Impacts of the Hatch Act on the Science of Plant Pathology

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On March 2, 1987, there began a year-long celebration of the centennial of the Hatch Act, also known as the State Agricultural Experiment Stations Act of 1887. This Act is perhaps the most significant piece of legislation affecting agricultural research in this country. Had it not been for the fortitude and deep conviction of Congressman William Henry Hatch of Missouri, this milestone legislation might not have survived. Congressman Hatch worked for several years against opposition from political and geographic special interests across the country before compromises were reached and final passage was secured. A permanent exhibit is being established at the Smithsonian Institution in Washington, DC, commemorating the Hatch Act and the contributions of the state agricultural experiment stations.

I shall discuss the Hatch Act and other funding sources in giving my views on impacts of the subject legislation on the science of plant pathology. In doing so, I use the following criteria to evaluate the roles of various funding sources in the growth of our science: changes in amounts of funding over time, proportions of funding supporting basic research, scientist manpower levels, and levels of competitive grant support. My discussion pertains only to research in the land-grant institutions. Comparisons with two allied disciplines are also presented.

Background

Although the Land-Grant College Act of 1862 (also known as the First Morrill Act) did not specifically provide for organizing experiment stations, the colleges nevertheless assumed responsibility for agricultural research and a few colleges voluntarily began station research ventures. It remained for the passage of the Hatch Act in 1887 to establish agricultural experiment stations in connection with the land-grant colleges established under the Morrill Act. Thus, federal appropriations were set aside for each state agricultural experiment station to conduct research on all aspects of agriculture, forestry, and rural life. Initially, the Hatch Act provided \$15,000 to each experiment station. Today, Hatch Act funds are the largest formula-based resources administered by the Cooperative State Research Service, amounting to \$156.4 million in fiscal year 1985. The state institutions conduct about 60% of the publicly supported agricultural research in the United States.

A portion of the formula funds allocated to states is available to support cooperative regional research under provisions of the 1955 amendment to the Hatch Act. Up to 25% of each state's Hatch fund allocation may be used to support regional research that involves scientists from two or more states. Under these provisions, plant pathologists and virologists are involved in research projects in all regions of the United States. A key feature of this program has been its stability. Projects are usually funded for 5-year periods, with renewal, revision, or termination as options at the end of each period.

In 1962, the U.S. Congress passed the McIntire-Stennis Cooperative Forestry Research Act. Known as the McIntire-Stennis Act, this legislation provides for formula funding of forestry research and the development of a trained pool of forestry scientists and managers in schools of forestry and other qualifying state institutional units.

Approach

Information in this report is based on data obtained from the CSRS Current Research Information System (CRIS). This is a computer-based system containing agricultural research information in a project-by-project format. The CRIS was initiated in 1967. Funding information for fiscal years 1970, 1975, 1980, and 1985 was retrieved and evaluated as the basis for this report.

For comparison, funding and manpower data were also collated for plant-oriented entomology and plant genetics/plant breeding. Funding information for nonfederal (state and industry) sources, other U.S. Department of Agriculture (USDA) research agencies (essentially the Agricultural Research Service and the Forest Service), and USDA competitive grants is included to develop the theme of impacts of Hatch Act funding on the science of plant pathology over several years and in comparison with other sciences. Where dollar amounts are shown, these values cover basic and applied research for each discipline and are presented in actual dollars and in constant 1984 dollars.

Levels of research manpower in plant pathology/plant virology and the aforementioned fields of science can provide further insights on relative sizes of discipline research cadres in relation to funding levels. The scientist year (SY) manpower category in the CRIS reports is the basis for these data. An SY is the effort by researchers at the assistant professor level and above, responsible for independent study, judgments, and accomplishments directly assignable to the project reported. Again, this report focuses on research activities in the state land-grant institutions.

Results

Total funds allocations, in actual dollars, supporting research in plant pathology/plant virology and two allied disciplines—plant-oriented entomology and plant genetics/plant breeding—are shown (Fig. 1A). The chronology is on a fiscal year basis.

Total funding for research by land-grant university plant pathologists amounted to \$25.5 million in 1970 and rose steadily to \$95 million in 1985. Funding for plant-oriented entomological research was \$27.2 million in 1970 and climbed to \$102.6 million in 1985. Total funds allocations for plant genetics/plant breeding amounted to \$32.1 million in 1970 and rose to \$122 million by fiscal year 1985.

