Agriculture: Signs of Dead Wood in Forestry and Environmental Research

The agricultural research establishment is an enterprise that commands the services of more than 10,000 scientists and spends about half a billion dollars a year. By size, and by its impact on people's daily lives, it ranks in the same league as the medical research community, yet it enjoys far less visibility. One reason may be that the agricultural community is more inward-looking than other scientific specialties. Another is that its major patron, the U.S. Department of Agriculture (USDA), keeps a tighter rein on its scientists than do universities or the National Institutes of Health.

A recent study that has brought some of the establishment's problems to public attention is the report of the National Academy of Sciences committee chaired by Glenn S. Pound. Earlier articles have presented a summary of the main report (*Science*, 5 January) and a discussion of its findings on basic research (*Science*, 27 April). This article discusses what the Pound committee has to say about forestry research and the USDA's research on certain environmental problems. The Forest Service, like the Agricultural Research Service, is an independent agency within the USDA. It's total budget recently has averaged $350 million a year, of which some $60 million is devoted to forestry research. About another $20 million is spent by state forestry schools and agricultural stations.

The quality of forestry research conducted by the Forest Service and state institutions was studied by two members of the committee, whose analyses are published as appendices to the Pound report. Paul E. Waggoner, of the Connecticut State Agricultural Experiment Station, studied research on forest pathology, and Robert L. Metcalf, of the University of Illinois, Urbana, looked at entomology research. They based their evaluations on abstract-length summaries of research projects provided from the USDA's current research information system (CRIS).

The projects were ranked in three categories: good (containing fresh and modern ideas, using modern techniques, and highly productive), indifferent (moderately well carried out and reasonably productive), and bad (totally pedestrian, outmoded, or nonproductive) (see Table 1).

A second measure of quality was the number of "messages" (defined as any kind of output, whether research publication or film) that resulted from the project. The number of messages was assumed to afford a reasonable indication of quality as well as quantity, because in three pilot surveys conducted by Waggoner among forest pathologists there appeared to be a strong correlation between the volume of a man's output and the number of times his work was cited by others.

Projects conducted by Forest Service scientists in forest pathology are rated by Waggoner as 43 percent good, 44 percent indifferent, and 12 percent bad. The projects are of generally lower quality than those conducted by the states in state forestry schools and experiment stations. Again, by the criterion of research output, the Forest Service spent 81 percent of the total dollars involved but produced only 73 percent of the messages, while the states spent 17 percent of the dollars and produced 24 percent of the messages. In-house research, Waggoner notes, is clearly "an expensive way of getting information and a difficult way to direct funds towards good research." But extramural grants do not seem to afford a better mechanism, because much of the work done on this basis is pedestrian. Waggoner says the Forest Service is to be congratulated on coping so well with the inherent difficulties of dong intellectual work in a large organization, but that "society may best be served by putting more of its eggs in other baskets."

Table 1. Quality of state and federal forest research projects.

Type of project	Good (%)	Indifferent (%)	Bad (%)	Total projects (No.)
Forest pathology	49	40	11	75
Forest entomology	25	43	32	168

In forest entomology, Metcalf has found the general standard of state and federal projects to be much lower than that of the pathology projects (Table 1). The average cost per message in forest entomology is $23,000, compared with $13,800 for forest pathology, which suggests that the average entomology researcher "is fairly pedestrian and not satisfactorily motivated, especially as compared with his counterpart in forest pathology." Unlike the situation in pathology, the Forest Service's entomology work is of higher quality than the states'. Whereas 18 percent of the states' 96 entomology projects were judged good, 38 percent indifferent, and 44 percent bad, the ratings for the 44 Forest Service projects were 43, 50, and 7 percent, respectively. This suggests to Metcalf that in-house research has now been expanded and modernized and is attracting able young investigators.

Another test of quality devised by Metcalf was to divide the entomology projects into 12 subject areas, including conventional areas such as the biology and ecology of forest pests and modern areas such as study of pheromones and integrated pest control. By this analysis, nearly half of the total effort turned out to be highly traditional research, and a substantial number of the projects were "outmoded, ultraconservative, and relatively nonproductive." In contrast, the quality of the projects in the newer fields of research was very good. Metcalf concludes that the quality of forest entomology research is clearly open to substantial improvement, but that the breadth of effort is highly commendable and the prognosis favorable.

Forest Service officials consider the Waggoner and Metcalf analyses to be neither valid nor even interesting. "I learnt nothing from them, and I'm not doing anything about them," says R. Keith Arnold, Forest Service deputy chief for research. Both Arnold and Robert L. Youngs, associate deputy chief for research, believe that the inadequacy of the CRIS system, on which the analyses were based, renders them devoid of merit. Asked about Metcalf's finding that much forest entomological research is of a conventional nature, Youngs said this had not been looked

into specifically because of the report's inadequate information base and because the Forest Service knew its program was well balanced.

