405.9	100.0	760.2	100.0

[a]Estimated from data in: American Soybean Association, The Soybean Blue Book (Hudson, Iowa: American Soybean Association, 1962), pp. 26-36 and American Soybean Association, Soybean Digest, Blue Book Issue (Hudson, Iowa: American Soybean Association, 1972), pp. 59-62.

TABLE 5

NET REGIONAL CHANGE IN PROCESSING[a]
(1960 to 1970)

Region	Volume Increase (Million Bushels)	Percent Change
Central	118.5	39.4
Lower Mississippi	98.4	178.6
Southeastern	14.5	273.6
Other Areas	122.9	272.5
United States	354.3	87.3

[a]Computed from data in Table 4.

The Lower Mississippi Region

The Lower Mississippi Region is a dynamic region with expanded processing and an increased number of plants. Information in Tables 2, 3, 4, and 5 substantiates this characterization. Based on the number of plants, the Lower Mississippi Region was the only region that had an increase in the number of plants from 1960 through 1970. The region increased from 33 plants or 23 percent of the United States total in 1960 to 36 plants or 29 percent of the 1970 total. Compared to the negative United States change in number of plants, this region's 9 percent positive change was so unique that its change was about as much positive as the national change was negative. The Lower Mississippi Region increased from 13.6 percent of the soybeans processed in 1960 to 20.2 percent in 1970. This change was the largest of the three regions and close to the change for scattered plants in miscellaneous areas. On the basis of percent change in the volume of soybeans processed, the Lower Mississippi Region progressed at approximately twice the national rate.

The Southeastern Region

The Southeastern Region experienced a mixture of changes as indicated by information in Tables 2, 3, 4, and 5. Although the number of processors in the region decreased from 18 in 1960 to 16 in 1970, the region's national percentage of plants remained constant. The percent change in the number of plants therefore was similar to the national change. Processing levels however were a different matter with the region's processing level increasing from 5.3 million bushels in 1960 to 19.8 million in 1970. This increase resulted in the

region's national percentage of processing doubling in that 10-year period. From the standpoint of percent change, the Southeastern Region was first among all areas with a 273.6 percent increase in the volume of soybean processing.

Miscellaneous Areas

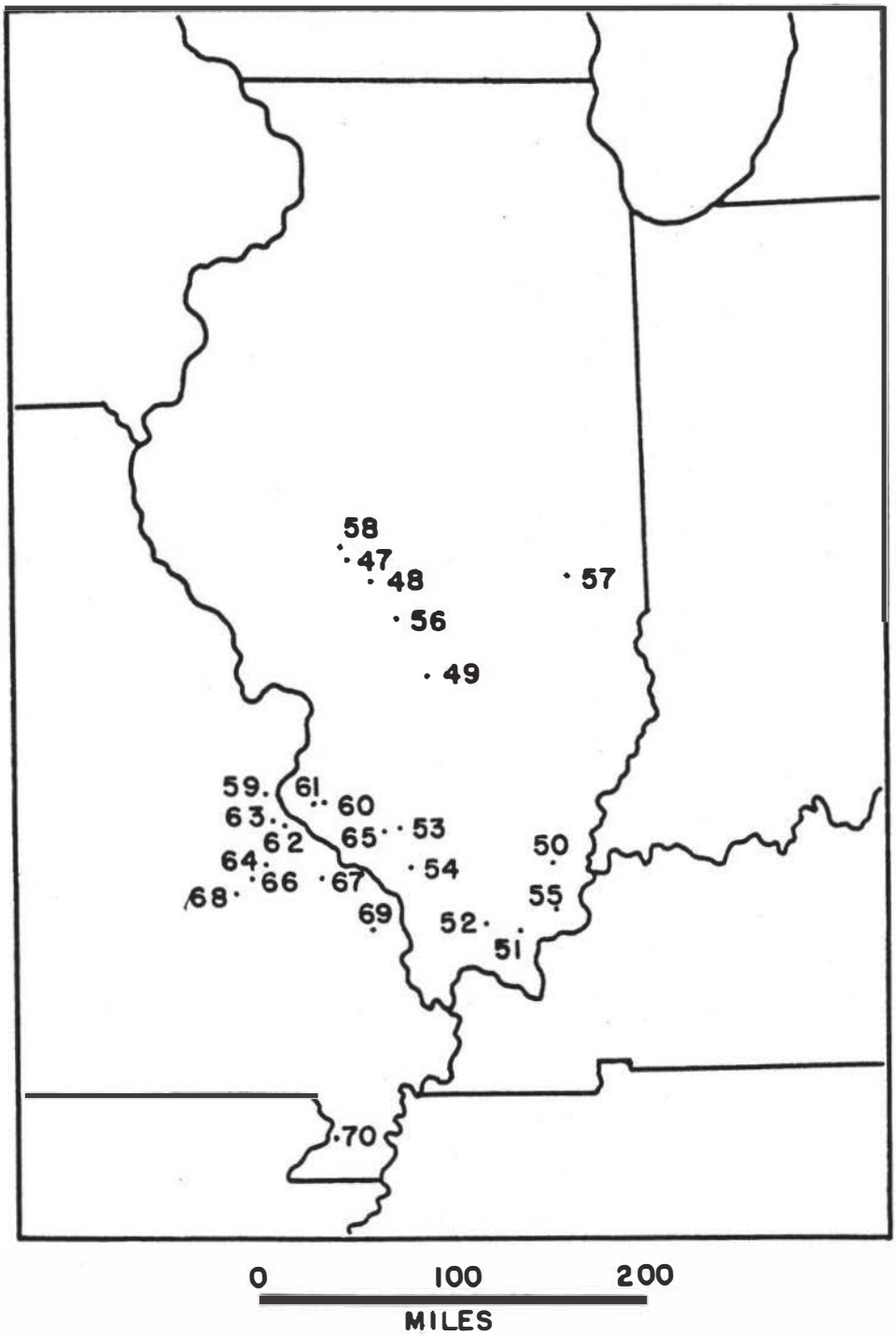
Areas of processing not regarded as a specific region also exhibit interesting characteristics which are substantiated by data in Tables 2, 3, 4, and 5. The net number of plants and the percent change in plant numbers remained essentially unchanged from 1960 through 1970. The level of processing, however, increased from 45.1 million bushels in 1960 to 168.0 million bushels in 1970. Collectively scattered plants in the United States doubled in their percentage of the national total thus reflecting a processing trend similar to the Southeastern Region.

NATIONAL BASIS

Although the preceding state and regional analysis of plant location and processing levels have identified various aspects of the industry, the degree and the direction of locational shifts were not adequately determined and measured. To correct this situation, a more refined analysis based on national geographic centers of soybean plants on an annual basis from 1947 through 1970 was undertaken. The sequence of centers, shown in Map 3, provided the basis for mathematical measurement on the national scale. Because specific processing data for individual plants was unavailable, the mathematical procedure was restricted to determining only non-weighted geographic centers.

MAP 3

THE GEOGRAPHIC CENTER OF SOYBEAN PROCESSING PLANTS BY YEARS, 1947—1970



COMPUTED FROM DATA IN: AMERICAN SOYBEAN ASSOCIATION, THE SOYBEAN BLUE BOOK, 1947—1964 (HUDSON, IOWA: AMERICAN SOYBEAN ASSOCIATION, 1947—1964). AND AMERICAN SOYBEAN ASSOCIATION, SOYBEAN DIGEST, BLUE BOOK ISSUE, 1965—1970 (HUDSON, IOWA: AMERICAN SOYBEAN ASSOCIATION, 1965—1970).

Assuming that the distance between any two computed centers indicates the amount of net geographical shift of the industry as a whole, locational changes have been erratic. The greatest change occurred in the late 1950's when the center shifted northwestward 137 miles from 1955 to 1956, 93 miles westward from 1957 to 1958, and 103 miles southwestward from 1958 to 1959. These changes greatly exceeded the average annual distance of 48.47 miles for the 23-year period. From 1960 through 1964 the center was unusually stable changing only an average of 7.33 miles per year. From 1964 through 1970 the rate of change accelerated and exceeded the 23-year rate by averaging 52.83 miles of change annually with the fifth greatest shift (88 miles) occurring from 1969 to 1970.

