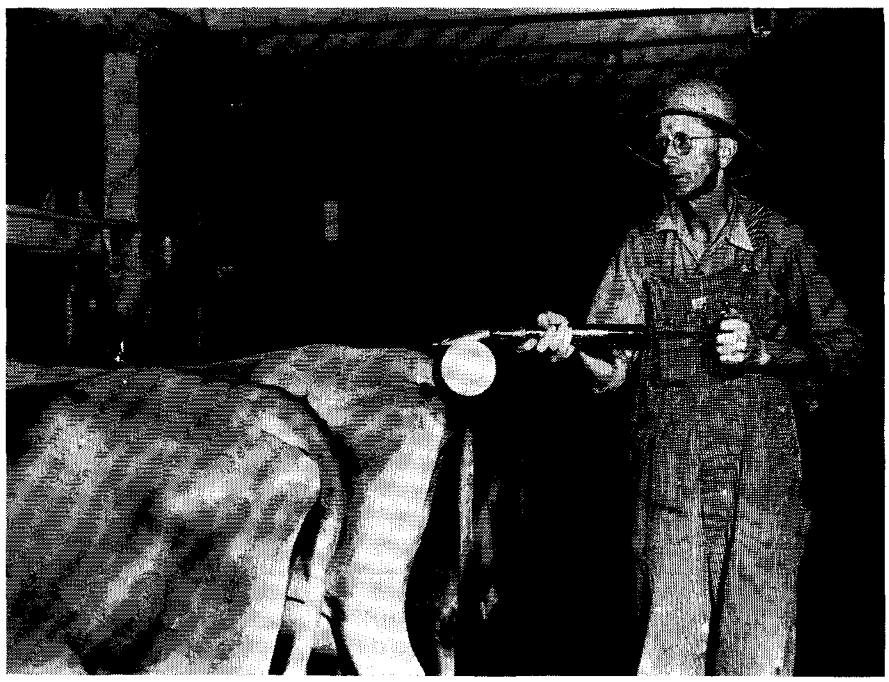
Ag and Food Interprets . . .

- Are residues in milk and meat more hazardous than in other foods?
- Soil testing becoming universally regarded as tool for farm managers
- Food additives and pesticide residues—an international problem
- Promising results piling up for food irradiation
- Primary nutrient use increased 2.1% in 1957–58

Pesticides in Milk and Meat

Symposium speakers discuss whether hazards are actual, potential, or merely imaginary



Many pesticides that would help dairymen to produce milk more efficiently are banned because of fears of possible hazards resulting from their residues in milk

TODAY, it's practically unavoidable; under some circumstances, pesticides do appear in milk and meat. This fact has stimulated increasing research on the actual, potential, or imaginary hazards involved. At the same time, says George C. Decker of the Illinois Natural History Survey, "to those individuals dedicated to a continuing campaign for the defamation and condemnation of pesticides, the appearance of pesticide residues in meat and milk represented one more ghost which, when properly dressed with misinformation, suspicion, and apprehension, could be paraded before a perplexed and skeptical public as another horrible example of the hazards involved in pesticide usage."

This observation was made by Decker (see page 681) at the symposium on pesticide residues in meat and milk during the ACS National Meeting last month in Atlantic City. The day-and-a-half symposium, featuring 22 papers, covered not only the over-all problem of pesticide residues but also specific details on residues found in individual agricultural products.

