Ag and Food Interprets . . .

- **Pesticide industry goes out of its way to make plants safe**
- **In sublethal amounts, some herbicide compounds improve growth**
- **Chemical industry digs deep into basic nutrition research**
- **Chemicals improve quality, appearance of everyday foods**
- **Speed, new equipment improve aerial applicators' business**

Safety in Pesticide Plants

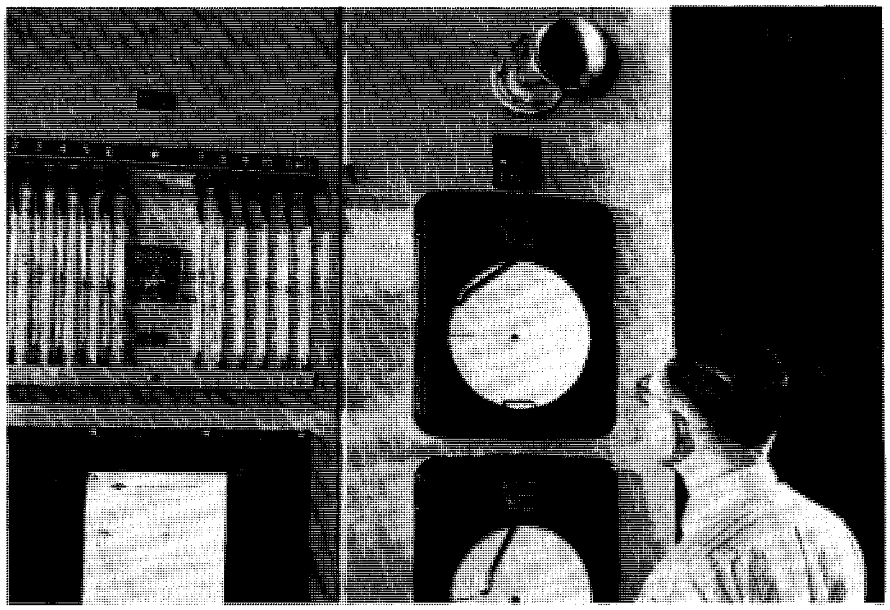
Pesticides are inherently dangerous, but the industry can be proud of its safety record. Here's why

PESTICIDES present many hazards. Most of the hazards rightly affect the pests upon which pesticides are used. But if not handled correctly, pesticides can be hazardous to humans, too, especially during their manufacture. Much credit is due the pesticide industry's safety men, hygienists, and toxicologists, who have turned a hazardous job into a relatively safe one.

When American Cyanamid set out a few years ago to make parathion, the company called in many experts to engineer safety to the "nth" degree. One judgement of its success came from the workers themselves. Men from other parts of the plant soon began to line up for transfer to the parathion department because of its excellent working conditions.

Safety in manufacturing pesticides has not always been what it is today. Back around 1900 when William Piver developed calcium arsenate, one of his main safety problems was keeping himself safe from his landlady, who wanted no poisonous or explosive chemicals in her house. Piver got around this by hiding his experimental apparatus under the bed.

Today the industry has no need to hide under the bed where safety is concerned. A case in point—Monsanto. A year ago an explosion destroyed Monsanto's parathion plant at Nitro, W. Va. The company shared knowledge gained from its experience with the entire industry, so that others might avoid a similar tragic mishap. And when Monsanto put its new parathion and methyl parathion plant on stream this January, it gave out full details on the many safety features built into the unit.

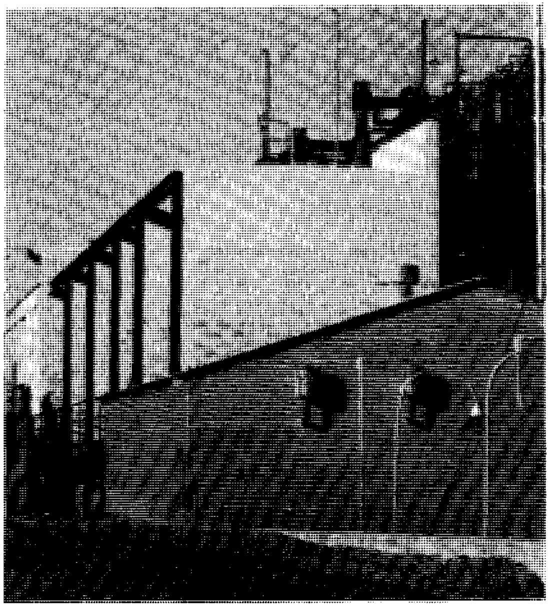


Safety is a byword in pesticide manufacturing. For instance, Dow uses this equipment to make a continuous check on the air in its methyl bromide plant. If air at any of 12 locations in the manufacturing area approaches a toxic concentration, alarms sound and lights flash

In designing the new plant, Monsanto took pains to install extra safety factors in spots where trouble might crop up. Dual sets of control instruments at critical points in the process guard against instrument failure, believed to have been the cause of the Nitro blast. Operators work behind 12-inch, steel-reinforced concrete walls, and can instantly dump by remote control the contents of any kettle, should a reaction get out of hand. Pneumatic instruments are backstopped by electronic controls that would operate in the event of a power failure. And a secondary Diesel power system takes over if air pressure drops too low.

