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Agricultural & Food Chemicals-Today

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AGRICULTURAL AND FOOD CHEMICALS-TODAY

Chemicals are an essential part of food and fiber production and marketing. Controversies regarding their use are as old as chemicals themselves. But the benefits far outweigh the disadvantages, so long as they are used with intelligence and caution.

For centuries man has used chemicals to help safeguard his food supply. The ancient Egyptians used certain dusts to help protect seed and grain put in storage. Nearly 3,000 years ago Homer, the Greek epic poet and author of the Iliad and Odyssey, mentioned the "pest averting sulfur with its properties of divine and purifying fumigation." Other ancient remedies for plant pests included fumigation with a mixture of boiled sulfur and asphalt and sprinkling plants with pure amurca of olives.

Whether or not we need chemicals in our modern society is hardly a debatable question. Pesticides, food additives, and a wide variety of other chemicals make it possible for all of us to have an adequate supply of attractive, palatable, nutritious, and economical food and other agricultural and horticultural products.

Pesticides enable crop growers to produce more efficiently and abundantly. Growers operate on narrow profit margins. By substituting chemical energy for mechanical and human energy they reduce costs of production. Pesticides reduce financial risks by giving reasonable insurance for stable production each year. Consumers are assured of lower food costs, higher quality, and a larger variety of foods than would be possible without pesticides.

Herbicides furnish a practical means to control undesirable vegetation that impairs human health (hay fever, poison ivy, other effects); interferes with use of water or recreation areas; obstructs drainage; destroys landscape beauty; increases maintenance costs of such things as buildings, roads, and railroads; harbors plant diseases; reduces land values; poisons livestock; or reduces quantity and quality of livestock products.

Many fruits and vegetables have not been produced successfully on a commercial scale since the late 1800's without the benefit of chemicals to control insects and diseases. And today, more than ever, high standards of quality place a high premium on pest control methods that make available wholesome, high-quality produce free from weed, disease, insect, and rodent damage and contamination.

Techniques of chemical warfare against pests have undergone constant development. Today a complex and varied group of pesticides is available to us through research and the chemical industry.

The concept of pest control is manmade. When man started to cultivate crops, build villages, and raise livestock, certain organisms in the same environment came into conflict with his interests and goals. The more man attempts to modify his surroundings, the more conflicts he encounters.

Nature is a constantly changing system in which there is continuous competition for available resources. Man has changed "natural" relations of organisms and their environment to controlled systems for adequately producing the food and fiber needed by increasing populations. Our highly intensive type of agriculture is not a "natural" state of affairs; it is an upsetting of the balance of nature in man's favor that is brought about by his knowledge and technology. When pesticides must be used it is to control organisms already out of balance, a situation usually brought about by man's other influences on his environment.

Man has introduced plants and animals that are more efficient in terms of food production but that require protection from other elements of nature. For example, corn, as we know it today, would not survive in a natural environment.

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TERMINOLOGY

Several terms in common usage are frequently misused or misunderstood. An *agricultural chemical* is a chemical agent used in food or fiber production, storage, or processing. A *pesticide* is a chemical used to kill or suppress an organism that in a specific situation is a pest. So the term "pesticide" can be something used to control weeds, plant diseases, rodents, insects, mites, ticks, etc. Among the pesticides are:

FUNGICIDES—to control fungi

BACTERICIDES—to control bacteria

NEMATOCIDES—to control nematode worm parasites of plants and animals

INSECTICIDES—to control insects and related arthropods

MITICIDES—to control mites

RODENTICIDES—to control rats, mice, gophers, moles, and other rodents

HERBICIDES—to control weeds or undesirable, unwanted vegetation

Some of these classes may be subdivided, for example, an insecticide may be an adulticide (effective against the adult stage of an insect) or a larvacide (effective against the larval stage).