The location, over-all direction, and rate of movement of the center of processing on a mathematical basis generally agree with the state and regional information presented earlier in this study. As shown in Map 3, the national geographic center of processing plants has consistently been in the states of Illinois and Missouri. This tendency indicates that although shifts have occurred in the industry, processing plants have remained in the same general distributive pattern from 1947 through 1970. Earlier findings indicated that there was a southward shift in the location of the industry and according to the information in Map 3 the industry moved southward with a net change of 9.6 miles per year from 1947 through 1970. From 1960 through 1970 the net southerly change was about 13.8 miles per year or about 44 percent greater than the 23-year average.

CHAPTER II

LOCATIONAL FACTORS

Any factor of operation that requires a considerable amount of expenditure and varies geographically has a direct influence on location decisions in most industries. Costs for most goods or services vary from one place to another thus creating a geography of industrial costs.[1] Geographical variations affect as much as 10 percent of total manufacturing costs in many industries; however, in industries with a single prominent item in their cost structure the locational effect on profit may be considerably higher.[2] The geography of costs not only influences new plant location but may also determine the longevity or profitability of existing establishments. Should dominant costs change with time and conditions at a particular processing location, the affected plant must either operate at a financial loss, employ new technology or equipment, alter its level of operation, change its products or materials, go out of business, or relocate at a point where costs are advantageous.

OPERATIVE COST STRUCTURE

A device commonly used to determine the most significant locational factors for a manufacture is the tabulation of the operative

---

[1] Leonard Yaseen, Plant Location (New York: American Research Council, 1956), p. v.

[2] Ibid., p. 5.

cost structure for that particular industry. The cost structure is essentially the indication of what different items, commodities, services, etc. cost in regard to the total cost of operation. This compilation identifies the higher-cost aspects of operation that most readily affect the financial return of the manufacturing operation.

The general cost structure of a moderate-sized soybean processing plant is shown in Table 6. Of the costs shown, the acquisition of soybeans is decidedly the most significant expenditure at approximately 27 percent of all operative costs. Acquisition costs consist of expenditures for transportation, commissions paid, storage costs, and other intermediary charges related to getting beans to the processing plant.[1] Acquisition costs do not include the actual price paid for soybeans purchased for processing. The significance of acquisition costs is further accented through the realization that the second largest cost relates to the plant. Plant costs, as used in Table 6, are a combination of depreciation, interest, insurance, and anticipated obsolescence on capital items.[2] Plant costs therefore may vary more with engineering, investment levels, and financial arrangements than with specific plant locations.

AVAILABILITY AND PRICE OF SOYBEANS

The availability and price of soybeans are also major locational factors in the processing industry. Processors are particularly sensitive to both the physical supply of soybeans and to prices they must

---

[1] Charles Harper, Missouri and the Soybean Processing Industry (Jefferson City, Missouri: Missouri Division of Resources and Development, 1958), p. 20.

[2] Ibid.

TABLE 6

PROCESSING COSTS FOR AN AVERAGE SOLVENT PLANT HANDLING 300 TONS OF SOYBEANS PER DAY (total cost--37.97 cents per bushel)

Cost	Percent
Acquisition of Soybeans	27
Plant	17
Labor	10
General Administration	8
Salaries	7
Meal Bags	7
Fuel	5
Working Capital	4
Selling Expense	4
Electricity	3
Maintenance and Repairs	3
Solvent	2
Other Expenses	3
	100

Source: Charles Harper, Missouri and the Soybean Processing Industry (Jefferson City, Missouri: Missouri Division of Resources and Development, 1958), p. 20.

pay to obtain that commodity. Processors do not normally store excessively large amounts of beans on the plant site but rather depend on frequent incoming shipments from elevators and intermediate sources.[1] Should large buyers, exporters, or speculators purchase large amounts of beans in any processing area, the processors therein could be forced to pay a higher local price, process a different commodity, or buy from more distant sources and pay increased shipping costs. The same undesirable situation would occur if there were insufficient beans produced in a processing area to maintain an economical level of processing. A good location for a processing plant would be in an area where large amounts of beans are either produced or concentrated by transportation nets, competition between other processors and exporters was tolerable, and/or where other oilseeds such as cottonseed or sunflowerseed were available for alternate processing.

Expenditures for soybeans are decidedly the largest entry in a processing plant's total operative budget. Compared to the operative cost structure with a total cost of about $.38 per bushel, soybean prices paid to farmers averaged about $2.48 from 1960 through 1970.[2] If the prices paid to farmers varied geographically by only $.10, they could offset any advantage in acquisition costs and if areal variations in prices paid to producers exceeded 15 percent, such a variation could equal the entire cost of in-plant processing. Areal variations in soybean prices will be discussed later in this study.

---

[1] Ibid., pp. 15-24.

[2] American Soybean Association, Soybean Digest, Blue Book Issue (Hudson, Iowa: American Soybean Association, 1972), p. 59.

SOYBEAN PRODUCTION

The United States is unquestionably the leading soybean producing country with sufficient yields to dominate recent world production levels. As shown in Figure 1, United States production has accounted for some 65-75 percent of the world total since 1962. In 1969, for example, the 1,126,314,000 bushels produced in this country equaled 76 percent of the 1,480,306,000 world total. This level far exceeded production in any other country since the next four leading producers were China (15.5 percent), Brazil (2.3 percent), USSR (1.3 percent), and Indonesia (1.0 percent). Collectively these countries produced 20.1 percent of the 1969 world output which when combined with the United States production accounts for 96.1 percent or most of the world total. The dominance of United States production on the world scene also occurred in other recent years. For example 75.8 percent of the 1968 and 74.3 percent of the 1970 estimated world production grew in the United States. As graphically demonstrated in Figure 1, United States production is so significant in the world total that it not only dictates general trends but directly accounts for many of the annual fluxuations in total production.[1]

