Ag and Food Interprets . . .

- **Grasshoppers licked for this year with little damage to crops**
- **Too little lime is used, but too much lime is warned against**
- **Operations research may bring better crop forecasts**
- **Colors and odors for fertilizers sold to suburbia**
- **Chemical process industries aim products at farm market**

Hopper Fight

Western grasshopper infestation licked by insecticides; crop damage virtually nil

FARMERS, workers from USDA and state departments of agriculture, and extension specialists who battled the western grasshopper infestation are breathing easily now. Their fight against the worst grasshopper plague in more than 20 years has been successful. And although the insects caused some crop damage, consensus is that it could have been much worse if control programs had not been set up in the nick of time.

Major trouble spots were parts of Colorado, western Kansas, western Oklahoma, northeastern New Mexico, and the Texas Panhandle. Cash crops affected included wheat and sorghum; considerable rangeland and waste lands were infested, too. Estimates of the acreage involved vary—USDA says from 10 to 12 million acres, scattered over 70 counties in the five states.

In their spray program, the control workers were up against a deadline imposed by nature. Using aldrin, dieldrin, or heptachlor (2 ounces of insecticide per gal. diesel oil), they had to achieve two major objectives before the insects matured enough to lay eggs and migrate. The first goal was simply to kill as many grasshoppers as possible. This done, preventing crop damage by preventing migration loomed as the biggest hurdle. Fortunately, though, winter wheat was far enough along—in some states harvesting was actually taking place at the time—that the danger to wheat turned out to be slight. But rangelands did not fare so well. Some damage occurred, although far less than the size of the infestation would normally indicate.

The deadline for the different states varied by a few days. In Kansas, for example, July 1 was target date for completing the spraying program. Kansas State College's Dell E. Gates says the program was completed in time. Most of the treatment there consisted of roadside spraying, while a half dozen counties were sprayed by airplane.

About 80% of the infested area consisted of rangeland. USDA says that more than 50 airplanes, operated by contractors, were used in spraying the ranges and some roadsides. Each plane carried from 180 to more than

Most of the fight against the grasshopper was done with ground rigs such as this one in use near Dalhart, Tex.

Planes sprayed most of the rangeland and occasionally some roadsides as shown here

2000 gallons of insecticide mixture. Even with weather and other obstacles confronting the air sprayers, the task was completed in time. Heat and wind were the air sprayers' biggest bugaboos. And in Texas, no spraying is ever done on weekends.

Ground Rigs Do More Than Half

Despite the huge amount of air spraying, over half of the insecticide application was done by ground rigs. USDA provided 44 high-power ground spray machines for this use, called the most urgent phase of the program. Most of the spraying took place along roadsides and the margins of cultivated fields, as well as on other waste and idle lands near crops. A big part of the job was done by farmers and ranchers themselves in cooperation with federal, state, and school officials and commercial applicators.

The three major types of control program used included:

- Rangeland—in this program, separate contracts cover the insecticide and its application. Sometimes one contractor gets a package deal in which he supplies both materials and application services. In other instances, though, a chemical company, e.g., sells the material while equipment and application are contracted separately.
- Roadside—counties buy the insecticide, and the states supply labor and some equipment. USDA furnishes most of the equipment as well as technical supervision.
- USDA-County Cooperative—under this program, USDA signs an agreement with a county to provide treatment for a certain number of acres including roadways and grass land. Cropland is excluded from this program. The county is the actual contracting agency for materials and for application. USDA pays one-third of the cost per acre, up to a limit of 25 cents per acre. Total federal costs in this instance ran up to $1 million.

No Guarantee for Next Year

USDA is optimistic that this year's program will markedly cut down the grasshopper population next year. But this may not necessarily be so. In Kansas, for example, there was at this time a year ago no indication of a huge grasshopper infestation. A flight of the insects settled on fields in the fall, and the eggs they laid then led to this summer's problem. So, according to Kansas State, although the rest of this season promises to be clean, there is no guarantee that another flight of insects will not hit the area this fall, calling for a repeat performance next year.

Intelligent Liming

While many agriculturists step up efforts to get farmers to use more lime, some warn of over-liming

ALMOST ALL EXPERTS AGREE that American farmers on the whole use too little lime. Last year's estimates pegged agricultural use of lime at about 22 million tons, while estimated requirements ran upwards of 80 million tons. Most of the 300 million acres of agricultural land which could stand liming lies in the humid areas of the country—areas which receive more than 20 inches of rainfall a year. Some soils, such as those in the Far West and Southwest, are naturally alkaline.