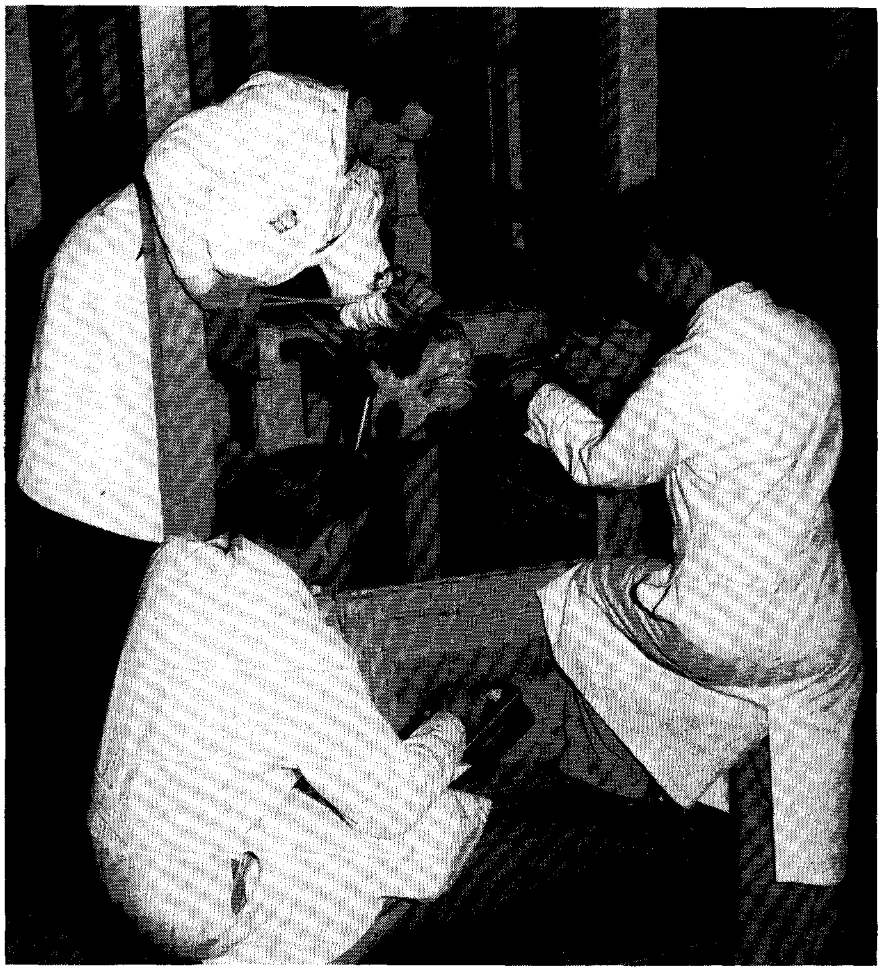
Use of pesticides is essential for the production of an adequate food supply, emphasizes symposium speaker Mitchell R. Zavon of the University of Cincinnati. Yet use of these chemicals must be guided by the need to protect the consumer of the end-product. Studies must be made to determine whether pesticides produce either acute or chronic injury or perhaps even cause harm to future generations.

In evaluating a pesticide residue, the researcher must answer at least seven fundamental questions:

1. How much pesticide residue is there in milk and meat?
2. What chemical form does the residue take?
3. How much of the residue is present after food preparation?
4. How much of the residue is ingested?
5. How much of the residue is excreted unmetabolized?
6. How much of the residue remains in the human body?
7. Actually, what is the effect of the residue in the body?

Answers to these questions are often difficult to obtain. The situation is made particularly complex by the great number of new chemicals that have been introduced into our environment in recent years, as well as by the introduction of new sources of atomic radiation.

Studies of population groups exposed to pesticides for long periods fail to show any differences in the incidence of illness or death attributable to pesticides, says Zavon. In one of the few controlled studies to date, DDT fed to a group of volunteers for a prolonged period had no detectable effect. All evidence to



Administering a radioactively tagged pesticide to test animal makes it possible to detect types and amounts of residues that remain in animal's tissues and milk

date, he says, fails to substantiate the charges that pesticide residues cause aplastic anemia, leukemia, psychoneuroses, virus-like diseases, or other ailments. Until methods of clinical evaluation become much more refined, it probably will be impossible to detect the effects of the residues now found, he declares.

Is It Natural?

Whether a chemical is natural or synthetic has absolutely no bearing on whether it is toxicologically safe, says John P. Frawley of Hercules Powder. Actually, many natural products are quite unsafe for human consumption. Only after centuries of trial and error has man learned to cultivate the products that are edible and avoid those that are acutely toxic. Obviously, safety cannot be judged solely from the source of the chemical.

The toxicologist has at least two ways to determine the safety of chemicals in foods. The first of these is based on trial and error or a long history of satisfactory usage. Better than 99% of our food is assumed to be safe because of long-term use rather than because of laboratory proof, says Frawley.

A good example is cow's milk. The safety of the casein, lactalbumin, and other components of milk is widely taken for granted. Man has consumed these for centuries and has maintained a satisfactory state of health—assuming that the degree of health and longevity associated with man's traditional diet is "satisfactory." Accepting normal cow's milk as safe means assuming not only the casein and lactalbumin are safe but also some of the less commonly recognized ingredients of cow's milk, such as dilactotetraose, pyridoxamine, hexadecanoic acid, fluorine, and arsenic. But are these assumptions valid?

Another way to evaluate the safety of chemicals in foods is to determine the safe dose for various species of laboratory animals. To the scientist, this is by far the better approach because he gets positive results that he can measure. He determines the relationship between dosage and effect and can more intelligently evaluate the potential risks involved in the use of a specific component in the diet. Using a margin of safety, he then arbitrarily sets a predicted safe level for man—one well below the established safe level for the laboratory animal.

Despite considerable scientific evidence that many chemicals at specified concentrations are entirely safe, they still are banned from certain foods, particularly milk. As Frawley points out: "Sufficient information is now available on a number of chemicals, especially pesticides, to permit scientists, by conservative application of the fundamental principles of pharmacology, biochemistry, and toxicology, to make positive recommendations for tolerances in milk which are safe beyond any reasonable doubt and perhaps even safer than some of the natural constituents of milk."