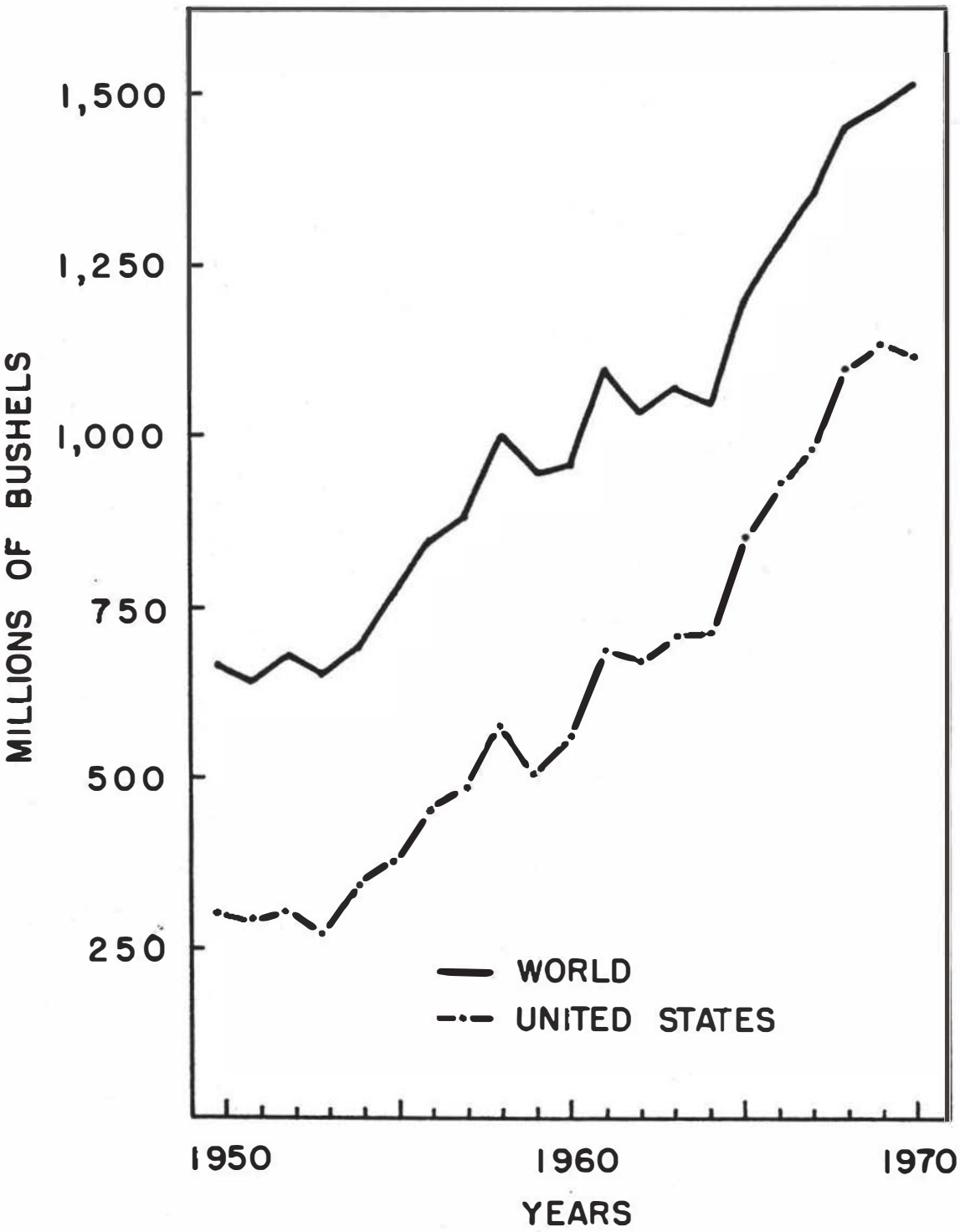
Recent soybean production is also important in domestic agriculture with financial returns sufficient to rank soybeans as a major source of agricultural income in the United States. In 1969 the principal farm commodities in order of cash receipts to farmers were cattle, dairy products, hogs, corn, and soybeans. Also that year, soybeans

---

[1] American Soybean Association, Soybean Digest, Blue Book Issue (Hudson, Iowa: American Soybean Association, 1971), p. 54.

FIGURE 1

SOYBEAN PRODUCTION 1950—1970



SOURCES: AMERICAN SOYBEAN ASSOCIATION, THE SOYBEAN BLUE BOOK, 1952–1964 (HUDSON, IOWA: AMERICAN SOYBEAN ASSOCIATION, 1952–1964). AND AMERICAN SOYBEAN ASSOCIATION, SOYBEAN DIGEST, BLUE BOOK ISSUE, 1965–1972 (HUDSON, IOWA: AMERICAN SOYBEAN ASSOCIATION, 1965–1972).

were regarded as a leading commodity in eleven states.[1] In 1969, soybean production involved 40,982,000 acres which yielded 1,126,314,000 bushels with a value of $2,647,499,000.[2] Based on farm values that year, the four leading crops were corn, hay, soybeans, and wheat. In 1969, corn accounted for 22.8 percent, hay 13.1 percent, soybeans 11.7 percent, and wheat 7.9 percent of the $22,619,303,000 value of all United States crops.[3]

Farmers tend to plant crops that produce maximum profit from their particular operation; therefore, soybeans must compete on an economic basis for field space with other crops. Planting decisions are usually based on a combination of costs, yields, and prices for the individual crops. In making production decisions, many farmers use an analysis formula similar to that shown in Table 7. Such a device provides individual farmers with some idea of the crop that will produce the highest return but other factors such as individual preference, integrated farm crop utilization, and market reliability may also influence individual decisions.

Although soybeans are grown domestically in many areas, intense production occurs in 26 states predominantly in the eastern half of the United States. Intense production areas, comprised of contiguous counties with 25,000 acres or more devoted to the production of beans, are shown as significant producing areas in Map 4. On a state basis

---

[1]United States Bureau of the Census, Statistical Abstract of the United States: 1970 (Washington, D.C., 1970), p. 595.

[2]American Soybean Association, Soybean Digest, Blue Book Issue (Hudson, Iowa: American Soybean Association, 1972), p. 71.

[3]United States Department of Agriculture, Agricultural Statistics: 1970 (Washington, D.C., 1970), p. 446.

TABLE 7

CORN AND SOYBEANS--BREAK-EVEN PRICES

Items	Corn		Soybeans	
	Example	Your farm	Example	Your farm
Variable costs per acre				
Fertilizer	$18	____	$ 0	____
Seed	6	____	4	____
Crop expense	5	____	5	____
Machinery	17	____	15	____
Dry and conditioning	6	____	0	____
Total	$52	____	$24	____
Yield, bushels	115	____	36	____
Price per bushel	$ 1.20	____	($ 3.06)[a]	____
Total returns	138	____	(110)[b]	____
Return over variable costs	$86	____	($86)	____

[a] Total returns for soybeans, divided by the yield per acre.
[b] Returns over variable costs for corn, plus the variable costs for soybeans.

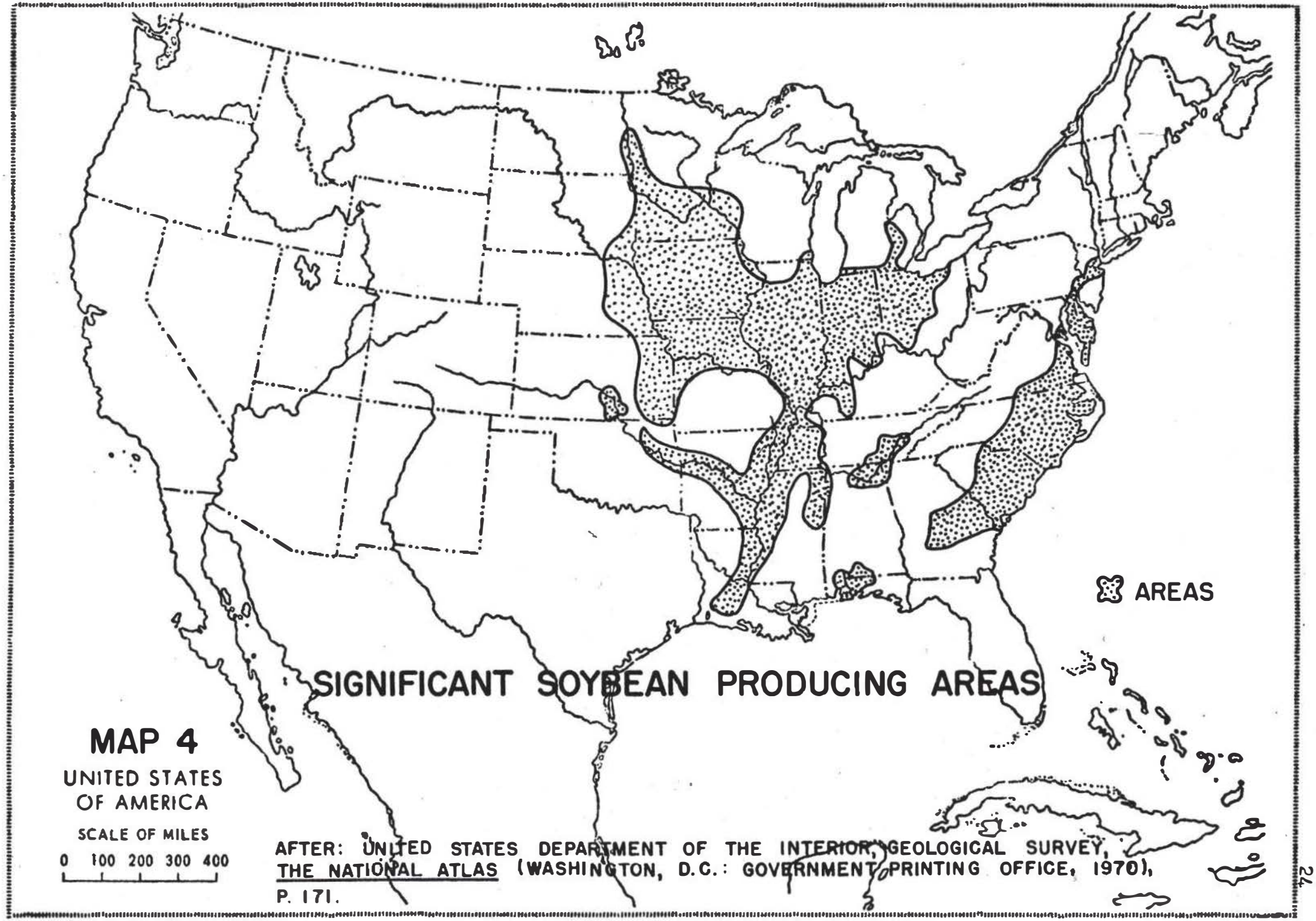
Source: United States Department of Agriculture, Department of Agricultural Economics, Farm Management, Number 67-7 (Urbana, University of Illinois, April 3, 1967), p.2.

