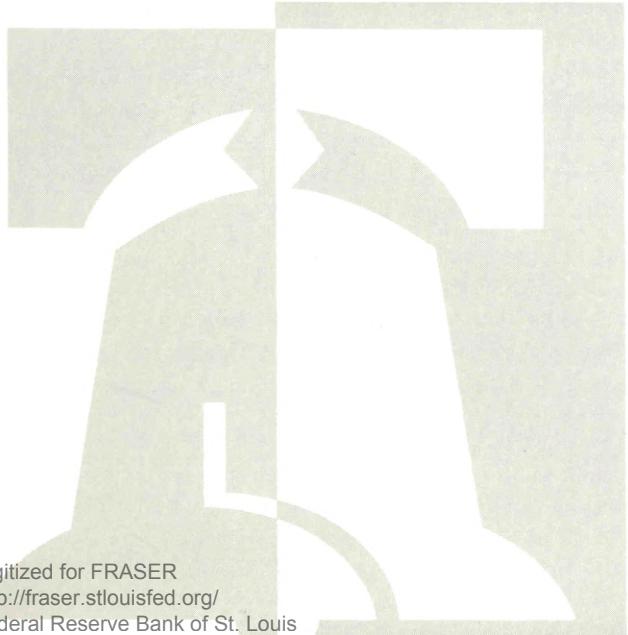
The Potato: Prince or Pauper of Vegetables?

The Innovation Industry

FEDERAL RESERVE BANK OF PHILADELPHIA

BUSINESS REVIEW



AUGUST 1965

THE POTATO: PRINCE OR PAUPER OF VEGETABLES?

A lowly vegetable is the potato, but oh so versatile! It can be boiled, baked and foiled; home fried or French fried; creamed, diced, or riced; chipped or whipped, scalloped, souped, or saladed; lyonnaised, julienned, or au gratined. Rare, indeed, is a full-course dinner without potatoes in some form. Gastronomically, the potato is the most popular member of the vegetable kingdom. Botanically, it is a berry-bearing herb, with esculent roots, winged leaves, and a bell flower. Economically, the potato is wayward, capricious, unpredictable.

The potato is readily growable, gradable, packable, storable, transportable, marketable, processable—even hedgeable—but not always profitable. Between sowing and reaping (or as the English say, between planting and lifting) many things can happen. So much depends upon the acreage planted, the weather, the bugs, the yield, the quality, and the carryover. All of these contingencies, in the face of a steady but inelastic demand, conspire to make prices erratic. Hence the potato farmer is likely to be a prince one year and a pauper another.

The last time we planted potatoes we cut them by hand with a little paring knife, making sure each wedge had at least one eye. With a hand hoe, each wedge was carefully covered with soil. During the growing season, pestiferous bugs were battled with frequent applications of Paris green. Irrepressible weeds were uprooted by means of a horse-drawn, hand-guided cultivator. In the fall when the potato vines died, the potatoes were dug with a potato hook and hand picked into gunny sacks. That was about seven or eight Presidents ago. How times have changed —potato times!

Today, potato growing is big business. Most of the potatoes are now grown in areas favored by soil and climate, on farms of extensive acreage, cultivated with specialized and costly machinery —the entire operation requiring a capital investment that often runs into six digits west of the decimal. To be sure, little potato patches are still an adjunct of many small general farms throughout the country; but "small potatoes" is no longer an apt description of the potato business.

Potatoes are grown in every state of the country, which may give the impression that they thrive anywhere. Their ancestry can be traced back to the Bolivian and Peruvian Andes, where close botanical relatives of the potato still flourish at mile-high altitudes—indicative of the fact that the tuber tolerates a cool climate.

The potato in Pennsylvania

Potatoes are grown in all 67 counties of Pennsylvania, including Philadelphia County, though

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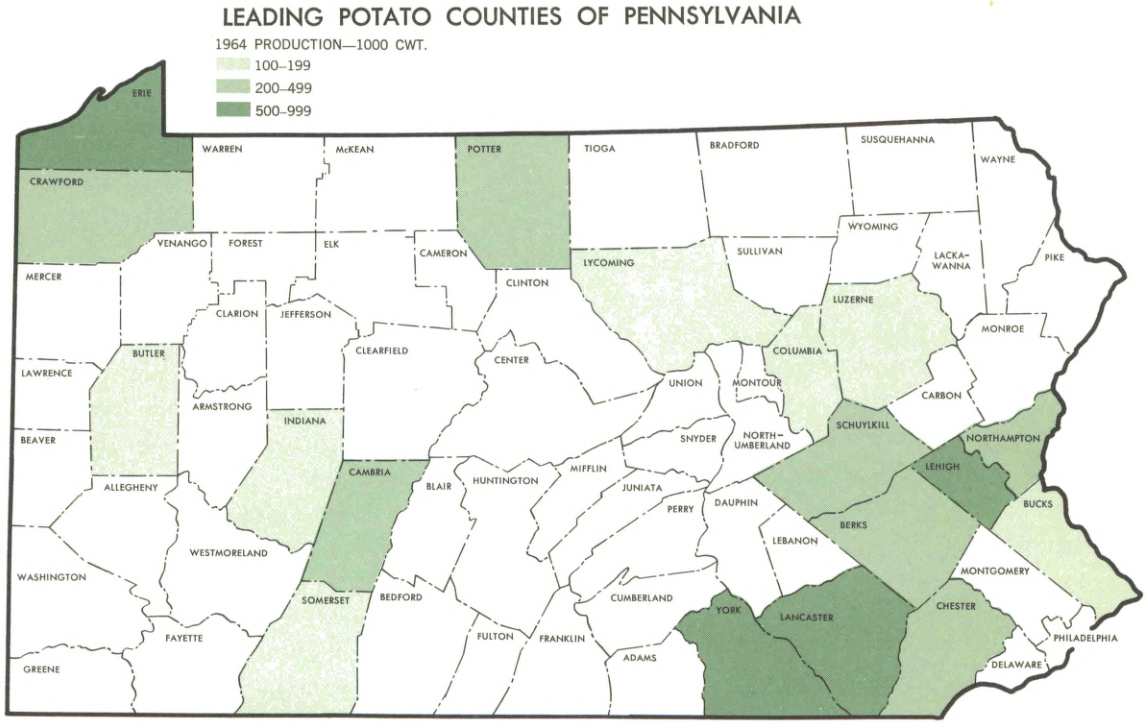


Source: Pennsylvania Department of Agriculture.

a good many years have passed since potatoes were cultivated at Broad and Chestnut. Last year the Commonwealth produced $25 million worth. Corn and hay were the only field crops that yielded more money. New Jersey and Delaware also grow potatoes, but in this article special attention is called to the Pennsylvania potato.

Pennsylvania's most productive areas are shown on the map. The leading counties are Erie, Lehigh, Lancaster, York, Potter, and Cambria—in that order. These half-dozen counties produced over half of the state's 1964 crop.

Field notes

To understand potato farming, you ought to see it. Let us take you on an armchair tour into Pennsylvania potato country. Lehigh is our nearest big potato county; but distance lends enchantment, so let's go northwest to Potter County, bordering New York State; then to the western extremity of our district in Cambria County, rich in both potato land and soft soal beds.

Potter and Cambria counties are hilly. Potatoes have no objections to summits and slopes—and there is where most of the potato fields are found, because only the higher elevations afford sufficiently broad acreage to permit the use of field machinery; the valleys are too narrow for mechanized potato culture.