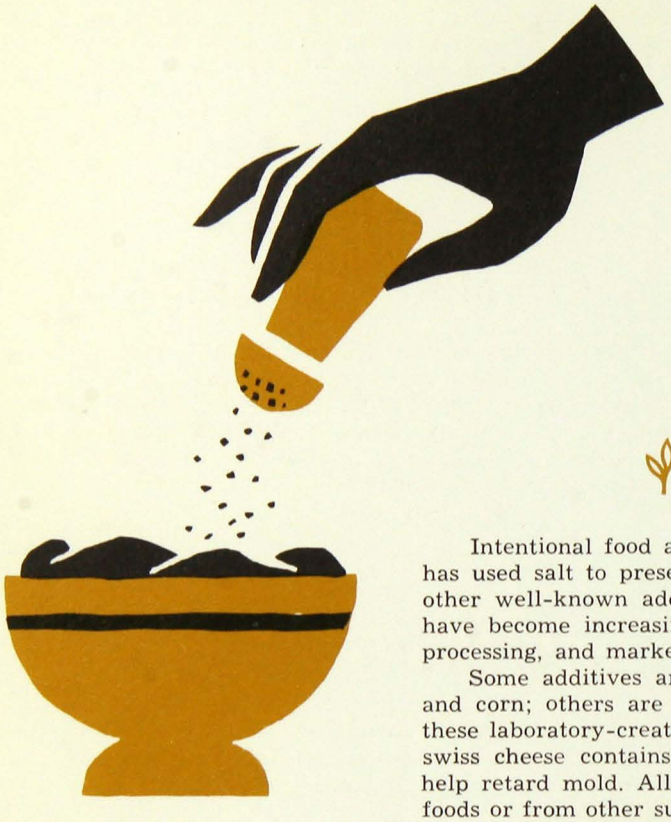
A *FOOD ADDITIVE* is a substance or mixture of substances, other than a basic foodstuff, which is present in food as a result of any aspect of production, processing, storage, or packaging. The term does not include chance contaminants.*

Food additives are classified as intentional and incidental. Intentional additives are added to perform specific functions. Incidental additives have no function in the finished food. They become part of the food product through some phase of production, processing, storage, or packaging.

FEED ADDITIVES can be classified according to their intended purpose:

1. Additives used to improve growth and feed conversion, decrease mortality, and improve the general well-being of poultry and animals. These include minerals, vitamins, antibiotics, hormones, and arsenicals.
2. Additives used to control parasites. Examples are coccidiostats and wormers.
3. Additives used for improving market qualities and consumer acceptance of animal products.
4. Additives used for effects in the preservation and the physical state of a feed. Examples are antioxidants, emulsifiers, coloring agents, and flavors.

* Definition source: The Food Protection Committee of the Food and Nutrition National Board.



FOOD ADDITIVES FOR MAN

Intentional food additives have been used for a long time. For centuries man has used salt to preserve his meat. Spices used to flavor and preserve foods are other well-known additives. Today we use hundreds of food additives, for they have become increasingly important with the many changes in food production, processing, and marketing since the turn of the century.

Some additives are derived from food crops, such as *lecithin* from soybeans and corn; others are synthesized in laboratories by our food scientists. Some of these laboratory-created chemicals are also found naturally in foods; for example, swiss cheese contains *propionates*, substances used in bread and other foods to help retard mold. All additives are chemical in nature, whether they come from foods or from other substances.

An incidental additive could be an agricultural chemical applied to crops. This additive might be carried over into some processed foods, or it could be a substance transferred to the food from the package.

Food additives are used to improve the nutritive value of certain foods, to improve flavor, color, and texture, and to delay natural deterioration. The nutritive value of foods is improved by the addition of vitamins and minerals, such as B vitamins and iron to enriched white bread. Vitamin D is added to milk. Potassium iodide is added to salt to furnish iodine necessary to prevent simple goiters. Bakery products, ice cream, and other foods are improved through use of synthetic flavors. Color may be added to cheese, jams, and jellies. Texture of many products is improved through use of emulsifiers in moisturizing agents, maturing and bleaching agents, stabilizers, and thickeners. Food deterioration can be delayed through mold, bacteria, and yeast inhibitors, and use of antioxidants. Thus, food additives play an important role in many of our processed foods.

FEED ADDITIVES FOR LIVESTOCK

Today nearly all commercial livestock feeds contain additives. More than 200 additives are registered with regulatory agencies. There are additives in an estimated 80 percent of the swine feeds and 90 percent of the poultry feeds. Most beef cattle fed today receive additives in one form or another.