the seven leading producers and their percent of the 1,123,740,000 bushels produced in 1970 were Illinois (19), Iowa (16), Indiana (9), Arkansas (8), Missouri (8), Minnesota (7), and Ohio (6).[1] These data reflect the concentration of soybean production within the seven leading states which collectively produce about 73 percent of the soybeans grown in the United States. Since these seven states also produce 71 percent of the national corn crop, soybeans have intense competition for field space.[2]

---

[1] American Soybean Association, Soybean Digest, Blue Book Issue (Hudson, Iowa: American Soybean Association, 1972), p. 70.

[2] United States Department of Agriculture, Agricultural Statistics: 1970 (Washington, D.C., 1970), p. 29.



AFTER: UNITED STATES DEPARTMENT OF THE INTERIOR, GEOLOGICAL SURVEY, THE NATIONAL ATLAS (WASHINGTON, D.C.: GOVERNMENT PRINTING OFFICE, 1970), P. 171.

CHAPTER III

AN ANALYSIS OF LOCATION AND SHIFTS

This section of the study is concerned with the identification of possible causes for the general location of the soybean processing industry and the locational shifts that occurred from 1960 through 1970. Specific consideration is given to the general locational influence of soybean production, exporting, prices, size of plants, and the availability of other oilseeds for alternate processing. As each aspect of the industry is discussed, its geographic variation and influence on plant location will be indicated.

SOYBEAN PRODUCTION AND PLANT LOCATION

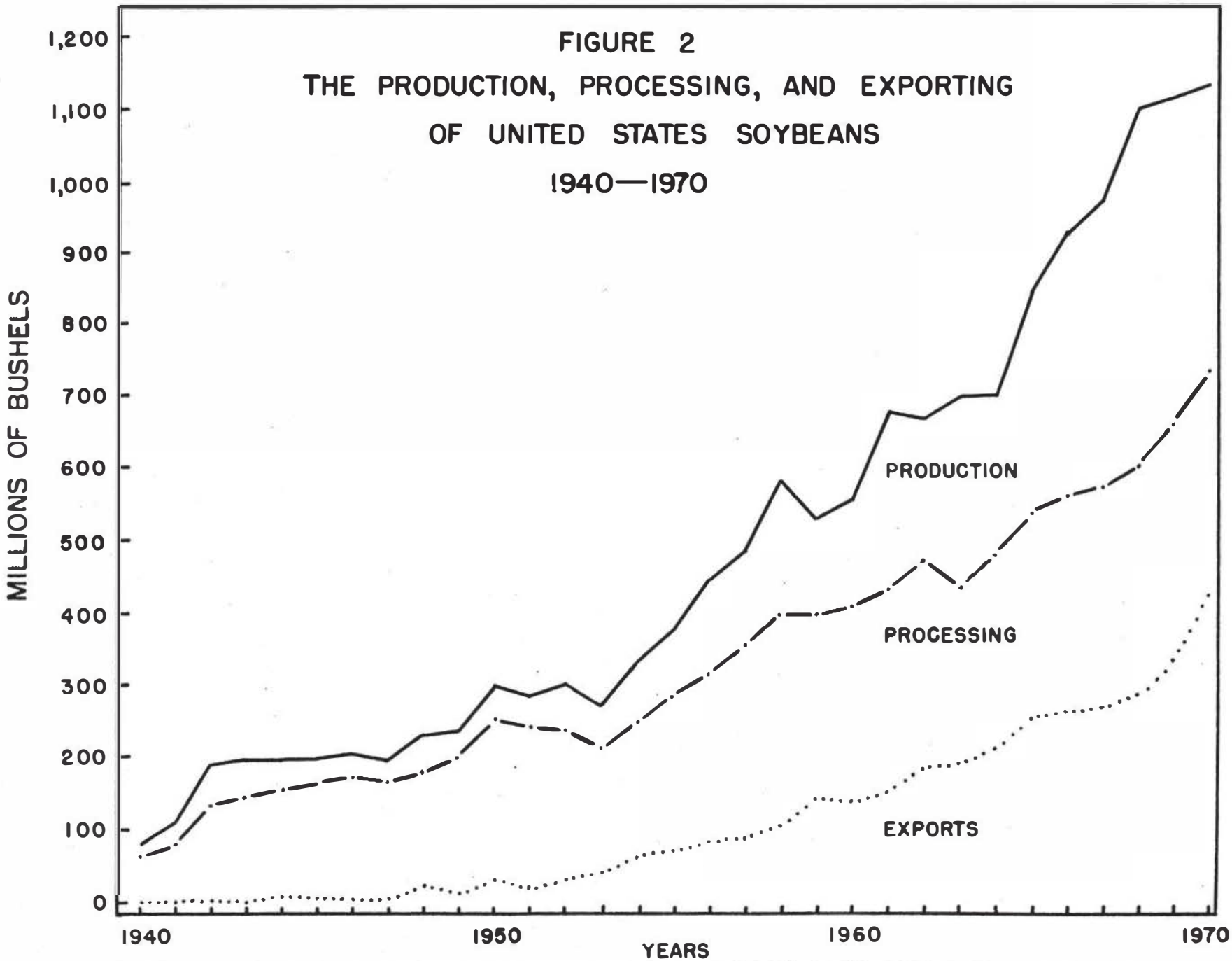
A general law of processing stating that the level of processing increases or decreases in relation to the amount of soybeans produced still has some validity on the national level and a direct implication on a regional basis.[1] As shown in Figure 2, this production/processing relationship was pronounced from 1940 through the late 1950's but diminished to a more general relationship through the 1960's. If this general relationship is valid and the information presented earlier regarding the acquisition of beans is pertinent, processing activities should be located in major production areas and new plants should come into areas of expanded soybean production.

---

[1] Charles Harper, Missouri and the Soybean Processing Industry (Jefferson City, Missouri: Missouri Division of Resources and Development, 1958), p. 15.

FIGURE 2

THE PRODUCTION, PROCESSING, AND EXPORTING OF UNITED STATES SOYBEANS 1940—1970



SOURCES: AMERICAN SOYBEAN ASSOCIATION, THE SOYBEAN BLUE BOOK, 1947–1964 (HUDSON, IOWA: AMERICAN SOYBEAN ASSOCIATION, 1947–1964). AND AMERICAN SOYBEAN ASSOCIATION, SOYBEAN DIGEST, BLUE BOOK ISSUE, 1965–1972 (HUDSON, IOWA: AMERICAN SOYBEAN ASSOCIATION, 1965–1972).

