Chapter III

The Role and Development of Public Agricultural Research

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For centuries, farmers have tried to find ways of increasing production on their own land—to make two blades of grass grow where one grew before. But as long as land was plentiful, output could be rather easily increased just by enlarging the area grown. As land became more scarce, however, there was an increasing need to expand the productivity of existing land. This often was a more difficult process and required new techniques of production beyond those which could be generated at the farm level.

The result was a gradual realization of the need to find a way to expand the broad-scale development of agricultural knowledge and technology. This inevitably led to calls on the government for assistance,

THE ROLE OF AGRICULTURAL RESEARCH

Agricultural research is the systematic search for new ways of improving agricultural production and marketing. In most cases, production research is oriented to maintaining or increasing the productivity of our agricultural resources. Marketing research is largely devoted to maintaining quantity and quality of products as they move to and through the market. The result of both types of research is an expanded supply of agricultural products at a lower cost per unit of product than otherwise would have been the case. This outcome usually benefits many producers and all consumers of that product, Some research is increasingly devoted to related questions concerning, for example, environmental quality and human nutrition where the measure may be somewhat different. But generally the final measure is a more ample food supply at reasonable cost, while maintaining a sustainable production system and reducing the uncertainty of production.

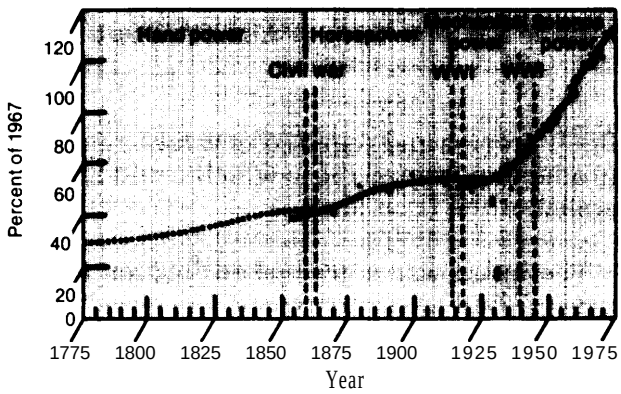
The United States is generally recognized as having developed a productive and efficient food system. Many factors contribute to such a situation, but research is of vital and central importance. Research relates to all three major factors of production: land, labor, and capital, Land became less abundant with the closing of the frontier in 1890. On the other hand, production inputs that could be purchased with capital—particularly machinery and chemicals—have grown in supply.

Viewing the development of productivity—measured by output per unit of inputs—in American agriculture from 1775 to 1975, one might separate the 200 years into four periods. The first, from 1775 through the Civil War, largely relied on hand power, supplemented near the end of the period by the introduction of labor-saving equipment. From the Civil War to World War I, horse-drawn equipment was increasingly substituted for human labor. From World War I to World War II, mechanical power increasingly substituted for animal power. The fourth period, which started in the 1930's and extends from World War II to the present, might be considered the era of "science power" (Lu et al., pp. 8-10). *

Overall productivity changes were quite modest through the mid-1930's (fig. 3), Much

*It should be recognized that these are relative terms and that there is considerable overlap between periods. Some science was involved throughout, but its role grew materiality over time.

Figure 3.–U.S. Agricultural Productivity Growth During the Past 200 Years



SOURCE: Lu, Cline, and Quance, p. 10

of the effect of new technology was to increase labor productivity; considerably less was accomplished in increasing land productivity. But starting in the late 1930's there was a sharp growth in the rate of productivity, particularly in yields per unit of land (Cochrane, pp. 127-128, 202, 245). This was caused by the introduction of science power, which in turn was largely the result of research.

The research undergirding science power was carried out in the private and public sectors. Actually the private sector had long taken the lead in developing new forms of horse-drawn equipment and mechanical power for agriculture; the public sector contributed relatively little in this area. The private sector also played an important role in the development of chemical fertilizer, a vital component of increases in agricultural productivity. All of these products are proprietary goods where the manufacturer can retain at least some of the profit of innovation, in part through patents.

The public sector–composed of U.S. Department of Agriculture (USDA) research agencies and State agricultural experiment stations—arrived on the scene in a meaningful way only in the late 1800's and did not become a significant source of new technologies until the early 1900's. The public sector devoted most of its resources to biologically oriented research. This kind of research is considerably less likely to produce a proprietary or patentable product. The public sector did not move far into the area handled by private industry, but rather moved on from it. Its work in breeding new higher yielding varieties of crops, for instance, greatly enhanced the potential value of chemical fertilizers. The result was a highly productive symbiosis of public and private research and development activities.

Research and its associated science power have been the major factors in bringing about the sharp increase in total agricultural productivity. But recent dropoffs in the rate of productivity growth have increased concern about the condition and productivity of agricultural research in the United States.

EARLY INSTITUTIONAL DEVELOPMENTS, 1862 TO 1887

The early agricultural societies stirred up considerable interest in agricultural experimentation in the first half of the 1800's. Quite independently, and nearer the middle of the century, a number of American scientists received graduate training in Europe and brought back the idea of agricultural experiment stations.[1] This concept was in turn fed to the agricultural societies and other such groups. But little resulted in formal terms except for some institutionalization of fertilizer analyses.

Two major steps toward the creation of agricultural research systems were taken in 1862 with: 1) Presidential signature on a bill on May 15 establishing USDA, and 2) the pas-

[1] Agricultural experiment stations were established in Europe at an earlier date than in the United States and had considerable influence on American thinking. For details, see: Atwater; Knoblauch, et al., pp.5-18; Rossiter, 1975; True and Crosby; Congressional Globe; and Agricultural Experiment Stations.

sage of the Merrill Act on July 2, which provided the basis for the land-grant colleges of agriculture. Neither bill said very much about research, which was to be a source of some difficulty, but they did create the basic institutions that could in turn foster research.

As Knoblauch, et al., stated: "Born in the same year, the Federal Department of Agriculture and the land-grant colleges grew up together. Confronted by a mutuality of problems, the colleges and the Department matured into a nationwide system of agricultural research and education" (p. 111). The interaction of USDA and the colleges provides a main theme in the subsequent development of agricultural research in the United States.

The U.S. Department of Agriculture

Although the act that established USDA said little about research, the House Committee on Agriculture clearly had research in mind. In its report on the bill, the committee noted the establishment of agricultural experiment stations in England and France, citing in particular the role of the French Government in promoting agricultural science. The committee stated that accurate knowledge of the processes of nature "can be obtained only by experiment, and by such and so long continued experiments as to place it beyond the power of individuals or ordinary voluntary associations to make them" (Congressional] Globe, p. 856).

In any case, USDA was hardly in a position to do much research when it was established in 1862. Such resources as it had initially were inherited from the Patent Office: a few employees, a few rooms in the basement of the Patent Office, and a small 6-acre propagating garden and house on the Mall in front of what is now the site of the National Gallery of Art.

In April 1863, USDA was given authority to use roughly 40 acres of land at the west end of the Mall (the square between 12th and 14th Streets and Independence and Constitution Avenues) for use as an experimental farm. The site was then occupied as a holding yard for livestock for the Union Army and did not become available to USDA until the spring of 1865. During the next two seasons, a wide variety of imported seeds and plants were planted and evaluated; the results were reported in considerable detail in the annual reports of the Commissioner of Agriculture. The limitations of the site, however, were becoming apparent. Also, space was needed for a new USDA building.