Air Check

Dow is another company that has gone out of its way to make operations safer. Dow makes the fumigant methyl bromide, which is not only highly toxic, but is also a colorless, odorless gas. Thus, it is vital to keep a close check on methyl bromide in the plant's atmosphere. To do this, Dow installed a completely automatic air monitoring system with 18 sampling points to provide an accurate, continuous record of methyl bromide concentration. Dow went out of its way in setting up a tough standard to meet: methyl bromide concentration is kept essentially zero at all times even though the allowable limit is 20 p.p.m.



Isolation compartments (left) for reactors are part of built-in safety at Monsanto's new parathion plant in Alabama

Large and small pesticide manufacturers and formulators alike employ organized safety programs. Generally, the larger the company, the more formal is the set-up. For instance, at Calspray the safety manager reports directly to the president. He has his own staff to handle general safety matters, while specific plant safety problems are delegated to the plant manager. The plant manager heads up the safety committee composed of workers, foremen, and upper management.

Dow's Midland Division has 11 safety engineers on its safety staff. It supplies each production manager with a safety engineer who acts as a staff assistant. Dow prefers to play down the authority of safety men, finds it gets better results if safety suggestions come from the production manager. Dow points out that pesticide safety is a three way effort with the medical department, biochemical research lab, and safety department working as a team to advise the production people.

Smaller firms, particularly small formulators, may not even have safety departments as such. Nonetheless, safety is emphasized at every turn. Usually the job of coordinating safety activities falls to the plant manager.

The pesticide industry shares many safety problems with the chemical industry of which it is a part. The hazards of handling acids, alkalies, or highly reactive or explosive materials, as well as the more common safety problems like promoting good housekeeping around the plant, are not unique to making pesticides. But one feature is more common: toxicity.

The Hygienists

The toxicity aspect of pesticide manufacture has helped to foster a relatively new profession: industrial hygiene. Concerned with health in general rather than the specifics of plant safety, hygienists play a prominent role in the safe operation of pesticide plants.

Lloyd W. Hazleton of Hazleton Laboratories points out that one of the main reasons why the pesticide industry has such a good safety record is because of the industry's awareness of potential toxicity. Too often in other lines of work hazards are recognized only after an accident actually occurs.

But pesticide makers are experts at anticipation. As soon as a potential pesticide emerges from the chemist's test tube the toxicologist goes to work —or more likely a group of toxicologists, since several disciplines are involved: pharmacology, biochemistry, pathology, and others. These men evaluate the effects of the toxic material on pests, on the people who might eventually use it, and on the production men who will make it. Laboratory data give background for the hygiene needed in the pilot plant. Features like proper ventilation, hoods to remove vapors and dusts, protective clothing, sampling techniques, and worker safety education are emphasized. And then pilot plant experience is applied to design and operation of the full-sized plant.

And basic producers are eager to extend help to formulators. By way of proper labeling, convenient packages, and safety handbooks, the producers solve many safety problems for their customers. If needed, a technical service man is usually available to make visits to discuss specific safety matters. American Cyanamid, to cite just one example, says its industrial hygienists have made over 150 visits to formulators and dust mixers to advise and guide them in preventing illness or accidents to workers.

Harold Hoyle, hygienist at Dow, does a neat job of summing up. According to Hoyle, safety is a matter of getting the right information, at the right time, to the right people. Doing this makes pesticide manufacture a relatively safe operation. The industry probably can never eliminate *all* accidents, but because of the emphasis it places on safety it is far safer than many occupations that most people would consider nonhazardous.

Herbicides and Plant Growth

In some cases herbicides applied in sublethal amounts enhance plants' growth, improve properties

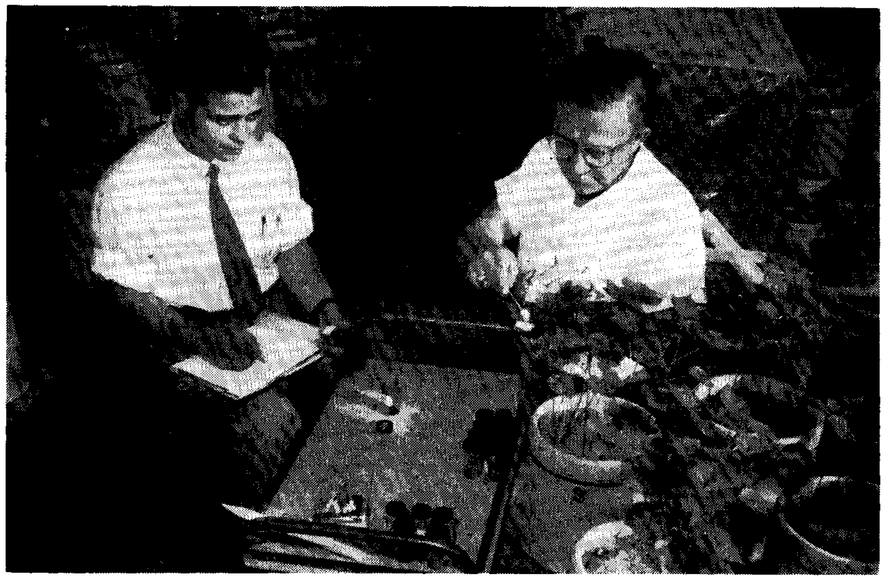
EARLY EVIDENCE that herbicides can improve plant properties or products is now being put to commercial use. Admittedly, such commercial use remains small in comparison with the standard use of these materials for their herbicidal effects. However, the field of application for these new uses widens rapidly, even though it does not yet have a big volume.

