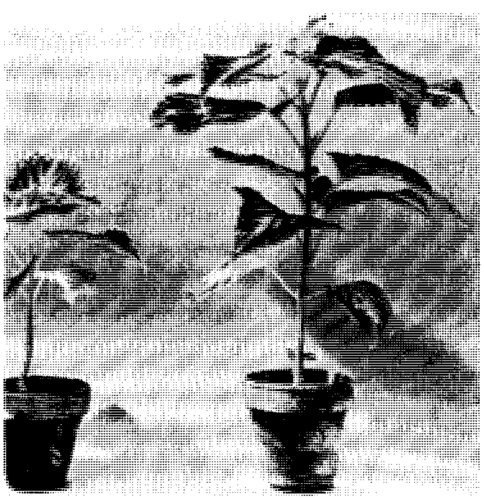
Ag and Food Interprets

- **Gibberellins may soon have some commercial uses in agriculture**
- **Toxaphene-DDT still controls cotton insects in Louisiana**
- **Feeds, plants, food use $27 million worth of antibiotics**
- **Aerial application of chemicals—a $90-million business in '56**
- **Drive is on to speed product acceptance by farmers**



Coleus plant on right was sprayed with gibberellic acid four weeks before it was photographed

Gibberellins

Flash in the pan or pay dirt? Crash program of research may produce an answer soon. Indications are that gibberellins will soon have some commercial uses

PLANT SCIENTISTS are responding to gibberellins in ways almost as interesting as the responses of plants themselves. Throughout the country this season nearly 1000 scientists have been testing these plant growth substances on as many varieties of plants as they could manage. One estimate is that as many man-days were spent on gibberellins this summer as were spent on 2,4-D in its first two years.

As fall approached and the convention season opened, these scientists flocked to technical meetings such as those of the AMERICAN CHEMICAL SOCIETY and the American Institute of Biological Sciences, carrying briefcases bulging with data from their experiments. At the ACS meeting, the symposium on Chemistry and Physiological Actions of Gibberellins opened to an audience of more than 500.

Meanwhile, other scientists have remained dubious. They feel that the gibberellins are producing a sort of jet-propelled science as well as jet-propelled plant growth. And they object to "gee-whiz" stories in the popular press, warning that such publicity may set the stage for an eventual disillusionment with gibberellins. They also mention that many purchasers of gibberellins got little or no effect when they tried the materials on backyard gardens this summer. And they are chuckling over 10-foot cabbages and wildly-blooming African violets.

But the gibberellin enthusiasts become philosophical when confronted with such criticisms. They say it is impossible to stop such publicity once widespread interest is aroused. They contend that some of the gibberellin formulations made available to the public this summer contained too little gibberellin and had too little formulation know-how behind them. To objections that gibberellin is moving too fast, they point out that it is now possible to do in one year the technical development work that took three years before World War II—although the psychological development period has not been shortened correspondingly. Science, like everything else today, operates at a much faster pace.

A 10-foot cabbage, they admit, is a caricature of the effects that gibberellin produces. The job, they say, is to channel such weird responses into practical uses for agriculture.

One such practical use in agriculture, for which dollars-and-cents economics already has been worked out, is in California vineyards. University of California plant scientists have found that gibberellin can produce Thompson seedless grapes that are as large as those produced by girdling, a hand-labor job that involves cutting the bark of the vine. Using gibberellin would reduce labor costs in those vineyards. A quick calculation indicates that Thompson seedless grapes in California could become a $9-million market for gibberellins every year.

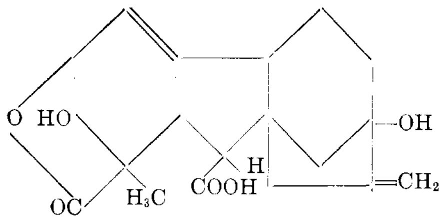
A few of the other promising leads that may develop into economical uses for gibberellins in commercial agriculture are the early indications that gibberellins produce:

- Longer-fiber cotton, which sells at a premium.
- Longer-stemmed roses, which also command premium prices.
- Earlier harvest of celery and sugar cane.
- Higher tobacco yields, because of larger leaves.
- One and maybe two extra cuttings of alfalfa.