Chief use of lime, of course, is to neutralize acidic soil. But it does much more than that. It improves the physical condition of the soil, hastens decomposition of organic matter, improves tilth, and acts in effect as a calcium fertilizer. It also increases the efficiency of other plant nutrients.

Take the case of nitrogen, for instance. Excessive soil acidity can be extremely detrimental to efficient plant use of reduced forms of nitrogen, such as anhydrous ammonia and urea. Plant absorption of ammonium nitrogen occurs most rapidly in the pH range of 7 to 8, and decreases with increasing soil acidity. Soil reaction, however, has less effect on nitrate nitrogen absorption. Nitrate is most rapidly absorbed in the low pH (high acidity) range of 4 to 5. Highest total absorption of nitrogen takes place at about pH 6, and when both ammonium and nitrate are present.

Since a large percentage of soils tested have a pH below 6, the need for lime is apparent. And even after the proper soil reaction is achieved, additional lime is needed; it takes about two pounds of limestone to offset the acidity produced by applying one pound of nitrogen as ammonium nitrate, anhydrous ammonia, or urea.

Much effort has been and is being made to get farmers to use more lime. Federal, state, and county agencies, trade associations, and industry have distributed reams of literature describing the merits of lime. Many kinds of promotion and demonstration programs have been held throughout the country. But amid all this clamor, some soil experts worry that farmers may throw caution to the winds and lime indiscriminately. They argue that too much importance is given to the reading on the pH meter, and not enough to the over-all fertility of the soil. For in order to obtain a proper chemical balance in many soils, both lime and fertilizer are required.

During past liming crusades, farmers saw that raising the pH of highly acidic soils, with lime, brought increased crop yields. Many immediately jumped to the conclusion that acidity was the cause of all their troubles. Research has proved, of course, that this is not necessarily true. It is often not acidity, but the low nutrient availability accompanying acidity, that is detrimental to proper plant growth. In some cases, acidity can even be beneficial.

The proponents of proper liming point to a simple set of facts to prove their point. Adding soda lime, or sodium carbonate, to acidic soils will raise their pH. But it usually will not improve plant growth. The reason—sodium, unlike the calcium in limestone, is not a plant nutrient.

Besides reducing soil acidity limestone supplies calcium and, often, magnesium, nutrients severely deficient in leached soils. But when farmers lime soils which already contain large amounts of calcium, they may be doing more harm than good, say some. Lime stimulates the decomposition of organic matter. But to add lime to sandy soil that contains little organic matter is to rob crops of the benefit of this material. Too much lime on sandy loam or loam soils may also lock up trace minerals such as boron and manganese, and cut down on the availability of other nutrients.

Acidic soils contain excessive hydrogen. They may also have considerable calcium and other nutrients—magnesium, potassium, manganese, and others. These are usually held, however, with less force than either the hydrogen or calcium. Suppose enough lime were added to neutralize an acidic soil, that is, bring its pH up to 7. This would substitute calcium for the hydrogen, but other nutrients would be more readily driven out and subsequently leached away.

Excessive liming, then, would not only drive out the hydrogen, but would also drive out all other fertility cations except calcium. And plants with a calcium-only diet, even though on neutral soil, would fare no better than if they were on acidic soil and lacking other nutrients. A situation of this kind exists in some of the semi-arid soils of the western states.

Obviously, all of this does not mean that lime is unnecessary. There are too many statistics from too many places which indicate differently. But it does mean that liming must be done intelligently. To do this requires a more thorough soil test than can be obtained with a pH meter alone. A thorough soil analysis should be performed to indicate the amounts of exchangeable calcium and magnesium (and in some cases, sodium and potassium, also), and the total exchange capacity of the soil. The chemical composition of the liming material (e.g., high calcium lime, dolomitic lime) should also be considered. With this information, farmers can plan an intelligent liming program.

Toward Better Crop Forecasts

Operations research may bring more accurate predictions, but many difficult problems must be solved first

CROP PREDICTION—in terms of yield, quality, and maturity date—is a subject of major importance to almost all segments of the agricultural industry. But present forecasting techniques are far from adequate. True, USDA publishes widely quoted figures predicting yields of key crops. And universities and food processors have made some progress in increasing the accuracy of their estimates of maturity dates. However, there is a real need for more precise forecasts which will be applicable to specific situations.