A case in point is United States Rubber's Duraset-20W (*N-meta*-tolyl phthalamic acid). This material is claimed to increase plant yields by reducing the effects of periods of high heat, drought, prolonged rain, sudden cold snaps, or overfertilization. While the material itself has little herbicidal action, its analogs are herbicidal.

Researchers with U. S. Rubber's Naugatuck Chemical division are not completely certain how the chemical works. They theorize that it corrects an imbalance among auxins—a class of plant hormones. Unfavorable growing conditions are thought to cause shock or stress in a plant and in turn cause a hormone deficiency. By correcting the deficiency, the chemical permits such plants as cotton, beans, and other vegetables, strawberries, pears, and cherries to retain fruit-producing blossoms longer. On some plants it increases—sometimes more than doubles—the number of blossoms.

A Circuitous Research Path

Growth improvement research on chemicals with herbicidal properties got its start when certain chemicals—notably the phenoxy derivatives—were found to stimulate plant growth. High application rates turned up their herbicidal properties. Then efforts to find minimum quantities needed for effective control led to studies of how the phenoxy derivatives and other herbicidal chemicals improve one or more properties of a plant.



Dow researchers try out some potential growth regulating compounds. An aim of such research is development of a chemical that will promote uniform growth

For example, W. R. Furtick at Oregon State observed that carbamate and substituted urea herbicides produced a darker green foliage on forage plants. Following up these observations, Furtick applied CIPC and monuron to forage grasses and corn and beans. Spring applications of these materials frequently reduced yield of both grass and legume type perennial forages, but fall application increased yield. Monuron applied in the spring, while reducing yields of forage grasses, raised protein content 50 to 100% over that of untreated grasses. Fall application increased protein content, although much less than spring application.

In Furtick's opinion, higher protein with lower yield could be explained on the basis of the herbicides' preventing normal photosynthesis; hence the protein content gain is relative to a reduced carbohydrate content. This explanation fails in cases in which both yield and protein content are increased.

Growth stimulation is one of the ways that herbicide selectivity can be achieved (Ag and Food, September 1956, page 738). From work on this aspect of herbicidal activity has come other information that herbicides can spur growth through improved plant metabolism. University of Minnesota researchers have found that sublethal quantities of 3-amino-1,2,4-triazole (ATA) put on plant foliage apparently increase uptake of oxygen through increased respiration—provided that adequate supplies of phosphorus are available to the plant.

Other workers at Purdue using ATA on carrot tissue cultures found that 10 p.p.m. concentrations caused a 60% increase in growth (wet weight), while 100 p.p.m. reduced growth by 86%. Such is but one example of how important to growth improvement are differences in applied concentrations of herbicides. Often concentrations must be reduced to 0.01 or 0.001 those of toxic quantities.

Phenoxies Widely Tested

Much experimental information is available on test applications of 2,4-D to enhance plant growth. The material has been found to alter amounts of phosphorus, potassium, and calcium taken up by plants, and alters in turn their growth and properties.

U. S. Rubber uses 2,4-D as a hormone to stimulate latex yields and to extend life of rubber trees in Malaya and Indonesia. Quantities less than an ounce per tree increase latex yields 25% to 40%. Older trees—up to 50 years old—continue to produce latex at a profitable rate. Applied in a palm oil carrier to a peeled section of the trunk, the 2,4-D seems to be absorbed by the tree into its system.

Other materials such as 2,4,5-T find limited application on specific fruits. In California, 2,4,5-T has been used to increase size and sugar content of apricots. In other parts of the country, the material is used to improve color and to inhibit drop of apples. The success of 2,4,5-T in this application varies widely with different varieties of apples.

Influence of Growing Conditions

Effects of herbicides in varying growth are limited by the same factors —moisture, fertility, temperature—that limit plant growth. Analyses of specific relationships between these factors and herbicide effects remain very few.

University of Minnesota work with ATA to increase respiration shows a limited phosphate level will limit respiratory stimulation provided by ATA. Other work has shown some positive correlation between soil fertility and susceptibility to herbicide doses.

Researchers point out that it is difficult to observe the influence of soil moisture as it affects growth of plants either treated or untreated with herbicidal materials. For in the case of soil moisture, slight differences often cause large growth responses.

