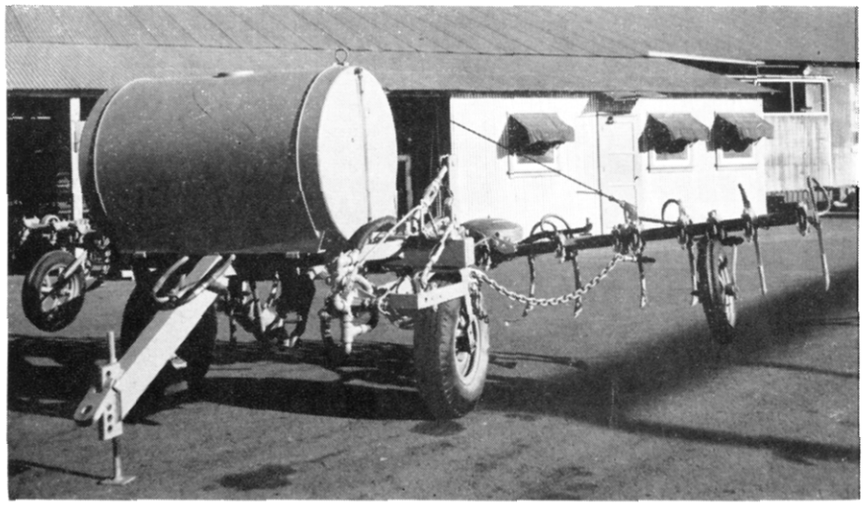
Ag and Food Interprets...

- **Liquid fertilizer dealers watch costs on application rigs**
- **Lower price key to bigger markets for urea-forms**
- **Colchicine can be valuable tool for breeding large varieties**
- **Studies of pesticides effects on wildlife urge judicious use**

Equipment Management

Liquid fertilizer formulators, dealers need to apply sound accounting practices to application equipment, while long-range trend is to farmer ownership of necessary rigs



To buy or lease liquid fertilizer rigs is dilemma faced by many dealers, applicators

THE LIQUID FERTILIZER industry becomes more firmly established each year. And with this "coming of age," it is moving in the same direction as its predecessors in new agricultural techniques—dealer and custom application first followed by farmer application with his own equipment.

The day will undoubtedly come when liquid fertilizer formulators and dealers can confine their activities to selling fertilizer, leaving application to farmers as their "dry" counterparts do today. Meanwhile, they must still carry substantial inventory in application equipment and apply sound management practices to its operation for some time to come, if it is not to be a financial burden. Newcomers to the liquid fertilizer industry see high gross margins between raw material cost and finished goods price, but they may overlook high costs involved in servicing their accounts—equipment delivery, haul-back, and maintenance. Thus, their rents for farmer application or for custom application are apt to be low—in effect, discounts on fertilizer sold. Trouble shows up as shrunken profits within a season or two when carried to extremes, especially in the haste to become established in highly competitive market areas.

Equipment operation costs obviously depend on the type of farming community within which a company operates. Costs in California's Salinas Valley, predominantly in vegetables, will differ from those in near-by San Joaquin Valley's vast cotton acreages. Costs will also differ between the West, say, where liquids are almost entirely injected (excepting irrigation application), and the Midwest, where most are sprayed on and plowed down. Specific prices, therefore, are meaningful only within the area to which they apply.

"Catalog" prices for dealer or custom application—rig, tractor, and labor—vary from $1.50 to $3.00 per acre in most sections of the country. Rig rent is about 50 cents an acre, with the farmer furnishing tractor and labor. How much these prices are shaded as one liquid company competes with another in a given area is anybody's guess. In California, where liquids are most firmly established, a fairly standard price for rent of an average injection rig is 40 cents an acre, but this may drop to 25 cents or lower in highly competitive regions. Price differences from area to area may also be due in part to the amount of service offered.