Much of the gain in agricultural efficiency of the past two decades is due to the development and use of new chemical compounds in agriculture. They are used as nutrient supplements, growth stimulants, disease- and parasite-controlling agents, and feed preservatives. Additives and other medicaments have been helpful

in increasing growth rates and efficiency of production and controlling disease in livestock and poultry. Increases in yield of meat per pound of feed, improvements in texture and tenderness of meat, and prevention of production losses due to disease bring consumer benefits in the form of wholesome, high-quality animal products free from pest damage and contamination.

SPECIAL CHEMICAL MATERIALS

Growth regulators, fruit and blossom thinners, hormones that promote root growth, and many other special materials are used in crop production. Most agricultural chemicals cannot be used in the pure or technical form so they are processed into usable formulations. Solvents, diluents, wetting agents, emulsifiers, spreaders, or stickers are added to fit a particular chemical for its specific job. These additives must also be considered when appraising the total effects of pesticides.

PRESENT SITUATION IN MINNESOTA

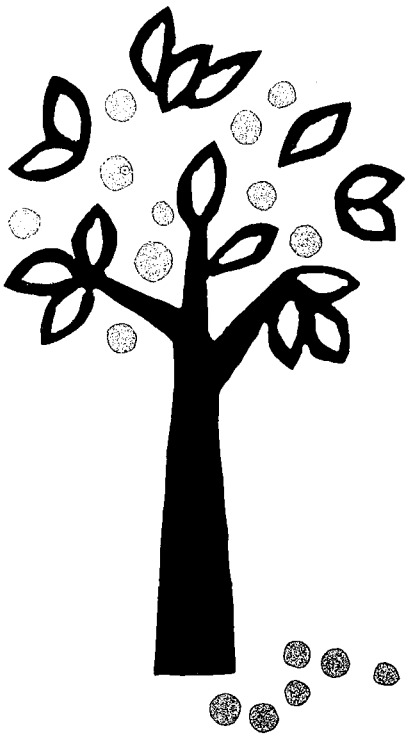
Agricultural and food chemicals are used in increasing variety and total volume each year. Some materials such as insecticides are used in widely varying amounts from year to year because of the sporadic appearance of many insect pests.

INSECTICIDES

According to estimates by county agricultural agents and the Minnesota Department of Agriculture, Minnesotans used insecticides as follows in 1964:

CROP	ACREAGE TREATED
Corn: soil treatment	1,650,000
foliage treatment	147,000
Small grain	202,000
Alfalfa	54,000
Sugar beets	81,000
Potatoes	69,000
Sweet corn for canning	63,400
Canning peas	15,000

LIVESTOCK	NO. OF TREATMENTS FOR FLIES, LICE, ETC.
Dairy cattle	1,400,000
Beef cattle	800,000
Swine	700,000
Sheep	275,000



The total treatment for the six major perennial crop insect groups in Minnesota (grasshoppers, corn borers, beet webworms, corn rootworms, pea aphids, and the potato insects) in an average year is about 1½ million acres. Soil treatment accounts for about 6 percent and treatment to foliage only about 1 percent of the total acreage treated.

Other fairly large-scale insecticide applications include urban mosquito control and forest insect control, but all of these uses affect far less than 1 percent of the total land area. Only comparatively small amounts of insecticides are used in gardens, orchards, yards, and in homes and other buildings.

FUNGICIDES

Fungicides or other chemicals used to control plant diseases are not used in large quantities on Minnesota field crops. Potatoes and sugar beets are the only field crops receiving fungicide sprays, and probably not more than 40 percent of Minnesota's 96,100 acres of potatoes nor more than 25 percent of the 119,600 acres of sugar beets was treated in 1964. These fields were treated from one to six times during the growing season.

Fungicides are used extensively in apple production in Minnesota, and no reliable grower would expect to get salable apples if he neglected to use fungicides on his trees. Vegetable growers make substantial use of fungicides, but the amount they use is not known. Greenhouse operators and homeowners use the smallest quantities of fungicides.

HERBICIDES

Herbicides have many diverse uses in Minnesota. They are used to control competing weeds in crops, pastures, orchards, lawns, gardens, roadsides, railroads, recreational areas, forests, lakes, and other areas. Estimates of herbicide use on some of the major field crops shows that the volume of herbicides used has more than doubled in the last decade.