In May 1868, the Commissioner of Agriculture, Horace Capron, reported that he had abolished the experimental farm and recommended that ". . . not less than 200 acres of land should be obtained in a conspicuous locality, upon one of the great thoroughfares, within easy access from the city; a portion to be appropriated to the propagating garden, and the remainder to constitute the farm proper." (Report, 1867, p. 19). The new administration building, with some laboratory space, was erected on the southern side of the experimental farm site, and much of the remaining land was gradually converted into a public arboretum. Still, some land remained for outdoor plots, and a few greenhouses were erected.

Despite Capron's request for more land, none was forthcoming through 1887 and, in fact, not in any significant quantity until the early 1900's. In 1879, Commissioner Le Duc cited as one of the USDA's "immediate necessities" the acquisition of an experimental farm of 1,000 acres in the Washington area (Wiser and Rasmussen, p. 288). In 1880, he suggested making use of land that was part of Arlington National Cemetery (Report, p. 18). Nothing immediately came of either idea. Some land, however, was rented for research on animal diseases in 1883. The very limited facilities on the Mall continued to be critical restraints on any extensive experimentation.

Moreover, the early commissioners of agriculture were not particularly committed to the experimental work. As Knoblauch, et al., stated, they were:

> . . . unfamiliar with the intricacies of scientific research. There was a tendency in those

> early years to become preoccupied with other responsibilities outlined in the Act, Many problems combined in delaying until the late 1880s crystallization of any clear departmental research policy based on "long continued experiments" (p. 27).

Thus lack of direction by the commissioners and a lack of facilities meant that for its first 25 years USDA did relatively little in agricultural research. Nor did it provide any particular leadership to others except in relation to the Hatch Act.

The States[2]

It has been suggested by Knoblauch, et al., that the slow progress in developing the USDA as a national agricultural experiment station served ". . , as an incentive in the States to go ahead with State stations" (p. 27). This was not much of an incentive, however, and early State progress was hardly striking. Part of the problem was that Senator Merrill "had not clearly indicated his ambitions concerning the nature and extent of research activity in the land grant colleges" (p. 32). The bill itself made only two references to the research function: it provided that: 1) up to 10 percent of the initial endowment could be used to purchase lands for experimental farms, and 2) that the annual report should record any experiments made with their cost and results.

As a consequence Knoblauch, et al., state that:

> Collegiate experimentation in agriculture appeared very early in the agricultural colleges founded in the mid-19th century. The first States to institute the new schools explicitly directed, either by charter provision or by separate enactment, that the collegiate governing bodies initiate and maintain a program of experiments. These directives did not authorize, however, or imply the establishment of experiment stations (p. 29), The indistinct nature of the research authority . . . prompted the first generation of college administrators to doubt that the Act of 1862 required the colleges to experiment, except as an aid in the instruction of students (p. 32).

The first significant State development occurred in Connecticut as the result of work by several members of the Sheffield Scientific School at Yale University. During the mid-1800's, Sheffield (and its Analytical Laboratory) was widely known for its teaching of agricultural science. One staff member, Samuel W. Johnson, had studied in Europe where he had become acquainted with the experiment-station concept. In 1863, Connecticut's Merrill Act funds were given to Sheffield, which in turn employed William H. Brewer as professor of agriculture, Among those studying under Johnson and Brewer was W.O. Atwater, who also later studied in Europe and became familiar with the agricultural experiment station concept.

Johnson encouraged the formation of a State Board of Agriculture in 1866 and secured an appointment as its official chemist. He, Brewer, and Atwater then pressed for the idea of an agricultural experiment station. In 1875, some State and private funds were provided for a 2-year experiment-station program at Wesleyan University; Atwater was named director. The initial work, principally fertilizer analysis, was considered promising, and in January 1877, the State Board proposed renewal of the station.

On March 21, 1877, the proposal establishing the Connecticut State Agricultural Experiment Station became law. A $5,000 appropriation was provided. The charter severed organic connection with a university: the Wesleyan operation was closed and the station leased space at Sheffield. Johnson was named director, while maintaining his position at Yale. The station continued at Sheffield until 1882, when the State legislature provided funds to purchase the former Eli Whitney estate in suburban New Haven. Although the Connecticut station was thus the first public station in the U.S. in a formal sense, much of the early work related to fertilizer analysis and ". . . Johnson found it practically impossible to incorporate re-

[2] This section is based, except where otherwise noted, on True, pp. 82-118, and True and Clark, pp. 29-34, 146-147, 163-164. On California, also see Rosenberg, 1971, pp. 11-12,

search into the station program before 1890" (Rossiter, 1975, p. 170).

A quite different pattern was followed in California. In early 1875, E. W. Hilgard joined the College of Agriculture at the University of California in Berkeley. The university regents gave him a laboratory and $250 a year for 2 years for experimental work. In that year, he began a field experiment on deep and shallow plowing for wheat grown for hay; he soon added an experiment on the fertilization of wheat. In 1877, the first legislative appropriation was made specifically for experiment station work: $5,000 a year for 2 years. The amount was raised to $10,000 a year in 1879. Hilgard does not seem to have been tied down with fertilizer analysis, as was the Connecticut station, and hence was able to more fully engage in the type of work now done by experiment stations.

During the next decade, the Connecticut and California models of organization were followed, although slowly, in several other States. Independent stations were established in North Carolina [1877), New Jersey (1880), New York (1880-81), Ohio and Massachusetts (1882), and Louisiana (1884, 1886). In several cases, however, the stations were located near the land-grant college. Experiment stations connected with land-grant colleges were established in New York (at Cornell, 1879-81), Tennessee (1882), Alabama and Wisconsin (1883), Kentucky and Maine (1885), and Vermont (1886). Establishment of several of the stations in the mid-1880's was no doubt encouraged by ongoing congressional discussions of predecessors of the Hatch Act of 1887. In addition, more or less systematic agricultural work was being done at land-grant colleges in 13 other States.

Thus the first 25 years after the passage of the Merrill Act scarcely brought about a great increase in experiment stations at colleges of agriculture. There were about as many stations established independently of colleges as were established in association with them. Knoblauch, et al., note that the governing boards of the land-grant colleges were hesitant to organize experiment stations and that "customarily until the mid-eighties they accepted as satisfactory the State legislative actions which founded and subsidized stations operating independently of college control" (p, 29), "Thus in the early eighties the outlook for establishing permanent stations under college direction appeared, if not bleak, distant and uncertain" (p. 38).

THE TURNING POINT: THE HATCH ACT OF 1887

The Hatch Act of 1887 was undoubtedly the most important legislative step taken in the development of agricultural research in the United States. In one stroke it brought about the establishment of the modern network of State agricultural experiment stations, and it bound the USDA and the States together in the process.

The Hatch Act was not developed overnight; it had a long and complex history. The precursors might be said to go back to 1871, when representatives from 12 land-grant colleges met to discuss how to accelerate agricultural research, and to 1872, when Commissioner of Agriculture Watts called a national agricultural convention (involving colleges of agriculture) at which a committee on experiment stations was appointed. The campaign for Federal support, however, did not pick up much speed until the early 1880's. In 1880, a group of research-oriented professors from Midwestern colleges met at the University of Illinois and formed a group known as the Teachers of Agriculture to promote college-affiliated stations. They met again in 1881 and developed a more detailed proposal. It called for State support—justified in part by the fact that ". . . improved agricultural production benefits the entire population, not solely the producers on the farms" (Knoblauch, et al., p. 39). The role of experiment

stations was also discussed at two meetings of land-grant colleges called by Commissioner Loring in Washington in January 1882.