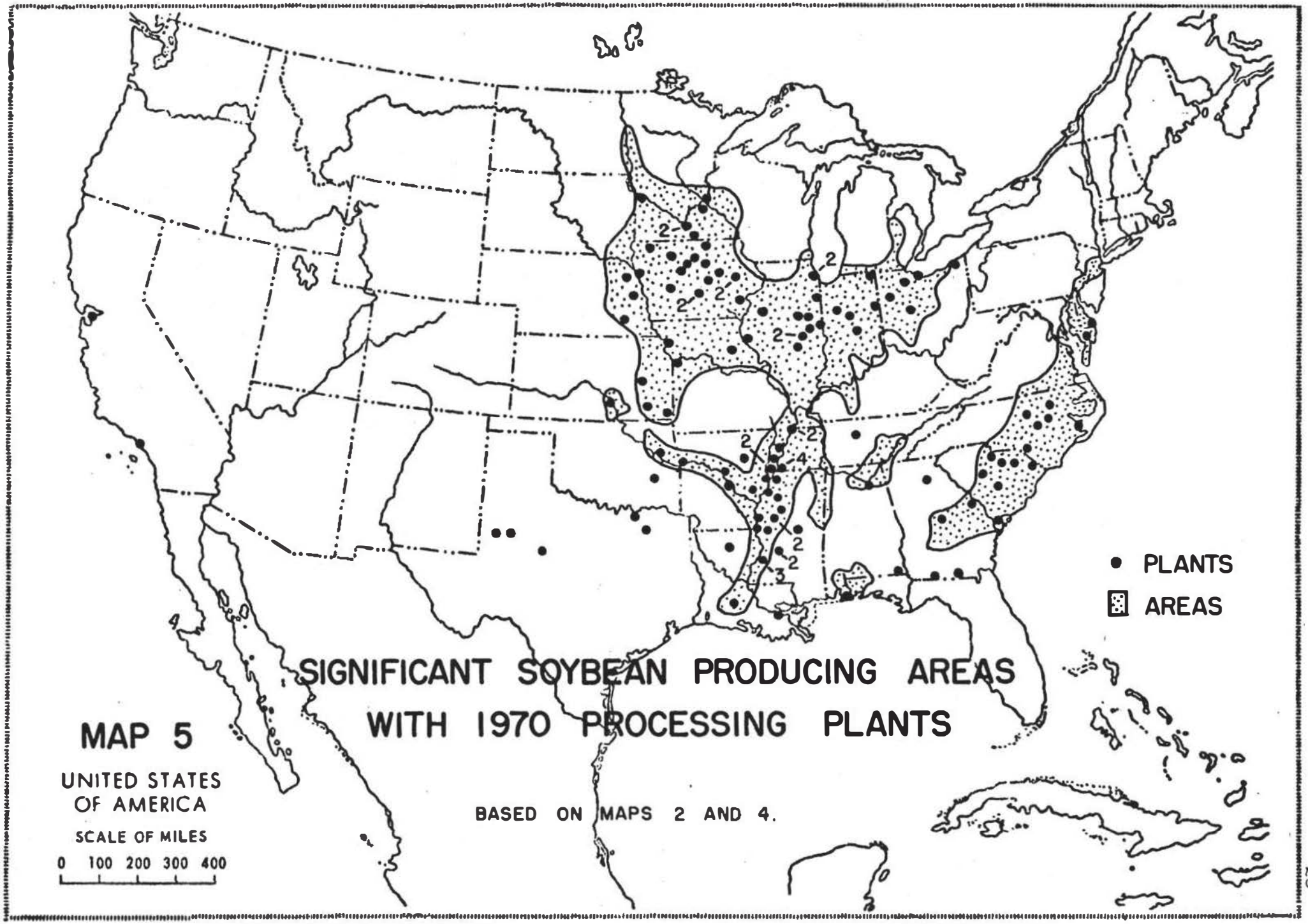
The strong relationship between the location of production and processing is evident from both a visual and a statistical appraisal. As shown in Map 5, most of the processing plants are located within major producing areas. Statistically 103 or 84 percent of the 1970 plants were located within areas of high bean production and only 16 percent were located elsewhere. Of the 1960 plants, 87 percent were located in high-production areas. The same percentage also applied to the 97 plants that continuously existed throughout the 1960-1970 study period. Although soybean production increased in the United States by about 202 percent from 1960 to 1970, this rate was not geographically uniform.[1] Based on state data, soybean production associated with the Central Processing Region increased about 195 percent in the ten-year period. Soybean production in states associated with the Lower Mississippi Region exceeded the national rate of increase with 1970 production at about 261 percent of the 1960 level. It should be noted that the Lower Mississippi Region was the only area to exceed the national production rate and the only area to have a positive gain in the number of processing plants.

EXPORTS AND PRICES

The exportation of soybeans could affect the domestic processing industry in two basic ways. First, heavy exports could reduce the supply of beans thus making the commodity difficult to obtain by domestic processors. And second, export buyers could bid against processors in the market thus influencing the prices paid for soybeans.

---

[1] American Soybean Association, Soybean Digest, Blue Book Issue (Hudson, Iowa: American Soybean Association, 1971), pp. 60-64.


PLANTS
AREAS
SIGNIFICANT SOYBEAN PRODUCING AREAS
WITH 1970 PROCESSING PLANTS
MAP 5
UNITED STATES
OF AMERICA
SCALE OF MILES
0 100 200 300 400
BASED ON MAPS 2 AND 4.

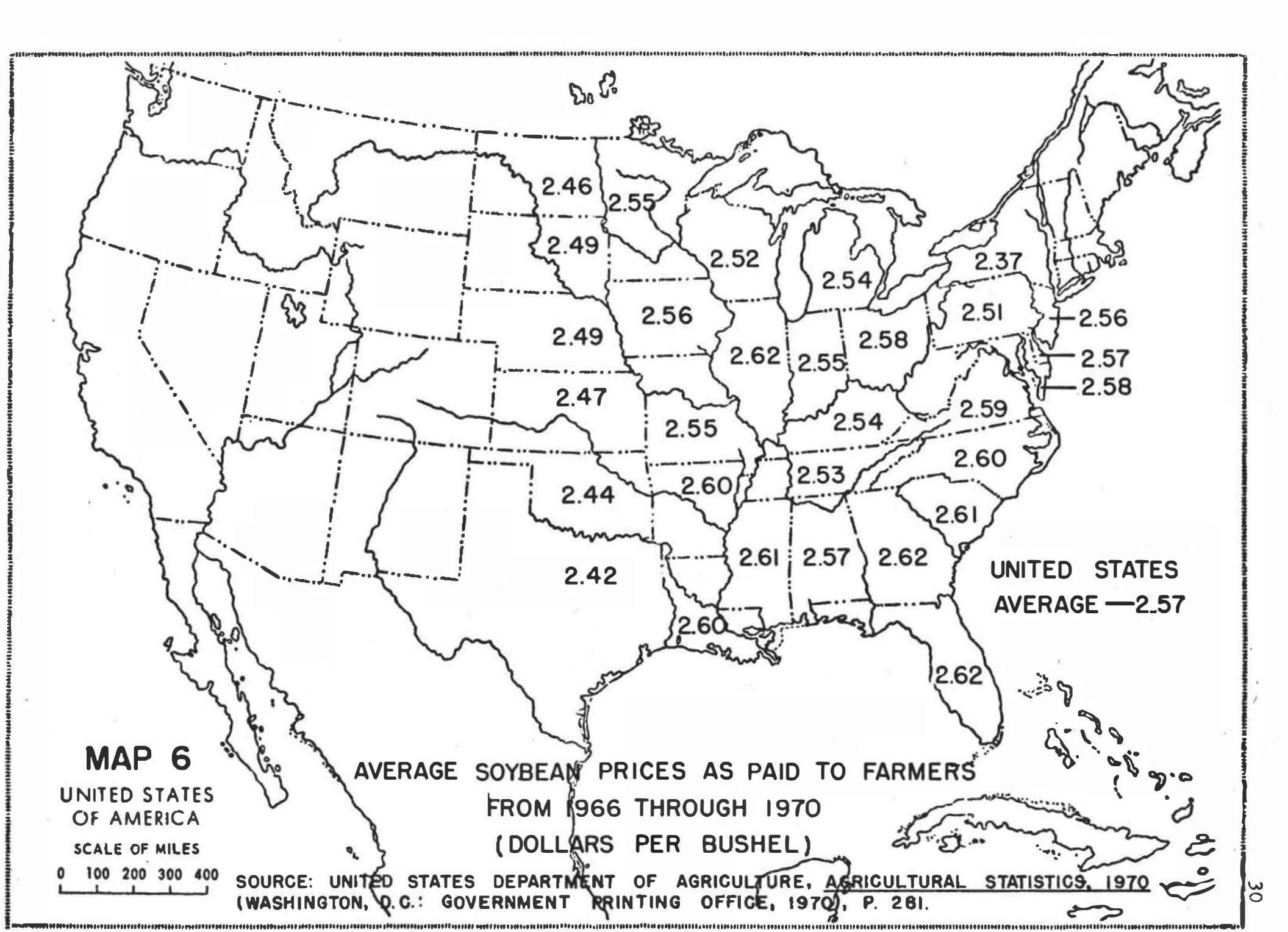
The question now is to what degree does exporting influence the location of domestic soybean processing operations.