Minnesota Department of Agriculture estimates show usage in 1964 as follows:

CROP	ACREAGE TREATED
Corn	3,445,431
Small grains	2,475,725
Soybeans	400,000
Flax	314,993
Soil bank and diverted acres	531,700
Noncrop lands	163,847
NONAGRICULTURAL	**MILES TREATED**
State trunk highways	8,026
County and state aid roads	25,015
Township roads	15,401
Railroad rights-of-way	3,865
Telephone and power line rights-of-way	11,822
Ditches	3,212

POTENTIAL HAZARDS

Using chemicals to ensure the efficient, economic production of high quality food, ornamentals, fiber, and timber and to control public health and nuisance pests is not without some problems. Carelessness and misuse can result in:

1. HAZARDS TO THE USER

Any chemical can be toxic if a sufficient quantity enters the body. The *amount* of a chemical needed to cause toxicity and the *way* by which it enters the body are important.

For example, common table salt, sodium chloride, is an essential chemical in certain amounts but too much can be harmful.

Main routes by which chemicals may enter the body are: *oral,* through the mouth and digestive tract; *dermal,* through the skin; and *respiratory,* through the nose, mouth, and lungs. Certain chemicals may be able to enter the body in two or more ways.

2. HAZARDS TO TREATED PLANTS, LIVESTOCK, CROPS

Some chemicals, or certain formulations, may cause damage to plants or to livestock. Applying a chemical at the wrong time or at a higher than recommended dosage may also cause direct damage or may leave residues to remain on the treated commodity.

Drift of chemicals from a field being treated to adjacent fields may result in damage to susceptible crops and can account for harmful residues on food or feed crops.

Recommendations of competent authorities and directions on labels should be thoroughly understood and carefully followed to avoid this hazard.

3. HAZARDS TO CONSUMERS

Some chemicals used in food production or processing may remain in small amounts as residues in or on the finished product. But there is no evidence that residues resulting from *approved* use of the chemicals present any hazard to human health. Following the label limitations for each crop—including home garden and orchard crops—prevents residues above those permitted in food products by the Food and Drug Administration.

Because vitamins, hormones, medications, and other compounds added to feed can remain as residuals in meat, milk, or eggs, potential human health hazards do exist. Precautions are necessary to assure that such leftovers will not be harmful to people. And control is necessary to prevent use of additives that have not been tested for safety to the ultimate consumer.

Drugs used to control disease, though not feed additives as such, also may pose residue problems. Antibiotics, sulfa drugs, and medications to combat internal parasites may show up in the various livestock food products.

Residues can result under all methods of administering drugs—oral, intramuscular injection, or, in cases of udder disease, intramammary infusion. Drugs taken orally or by intramuscular injection may leave residues in meat, milk, or eggs. An antibiotic infused into one quarter of an udder will be picked up by the blood and transported to other quarters, thus contaminating all the milk from a cow treated in this manner.

Although most of us would show no ill effects from the minute quantities of contaminants present as residuals, a few of us might react to some of these compounds. Allergy symptoms occur in some persons exposed to residual antibiotics in foods. And there's a question of potential hazards of repeated intake of even small doses of feed additive materials and/or medications. For this reason, laws have been enacted to rigidly control the type and amount of feed additives as well as the use of drugs for treatment of animal and poultry diseases. The Food Additives Amendment to the Federal Food, Drug and Cosmetic Act provides safeguards to prevent presence of harmful residuals and to assure that any residual is kept well within acceptable levels.

Under this law, such chemicals must undergo safety tests before they are marketed. Limits on tolerances can be established controlling amounts used, and conditions under which use is permitted can be regulated.

Chemicals known to cause cancer in animals or man are prohibited from use as feed additives or as medications which can find their way into food products.

For antibiotic and antibiotic-containing drugs intended for use on dairy animals, the law requires certain label information. One of two warnings must appear, either (1) "Not for use in milk-producing animals since this use will result in contamination of the milk," or (2) "Milk taken from treated animals within ..... hours after the latest treatment must not be used for food." The blank space is filled in with the specified number of hours which in no case may exceed 96 hours. If no residuals result, this label information is not required.

Today the laws passed by Congress in dealing with the problem of the food additives protect the consumer when foods shipped interstate are involved. State regulations regarding food additives protect foods sold within the state.