Few companies, apparently, have accurate accounting records on equipment operation. One company dealing in several states in the Midwest says, "Accounting charges to enable us to pinpoint equipment costs would exceed the value gained," and it believes its rough rule of thumb shows rent to equal or exceed operation costs. One of the West's larger and more successful companies, by contrast, has an extensive cost accounting system in operation. Here's what it finds (average figures based on the diversified regions in which it operates):

An average 24-foot injection rig costs about $2000 new. Such a rig can cover up to about 50 acres a day and work about 100 days a season. If rented at 40 cents an acre, income will be $2000 for the season, an impressive total until one starts subtracting costs.

First, the company finds useful life of injection rigs to be two seasons, as maintenance costs mount rapidly dur-

ing a third season. Therefore, the rig must earn 50% of the purchase price each year for depreciation. Secondly, the company finds delivery, haul-back, and maintenance total about $1000 a year. This, coupled with the $1000 depreciation, means rent must cover the full purchase price each year. If the rig can get in a full 5000 acres at 40 cents per, the company breaks even. Such optimum conditions seldom prevail in this company's experience, and it actually loses on the average at least $6.00 above the return by rental on every ton of fertilizer sold and applied.

Faced with a two-year service life for equipment, this California company strongly recommends the declining balance, three-year write off permitted for new equipment in computing taxes. (On a $2100 unit, amortization will be $1400 the first year, $467 the second, and $233 the third.) Only in this way does it feel it can come close to breaking even on equipment costs.

Reaction in western liquid fertilizer circles to the foregoing figures is mixed. Several companies—both equipment manufacturers and operating fertilizer companies—substantiate the "40 cents, 5000 acres" as an average maximum for one season for the rig in question. At least one equipment manufacturer, however, believes these figures should be closer to 50 cents and 10,000 acres. This company also takes exception to an indicated two-year useful life for injection equipment, believes it should be at least five years.

Equipment Purchase: Buy or Lease?

A second problem facing liquid fertilizer companies is equipment purchase. If the company lacks sufficient working capital to pay cash—and many newcomers are apt to be in this position—it must find a credit source. Traditional approach, and one recommended by many established formulators, is through the local bank. Common terms are 25% down and the balance in one or two years (or more, depending on loan size). Interest averages 5 to 6% a year on the amount borrowed. Where a large company establishes a dealership organization, it may lend its credit position to secure a lower down payment for dealers, such as 10% down and the balance in 36 months.

On the theory that formulators or dealers can profit by conserving working capital with a lower down payment and get a more extended line of credit by not having a note appear on the books as a liability, at least one western equipment manufacturer is promoting a lease arrangement whereby the prospective buyer needs less cash to get the use of equipment. Such leases are written for two years with an option to renew for three, or vice versa. In either case, at the end of the original lease period, the lessee can return the equipment, renew for the proper option period, or purchase the equipment at the then current market value. With either sequence of lease period, the lessee pays four months' rent in advance, amounting to a "down payment" of nearly 17% on the two year option, 11% on the three. Typical payment for $25,000 worth of equipment on a two-year-lease, three-year-option is $1237.50 a month. If the option to renew is exercised, payments are about $5.60 a month for each $1000 worth of equipment rented.

With these equipment management problems in the background (or foreground, depending on your view), it is not too surprising most in the liquid fertilizer industry are lending support to farmer ownership of equipment. National Nitrogen Solutions Association, for instance, is actively working with equipment manufacturers to develop new applicators and standardize fittings. National raw material suppliers, such as Allied Chemical & Dye's Nitrogen Division, devote ads in farm papers to promote farmer ownership.

Equipment manufacturers themselves support the trend to varying degree. Some, such as California's Fabricated Metals, still confine sales to formulators and dealers but acknowledge farmer ownership is probably coming. Indication of how formulators and dealers will promote this ownership comes from John Blue Co. (Huntsville, Ala.). General Manager W. D. Tucker puts it this way: "We are firmly convinced distributors and manufacturers will intensify sales efforts on equipment. In some instances they will sponsor their own brand names and in others sponsor equipment already manufactured by companies such as ours."