Impressive funding growth curves are apparent for the three disciplines, based on these data. However, what is growth of support if we consider the effective purchasing power of these funds? An insight on this characteristic can be gained by adjusting these funds to constant dollars. The Price Index for Agricultural Research (W. E. Huffman and R. E. Evanson, personal communication) was used to adjust values to 1984 dollars.

The total funding growth curves, in constant dollars, for plant pathology and the two allied disciplines are shown in Figure 1B. This treatment of the data presents a more modest picture of funding dynamics over time than do the previous curves. The period 1975-1980 showed relatively large increases in amounts for all three disciplines. However, entomology funding also increased dramatically during the 1970-1975 period. Very little growth occurred in constant-dollar value for all three disciplines during the 1980-1985 period. In fact, support for research in entomology declined during this period.

Next, the funding amounts for the three disciplines were dissected to identify the roles of various funding sources in supporting research. Allocation of funds, by funding source, for support of plant pathology and plant virology is shown in Figure 2A. Hatch Act support for plant pathological research in 1970 was \$6.8 million, peaked at \$9.1 million in 1980, and declined to \$8.4

million in 1985. Forest pathology research was supported by McIntire-Stennis funds amounting to $489,000 in 1970. The support peaked at $754,000 in 1975, declined markedly by 1980, and rose modestly by 1985. USDA competitive grant support was $1.4 million in 1970 and continued a steady rise through 1985 to $2.1 million. Nonfederal (state, industry, and other nonfederal sources) support for research on plant diseases was $26.4 million in 1970 and has continued to increase, reaching $47.7 million in 1985. USDA funding (Agricultural Research Service and Forest Service) amounted to $23.8 million in 1970 and has risen at a modest rate through 1985.

Allocation of funds, by funding source, for support of plant-oriented entomological research is shown in Figure 2B. Hatch Act funding was $5.6 million in 1970 and had risen to almost $8 million in 1985. McIntire-Stennis funding for research on forest insects amounted to $543,000 in 1970, peaked at $893,000 in 1980, and declined to $669,000 in 1985. USDA competitive grant support for research on insects was $1.6 million in 1970, peaked at $3.3 million in 1980, and declined to $2.2 million in 1985. Nonfederal funding was $22 million in 1970, peaked at $37.6 million in 1980, and declined slightly in 1985. Support for entomological research in other USDA agencies was $34 million in 1970, rose to almost $52 million in 1980, and dropped to about $47 million by the end of 1985.

Support for research in plant genetics/plant breeding by funding sources is shown in Figure 2C. Hatch allocations were $8.8 million in 1970, rose to $10.6 million in 1980, and declined to $9.8 million in 1985. McIntire-Stennis funding was $548,000 in 1970, reached $925,000 in 1980, and dropped slightly to $867,000 in 1985. Nonfederal support for plant genetics/plant breeding research was $39 million in 1970 and had risen steadily to almost $118 million by the end of 1985. Support for this area of research in other USDA agencies was $31 million in 1970, rose to a high value of almost $37 million in 1980, and dropped to $32.8 million in 1985.

Data in the projects submitted to CRIS include proportions of research effort devoted to basic research. This information, therefore, was collated to provide insight on relative levels of support for basic research from the aforementioned funding sources (Fig. 3). Data on these factors for the two allied disciplines are also included.

The percentage of Hatch Act funding for basic research in plant pathology/plant virology was about 45% in 1970 and has remained consistently around 50% in recent years (Fig. 3A). Although less than one-third of the McIntire-Stennis funding for 1970 supported basic research on forest tree diseases, the proportions rose to well over 50% in the mid-'70's and remained at the 50% level through 1985. Proportions of nonfederal funds supporting basic research