An early June landscape presents a view of curvaceous sweeps of freshly cultivated brown earth contoured between stands of green grass on one side and greener oats on the other. The foliage of newly sprouted potato plants is just

beginning to pin-stripe the brown soil with green, and when the vines bloom the fields turn white. The interspersed oats and grass-legume crops are part of the rotation plan to replenish the soil with moisture and nitrogen; and the gracefully curving contours help to prevent the soil from washing away.

A farm with 100 acres in potatoes, which is about the minimum size for profitable commercial operation utilizing machinery, usually has a total of 300 to 400 acres for purposes of crop rotation. Land, buildings, and machinery—a Potter County farmer told us—requires a capital investment of $150,000 and up. On a large 1300-acre Cambria farm with 350 acres in potatoes, we counted 14 tractors, two potato harvesting machines (each worth about the price of three Cadillacs), numerous plows, planters, cultivators, sprayers, and miscellaneous equipment. The owner-operator employs 14 full-time, year-round workers with, of course, a greatly augmented labor supply during harvest time.

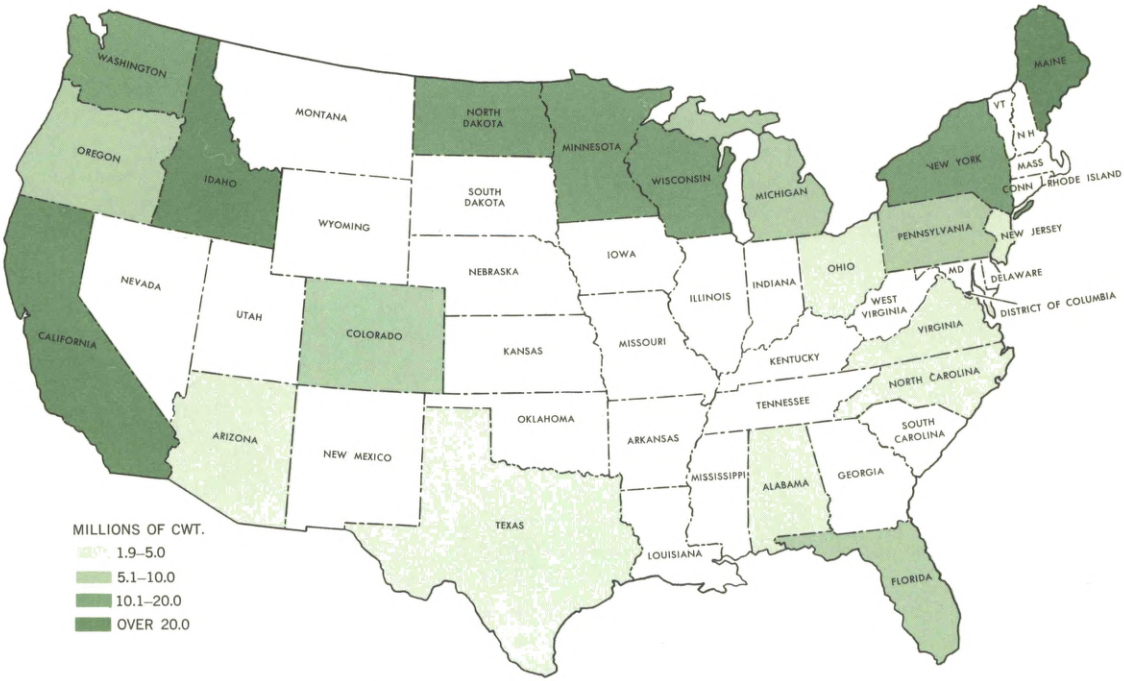
To grow good potatoes, one must plant good seed. Pennsylvania farmers import large quantities of certified seed potatoes from Maine. Some are also grown in Potter County—the only place in Pennsylvania. Certified seed potatoes grow best in low-temperature northern areas and assure the commercial potato grower the maximum protection against ravages such as ring rot, infection by mosaics, leaf-roll disease, and other seed-borne diseases which cause losses up to 20 per cent of the crop.

The seed potatoes are machine cut, machine loaded, machine planted, machine cultivated, machine sprayed, machine harvested, and machine graded for size. Everything is done mechanically except the eating thereof. The modern farmer must be not only a good manager, but also must be or must employ a good welder and all-around mechanic to make repairs rapidly when something goes wrong. Incidentally, the mechanized planter plants with each potato seed a systemic insecticide which finds its way up through the stalk to give instant battle to some of the attacking enemies.

The harvesting machine—drawn by a big caterpillar or four-wheel-drive tractor—is a costly and colossal newfanglement which unearths two rows of potatoes simultaneously, shakes out the soil, separates the rocks from the potatoes which are delivered by moving belt to the accompanying truck that hauls the potatoes to the potato barn where they are mechanically unloaded. In a Cambria County potato field, we came upon a healthy stand of young potatoes in a field so full of stone that we were moved to say, "I never knew potatoes could be grown in a rockery," to which the farmer's only reply was, "You should see all the rocks we have already removed from that field."

Potato storehouses—barn-like in appearance but commonly referred to as potato storage—are equipped with air ducts below the floor and gigantic blowers provide good circulation. These precautions, along with insulated ceilings, keep the stored potatoes in good condition awaiting delivery which may be as late as the next year's planting time. The structures are always larger and, in many instances, better cared for than the homestead because they are the base of operations in quest of potato profits. The potato storage is a multiple-purpose building which serves not only to store seed potatoes, harvested potatoes, and fertilizers but serves also as a place for cutting seed, grading, sorting, packing, and often includes a machine shop and a telephone. Sideline operations such as fattening hogs or breeding horses may also be under the same roof.

LEADING POTATO STATES
1964 production.



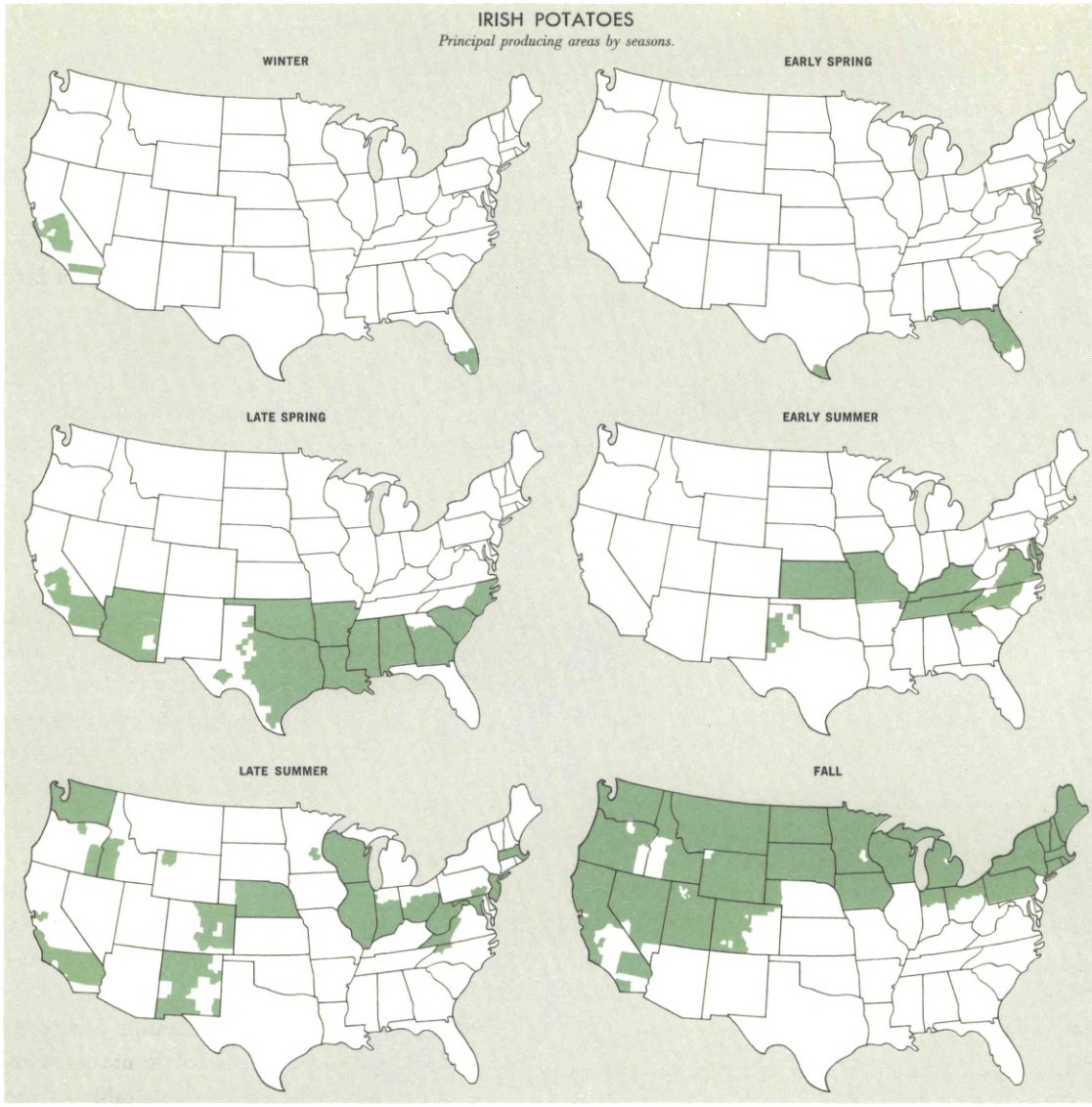
Source: United States Department of Agriculture.