The first proposal for Federal funding seems to have been advanced in an article by E. W. Hilgard of California in The Atlantic Monthly in May 1882. He noted the meager funds available at the State level and criticized the commissioners of USDA for their neglect of Federal research. He encouraged the use of Federal funds in cooperation with the land-grant colleges for the operation of a station in each State.

A bill toward this end was introduced in Congress in May 1882 by Representative Carpenter of Iowa. The bill was based on a proposal by Seaman Knapp of Iowa State. It called for "national experiment stations" at each college. Carpenter contended that the American farmer, confronted with the need for developing intensive cultivation, needed as never before the aid of scientific research. The bill called for an annual Federal allocation of $15,000 for each station. Management of the station was basically to be under State control. As finally reported out from the House committee in July 1884, the bill was somewhat different and became known as the Cullen bill.

In July 1885, the new Commissioner of Agriculture, Norman Colman, called a special convention of college delegates in Washington. The experiment-station proposal was on the agenda and was favored by Colman. It was decided to push the proposal on the basis of two points: the duty of the Federal Government to aid agriculture, and the duty of the land-grant colleges to aid the farmer. Having subsidized the colleges for teaching students, Congress should now subsidize the stations for assisting farmers,

The report on the bill prepared by the House Agriculture Committee (chaired by Congressman Hatch), dated March 3, 1886, contained the following statements:

> The object should be to increase production at a decreased cost and at the same time to preserve the fertility of our soils (p. 2).
>
> Combining as they do the precision of scientific methods with an intelligent regard to the requirements of practical operations, it is not surprising that they (the experiment stations) have come to be looked upon, wherever established, as the most important aids to successful farming as well as the foremost agency for the advancement of agricultural science (p. 3).

The bill was the subject of a fiery debate in the Senate in January 1887. There was widespread sympathy for the new idea of Federal subsidies for conducting research on State stations. But there was also, even then, concern that Federal dictation would automatically follow the flow of Federal funds. Revisions made on the floor allowed funds to go to independent (noncollege) stations (a grandfather clause) and removed all statements that the Commissioner of Agriculture had powers beyond aiding and assisting the stations. The bill was passed by the Senate on January 22 (without a record vote) and by the House on February 25 (152 to 12). It was signed into law by President Cleveland on March 2, 1887. It was reportedly the first direct cash grant-in-aid to individual States (Rosenberg, 1964, p. 3).

The Hatch Act provided, as did the previously proposed Carpenter bill, $15,000 for agricultural experiment stations in each State. The first appropriation for the stations was provided in a special act of February 1, 1888. On July 18, the Hatch Act funds were carried in the annual appropriation act for USDA. The appropriation provided $10,000 for administration of the act; the Office of Experiment Stations was established for this purpose on October 1, 1888.

In commenting on the Hatch Act, True said that it "established a new policy of relationship between the Federal Government and the States by granting money to the States for agricultural experiment stations, which were thus to be distinctly State institutions" (p. 130). As such, they were to focus on State and local problems.

GROWTH AND INTERACTION, 1888 TO 1953

The Hatch Act set the stage for the Federal-State agricultural system as we know it today. It led to the establishment of an experiment station in each State and provided the basis for continuing Federal support. The Hatch Act, however, had a less immediate impact on the role of research within USDA itself.

Federal Research

The course of Federal research changed relatively little from 1887 through 1897. Thereafter the situation changed sharply.

1888 to 1897

In February 1889, USDA was given Cabinet status, but only modest increases were made in Federal agricultural research under the first two Secretaries of Agriculture (excluding N. J. Colman who served only 3 weeks). Under Secretary J. M. Rusk (1889 to 1893), "the aggregate funds used for experimental work did not materially increase, " though "more scientific work was performed in a few lines, especially vegetable pathology and biology" (True, p. 178). Under Secretary J.S. Morton (1893 to 1897), there was no increase in overall appropriations for USDA, but the proportion of funding for scientific work increased somewhat.[3] This was particularly true with soils, grass and forage plants, and forestry (True, p. 183).

USDA research facilities remained very limited during this period. In 1887, then-Commissioner N. J. Colman suggested the establishment of a central experiment station (Report, p. 12). The following year, he elaborated on the concept which was:

> To relieve the State stations of much costly and laborious scientific work and enable them to devote their energy the more completely to the things that are of practical interest to the farmer, and to enable the Department to give the advice and assistance which Congress calls for and the stations need . . . This would in no way take the place or do the work of the stations throughout the country but would, on the other hand, be a most helpful, economical, and I am inclined to add, essential part of the whole organization (Report, 1888, pp. 12-13].

Not everyone felt this way. Edwin Willets, the first Assistant Secretary of Agriculture (and former president of Michigan Agricultural College), who was placed in charge of scientific work, said in an 1889 speech that while the previous Commissioners of the Department "without exception . . . wanted an experiment farm" for their own research, he hoped to "head off any such proposition. . . ." Yet late in that same year Secretary Rusk formally requested transfer of the Arlington land to USDA [Wiser and Rasmussen, pp. 288, 289).

Meanwhile, the facilities on the Mall proved increasingly inadequate. In 1894, Secretary J. S. Morton commented that: "There is hardly a university or agricultural college in the United States which has not better constructed, better lighted, or better ventilated laboratories than those used by the Department of Agriculture" (Yearbook of Agriculture, 1894, p. 64).

Thus, from 1888 through 1897 agricultural research in USDA continued at a relatively modest level and was severely handicapped by limited facilities.

The Wilson Era, 1897 to 1913

The research situation, however, began to change sharply with the arrival of James Wilson as Secretary of Agriculture in March 1897. The following September, he took charge of scientific and regulatory work (previously under an Assistant Secretary). He continued in this position for an unparalleled term of 16 years.

[3] According to one calculation, the following proportions were spent on "scientific work:" Fiscal Year 1892, 46.2 percent; 1893, 45.6 percent; and 1894, 51.8 percent (Dabney, p. 66). The definition of scientific work may have been much broader than the definition of research used in later years (see Moore, p. 3).

Wilson did not necessarily arrive with the upgrading of Federal research prominently in mind. He described his metamorphosis to the State experiment station directors in these words in November 1905:

> when I came down here—with a good deal of reluctance–to do something in the Department of Agriculture, my prevailing thought was that I would try to make that institution subservient to the stations of the country, and to help build them up. I found that it was necessary to first build the Department up; that it was not as strong in educated scientists as it should be . . . and so I was compelled to turn my attention to that one thing and push it in all possible directions, to select strong men, and interview Congress occasionally for increased appropriations. We have been doing what we can (Wilson, p. 15).'

In congressional hearings earlier that year, he acknowledged that his already-achieved goal had been to build a corps of full-time specialists, "the greatest scientists in their respective lines today that the world knows of" (Knoblauch, et al., p. 105).

During Wilson's regime, seven new scientific bureaus were established (only one, the Bureau of Animal Industry, existed before his arrival). Four were established in 1901 alone: Plant Industry, Forestry (which became the Forest Service in 1905), Soils, and Chemistry. Three were established in subsequent years: Statistics (1903), Entomology (1904), and Biological Survey (1905).' The bureaus were built on previous organizations but represented an elevation in status and eventually an enlargement in size. The latter point is illustrated in data on the growth in number of employees between 1897 and 1912:

	Number of employees	
Bureau	1897	1912
Animal Industry.	777	3,311
Plant Industry.	127	2,128
Soils	33	159
Chemistry , , , ...	29	546
Entomology ., ...	27	339
Biological Survey.	23	97
Total	1,016	6,580

SOURCE: True, p 190

Staff increased more than sixfold. Not all of the work of the bureaus, however, was devoted to scientific work; regulatory work played a large role in some cases.