This view is echoed by George Decker, who says: "But while all seem to agree milk should receive special consideration, there seems to be no valid scientific or moral reason why it should be set apart as something to be worshipped like the sacred cow of India if the establishment of safe tolerances falls within the realm of possibility. There are many competent scientists who feel that this can and should be done."

Finding Out How Much

Analysis of pesticide residues in milk and meat offers a real challenge to chemists, says symposium speaker W. E. Westlake of USDA. In many cases, analytical methods available today need considerable improvement.

Particularly needed are better methods that will detect and identify not only the original pesticide but any of its derivatives present in milk and meat. And the methods must be able to determine very small amounts to check the requirement that there be no residue in milk, and exceedingly small amounts in meat. Now in use are procedures sensitive to 0.1 p.p.m. and, in a few cases, to 0.01 p.p.m.

Significant strides have been made in the recent past. The infrared spectrophotometer, for example, is being modified to make it a more versatile analytical tool. Research is going ahead on the use of high-temperature gas chromatography in determining pesticide residues. This method makes it possible to separate and identify the pesticides present, as well as any stable metabolites and derivatives. Emphasis now is being placed on developing more efficient columns and more sensitive detectors.

Fluorometric methods are attracting more and more interest, particularly since the advent of relatively inexpensive fluorometers. Increased use is also being made of the coulometric titrimeter for determining chloride. It is especially useful in connection with combustion techniques for determining organic chlorine.

Use of radioactively tagged pesticides (with paper chromatography to identify the compounds detected) has contributed much toward understanding the metabolism and decomposition of pesticides. In pesticide residue analysis today, the big trend is toward greater use of instrumentation, stemming largely from the development of new and better instruments, says Westlake.

Soil Testing

More farmers are beginning to see the usefulness of soil testing. Before long, the soil test will be universally regarded as a necessary tool of farm management

SOIL TESTING can be used for many purposes—ranging from a psychological tool that helps to sell fertilizer, to a guide in evaluating soil productivity. But whatever their use, there is no doubt soil tests are becoming more and more popular with farmers. Between 1955 and 1957, for example, the number of soil samples tested by state and county laboratories jumped by nearly half a million. And in the period 1950 to 1954, total samples tested in the U. S. rose 50%.

This evidence of soil testing's importance was cited by James R. Miller of the University of Maryland at the September meeting of the American Chemical Society in Atlantic City, where the Division of Fertilizer and Soil Chemistry spent a whole day discussing various ramifications of soil testing.

M. S. Anderson of the Agricultural Research Service, USDA, kicked off the symposium by tracing the history and development of soil testing. He also took a look at the present and future, saw progress: Use of modern instrumentation in testing is under way, mainly with the flame photometer and spectrograph. This trend will grow, he thinks. And studies of minor trace elements have been expanded by instruments and deserve further attention, he adds.

What's ahead in soil testing? A trio of scientists from the American Potash Institute did some serious mind searching, concluded: The farmer who lives strictly on farm income will be forced to practice soil testing to stay in business. And the fertilizer industry will be a leader in promoting tests, R. D. Munson of API told the division.

The industry, itself, will probably increasingly give soil testing aid to the farmer, performing many services alongside the agricultural extension service, say Munson and coworkers Werner L. Nelson and J. Fielding Reed.

And they think demand for soil testing and other services may reach the stage where it will be necessary for a group of farmers in a single region to employ a specialist to handle the work. Or it might be feasible for one farmer to hire a full-time specialist as farming turns further to science. More commercial labs are also in the cards to meet the challenge of soil testing growth, Munson feels.

Certainly, large well-equipped labs are prepared to do a top-notch job in soil testing. Standard Oil's L. L. Schrader made this point at Atlantic City. As an example, Schrader cites Schrock Bros. Co., which set up a consolidated lab for soil testing in Congerville, Ill. It serves the Midwest Corn Belt, has operated for one year. In that time it has tested about 20,000 samples, each having been handled as prescribed by the state from which the soil came.

Facilities installed at the lab include a Spectronic 20 used for interpretation, a custom-built pH meter, a distillation apparatus for determining available nitrogen, a soil grinding and screening unit, and automatic pipet equipment for metering reagents. These facilities make it possible to determine exchange capacity, organic matter, pH, calcium, magnesium, hydrogen, nitrogen, phosphorus, and potassium, and to interpret the test results.