A word of caution comes from one prominent company, however, which "feels quite strongly that liquid fertilizer application can best be controlled by the dealer because the industry is still in its infancy, and custom service or supervised application by the sales organization is paramount." To this end, many of this company's dealers discourage use of custom applicators, and they retain a service relationship on those accounts where a farmer owns his own equipment.

Urea-Forms

Slow release nitrogen products find sizable market for use on turf and ornamentals; lower price key to expanded use

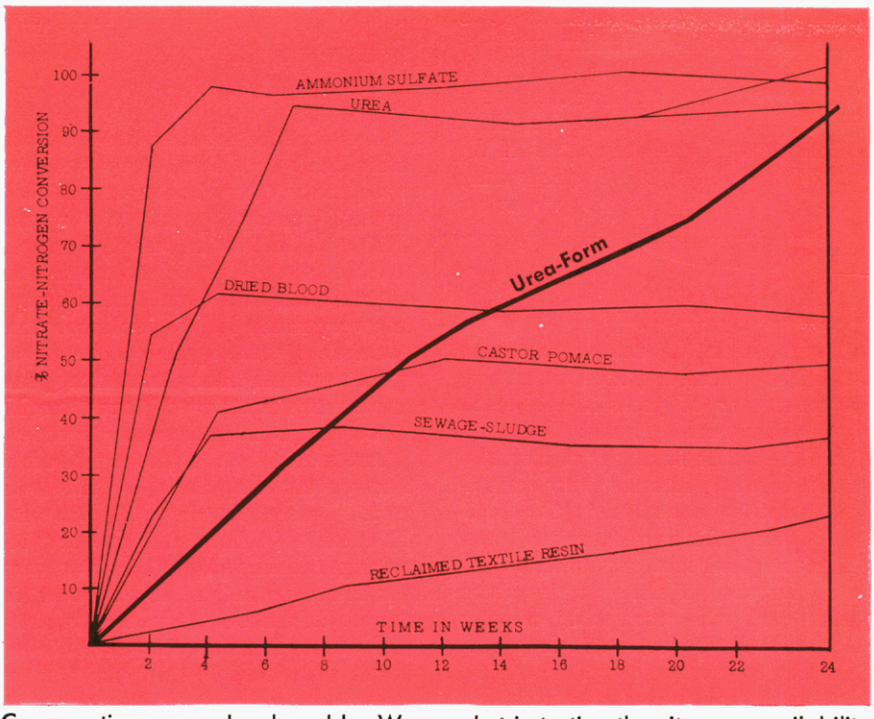
THE UREA-FORMALDEHYDE fertilizer products hit the commercial market only last year, but already promotion is being stepped up and industrial sources are forecasting greatly increased use this season. Advantage of the urea forms is that they have low initial solubility and release nitrogen slowly for a prolonged period; the problems of burning and leaching are eliminated. So far price has ruled out most applications other than to ornamentals and turf.

Technically the urea forms have been defined as mixtures of polymethyleneureas which exhibit urea-formaldehyde mole ratios greater than 1, nitrogen contents in excess of 37%, low solubilities in water and organic solvents, and lower rates of nitrification in soil media than the more soluble forms of chemical nitrogen fertilizers.

Development of these newly marketed compounds dates back to pre-world war II days. The USDA in collaboration with chemical companies producing urea-formaldehyde resins did the early field testing. Later, pioneering work was done on turf grasses at Penn State University and on ornamentals at Rutgers and the University of California. In 1946, trials were conducted by the North Carolina Agricultural Experiment Station on field and plant bed tobacco.

The fertilizer products differ from the highly insoluble plastic resins in that a higher ratio of urea to formaldehyde is used in the fertilizers. Quality measurement is of particular importance. Recognizing this the AOAC last year announced a new method for determing the nitrogen activity index of urea-forms. The activity index, arrived at by routine chemical methods, correlates closely with the wide spread greenhouse and field tests.