The Pound committee in its main report stresses the link between poor research and failure to have projects reviewed by outside peers. The Forest Service does not have a formal peer review system. Projects are reviewed for scientific merit (as well as relevance) at the station level and by the Washington staff of the Forest Service. There is no formal requirement for peer review at the station level, but because of the close relationship with universities—some 60 percent of Forest Service scientists are located on campus—station directors often ask academic colleagues to review projects. Arnold estimates that half of all Forest Service projects are reviewed by outsiders in this way.

The review at the Washington level is undertaken by a staff of 30 people who are not active scientists but are "among the leaders in their fields." Asked if there might be a danger of the staff failing to keep up with new developments, Youngs said that, although many of them have been "away from the bench for some years," they have all maintained close contact with their field of research. According to Arnold, the review staff are "not retirement posts" and there is a rapid turnover, the average tenure being about 3 years. A principal function of the Washington review staff is said to be that of ensuring quality control. Arnold estimates, however, that "maybe 10 percent" of the projects submitted are returned for modification, and none are rejected outright.

It is the belief in the Forest Service that, apart from the Waggoner and Metcalf studies, the Pound committee's report on USDA research does not refer to them. "We have a larger proportion of our scientists on campus than does the USDA as a whole. I assumed the Pound report didn't apply directly to us," Arnold says. A check with Pound would have told him that it applies to all USDA research, the Forest Service's included.

A search for an outside perspective on the Waggoner and Metcalf studies met with a mixed response. According to J. R. Parmeter, a plant pathologist at the University of California, Berkeley, the Forest Service in the California region has developed a superb program of research. "Within the last 6 years, they have been organizing

New Energy Message Downplays R & D

There were few surprises in President Nixon's second energy message delivered to Congress on 18 April. The emphasis, as expected, was on increasing the nation's domestic supply of energy, with special reliance to be placed on new coal and oil resources for the near future. The near future is defined as up to 1985; after that, nuclear reactors are expected to play an increasing role to the point where they will supply over half the nation's electricity needs by 2000.

Most newsworthy was the President's decision to end oil import quotas, regarded by many as long overdue. (The President ignored the recommendation of one of his commissions in 1970 to end the quotas.) Nixon also recommended that the cost of natural gas become gradually deregulated to the point where consumers will pay the real costs. Consumption of natural gas has been artificially stimulated by low price ceilings, and the government wants gas-using industries to switch to coal.

A big push toward development of new oil resources is also on for the near future. To stimulate oil production Nixon has recommended that annual acreage leases on the outer continental shelf be tripled by 1979 and that oil producers be given tax credits for exploration outlays. Since the government is anxious, for political and balance-of-payment reasons, to avoid relying on foreign oil, tariff-free oil imports will be phased out over a 7-year period.

In order to allow industries and utilities to keep on using coal, Nixon has asked states to postpone implementation of secondary air-quality standards. Primary quality standards must go into effect by 1975, but 22 states have set that date as the deadline for compliance to secondary standards as well. The administration feels that, if these standards are delayed, a couple of years of research on clean coal will make it possible for coal users to adhere to new standards without a sag in production.

Environmentalists are not pleased with the general tenor of the report, which, they say, emphasizes the need to step up the nation's energy production while paying only lip service to the need for energy conservation. Nixon said we must develop a "national energy conservation ethic" but recommended only voluntary efforts such as the labeling of electric products to indicate how much electricity they use. He did point out, though, that rising energy prices—which are expected to double by 1985—will provide the most effective deterrent to waste.

The research and development section of the report contained nothing new. Highest priority is the development of low-cost clean-burning coal, and great confidence is expressed in the boons expected from the liquid metal fast breeder reactor.

In Congress, the most outspoken critic of the President's energy policy is Senator Henry M. Jackson (D–Wash.), chairman of the Senate Interior Committee, who flatly called it "inadequate." Jackson has called for a $20 billion research and development program that would make the country self-sufficient in energy by 1983. In addition to developing current sources, Jackson wants a much heavier commitment to future sources, such as nuclear fusion and solar energy. (The President's budget asks a total of $772 million for energy research in fiscal 1974.)

In keeping with heightened concern about energy, the proposed Department of Natural Resources is now the proposed Department of Energy and Natural Resources, (DENR) and a new Office of Energy Conservation is being set up in the Department of Interior. A division of energy and science is also being created within the Office of Management and Budget. John Sawhill, a Baltimore financier, has been brought in to head the new office. He points out that his office is all part of Nixon's grand governmental reorganization scheme—its functions, which cut across all the energy-related agencies in government, would parallel the responsibilities of the would-be DENR and of natural resources supersecretary Earl Butz.—C.H.

their work around problems that had been ignored for years," Parmeter says. "There are deficiencies and, as in any group, some dead wood, but by and large the Forest Service program has been very good."