Probably the best ultimate approach to accurate forecasting is to apply the techniques of operations research to derive meaningful correlations. Proponents suggest that such a procedure

Modern high-speed electronic computers make it possible to process all the data that will have to be collected and analyzed for better crop forecasts

could be very fruitful. Many workers in this field, however, feel that there will be formidable difficulties in practical application.

In simplified terms operations research can be described as the scientific application of mathematical techniques to business problems. And crop prediction is primarily a business problem. Application of operations research techniques to crop prediction might work out something like this. A team representing several scientific disciplines (an agronomist, a mathematician, and a climatologist, for example) would identify the most important factors influencing yield, quality, or maturity date of a given crop. Past records would then be used to establish mathematical relationships among the variables. These relationships could then be used to make accurate forecasts.

Superficially, at least, this attack on the problem is appealing in its simplicity and promise of scientific accuracy. And the key to the whole thing, say some operations research specialists, is the availability of modern, high-speed electronic computers. For the number of variables involved is so great that machine handling of the data is the only possibility. Now, with high-speed computers to tackle the job, accurate predicting methods can be formulated, say the advocates, by a relatively straight-forward operations research approach.

Not so, say other experts in agriculture and in operations research. They point to the many and difficult problems which must be overcome before an operations research team could have any chance of developing a successful forecasting method.

The extent of these problems can be shown by reference to the hypothetical example, examining the steps in some detail. The first need is to "identify the most important factors influencing yield, quality, or maturity date." In most cases and for most crops the major factors and their relative importance are not known. They certainly will differ from one crop to another and possibly will differ with geographical location as well. So first, before even a start can be made with one crop, the effects of the various factors must be determined under carefully controlled conditions.

This is the approach of F. W. Went of the Earhart Plant Research Laboratory at California Institute of Technology. By working under conditions of complete environmental control, Went has been able to determine those factors (and their timing) which are of the most importance to the yield of a particular crop. In this way he has shown, for example, that higher temperatures in the early growing stages are advantageous for beet sugar production, while later in the growth cycle lower temperatures are needed. In this case, it also turns out that night temperature and not average temperature is the important factor.

Once basic data have been obtained on the factors governing yield and maturity of a crop, it should then be possible to use past records to develop the mathematical relationships needed for prediction. Unfortunately, in most cases, past records are totally inadequate for the job. The science of meteorology, originally developed primarily to satisfy the needs of agriculture, has become almost entirely aviation-oriented. As a general rule, weather data are recorded in urban areas, at airports, and at other locations which have very little relation to the climate affecting agriculture.

Micrometeorological data, to be useful for crop prediction, need to be obtained in the fields where crops are grown, and at or near ground level. One authority has pointed out that there is often a greater temperature gradient between the conventional instrument shelter and the ground below than there is between two shelters 100 miles apart. And most of the available data are deficient not only in location of the observations, but in kind as well. Soil temperatures and soil moisture content may have a much more important effect on plant growth than air temperature and precipitation.

Two basic requirements must be met, then, before a successful operations research attack on the problem of crop prediction can be undertaken:

- Data must be developed experimentally on the major factors (and the influence of timing on these factors) affecting growth of a particular crop.
- Microclimatological records covering the factors of major importance must be collected over a considerable period, along with information on crop yield, quality, or maturity.

Operations research can then develop quantitative relationships among variables. But even then the way will not have been completely cleared for accurate prediction of the crop. Meteorological research must first provide adequately precise methods of forecasting the microclimate. Then only will it be possible to forecast accurately—for a particular crop in a particular area—yield, quality, and/or maturity date.

Development of a masking and reodorizing compound for a fertilizer involves the possible use of as many as 5000 different aromatics. A corner of the stock room in the laboratories of Dodge & Olcott where a perfume technician is making a selection

Colors, Odors for Fertilizers

Home owners are today's major targets for fertilizers that look and smell nice

FERTILIZERS are getting more colorful and fragrant. In a bid for expanding markets, an increasing number of fertilizer companies are adding colorants and odorants to their products. Those that do are confident they're helping to boost sales. As one fertilizer company v.p. recently pointed out: "Use of these additives has definite sales promotion and consumer advantages—advantages that cannot be overlooked."

