cal practice. The result is, first of all, a general shortage of public hospital beds and patients relative to the rapidly expanding student enrollments (last year, in the Paris area, there were only 3.9 beds per student; 5 is considered a desirable minimum, and, second, a shortage of the sort of routine cases that a student will encounter in his medical career. Over and over again one hears such statements as "The routine ones are all in the private hospitals. All our students ever get to see are medical oddities."

The apparent solution, of course, is an expansion of the public hospital facilities and the incorporation of private hospitals into the medical training program. But these are remote possibilities, both because of the government's austerity program and because of France's traditional incapacity to carry through major institutional realignments. "Hopeless" is the word most frequently used in regard to this particular aspect of the medical school problem, as well as to others.

Basic to the problem of the flood of enrollments, Milhaud said, is the fact that "we can't accept the principle that anyone who feels like becoming a doctor can become a doctor. If we are going to give the public good doctors, we have to have a selection process. And, if we are going to reform medical training, which we are trying to do, we can't do it successfully under this huge burden of students. Reform is hampered by the numbers we have to deal with. In the United States," he pointed out, "years of planning go into a new medical school and then it starts off with a handful of students. Here, almost overnight, we have had schools start with over a thousand students."

Among the striking students and their faculty supporters, these and similar arguments are dismissed as a cover-up for impeding reform and preserving the financially privileged position of the medical profession. The vindictive treatment of Montrouge's students is cited as evidence of the "mandarins'" true attitude toward reform. The opposition to "common stem" programs that would permit medical school dropouts to go on to other university degrees is regarded as evidence of blind opposition to reform and indifference to the plight of thousands of students. And the seemingly carefully worked out figures on enrollments versus future medical "needs" are regarded as technical arguments cooked up for political purposes.

An evening spent with a group of strike leaders and followers quickly conveys the bitterness they feel toward the distant and aloof professors and government administrators who are seeking to decree their fate. "We have no confidence in what these people tell us," one of them explained. "The examination decree does not arise from health considerations. No one can say with any certainty how many doctors, nurses, researchers, and other medical people we are going to need. They have simply picked a number, and they don't care what happens to people who fall outside that number."

But what of the problem of assuring a reasonable measure of quality in medical graduates? "We are not against quality," was the answer. "But quality of graduates is also related to the quality of teaching and facilities, and we don't see very much improvement there. There is no interest shown by the schools in modern preventive medicine or in medicine related to the problems of modern society. In their selection of students and in the material they teach and in their ways of teaching, they are following the medicine of an old social system.

"The students know that something is wrong with all this. They don't understand it completely and they can't explain it. But they know it is wrong, and they will not tolerate it."

—D. S. GREENBERG

Pesticide Research: Industry, USDA Pursue Different Paths

The Nixon administration's announced ban on most DDT use, which is to be extended later to other pesticides considered dangerous, is based on the assumption that there are adequate alternatives to these pesticides.

This policy, as announced recently by Secretary of Agriculture Clifford Hardin, calls for cancellation of all uses of DDT by 31 December 1970, and later of the use of other "persistent" pesticides, except where they are needed "for prevention or control of human disease and other essential uses for which no alternative is available." Some government officials say that use of DDT in this country will be reduced by at least 90 percent (most use for disease control, especially malaria, is in foreign lands); but the solution to the pesticides problem is not that simple. DDT substitutes, many experts say, are often potentially at least as dangerous as DDT, if not more so. In many cases no really adequate alternative is available.

Since the administration is committed to the idea that pesticides are necessary (the U.S. Department of Agriculture estimates that there would be a 25 to 30 percent drop in food production without them), a truly safe pesticides policy can only develop as fast as R & D comes up with less-hazardous methods of pest control.

Both the federal government and private industry are engaged in pesticides R & D. Federal interest in pest control spans several departments, but research on new methods is centered in the Agricultural Research Service (ARS) of the U.S. Department of Agriculture (USDA). (ARS is also responsible for regulation of pesticides now in use, and in this capacity it has come under sharp criticism from the General Accounting Office and a House subcommittee for failing to prosecute a single case in 13 years.) Industrial research is performed by 40 large chemical companies. Although there is some overlap and considerable cooperation between the two sectors, government and industry are basically pursuing different research paths toward somewhat different goals.

The predominant form of pest control now in use is the chemical pesticide, a category that includes insecticides, herbicides, and fungicides. Although there are several thousands of these chemical products on the market, they are composed of fewer than 400

basic ingredients, 32 of which account for more than half the total sales. With a few exceptions, most fear of the dangers to environment and human health focuses on insecticides. These insecticides—including DDT, about which the most is known—are considered dangerous because they do not rapidly break down in the environment (persistent), are ingested and stored in animal systems (nonbiodegradable), and kill a wide variety of insects, including some beneficial to the environment (broad-spectrum). Persistence itself, often incorrectly cited as an indictment of a pesticide, is not necessarily harmful, but a safe pesticide must be biodegradable and highly specific. (Herbicides have a built-in safety factor: if they were not highly specific, they would kill the crops they are supposed to defend as well as the undesirable plants and weeds.)