Gibberellin treatment can produce a variety of responses in plants (AG AND FOOD, November 1956, page 907). There is stem elongation, increase in vegetative growth, earlier and more profuse flowering (although in some plants, it delays flowering), earlier seed emergence, faster seedling growth, earlier sprouting, elimination of requirements for periods of cold or light. According to Paul Marth of USDA, no known plant growth regulator produces the same effects as does gibberellin. He says also that it is the most systemic of all chemicals in beans and other plants. In woody plants, however, it is not so systemic.

What is gibberellin? The chemical

structure proposed for the acid looks like this:



Biologically speaking, scientists are not sure how to classify the material. For gibberellin is in a class by itself. Many are convinced gibberellin is not an auxin. They now refer to gibberellin as a plant growth regulating substance. Others hold different points of view, so that nomenclature has become one of the tricky problems associated with gibberellin. J. MacMillan, Imperial Chemical Industries, asked at the ACS meeting that the term gibberellin be reserved as a generic term applicable to gibberellic acid, and to gibberellins A_1 and A_2.

Safety

So far, toxicologists have found no evidence that gibberellins produce any untoward pathological reactions in animals. The intravenous LD_{50} for mice is around 6.3 g./kg. Oral doses as high as 25 g./kg. have failed to cause clinical or histomorphologic signs of toxicity in albino rats.

Chronic toxicity tests are still under way, but Merck reports that a diet containing 5% gibberellic acid, fed to rats for five weeks, produced no change in food consumption or body weight. Nor did it produce any hematologic or histomorphologic changes. Frank H. Stodola of USDA, one of this country's pioneers in gibberellin research, told the ACS meeting that B. O. Phinney's work on gibberellin-like substances isolated from plants may minimize apprehension about safety, if the gibberellin-like substance occurring naturally proves to be identical chemically with gibberellins now prepared "artificially" by fermentation.

Not being insecticides, fungicides, or any of the other materials controlled by the Miller Pesticides Amendment, gibberellins are not subject to its machinery. Presumably, gibberellins will be subject to the older sections of the Food, Drug, and Cosmetic Act.

At this point gibberellins seem definitely headed for a place in the agricultural sun. And, unless some unforeseen hitch develops, they may take that place sooner than most scientists anticipated as recently as last fall. How big a place they will eventually occupy depends on economics. The four companies that produce them—Merck, Eli Lilly, Abbott, and Pfizer—feel they have production problems under control. G. W. Probst of Lilly told the ACS meeting that present producers can make all the gibberellins U. S. agriculture could use, so production shortage is unlikely to be a bottleneck to extensive use. The big question that remains is that of economics of use—and the answer will probably be worked out crop by crop over the next few years.

Should that unforeseen hitch develop, gibberellin could still be classed as a significant milestone in the agricultural sciences. For it has provided the plant physiologist, the more or less forgotten man in plant research, with a break-through of considerable proportion. Tracing down all the interesting research leads that gibberellin has opened up will keep plant physiologists busy for several years to come.

Cotton Insect Control

In large-scale farm demonstrations, toxaphene-DDT spray program controls pests, gives excellent cotton yield

RESISTANCE OR NO RESISTANCE, boll weevils can be controlled by a proper program of spraying with chlorinated hydrocarbons—specifically toxaphene and DDT. This is the conclusion reached by Hercules Powder and a group of Louisiana cotton growers, who this summer cooperated in a season-long study of cotton insect control.

The study was initiated by Hercules, following its evaluation of 1955 and 1956 reports that weevils were developing resistance to chlorinated hydrocarbons (AG AND FOOD, April, page 244). Records of its own from farms that used toxaphene or toxaphene-DDT mixtures in 1955 and 1956, supported by results of research at the Red River Experimental Station in both years, had convinced Hercules that good boll weevil control and excellent cotton yields could be obtained with a toxaphene-DDT formulation.