The growth in research may also be reflected in other terms. It has been estimated that expenditures on USDA research increased from $800,000 in 1900 to $4 million in 1910 (Hayami and Ruttan, p. 144), Between 1887 and 1904, the Federal Government quadrupled the portion of the Department budget (excluding the Hatch appropriation) spent for research. The Bureau of Plant Industry (BPI), for example, in 1904 reportedly operated on a budget larger than the total Hatch appropriation to all of the States. Similarly, the departmental scientific staff had grown steadily until in 1904 it substantially outnumbered the nationwide total of station workers (Knoblauch, et al., p. 103).

In terms of management philosophy, the emphasis:

> . . . was on lines of work directed by prominent individuals rather than on administrative units. In general, subordinate units were organized on an informal basis , , , Informality was fostered by Secretary Wilson, who made a point of knowing who the scientists were and what they were doing. He frequently visited the laboratories in the buildings that were clustered in the vicinity of the main building of the Department (Baker, et al., p. 42).

During Wilson's early years, USDA had been stuck with the same limited facilities in Washington that had existed previously. But in 1900, he was able to secure the use of 400 acres of the Arlington National Cemetery, although it took about 3 years to get the site

[4]Rosenberg notes that "though the stations had hoped that 'Tama Jim' Wilson, originally an experiment station man, might be a bulwark of State interests in Washington, he had been a disappointment" (Rosenberg, 1964, p. 5), Wilson had also served previously for three terms in the House of Representatives.

[5]For further details on the bureaus, see: Baker, et al., pp. 42-56; Dupree, pp. 158-169, 176-181; and Rossiter, 1979, pp. 220-239,

ready for use. In 1907, two laboratory buildings were completed on the Mall site (the current east and west wings of the present administration building). In 1910, a 475-acre farm was purchased near Beltsville for work in dairying and animal husbandry.

Expansion was not confined to the Washington area. After its establishment, a large and increasing amount of the work of BPI was conducted at USDA field stations. By 1913, BPI operated 18 field stations in 9 States, 8 in cooperation with State experiment stations. In the same year, the Bureau of Entomology had 35 field laboratories in different parts of the United States (True, pp. 197-198, 203),

The Office of Experiment Stations, established to administer the Hatch funds, also became involved in the conduct of research in cooperation with State stations. Nutrition investigations began in 1894, irrigation investigations in 1898, and drainage investigations in 1902. In 1898, the Alaska Experiment Station was put under this office; the Hawaii and Puerto Rico stations were added in 1901 (True, p. 133).

USDA's growth in research staff and geographic scope was not looked upon entirely favorably by the States. Some of this was probably jealousy, for the State stations were not having an easy time with their own legislatures. Some was a result of dislike of certain Bureau chiefs. And some was a result of concern that USDA activity in the States might lessen financial support for State agricultural experiment stations.

W. H. Jordan, director of the New York SAES at Geneva, expressed the concerns of many of his State colleagues, when he stated in January 1905:

> As a natural and inevitable result the Department with its overwhelming equipment of men and means, is not now, as formerly, confining its research work largely to that which can be done in the laboratories at Washington, but is, of very necessity, as a means of securing opportunities, reaching out into the several States and . , , is now traversing, to a large extent, the field that had been and still is also traversed by the experiment stations (Knoblauch, et al., p. 103).

USDA administrators undoubtedly would have put the matter differently.

The Adams Act of 1906 doubled Federal funding to the States, which thus became less vocal, although still irritated, on the matter of Federal research. By any measures, however, Wilson put USDA solidly on its feet in agricultural research.

Early Coordinated Research Programs

Research conducted by USDA and the State experiment stations before 1900 was largely by individual investigators, with cooperation based primarily on personal contacts. One of the first efforts to conduct coordinated research programs involving Federal and State scientists and cooperating farmers was the work on dryland agriculture in the Great Plains area (Quisenberry, pp. 218-228; Moseman, et al., 1981).

When the Hatch Act was passed by Congress in 1887, only a few States had agricultural experiment stations and none were in the Great Plains. However, systematic experiments were in progress in Colorado, Kansas, and Nebraska. Dryland research was started by E. C. Chilcott at Brookings, S. Dak., in 1897. The need for such work was subsequently recognized by M. A. Carleton of USDA. In 1905, Carleton hired Chilcott to take charge of dryland research. In 1906, the Office of Dry Land Agriculture (DLA) was established with Chilcott in charge.

One of Chilcott's first moves was to call a meeting in Washington, D. C., to plan cooperative research, with representatives from various units of BPI and from the agricultural experiment stations of North and South Dakota, Kansas, Nebraska, and Oklahoma. The stated purpose of the meeting was "to encourage and facilitate the coordination, systemization, and unification of all the cooperative experimental work to be engaged in by BPI and the experiment stations and sub-stations of the several states included in whole or in part in the Great Plains area. "

Later it was agreed that Texas and Colorado should be included in the cooperative program,

The first meeting of the new Great Plains Cooperative Association was held in Lincoln, Nebr., in June 1906, and such meetings were continued until World War I. This was the start of State-Federal cooperation in agricultural research and set the pattern for similar cooperation on other regional and national problems confronting agriculture in later years,

The association conducted research at the stations then in existence and also established new stations—by the States, the Federal Government, or cooperatively—with the experimental work done jointly by the State and Federal workers. Stations were established at Hays, Kans., in 1901; Nephi, Utah, in 1903; Amarillo, Tex., in 1904; and North Platte, Nebr,, in 1906. By 1910, there were 20 stations in operation and by 1916 there were 29. Eventually 30 stations were involved. The Pendleton, Oreg., station was started in 1928 and was the only DLA station outside of the Great Plains.

1913 to 1953

The patterns of operation established during the Wilson period generally continued until 1953. Although an increased amount of research was done in the Washington, D. C., area, a substantial amount was carried out in various field locations. A. C. True reports that in the case of BPI from 1922 to 1925, "fully 60 percent of the research was carried on at field stations, and much of it was done in cooperation with the State experiment stations" (p. 255). By 1931, USDA reportedly maintained 51 field stations in 24 States (Waggoner, p. 242). The field operations in some cases continued to be a source of friction with State experiment station officials.

Meanwhile, the Arlington farm was enlarged slightly in 1915, and gradual but substantial additions were made to the land area at Beltsville. The Beltsville Research Center was formally established in 1934. In 1940-41, the Arlington farm and the greenhouses on the Mall were closed down and activities shifted to Beltsville.

Regional research activities were given a substantial boost by two congressional acts during the mid to late 1930's. In 1935, the Bankhead-Jones Act authorized the establishment of laboratories in different regions of the country to work on priority problems of the region. Nine were established by 1939: Plant, Soil, and Nutrition (Ithaca, N.Y.); Pasture Research (State College, Pa.); Vegetable Breeding (Charleston, S.C.); Poultry Research (East Lansing, Mich.); Soybean Research (Urbana, Ill.); Sheep Research (Boise, Idaho); Salinity (Riverside, Calif.); Plant-Growth-Regulating Substances, and Photo-Period and Plant Development (Beltsville). These facilities tended to be regarded as Federal field laboratories (Moseman, et al., 1981; Purcell, pp. 235-236).

The Agricultural Adjustment Act of 1938 authorized USDA to establish four regional utilization-research laboratories that were to concentrate on developing new uses and outlets for surplus commodities. The laboratories were located at Philadelphia, Pa.; Peoria, Ill.; New Orleans, La,; and Albany, Calif. The laboratories were constructed around 1940 and cost $1 million each; the annual budgets were approximately the same (Moseman, et al., 1981; Purcell, pp. 238-239).