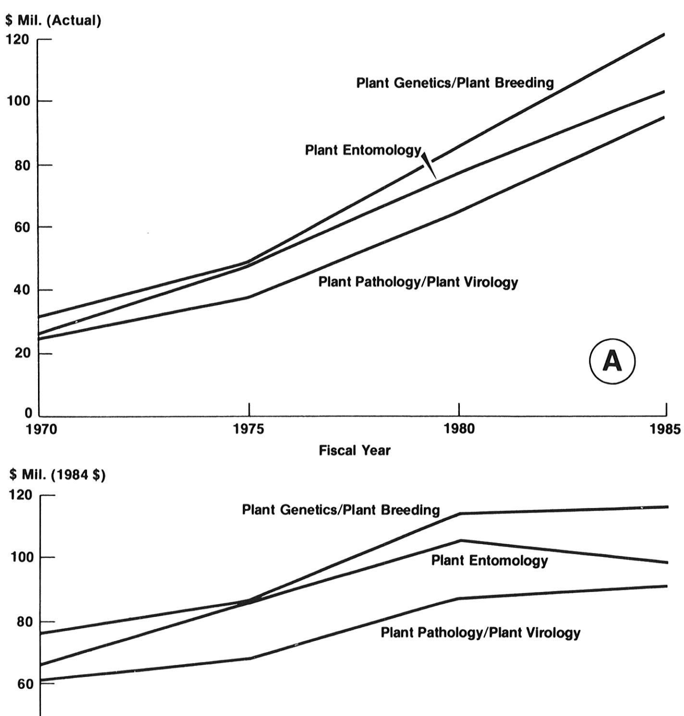

Fig. 1. Annual total funds allocations supporting research in plant pathology/plant virology, plant-oriented entomology, and plant genetics/plant breeding, 1970–1985. **A,** in actual dollars; **B,** in 1984 constant dollars.

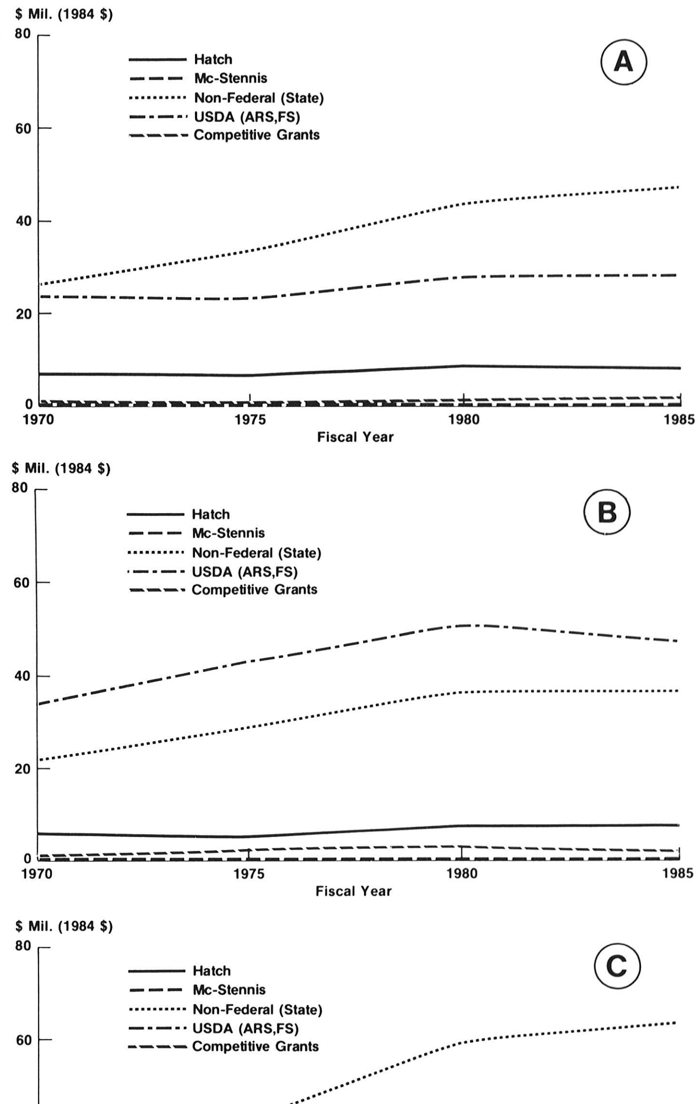

Fig. 2. Annual allocations of funds, 1970-1985 (in 1984 constant dollars) by funding source, for research in: **A,** plant pathology/plant virology; **B,** plant-oriented entomology; **C,** plant genetics/plant breeding.

on plant diseases have remained consistently at about 40% from 1970 through 1985.