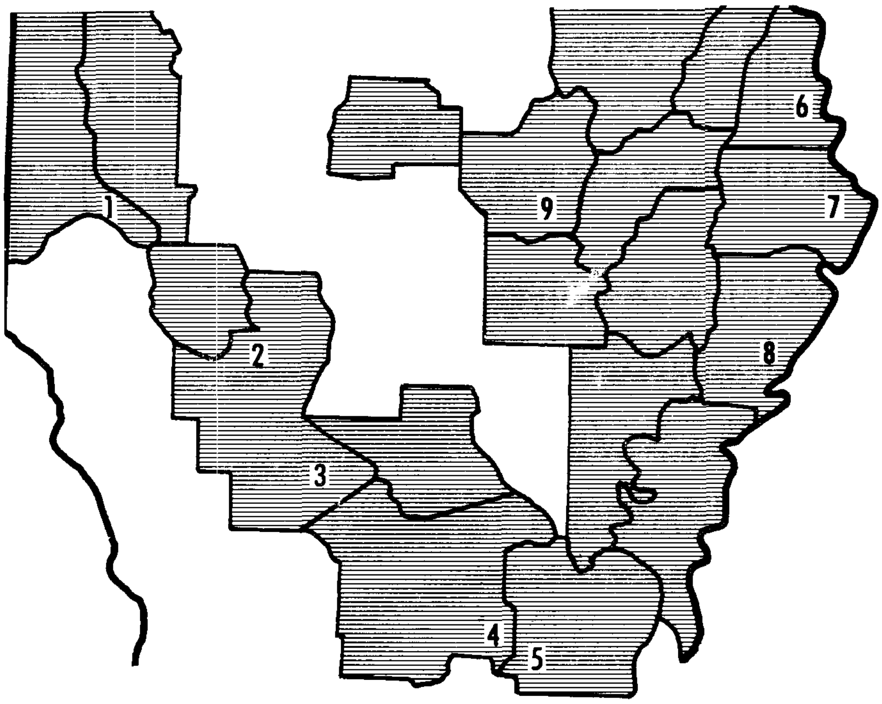
Last spring, the company determined to conduct demonstrations under field growing conditions on a scale large enough to permit a true economic evaluation of toxaphene and toxaphene-DDT formulations in a full-season pest control program. To this end it enlisted the participation of nine growers, carefully selected on the basis of their:

- location in the areas in which boll weevil problems have been especially significant (See map);
- having one or more large fields with a history of repeatedly severe boll weevil infestation;
- interest in a more economical insect control program, with lower late-season infestation counts, and reasonable safety for other farm crops, livestock, and applicators and farm personnel;
- possession of suitable application equipment;
- willingness to make applications according to Hercules' recommendations.

The demonstration program embraced a total of some 1730 acres. An important feature of the program, and one in which it differs markedly from those recommended by official agencies in the state, is its provision for early-season pest control. This feature is aimed not only at reducing populations of overwintering weevils, but also at control of fleahoppers, thrips, plant bugs, and other pests which, along with the weevil, destroy early squares of the cotton plant. Control of these pests, especially thrips, permits fast early growth, earlier fruiting, and earlier maturing. The double advantage of early maturity, says Hercules, is that it results in cotton of higher quality, and removes the threat of damage from extreme build-up of pests late in the season.

Briefly, the spray program was conducted according to the following outline:

- Two early applications of toxaphene, one pint per acre, to control thrips. First application as soon as crop had come up to stand; second treatment seven days later.
- Four applications of toxaphene, one quart per acre, to control overwintering weevils, other early-season insects. Applications started when cotton reached 6- to 8-leaf stage, and repeated at 7-day intervals until emergence of overwintering weevils was 95% complete. (On some farms a treatment with 2–1 toxaphene-DDT mixture was appended to control the spring brood of bollworms.)
- Routine late-season spraying with 2–1 toxaphene-DDT, at 4- to 5-day intervals, based on infestation counts. First application at or before the time infestation from first generation of emerging weevils reached 10%, i.e., when 10% of cotton squares had been