The reaction of urea with formaldehyde must be closely controlled to produce a polymer in which the nitrogen will be mineralized at a desirable rate when the polymer is added to soils under favorable environmental conditions. Transformation of urea in soils is a biological process depend-



Comparative curves developed by Woonsocket in testing the nitrogen availability of various materials. Company's urea-form is now being marketed as Nitroform

ent upon several soil factors. However, the urea forms have been found generally satisfactory in all soil types. While enzymatic activity is essential to nitrify urea-form materials, it is not essential to have an exceptionally high microbial development in the soil. Only a normal and even a low microbial activity will satisfactorily nitrify urea-form materials.

Allied Announces U-F Solutions

Early last month Allied's Nitrogen Division announced a new urea-formaldehyde solution from which formulators can produce granular-type fertilizers containing the slow release nitrogen. Trade named N-dure, the solution produces complete fertilizer mixtures but requires only standard ammoniation apparatus. A separate spray pipe in the mixer is used to introduce the N-dure into the superphosphate and other dry ingredients. This is done before introduction of the ammoniating medium.

N-dure contains only 12% nitrogen and consequently, in a strict technical sense, does not qualify as a "urea-form." But its mode of action is the same and it is certainly destined to be a factor this season in solid urea-form's market picture.

Feature of the liquid product, say Allied officials, is that it allows manufacturers, for the first time, to make mixtures containing a wide variety of ratios between water soluble and insoluble nitrogen. N-dure is being shipped in insulated steel tank cars from the Nitrogen Division plant at South Point, Ohio.

Basic producers of the urea-forms today include: Du Pont with Uramite; Borden with Borden's 38; Woonsocket Color & Chemical with Nitroform; and Swift in Golden Vigoro.

Du Pont announced Uramite in June of last year. But development had been under way since 1938. Pilot scale production was used for exhaustive field tests in all regions of the country. New plant facilities were constructed at Belle, W. Va., to produce it.

Borden's 38 is being sold in 50- and 25-pound bags, 5- and 1-pound cans and even a 2.5-ounce shaker. Company spokesmen say cost of nitrogen is no more than cost organic fertilizers containing only 3 to 7% nitrogen.

Woonsocket Color & Chemical is offering urea-form both to the fertilizer trade for use in specialty mixes and to retail and consumer trade. The inclusion of the urea-form in mixed fertilizer goods will actually be quite a boom to this industry since it will now be possible to turn out extremely safe high analysis products, says a Woonsocket executive.

Swift's fertilizer product, Golden Vigoro, containing urea-form has been on the market for over a year. In the Swift process the urea-formaldehyde reaction is understood to take place right in the mixture.

The urea-forms are still too costly for widespread application. However, informed opinion is that with further progress in manufacturing techniques and with anticipated higher volume of sales the unit price of nitrogen from urea-form will be greatly reduced.

In California alone for just the turf and ornamentals market one experiment station official estimates an annual requirement of some 1000 tons of the urea-forms.

One producer confidently predicts that once the unit price of nitrogen from urea-form reaches a competitive position with natural organic nitrogen, the urea-forms will take over the vast majority of the market. This market could approach the staggering annual figure of 420,000 tons of nitrogen.

Some sources are classing development of the urea-forms as one of the greatest advances in fertilizer manufacture since the development of superphosphate. While this may be open to debate, there is no doubt that the urea-forms are potentially important to the fertilizer industry.

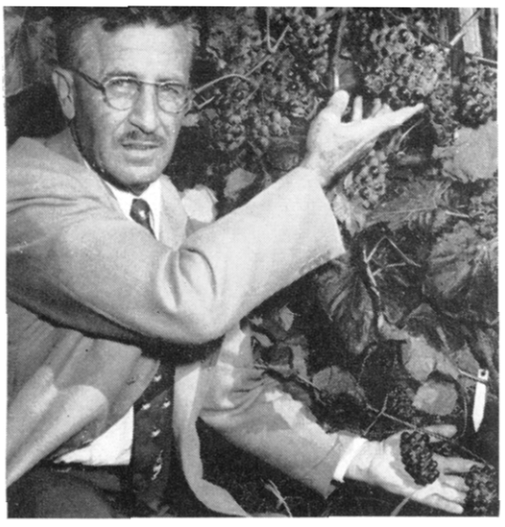
Colchicine in Agriculture

Drug provides potentially valuable tool for breeding crops with unusually large fruit, flowers, and seeds