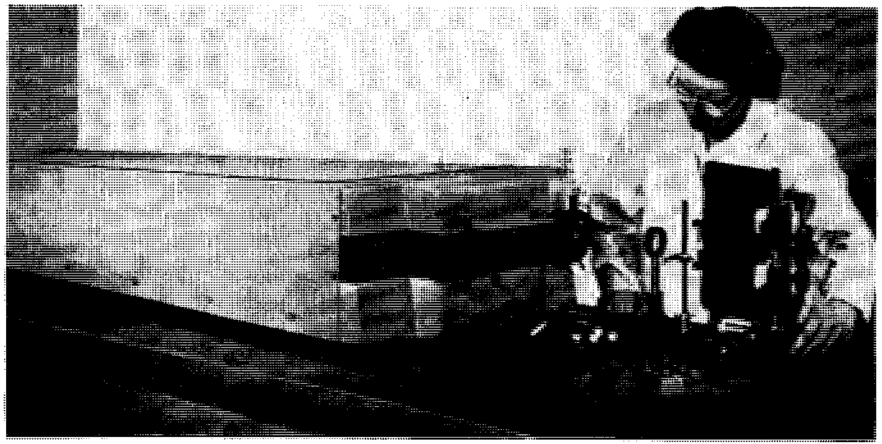
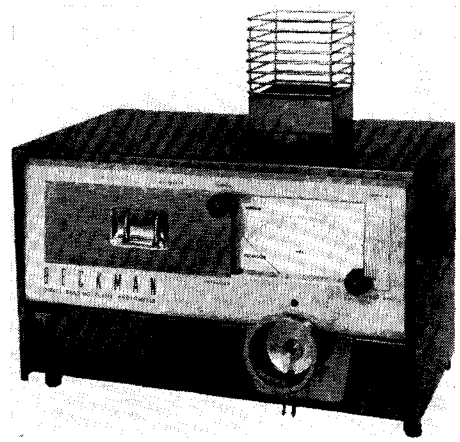
As a result of this service, Schrader says, yields per acre have increased, crop quality has improved, and fertilizer dealers are selling much more material.

Other things to look for in the next 10 years or so, according to Munson:

- Soil sampling every three to five years on each farm.
- Effort by soil testers to give advance recommendations for three to four crops in rotation.
- Possible trend to fewer cores per composite sample, but more samples.

Turning to the more technical as-

Soil testing laboratory at Seabrook Farms inventories available plant food in each field and does research on farm practices. It handles 20,000 samples a year

The spectrograph (left) and the flame photometer (right) have modernized soil testing procedures

pects of testing, Maryland's Dr. Miller reported to the symposium on current research in that state. Among the proposals based on his work: For investigating soil treated with rock phosphate or superphosphate, 0.03N H_2SO_4 and 0.03N NH_4F extract the most phosphorus, show the best relationship with crop response.

Extensive research by Eugene Kamprath and J. W. Fitts at North Carolina State College has centered on interpreting soil tests. Kamprath calls for basic research into soil properties. Since soil fertility is an important factor in crop yields, he states, much data must be acquired on responses to fertilization—how to build fertility and keep it.

Whether in symposium technical sessions or in corridors of Boardwalk hotels, those who participated in the symposium got around to the subject of soil test recommendations and the need for farmers to follow them. C. J. Jones, a North Carolina farmer, recently had something to say on this point.

Mr. Jones had taken tobacco soil samples for years, but had not followed recommendations closely. Result: about 2000 pounds of mediocre tobacco per acre. But this year he applied fertilizer amounts more in line with his county agent's advice. As a result, he is "curing some of the best tobacco I've ever grown. . . the quality of my crop is up 50%."

Adds farmer Jones, "It'll net me more money than any crop I have ever grown. And I know I have neighbors who could increase their income the same way, if they would use soil test recommendations."

This kind of testimonial gives strong evidence that research in soil testing, such as that described at Atlantic City, is of immense potential benefit to the practicing farmer.

Additives Abroad

Control of additives and pesticide residues in foods is an international problem

Many chemical companies are in the food additives business and are affected by foreign food laws without being aware of it, according to L. W. Hazleton of Hazleton Laboratories. For example, an American chemical company might sell a chemical for export to South Africa, where it is used in a preparation for treating tissue paper for wrapping fruit. The fruit is exported to a European country. Officials there may prohibit the use of the particular chemical in food, and refuse to pass through customs any fruit exposed to it, although there is no prohibition against the chemical in the United States. So eventually the chemical company loses some of its export sales.