The total volume of colorants and odorants used in fertilizers today is anybody's guess. Davison Chemical reports that it is currently using about 24 tons of colorants a year. Assuming that 2% of all mixed fertilizers sold in the U. S. contain an added dye or pigment, this possibly represents a market for about 500 to 800 tons of colorants a year.

Fertilizers containing colorants and odorants are mainly intended for the homeowner. The average farmer may not be too concerned about what a field fertilizer looks and smells like, but homeowners are likely to be considerably more fastidious. An attractively colored product with a clean, floral odor can pack extra appeal—especially for women, who do a high percentage of the nation's gardening.

By now, use of colorants in fertilizers is fairly common. And even though their use is largely in specialty fertilizers for homeowners, colorants are beginning to appear more widely in the farm field. DuPont's Nugreen, mainly a farm fertilizer, contains a colorant that imparts a distinctive green. Its Uramite slow-release fertilizer has a rich yellow color. Swift's Golden Vigoro also is colored yellow.

Davison's Davco Gold, a 15–15–15 farm fertilizer, is treated with a yellow ochre dye. Nurish, Davison's 20–20–20 for home owners, contains a blue-green colorant that helps spruce up the product's appearance as packaged in clear polyethylene bags.

Smith-Douglass makes a 14–14–14 farm fertilizer that's colored green. Spencer recently introduced its Spensol Greeen, an ammoniating solution colored green to highlight the fact that it contains a new corrosion inhibitor.

Many other fertilizer companies also add colorants. Olin Mathieson's Plantrons 12–24–12 for lawns and gardens is colored a pale shade of green. The Thrive lawn fertilizer made by International Minerals contains 1% of an iron pigment to impart a pinkish tan.

Companies are convinced that color is an important help in promoting brand consciousness. It's particularly useful in identifying premium-grade fertilizers. It also helps standardize product color, which might otherwise vary from one batch to the next, and in some mixed fertilizers, it helps to make all the particles the same color.

One problem, of course, is picking the right color. If it's designed to promote brand awareness, it should be fairly distinctive. It should give uniform color to all particles in a fertilizer mixture. It should require a relatively inexpensive dye. And, in addition, the color should be pleasing—attractive but not flashy.

Added Fragrance

Use of odorants in fertilizers is a fairly recent development. Usually, they are added to mask an inherent bad odor, but they may also be used to impart a new one. To a lesser extent, they are used to give scent to an essentially odorless fertilizer.

Rarely is the added odor anything remotely similar to "Evening in Paris." The odorant may suggest rich moist soil, humus, peat, or new-mown hay. Sometimes it lends a distinctly barnyard odor. To some farmers and gardeners, a fertilizer just isn't "the real stuff" unless it reeks. To satisfy the demands of these users, odorant manufacturers are equipped to supply a whole range of barnyard and stable smells. In the past, some producers of essentially odorless fertilizers have imparted a smell by tossing in a few handfuls of meat scrap or fish meal.

Biggest use for odorants is in organic fertilizers such as sewage sludge, manure, tankage, dried blood, and meat scraps. The additives serve mainly to camouflage the odor. California Spray-Chemical, for example, uses a special additive to mask the fish odor of its Ortho-Gro plant food. Before introducing this odorant, Calspray received quite a few complaints from homeowners who had found their lawns overrun with the neighbors' cats and dogs, smelling or digging for fish.