The all-American potato scene

Although Pennsylvania is representative of the way potatoes are grown, it is not to be inferred that the Commonwealth is a leader; in fact, Pennsylvania ranked twelfth in the 1964 interstate potato derby in which all fifty states participated. New Jersey ranked fourteenth.

Anyone who has ordered food from a printed menu has come across Idaho potatoes; and housewives, cruising through supermarkets, are familiar with Maine potatoes whether or not they have heard of Aroostook County. Those two states, along with two others—California and New York—produced half of the country's 1964 crop, which is indicative of the regional specialization. All the other states together produced the other half. The accompanying map points up the 20 leading states. Delaware doesn't qualify because of its small size, but the little state is not to be overlooked; it is among the states that produce early-summer potatoes—which brings up another point.

Almost three-fourths of the annual crop of potatoes is grown in Northern states, including California, and is harvested in the fall. Some states, however, harvest their potatoes in late summer; others in early summer; others in late spring, and still others in early spring; and a few states harvest winter potatoes—notably Florida and California. The accompanying panel of maps shows the origin of the six seasonal marketing areas. There is no month in the calendar without new potatoes originating somewhere. Remarkably accommodating is the potato.



Source: United States Department of Agriculture.

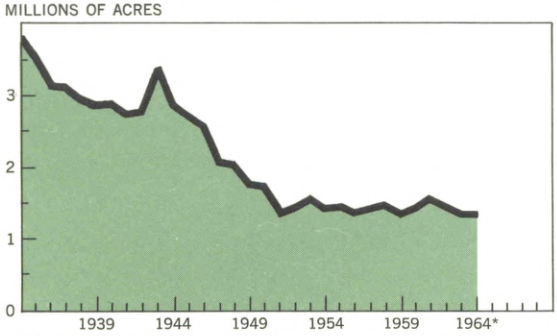
Potato productivity

The potato is a most accommodating vegetable in still another respect—its amenability to expansive productivity. This feature of the spud is graphically portrayed on the charts showing acreage planted and the yield per acre. Note the phenomenal decline in acres planted and the equally phenomenal growth in yield per acre. Never have so many potatoes been grown on so few acres as in recent years. Last year, acreage was down to almost 1⅓ million—the smallest reported since 1867—and the yield per acre was close to the peak of 200 cwt. (hundredweight) per acre. These are national averages. Some individual farmers do far better than twice the national average. Moreover, some of those top-

flight farmers are in Pennsylvania (pardon the commercial). Noteworthy is the fact that recent yields per acre are almost triple those of three decades ago.

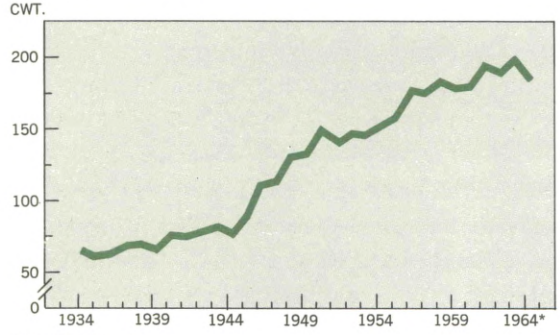
Rising productivity, as might be supposed, is not fortuitous. It has come about through steadily improved practices such as the use of certified seed, better strains obtained by cross-breeding, improved disease and insect control, irrigation, judicious use of fertilizer, and moisture control. For example, some farmers, instead of cutting their grass for hay making, plow under the entire crop of grass thus insuring adequate moisture for the ensuing potato season regardless of how niggardly the rainfall.

TOTAL ACREAGE PLANTED



* Preliminary.
Source: United States Department of Agriculture.

YIELD PER ACRE



* Preliminary.
Source: United States Department of Agriculture.

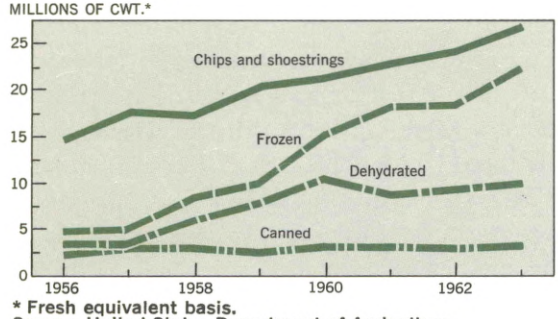
The trek to market

With increased regional specialization in potato growing and increased urban and suburban concentration of population, potatoes have a longer and longer trek to market. Formerly, most of them went by rail but a rising tonnage is going by truck. The cost of moving potatoes from farm to market has also been increasing, partly as a result of longer hauls, partly owing to increased services incident to marketing, and partly because of rising wages. In many instances there is also a middleman or two, or three, between the grower and the ultimate consumer. As a consequence of these developments, consumers are likely to pay more than formerly and farmers are likely to receive less than formerly.

Potatoes go to essentially two major markets: the fresh table market and the processing market. The fresh table market is the larger, and it has undergone some notable changes in recent years. Potatoes for the fresh table market are mass merchandised. Potatoes, like other vegetables, now reach consumers by way of big shippers, big supermarkets and corporate chains. There is more direct buying and less movement through terminal markets. As a result, growers and shippers must adjust their grading, packaging, and other services to meet large-scale demands of the changing marketing structure; however, the fresh table market is not growing. Reasons for the languishing fresh table market in the face of an ever-growing population will be explored several paragraphs later in connection with the discussion of our changing dietary habits.