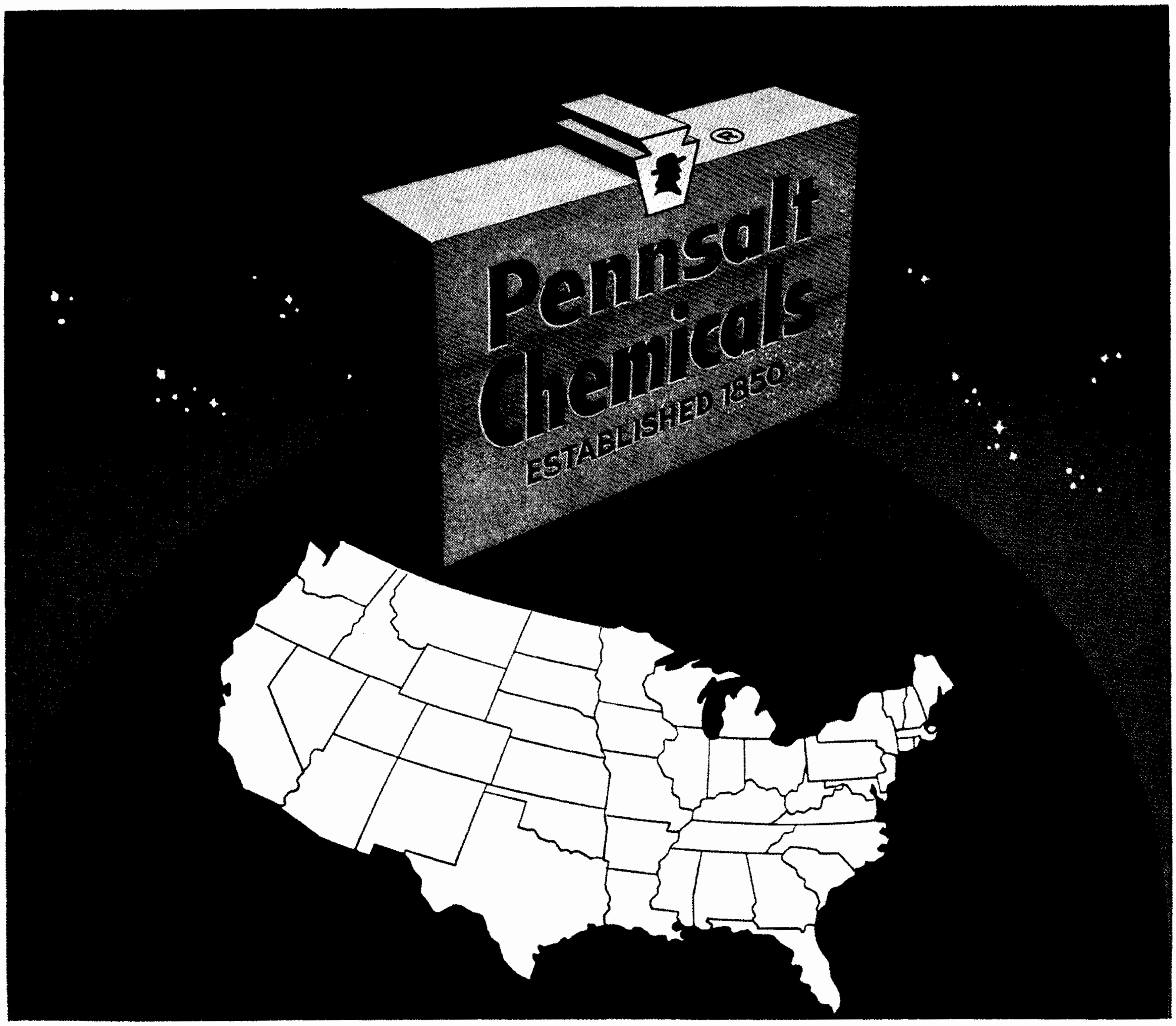
Americans should change their attitude regarding foreign food laws, Hazleton feels. Instead of saying to officials in Germany—where food laws are being revised—"If it is good enough for the United States it is good enough for Germany," Hazleton considers it more logical to recognize that Germans have different dietary and social customs from those of Americans, to explain just why the American regulations are what they are, and to try to find out the reasons behind the German regulations.

The big problem is to secure passage in various countries of food laws which agree one with another, at least to the extent that international trade will not be hindered. The objective of food laws should be to allow safe and beneficial use of food chemicals, not to exclude their use. Food laws should definitely not be written so that they could be perverted to other purposes—such as excluding imports of some foods by unreasonable requirements concerning additives, when the real object is to prevent imports for economic reasons. Tariffs and quotas should be used for this type of control.

Ideally, the World Health Organization should sponsor a universal food law. But this is a long way off. In the meantime the main problem is to exchange enough information that food chemists in different countries can keep well up to date on analytical approaches, and can understand the attitudes of food chemists in other countries. Maintaining such an exchange was the purpose of a symposium on food additives and pesticide residues in foods held at the recent Munich meeting of the International Union of Pure and Applied Chemistry, where Hazleton gave one of the special lectures.

Hazleton told the group that safety evaluation of chemicals in a biological environment is an applied science in its own right, and cannot be practiced without firsthand knowledge and experience. It should not be confused with utility, consumer preferences, national dietary habits, economics, or other aspects of the problem which are also involved in regulation by individual countries. Modern safety evaluation can be truly international, Hazleton points out, if detailed facts are available.

In Canada the philosophy of control of pesticide residues in foodstuffs is basically the same as it is in the U. S., although there are some minor differences in the laws. In both countries health authorities bear the



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entire legal responsibility for establishing residue tolerances. But this unilateral approach can mean problems for agricultural agencies, according to H. Hurtig of the Canadian Department of Agriculture.