Basic research proportions by funding source for entomology are shown in Figure 3B. The percentage of Hatch funds supporting basic research on insects was about 35% in 1970 and remained below 40% throughout the 15-year period evaluated here. In contrast, McIntire-Stennis funding proportions supporting basic research on insects rose dramatically from about 30% in 1970, remained at well over 50% in the mid-'70's, and has stabilized recently at almost 48%. Nonfederal funding supporting basic research in entomology was about 33% in 1970 and remained well below 40% through 1985.

Proportions of various funding sources supporting basic research in plant genetics/plant breeding are presented in Figure 3C. In 1970, about 36% of Hatch Act funds were allocated for basic research, and the funding proportions have remained consistently well below 40%. McIntire-Stennis funds proportions supporting basic research on tree genetics and breeding were about 30% in 1970 and have continued around the 40% level in recent years. The percentage of nonfederal funds supporting basic aspects of research on plant genetics and breeding was about 35% in 1970 and remained at about 33% through 1985. The relatively low levels of formula funding dedicated to support of basic research in plant genetics and breeding are understandable when one considers that progeny development and screening (a significant component of this field of science) are usually classified as applied research.

Manpower (SY) distributions for plant pathology/plant virology and the two allied disciplines during the 1970-1985 period are shown (Fig. 4). The plant pathology/plant virology research manpower base in state agricultural experiment stations and schools of forestry was 379.8 SY in 1970, peaked at 419.6 in 1980, and declined to 414.6 in 1985. In 1970, the entomology SY research base was 305.8, reached a maximum of 373.5 in 1980, and declined to 360.9 in 1985. SY resources for plant genetics and breeding were 406.9 in 1970 and steadily increased to 481.7 in 1985.

Fiscal year 1985 Hatch fund allocations for regional research involving plant pathologists and plant virologists supported 25 regional and two interregional projects. Funding for Hatch and regional research in actual FY 1985 dollars allocated for these projects amounted to $4.5 million. About $13 million (including other state and federal sources) in total funding, was earmarked for these projects in 1985. It is apparent that formula funding attracts other sources of funds. It can be shown, therefore, that these formula funds stimulated a nearly threefold leveraging of support from other sources.

Discussion and Conclusions

Some insights on the overall impacts of the Hatch Act funding on our science, in relation to other mechanisms of funding, can be gained from an analysis of financial and human resources committed over time. Comparisons with other discipline sciences add a further dimension to an assessment of impacts and relative growth of plant pathology. Summaries of this assessment and derivation of other noteworthy data are presented in Tables 1 and 2.

In Table 1, actual-dollar allocations, by major funds source, and manpower resources for plant pathology and the two allied disciplines are presented. Support for research in our discipline has been and remains successfully competitive with the disciplines analyzed. All three areas of science have enjoyed a more than fourfold increase in actual-dollar funding during the 15-year period.

However, an evaluation of constant-dollar support for the three sciences, using the same support criteria, shows a different picture of change between 1970 and 1985 (Table 2). In terms of "dollar purchasing power" by these funds, a less-than-twofold increase in resources has been achieved for all three science disciplines.