Colchicine, a drug known for at least 35 centuries and used originally in the treatment of rheumatism and gout, is finding increasing application today in experimental plant breeding. Of special interest to growers, colchicine, an alkaloid derived from the crocus-like plant *Colchicum autumnale*, may profoundly alter the biological makeup of plants. In some cases, the result may be larger fruit, larger flowers, larger leaves, larger seeds. Fruit, for example, may possibly be produced in increased yield, with better flavor, greater nutritional value, greater disease resistance. By the action of colchicine, sterile hybrids may in some cases be made fertile.

Although colchicine can possibly produce changes of this type, the results thus far have fallen short of original expectations. Some early writers, confident in colchicine's ability to work biological miracles, were freely predicting that the drug would create an agricultural revolution. This, obviously, has not been the case.

In many instances, the disadvantages in using colchicine in plant breeding far outweigh the advantages



Haig Derman, USDA colchicine researcher, shows the bigger size grape on Loretto vine resulting from doubling of chromosome number

—at least for the present. New plant varieties obtained by colchicine treatment may be different from conventional varieties, but not necessarily better. Treated plants may have much lower fertility than normal crops, may be much more difficult to grow, or may grow much more slowly. The quality of treated fruit and vegetables may be impaired. Furthermore, because of the special techniques required in the breeding and growing of colchicine-treated plants, the cost of production may be appreciably higher.

Basic Changes

The fundamental property of colchicine is its ability in many cases to double the number of chromosomes in plant cells—provided the drug is applied in the right concentration and at the proper stage of cell development. Normal cells of most plants contain in their nucleus two identical sets of chromosomes. Before these normal so-called diploid cells divide, the chromosomes split lengthwise and each half migrates to opposite ends of the cell. The cell then splits in two, with each new cell containing the same number of chromosomes as the original.

On the other hand, when a dividing cell is treated with colchicine, the chromosomes, after splitting in two in the usual way, do not migrate to opposite ends of the cell, and the cell itself does not divide. As a result, the number of chromosomes is doubled, forming the new tetraploid variety. All cells subsequently produced from this tetraploid also contain twice the usual number of chromosomes.

Since chromosomes carry the all-important genetic factors in plants, this increase in number may have a substantial effect on growth. By use of colchicine, new man-made varieties of plants may be rapidly created that might otherwise take millions of years to be produced by natural means.

Unlike insecticides or herbicides, colchicine is not something the farmer sprays on his crops in the field. Rather, it is a tool in the hands of the plant breeder for use experimentally and possibly also for the production of seeds and plants used by the grower.

Worldwide Investigations

Research on the use of colchicine in plant breeding has been under way for more than 15 years in the U. S., Japan, England, Russia, Belgium, Sweden—in fact, in all major countries of the world. Virtually every agricultural experiment station in the U. S. has at one time or another used colchicine in plant breeding studies.

In Europe, triploid sugar beets, which are hybrids formed by crossing a colchicine-produced tetraploid beet with the conventional diploid variety, are now being grown commercially. These beets reportedly yield 5 to 10% more sugar than ordinary varieties. Thus far, however, triploid sugar beets have gained relatively little headway either in the U. S. or Great Britain. A big problem is that the production of high-yield triploids is a difficult, painstaking, and costly job that may not give sufficiently outstanding results compared to other methods of increasing sugar beet yields.

Japanese researchers report that tetraploid radishes are not only larger than ordinary radishes but are also more resistant to root disease. Tetraploid watercress is said to be more succulent, flavorful, and to have a higher vitamin C content. On the other hand, British scientists say that, despite some advantages, tetraploid watercress is still not sufficiently attractive economically.