Pesticide chemicals are often the only means of obtaining the required protection for crops during critical periods of attack by insects or other pests. In North America, where there are huge food surpluses, there is strong sentiment for erring on the side of safety in setting tolerances. However, after a tolerance for a new chemical has been set and enforced for a certain time, Hurtig feels, investigations should be made to reconcile agriculture's need with the real need to regulate the level of the chemical residues.

Chemists, engineers, and biologists can collaborate in research to enable smaller amounts of pesticides to perform more effectively, with predicted persistence and selective toxicity. In this way research effort can be apportioned very effectively, with less waste of research talent on problems of the moment. Arbitrary regulations can place a serious drain on available research personnel, and limit more constructive work, says Hurtig.

The types and quantities of pesticides and food additives used in different countries vary in direct relationship with the degree of mass production and distribution of food, according to B. L. Oser of Food and Drug Research Laboratories. Hence, food regulations must be adapted to local conditions, and therefore will be different in different countries.

The new laws in the United States requiring prior toxicological testing and approval of pesticides and food additives are enforced and assure safety of food produced domestically. However, enforcement is difficult with imported foods—one more international problem for food chemists.

Food Irradiation

Its use is still in the future, but promising results are piling up

MILLIONS OF DOLLARS and a decade of intense research have gone into developing food irradiation as a processing technique. Today, answers to some of the big problems are slowly coming in. However, food irradiation is still plagued by unresolved questions in the areas of public acceptance, wholesomeness, and economics.

Researchers are optimistic, but are proceeding with caution, since irradiated foods must be acceptable to the consumer in taste, odor, appearance, and texture when they are first placed on market shelves. The big push now is on resolving the basic mechanisms of radiation reactions, with an eye toward blocking those that cause flavor and texture damage.

The performance picture is mixed. Radiation doses vary from around 7000 rads for low levels, through the range of 50,000 rads to 1 megarad for pasteurizing, and on up to 3 to 5 megarads for sterilizing. Pasteurizing shows the most immediate promise. Shelf life of chicken, for instance, can be extended some 21 days by pasteurizing doses of radiation. Such doses can also prevent the sprouting of potatoes and delay the molding of strawberries.

Fish and certain other types of seafood will most likely be the first irradiated products commercialized. Irradiation does not affect texture, color, flavor, or odor of many fish items, according to tests.

Milk performs badly, and shell eggs are just about out as an item for irradiation, since whites become water thin. Frozen eggs show some promise, however, even though there is a noticeable, mild effect on flavor and baking properties.

Beef Draws Interest

Most research today is going into meat, and of this effort, beef gets the biggest share. It is the most important item from both the military and the civilian standpoint. It is also the worst performer.

Meats other than beef have not fared too badly under irradiation. Pork, for instance, is almost unaffected. Chicken likewise develops very little off-flavor. Lamb and veal fall between pork and beef, but their market volume is not too significant.

Off-flavor in beef has been traced to the formation of carbonyls, free amino acids, and volatiles, such as methyl mercaptan, and hydrogen sulfide. Certain techniques, such as removal of oxygen from the irradiation atmosphere, the use of free radical acceptors, and freezing the meat before irradiation help some by limiting the influence of free radicals. However, some off-flavor is still present, and other techniques are needed.

It now appears, for instance, that blanching—heat treating the meat at 140° to 160° F.—will always have to be combined with irradiation. The reason: proteolytic enzymes. These enzymes cause meat proteins to hydrolyze, giving amino acids. It takes two to three times the bacteria-killing irradiation dose to inactivate the enzymes, and this is impractical. Thus irradiation will be used to kill bacteria, blanching to inactivate the enzymes. The meat becomes cooked to some extent with blanching. However it is much better than canned meat, processed at around 250° F. for extended periods.

Current work on basic reaction mechanisms in irradiated beef falls into two areas, and some significant results are being obtained. One area is the use of additives. Researchers find that using a tomato preparation results in little off-flavor in the meat after irradiation.

Flavor damage seems to come from changes in the proteins. Vitamins A and E, among other tomato constituents, appear to play a big part in preventing off-flavor. They most likely react with protein to form complexes, which have higher energies of dissociation. Heat, along with the additive, is also needed during irradiation. It seems to "unfold" the proteins so that the added material can react. Researchers have also used a synthetic mixture of tomato constituents which has given a beef product with little if any off-flavor.

Using a fractionating technique, other researchers are trying to pin down the fractions of meat that contribute to off-flavor, and to determine the mechanisms involved. Results to date show that off-flavor is pretty much limited to two fractions. One contains small-chain peptides, amino acids, sugars, and any salts present; the other contains mostly connective tissue.

Wholesomeness Tests

Licking the off-flavor problem is only part of the struggle. The foods must meet Food and Drug Administration requirements for wholesomeness. A huge, multimillion-dollar program to get proof that such foods are not harmful is now being sponsored by the U. S. Army Quartermaster Corps along with the Office of the Surgeon General and FDA.