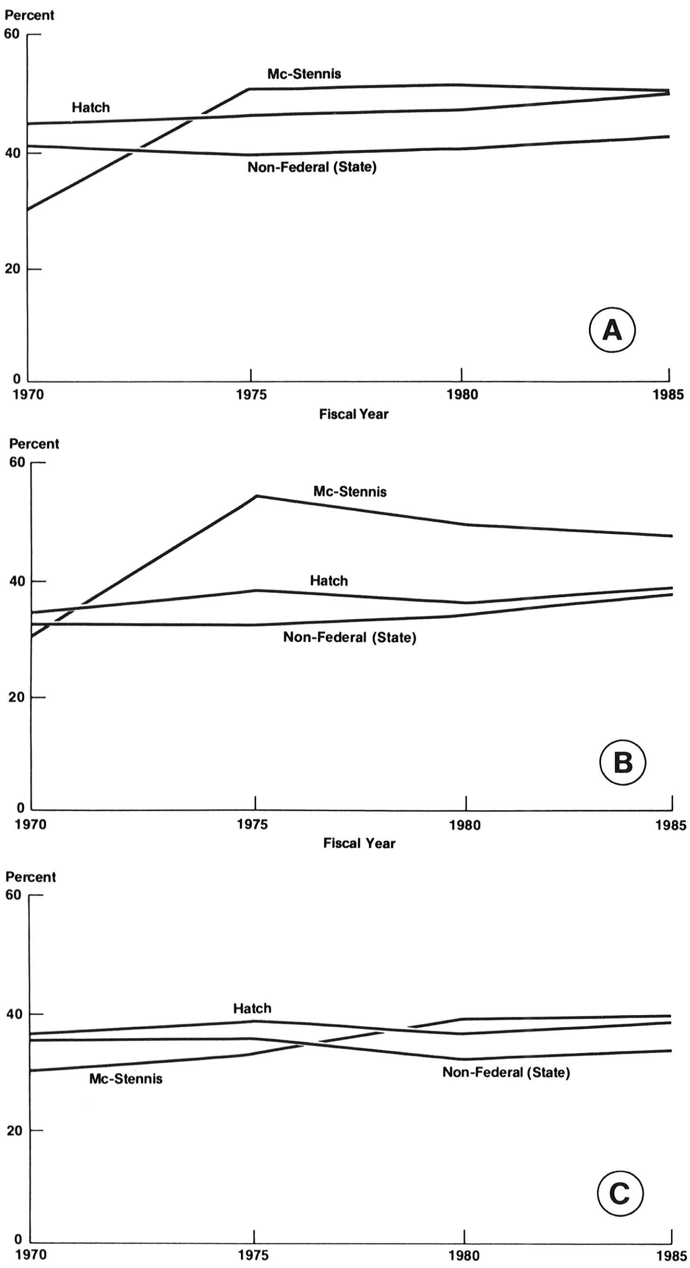

Fig. 3. Percentage of funds supporting basic research, fiscal years 1970-1985, by funding source, for research in: **A,** plant-pathology/plant virology; **B,** plant-oriented entomology; **C,** plant-genetics/plant breeding.

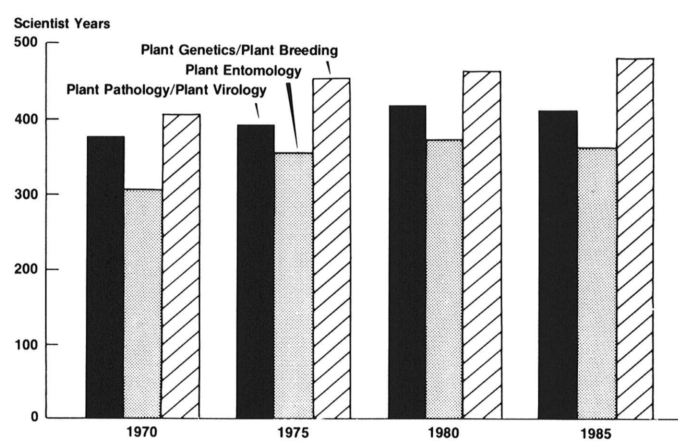

Fig. 4. Annual research manpower for land-grant university scientists in plant pathology/plant virology, plant-oriented entomology, and plant genetics/plant breeding, 1970-1985.

TABLE 1. Summary of nonfederal, grant, and formula funding and manpower resources for plant pathology/plant virology, plant-oriented entomology, and plant genetics/plant breeding (in actual dollars).

Research discipline	1970						1985					
	Funding category ($000)					$/SY[b]	Funding category ($000)					$/SY
	Formula	Grant	Nonfederal	Total	SY[a]	(000)	Formula	Grant	Nonfederal	Total	SY	(000)
Plant pathology/ plant virology	3,038	584	11,027	14,649	379.8	38	9,400	2,200	49,300	60,900	414.6	147
Plant entomology	2,581	686	9,239	12,506	305.8	41	8,900	2,300	38,500	49,700	360.9	138
Plant genetics/ plant breeding	3,896	381	14,228	18,505	406.9	45	11,000	1,500	67,000	79,500	481.7	165

[a]SY = scientist year.
[b]$/SY = funding category total ÷ SY.