Fortunately for the potato grower, the processing market is flourishing. A mere decade ago about 14 per cent of the potatoes grown for food was processed; now almost a third is being processed. Processing consists of converting po-

VOLUME OF POTATOES FOR FOOD PRODUCTS SHOWS GAIN



* Fresh equivalent basis.
Source: United States Department of Agriculture.

tatoes into various finished or semi-finished products for consumption. Potato chips and "shoe strings" are the leading items; other are frozen potatoes, dehydrated potatoes, and canned potatoes. The growth in relative importance of these items is shown in the accompanying chart. As many housewives know, particularly gainfully employed or bridge-playing housewives, processed potatoes appear on the shelves of supermarkets in various attractive packages. There are frozen fries, puffs, whole potatoes, and prepared dishes such as scalloped potatoes and others ready to put in the oven. Dehydrated potatoes take a variety of forms such as mashed potato flakes, mashed potato buds, and potato pancakes, which enable the housewife to assemble an instant dinner—almost.

Whether a farmer sells to the fresh or processed market depends upon the type of potatoes he grows, the length of the haul, prices offered—in short, the market promising the best return. Some Pennsylvania growers ship potatoes as far South as Florida and Texas—the potatoes going South on return trips of trucks that brought citrus fruits North. The trend, however, is definitely toward the processing market, not only for Pennsylvania growers but also for growers in the leading areas.

Many chippers buy on contract, which has both good and not so good features for the farmer. The farmer who sells to a chipper is assured a definite contract price, which is perhaps to the farmer's advantage in the long run, but there are times when the farmer wishes he had not been under contract. A Cambria County farmer told us that last year he could have made $60,000 more on his potato crop had he not been under contract to a chipper. It is also alleged (and denied) that various clauses in the contract allow more loopholes for the chipper than the grower.

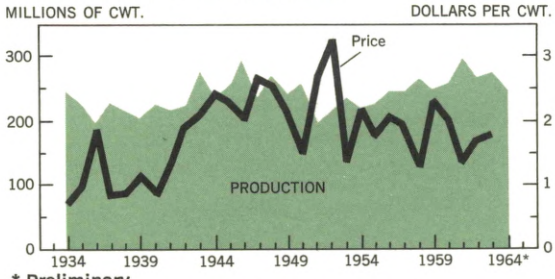
A controversial aspect of potato marketing is the futures market in New York City, which deals in Maine potatoes. A futures market affords the opportunity of buying or selling potatoes for future delivery. Some growers, dealers, and others use the market for hedging purposes. Numerous farmers, however, believe that the futures market exerts adverse effect on the cash market for potatoes.

Glory, what prices!

Never, or almost never, have potato prices been so high as they have been recently. Reason? A short crop in 1964.

The 1964 crop of 243 million cwt. is referred to in a U.S. Department of Agriculture monograph as "relatively small." It was 11 per cent less than that of the preceding year. For the 1963 crop, which was about "normal," farmers received an average price of $1.77 per cwt. At this writing, not all of the 1964 crop reports are in; but on the basis of recent and current prices, it appears that the average price that farmers will have received will be about double that of 1963. Thus an 11 per cent decline in production from one year to the next caused almost a doubling of the price. Such is potato economics.

UNITED STATES PRODUCTION AND AVERAGE PRICE RECEIVED BY FARMERS



* Preliminary.
Source: United States Department of Agriculture.

A somewhat longer-run picture of potato economics is shown in the chart entitled "United States Production and Average Price Received by Farmers." Production for the 30-year period portrayed, it will be observed, has a sawtoothed contour; but the contour of prices is sawtoothier.

Irregularities of production are caused by several things: changes in acreage planted, changes in yield owing to the vagaries of weather, insects, diseases, the carryover and, of course, changes in price. Often, though not always, a large crop and low prices are followed the next year by smaller acreage planted, a smaller crop, and higher prices.

Weather is most unpredictable. Sometimes shortage of rainfall may result in smaller crops in some areas, which redounds to the benefit of growers in other areas with adequate rainfall. Last year, for example, potato growers in Potter and Cambria counties encountered only minor shortages of rainfall, contrary to the experience throughout other areas of the state—with the result that potato profits are the source of some nice new homes being built in those two counties. But, who knows? Next year some of these new "potato" homes may have to be mortgaged to buy seed and fertilizer. Abnormality is normal in potato growing. The potato farmer, to repeat, is usually either prince or pauper. He seems doomed to ride the price roller coaster.

The unsupportable price support program

A Potato Control Act was passed as early as 1935, but it ran into a legal snag. The objective of the Act was achieved, however, by using Section 32 funds for surplus removal. In 1940, several million bushels were bought, most of which were diverted to livestock feed and starch production.

Subsequent to our involvement in World War II, the Congress, anticipating heavy wartime demand for food, authorized outright support programs and further specified that supports be at 90 per cent of parity.

During the years of price support, 1943 to 1950, tremendous gains were made in yield per acre, so that heavy production persisted in spite of acreage cutbacks. Reduction of the support level from 90 to 60 per cent of parity failed to prevent continued overproduction.

Inasmuch as potatoes are difficult to store over a year and are ill-suited for uses other than human consumption and, above all, since large reductions in price bring about only minor increases in consumption, little could be done with the Government surpluses other than to destroy them or feed them to cattle. The experiment cost the Government over a half-billion dollars and drew avalanches of criticism. Price support was abandoned in 1951, whereupon the industry reverted to the *status quo ante;* that is to say, the good old law of supply and demand.

The potato in our diet

Thus far we have explored potato economics only in terms of production and price. There remains demand, which cannot be ignored.

Despite the widespread dietary utility of the

potato, demand for the vegetable harbors a basic infirmity. Demand is said to be inelastic, which is the economist's way of saying that price has only a minor influence on consumption. People eat what potatoes they like and pay little attention to the price. Potatoes are cheap even when they are high priced. The diner will not order an extra helping of potatoes because they are cheap, nor will he curtail his consumption because they are dear; at any price, they are an insignificant proportion of the total tab.

Per capita consumption has declined from about 200 pounds in 1910 to not much over 100 pounds currently. Why the slippage? Students who have given considerable attention to the problem point out various reasons, such as the virtual cessation of immigration, higher real incomes, increasing abundance and variety of other foods on the market, the growing ascendancy of white-collar over blue-collar jobs, increasing urbanized dwelling, greater girth-consciousness—especially among women—and the slowness of some potato merchandisers to doll up potatoes into fancy packages for the fresh market.

There may also be psychological reasons. For example, for purposes of distinguishing it from the sweet potato, the white potato is commonly called the Irish potato. The Irish are lovely people and we have nothing against them, but over a century ago they made the mistake of making the beautiful Emerald Isle a one-crop country, against which they had been warned. A potato famine caused by two successive bad harvests resulted in widespread starvation, whereupon Irish immigrants poured into this country in great numbers. The misfortune was a poor advertisement for potatoes—it gave rise to the widespread impression that the potato is the poor man's diet. Perhaps worse for the potato is the popular misconception that consumption of potatoes causes obesity.

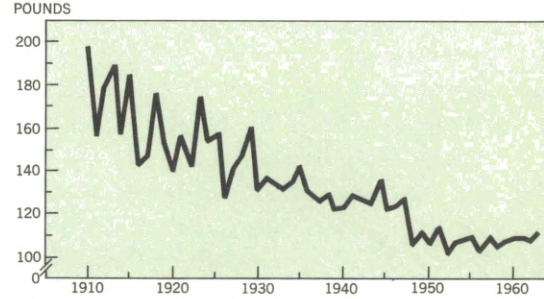
In defense of the potato it should be pointed out that to think of the vegetable as fattening is erroneous. All foods eaten to excess are fattening. Pound for pound, potatoes are less fattening than most items in the American diet. It is not so much the ingestion of potatoes that causes equatorial expansion of the human form as it is the butter, the sour cream, or the gravy with which potatoes are so often garnished. The "fattening" tendency of potatoes is one-tenth that of margarine, one-fifth that of dry cereal, one-third that of bread, and one-half that of beef or hamburger. The case rests.