Swedish investigators report that tetraploid rye is superior to conventional rye in the production of soft and hard breads. According to Mitchell Farms of Windfall, Ind., which has been distributing tetraploid rye in the U. S. for the last two seasons, this grain offers superior size, vigor, and yield.

In many laboratories, experiments are being carried out on the growth and properties of colchicine-modified corn, wheat, oats, rice, sorghum, flax, cotton, soybeans, tobacco, and oil-bearing seeds. One U. S. experiment station reports that a new polyploid cotton will shortly be released for commercial use. Elsewhere, researchers for many years have been working with colchicine to develop larger, more abundant Chinese tallow nuts in the hope of making this crop more economical in the U. S.

Modified Fruit

A major focus of attention has been colchicine's action on the growing of fruit, such as strawberries, cranberries, apples, peaches, pears, and others. The tetraploid of one variety of apple is almost twice the size of the diploid from which it was developed, although not very much larger than some conventional types of apples. Researchers report that in some cases tetraploid apples have superior resistance to cold.

Considerable interest has been expressed lately in the growing of seedless watermelons from hybrids produced by crossing the tetraploid with an ordinary diploid variety. The resulting seedless triploid, first grown commercially in Japan and later in the U. S., can be produced in greater yield than ordinary watermelons and is reported to be sweeter and to have better texture and storage qualities. However, because of problems involved in breeding seedless watermelons, costs are relatively high. American Seedless Watermelon Seed Corp. of Goshen, Ind., and others are convinced, nevertheless, that seedless watermelons will find widespread markets in the future.

By use of colchicine, scientists at the U. S. Department of Agriculture have created more than 30 different tetraploid varieties of grapes. Tetraploid Loretto grapes are nearly three times as large as ordinary Loretto grapes. This disease resistant variety should be of particular interest in the South, where ordinary grapes are often destroyed by diseases within two or three years. At least five years of additional research may be required, however, before enough is known about these tetraploid grapes to determine whether they can actually be grown commercially.

Much research is currently being done at the Department of Agriculture and elsewhere on the modification of flowers with colchicine. Work is in progress on carnations, snapdragons, lilies, phlox, rhododendrons, marigolds, African violets, and other plants. Colchicine may not only be able to increase the size of the flowers but may also improve their fragrance and intensify their color.

Colchicine today continues to provide the groundwork for extensive, long-term studies of plant breeding and selection. As researchers emphasize, colchicine, a compound on which considerably more research remains to be done, is obviously of value in the breeding of new plants.

Ag Chemicals and Wildlife

Studies recommend no more control legislation. Attention to recommendations and protective measures can minimize damage to and even benefit wildlife

WITH INCREASING USE of chemicals to destroy crop pests have come many side-effect problems. The Miller Amendment is a major step in guarding against food contamination. But there are other toxicity problems. One of these is possible destruction of wildlife. While investigations in the U. S. and Britain have advocated no additional restrictive legislation, both have emphasized the need for active attention to the problem on the part of experts in the fields concerned.

In general, it appears to be recognized, by agricultural chemicals producers, conservationists, and state and national governments alike, that wildlife is subject to dangers inherent in the increasingly widespread use of toxic materials. The extent of potential danger varies with control chemicals used, how and to what extent they are applied, and the specific wildlife which might feed on or come in contact with areas treated. At the same time, the opinion often expressed by informed persons, who have carefully evaluated and considered the problem from all viewpoints, is that the wise application as recommended of thoroughly tested materials poses no major problems.

Accidents and gross misuse of agricultural chemicals produce numerous, and unfortunate incidents, which in many cases have been grossly exaggerated and overemphasized. These result in opinions based on apprehension and speculation rather than actual facts. Bodies investigating reports of damage to wildlife often find actual extent of damage considerably less than indicated by earlier rumors—a single carcass seen by 12 persons separately easily grows to 12 carcasses.