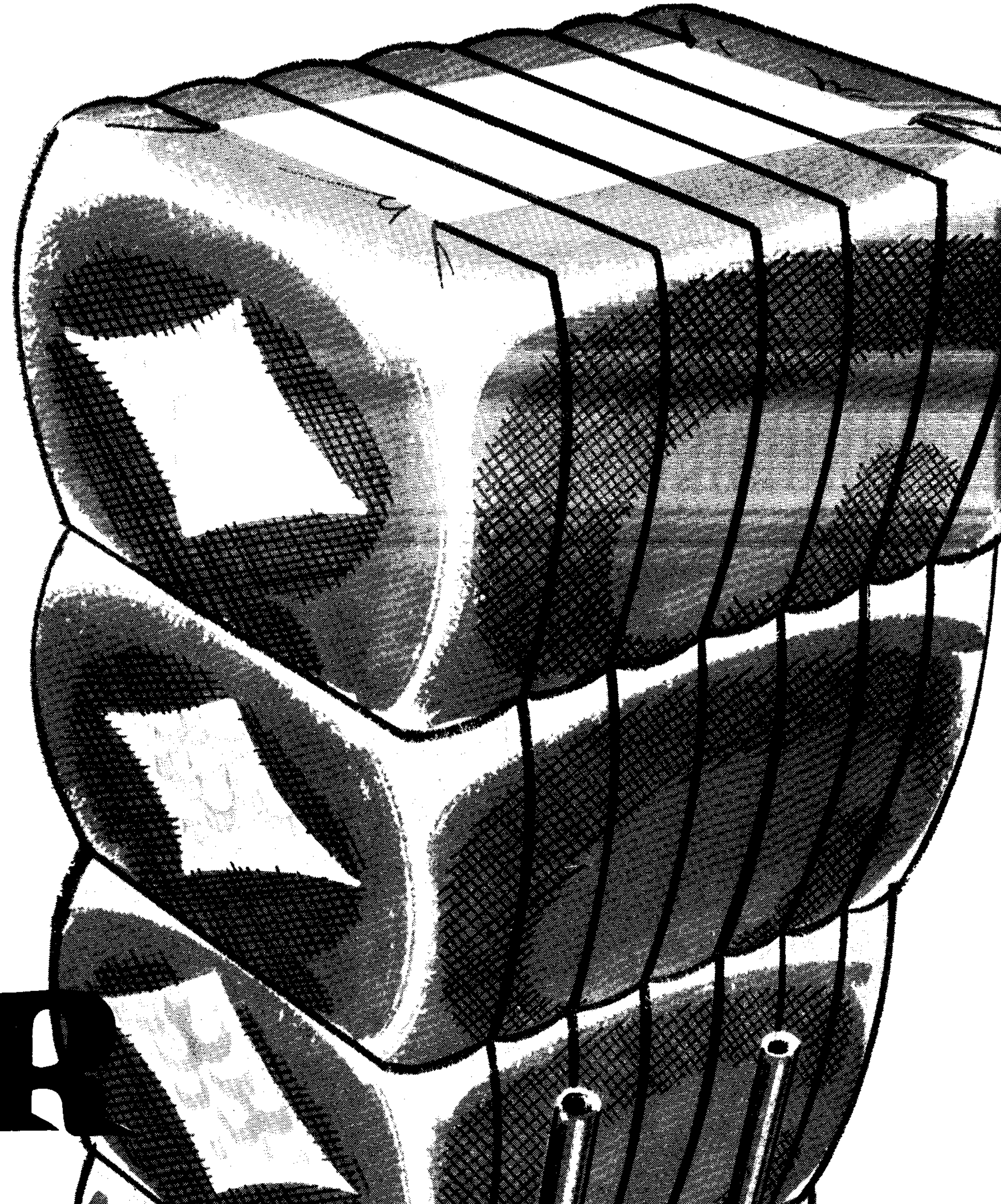
Toward Greater Returns

With an increasing number of herbicides finding use in growth improvement fields, research takes on an especially practical aspect. Manipulation of economic plants for increased yield of the plant or a product from the plant has long been an objective of plant physiology work. Additional practical results can safely be expected

Some Properties Wanted in Plants from Treatment with Herbicidal Materials

Agronomists hope to obtain these effects with small doses of herbicides:

- Over-all increases in yield, coupled with longer producing life
- Higher protein content in forage crops
- Improved fruit set and retention
- Better resistance to drought, cold weather, and other climatic changes
- Improved rooting
- Control over maturity to gear growing periods to marketing or canning schedules
- Increased mineral content
- Disease resistance