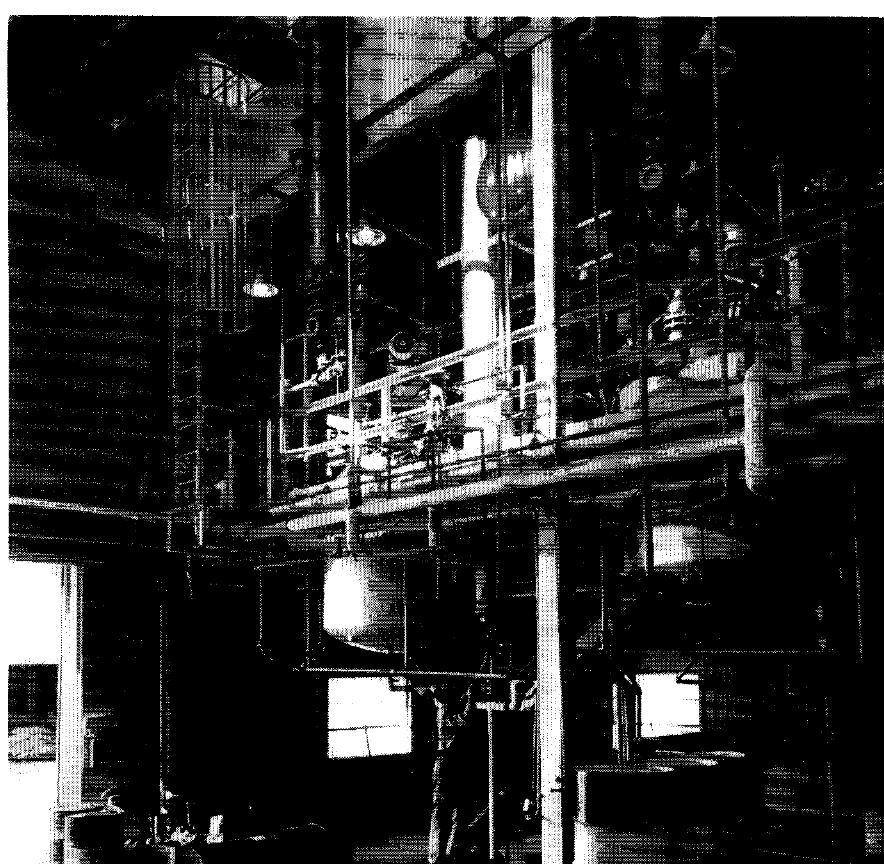
Dodge & Olcott, a large supplier of aromatics, reports that many of its customers in the fertilizer industry want an odorant with a fruity smell. Peach, strawberry, and citrus odors are popular. There is also a demand for violet, pine, and vanilla odors. These are smells of the clean, fresh outdoor type. A combination of lemon-orange-grapefruit smell has been particularly successful, the company says.

Fritzsche Brothers, another leading supplier of odorants, finds that its most widely used product in fertilizers is Neutroleum Alpha. It provides a fresh aromatic odor with a touch of spice and pine. The company reports that fertilizer manufacturers generally prefer clean, indefinite, or floral type odorants.

For the home market, Olin Mathieson makes a liquid lawn fertilizer called Rosy Future. Basically an odorless material, it contains phenyl ethyl alcohol, supplied by van Ameringen-Haebler, to give it a rosy fragrance.

It's the rare fertilizer for farm use, however, that contains an odorant to pretty up the smell. As International Minerals emphasizes: "Let's face it. The average farmer has spent plenty of time around a barn. He knows what it's like. He's not *that* fussy." Yet one odorant manufacturer comments that: "With the advent of the fragrant life into merchandizing circles

Glass lined kettles are used by van Ameringen-Haebler to make phenyl ethanol, an ingredient in the odorant Olin Mathieson uses in its Rosy Future fertilizer



at all levels, even the venerable manure-type fertilizer is now being subjected to olfactory overhauling."

How Much to Add

The concentration of odorant used in fertilizers varies, depending on the material. A really bad smelling fish meal might require 0.2% of an odorant. For most fertilizers, from 0.05 to 0.1% is sufficient. Often the smell of a fertilizer becomes objectionable only when it is heated or wetted. Available for such fertilizers are odorants that become effective only when subjected to heat or moisture.

Usually, the odorant is added just to the fertilizer. In some cases, it is also added to the bag. A package with an attractive smell can be a potent sales gimmick, especially since many buyers of specialty fertilizers select their brand mainly on impulse.

Both odorants and colorants must be fairly cheap. One odorant supplier estimates that it ordinarily costs no more than about 60 cents to $1.00 to odorize a ton of fertilizer. "This small expense," he says, "should be no deterrent." Yet quite a number of fertilizer companies believe that, for at least some of their products, this much added cost would be hard to justify.

Nevertheless, use of these additives in fertilizers appears certain to increase. With the growth of suburbia, home gardening is becoming steadily more popular. More and more lawns need to be kept up. At the same time, homeowners are becoming choosier not only about the nutrients in fertilizers but also about their aesthetics.