This program includes an animal feeding test program: four-generation feeding studies using two species—rats and either dogs, monkeys, or chickens. Twenty-one foods or combinations of foods irradiated with 2.8 or 5.6 megarads are being fed to the animals after the foods have been stored at room temperature for six to nine months. So far, no ill effects on growth, reproduction, longevity, and the like can be traced to irradiated foods, according to researchers.

But induced radiation is still a big question. It can be calculated, but it is difficult if not impossible to detect with existing equipment. Thus, no one has yet determined the significance of the calculated amounts.

This is a real problem, though, since FDA may decide that any induced radiation violates the Delaney clause in the new food additives law. This clause prohibits use of any carcinogenic additives—and radiation is carcinogenic.

Economics Still Not Known

The third area still holding unresolved questions is that of economics. Theoretical and laboratory cost estimates form the only basis for economic evaluation right now. But the U. S. Army ionizing radiation center "pilot plant" being built at Stockton, Calif., should come up with some cost figures that will clarify the picture.

Whether or not cost will be the determining economic factor is a subject of debate in food irradiation circles. Some feel that costs must be competitive if the process is to be economically acceptable. But at the same time, others feel that irradiated food products will be successful regardless of added costs, as long as they are acceptable to the consumer and offer him benefits.

The over-all food irradiation picture contains many unanswered questions. But partial answers are piling up. No one doubts that food irradiation will some day be put to practical use. Likewise, no one is predicting when.

Facts from the Scholl Report for 1957–58

Total fertilizer tonnage—down 0.9%

Total tonnage of primary plant nutrients—up 2.1%

Mixtures consumption—down 2.4%

Top-selling mixture—5-10-10

National weighted average of primary nutrients in mixtures—5.96% N, 12.53% available P_2O_5, 11.73% K_2O

Tonnage of direct application materials—up 2%

Total nitrogen in fertilizers—up 7%

Total available P_2O_5 in fertilizers—down 0.5%

Total K_2O in fertilizers—down 0.1%

Fertilizer Use 1957–1958

Fertilizer industry managed to increase use of primary plant nutrients by 2.1% despite an unfavorable season

FERTILIZER CONSUMPTION slipped slightly in 1957–58, by 0.9%. But on a primary plant nutrient basis, consumption actually achieved a new high—6,512,387 tons, an increase of 2.1% over the previous year's total. This record was accomplished in a year of generally unfavorable conditions—bad weather, tight money, and the Soil Bank. Furthermore, it was accomplished despite a set-back in consumption in the South, the fertilizer industry's old stand-by and stronghold. Midwestern and western states increased their consumption sufficiently to offset southern lethargy.

By other standards, 1957–58 was not an unusual year for the industry. Trends that had been apparent for several years were operating again—especially the trend to higher analysis materials and the popularity of the newer fertilizers such as anhydrous and aqua ammonia, nitrogen solutions, and ammonium phosphates. And for the fifth year in a row, the quantity of mixtures decreased.

Shipments of fertilizer in 1957–58 added up to the grand total of 22,515,763 tons—21,576,035 tons of it in products containing one or more of the primary plant nutrients, and 939,728 tons of materials containing secondary and trace nutrient elements.

Mixtures consumption for the 1958 year amounted to 14,353,023 tons, a decrease of 2.4% (349,784 tons) from the previous year's total. Mixtures use increased in most of the states of New England, West North Central, Mountain, and Pacific regions, but in other areas, mixtures use fell off.

The 15 best-selling mixtures accounted for 61.3% of total mixtures sold. As in the year before, 5-10-10 led the list. A newcomer to the list was 5-10-15, which replaced 3-9-6 at the bottom of the list. Relative order of the other top 15 grades remained the same, with two exceptions: 5-20-20 moved up a notch ahead of 3-12-12 to become third, and 4-10-7 moved ahead of 2-12-12 to become 11th.

National weighted average of primary nutrients contained in mixtures was 5.96% N, 12.53% available P_2O_5, and 11.73% K_2O—for a total of 30.22%. Corresponding values in the 1957 year were 5.74%, 12.36%, 11.43%, and 29.53%.

Four nutrient ratios (1-2-2, 1-4-4, 1-1-1, and 1-3-3, in that order) accounted for 55% of the mixtures sold. Each of those ratios accounted for at least 10% of the market, whereas the next big-selling ratio—1-2-1—accounted for only 5.7% of the market.

Materials for Direct Application

Total use of materials for direct application, including the secondary and trace nutrient products, amounted to 8,162,740 tons—36.3% of all fertilizers used, compared with 35.3% for the preceding year. Total tonnage was 2% above that for 1956–57.

Chemical nitrogen materials and the natural organics showed gains of 4.8% and 2.6% over the previous year's totals, but phosphate and potash materials both declined.