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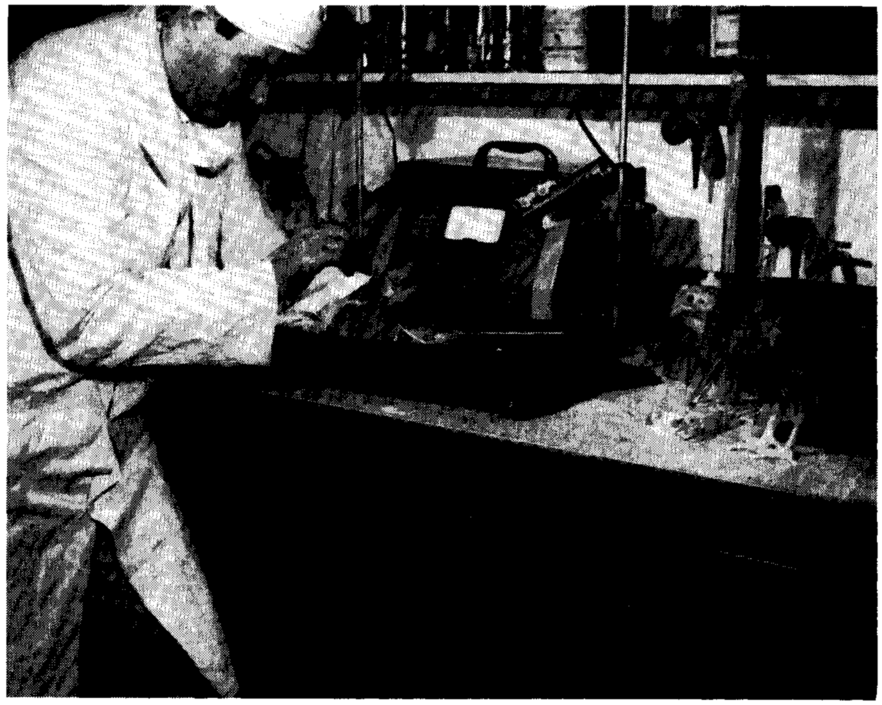
from continued trial and error methods.

But clear-cut reasons why certain herbicidal chemicals act to improve (for man's purposes) properties of a few isolated plants remain to be found. If even general correlations could be developed between molecular groupings in chemicals applied to plants, and plant classifications as related to the plant property that is to be improved, points out a plant pathologist, then chance observations such as leaf darkening will be replaced in large part by systematic research. In any case, developing knowledge of growth improvement effects of herbicides increases the possibility of returns on herbicide research—besides those promised by weed control—and may make such research more attractive.



Richard S. Gordon, Monsanto, administers a capsule of radioactive MHA-S35 to investigate uptake of amino acids by broilers. Such studies are part of the chemical industry's accelerated probing into the biochemical basis of animal nutrition

Animal Nutrition Research

Feed bag's contents get a going over as chemical industry gets deeper into basic nutrition research

Over the past several years, dramatic results obtained with feed additives like hormones and antibiotics have overshadowed even more extensive research progress in the field of basic feed ingredients. Efforts to determine more precisely the nutritional value of a feed bag's contents are going on at chemical, food, drug, and feed companies, as well as universities. Most of this work sheds more light on the nutritional value of old stand-bys rather than resulting in new, startling developments.

That research on feed ingredients is paying off is evidenced by today's improved feed efficiency, a small but significant part of which is due to chemical additives, says Harold L. Wilcke of Ralston Purina. This, he notes, is especially true in broiler and swine nutrition. And research emphasis by nutritionists is on developing even more efficient usage of feed ingredients like corn, soybean meal, fats, fish meal, meat scraps, and distillers' feeds.

Proteins and amino acids are among the many factors being studied by nutrition workers. The nutritional problem with proteins is their amino acid content—specifically, the proportion of amino acids present. Once the essential amino acid requirements of an animal have been met, says University of Florida's George K. Davis, it's the balance and quantity of essential amino acids that's important (rather than how many of them there are).

Research in natural protein sources includes amino acid evaluation and attempts to find factors that stimulate or improve animal growth and feed conversion. The same holds for distillers' feeds. Research with soybean meal seeks to learn and improve its efficiency as an animal feed. Cotton seed meal work is almost entirely aimed at making the product useful in poultry and swine feeding by removing gossypol.

Fats in feeds are coming in for increasing attention—and use. Just a short while ago, fat content of feeds ranged from 3 to 5%. Now it's up to 6 or 8% in some high energy formulations, and some feed makers foresee an even higher fat content in the near future. How high fat content can go will be dictated more by economics and the mechanical limitations of mixing than by anything else.

From a nutritional point of view, as fat content increases, protein needs to go up too. Increased fat consumption, say nutritionists, means that the amount of feed eaten by an animal is reduced, and the protein content must, therefore, be increased. Other supplementation has to go up also, to compensate for decreased feed consumption.

Chemical Industry Role Gets Bigger

More and more, research in feed ingredients is being taken over by the chemical and allied process industries (especially drug houses). As recently as 10 years ago, products sold to the feed industry were only those already on hand. Drug companies, for instance, marketed sulfa drugs, antibiotics, and vitamins on the basis of their known application to human health and nutrition. But today, a number of chemical and drug companies have extensive animal nutrition research programs of their own.

One of the chemical industry's greatest long range interests in nutrition work is in the role of synthetic amino acids as feed ingredients. Evaluation of synthetic amino acids in poultry feed has been under way for several years (Ag and Food, August 1955, page 646), and methionine and its hydroxy analogs are used today in many broiler rations. But synthetic acids' relatively high cost is a handicap.