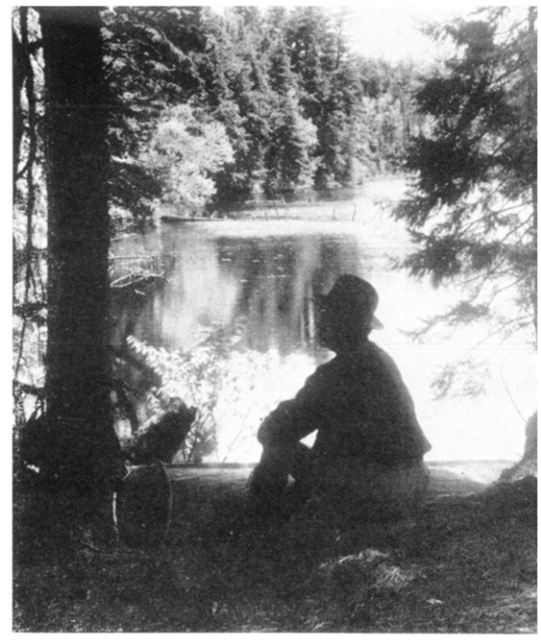
Those who say there is "little danger if applied under proper circumstances and in prescribed dosages" realize, nevertheless, that some wildlife is seriously affected by certain materials and some loss or damage is unavoidable. Whether very limited or serious enough not to be neglected, the danger to birds, animals, and fish is not easily compared with the economic benefits resulting from chemical use. It is difficult to measure the value of song birds or small animals, but wildlife is important economically, recreationally, and esthetically and bears consideration in serious discussions of chemical usage and effects, even though its value cannot be reduced to dollar marks.

Concern has spread far, and, damage to wildlife is receiving careful study and investigation in many areas. While the problem differs in different countries, there is striking similarity in some of the general conclusions reached. In Great Britain, where it is recommended that 10% of the country's 59 million acres be sprayed for needed agricultural expansion, and the people are sensitive to the beauty of the countryside, there have been many reports of game birds, bees, and other animals dying in fields treated with toxic chemicals and of unwanted changes in hedgerows and border shrubs following pesticide use.

In 1953, the appropriate Ministries in England and Scotland were asked "to investigate the possible risks to natural flora and fauna of the countryside from use in agriculture of toxic substances, including the possible harmful effects for agriculture and fisheries and to make recommendations." An extended study, including field experiments, followed.

The investigating body, in its report of last year, established that while dangers are difficult to define precisely and exact scientific answers difficult to formulate, potential dangers do exist, and measures should be taken to minimize them. However, and importantly, it concluded that the total casualties to wild birds and mammals caused by spraying during an average season is not high, and direct mortality from use of toxic sprays is very low compared with other causes of death. These conclusions, based on best evaluations possible under difficult conditions, nevertheless satisfactorily disprove less scientifically based rumors which suggest that near-extinction of wildlife results from agricultural spraying.

As observed by the U. K. committee, sprays most likely to be harmful to wild birds and mammals, in order of danger when applied under unrecommended conditions, are organophosphorus insecticides, arsenicals, dinitro weedkillers, and DDT insecticides. When applied as prescribed and proper precautions are taken, however, no serious danger would be expected from use of these chemicals.



There is little threat to natural flora and fauna from ag chemicals if used wisely

The U. K. committee concluded that no further legislation is at present needed to deal with or reduce damage to wildlife. It recommended: increased attention to proper labelling and instructions, application, and safety precautions; additional fundamental research and exchange of information between all interested bodies; and that the permanent committee responsible include nature conservation interests.