4. HAZARDS TO FISH, WILDLIFE, AND OTHER NONTARGET ORGANISMS

In any area that must be treated for pest control there will undoubtedly be other living organisms that are desirable, or at least cause no economic damage. Chemicals that are specific in their action are selected for use in such areas. Habitats most attractive to wildlife usually are not treated with pesticides in sufficient quantity or of a kind that will pose a threat. The hazards to wildlife are generally considered minimal to planned operations against mosquitoes and pests of farm and forest.

There have been some cases of serious damage to certain species in localized areas. Much has been learned from these cases and, generally, the problems have been corrected.

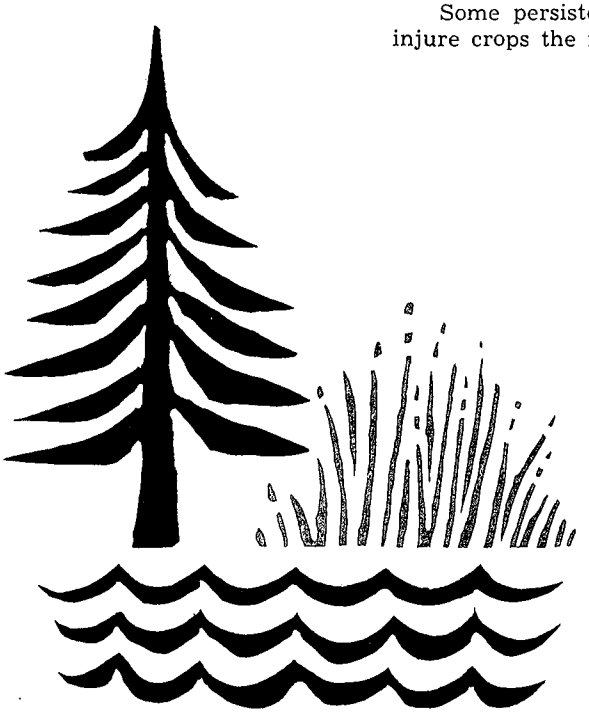
Potential hazards to honeybees, fish, birds, and other wildlife are of major concern to those who recommend pest control practices, and any large-scale undertaking involving the treatment of large acreages of forest or rangeland is reviewed by representatives of state departments of conservation, health, and agriculture.

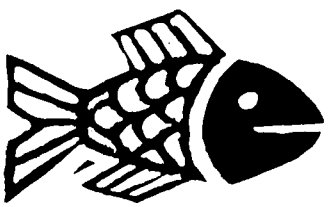
The threat of a chemical application to the wildlife of an area to be treated is minimized by proper selection of the pesticide, time of application, rate of application, and treatment of the minimum area to achieve the control desired.

5. HAZARDS TO SOIL AND WATER RESOURCES

Some of the agricultural chemicals when introduced into soils, shallow wells, ponds, and other bodies of water may persist for considerable periods of time. In soils the residual level of chemicals depends upon temperature, moisture, the amount of chemical applied, the amount of re-treatment, the type of soil, the organic matter content of the soil, and other factors.

Some persistent herbicides may remain in the soils of treated fields to injure crops the following year.





Field applications of herbicides present very little hazard from long-term residues for several reasons. Relatively low rates are applied to soils. Most herbicides are broken down and inactivated by naturally prevalent organisms. Herbicides may also be inactivated by chemical decomposition, light decomposition, combination with water, soil adsorption, plant uptake and subsequent decomposition, and volatization (loss in a gaseous form), or leached out of the soil by water. Most herbicides are inactivated by several of these mechanisms.

Some of the chlorinated hydrocarbon insecticides (such as aldrin, dieldrin, DDT, and heptachlor) may remain in treated soils and cause illegal residues to appear on some root crops grown in such fields the following years.

The normal agricultural and public health uses of chemicals and resultant possible runoff from treated fields into bodies of water is not considered an important source of water contamination. The accidental or careless dumping of chemicals or the containers, or the application of certain pesticides directly on or over the water present the greatest threats. Great care must be taken to avoid the contamination of water resources used for wildlife or recreation, or water supplies for humans or livestock through careless or through unauthorized or nonrecommended applications.