Hence, for some time at least, demand on feed staples like soybean and fish meals will increase. A growing demand of this kind, though, will tend to raise the price of the staples. But if synthetic amino acid demand increases too, prices on the synthetics will tend to come down. Thus increasing use of protein feedstuffs will result in price changes for both components.

Nutrition research by the chemical industry extends considerably beyond that aimed at product utilization, and into areas generally regarded as basic. One such program has led to the "growth spurt" theory of broiler nutrition.

Developed by Monsanto and made public last summer, this theory maintains that a complete reversal of the feeding cycle of broilers may be called for. Monsanto researchers show that through an altered feeding pattern, improved feed utilization occurs in the last two or three weeks before a bird is sent to market. Usually, a broiler's growth curve is considered to be a straight line from birth only until about four to five weeks of age. Then, the growth rate declines rapidly until marketing age (9 to 10 weeks). But the Monsanto researchers show that even in the last few weeks, growth can continue at a high rate instead of reaching a plateau if proper nutritional balance, especially in amino acids, is maintained. Significance: better feed efficiency can be maintained during the broiler's growth period. Since the total life span of a broiler takes in only a very short period of its total growth potential, this improvement in feed efficiency does not alter accepted theories of diminishing returns in feed utilization, Monsanto points out.

Monsanto translates its theory into practical terms this way. Instead of feeding the bird with high energy feed during the first few weeks of growth, and then maintaining it on a lower grade before marketing, the reverse may be more profitable. The high energy feeds, when fed near the end of the premarketing growth period, would allow the bird to maintain a constant weight gain up to marketing. And since feed conversion in a young bird is good even with a cheaper feed, costs could be held down for the major part of the feed cycle. When the higher energy feed is fed later in the period, conversion seems to be even better than during earlier weeks, with subsequent large weight gains.

Nutritionists contacted by AG AND FOOD are about evenly divided over Monsanto's findings. One says that the theory doesn't necessarily indicate a reversal of the feeding cycle, but may suggest increase in the calorie-to-protein ratio. In a growing bird, this ratio is kept within certain limits for best results. But an older bird, some say, can stand a higher ratio. This kind of ratio change, researchers agree, can add more weight—but feed efficiency increases need only be slight to do so.

General Mills' H. Ernest Bechtel calls the straight line theory a challenge to nutrition workers. He says that it emphasizes a weakness in know-how among nutritionists today. Some researchers, in his opinion, like to think that it should now be possible to obtain even better results during the early part of the growing period.

Work of this kind seems, at first glance, to be far afield for chemical producers. However, nutritionists are aiming toward rapid and economical production of animals for human food. This aim calls for nutrients that satisfy animal needs, including vitamins, proteins, minerals, and other supplements—all products of chemical and allied process companies. Basic nutrition research coupled with feed experimentation is the only route.

Food Additives

Chemicals improve quality, appearance, and lasting properties of everyday foods

HUNDREDS OF CHEMICALS today are added to foods. They are designed to increase the nutritive value of foods. They improve the appearance of foods. They enhance flavor and aroma. They help preserve foods, make them more economical, and increase their convenience in use.

The whole broad field of food additives was surveyed last month at the ACS Division of Agricultural and Food Chemistry program in San Francisco. A day-and-a-half symposium, featuring over a dozen papers, covered everything from the supplementation of bread with vitamins and minerals to the use of additives in potato chips, margarine, and frozen turkeys.

As one speaker emphasized, additives are helping the nation to a greater supply of foods—foods that are more nourishing, more attractive, and more varied. "We who are in the food business," he pointed out, "are fully convinced that many of nature's fine foods can be improved upon. In this respect, the food chemist of today is making a real contribution to human welfare and progress."

Value of Antioxidants

Most of the chemicals used in foods—nutrients, flavoring materials, antioxidants, antimicrobial agents, mold inhibitors, emulsifying agents, stabilizers, thickeners, anticaking compounds—were unknown to food manufacturers only a few decades ago.

A major development in recent years has been the growing use of antioxidants to prevent rancidity. They help retard the oxidative breakdown of fats, oils, and vitamins.

Most widely used antioxidants are butylated hydroxyanisole (BHA), butylated hydroxytoluene (BHT), nordihydroguaiaretic acid (NDGA), and propyl gallate. They are often used with such acid synergists as citric acid and ascorbic acid to give added protection. A high percentage of today's lard is stabilized by BHA, propyl gallate, and citric acid.

Recently the antioxidant trihydroxybutyrophenone was accepted for inclusion in foods and feeds. It appears to be slightly better than propyl gallate in animal fats, and about equal to it in vegetable oils. In deep-fat frying, it appears superior to either propyl gallate or BHT.

Vitamin Enrichment

Vitamins, important among additives to foods, are frequently added to restore vitamins removed or destroyed in milling, dehydration, or heat processing. Usually, the amount added is just enough to restore the food's original vitamin content.

On the other hand, some foods are substantially enriched with vitamins. Bread now often contains an extra supply to promote over-all human nutrition. So do many baby foods and foods for older people.