As shown in Figure 2, the exporting of soybeans has increased in volume in recent years but has remained fairly constant on a percentage basis since 1965. The trend toward greatly increased exports started in the late 1950's with exports accounting for 18 percent of the United States crop in 1955, 24 percent in 1960, 29 percent in 1965, and 29 percent in 1970. Doubtlessly some processors experienced some supply shortage in their immediate area but with the national production increasing by 202 percent from 1960 to 1970 the impact of exports through the physical disappearance of soybeans was insignificant on the industry as a whole.

If exporting activities have a direct effect on soybean prices, areas near the principal ports should receive a higher price for soybeans than more inland locations. As prices are constantly changing and the prices paid by individual processors are not readily available, the average prices received for beans by farmers from 1966 through 1970 were selected and presented in Map 6. Of the soybeans exported, about 6 percent are through Atlantic ports, 23 percent are through ports on the Great Lakes, and 71 percent move through Gulf and related ports.[1] According to information in Map 6, there are basically higher average soybean prices in states along the lower Mississippi River, states along the Gulf and south Atlantic coasts, and in Illinois. These prices indicate that there is some influence exerted in the

---

[1] Ibid., p. 83.


2.46
2.55
2.49
2.52
2.54
2.37
2.56
2.49
2.62
2.55
2.58
2.51
2.56
2.57
2.58
2.47
2.55
2.54
2.59
2.60
2.44
2.60
2.53
2.61
2.42
2.61
2.57
2.62
2.60
2.62
UNITED STATES
AVERAGE —2.57
MAP 6
UNITED STATES
OF AMERICA
SCALE OF MILES
0 100 200 300 400
AVERAGE SOYBEAN PRICES AS PAID TO FARMERS
FROM 1966 THROUGH 1970
(DOLLARS PER BUSHEL)
SOURCE: UNITED STATES DEPARTMENT OF AGRICULTURE, AGRICULTURAL STATISTICS, 1970
(WASHINGTON, D.C.: GOVERNMENT PRINTING OFFICE, 1970), P. 281.

market place by export buying. The generally lower prices in states along the one hundredth meridian tend to reflect their remoteness from export outlets and/or perhaps domestic markets. The average prices shown in Map 6 for New York, Michigan, and Wisconsin do not fit the export influence concept, thereby indicating that exports do not always increase bean prices.

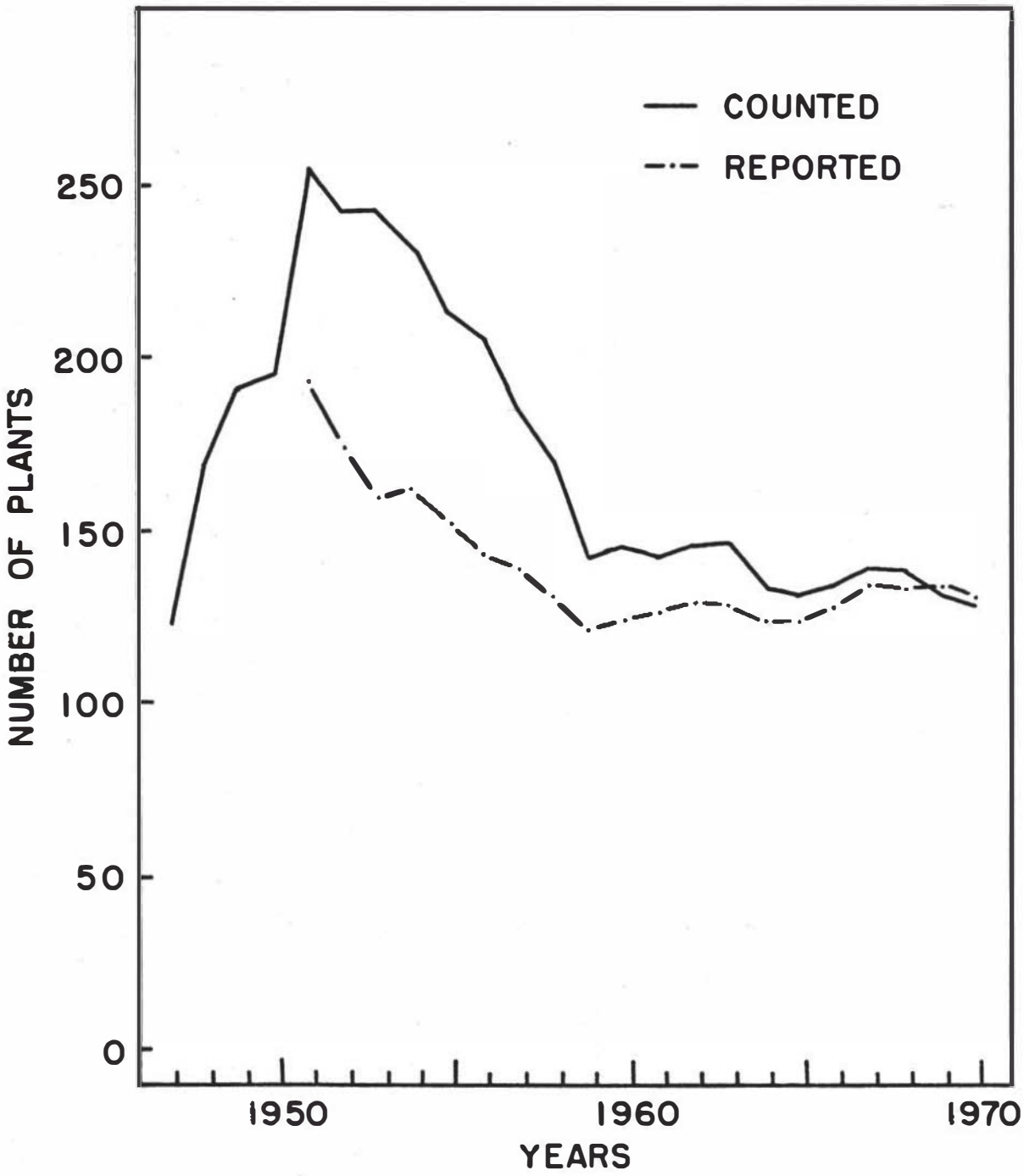
The apparent relationship of exporting to area soybean prices is also challenged by noting the previously identified locational shifts in the processing industry. The high price of beans in the Lower Mississippi Processing Region should discourage new plants and perhaps reduce the number of existing plants; however, this notion is disputed by the fact that this is the only region in which the number of processing plants expanded in the study period. The effect of higher bean prices along the Atlantic coast is also disputed by the fact that the Southeastern Processing Region generally maintained its relative position in the number of processors and greatly increased its percent of national processing. The Central Processing Region should have taken advantage of the slightly lower prices in the related production area; instead, this region lost more plants than the other processing regions from 1960 to 1970. These observations indicate that although exports may influence prices paid for soybeans, other factors influencing plant location or longevity may be more dominant.