Industrial Research

The 40 firms engaged in industrial research concentrate primarily on developing new chemical pesticides which are less hazardous than many of the present ones. The National Agricultural Chemicals Association, the firms' trade association, estimates that they spend over $60 million annually on this R & D. (A spokesman for the association calls this a conservative guess—since the industry is highly competitive, the firms are "tight with their statistics.") They have long given up developing new chlorinated hydrocarbons, the family that includes DDT. More than half a dozen chlorinated hydrocarbons are now on the market, and in 1964 (the last year for which USDA figures are available) they still accounted for 65 percent of all insecticide usage in the country. But given the serious questions about their environmental effects, a spokesman for the association says, "the firms would be foolish to develop any more." Instead, industry has turned to other families of organic chemicals, notably organophosphates and carbamates. As these chemicals have been developed, DDT use has declined in this country, a decline that began long before USDA announced its recent ban. While pesticide usage in general has risen sharply, DDT production declined 20 percent from 1960 to 1968, despite increases in the amount exported, primarily as an antimalaria agent.

In this search for new chemicals, industry operates almost wholly on an empirical basis. Chemical firms start by synthesizing a product and then "screening" it—testing to see if it has pesticidal properties. Probably close to 80,000 chemicals are screened this way every year. A study by Arthur D. Little Inc. published in *Chemical Week* (12 April and 26 April) indicates that only one out of 100 synthetic chemicals is carried to the next step, toxicity testing—the other 99 are found to have no usable pesticidal properties. The decision about what chemicals to synthesize is essentially a guess. The general rule, to synthesize the cousins of chemicals that have previously shown some pesticidal action, explains why most pesticides on the market fall into only a few structural categories. The one chemical in 1000 that both shows pesticidal action and passes the toxicity tests is carried through a series of evaluations and test marketings. According to the Arthur D. Little survey, only 1 out of 36,000 products synthesized reaches the market. Even then, no one knows why it works. "It is a striking fact," wrote entomologist E. H. Smith in 1966, "that knowledge of mode of action has rarely preceded the use of any insecticide." Nor does such knowledge necessarily follow use of the insecticide. Even today, Smith wrote, "we do not know precisely how DDT induces its toxic action." This pattern of industrial product research has also been criticized by ecologists, who claim that industry tests only for acute toxic effect on man and animals, without studying the broader ecological consequences of using the chemical.

High Development Costs

This empirical method of product development not only leads to narrow research paths but also costs a great deal of money. The National Agricultural Chemicals Association estimates that it costs a firm $2.5 to $6 million and takes anywhere from 6 to 96 months to develop a new pesticide for the market. The financial risk is growing as the industry now looks for more specific products, since a more specific insecticide has a smaller sales potential than does a broad spectrum killer like DDT. As a result, a spokesman for the association says, some firms may decide to scrap their pesticide chemical business. This step would be possible for pesticide manufacturers because they are generally subsidiaries of conglomerates, which can give up one manufacturing line without going out of business. In spite of the fear of rising costs on the part of some industry people, the pesticides business is in fact booming. Its sales, which reached $1.7 billion at consumer prices last year, are growing at the impressive rate of 16 percent per year, and the Arthur D. Little survey predicts that this boom will continue through 1975 at least.

Measured in terms of rate of introduction of new products or sales growth, the industrial research effort is a success. But measured by the standards of environmentalists, it is not. Not only do chlorinated hydrocarbons continue to dominate the pesticides field, but the next largest family of chemicals, the organophosphates—the family from which most substitutes must be taken in the immediate future—are widely considered to be potentially more hazardous than most chlorinated hydrocarbons. These organophosphates, including Shell's widely criticized DDVP (*o, o*-dimethyl-2,2-dichlorovinyl phosphate) No-Pest Strip, are close cousins of the original nerve gases. Newer research paths, like systemics which make the plants themselves toxic, and carbamates, seem to be safer but are only slowly increasing their share of the market.

The government's research effort is quite different in approach from industry's. According to the Federal Committee on Pest Control, a coordinating body, less than 40 percent of the $42 million spent in 1967 on research on pest control methods was spent on chemical pesticides research. In the Entomology Research Division of the ARS, which is primarily responsible for insect and insecticide research, only 16 percent of the budget is devoted to chemical insecticides. The ARS began to shift away from the chemical killers in the early 1950's, long before Rachel Carson wrote *Silent Spring*. Even then, scientists knew that DDT was stored in animal systems, although most were not yet alarmed. There were some known cases of wildlife killings by DDT, but a more important consideration at the time was that some insects were beginning to demonstrate resistance to DDT. H. C. Cox, assistant director of the ARS Entomology Research Division which conducts most federal insecticide research, says that division director E. F. Knipling "saw that chemical pesticides were not the wave of the future."