Among the nitrogen fertilizers, nitrogen solutions made the best per-[illegible] gain—up 32% for a total of 324,536 tons. Anhydrous ammonia also gained—by 29% for a total of 583,434 tons. Ammonium sulfate was up 12% to a total of 577,111 tons. Ammonium nitrate climbed 1% to a total of 1,116,908 tons. On the down side were aqua ammonia, urea, ammonium nitrate–limestone mixtures, and sodium nitrate.

In some areas, increased use of anhydrous ammonia, aqua ammonia, and nitrogen solutions bordered on the phenomenal (see table on page 672). For instance, the East North Central region used 65.4% and the West North Central region 43.5% more anhydrous in 1957–58 than in 1956–57.

Tonnage of Anhydrous and Aqua Ammonia, and Nitrogen Solutions by Regions

	ANHYDROUS AMMONIA		AQUA AMMONIA		NITROGEN SOLUTIONS	
New England						
1957–58	0		0		904	
1956–57	0		0		224	
Middle Atlantic						
1957–58	2,485	up 18%	0		3,692	up 25%
1956–57	2,100		0		2,955	
South Atlantic						
1957–58	25,175	up 15%	846		83,748	up 10%
1956–57	21,820		0		75,941	
East North Central						
1957–58	57,151	65% gain	2,261		59,373	rise of 55%
1956–57	34,542		2,288		38,147	
West North Central						
1957–58	139,082	rise of 43.5%	9,401	increased 230%	82,673	up 64%
1956–57	96,924		2,854		50,374	
East South Central						
1957–58	51,832	down 10%	46		9,420	up 6%
1956–57	57,450		258		8,854	
West South Central						
1957–58	139,927	up 32%	7,844	tremendous gain of 386%	22,686	rise of 28%
1956–57	105,836		1,614		17,688	
Mountain						
1957–58	42,754	up 30%	26,937	rise of 59%	5,668	
1956–57	32,786		16,904		5,879	
Pacific						
1957–58	124,256	gain of 23%	289,640	up 1%	56,382	up 25%
1956–57	100,340		285,503		45,816	
Hawaii and Puerto Rico						
1957–58	772		28,087	labor troubles on sugar plantations in Hawaii.	0	
1956–57	904		72,011		0	
Total U. S.						
1957–58	583,434	up 28.9%	365,062	down 4% but 9% gain on Continental U.S.	324,546	gain of 32%
1956–57	452,702		381,432		245,878	

In marked contrast to the nitrogen materials were phosphate and potash materials. Until this year, direct application potash materials had been steadily increasing, but this year brought a decrease on both a tonnage and a primary plant nutrient basis. For the phosphate materials there was again a decrease on a total tonnage basis, but an increase of nearly 7000 tons on a primary plant nutrient basis.

Among the phosphate materials it was the newer, higher analysis materials that showed the increases. Ammonium phosphate (11-48-0) was up 30%; ammonium phosphate sulfate (16-20-0) showed a 13% increase; ammonium phosphate nitrate (27-14-0) was up 60%; and the grades of superphosphate over 22% showed a slight, 0.1% increase.

The dip in total use of direct-application potash materials in 1957–58 was the first in many years. The decline amounted to 12,361 tons (2.7%). On a primary plant nutrient basis, it was 4,474 tons. Use of 50 to 62% grades of potash materials, which comprised over 81% of total consumption of direct application potash, decreased by 11,379 tons (3%). The only potash materials to show increases were potassium–magnesium sulfate (up 28%), potassium–sodium nitrate (up 58%), and potassium sulfate (up 2%).

Primary Plant Nutrients

The fertilizers used in 1957–58 contained a total of 6,512,387 tons of nitrogen, available P_2O_5, and K_2O. That total was 2.1% ahead of the 6,377,202 tons consumed in 1956–57. Making up the total were 2,284,359 tons of nitrogen (a gain of 7% over the previous year), 2,292,890 tons of available P_2O_5 (a decline of 0.5%), and 1,935,138 tons of K_2O (a decline of 0.1%).

Regional Shifts

The South Atlantic region still consumes more fertilizer tonnage than any other region of the U. S., but top rank on the primary plant nutrient basis continues to be held by the East North Central area. In 1957–58, the South Atlantic consumed 5,668,527 tons, 4% less than the year before, but only 1% less on a primary plant nutrient basis. The East North Central increased its use of fertilizer in the 1958 year by 3% to 4,677,995 tons—representing 5% more on a primary plant nutrient basis than in the 1957 year.

The table at the top of this page gives results for all regions.

	Total Tons Fertilizer	Change from 1956–57	Change in Primary Plant Nutrients from 1956–57
New England	437,717	+1%	+3%
Middle Atlantic	1,931,781	−1%	0
South Atlantic	5,668,527	−4%	−1%
East North Central	4,677,995	+3%	+5%
West North Central	2,312,096	+6%	+8%
East South Central	2,624,855	−9%	−8%
West South Central	1,341,419	+2%	+4%
Mountain	551,050	+17%	+20%
Pacific	2,613,445	+6%	+11%