Demonstration Farms in Northern Louisiana

(Shaded areas are parishes in which weevil infestations have been severe, and difficult to control)

Farm No. (See Map)	Acreage in Test Program	Weevil Infestations, % of Squares Punctured: Season Average	Maximum Recorded	Latest Count Prior to Sept. 19	Per-Acre Cost of Control up to Sept. 19
1	450	4.2	9.0	8.5	$13.30
2	215	4.0	8.0	8.0	19.45
3	116	5.5	11.0	10.0	24.50
4	150	4.2	7.0	5.0	25.70
5	50	6.0	9.0	8.0	22.70
6	450	10.6	18.0	18.0	22.85
7	150	11.0	22.0	18.0	27.70
8	70	7.8	11.0	4.0	27.20
9	80	5.5	14.0	8.0	25.70
Weighted Average	1731[a]	6.8	12.1	11.3	19.70

[a] Total acreage in test program.

punctured. Mixture controlled bollworm as well as weevil.

- At some locations, a single application of ethyl parathion to control aphids. This compound, says Hercules, is a good aphicide, but was not considered sufficiently effective against boll weevil to affect results in the toxaphene-DDT evaluation.

Throughout the season, all applications were made by the farmers themselves, using conventional equipment, or by local aerial crop sprayers under the farmers' supervision. Weather conditions, especially frequent and heavy rainfall, were conducive to heavy weevil infestation, and provided, Hercules feels, a severe test of the materials and programs used.

Weekly infestation counts, made by professional cotton scouts, showed that weevil damage was held to satisfactory levels in all fields in the test program, and to extremely low levels in some (See table). Without exception, the cotton in the test program fields matured earlier than that in other fields in the same communities. Yields of two bales per acre are expected from a number of the test fields, and some will yield well above the two-bale level.

Infestation counts in fields adjoining those in the test program, either on the same or on neighboring farms, revealed pest damage in most cases far above that on the test fields; yield estimates are in most cases considerably lower.

The boll weevil control difficulties reported in 1955 and 1956 by both farmers and research people had led to removal of all chlorinated hydrocarbon insecticides from Louisiana's 1957 control recommendations over most of the state. On the basis of the results of its test program this year, however, Hercules is convinced that further revision of the state recommendations is in order. The company plans to submit for registration in 1958 a new label for toxaphene-DDT, in which the directions for use are spelled out in accordance with this year's test program.

As for the farmers who participated in the tests, they intend next season to follow on their own initiative the patterns that have proved so successful in 1957. One of the growers, Otto Newman of Rapides Parish, showed Ag and Food a field in which boll weevil infestation has always been extremely high, and where in past years "we were lucky to make a half-bale an acre." This year the yield will probably go well over two bales. And Arledge Ware of Natchitoches Parish also is sold on the toxaphene-DDT program. Says Ware, who expects to market at least two bales per acre this year, as compared with less than 1.5 in 1956: "The proof of the pudding is right out there in the field."

The Hercules program was not designed or intended to prove whether or not Louisiana boll weevils have developed resistance to chlorinated hydrocarbons. Nor was its object to compare toxaphene with any other product. But Hercules has proved to its own satisfaction, and that of at least nine Louisiana cotton growers, that excellent pest control and good yields are still possible at reasonable cost with toxaphene and DDT—properly timed and correctly applied.

Antibiotics in Agriculture

Last year, sales of antibiotics for animal feeds, food preservation, and plant disease control reached a whopping $27 million

Not too long ago, drug manufacturers considered sales of antibiotics for nonmedical uses as merely a minor fringe benefit. Not any more, of course. In 1956, sales of antibiotics for animal feed supplements, food preservation, and plant disease control reached 700,000 pounds, with a total value of $27 million. Actually, nonclinical uses have become a major spur to the growth of the antibiotics industry. A leading segment of the population to benefit from this development: the nation's farmers.