The division, and the federal effort in general, now focus more on biological control, a broad term encompassing almost all methods of pest control that do not involve chemical killers (excluding mechanical methods such as the

flyswatter). Biological control of insects may take one of many forms: introduction of a parasite or predator insect, which will reduce the population of the target insect; introduction of large numbers of sterile insects of that species to reduce the population in the next generation; introduction of disease organisms that spread a fatal disease through the target population; use of a hormone to induce sterility in the target population; use of sexual attractants to lure insects into a mechanical or chemical death trap; and development of strains of the crop that are resistant to insect damage.

Scientific interest in biological control is growing. If perfected, its proponents argue, biological control would be cheaper, have fewer, if any, environmental side effects, and be more permanent than the one-year chemical insecticide spray. However, given the difficulties so far encountered in working with biological controls, most of its proponents now argue for "integrated controls"—combinations of many methods, biological and chemical, to deal with a single problem. For example, sterile mating is most effective if the target population has first been reduced substantially by chemical means, so that the sterile males will substantially reduce the proportion of fertile matings that occur.

"Complex" Problems

The state of the art is not well advanced, despite increased federal attention to it (the entomology research division budget has tripled in the last decade while the ARS budget as a whole has not quite doubled). To date, only a handful of the thousands of agricultural pests in this country can be dealt with biologically. Cox says the lack of success is partly due to "terribly complex" scientific and technical problems—many times, he says, ARS scientists seemed on the verge of a breakthrough on one or another pest, when "something went wrong."

There is a surprising amount of trial and error in the entomology division's approach, even though it devotes one-third of its budget to pure research on insects. Cox cites the biological method of plant resistance as an example of this hit-and-miss *modus operandi*. For more than 40 years, the USDA has been working to develop strains of certain crops that will be resistant to pests, and it has had some successes with particular crops: corn has been made resistant to the European corn borer, and wheat

Food Delegates Focus on Poor

The White House Conference on Food, Nutrition, and Health, held from 2 to 4 December, was spared any major confrontation scene but provided an arena for a series of small clashes between activists and go-slowers, consumer and industry representatives.

The 2700 delegates had been invited to discuss a broad range of nutritional problems, but, by the end of the conference, attention turned to one currently controversial subject—federal programs for feeding the poor.

About 1500 of the delegates were educators, scientists, professionals in the fields of medicine and health, representatives of agriculture, food industry people, and government officials. The rest were consumers—spokesmen for various business, civic, student, religious, and community-action groups. This is the first White House conference to include such a large group of consumer advocates.

President Nixon, who keynoted the conference, outlined three general proposals for ending hunger: a guaranteed minimum income of $1600 for a family of four; unspecified reform and expansion of the food stamp program; and establishment of a Commission on Population Growth and the American Future.

The delegates pressed for broader changes, and by the end of the conference the President had promised to extend the food stamp program, within 6 months, to the 307 counties that now have no federal food programs; and to hasten the increase in allotment of food stamps, so that a family of four will get $106 per month (the present allotment can go as low as $58).

Most of the work of the conference was done in some 20 discussion panels. The panels were grouped under the general headings of nutrition of the American people; guidelines for the nutrition of vulnerable groups; nutrition teaching and education; food delivery and distribution; food as it affects the consumer; and what voluntary action groups can do to better nutrition and eliminate hunger.

Most groups began by sticking closely to their assigned topics, but left those topics later to discuss feeding the poor. In almost every group, consumers seemed anxious to exploit their growing confidence and sophistication, but industry people were seemingly anxious to quiet them.

Two panels of special scientific-technical interest concerned food safety and food quality. Their recommendations centered about two themes: that new foods and additives be marketed only after more thorough testing than is now required, and that consumers be told, in detail, what they are getting.

The two panels offered more than 30 specific, mostly technical, recommendations designed to remedy the current deficiencies in the operations of food regulatory agencies.