The market for colored and odorized fertilizers on farms is considerably less certain, mainly because of cost. But who knows? Some day the typical American farmer may insist that his mixed fertilizer be a subtle shade of red-orange and that its odor be that of pine, mingled with peach-raspberry. But for most fertilizer companies, that day is still a long way off.

Other Chemicals for the Farm

Continuous growth characterizes farm market for many CPI products besides pesticides and fertilizers

COMMERCIAL farming today, like any other large industry, is specialized, complex, and highly capitalized. Through the commercialization of agriculture, half of all farms in this country produce over 90% of all farm products sold for off-the-farm consumption.

Just as they are major users of fertilizers and pesticides, commercial farm operators also are large users of other chemical process industry (CPI) products. These range from antifreezes to zinc-coated metal products. In between are a myriad of products including many types of feed supplements, veterinary medicinals, paints, plastics, and preservatives.

But by far the largest is the class of petroleum fuels. To power their cars, trucks, and tractors, farmers purchased over 6.6 billion gallons of motor fuel in 1955, the last year for which complete estimates are available. To lubricate these engines, slightly under 133 million gallons of motor oil was used in 1955. In addition over 2 billion gallons of petroleum products went for other fuel uses.

According to the American Petroleum Institute, the average farm tractor is used about 800 hours annually. Modern tractors with more power and speed plus "convenience" accessories that almost immediately become necessities—lights, power takeoffs, and many hydraulic attachments—continue to raise this in-use time. Result—farm fuel use jumps. In some states, Texas for example, farmers and ranchers as a group are the largest users of petroleum products.

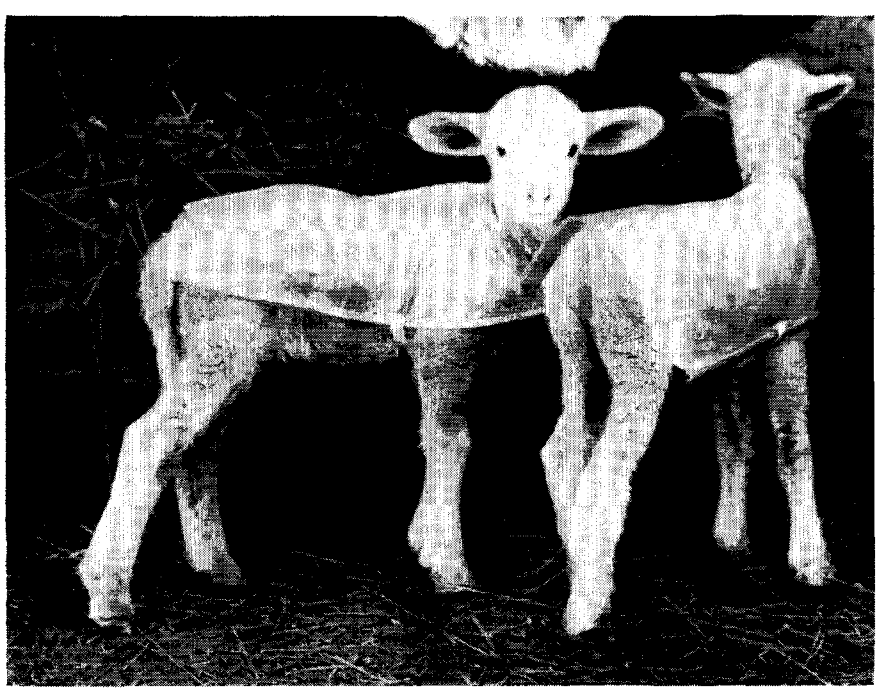
LPG Booms

While gasolines still make up between 80 and 85% of tractor fuel used annually, liquefied petroleum gases show large increases in consumption. According to officials of the Liquefied Petroleum Gas Association, farmers are estimated to use 400,000 LPG-fueled tractors—each of which, on the average, burns between 900 and 1000 gallons of LPG annually. With a net increase of 60,000 to 80,000 LPG-fueled tractors each year, consumption of LPG for tractor fuel should easily reach 500 million gallons annually by 1960.

But LPG industry economists point out that tractor fuel accounts for just a little more than a quarter of all LPG consumed on farms. Big use is in the farm home—for cooking, and house and water heating.