NUMBER OF PLANTS

Although there are differences in the number of processors by different sources shown in Figure 3, two general time and number

FIGURE 3

NUMBER OF PROCESSING PLANTS 1947—1970



SOURCES: AMERICAN SOYBEAN ASSOCIATION, THE SOYBEAN BLUE BOOK, 1947—1964 (HUDSON, IOWA: AMERICAN SOYBEAN ASSOCIATION, 1947—1964). AND AMERICAN SOYBEAN ASSOCIATION, SOYBEAN DIGEST, BLUE BOOK ISSUE, 1965—1970 (HUDSON, IOWA: AMERICAN SOYBEAN ASSOCIATION, 1965—1970).

relationships are apparent. An analysis of data from both sources indicate a considerable decrease in the number of processing plants during the 1950's and a lower rate of change in the 1960's. The primary data used in this analysis of location and shifts of the industry was derived from listings containing the addresses of establishments processing beans in any amount. Resulting data and conclusions based on these data may be different than if estimates contained in census data were used.[1] Based on primary data there was a continued but lower rate of decrease in the number of United States plants in the 1960's with a net decrease of 18 plants. A decrease in the total number of plants could directly cause some relocation of the industry as a whole but as indicated previously different regions had different net experiences. Indications for the basic change in the number of plants on a regional basis is provided in the following discussion of plant size on a regional basis.

SIZE OF PROCESSING PLANTS

Although the number of plants diminished in the United States in the last 15 years, processing increased primarily because of the increased size or capacity of plants and the high level of plant utilization. As shown in Table 8, there has been a near constant increase in the average processing capacity of plants from 1955 to 1970. The average capacity per plant increased from 4.2 million bushels in 1960 to 6.7 million in 1970. This represented an increase of about 59.5 percent for the 10-year study period. The percent of

[1] Ibid., p. 86.

TABLE 8

ESTIMATED AVERAGE CAPACITY AND UTILIZATION OF UNITED STATES SOYBEAN PROCESSING PLANTS[a]

Year	Average Processing Capacity (Million Bushels)	Percent of Capacity Utilized	Soybeans Processed (Million Bushels)
1955	2.3	79	281.9
1956	2.6	85	313.6
1957	3.2	78	350.9
1958	3.5	89	398.8
1959	4.1	79	406.1
1960	4.2	77	431.4
1961	4.1	81	472.8
1962	4.2	86	436.8
1963	4.4	76	479.0
1964	4.7	82	537.5
1965	4.8	89	559.4
1966	5.0	86	576.4
1967	5.5	77	605.9
1968	5.6	81	707.0
1969	6.1	92	737.5
1970	6.7	87	760.0

[a]Computed from data in: American Soybean Association, Soybean Digest, Blue Book Issue (Hudson, Iowa: American Soybean Association, 1967-1972).

capacity utilized in actual processing has been generally high; therefore, the expansion of plant capacities has been for actual processing rather than for investment manipulations. These expansions in plant size and high levels of plant utilization resulted in a steady increase in the volume of soybeans processed.

There is considerable geographical variation in the size of soybean processing plants. Based on information presented in Table 8, the average United States plant processed about 5,612,000 bushels of beans in 1969. In analyzing average plant processing levels on a state basis, two significant geographic variations became apparent. In states associated with the Central Processing Region, average processing levels substantially exceeded the national average. For example, processing averaged 12,639,000 bushels in Illinois, 10,087,000 in Indiana, 9,669,000 in Missouri, and 7,013,000 in Ohio. In states associated with the Lower Mississippi Processing Region plant averages were lower than the national average with establishments in Mississippi processing an average of 2,230,000 bushels and Arkansas plants averaging 4,637,000 bushels in 1969.[1]

The regional variation in the size of plants indicates that there are regional differences in the basic operations of processing establishments. Because processing plants in the Central Region are large, they are apparently basing their production economics on the volume of beans processed per unit of invested capital. This economic alignment requires that plants expand their processing to produce the greatest net profit regardless of the increase in any individual cost

---

[1] Ibid., p. 69.

of operation. Large operations are forced to purchase soybeans primarily from brokers, elevators, and marketing complexities; therefore, they must pay perhaps 15 to 20 cents more per bushel for marketing and related services. Usually plant operations that reach processing levels of 5.5 to 6.0 million bushels annually are forced to acquire practically all of their beans through marketing concentrations and pay the higher acquisition costs. Purchases above this level generallyhave a fairly uniform commission and storage rate per bushel with additional variation being based on the incoming transportation costs as purchase points become more distant from the plant.[1] Very large processing operations therefore concentrate on the reduction of in-plant costs and marketing advantages because further increases in volume will not increase unit acquisition costs. If many plants within a region follow this volume-based economic alignment, smaller plants may close as they find it more difficult to obtain beans or market their products from diverse locations. These economic tendencies may have resulted in the number of plants decreasing in the Central Region as the economic environment required processors to either expand or perish.

A different plant size and economic alignment apparently existed in the Lower Mississippi Region which helped to promote the increasing number of plants in that Region. The processing level of plants in this region is generally below the national average with those in Mississippi averaging about 2,230,000 bushels annually.[2]

---

[1] Charles Harper, Missouri and the Soybean Processing Industry (Jefferson City, Missouri: Missouri Division of Resources and Development, 1958), pp. 21-23.

[2] American Soybean Association, Soybean Digest, Blue Book Issue (Hudson, Iowa: American Soybean Association, 1971), p. 69.

Small plants that process up to about 55,000 bushels annually may purchase from 75 to 100 percent of their beans directly from farmers.[1] This purchasing arrangement enables processors to pay farmers a few cents per bushel more than other buyers if the farmers will deliver the beans to the plant thus reducing incoming transportation costs. This arrangement also eliminates storage costs charged by elevators and other acquisition costs. Collectively these direct purchase and delivery arrangements can reduce the operative costs of a small plant by possibly 20 cents per bushel. Under this type of purchasing arrangement, increased production could inspire additional small processing operations to come into existence and could perhaps inspire processors of other oilseeds to switch to soybean processing. The tendency toward small plants in the region, related soybean acquisition practices, and expanded soybean production may have influenced the increase in the number of plants in the Lower Mississippi Region.

OTHER OILSEED PROCESSING

The processing of cottonseed in the Lower Mississippi Region could also influence the number of plants engaged in soybean processing in any given year. Should the price for cotton decline, farmers may shift to a more profitable crop which could easily be soybeans. As shown earlier in this study, soybean production has increased more than the national average in this region. This indicates that beans are replacing cotton in the changing market. Processing equipment in existing plants may be used for either cottonseed or soybeans thereby

---

[1] Charles Harper, Missouri and the Soybean Processing Industry (Jefferson City, Missouri: Missouri Division of Resources and Development, 1958), p. 21.

allowing processors to alternate between these commodities when either supply or prices change. This ability to change from one raw material to another also adds a degree of economic security to the small processors in the region. The alternating of commodities processed could enable smaller plants to operate profitably in spite of the national trend toward larger and highly specialized processing plants.

SUMMARY

This study attempted to accomplish its primary goal of determining what locational shifts occurred in the soybean processing industry from 1960 to 1970. Locations and shifts were identified on a state, regional, and national basis using a combination of historical, cartographical, and mathematical techniques. The investigation was also concerned with the identification of possible causes of relocation in the processing industry such as geographic shifts in soybean production, the areal influence of export buying on the price of beans, and availability of cottonseed as an alternate commodity for processing operations. Consideration was also given to trends and general relationships that might influence the location of soybean processing plants with specific attention given to the operative cost structure of a processing plant, the general decline in the number of plants in the United States, and the increase in the average size and utilization of plant capacity.

Based on the number of soybean processing plants, the leading states throughout the 1960-1970 period were Iowa, Illinois, Mississippi, and Arkansas. Within this time span, the individual rankings of the five leading states changed from Iowa, Illinois, Mississippi, Arkansas, and North Carolina sequence in 1960 to Iowa, Mississippi, Illinois, Arkansas, and Tennessee respectively in 1970. The change in state rankings indicated a shift in the location of processing establishments away from the Iowa-Illinois area to the Mississippi-Arkansas-Tennessee area.