Antibiotics today are widely used to stimulate the growth of poultry, swine, and other animals. They are used to prevent and cure animal diseases. They are dusted and sprayed on plants to control crop diseases. They help preserve the freshness of poultry. They are also used (mainly experimentally) to preserve agriculturally-derived industrial materials, such as textiles, paper, leather, cork, and wood. With advancing research, other important nonclinical uses for antibiotics are bound to develop.

Originally, antibiotics were looked upon solely as a means of controlling infectious diseases in man. Then came 1946 and the discovery that antibiotics were effective in stimulating the growth of chickens. Scientists found that chickens fed antibiotics grew 10 to 15% faster. Partly because these animals are healthier and therefore able to use their food more efficiently, their food consumption is reduced by 10%. Other studies have shown that, when turkeys are fed antibiotics, they are 15 to 20% heavier at the usual market age. In swine, the growth increase is 10 to 20%, most noticeable in younger animals.

Antibiotics such as penicillin, streptomycin, chlortetracycline (American Cyanamid's Aureomycin), oxytetracycline (Pfizer's Terramycin), and bacitracin are also used in treating animal diseases. They control calf scours, pneumonia, and foot rot in large animals, infectious enteritis in swine, chronic respiratory disease in chickens, infectious sinusitis in turkeys, and other diseases.

Antibiotics have been particularly effective in controlling mastitis in cows. One problem, however, is that, immediately after the cow is treated, the antibiotic shows up in the milk.

Last year, a nationwide FDA survey showed that 5.9% of over 1700 samples of market milk contained penicillin. Although the small residues found are harmless to the average person, they might give trouble to people highly sensitive to penicillin. To meet this problem, a special educational program has been launched to get farmers to discard the milk from treated cows until it is free of antibiotic. Another step was taken in August when the maximum permissible dose of penicillin for treating mastitis was lowered to 100,000 units —instead of the 10 to 15 times that quantity used previously.

In fish hatcheries, antibiotics are being used increasingly to control a variety of bacterial diseases. Chloromycetin and Terramycin are particularly effective in preventing disease among hatchery trout. Chloromycetin and streptomycin are being used to ward off infectious dropsy, a serious disease among pond-water fish.

Today, FDA permits only one type of food to be preserved by antibiotics. Raw, dressed poultry can be preserved by being dipped in a weak solution of either Aureomycin or Terramycin. This use received government sanction because the antibiotic is destroyed during cooking. Before long, antibiotics may also be approved for use in preserving fish—a practice now common in Canada.

Antibiotics are also being suggested for use in preserving beef, ham, fresh vegetables, salad mixes, cream puffs, and other perishables. A 15-second dip in Terramycin solution, for example, increases the shelf life of unrefrigerated spinach by 24 hours. The same treatment prevents for 48 hours the decaying of salad mix.

None of these uses is now permitted commercially in the U. S. for fear the antibiotic might remain on the food as eaten. But extensive work is under way to determine whether a small residue of antibiotic on foods is actually a safety hazard. Government authorities are moving slowly and cautiously in this area.

Warding Off Plant Disease

An important use for antibiotics is in controlling plant diseases. In the case of tomato, bean, pepper, and other plants, treatment is carried out during the seedling stage. As a result, the antibiotic is removed or destroyed before the edible part of the plant is formed. On fruit trees, spraying or dusting is done only before and immediately after blossoming, which is before the fruit develops.

Three antibiotics are used in treating plant diseases: streptomycin, a combination of streptomycin and Terramycin, and cycloheximide (Upjohn's Actidione). Streptomycin alone or together with Terramycin controls fireblight of apples and pears, halo blight of beans, bacterial blight of celery, soft rot of potatoes, bacterial spot of peppers and tomatoes, and other plant diseases. Actidione is particularly effective in preventing cherry leaf spot. Experimentally, the antibiotic is being studied for use in controlling blister rust of white pine and black stem rust of wheat. One problem with Actidione, however, is that, if not properly used, it may injure the plants themselves.