A rather different opinion of Forest Service research is held by Ronald W. Stark, a forester and forest entomologist who is dean of the graduate school at the University of Idaho. Metcalf's observation of the emphasis on traditional research is likely to be absolutely true, Stark believes. "The biggest fault I would find with the Forest Service is that, historically, they have just not kept up with current trends." As an example, he cites the way in which the Service has for years used pesticides to control the bark beetle, even though this method has long been known to be largely ineffective.

The pest control arm of the Forest Service is separate from the research arm and often goes its own way. Many of the control programs are politically oriented, Stark believes, in the sense that they are carried out over the objections of Forest Service scientists in order to appease some pressure group demanding action. Spraying bark beetles is one example; another is the Forest Service's attempt (vetoed last week by the Environmental Protection Agency) to resurrect DDT for use against the tussock moth, even though their own scientists have shown that the moth populations collapse naturally after 3 years or so from the attack of a virus.

The regional administration of the Forest Service tends to dominate research policy, and scientists, far from having a viable input, are pretty much told what to do. "As a result," Stark says, "some of the creative and innovative people have been driven out." An instance of the way in which scientists are treated is that travel allowances and technical help were so much reduced last year that some researchers "literally could not work. They just sat on their butts and read scientific magazines."

But the situation is not all black. Stark thinks there have been signs of change in the last 2 to 3 years and that Arnold, the deputy chief for research, has been trying to tackle some of the problems described and to institute new ideas. He has been hampered, however, by the "rigidity of the Forest Service structure," as well as by the tight budgets of the last few years.

Queried about some of these points, Arnold said it was possible that some scientists had been left with no travel money but that he had provided extra funds to all stations pleading hardship. He agreed that the use of pesticides against bark beetles was inefficient but said this was last done 10 years ago. It was "absolutely false" that the advice of Forest Service scientists had been ignored in the case of the tussock moth. Asked why the Forest Service was even considering the use of DDT if the moths would in any case succumb to a virus, Arnold said the inevitable population collapse might be delayed for a year and that meanwhile there were representations from state agencies and chambers of commerce in places where the timber supply was under threat.

Another criticism voiced by Stark is that Forest Service scientists often have difficulty in getting new ideas across to their regional foresters, some

Environmental Research Undirected

The Pound committee panel on environmental research had one of the more difficult fields to survey, and its findings, although generally critical of research in specific subject areas, do not add up to a conclusive verdict. The panel's approach was for individual members to survey particular aspects of environmental research. The following are among the conclusions reached.

► *Effect of fertilizers on water quality*: Of some 910 fertilizer studies undertaken by federal and state researchers, only 45 dealt with the effect of fertilizers on water quality, according to C. R. Frink of the Connecticut Agricultural Experiment Station. Frink rates 38 percent of these projects as being of good quality and the rest as routine (which, he points out, is not necessarily bad). Of the $90 million spent annually by the USDA and state stations on pollution research, only the "unjustifiably low" amount of $2 million is devoted to problems of fertilizer and water quality.

► *Air pollution and plants*: The quality of USDA research on this topic has, in general, been good—better than much of that in the universities, because the problem has been more clearly defined and the workers closer to the problem. Expansion of the USDA effort is not required, because air pollutants are expected to decrease, says A. Clyde Hill of the University of Utah.

► *Insect control*: State and federal agricultural entomologists have failed to recognize the critical need for developing insect control methods that are less prone to pollute than conventional pesticides, says L. D. Newsom of Louisiana State University. Far too much effort is still being devoted to the routine testing of conventional chemicals. There continues to be a serious lack of emphasis on ecological approaches to insect control—only 2 percent of the total research effort, and only 20 scientific man-years (as of 1968–69) are being devoted to such methods. Newsom did not try to evaluate the quality of research conducted by the various agencies, because in his view the CRIS reports did not provide enough information. Citing as an example the campaigns to eradicate the fire ant with heptachlor and now mirex, Newsom observes that far too much is spent on insect control programs that are not supported by a strong research base. "Many of these projects are initiated before need for the program, probability of success, and undesirable consequences have been evaluated by necessary research."

Newsom's findings are vigorously disputed, at least as far as the Agricultural Research Service is concerned, by E. F. Knipling, former chief of the service's entomology research division. Knipling, best known for his development of the sterile male technique to combat the screwworm fly, says that, as early as 1955, some 5 years before Rachel Carson's *Silent Spring*, the entomology research division had begun to reorient its programs toward more selective forms of insect control. By 1970, the division was spending 51 percent of its resources (measured in scientific man-years) on biological and selective means of control. Fundamental entomological research accounted for 34 percent of the division's effort, and conventional insecticides for only 15 percent.