As with the field stations, these regional laboratories were a source of concern to some State agricultural experiment stations because they found it difficult to cooperate with them. They were also considered interlopers by some of the old-time USDA bureaus. Partly to help correct these problems, an Agricultural Research Administration was created in the early 1940's as an administrative layer between the bureaus and the Secretary (Irving, et al., 1981; Purcell, pp. 237-240),

Of greater importance was the passage of the Research and Marketing Act of 1946. It was initially designed to increase marketing research in USDA, but by the time it was passed involved substantial sums for research on utilization, quality improvement, and

other areas of agricultural research (Moseman, et al., 1981).

As a result of these changes, agricultural research in USDA appears to have been in relatively good condition in the early 1950's.

State Research

The State agricultural experiment stations (SAES) underwent a remarkable period of growth following passage of the Hatch Act. * This growth was then stimulated in surges by the passage of additional legislation, the first of which was the Adams Act in 1906.

1888 to 1906[6]

Passage of the Hatch Act in 1887 provided a great and immediate impetus to the establishment of State agricultural experiment stations. As noted previously, an Office of Experiment Stations was established in 1888, with W. O. Atwater as its first director, to administer the Hatch funds.

Just before the passage of the act, there were only 15 State stations, By the end of 1888, there were 46 such stations. The number grew to 55 in 1893, 56 in 1894, and 60 in 1906—quadrupling in number in less than 20 years.

Within the overall numbers, a few stations continued to be wholly State-sponsored (two by 1906), and three of the territorial stations (Alaska, Hawaii, and Puerto Rico) were sponsored by USDA. Virtually all of the remaining 55 stations were tied to land-grant colleges.

All of this was accomplished with a rather modest expenditure of Federal funds. The total annual Hatch funding was: 1888 to 1893, from $585,000 to $708,000; 1894 to 1906, $720,000. There was no allowance for growth or inflation. On the other hand, the $15,000 provided to each station was large compared to funding available in Europe.

Yet modest as they were, the Federal funds were of vital importance because of the limited or nonexistent State funding available. True notes that in fiscal year 1902, of the 52 stations receiving Hatch funds, 27 (52 percent) did not receive any State aid, while only 25 (48 percent) were also supported by State funds. In the latter case, only eight States equaled or exceeded the Hatch appropriation ($15,000); six did not exceed $1,000; and several provided support only for substations (for which Hatch funds could not be used).[7]

The role of Federal funds, while massive at first, gradually declined as the Federal contribution held steady and as State contributions gradually increased. In 1888, the Hatch funds accounted for 82.4 percent of the funds available to the State stations; by 1906, this proportion had been reduced to 47.6 percent.

One of the problems in administering the Hatch Act was to limit its use to scientific research, particularly original research. Then, as now, there were many competing demands for overhead, applied research, and extension. The result was a "snail's pace toward significant research" (Knoblauch, et al., p. 87).

The question of applied v. original research became a major topic at the annual meetings of the American Association of Agricultural Colleges and Experiment Stations around 1900.[8] Few States were inclined to make substantial grants for original research, and even then they were commonly earmarked for specific topics.

Adams Act of 1906

The answer to these problems appeared to be to obtain additional Federal funds. Cong. H. C. Adams of Wisconsin was contacted in late 1903, and he in turn requested A. C. True of USDA to draw up a proposed bill. True's

*The SAES as discussed in this section do not include the 1890 colleges of agriculture for which no Federal research funds were regularly provided from 1888 to 1953. Details on subsequent Federal support are provided on p. 46.

[6]The statistics reported in this section were derived from True, pp. 130-131, 138, 166, 212, 237-238, 274.

[7]At first, some Hatch funds were used for substations, and by 1894 there were 40 such stations. However, in 1896 the Office of Experiment Stations ruled against their use for this purpose, and by 1897 their number was reduced to 11. The use of State funds raised their number to 16 in 1899 and 28 in 1904 (True, p. 131).

[8]This matter is discussed in more general terms in Rosenberg, 1977, pp. 403-412.

proposal followed the Hatch Act in its funding level ($15,000 per year per State), but limited expenditures solely to original research.

In mobilizing support for the bill, much comment was made about the sharp expansion in Federal research and the comparative poverty of the States. The State group sought "some measure of equity in the appropriations made for this purpose from the National Treasury" (Knoblauch, et al., p. 100).

The bill was passed by the House and Senate early in 1906 and was signed by President Roosevelt on March 16. According to Knoblauch, et al., the act "firmly established the principle in American governmental policy that Federal aid shall join with State aid for the purpose of subsidizing scientific research in the State stations" (p, 107). Rosenberg viewed the matter less grandly: ". , . as a strategic victory for the stations in a continuing conflict with the Department of Agriculture" (1964, p. 5),

It is not commonly noted that the act states that its funds are to be used for ". . . paying the necessary expenses of conducting original researches or experiments bearing directly on the agricultural industry of the United States, having due regard to the varying conditions and needs of the respective States or Territories" (Knoblauch, et al., p. 221).

1907 to 1953[9]

The Adams Act doubled the Federal contribution to each State—although the increased funding was phased in over a 5-year period. Thus the Federal contribution of $720,000 in 1906 was raised to $1,44 million by 1911. It remained at that level through 1925,

During this period the level of non-Federal funds available to the stations increased so that the proportion of Federal funds provided through USDA continued to decline—from 47.6 percent in 1906 to an all-time low of 14.9 percent in 1925. Still, a substantial number of stations received only limited State funds. In fiscal year 1921, for example, 22 stations received less than $50,000 of State funds, including 6 which received none (True, p. 238).

Several other developments were also of significance. The number of substations continued to grow, from about 70 in 1913-14 to 130 in 1920 (True, pp. 210,238). Passage of the Smith-Lever Act in 1914 formalized and funded the extension function, sharply reducing pressures on the experiment stations,

The Federal research funding provided through USDA was subsequently raised with the passage of the Purnell Act in 1925, which also enlarged the scope of research at the stations by stressing studies of economic and social problems of agriculture, including marketing and prices. In addition to the $30,000 of Hatch and Adams funds, the States were to initially receive an additional $20,000 a year; the amount was to be ultimately increased to an additional $60,000 a year by fiscal year 1930. Thus total Federal funding increased from $1,44 million in 1925 to $4.335 million in 1930, a figure which then held through 1935. The proportion of station funds provided by the Federal Government increased from 14.9 percent in 1925 to 32.5 percent in 1935 as State appropriations withered during the depression (Porter, p. 99),

In 1935, the Bankhead-Jones Act provided additional funds to the States and for regional Federal research. Funds were allocated on a formula basis rather than as an equal sum to each State, as had previously been the case, States were also required to match the Federal funds dollar for dollar, Federal funds to the States gradually increased through the end of World War II–from $5 million in 1936 to $7 million in 1946. The Federal portion of funding dropped gradually—from 33.9 percent in 1936 to 25.7 percent in 1946.

In 1946, substantial changes were introduced by the Research and Marketing Act. It increased Federal funds for the States on a formula basis and made provision for support of regional research by the State stations, Federal funds increased from $7.197 million in 1947 to $12.265 million in 1953; still, the Fed-

[9]The statistics reported in this section were derived from Agricultural *Appropriations for 1957*. They may differ slightly from those reported in app. B. The percentages are presented in fig. 7 on p. 43.

eral proportion of station funding dropped from 20.6 percent to 16.5 percent in the same years.