SAFEGUARDS THAT MINIMIZE PROBLEMS AND HAZARDS

Legal Safeguards

THE FEDERAL FOOD, DRUG AND COSMETIC ACT—Individual states passed the first laws regulating foods and drugs produced in this country. The need for federal legislation was recognized with an increasing proportion of foods and drugs being shipped between states. Thus, the first major legislation regulating food in the United States was passed in 1906. It was known as the Federal Food and Drugs Act (our national pure food and drug law).

With changing times and advances in modern science and food technology there was a need for new legislation. Thus the Federal Food, Drug and Cosmetic Act of 1938 was passed. This act retained the provisions of the 1906 act and added new provisions to meet the needs for consumer protection at that time. Definitions and standards for about 200 foods were set following the passage of this law. Some foods for which definitions and standards are established include: canned fruit and canned fruit juices, canned vegetables and vegetable products, milk and cream, chocolate and cocoa products, cheese and cheese products, eggs and egg products, wheat and corn flour, and bakery products.

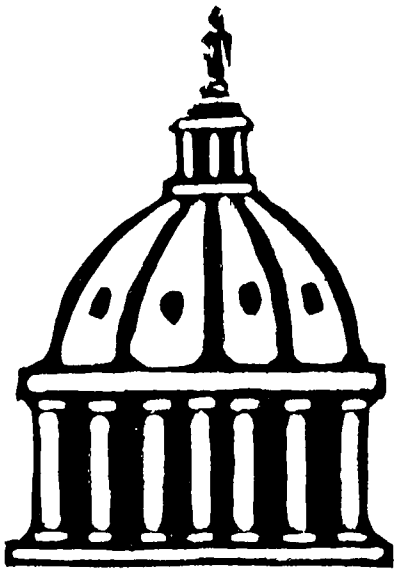
There are three major amendments to the 1938 law: the 1954 Miller Pesticide Amendment, the 1958 Food Additives Amendment, and the Color Additive Amendment of 1960.

The Miller Pesticide Amendment established a procedure for determining safe amounts (referred to as tolerances) for residues of pesticides that may remain on raw agricultural products when shipped interstate. The 1958 Food Additive Amendment required that new food additives be tested for safety prior to use and that government approval be secured for their use. The Color Additive Amendment of 1960 regulated the listing and certifications of colors used in foods, drugs, and cosmetics. In addition, it provides for testing existing colors as well as new colors for safety.

The 1958 Food Additive Amendment to the Food, Drug and Cosmetic Act of 1938 requires food and chemical manufacturers to run extensive animal feeding tests on these additives before they are marketed; results of these tests are submitted to the Food and Drug Administration. If Food and Drug Administration scientists are satisfied that the additive is safe, a regulation known as an "order" permitting its use is issued. This regulation places a limit or "tolerance" on the amount which may be used and specifies other conditions necessary to protect the health of the people. If the evidence presented is not convincing as to its safety the food additives will not be allowed. This law applies to both intentional and incidental additives.

The Delaney Clause of the Food Additives Amendment of 1958 and the similar clause in the Color Additive Amendment of 1960 state that no additives may be permitted in any amount if the tests show that it produces cancer when fed to man or animals or by other appropriate tests.

THE FEDERAL INSECTICIDE, FUNGICIDE AND RODENTICIDE ACT—No pesticide may legally move in interstate commerce until it has been registered and granted label approval by the U. S. Department of Agriculture. Before such approval is granted the applicant must supply adequate research data to demonstrate (1) the effectiveness of the chemical for each specific use for which the compound is to be sold; (2) that, when used according to the detailed instructions to be included on the label, injury to man, treated crops, or livestock will not occur; and (3) that any residues left will be within those permitted by the Food and Drug Administration. No recommendation for the use of a pesticide is made in Minnesota unless it has this federal registration. Chemicals moving within the state of Minnesota are controlled by regulations which conform to the federal act and provide for the registration of pesticides with the Minnesota Department of Agriculture.



OTHER REGULATIONS—Although the Food Additive Amendment contains no provisions dealing exclusively with animal feeds and animal drugs, it does require that edible products of animals—meat, milk, or eggs—be free of any harmful residues of a chemical or its degradation products. Thus, the use of the drug in treatment for bovine mastitis may be governed by a food additive regulation even though the drug is not fed to the cow but is infused into her udder. Public Law 518 requires that the label on a chemical product carry specific instructions for its safe use.