Recent years have also seen the enrichment of foods to bring them up to the level of competing foods. Margarine is enriched with a standard amount of vitamin A to raise it to the average level of butter and keep it there consistently. Apple, grape, and pineapple juices are fortified with vitamin C to put them on a par with orange juice. Apart from their use as vitamins, such products as ascorbic acid (vitamin C) and tocopherol are also used in foods to protect unstable compounds from oxidative attack.

Vitamin D is widely used in enriching milk. And since milk in the wintertime is often deficient in vitamin A, supplementation with this vitamin has been recommended.

Minerals are rising in importance as additives to foods, even though relatively little is known about the mineral requirements of man. Potassium iodide is added to salt as a health measure. Iron and calcium are used to fortify bread. The body also needs comparatively large amounts of phosphorus and potassium, although enough of these minerals is usually supplied by ordinary diets.

Protein Supplements

In many parts of the world, large segments of the population suffer from lack of protein. Researchers concerned with this problem have been recommending that such protein sources as wheat, rice, and corn be supplemented with lysine and other amino acids. Some specialty breads available in the U. S. now contain supplementary lysine. Because of the importance of protein during periods of growth and stress, lysine-supplemented bread is being recommended in some quarters for hospital patients, infants, and adolescents.

Where diets are based mainly on cereals, lysine is the first amino acid likely to be deficient. Most research so far on lysine has been on laboratory animals. Nevertheless, as one symposium speaker emphasized: "Present data certainly suggest that lysine supplementation might be beneficial to man. One is reminded of the short size of the average Chinese and of the totally different and larger body size of his children born and raised in this country. Much of the difference is undoubtedly due to a higher intake of lysine." This point, however, has still to be proved experimentally.

Improving Dairy Products

Dairy products continue to be a major market for food additives. Various specialty milks are enriched with vitamins and minerals. Chocolate milk usually contains vegetable gums to prevent the chocolate from settling out. Nonfat milk often contains supplementary vitamin A to replace the amount removed with the fat. In some areas of Switzerland, fluorides are added to milk to guard against dental caries.

The fresh milk product containing by far the largest variety of additives is ice cream. Helping to preserve the smooth texture of ice cream are stabilizers that tie up the free water and prevent it from forming ice crystals. Widely used for this purpose are gelatin, sodium carboxymethyl cellulose, and various vegetable gums.

Emulsifiers such as glycerides of fatty acids promote and stabilize the oil-in-water emulsion in ice cream. Whipping agents, drying agents, flavors, and colors also are added, as are various natural or synthetic sweeteners.

Cheeses contain a host of food additives. Vegetable gums, algin, gelatin, and other products help give cheeses their characteristic spreadability. Sodium phosphates as emulsifying agents prevent fat separation. Harmless yellow, blue, or green dyes provide the desired color. Sorbic acid and sodium or calcium propionate inhibit mold growth. Enzymes are added to promote the development of flavor.

Dried whole milk contains wetting agents and emulsifiers to speed up its dispersion in water. As one speaker pointed out, more research is needed on additives that prevent dried whole milk from developing an oxidized or stale flavor during storage. One way of minimizing flavor changes is to pack the product in nitrogen or carbon dioxide, although this method loses its effectiveness once the container is opened.

Vital Role of Additives

Additives are essential to modern food industry. Fifty years ago, most food was prepared in the home from simple, basic raw materials. Today, much of it when purchased is already processed, modified, improved, and packaged. Obviously, the diversity, convenience, attractiveness, and abundance of our food supply would be impossible without food additives.

The general public is coming to appreciate the need for chemicals in foods. It is becoming increasingly open-minded. "But," said one symposium speaker, "the average person is still unaware of the tremendous role that chemicals are *already* playing in this field."

Ag Flying Progress

Inherent speed, improved equipment build business for aerial application industry

Billy Mitchell probably didn't consider aerial application when he predicted the growth of air power, but he should have. Today aerial application is big business. And it will get bigger.

Although complete and accurate statistics on aerial farming are hard to come by, here are a few figures which indicate size:

- In 1957 agricultural pilots dropped an estimated $150 million worth of chemicals on nearly 70 million acres of land.
- This included about 380,000 tons of dry chemicals and 90 million gallons of liquid.
- To accomplish this, more than 4000 planes and helicopters logged over 850,000 hours of flying time.
- Last year over 95% of all the rice grown in California was seeded, weeded, and fertilized by air. Agricultural pilots also treated an estimated 60% of all cotton grown in this country.

