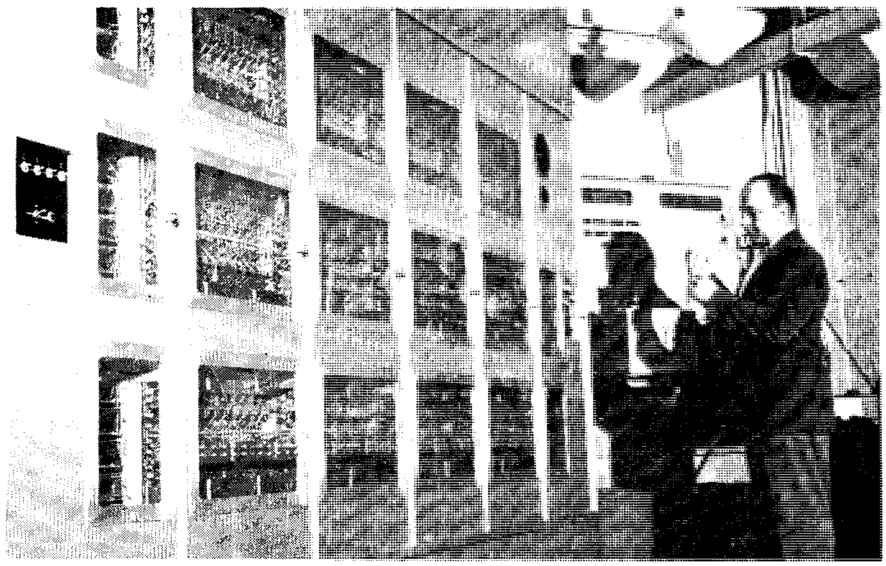
Ag and Food Interprets . . .

- **Electronics becoming valuable tool for agriculture**
- **USDA to issue white paper on pesticide labels approved**
- **Chemicals aid livestock industry to stop loss from internal parasites**
- **Getting residue data biggest step in complying with Miller Amendment**
- **Mineral nutrition, long neglected, getting new emphasis**

Computers in Agriculture

Without much fanfare, electronic data handling systems are becoming a valuable agricultural tool. More progress on the way



Agronomy Professor Walter Jacob, University of Illinois, uses the university's Illiac, high speed computer, to process data from agronomy research projects. He estimates about 10 times as much work can be done with the special equipment

ELECTRONICS AND FARMING might seem to be strange bed-fellows. Yet in numerous spots across the country, the world's oldest trade is teaming up with one of the newest sciences. The merger of the two promises a new concept in agricultural problem-solving.

In recent years, scientists have uncovered many of nature's secrets. The wealth of information they have amassed has been aptly applied to increase farm efficiency. But just as a plant or animal is itself vastly complex, analysis of the data concerning its life is also a complicated matter. To make the most of available information, agricultural researchers are now enlisting the help of electronics—in the form of punched card systems, digital computers, and analog computers.

At the University of Illinois, results of hybrid corn performance tests are being transferred to punched cards and paper tapes for analysis and correlation. In St. Louis, Monsanto is using an IBM 702 computer to formulate fertilizers (AG AND FOOD, November 1956, page 925). At Cornell University, electronic records are keeping track of dairy herd performance. And all across the nation, agricultural statisticians are looking at their data, visualizing the possibilities that electronics offers.

When discussing the role of electronic computers in agriculture, most experts hasten to point out that computers can't perform miracles. Electronic brains are no better than the human brains that run them. But as a practical tool for the economist or researcher, they can remove the bottleneck of data analysis, and allow him to make fuller use of his experimental facilities.

Down on the Farm

In some spots, the "electronic revolution" is already helping the farmer do a better job in his day-to-day activities. Iowa State College, University of Illinois, and North Carolina State College are among the pioneers in applying linear programming techniques to farm management. Earl Heady at Iowa State forsees the day when farmers will have use of a farm planning service similar to present soil testing services. The farmer would provide information on the resources available to him. Then an electronic computer would sift through the thousands of possibilities, and derive the most profitable combination of enterprises.

There is a staggering number of variables present in farming and related activities. Such problems as fertilizer formulation, of course, are usually handled by the manufacturer, but the farmer himself must decide which crops to plant on which land and what livestock to raise with what feed. Right now, farm economists are handling up to 300 variables with high speed computers. Obviously, a job such as this couldn't even be approached with ordinary "hand" methods.

While most computer applications which directly aid the farmer are still in the experimental stage, dairymen in the Northeast already have a practical service available. Performance data collected by the New York Dairy Herd Improvement Cooperative are analyzed by Cornell, and a monthly report is sent back to each dairyman. The reports pin-point the spots where management can be improved, as in the case of one man who found he was feeding a particular cow 12 pounds of grain per day when one pound would give almost equal results. The calculating service has been in existence for some time, but only recently has an electronic computer been used to process data. The speedy computer makes it possible to issue monthly reports, in sharp contrast to the previous yearly reports. Thus, an error in farm management can be caught almost at once, rather than being compounded over a year's time.

And perhaps best of all, computers can be made available to farmers at reasonable cost. The dairymen taking advantage of the Cornell service pay only $1.08 per cow per year.