A salute to the chip

Potato people are hopeful that the declining per capita consumption has reached the end of the road; indeed, the curve seems to have reached bottom and is rising again. For that happy turn of events the growers can thank potato chips and associated processed products—but chiefly the chip.

No one stops with one potato chip, any more than one stops with one salted peanut. Chips and "shoestring" consumption is already above the

PER CAPITA CONSUMPTION* OF POTATOES IN THE UNITED STATES



* Civilian consumption; includes fresh weight equivalent of processed potatoes.
Source: United States Department of Agriculture.

25 million cwt. range and takes one-eighth of the total amount of potatoes going to the fresh market and food processors. And frozen potato products are close on the heels of the chips. Could it be that the future of the potato lies in the chip, frozen, and other processed products yet to be devised by the ingenuity of man? We are loath to predict, especially in print, but the enthusiasm of processors is understandable, and it is not unrealistic to anticipate additional new potato products from experimental laboratories like the Eastern Utilization Research and Development Division of the U.S. Department of Agriculture, on Mermaid Lane on the edge of Philadelphia.

Pennsylvania revisited

When we embarked upon this little survey of the potato situation, we were chagrined to discover that potato production in Pennsylvania is going downhill. In 1946, the Commonwealth produced 13 million cwt.; last year, only half that amount —less than 7 million. Is it a case of opportunity cost, that Pennsylvania farmland can be used more productively otherwise; or is it a case of opportunity lost—lost to Idaho, to Maine, to Long Island?

Pennsylvania grows quality potatoes and a large proportion goes to the chippers and other processors who demand high quality. For the fresh market, Pennsylvania might do better if it adopted Idaho expertise in grading, packaging, marketing, and advertising. The Idaho potato isn't a variety, like the Katahdin or Russet Burbank, or Red Pontiac, or Sebago, or Kennebec. The Idaho potato is the potato grown in Idaho, and the Maine potato is the potato grown in Maine. Perhaps the only thing the Pennsylvania potato needs to reverse the declining production trend is more Pennsylvaniaizing.

Daring ideas are like chessmen moved forward; they may be beaten, but they may start a winning game. —*Goethe*

THE INNOVATION INDUSTRY

Unique characteristics make research and development an industry in its own right—a big industry that is growing spectacularly. While the impact of this innovation industry is all pervasive, it has special implications for regional economic development. A region's participation in this growth industry of the future will depend largely on the strength of its scientific manpower base. Within the Third Federal Reserve District, Wilmington and Philadelphia so far have shown the greatest potential for becoming research complexes.

Just for a moment, try to recall 1955. Can you remember that commercial jets had not yet flown the Atlantic? Could anyone have convinced you then that ten years later a man would take a walk in space—and come back to tell about it? For most of us, the answer is no. A few scientists believed that a man in space was possible, but even they doubted he could come back alive.

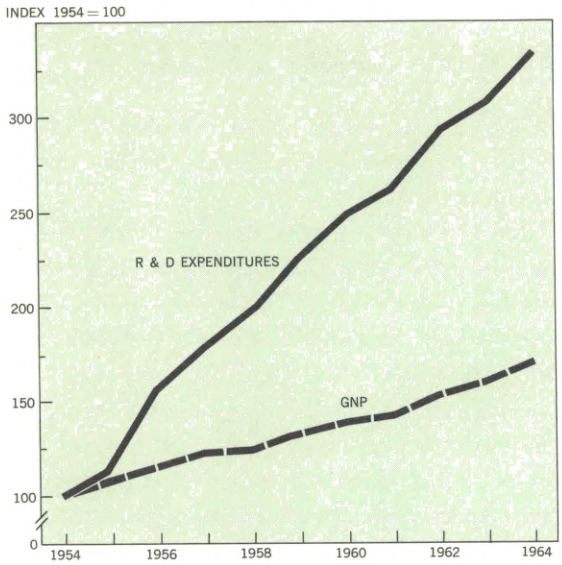
A decade ago a handful of men at the General Electric Company disagreed with those scientific skeptics. They were convinced that a vehicle could be developed to protect a rocket's payload from the extreme impact and heat of atmospheric re-entry. With a Government contract and determination, they set out to solve the problem. In the process of solving it, G.E. grew. The six men who initiated the re-entry project could not have conceived that their effort would snowball into a Missile and Space Division 12,000 strong. Most of these employees are in the Delaware Valley: 3,500 are at work in West Philadelphia; 6,000 are at the Space Technology Center at Valley Forge, Pennsylvania.

This experience of one company illustrates three important reasons for the current interest in research and development—commonly known as R & D. A highly organized team effort of scientists, engineers, and technicians was basic to the re-entry success story. The proliferation of such team efforts for complex problem-solving has made R & D one of the nation's major employers. Secondly, the growth of a G. E. Division from six people to 12,000 in ten years exemplifies the phenomenal growth of research and development in the past decade. Thirdly, the nearly 10,000 new jobs generated by R & D in one company have a significant impact on the economy of the Philadelphia area. Similar experiences throughout the nation have stimulated intense regional competition for research and development activities.

R & D: big and growing

Research and development employs 800,000 scientists, engineers, and technicians. A substantial but unknown number of craftsmen, secretaries, clerks, laborers, and other personnel support the innovative efforts of the 800,000. R & D today employs more people than banking. It is four times the size of the air transport industry, one-third the size of the entire wholesale trade of

A DECADE OF R & D GROWTH



Source: National Science Foundation; McGraw-Hill Department of Economics.

the nation. It is nineteen billion dollars' worth of big business.

Expenditures on R & D have more than tripled in the past decade—from 5½ to 19 billion dollars. R & D has grown three times as fast as the gross national product. Aggressive companies, out to beat their competitors in the race for "the new" or "the better," have expanded the research function in every major industry. Spending for R & D in manufacturing, for example, grew 50 per cent faster than total manufacturers' sales over the past ten years. Research and development has grown into a new industry in its own right—the innovation industry.

What innovation industry?

The research function is found in all of the traditional industries, but size and growth don't make it an industry. Its characteristics do. The kinds of personnel required for R & D, the way they work, and the product they produce make the research and development function an innovation industry.

The 800,000 persons employed in R & D are highly skilled, through education or work experience or both. They include scientists of all kinds, such as chemists, physicists, mathematicians, life scientists, metallurgists, and engineers. Each of these professional cadres depends on the supporting aid of technicians. A common attribute of these R & D employees is their interchangeability between one traditional industry and another. A professor at the University of Pennsylvania's Moore School of Engineering, for example, may spend his scholastic year in full-time research on advanced electronic devices. During that time, a survey of the U. S. Department of Labor would list him among those employed in education. Should a survey be conducted during the summer, when he is consulting for an electronics firm, he would be classified as an employee of the electrical machinery industry. As with other R & D employees, the professor is intellectually and geographically mobile among any number of industries which can use his talents and skills. He is really employed in the innovation industry.