In a summary of the various surveys of environmental research, Waggoner concludes that "a great deal of trivial research" takes place both in the USDA and at state stations, and that "failure to direct work toward significant societal needs is marked."—N.W.

of whom will not deviate from their manuals. This point is indirectly corroborated in a survey published last year by the General Accounting Office (GAO), the investigatory arm of Congress. The GAO reviewed ten forestry research findings that Forest Service officials said could be used by field managers. The ten findings had been cited as achievements, some of them in support of the Service's budgetary requests to Congress. In visits to various field locations, the GAO auditors found that some managers were using some of the findings, but two findings were not being used anywhere, and none was being used universally. Some of the findings were not being used because of differences of opinion, which the Forest Service had failed to resolve, about their usefulness. In short the Forest Service was not making the best possible use of its research results. According to Arnold, steps have now been taken to resolve this issue.

The Waggoner and Metcalf studies do not afford a complete picture of federal and state forestry research, and do not take into account the recent changes Arnold has been trying to make. But the indications, as far as the Forest Service is concerned, are of an agency that has allowed its research activities to become enfeebled by in-growth and too subservient to the action arm to veto demands for control programs that are scientifically unwise. "Most of it is me-too research," says Metcalf. "It goes on because the people reviewing it are the same people who carried it out in the past." The solution, he thinks, would be some kind of outside review. To judge by the Forest Service's interest in the Pound report, that is not likely to happen soon.—NICHOLAS WADE

British Science Policy: After the "Great Debate"

London. The British, like the Americans, have been overhauling their machinery for making policy on research and development. In both countries the action has been prompted partly by disappointment with the results of heavy R & D expenditures. The practical effect of both reorganizations has been to give science policy a decidedly more utilitarian cast.

Increased pressure on basic research in both Britain and the United States has caused anxiety among scientists, particularly in the universities. In the United States, however, the relegation of the White House science advisory apparatus to the National Science Foundation was accomplished with an abruptness that induced a state of shock in the scientific community. In Britain, on the other hand, recent changes were preceded by a lively public discussion which lasted for the better part of a year.

Whether, in fact, this "great debate" significantly changed the outcome is unclear, but the British scientists came out of it still feeling that they had a foothold in the establishment and the power to influence events.

The spadework for an R & D reorganization in Britain had been done through a series of reports and well-circulated rumors. What had particularly aroused university scientists were predictions that the government would clip the wings of the semi-independent research councils* through which public funds had been channeled to support civil research. Involved was perhaps $275 million of the total of about $1.6 billion the British government spends annually on research and development. Research council funds go mostly for basic and applied research in university and government laboratories in the same categories primarily supported by the National Science Foundation and National Institutes of Health in the United States.

The key document in the debate was a Green Paper titled *Framework for Government Research and Development* issued late in 1971. (Green Papers are "for discussion only." White Papers state government policy.) The paper was unusual in that it combined two reports espousing significantly different approaches to the reorganization. The one that attracted the most attention at the time and generated most concern in the universities bore the name of Lord Rothschild, a former Cambridge don and Shell research executive who headed the Central Policy Review Staff in the cabinet office for the new Conservative government. Lord Rothschild was known to be less than enthusiastic about the research council system, and the report bore the unmistakable mark of his views and prose style. In the report he enunciated a "customer/contractor" principle for applied research, under which government departments ("customers") would decide what sort of research was needed and negotiate directly with researchers in universities and government labs ("contractors") to get it more or less on the same basis as had been done in the past with contractors in industry.

The other report, which was viewed as putting the case for the research council system, was produced by a working group from the Council for Scientific Policy (CSP), whose function was primarily to advise the government on research policy affecting the research councils. This group was headed by Sir Frederick Dainton, then chairman of the CSP at the time and one of the most influential scientific knights.

The debate began in earnest even before the Green Paper was published, in part because of government delay in making public the Dainton report, which was known to have been completed for some time. When the Green Paper did appear, it was, as one civil servant put it, "a Green Paper with a whitish tinge," since the government in a preface set the rules for the debate which was to ensue by stating that the government was committed to (i) accepting the customer/contractor principle for applied research, (ii) preserving the research councils, and (iii) seeking formation of an "authoritative body to advise on allocation of the science budget," the implication being that it would have to be a body representative of the customer departments and industry as well as of government and university researchers.

A central element in the Rothschild

* The five research councils are the Agricultural Research Council (ARC), Medical Research Council (MRC), Natural Environment Research Council (NERC), Science Research Council (SRC), and Social Science Research Council (SSRC).