Most White House conferences require 18 months' preparation, but the food conference was organized in 6 months by Harvard nutritionist Jean Mayer, who also served as chairman. Conference recommendations are now being redrafted by members of the original panels. The report will be given a final shaping by Mayer and will be presented to President Nixon by Christmas. The President has pledged that he will not let the report gather dust on a shelf, and he has also suggested reconvening a followup conference in 1 year, wtih many of the same delegates, to discuss what progress has been made with the recommendations. After the conference, President Nixon met with Mayer and six delegates who had emerged as leaders during the session to discuss their ideas, but Nixon's response to them was noncommittal. In his 8 December press conference, Nixon said he would consider the food conference's recommendations, but he could not give "really sympathetic consideration to" the one recommending a $5500 minimum annual income for a family of four; this, he said, would cost $70 to $80 billion in taxes.—NANCY GRUCHOW

to the Hessian fly. Of all methods of pest control, crop resistance is the cheapest and least troublesome, when it works. Cox says scientists know that the resistance takes one of three forms: antibiosis (something in the plant's system kills the insect); tolerance (the plant is able to grow despite the presence of the insect); or nonpreference (the insect is not attracted to the plant or is repelled by it). "But we don't know why resistance works," he admits. "It's empirical; in most cases we don't know the chemistry. If we did, we might be able to make it a universal solution to crop pests. If we could just isolate the genetic factors, we could breed resistant crops without so much trial and error."

The kind of fundamental knowledge that Cox admits his agency lacks is developed for most sciences in university basic sciences departments. But university research in biological controls is meager, with one exception—the University of California at Riverside, which has a full department of about 40 people studying biological control and scoring several successes. D. A. Chant—formerly chairman at Riverside, now at the University of Toronto, and one of the leading experts in the field—told *Science* that outside of Riverside, "there are individuals here and there, but they are working in a wilderness." Chant sharply criticized the government for not devoting funds to increasing university involvement in the field. (According to the department's figures, 95 percent of the ARS research budget is for in-house research at agricultural reserach stations around the country.) He said that university research must be stepped up, first, because the universities would train badly needed new scientific personnel and, second, because Chant doesn't think the USDA is doing a good job. "To be frank, the USDA does not have top-flight people and is going about the work in a superficial way. [Despite their expenditures] I don't think they really have much of a commitment to biological control."

Whether or not Chant's view is valid, the USDA quantitatively dominates the biological control field. Unless there is a sudden upsurge of interest at universities, the burden of developing the field to the point where it can dent the virtual monopoly of chemical pesticides rests with the federal government. Industry, the only other source of significant funding, has expressed little enthusiasm for biological control. A spokesman for the Shell Chemical Company, a subsidiary of Shell Oil and one of the largest pesticide manufacturers in the country, told *Science*: "We looked for chemosterilants and other hormones for several years, but found this unrewarding and very costly. Quite frankly, no one but the federal government can afford this research."

Research costs may not be the only consideration. If biological controls reach a level of sophistication that permits them to substantially replace chemical methods, firms will have to undergo a major retooling—to begin breeding millions of sterile insects, for example—or get out of the pesticide business altogether. As a spokesman for the National Agricultural Chemicals Association commented, "There really is not much in industry in this area [biological control research]; they would research themselves right out of a market."—

JOEL R. KRAMER

Pentagon Promises To Observe Congressional Curbs on Research

Senate leaders and the Pentagon appear to have reached an understanding on enforcement of a congressional ban interpreted as being aimed primarily at ending Defense Department support of basic research in the universities.

Last Saturday Senate Majority Leader Mike Mansfield (D–Mont.) read into the *Congressional Record* his exchange of correspondence with Defense Department Deputy Secretary David Packard in which Packard assured Mansfield that the Defense Department would fund only research which has "a direct, apparent and clearly documented relationship to one or more specifically identified military functions or operations."

In his letter Packard also said the Defense Department had contacted the National Academy of Sciences and "invited them to consider carrying out a complete examination of all projects and studies which might be regarded as marginal under provisions of Section 203." [This refers to Section 203 of the military authorization bill passed by the Senate (*Science*, 14 Nov.) which prohibits use of funds for a project unless it has "a direct and apparent relationship to a specific military function."]

National Academy of Science officials said Monday that they had received no formal request from the Defense Department to perform the services Packard described. Since Packard's proposal would involve an essentially new sort of activity for the Academy, its response presumably will entail a significant policy decision.

Mansfield has been the prime mover behind the effort to curb DOD support of basic research. The latest outburst by the usually mild-mannered Mansfield occurred when Senator J. W. Fulbright (D–Ark.) received a letter on the subject from the office of John S. Foster, director of Defense Research and Engineering which included the observation "I do not expect that the implementation of these sections will entail any new type of review or selection."

After seeing the letter, Mansfield reportedly indicated he would block passage of the pending defense appropriations bill until the Pentagon provided a "clear accounting" on its research budget.

The Pentagon position in the dispute has generally been that defense spokesmen are simply reiterating a long-standing Defense Department policy and that Congress misunderstands the Pentagon definition of basic research. In a memorandum to key defense officials also published in the *Record* Packard touched on this point when he wrote, "Insufficient attention has been given to making clear to Congress the basis for deciding to support work in a particular field, and particularly the connections between relatively basic research and long-range Defense problems and missions which require such research."

Mansfield, in a statement accompanying the letters in the *Record*, adopted a somewhat more flexible position on