Federal-State Financial Interaction

As a result of these congressional actions, Federal and State Governments were uniquely bound together in the sponsorship of agricultural research during the period of growth and interaction from 1888 to 1953. This partnership extended from straight funding to coordinated national and regional research programs,

Policy Aspects

The Federal-State funding arrangement that developed after 1888, while highly productive, had the seeds of conflict built into it. USDA not only sponsors its own research program but also passes Federal funds on to the States; this was bound to lead to some contention about the relative proportion of funds used for each purpose.

The countervailing forces and their attitudes were summarized in an exchange between a congressman and Whitman Jordan, representing the State stations, at a hearing on the Adams bill in January 1905:

> Congressman: Don't you think a fair inference from these figures is that we should give you all the money we have got?
>
> Jordan: No; you have a great big Department in Washington that needs all the money you can give it. But on reflection, I would say that we will take all the money we can get, and we can use it well. (Knoblauch, et al., p, 104)

Passage of the Adams Act was a major boost for the States ". . . but it made long and rigorous competition with the Department ineditable. " Other crises in the relationship arose in 1930-32 and in 1953-58 (Knoblauch, et al., p. 121).

In analyzing Federal/State relations since the passage of the Hatch Act, Knoblauch, et al., made the following observation in 1963:

> A theme of continuity runs through 20th century developments . . . . The thread is one of undulating competition between the experiment stations and Federal research activities within the States. Which of the two types of agencies should have priority? (p. 120)

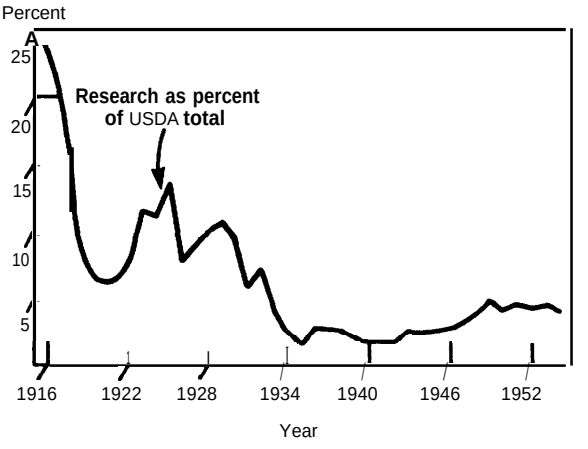
While the Federal/State relationship is commonly referred to as one of cooperation, in reality it is the product of "collision and compromise . . . the never-ending search for adjustments between the stations and the Department as to the division of responsibility for research in the States" (Knoblauch, et al., p. 121).[10]

Funding Aspects

Shortly after the conclusion of Secretary Wilson's term in 1915, research made up about 25 percent of the total USDA budget. The research proportion then dropped sharply until 1920, when it accounted for only 6 percent (fig. 4). The proportion rose through

[10]The job of the Office of Experiment Stations in such a situation must have been a most uncomfortable one at times. A. C. True, one of the early and long-time directors of this office, was, however, remarkably successful. Rosenberg attributes this in part to ". . . his ability to assuage the suspicions of station leaders and to convince them that his ultimate loyalties lay not with the Department of Agriculture, but with the State stations" (Rosenberg, 1964, p. 4, fn. 3)

Figure 4.— Role of Research in USDA Budget Allocations, 1915-55

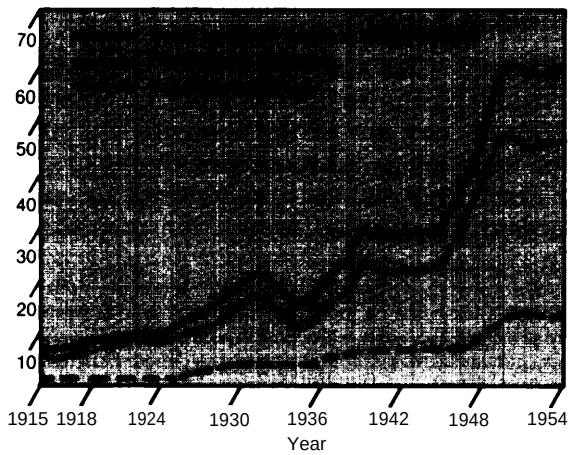


SOURCE App. B, table B-1 (col 3)

the mid-1920's, and dropped through the mid-1930's. It remained at roughly the 2.5 percent level until the 1950's, when it rose to 4 percent.

The declining relative importance of research was a result more of an expansion in the USDA budget for other activities than of any particular drop in the research budget. In fact, USDA's research budget rose through 1931, dropped during the depression of the 1930's, rose through 1940, remained constant through 1945, rose sharply through 1950, and then leveled off through 1954 (fig. 5). Allowance for inflation would have reduced the rate of increase.

Figure 5.–Appropriations for Research in USDA Budget, 1915-54 (in millions of dollars)



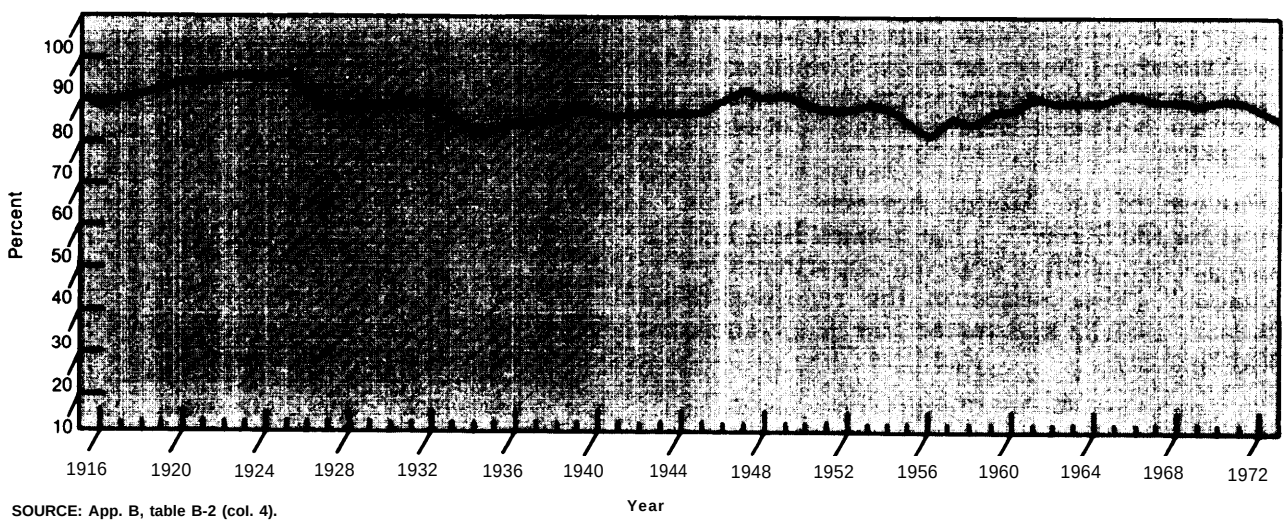
SOURCE: App. B, table B-2 (cols. 1-3)

Within the USDA budget, the actual dollar amount devoted to Federal research mirrored the above trends, while the amount passed on to the States was more stable—rising in response to each of the special funding acts and then leveling off (fig. 5).

Despite these variations, the actual proportion of the USDA research budget going for Federal research was remarkably steady over the 56-year period (fig. 6). The same is true of the State proportion. Over the period, an average of 78.8 percent was devoted to Federal research and 21.2 percent to State research. The highest Federal proportion, 86.6 percent, was reached in 1925; the lowest portion, 71.9 percent, in 1934. Over the 5-year period from 1950 to 1954, the Federal portion was down slightly to 77.6 percent.