Be he a physicist, a chemist, or an electronics technician, the R & D employee pursues three types of work—usually one at a time. They are basic research, applied research, or development. Basic research is original investigation to advance scientific knowledge, without a specific commercial objective in mind. Einstein's theory of relativity is a product of basic research. Though basic research takes the smallest share of the R & D dollar, its relative importance is expected to increase in the coming decade. The second R & D activity in size is applied research. Applied research is directed toward discovering

(*Continued on Page 16*)

SCIENTIFIC TALENT IN THE THIRD FEDERAL RESERVE DISTRICT

Growth of the innovation industry in any one region of the country is largely dependent on the region's scientific and technical manpower. Unfortunately, the geographic distribution of all persons employed in research and development is not known. Through the efforts of the National Science Foundation in Washington, however, the states and metropolitan areas where scientists are working have been pinpointed.[1] Knowing where the scientists are is a good indicator of where the rest of the R & D personnel are located. California, New York, Pennsylvania and New Jersey emerge as the leading science states. The top fifteen metropolitan areas are shown in the following table. The grand total of scientists in the nation approaches 215,000.

How does the Third District measure up in scientific talent?

Fairly well—primarily because of the desire of scientists to work in Wilmington and Philadelphia. But the rating is not outstanding. Too many small communities outside the Delaware Valley just don't attract top R & D talent.

There are about 12,000 scientists working in the metropolitan areas of the Third Federal Reserve District. This fact alone doesn't tell us how the area rates as a science center. But, using a measure designed to show the concentration of scientists here relative to the nation, the District can count among its assets a specialization in science. The measure of regional specialization works like this: if scientists in the District are the same proportion of its population as all scientists are to the total U. S. population, the index is 1. An index of 1 is frequently thought of as indicating a fair share. The area which scores over 1 gets classified as a scientific concentration. An area under 1 doesn't.

The Third District's index is 1.25.[2] The region ranks high as a scientific concentration because of three metropolitan areas: Wilmington, Trenton, and Philadelphia, in that order. Their indexes are 5.58, 3.83, and 1.25, respectively. In those areas, scientists concentrate out of

FIFTEEN TOP SCIENCE CENTERS, 1962

Standard Metropolitan Area	Number of Scientists	Rank	Population Rank, 1960
New York, N. Y.	14,513	1	1
Washington, D. C.	10,712	2	10
Los Angeles, Calif.	10,266	3	2
Chicago, Ill.	7,501	4	3
Boston, Mass.	6,611	5	7
Philadelphia, Pa.	6,483	6	4
San Francisco, Calif.	6,295	7	6
Newark, N. J.	4,405	8	13
Pittsburgh, Pa.	3,205	9	8
Houston, Tex.	2,832	10	16
Minneapolis, Minn.	2,729	11	14
Denver, Colo.	2,701	12	26
Cleveland, Ohio	2,520	13	11
Wilmington, Del.	2,470	14	65
St. Louis, Mo.	2,345	15	9
U. S. Total	214,940		

Source: National Science Foundation, **American Science Manpower 1962,** Washington, 1964; U. S. Census of Population, 1960.
Note: As explained in the text, available data do not permit comparisons of total R & D personnel by metropolitan areas. Hence the above rankings are for scientists only and exclude engineers. Inclusion of the latter is necessary for ranking "research complexes."

[1] Surveys published by the National Science Foundation do not, as yet, cover engineers. There is a very high correlation, however, between the geographical location of scientists and the resident states of engineers reported by the U. S. Census for 1960. Engineers and scientists concentrate in the same areas of the country.

[2] This is a descriptive measure of concentration, usually called a location quotient. It is a device for comparing a region's percentage share of a particular activity (in this case, science) with its percentage share of some basic aggregate (e.g., population). As used here, the location quotient for the concentration of scientists in a region is stated by the formula

$$\frac{Sr/Pr}{Sn/Pn} \text{ or } \frac{Sr/Sn}{Pr/Pn}$$ where:

Sr = the number of scientists in the region; Pr = the population of the region; Sn = the number of scientists in the nation; and Pn = the population of the nation.

proportion to population. Adding in the Allentown area, 90 per cent of the scientists in the District are in four of its 13 cities. Though these four cities are major population centers of the District, they have a substantially greater share of scientists than people.

Philadelphia and Wilmington lead

In terms of absolute numbers of scientists, Philadelphia and Wilmington are the heavyweights. They employ 76 per cent of the District's scientists. A look at the table on the preceding page shows that they also rank high nationally as science centers. Philadelphia, which has the fourth largest metropolitan area population in the country, is sixth on the list for scientists. Wilmington is in a contrasting position. By population size, it's way down in 65th place. It ranks 14th as a science center. In fact, relative to population, more scientists work in Wilmington than in any of the ten largest metropolitan areas in the country.

Compared to the nation, Philadelphia is a specialist in chemistry and the biological sciences. Research in these fields makes a major contribution to the economic health of the area and, in some cases, the physical health of the world. Drug research at Smith Kline and French, for example, has paid off for the company as well as for the Delaware Valley economy. SK&F's eight-man research staff in 1936 has grown to 850 scientists and supporting personnel today. R & D at their Philadelphia laboratories is the chief source of products sold throughout the world—218 million dollars' worth last year. For the Philadelphia economy, SK&F's investment in research has increased area jobs, not just for the 850 researchers but for all of the other employees required for production, marketing, and administration. It has also resulted in increased capital investments, the latest being a $5 million research laboratory in Montgomery County, Pennsylvania.

Though Philadelphia tends to specialize in chemical and biological sciences, the proportion of scientists working in physics, mathematics and statistics, and psychology, closely resembles the national scene. As is the case with industry, Philadelphia is more scientifically diversified than Wilmington.

Wilmington has all of its eggs in one test tube —chemistry. A whopping 65 percent of its scientists work in this one field. Research at Du Pont is, of course, no small factor. The impact of Du Pont on Wilmington is a well-known story; however, research at Du Pont tells other stories. It provides a good example of the rapid change which characterizes the whole innovation industry. R & D at Du Pont led to the development of nylon. To produce their new product, the company set up a plant in 1939. This, the oldest commercial nylon plant in the world, is only 26 years of age. R & D continued, and today the company's nylon products alone number over 1,000. Sixty per cent of these were introduced in the last seven years. In a typical year, Du Pont's research results in 475 patents on new products and processes for apparel, household, industrial, and defense uses. But chemical research in the area is by no means confined to Du Pont. Atlas Chemical has about 300 employees

DISTRIBUTIONS OF SCIENTIFIC EMPLOYMENT

Field	Philadelphia	Wilmington	Nation
Agricultural Sciences	1.3%	.8%	5.8%
Biological Sciences	14.9	3.9	11.9
Psychology	7.9	2.8	7.8
Earth Sciences	1.3	.7	8.7
Meteorology	.7	.1	2.5
Mathematics and Statistics	8.0	2.5	8.5
Physics and Astronomy	11.7	3.9	12.0
Chemistry	36.5	65.2	25.1
Other Fields	17.7	20.1	17.7
All Fields	100.0	100.0	100.0

Source: National Science Foundation.

in research and development. Hercules Powder has 750 R & D personnel at its major laboratory in Wilmington. And there are many others.

How about the future?

In spite of its specialization in chemicals, the Wilmington research outlook is good. For one reason, the chemical industry in general is the biggest funder of its own research. Hence, it does not have to worry so much about Government cut-backs as do communities with greater dependence on defense contracts. More importantly, Wilmington has an extremely strong base of brainpower on which to build its research future. Its R & D personnel are very highly trained. In the 25 major science cities, 32 per cent of the scientists have at least a Ph.D. In Wilmington, the figure is 53 per cent. This is vitally important because such talented manpower in residence tends to attract more brains to the area.