TABLE 2. Summary of nonfederal, grant, and formula funding and manpower resources for plant pathology/plant virology, plant-oriented entomology, and plant genetics/plant breeding (in 1984 constant dollars)

Research discipline	1970						1985					
	Funding category ($000)					$/SY[b]	Funding category ($000)					$/SY
	Formula	Grant	Nonfederal	Total	SY[a]	(000)	Formula	Grant	Nonfederal	Total	SY	(000)
Plant pathology/ plant virology	7,262	1,396	26,372	35,030	379.8	92	9,095	2,087	47,648	58,830	414.6	142
Plant entomology	6,171	1,640	22,088	29,899	305.8	98	8,659	2,226	37,190	48,075	360.9	133
Plant genetics/ plant breeding	9,315	910	34,014	44,239	406.9	109	10,668	1,489	64,725	76,882	481.7	160

[a]SY = scientist year.
[b]$/SY = funding category total ÷ SY.

An analysis of scientist effort (SY) and levels of funding per unit of scientist effort can be drawn from data in Figure 4 and Tables 1 and 2. Support per SY has changed only marginally, averaging less than 1.5-fold increases in constant-dollar amounts, in contrast to the large changes in actual-dollar support over the 15-year period. These marginal changes in constant-dollar support become more compelling when one considers that, except for plant genetics and breeding, the scientist base has declined since 1980. I suspect that the increases for plant genetics and breeding are due to recent reductions in federal effort in germ plasm development and the resultant shift in land-grant applied research resources to meet continuing needs for improved plant varieties.

Nevertheless, it is clear—regardless of funding data adjustment—that Hatch funding (the major portion of formula funds) continues to leverage an almost sevenfold level of support from nonfederal sources for the three fields of science. Formula funding in the land-grant institutions has a history as a source of long-term, stable support for research. These funds help new faculty initiate research programs and provide base support essential to research program continuity. Productive research supported by these funds attracts industry and state funds, graduate students and postdoctoral talent and also provides an avenue to successful competition for grant funding.

Support for basic research in plant pathology/plant virology, in terms of percentage of formula funds and amounts of grant funding, has been successfully competitive since 1970 (Fig. 3). Almost 50% of Hatch funds have supported basic research on plant diseases, but less than 40% has been devoted to basic research in entomology and plant genetics and breeding. Proportions of nonfederal funds supporting basic research were less than the other funding categories for all three disciplines. These funds are generally used to address more urgent problems in a local framework. Competitive grant support for plant pathology/plant virology, in constant dollars, increased during the last 5 years analyzed, whereas grant support for the other two disciplines has declined.

At first glance, the appearance of the benefits of reliable formula funds in attracting other funds to projects brings a positive reaction. However, except for entomology, the constant-dollar values of federal funding, including formula funds, during the last 5 years analyzed have been essentially flat or have declined. Even in the case of entomology, where support for USDA research has been greater than that of other sources (including nonfederal), a continued decline in support of federal research would project a crossover with nonfederal funding levels for entomology in the near term, even if inflation were to stay near present levels.

This slowdown in the federal contribution to our research base has serious implications, in my view. What will be the future role of the federal government in support of agricultural research? There are viewpoints from various sectors that we are underinvesting in American agricultural research. I would like to conclude by citing some compelling statements made during the opening ceremony for the Hatch Act centennial celebration at the National Academy of Sciences on March 2, 1987. The statements were made by Dr. G. Edward Schuh, renowned agricultural economist, Director for Agriculture and Rural Development at the World Bank, on leave from the University of Minnesota.

> We thus have two issues before us. Are we investing in agricultural research at a sufficiently high level? The high rates of return to current investments suggest that we are not.
>
> The second question is related to the first, 'Do we have the funding of the research structured in the right way?' The answer to that question appears to be negative also. With many of the benefits of agricultural research now going to sustain the competitive edge of U.S. producers as a whole and thus to earn foreign exchange (whose benefits are distributed nationwide), then a major share of agricultural research support should now come from the federal government. That is the only way to offset the problem of free-riding that is now taking place at the state level. Needless to say, the role of the federal government in financing agricultural research has been fairly stagnant for some years. If we are to get our investments up to what they need to be, federal expenditures need to be increased significantly.

And, finally:

> In terms of its agricultural research establishment, the United States is now at a turning point—especially in shifting it to provide a stronger base for becoming more competitive in the international economy. The choices we make today will influence where we will be 10 to 20 years from now. But the choices are ours to make!
>
> After all, despite our difficulties, agriculture is the only truly world class industry this nation still has.