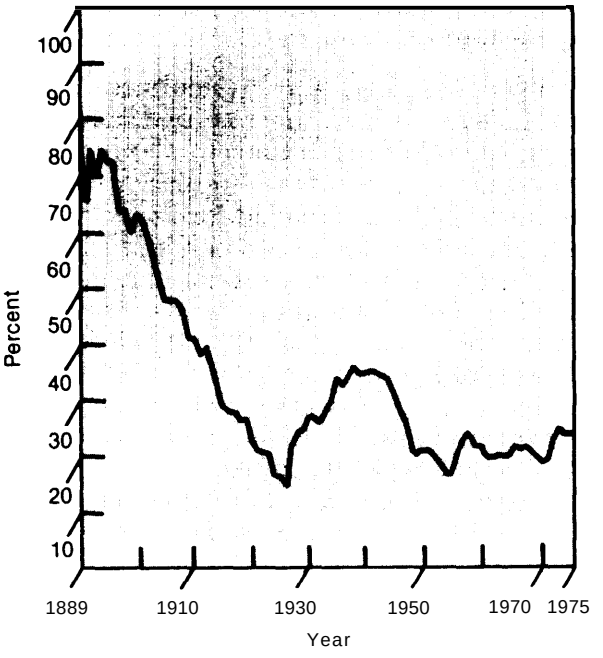
The proportion of the budgets of SAES coming from USDA funds is summarized in figure 7. Clearly, the USDA portion was very high at first and dropped rather steadily through 1925; and then, with the enactment of the Purnell and other acts, rose to another peak period in the late 1930's and early 1940's. It dropped again after 1944 to another low point in 1954. Non-Federal funds were largely composed of State appropriations, but

Figure 6.—Proportion of USDA Research Funds Used for Federal Research, 1915=73



SOURCE: App. B, table B-2 (col. 4).

Figure 7.—USDA Funds as Proportion of Expenditures by State Agricultural Experiment Stations, 1889-1975



SOURCE: Calculated from data in *Agricultural Appropriations for 1957,* Senate Hearings, 1956, insert opposite p. 136; and *Funds for Research at State Agricultural Experiment Stations,* USDA/CSRS, annual.

also included grants from foundations and industry, fees, sales, and miscellaneous.

On balance, it would appear that the Federal/State partnership through the early 1950's resulted in a remarkable degree of stability in terms of the division of USDA funds between Federal and State research. One hesitates to think, however, of how much tension and time were involved in reaching this state of relative equilibrium.

REORGANIZATION AND DECENTRALIZATION, 1953 To THE PRESENT

With the arrival of a new Secretary of Agriculture in 1953, the structure of research organization and administration of funds for State research underwent the first of a number of reorganizations that continued on through the late 1970's. These reorganizations will be only briefly introduced here; they will be discussed in greater detail in subsequent chapters. (Further organizational details and comments may be found in Moseman, et al., 1981.)

Reorganization

The reorganization of 1953 abolished both the long-standing scientific bureaus and the Office of Experiment Stations. Administrative authority for both functions was centralized with the Agricultural Research Service (ARS), which might be considered an outgrowth of the Agricultural Research Administration.

Although the reorganization may have led to some administrative improvements, it evidently had a very destabilizing effect on Federal research and cooperative programs. On the Federal end, much of the financial and decisionmaking authority was centralized and moved up a level. The division of the Office of Experiment Stations into two units and its placement under the control of the Administration of ARS was not well received by the States. (In 1962, a separate Cooperative State Research Service was established.)

Aside from the immediate problems it created, the reorganization "had the effect of subjecting the research structure of the Department—which had substantial stability and immunity from political interference for 40 years . . . —to a succession of pressures for further drastic reorganizations with the changes in political administration in future years" (Moseman, et al., 1981).

In the early 1960's the Life Sciences Panel of the president's Science Advisory Committee (PSAC) prepared a report entitled Science and Agriculture, which focused primarily on USDA. It included several recommendations relating to research organization. A Committee on Agricultural Science was appointed by Secretary Freeman in April 1962, and several changes were made in research organization in the first 6 months of 1963 (Moseman, et al., 1981). In the process, some of the PSAC recommendations were implemented. These were more in the nature of continuing adjustments, rather than major disruptions or reorganizations.

In late 1969, a National Academy of Sciences Committee on Research Advisory to USDA was established, later known as the Pound Committee. It, too, presented a number of recommendations for improving USDA's research program, many of which reflected the academic composition and thrust of the committee, Some of the committee's comments were quite critical of USDA and SAES, and these were given extensive coverage in the press, In the process, many of the committee's other comments, which would have been quite useful, were overlooked (Moseman, et al., 1981).

Shortly after the Pound report was issued, but unrelated to it, USDA initiated the reorganization of 1972. Developed by a small group of administrators, its main thrust was administrative decentralization. Line operating responsibility was delegated to four regions, each under a regional deputy administrator. Each of the regions was further subdivided into a series of research area centers. The national program staff (NPS) was retained in Washington, but otherwise all scientists and facilities, including Beltsville, were placed under regional administrators. The NPS, as its name implies, had staff and not line responsibility.

Finally, the Food and Agriculture Act of 1977 further defined the role of USDA, the States, and other institutions in planning and coordination agricultural research, extension, and teaching. It called for the establishment of a Joint Council of Food and Agricultural Sciences and a National Agricultural Research and Extension Users Advisory Board. The Science and Education Administration (SEA) was established in USDA with authority over research, extension, and teaching activities. While coordination of these activities is desirable, there is some question whether a new layer of management was necessary, desirable, or productive, The combination of the advisory groups and SEA has required a great deal of staff time—much of it contributed by the agencies involved. It is uncertain whether the cause of research has been materially advanced in the process.

Funding

Despite the many organizational changes since 1953, research funding continued to follow the same patterns that were established near the end of the previous period. *

Role of Research in USDA Budget, 1963 to 1980.—During this period, research funds continued to represent 3 to 4 percent of the total USDA budget, The average was 3.55 percent from 1963 to 1971, and 3.60 percent from 1972 to 1980 (Agriculture , . . Appropriations for "1972, and Special Budget Tables, FY 1981),

Division of USDA Funds Between Federal and State Use, 1955 to 1973 (fig. 6).—Over the period from 1955 to 1973, an average of

* Unfortunately, it was not possible to compile statistics comparable to previous data for the whole period since 1954. One key data series was discontinued in 1975; hence, only portions of the period are covered. The data are also not fully comparable with those reported in ch. IV.

77.4 percent of the USDA funds continued to go to the Federal research program, and 22.6 percent to the States.[11] The Federal figure was down slightly (from 78.8 percent) and the State figure up slightly (from 21.2 percent) compared to the previous 40-year period. The Federal proportion dropped and the State proportion increased somewhat in 1972 and 1973; data from other statistical series suggest that this trend continued through 1981.[12]

Role of USDA Funds at the State Level, 1955 to 1975 (fig. 7).*—uSDA funds continued to represent over 20 percent of the expenditures of the SAES. The average was 21 percent from 1955 to 1975, and rose to over 23 percent in the mid-1970's.

Although most of the research conducted by USDA is carried out under SEA, research is also conducted by several other USDA agencies, most notably the Forest Service (FS) and what was the Economics, Statistics, and Cooperatives Service (ESCS). Over the 1972 to 1980 period, 76.6 percent of the research was carried out under SEA, 16.1 percent under FS, 5.5 percent under ESCS, and 1.8 percent under other agencies (Special Budget Tables, FY 1981, table 10).