Philadelphia has attractions for R & D that Wilmington doesn't: its size can support a quality and variety of cultural assets, and personal and professional services, which the smaller community cannot; it is a major medical complex; it has many more colleges and universities. But it falls short in trained R & D manpower. The proportion of scientists with Ph.D's is not so high as in the average large city. If scientists with medical degrees are also considered, the picture stays the same. Philadelphia is still below average. New efforts in Philadelphia to develop the University City Science Center and to promote and attract research through the Southeastern Pennsylvania Economic Development Corporation are both important moves in creating a vigorous research community. Nevertheless, the importance of improved graduate and postgraduate education for the development of more topnotch Ph.D's, and the nurturing of an environment to keep them in the afea, cannot be overstressed. Here lie the keys to Philadelphia's development as a research complex.

(*Continued from Page 13*)

new knowledge for specific marketable objectives. The work of General Electric in devising the re-entry vehicle was applied research. The third pursuit—development—comprises two-thirds of the R & D effort. Development translates research findings into products or processes. Every company that draws on basic or applied research to create new products or processes, or to improve existing ones, is involved to some degree in development.

The end product of this total R & D effort is newness and change. Whether the field is organic chemistry, oceanography, or optics, the output of the research and development function is innovation. It is this common end product which makes the R & D function an industry. Food is the product of the food industry. Chemicals are products of the chemical industry. Innovation is the product of the innovation industry.

The impact of innovation

Innovation is inherently the most dynamic industry of all. Accelerated growth of research and development generates dramatic changes in our economy—and in every facet of our lives. Entire industries are created by R & D: television, plastics, synthetic fibers, computer services. We are witness to a population explosion of new products. Teaching machines, transistors, Polaroid film, integrated circuits, dacron, Xerox, and polio vaccine were not in the vocabulary a few

years ago.

The rapid changes produced by research have a double-barreled impact. The very nature of change creates both opportunities and problems for individuals, for industries, and for regions.

On people. The personal impact is demonstrated by the impersonal computer. It has spawned countless new job opportunities and destroyed many traditional jobs. This process will continue—at an accelerated rate. In 1946 the first electronic computer was unveiled in Philadelphia. The first installation by private business took place only 11 years ago. Today 23,000 computers are installed in this country, and 20,000 more are on order. Their use requires systems analysts, keypunch operators, data processing maintenance workers, magnetic tape librarians, and programmers. In five years the U. S. Department of Labor estimates that over 200,000 programmers will be needed by business and government. These are good opportunities for those who qualify.

But turn the coin, and someone else has a problem. Particularly vulnerable to displacement by computer use in the office are bookkeepers, accounting clerks, typists, file clerks, and accounting-machine operators. Moreover, the relatively new keypunch operator isn't safe either. He can expect competition from optical scanners and other electronic devices which "read" the printed word and automatically translate it into electronic machine language.

On industries. Research, similarly, is both a threat and a promise to business: a competitive threat to the firm out of step with the times and a promise to the research-oriented company. The latter may invest heavily in R & D to prosper. It doesn't necessarily have to—as long as it "thinks research." A firm can adapt the fruits of another industry's research to its own products and processes to keep competitive. By closely following technological change, surprising new markets can be found for present products. Regardless of the method employed to be research-oriented, if a firm is to reap the benefits of the research revolution, it has to know what's going on. The difference between company prosperity or failure in ten, or even two, years is in some laboratory today.

Note how R & D brings both hopes and headaches to industry. The birth of the transistor, for example, not only made the modern-day computer a reality but revolutionized the electronics industry. Many producers of vacuum tubes were caught napping. As fast as possible, they switched to transistors. At the moment, the small firm producing electronic components is suffering a migraine headache from the pressure of new integrated circuits. The story is similar in the plastics industry. Polyethelene research fathered it. A proliferation of plastic products followed which hurt many markets for glass and metals. Now metals are fighting back. Through a new forming process, an alloy of zinc and aluminum can be molded and shaped in ways previously possible only with plastics.

One of the latest miracle devices of science is the laser, a highly intensified light beam capable of producing flashes 100,000 times stronger than light at the sun's surface. One application of the laser replaces a surgeon's scalpel in delicate eye operations. Another welds and cuts difficult materials with minute precision. Wide-ranging laser applications already are expected for communications, computers, medicine, and weaponry. Each new use speeds the obsolescence of some other device. Will this kind of technological history repeat itself? Undoubtedly. In no industry can a company be research-ignorant and survive. In every industry R & D is becoming almost a pre-

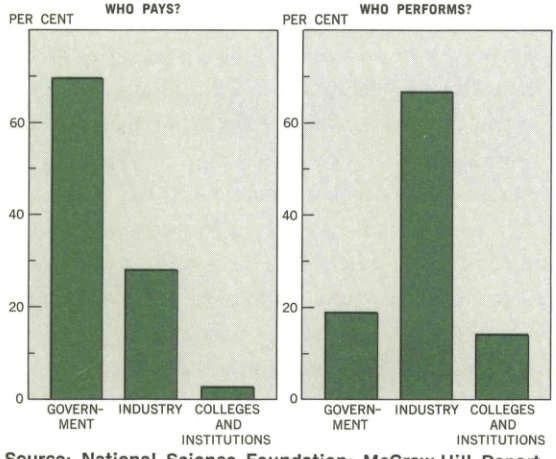
requisite for success.

On regions. The spectacular growth of the innovation industry provided a major economic boost to some regions of the country. Others have received little or no benefit. To a large degree this is because of a unique industry characteristic. That is, for the most part, those who pay for R & D don't perform the work. And those who pay decide in which regions of the country the work will be performed. Who pays? Who performs? What are the regional implications?

Most of the nation's research and development is performed by private industry, but the biggest single spender is the Federal Government. The Government tends to concentrate its R & D spending in relatively few industries, companies, universities, and geographical regions. The basic factors underlying this concentration are the special research needs of Government and its knowledge of the ability of performers to meet those needs.

Uncle Sam pays for 70 per cent of all R & D. Obviously Governmental decision-making has a big impact on what type of research is undertaken, who does it, and where it is performed. Most of the remainder of the research bill is paid by private industry. Universities and other nonprofit institutions pay only a tiny share of the $19 billion total.

FOR RESEARCH AND DEVELOPMENT



Source: National Science Foundation; McGraw-Hill Department of Economics.

The distribution of work differs greatly from the funding. Colleges and nonprofit institutions do 14 per cent of the job. Government laboratories account for 19 per cent. Sixty-seven per cent of all R & D is performed by private industry. Largely because of defense requirements, three industries do the bulk of the work: aircraft and missiles, electrical and communications equipment, and chemicals. They are responsible for 65 per cent of all industrial R & D. And the big researchers are getting bigger.

Not only is research volume concentrated in a few industries, but in a few companies as well. National defense needs are again an important influence. Since most federally sponsored research is for defense, a look at defense contracts provides an indication of company concentration. Of the 500 prime industrial contractors for defense R & D, *eight* companies were awarded 50 per cent of the total value of contracts between 1961 and 1963. Similarly, most university research is done by a small elite. Last year 38 per cent of Government R & D contracts to universities went to ten schools, led by the University of California and the Massachusetts Institute of Technology.

It just so happens that the industrial, company, and university concentrations of research tend to be in the same geographical areas. The San Francisco Bay and Boston metropolitan areas epitomize such regions—now known as research complexes. Why does research just happen to concentrate in, for example, these two areas? Most other parts of the country wish they knew.