Before an authorization for a new drug or a new use is made, clear-cut evidence of safety, not only to the animal or bird but to the consumer of the animal products, must be thoroughly documented to the satisfaction of Food and Drug Administration physicians, veterinarians, and other scientists. If accepted, the authorization may be written in the form of a food additive regulation which limits the use of the drug to the safe conditions established by the data submitted.

Quality of meats is also protected by laws enforced by the Meat Inspection Division of the U. S. Department of Agriculture.

All of the laws mentioned above are federal and involve the interstate movement of chemicals and foods. Minnesota has a uniform state act and other state statutes that regulate the intrastate movement of chemicals and foods. Federal and state laws, continuous inspection, and well-informed users of drugs for livestock guarantee safe foods and more nutritious foods at lowest possible cost.

Research Safeguards

Information obtained from careful research forms the basis for effective and safe use of chemicals and also for legal regulation of chemical use. Many agencies, public and private, are deeply involved in various aspects of agricultural and food chemical research. The chemical industries must make a very heavy commitment of resources in order to register and market their products.

On a federal level, the U. S. Department of Agriculture, the Department of Health, Education and Welfare's Food and Drug Administration and Public Health Service, and the Fish and Wildlife Service of the U. S. Department of Interior are among the agencies carrying on many research programs on different aspects of pesticides and other agricultural chemicals. In the states, scientists in many different subject matter departments of land-grant colleges and universities are conducting research on agricultural chemicals.

Research continues to uncover new, more effective drugs and feed additives. They are necessary to maintain and increase livestock productivity. They are necessary, in some cases, to control infectious disease germs which continually become more resistant to drugs currently available. Private and public funds are needed to support research and toxicological testing of food additives. This additional scientific knowledge should enable us to progress in the expanded use of safe food additives.

The combination of these efforts provides us with a foundation of knowledge on which to make sound decisions. As in any other technical field, there is always more to learn, so it is unlikely that the last answer to the last question will be found. However, at any point in time, decisions must be made on the basis of all the facts then available. As new information is obtained through research, new decisions and different practices may be necessary. So our use patterns and concepts about chemicals must be flexible enough to take advantage of the new knowledge research gives us.

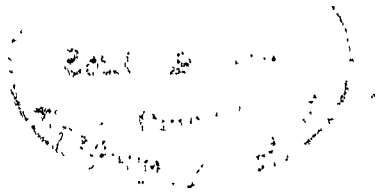
Educational Safeguards

Information is useless unless it is communicated to those who can use it or benefit from it. Industry and several public agencies conduct educational programs aimed at informing our citizens about chemicals. Much of this effort is devoted to instructing the users of pesticides in the safe and proper application of the complex variety of products available. Because of the legal requirement of labeling which industry must meet, the information on labels is extremely valuable to the user.

While more than 200 feed additives and many different combinations of them are authorized by governmental agencies, none of them is a substitute for good management and sanitation practices. Before a new drug, antibiotic, or food additive can be authorized for use, certain preclearance safeguards must be met. The purpose of the safeguards is to assure that the products of the livestock industry can be consumed without hazard by the public. The proper use of these additives is also essential in safeguarding the public welfare.

Proper use of chemicals is the responsibility of the user. The safest course to follow is to read and heed the directions and precautions on the container label. It is neither possible nor required to warn against all possible misuses of a product. Two critical misuses of chemicals are noncompliance with label limitations and unauthorized do-it-yourself treatment. The latter may include the unauthorized use of two drugs in combination that are authorized for use separately. The responsibility for the misuse of a product also rests with the user. Proper times, rates, methods of application, and safety precautions are on every label, but they must be read, understood, and followed precisely.

The Agricultural Extension Service of the University of Minnesota conducts educational programs on safe and proper use of chemicals as an integral part of its educational efforts in crop and livestock production and marketing. There are many opportunities for all citizens to become better informed about chemicals. The controversy and uncertainty about these essential tools can be resolved if we avoid opinions or fears and carefully seek the facts in each case, then make the wisest decisions we can on the basis of these facts.



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