Facilities

As of 1980, the Federal SEA research program was quite decentralized, both in administration and deployment of facilities and staff. Research was carried out at 148 locations, ranging from the massive 450-scientist facility of the Beltsville Agricultural Research Center down to one-scientist stations (Mission of SEA/AR, p. 12). A common arrangement is to place scientists at State agricultural stations. It is estimated that more than one-third of the 2,700 SEA/AR scientists are housed in such facilities (Ronningen, 1981). About one-half of the USDA research facilities were built through the initiatives of Congress between 1958 and 1977 (Flatt, et al., 1980).[13]

The highly decentralized nature of the USDA research system, a source of friction through much of the 20th century, now seems to be accepted and even favored by the States. Some observers have suggested that this is a case of divide and conquer: a highly dispersed program is easier for the States to influence and mold to their own purposes than would be the case with a highly centralized institution. This dispersion, in fact, has led to criticism that many USDA employees essentially function as State employees and that this in turn has led to a loss of focus on national issues.

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[11] lot her data series produce somewhat d i fferen t d i vi sions between Federal and State funds. One table provided by SEA for the *1960-81* period ["Appropriations . . . " SEA) indicates that the Federal use portion of SEA research averaged 70.7 percent, while the State portion was 29,4 percent. (As noted later in the text, the SEA totals accounted for about 76.6 percent of total USDA expenditures for research from 1972 to 1980; inclusion of the other USDA research activities would have raised the Federal portion and reduced the State portion.)

[12] The SEA dat, cited above indicate that the proportion of SEA funds spent for Federal research declined from an average of 72.5 percent for 1970 and 1971 to 67 percent for 1980 and 1981 ["Appropriate ions . . .," SEA). And while there was an increase in the proportion of funds going to the States, there was also a change in the composition of funds, More specifically, there was a decline in the relative role of Hatch funds (from 27.7 percent of total SEA research funds in 1960 to 20 percent in *1981)* and a relative increase in the non-Hatch portion of the State funds (from 1.1 percent of total SEA research funds in 1960 to 11.8 percent in 1980). This trend is a matter of great concern to the State directors and is a motivating force behind some recent legislative endeavors.

*The data cited in this section do not include Federal funds from agencies other than USDA and hence understate both the total Federal and other funds available to the stations.

[13] la Hadwiger, i, a forthcoming book, notes that 44 percent of all USDA research facility construction between 1958 and 1977 was in States represented by members of the Subcommittee on Agriculture of the Senate Appropriations Committee. He states that this practice has forced "the federal Agricultural Research Service to operate a 'traveling circus,' opening up new locations in current Senate constituencies, while closing some locations in States whose Senators are no longer members of the subcommittee. "

THE 1890 LAND-GRANT COLLEGES[14]

The role and development of agricultural research at the 1890 land-grant colleges have followed a somewhat different pattern than was true of the 1862 institutions. In August 1890, Congress passed what has become known as the Second Merrill Act. Basically, it authorized the establishment of separate land-grant colleges for Negroes. Seventeen Southern and border States established such colleges; 16 remain today, plus Tuskegee Institute.

Like the original Merrill Act, the 1890 act was vague about the role of research. And as it turned out, by far the main emphasis of the institutions established under it was on teaching, particularly the training of teachers. None of the Hatch Act or Adams Act research funds made available to the States were in turn directed to the 1890 schools. Nor were State funds provided for research. Only occasional funding was sometimes arranged for special projects. Consequently, no significant agricultural research programs were initially established at the 1890 schools.

The one exception to this pattern was Tuskegee Institute, which was not technically an 1890 institution, * The Alabama State Legislature established the Tuskegee State Experiment Station in 1897. It was headed by George Washington Carver from its inception until his death in 1943. Subsequently, the experiment station activities were deemphasized.

Agricultural research remained in limbo at the 1890 institutions until the mid-1960's, when the situation began to change sharply. Public Law 89-106, passed in 1965, made it possible to provide Federal research funds to the 1890 schools. The first appropriation for this purpose was provided in fiscal year 1967, when $283,000 was allocated for the 16 1890 schools (Tuskegee was at first excluded). This modest level of funding was carried through to 1971. In fiscal year 1972, however, a sharp increase—to nearly $8.9 million—was provided, and provision was made for inclusion of Tuskegee.

Under the Food and Agriculture Act of 1977, these institutions acquired a more complete funding authority and responsibility than they had previously (Public Law 95-113, sec. 1445), The funding level was set at 15 percent of the funding provided the SAES (Hatch funds), Funding under this authority was first provided in fiscal year 1979. The appropriation in fiscal year 1981 was nearly $19.3 million. In addition, a bill is before Congress that would provide $50 million over a 5-year period for capital construction.

So far, essentially all (about 99 percent) of the agricultural research funds for the 1890 schools are from Federal sources. State funding is limited to small amounts at a few institutions. Whether State funding will grow significantly remains to be seen. The 1890 schools must join with the experiment stations in their State and submit joint-funding requests to USDA, but thereafter, the Federal funds are allocated directly to them. Funds are administered by the Cooperative State Research Service. They might be viewed as additional funding for the States that receive them,

Thus, after a long period of financial neglect, it seems that agricultural research at the predominantly black 1890 schools is becoming a significant factor in publicly supported agricultural research in the United States.

[14] This section is based on information provided in Mayberry, Payne, and Schor, and by Mayes.

*However, a special act of Congress in February 1899 authorized the Governor of Alabama to select 25,000 acres of land from the public domain to endow Tuskegee Institute. Alabama Agricultural and Mechanical University was designated as the 1890 institution after a spirited competition with Tuskegee.

PRINCIPAL FINDINGS

• As population expands and quantity of land decreases, there is a growing need to increase agricultural yields per unit of land, Research is a major source of yield-increasing technology, Science has played a vital role in increasing U.S. agricultural productivity. Research is also needed to improve the marketing of this expanded production and to serve other needs of society.

• Agricultural research is conducted by public and private agencies in the United States. Each tends to generate different types of technologies: the public sector largely produces biological technology, and the private sector largely produces mechanical and chemical technology. The public sector produces public knowledge; the private sector tends to use it to produce proprietary goods. Yet, both are greatly needed, complement each other, and overlap. The public is well served by the combination.

• Since the turn of the century, both State and Federal agencies have been active partners and competitors in research. At first, the State research programs were heavily dependent on Federal funds, but this dependence lessened through 1920 as State support increased, Aside from the late 1930's and early 1940's, USDA provided about 20 percent of the funding of State stations through 1975. These funds have in turn represented from 20 to 25 percent of the research funding received by USDA.

. The substantial involvement of USDA in research brought about by Secretary Wilson early in the century has continued. Over time, from 75 to 80 percent of the research funding received by USDA has been used for its own in-house research program.

• Decentralization of USDA research was at first opposed by the State scientists. State administrators now favor a decentralized pattern, in part because they seem to have adapted it to their needs. This in turn has raised questions about whether the Federal system has sufficient national focus.

• The two-valved nature of USDA research funding—divided between State and Federal research units—has long been a source of friction. State and Federal researchers each would like a larger share of the pie. The actual division of USDA funds has been remarkably stable over time (though it may have swung in favor of the States in recent years), probably as a result of this dynamic tension. But maintenance of the balance has undoubtedly consumed an enormous amount of time and effort.

• While the State research structure has been relatively stable, as was the USDA research structure for many years, the USDA research structure" has been the subject of a number of reorganizations since 1953. A common characteristic of each reorganization is the continuous addition of administrative layers and functions and a certain loss of national focus,

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