The volume of soybeans processed increased in the United States from 1960 to 1970; however, individual states increased at different rates. Illinois ranked first among all processing states with a volume about twice that of second-ranked Iowa and over three times the volume of any other state throughout the study period. Processing levels did not increase at the national rate in the leading states of Illinois and Iowa; therefore, these states produced a lower percentage of the national volume in 1970 than in 1960. The increased volume of soybeans processed in Arkansas and Mississippi was proportionally greater than the national average; therefore, these states increased in their percentages of the national total from 1960 to 1970. The relative decrease in the volume of soybeans processed in Illinois and Iowa and the relative increase in Arkansas and Mississippi indicate a shift of the industry toward the Arkansas-Mississippi area.

Most of the soybean processing plants in the United States from 1960 to 1970 appeared to be arranged in three major groupings which were regarded as processing regions in this study. An examination of these regions revealed a general locational shift of both plants and levels of soybean processing. Throughout the study period the Central Region led in the relative shrinkage of the number of plants and volume of soybeans processed. The Lower Mississippi Region was the only region to experience a net increase in the number of soybean processing plants. The Lower Mississippi Region's percentage of the national volume increased more than any other region. The Southeastern Region had a slight reduction in the number of processing plants but increased in the volume of soybeans processed. This regional examination of the soybean processing industry also substantiated that there was a southerly shift in both the location of plants and the processing of soybeans.

In an attempt to measure the shift in the location of soybean processing plants, the geographic center of plants in the United States was computed on an annual basis and the direction and distance of their movement was analyzed from 1947 through 1970. This mathematical technique determined that, although the geographic shifting of the center was erratic, some rates and trends were apparent. The geographic center changed an average of about 48 miles annually in various directions from 1947 to 1970. From 1960 through 1964, the center was unusually stable changing only an average of 7.3 miles per year. From 1964 to 1970, the rate of change accelerated and exceeded the 23-year average by moving about 52.8 miles annually. The center has moved in various directions; however, the greatest shift has been southward at an annual average of about 9.6 miles from 1947 to 1970. From 1960 to 1970, the net southerly change was about 13.8 miles annually or about 44 percent greater than the 23-year average.

An analysis of the operative cost structure of a moderate-sized soybean processing plant revealed that the cost of acquiring soybeans was the largest operative cost factor. These acquisition costs, comprised of expenditures for transportation, commissions paid, storage charges, and other intermediary expenses related to getting beans to the plant site, accounted for about 27 percent of the plant's operative expenditures. Other costs were either considerably less or varied more with internal financial arrangements than with location. Processing operations that locate near significant soybean production areas should be able to minimize acquisition costs. Acquisition costs influence processing plant locations to the extent that about 84 percent of plants in the United States were located in areas of high soybean production in 1970.

The general law of processing stating that processing increases or decreases in relation to the amount of soybeans produced proved valid on an areal basis. Soybean production in the Central Processing Region was below the national rate of increase from 1960 to 1970. In response to the general law, the Central Region decreased in its percent of the national processing volume and lost more processing plants than any other region in the 10-year study period. In the Lower Mississippi Region, soybean production greatly exceeded the national rate of increase. The region therefore experienced the largest increase in the number of plants and the largest increase in the percent of the national processing volume of the soybean processing regions.

The number of processing plants in the United States decreased by 18 establishments from 1960 to 1970 while at the same time the volume of processing increased by 59 percent. All processing regions directly supported the increase in processing with higher levels of processing at the end of the 10-year period. The decrease in the number of processing plants was primarily caused by changes in the Central Processing Region. Plant losses in that region accounted for about 90 percent of the national reduction. Processing operations in the Central Region, which are much larger than the national average, are apparently basing their plant economics on high levels of mass processing and centralized marketing of products. Smaller plants in the Central Region were evidently forced to either enlarge their operation and fight for survival or withdraw from processing. Soybean processing plants in the Lower Mississippi Region are much smaller than the national average and are apparently basing their processing economics on the lower acquisition costs that can be obtained by purchasing soybeans from nearby producers.

This economic basis of operation evidently enabled existing processors to remain in business and encouraged other small processing plants to come into existence. The Lower Mississippi Region had an increase in both the number of plants and the volume of soybeans processed by the end of the study period.

The smaller plants of the Lower Mississippi Region have an additional economic advantage. Small plants can easily and quickly be converted from soybean to cottonseed processing. This ability to alternate between oilseed crops enables plants in the region to take advantage of either a supply or demand situation.

The influence of soybean exporting on the location of processing operations in the United States appears to be limited. This observation was substantiated by the stabilization of exports at about 29 percent of the domestic production level from 1965 to 1970 while production and processing levels continued to expand. Export buying appeared to have a relationship to prices paid to farmers in some areas but prices in other production areas near export outlets were apparently not increased. The limited influence of exporting on the location of the soybean processing industry is also substantiated by the growth of the industry in the Lower Mississippi Region. The exceptional growth of the region in both the number of processing plants and percent of the national volume occurred despite the fact that 71 percent of the United States soybean exports moved through Gulf and related ports.

PROSPECT

The soybean processing industry in the United States will continue to respond to economic factors that influence both the size and location of processing plants. The size of individual processing plants should be primarily determined by the volume of soybeans that may be economically acquired at any specific plant location. Some large processing operations in the Central Processing Region may be near their maximum growth. Further increases in processing levels could prove to be unprofitable without corresponding increases in regional soybean production because more competitive buying would increase soybean prices or necessitate above-average expenditures for transporting soybeans from more distant producing areas. Future expansion of the already large processing operations in the Central Region should be in direct proportion to future increases in soybean production within the region.

Some processing plants in the Lower Mississippi Region could become much larger in the next few years if regional soybean production continues to increase or even stabilizes at the current level. Plant locations in this region that have distinct advantages in acquiring soybeans should respond to that economic condition by installing larger and highly-efficient processing equipment. Accelerated soybean purchasing by these new enlarged installations could increase the competition for soybeans in the region and reduce the amount of beans available to less efficient plants. Processing operations without acquisition advantages or expansion capital will be forced to function as marginal soybean

processors or withdraw from processing. Such an increase in the size of plants in the Lower Mississippi Region would increase the Region's level of processing; however, the increased competition for beans could easily reduce the number of processing plants within the region.

The general distribution of soybean processing plants will change if crop production spreads geographically. An increased demand for beans could be triggered by technological advances in the utilization of soybeans for direct human consumption and improved rations for animals. An increased demand for beans could cause farmers to switch from cotton, corn, hay, etc. to soybean production. Such shifting would not only bring thousands of acres into soybean production in the present producing areas but would create now producing areas especially in Cotton Belt states. New varieties of soybeans with earlier maturity and greater drought resistant characteristics could cause soybean production to increase and spread in areas with lower rainfall and shorter growing seasons in Oklahoma, Kansas, Nebraska, South Dakota, North Dakota, Minnesota, and Michigan. New areas of production could warrant the development of new processing plants. These plants would tend to be small operations; however, they would collectively increase the national volume of processing and cause locational shifts in the processing industry.

BIBLIOGRAPHY

American Soybean Association. The Soybean Blue Book, 1947-1964. Hudson, Iowa: American Soybean Association, 1947-1964.

American Soybean Association. The Soybean Digest, Blue Book Issue, 1965-1972. Hudson, Iowa: American Soybean Association, 1965-1972.

Harper, Charles. Missouri and the Soybean Processing Industry. Jefferson City, Missouri: Missouri Division of Resources and Development, 1958.

United States Department of Agriculture. Agricultural Statistics, 1970. Washington, D.C.: Government Printing Office, 1970.

United States Department of Agriculture, Department of Agricultural Economics. Farm Management. Number 67-7. Urbana, Illinois: University of Illinois, 1967.

United States Department of Commerce, Bureau of the Census. Statistical Abstract of the United States: 1970. Washington, D.C.: Government Printing Office, 1970.

United States Department of the Interior, Geological Survey. The National Atlas. Washington, D.C.: Government Printing Office, 1970.

Yaseen, Leonard. Plant Location. New York: American Research Council, 1956.