Good Reasons for Growth

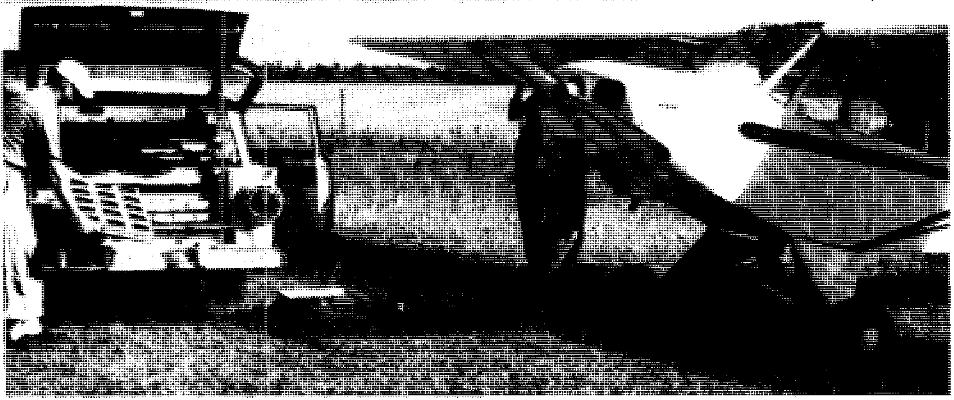
Best guesses indicate there are now about 1500 aerial applicators in the United States—who own 5000 planes—which are flown by 10,000 pilots. What is there about farming by air to cause this tremendous growth?

Probably the biggest advantage is speed. Speed depends upon many variables such as type of plane, weather, type of material being used, amount applied per acre, and the terrain itself. But a Stearman biplane, still the workhorse of ag planes, could probably cover 30 to 40 acres per hour under favorable conditions. Some crop dusters, flying as many as 60 missions, have dusted up to 1000 acres in a single day. Larger planes have sprayed up to 2000 acres per day flying only five missions.

How does this speed help the farmer? First of all, time is money, and any time saved is money saved. Not only do planes apply fertilizer, insecticides, defoliants, and herbicides faster than ground equipment; they can do it at times when ground vehicles are unable to operate. During rainy spring seasons, when the ground is too soft to support a tractor or truck, planes still fly. Thus farmers can get an earlier start on crops and take advantage of favorable growing periods. In excessively rainy seasons, this may be the factor that decides whether the job gets done at all.

Ground equipment can also cause excessive damage to crops by running over plants. At least part of the cost of aerial application reverts to the farmer because planes do not damage crops in this way.

Planes are the only economical answer, too, when it comes to the really big jobs, such as the gypsy moth spray program in the Northeast. Last year more than 6 million acres were sprayed



An interesting agricultural use of airplanes is in distribution of sterile male screwworm flies in USDA's screwworm eradication project

with DDT and fuel oil for gypsy moth control. It would have been impossible to cover this area from the ground, not only because of its size, but also because much of it was woodland and mountains, inaccessible to ground equipment.

Some Disadvantages

Aerial farming does have its disadvantages. For instance, it is much harder to control distribution from the air than it is from the ground. As a result, some parts of a field may receive excessive coverage, possibly causing damage to the crop, while other parts may receive little or no coverage.

Drift is also a hazard in aerial application. In the absence of proper caution, it is relatively easy for poisonous chemicals to drift to neighboring farms, causing harm to crops or livestock, and resulting in lawsuits. Consequently, ag pilots sometimes have very few hours of flying time per day—in the early morning and late afternoon when the wind is calm. Some pilots will dust in winds as high as 10 m.p.h. and spray in winds as high as 20 m.p.h. But if dangerous materials are being laid down, many will call it quits at 6 m.p.h.

Ground equipment can often treat small acreages more cheaply than planes. Therefore the small farmer has shied away from aerial application. But this does not have to be true. Several neighboring small farms can be banded together and treated in one operation.

Improvements Ahead

Much is being done to make aerial application easier, safer, and more economical. Granulated materials are coming into favor. These chemicals are much easier to handle than dust, and have far less tendency to drift. Research continues on nozzle and gate design to improve distribution patterns.

Even the planes are getting a closer look. Most of the planes in operation today are Stearmans or Piper Cubs rigged with spray and hopper equipment. Only about 75 so-called big planes, over 12,500-pounds gross weight, are in operation. These are chiefly C-82s and C-47s.

But now many airplane companies, realizing the potential of agricultural flying, are making or considering planes especially designed for aerial application. Transland Aviation, using some of the features of the Ag-1 designed at Texas A&M, came up with the Ag-2, reportedly the first commercially designed aircraft for farm and forest needs. Fletcher Aviation redesigned its utility aircraft and aimed it at the farm market. American pilots did not readily accept this plane but reports indicate that it made a hit in New Zealand. Another Fletcher product which agricultural pilots are considering is the FU-24, a heavier and higher load-carrying plane. Other developments in the small plane field:

- Call-Air offers its A-4, which will carry a payload of 1130 lb. at 45–50 m.p.h.
- Rawden is testing the T-1, still in the experimental stage.
- Cessna is considering converting its famous L-19 military aircraft into an ag plane.
- Grumman now has a prototype agricultural plane in test.
- Piper puts out several models of its Cub for aerial application.

Despite all this progress, perhaps the greatest need from the safety standpoint is better trained pilots. And something is being done about this, too. Several schools are in operation throughout the country training pilots in agricultural aviation. Many states now have aerial applicators' associations which work closely with state and federal agencies to spread information on safe handling techniques, protective equipment, and health hazards. With better equipment and better trained and educated pilots, aerial application should continue to grow.