Recent work shows that, when Actidione is chemically modified, it may act systemically. Actidione itself is a contact fungicide. One of the new derivatives, Actidione semicarbazone, might be useful in controlling wheat stem rust. Actidione acetate offers promise for controlling oak wilt. These and other Actidione derivatives are being studied experimentally also for the control of apple scab, early blight of tomatoes, and anthracnose of beans.

Studies are continuing on all phases of nonclinical antibiotic use. One area getting attention is the absorption and translocation of antibiotics in plants. Researchers have already shown that antibiotics such as streptomycin, Chloromycetin, and griseofulvin can be transported upward from the roots to the leaves. Downward movement has not been detected in most antibiotic studies. Recent work, however, indicates that when large amounts of antibiotics are used, some of the material may move downward. If ways can be found to promote this downward transport, a long-awaited answer might be found for controlling various root diseases.

Also needed are ways to prolong the effectiveness of antibiotics and thus cut down on the number of treatments required. This might be done by finding better ways of application or improved carriers, or by developing new derivatives. Also needed, as one agricultural expert points out, are superior antibiotics developed specifically for nonclinical use. Says he, "Let's not confine ourselves to testing, second-hand, the antibiotics used in medicine."

Based in part on material presented before the Division of Agricultural and Food Chemistry, 132nd National Meeting of the AMERICAN CHEMICAL SOCIETY, New York, N. Y., Sept. 13, 1957.

Agricultural Aviation

A $90-million business wants new chemicals, education program, more pilots in order to grow to its full potential

AGRICULTURAL aviation grew to at least a $90-million business in 1956. Although hampered somewhat by drought and low farm prices, applicators worked a million hours and treated more than 80 million acres of land. The $90-million gross revenue was realized on an investment of $75 million.

These and other growth figures of the agricultural aviation industry have been gleaned from a survey made by the National Aviation Trades Association. In projecting results of the survey, NATA found it particularly hard to estimate the actual number of active applicators in any one season. It feels, however, that total industry figures given are more likely to be low than high.

In terms of acres treated, agricultural aviation in 1956 used four times as much spray as dust, says NATA. Fertilizers were third in volume, following pesticide sprays and dusts, on the list of materials applied.

About 10% of survey replies said fertilizing by air represents a profitable path for expanding the industry. But they said better fertilizers, preferably liquids, are needed before air applicators can compete with ground operators. Also, applicators would like to develop fertilizing by air to include forest areas.

Applicators, the survey shows, believe future boosts to the industry could come through three major developments:

- Better and lower-cost chemicals.
- Educational programs for growers and applicators.
- A break from the weather.

With returns from 30 active agricultural states, NATA believes it has a fair picture of what applicators think of the chemicals available to them. Many say costs are high; others complain of limited effectiveness of materials.

An important question posed in the survey asked, "What new chemical products are needed for particular crops?" Among the answers, herbicides for use on wheat and small grains were mentioned most often. These included chemicals to control wild oats, wild buckwheat, and cheat grass. A nontoxic chemical to control alfalfa aphids appeared as another common need. All in all some 35 new or improved chemicals were called for (See table).

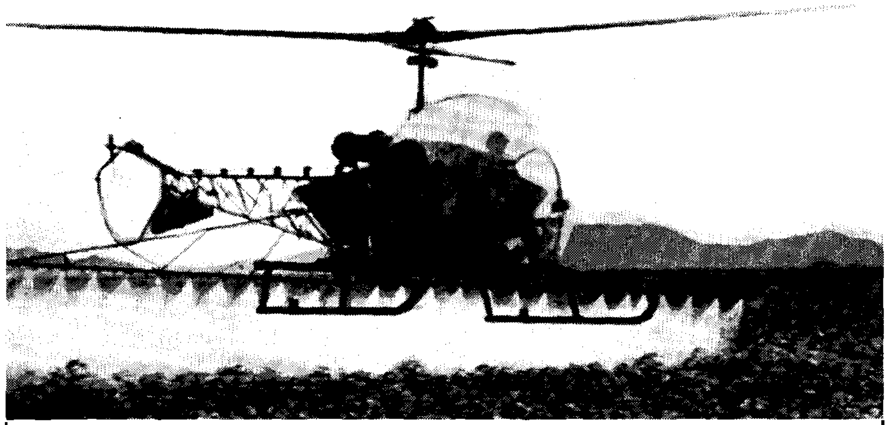
The question "What single development do you think would do the most to extend your season or increase the market for your services?" also brought replies centered on the need for special-purpose chemicals. For example, applicators requested:

- A defoliant that would also control weeds in soybeans to allow quick harvesting.
- A brush control chemical, long lasting regardless of moisture availability.
- A chemical that would hasten decomposition of straw and stalks.
- A low volume fungicide to control blight, scab, and brown rot on apples, peaches, tomatoes, and potatoes.
- A liquid arsenic compound (that works) for boll weevil control.
- Pelleted DDT.
- A cheaper carrier, other than diesel oil, with good spreading, penetrating, and nonevaporating properties.

In addition to the chemical answers to this question, applicators registered their opinion that the industry could profit from educational programs directed toward both growers and applicators. They believe farmers need more information on the benefits that can be obtained by air application of the proper chemicals, especially in emergency situations.

The survey also shows that almost all applicators use the services of their county agents. About 65% said short courses for dusters and sprayers were being given in their states. Most applicators reporting had attended three or more of these courses.

More than half the agricultural aviation companies surveyed showed their total business was from aerial activity. Usually, key personnel—83% of the owners, managers, and other company officials—fly planes in the service. This situation reflects probably the greatest need of the industry at this time—more qualified pilots. Some 87% of the companies said they had felt this shortage. An even higher number pointed out the need for agricultural pilot schools. However, survey results show the average company in the field could not absorb more than one additional pilot a year, even if many were available.



Profile of an Average Air Applicator, 1956:

Investment	$48,000	Acres treated	57,000
Income	58,400	Sprays used, gal.	63,800
Flying Hours	761	Dusts used, lb.	367,510

Applicators Want Many New or Improved Chemicals

Insecticides to control	Crop
Cabbage looper	Lettuce, cabbage, cotton
Thrips	Beans
Mites and aphids	Row crops and fruit
Cut worms	Cereal grains
Mosquitoes	Rice
Mosquitoes and gnats	Towns and swamps
European elm scale	Elm trees
Herbicides to control	
Annual weeds	Wheat and barley
Broadleaf weeds	Beans
Bindweed	Wheat
Thistle	Peas
Johnson grass	Corn
Hardwood	Pine forests
Fungicides to control	
Mildew	Lettuce and cantaloupe

Equipment and Safety

Piper planes, as reported, outnumber any other type used in the industry. Average number of planes per company was 4.2, compared with 3.5 in 1952 (AG AND FOOD, May 26, 1954, page 546).

Offering no apologies for their safety record, applicators told the NATA most claims against them are being settled out of court, and dollar value of claims remains low. In 1956, five accidents occurred in spraying for each one in dusting. This ratio is about the same as that between the number of acres sprayed and number of acres dusted.

Influencing Farmers

How to reach large numbers of farmers quickly is the problem now

THERE'S MUCH MORE to gaining farmer acceptance for a new agricultural chemical—or practice—than getting the most progressive farmer in each community to adopt it. And strong support from the county agent, the university extension service, and the state experiment station, while necessary and extremely important, is not an airtight guarantee that a meritorious product will quickly achieve success on a broad (profit-producing) scale.

The great majority of farmers and growers, according to the now famous Bohlen and Beal studies at Iowa State College (AG AND FOOD, July, 1955, page 577), may lag two, five, or even more years behind the "innovators" in taking up new farm practices. But the manufacturer of a farm chemical needs the market provided by the majority if his new product is to pay its way.

How can the agricultural chemicals industry reduce the lag between first awareness and general adoption of its products? How can it reach—and influence—the millions of potential customers who traditionally hold out until "friends and neighbors" have tried the new practices and reported them profitable?