Competition for research

Companies have always fought to be competitive. Regional competition for growth, however, is a relatively new fact of economic life. It is more intense daily. States and communities increasingly muster new forces to make their respective economies healthier. They are fighting for a larger share of the nation's economic activity. As the battle escalates, one weapon after another is employed to hold old industry and to entice plants from other areas. Free land, planned industrial parks with built-in amenities, low-interest financing, tax benefits, political influence, promotion campaigns, and other levers are all used to aid and abet local economic growth. The tendency of such gambits is merely to move the economic pieces around the big U. S. chessboard.

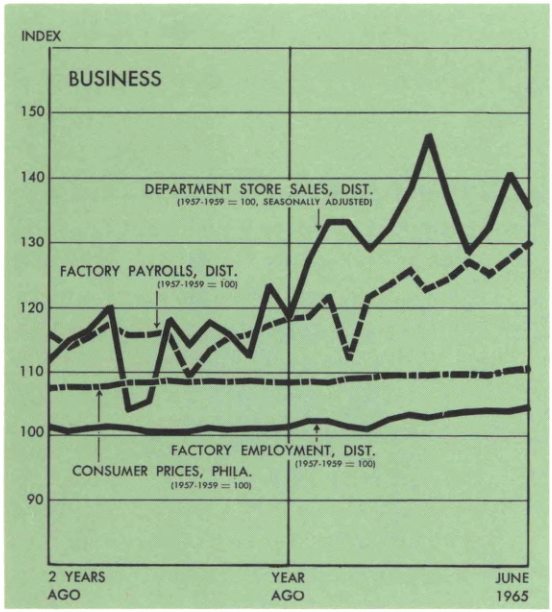
With the rapid growth of research and development, combined with the desire of all communities for "nice clean industry," a new set of weapons is being devised. It is aimed at the latest panacea for economic advantage of one area over another—becoming a research complex. Hence, communities are looking hard at existing R & D concentrations for clues to success. The economic implications of this new drive to develop research complexes should be very different from the earlier indiscriminate competition for industry. Successful efforts to increase research and development will create a bigger economic pie. More R & D means new techniques and processes and more efficient industry. These are the major factors behind increased productivity. And increased productivity contributes about half of the nation's economic growth. The more every community does to provide an environment in which new ideas are born and nurtured, the greater the national wealth.

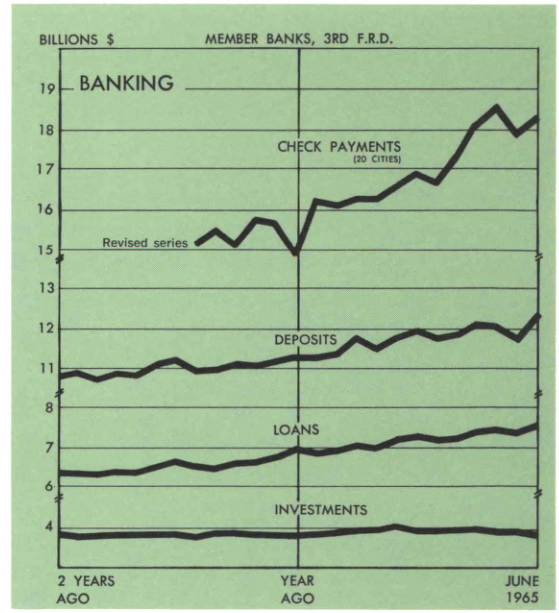
How can community competition for research contribute to national growth? It all depends on how each area goes about it. As with the fight for industry, different tools are being tried to encourage research. Major metropolitan areas where universities, culture, good schools, and good living abound have a head start over their less-endowed brethren. But these assets aren't enough. The competitors recognized this and seized first upon the research park. Aesthetically appealing campus-like settings marked "research companies only" were expected automatically to attract R & D. They weren't very successful. The currently fashionable key to building a research complex is a research institute. The institute can provide an important link between university research and the business community. Companies can make better and quicker use of the latest scientific findings of university laboratories by consulting the institute. The Stanford Research Institute is one prototype, among many, for this kind of undertaking.

But without a more fundamental asset, a research institute may be just as sterile as some of those research parks. That asset is top-quality scientific and technical brainpower. While no one weapon is sufficient to trigger the development of a research complex, the necessary one is brainpower.

A community that grows talented scientific and technical Ph.D's and provides a receptive climate for the use of their talent has the best base for growing research. Brains like companionship; they attract other brains. This is the beginning of the chain reaction which sets off the research complex. Brainpower is the only source of research and development. It is the source of vitality for a research institute. The more outstanding the brains, the richer the region. A community's investment in developing and nurturing topflight talent is an investment in its own economic growth as well as the nation's.

FOR THE RECORD...





SUMMARY

	Third Federal Reserve District			United States		
	Per cent change			Per cent change		
	June 1965 from		6 mos. 1965 from year ago	June 1965 from		6 mos. 1965 from year ago
	mo. ago	year ago		mo. ago	year ago	
MANUFACTURING						
Production	....	....	....	+ 1	+ 8	+ 9
Electric power consumed	+ 5	+10	+ 9	....	....	....
Man-hours, total*	+ 2	+ 7	+ 8	....	....	....
Employment, total	+ 1	+ 4	+ 4	....	....	....
Wage income*	+ 2	+11	+10	....	....	....
CONSTRUCTION**	−13	+23	+17	− 5	+ 3	+ 2
COAL PRODUCTION	+ 6	+ 7	+ 5	+ 2	+ 8	+ 7
TRADE***						
Department store sales	− 4	+ 2	+ 5	....	....	....
BANKING (All member banks)						
Deposits	+ 5	+ 9	+ 8	+ 4	+12	+10
Loans	+ 3	+10	+11	+ 2	+15	+14
Investments	− 1	+ 2	+ 2	+ 1	+ 3	+ 3
U.S. Govt. securities	− 2	− 6	− 4	0	− 5	− 4
Other	+ 1	+16	+14	+ 3	+16	+14
Check payments	+ 2†	+23†	+15†	+11	+18	+11
PRICES						
Wholesale	....	....	....	+ 1	+ 3	+ 1
Consumer	+ 1‡	+ 2‡	+ 1‡	0	+ 2	+ 1

*Production workers only
**Value of contracts
***Adjusted for seasonal variation

†20 Cities
‡Philadelphia

LOCAL CHANGES

	Factory*							
	Employment		Payrolls		Department Store Sales†		Check Payments	
	Per cent change June 1965 from							
	mo. ago	year ago	mo. ago	year ago	mo. ago	year ago	mo. ago	year ago
Lehigh Valley	+ 1	+ 6	+ 1	+12	....	....	+ 2	+17
Harrisburg	+ 2	+ 1	+ 5	+ 8	....	....	+ 5	+29
Lancaster	+ 4	+ 6	+ 3	+ 9	−12	+ 1	+ 3	+17
Philadelphia	+ 1	+ 4	+ 2	+10	− 4	0	+ 4	+19
Reading	+ 1	+ 6	+ 1	+11	− 6	+ 1	+ 1	+10
Scranton	+ 1	− 1	+ 4	+ 4	− 3	0	− 2	+15
Trenton	+ 1	+ 1	− 1	+ 4	− 3	+ 6	+ 6	+40
Wilkes-Barre	+ 1	+ 3	+ 2	+ 5	− 3	+ 3	+ 4	+20
Wilmington	+ 1	+ 4	− 1	+11	− 6	+ 8	− 6	+48
York	+ 3	+ 6	+ 3	+13	− 6	+ 7	+ 4	+18

*Not restricted to corporate limits of cities but covers areas of one or more counties.
†Adjusted for seasonal variation.