U. S. Studies

In the United States, work has been done on state, federal, and local levels. The Department of Interior's Fish and Wildlife Service keeps a cautious and continual lookout for damage to wildlife and evaluates extent of harm caused by toxic chemicals. According to this service, most herbicides appear to offer little or no direct hazards to birds and land animals, but their use to control submerged vegetation or presence as water pollutants may be hazardous to fish. Use of these compounds for removal of woody growths along streams and reservoirs may promote growth of desirable food for waterfowl, while similar use in forests promotes growth of berries and other animal food. At the same time, indirect damage may result from excessive destruction of cover and food for some wildlife. Hazards to fish are much more serious, death being possible from above 0.1 p.p.m. of copper sulfate, 5 p.p.m. of trichlorobenzene, 10 p.p.m. of the butyl ester of 2,4-D, or 100 p.p.m. of dinitrobutylphenol.

Application of insecticidal sprays or dusts necessarily exposes birds, fish, and some animals to immediate contact with relatively high concentrations or to prolonged contact with

toxic residues. The Patuxent Research Refuge is one of the Interior Department's branches which exerts extended effort and cooperation to determine the extent of this damage and to develop materials and procedures which will combine effective pest control with minimum wildlife hazards.

The Pennsylvania Game Commission might be considered typical of state groups involved in use and study of agricultural chemicals. It has dealt chiefly with herbicides and has found them exceedingly useful in game management. The commission's tests indicate that 2,4-D and 2,4,5-T and similar chemicals are not toxic if properly used. Sodium arsenite, when used as a spray or occasionally as a debarking chemical, has been found to be destructive to deer and possibly other browsing animals.

In a several-year study of the effect of chemical brush control on game food and cover in power line rights-of-way through forests, it was found that improved game food conditions resulted from all treatments. Common game species continued to use all treated areas during the third year of spraying tests, indicating that these areas were making an important contribution toward maintaining game population. At the same time, considerable saving in cost of maintenance of right-of-way was realized, guaranteeing lower cost of electric power to the areas served.

Published reports of damage to wildlife from toxic chemicals in U. S. are numerous and observations varied. Extent of damage ranges with chemical used, condition under which applied, and kind of wildlife present during and after spraying. Adequate information on many of the more common insecticides is not available, though constructive research is resulting in a continuing increase. DDT has been more intensively studied than any other compound, and informal recommendations for minimizing harmful effects of insecticidal operations have resulted. These include:

- Limiting rate of application to not more than 1 pound per acre.
- Restricting of insecticidal operations to minimum levels during bird nesting periods.
- Avoiding, in so far as possible, any direct application to water containing wildlife, or under conditions where excessive run-off might lead to water pollution.

Considerable information has been accumulated on other toxicants and adoption of similar recommendations, based upon relative acute and chronic toxicities are forthcoming.

An example of the thoroughness of some research in this field is a study on the effects of agricultural chemicals on wildlife undertaken a few years ago by the department of zoology, University of California (Davis) with assistance from the California Department of Fish & Game and U. S. Fish and Wildlife Service. A final report is now being prepared. The aim of the project was to accumulate and summarize all known facts regarding the biotic effects, methods of application, degree of usage, and areas where employed of all agricultural chemicals used in California. Data were accumulated from published reports and contact with large numbers of agriculture commissioners, farmers, sportsmen, and interested organizations throughout the state.

This study advocates, as did that in the U. K., no additional legislative restrictions. It advocates that the most reasonable method of ensuring safe chemical use is through joint meetings of experts representing the various fields concerned. Specific recommendations should come from such a group regularly and are the best that can be expected.

One problem which hampers satisfactory solution to the whole problem of agricultural chemicals and wildlife results from the extremes in opinion on the part of some conservationists, on the one hand, and pest control officials on the other. These have often resulted in an element of sensationalism in reports and publications devoted to the problem.

The long term answer to the problem of maintaining adequate insect, rodent, and weed control while, at the same time, restricting or minimizing harm to wildlife, rests in research and education. Environmental conditions affect the toxicity of agricultural chemicals to animals and plants, and thus basic toxicity information alone cannot be used to determine chemical hazards to wildlife. Other problems peculiar to any study of wildlife make extensive, accurate data difficult to accumulate. Continued research is necessary on the part of many different groups with widely varying interests—U. S. Fish and Widlife Service, state conservation departments, universities. chemical manufacturers, and public health services.

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