At the 24th annual meeting of the National Agricultural Chemicals Association last month at Spring Lake, N. J., several guideposts were erected, although no pat answer was offered. Key to the situation lies in the shape of the acceptance *vs.* time curve, which characteristically rises very slowly for quite some time after a new practice is first introduced, then rises rather sharply as the practice begins to catch on with the bulk of potential users, and finally levels off as the saturation point is approached. To reduce the delay between introduction and general use of a new chemical, obviously, the manufacturer must find a way to eliminate or shorten the initial flat portion of this curve.

To do so will require a major upset in the existing pattern of influences which motivate growers to adopt technical advancements. It probably means relegating "friends and neighbors" to a less critical role in determining when the grower will try a new product or procedure, and replacing that group with other influences subject to closer control or supervision from the product's sponsor. It might also mean speeding up the process by which friends and neighbors become informed, or perhaps seeking out the key friends and neighbors and working more closely with them to speed up the adoption process.

Acceptance of a new practice, Bohlen and Beal reminded NAC members, is actually a five-stage process for the individual farmer:

- Becoming aware that the new practice exists.
- Acquiring information about it.
- Evaluating it through discussion and thought.
- Giving it a physical trial, usually on a limited scale.
- Adopting it as a part of operating procedure.

At each of these stages the farmer is subject to a number of outside influences, chief of which are mass media (newspapers, magazines, radio, television), county agents and farm extension workers, commercial concerns (manufacturers, dealers, salesmen), and neighbors and friends. In general, the "neighbors and friends" group is increasingly influential as the individual farmer moves through the various stages toward adoption. Somehow the industrial or commercial interests must secure a greater role for themselves, particularly in the latter stages, if they are to shorten the time now lost in the stage-to-stage progression.

They must also take a hand in reshaping the diffusion mechanism by which this five-stage adoption process percolates through the farm community. It is usually easy to gain acceptance of a worthwhile practice by the "innovators" in each county. These individuals, few in number, are well advanced in farm technology, and are nearly always ready to try something new. But there is a lag between this group and the next—the "early adopters"—who are more numerous, but a little less quick to accept change. Next come the informal leaders or "early majority," and then, as the diffusion process gathers momentum, the "late majority." Here again, as adoption of the new practice spreads, "friends and neighbors" take on increasing importance as sources of information and advice concerning adoption.

By the time the "late majority" group has been largely converted, several years have elapsed since the new practice was first hopefully launched. To change this mechanism requires that the mass of "average" farmers who comprise the early and late majority groups be somehow induced to accept recommendations for change earlier in the game, without waiting so long to see what the neighbors do.

The big question this time is how to reach the large numbers of individual farmers. Bohlen and Beal offer no panacea, but their research does indicate that an alert and aggressive local dealer can speed up the diffusion mechanism in his own community.

The dealer who appears to play an influential role is more than an order taker. He is a person who understands the total farm management picture, and is thus looked to as a valid source of information. He works through face-to-face contact, found important in the research. The dealer who not only sells, but also helps the farmer carry out his trial, and then helps interpret results both during the trial stage and after adoption, is most likely to achieve continuing sales effectiveness.

While fertilizer and pesticide dealers and salesmen have shown up rather poorly in most studies to determine how farmers are motivated to buy or try, there may have been some built-in bias in most studies completed to date. Most results have been reported as averages for a number of farm innovations, including not only new materials or products, but also new practices—contour plowing, for example. In some of these practices, there would be no reason for the exercise of influence by dealers; grouping these with other innovations, therefore, may result in unduly low marks for the commercial representatives.

But even with allowances for unintentional bias, the dealer and salesman obviously have not yet realized their full potential as sources of information and advice for the bulk of the farm population. These groups are certain to be the subject of increasing attention (Dow Chemical is already sponsoring at Iowa State a Bohlen-Beal experiment station project evaluating the dealer's role in influencing farmers to adopt improved practices), as the drive to speed up communication—and trade—between farmers and farm chemicals producers gains momentum.