Productive uses for LPG on farms are as varied as is farm produce. LPG heats incubators, brooders, and watering tanks; it sterilizes milk utensils and other equipment; it dehydrates or dries fruits, vegetables, small grains, forage crops, and many others; it prevents frost damage; it warms ripening rooms. Poultry farmers use it for scalding and waxing. And LPG smokes meat, cures tobacco, and helps to control weeds.

One of the newest uses of plastic on the farm and ranch is the Lamcoat, a vinyl plastic coat that keeps new-born lambs warm and dry even on the open range



Nonfuel petroleum products on farms take on an ever-increasing variety of tasks. For example, solvents or carriers and diluents for hydrocarbon pesticides have grown along with the pesticides. As part of a trend toward light oils as herbicides, a rig for spraying naphtha (called lateral oiling) on cotton to control grass and weeds has been developed in Texas. Cost runs $1.00 to $1.50 per acre plus tractor operating costs. A hand operated "jet gun" sprayer developed at Texas A&M uses a hydrocarbon with or without a synthetic herbicide to control scattered patches of grass and weeds more cheaply than does hoeing.

An Esso oil product is used to retard growth of suckers on tobacco plants. White petroleum oils are used for veterinary purposes.

Convenient bulk distribution is one reason for the substantial gains shown in tractor and other farm use of this fuel. Service stations have installed LPG facilities

Plastics Use Widens

Plastics, especially black polyethylene and poly (vinyl chloride) or poly (vinyl chloride-vinyl acetate), for farm use grow at a rapid rate, but their total volume remains small compared to total plastic sales. Farm use of plastic film and pipe, it is estimated, will exceed 30 million pounds this year and reach 60 million pounds by 1960.

Film goes into such uses as mulch (at an investment of $50 to $300 per acre of crop, depending on such variables as row spacing and film thickness), as silos and greenhouses, or into bags for fertilizers and seeds—to suggest a few applications. Black polyethylene provides much of the film mulch. Because the vinyls and polyesters have considerable resistance to deterioration by light, they go into plastic greenhouses.

But such applications do not just come naturally. Bakelite, for example, has spent five years with 33 agricultural colleges and universities in cooperative study and development of plastic film silos. Du Pont also has worked with state agricultural stations in the development of polyester films for use in plastic greenhouses. Monsanto and Spencer among others have test programs under way for use of polyethylene bags to ship and store agricultural products and materials, such as fertilizers.

Liners for farm ponds or canals offer another limited outlet for plastic film, and some test work has been done with butyl rubber for this use. However, specially prepared asphalts sprayed on ditches or on graded depressions to be used as ponds find wider use than film. When either is used, it is covered with a layer of soil or gravel to protect it against water-carried debris.

Savings from lower installation cost, and from reduced seepage and evaporation losses, offset initial cost of plastic pipe for irrigation use. Black pigmentation has reduced the sunlight deterioration problem greatly for exposed pipe. For smaller sizes, buried polyethylene pipe has an expected life well beyond 20 years. Butyl rubber has been used with success for portable irrigation piping in the Rio Grande Valley. A 50-foot length of 10-inch tubing weighs only 53 lb.

Other Products—Varied but Not Small

Much more varied than plastics used on farms are the feed supplements and veterinary preparations sold to the farm market. Feed supplements have grown rapidly in the past 10 years. These include long used materials such as salt (over 1 million tons annually) and other minerals (phosphates, and iodine salts), and newer mineral supplements containing manganese or other trace elements, antibiotics, vitamins, amino acids, diethylstilbestrol, and urea. Between 80,000 and 90,000 tons of urea goes into feeds annually. Preservatives for feeds hold unusual promise as growth prospects in farm markets.

Other products with small total tonnage, but whose importance looms large, are a wide variety of sanitary materials, detergents, and disinfectants. Not so small tonnages of explosives find their way into farm markets. Paints and other chemical preservatives for wood, metal, and other building materials are used on farms at rates exceeding the nation's over-all per capita consumption. While reliable estimates are difficult to obtain, some 9 million gallons of creosote, mixtures of creosote and coal tar or petroleum fractions, pentachlorophenol in petroleum solvents, and other preservatives were believed used to preserve wood fence posts in 1957, for example.

Obviously the range of CPI products used on the farm is indeed large. Where the limit of uses will reach is difficult to determine. But recognition of the farm market potential for the many products of the CPI brings more efforts to sell to this market. And as the farm market expands its potential, the CPI will be ready to supply the market.