And in Industry

As a time-saving tool of the researcher, electronic computers are unsurpassed. Chemists can now plan and conduct research which would have been considered impossible before computers were available to analyze the results. One area of particular interest to agricultural scientists is the use of electronics to correlate structure and activity.

The Chemical-Biological Coordination Center pioneered this work. Through the CBCC code for expressing chemical compounds in numerical terms suitable for card processing, more than 60,000 compounds have been classified. Now, when pesticide research uncovers a compound with a certain functional group having a useful property, it is possible to list quickly the compounds in the system which exhibit the interesting property.

More recently, Ted R. Norton and Ascher Opler of Dow have developed the Norton-Opler code which is more specific in selecting compounds than the CBCC code. CBCC is stopping its operations on July 1, because of a lack of funds to continue its programs.

Extensive use of analog computers in agricultural chemicals manufacture appears a promising prospect for the future, in view of their already successful use in oil refineries to monitor process streams. By translating chemical analysis into electrical signals which in turn are compared with standard values, the analog computer acts upon the instruments which control the process.

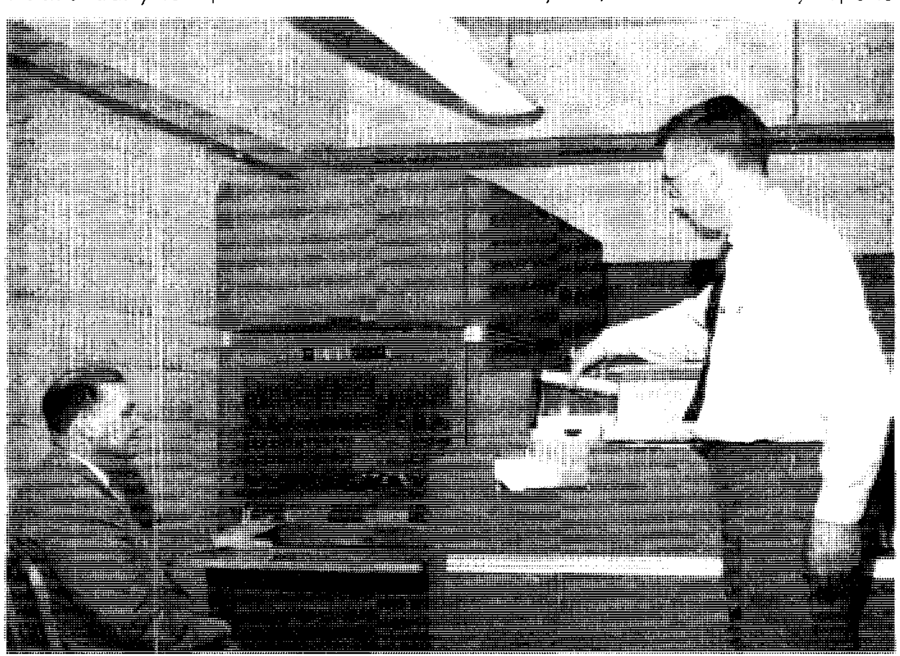
Many other promising computer prospects exist. A partial list would include some of these:

- Formulating feeds
- Preparing seed plans for maximum effectiveness
- Recording data for better livestock breeding
- Studying soil fertility
- Solving irrigation problems

Perhaps electronics can even do something about the weather. Iowa State's weather and agriculture program is using an IBM 650 to compute rainfall probabilities. And scientists at Cornell are going even further in harnessing weather to produce better crops. Their program uses a computer to analyze data on wind speed and direction, sun's radiation, humidity, temperature, soil moisture, and carbon dioxide concentration in the air.

In short, computers can be adapted to any problem involving a large number of variables. Certainly it is possible to make good use of agricultural resources without a precise mathematical solution to all the interrelationships. But in these cost-conscious days, the difference between "good use" and "best use" could be the difference between success and failure.

Wilmot Carter (left) and James Burke at Cornell operate the IBM 650. They keep track of dairy herd performance for New York dairymen, send them monthly reports



Pesticides Registration

First step toward enforcing Miller Amendment labeling requirements will be USDA's report of approved uses of pesticides

USDA expects to have its summary of approved pesticides registrations ready for mailing about May 20. Called "Summary of Certain Pesticide Chemical Uses," the report gives USDA guidance to manufacturers, formulators, and distributors of pesticides for proper labeling and registration under the Miller Amendment. It is a "white paper" designed to inform the industry of those uses which are in compliance.

In interpreting the report, registrants are guaranteed a full quota of shocks, warnings, and reassurances. But the industry has been waiting for the list, and USDA thinks it will welcome a start toward enforcement of Miller Amendment label requirements.

USDA's listings will serve notice to all companies that labels showing registered uses for chemicals not covered in the report have not yet been clarified. The charts name each acceptable basic chemical and list its approved uses in terms of crops, tolerances, dosages, and application limitations. Not every acceptable formulation is listed for every chemical. Instead, the charts present patterns of use—guides rather than strict limits. If a registrant has uses that fit a pattern (are within dosage and application limitations), USDA says they will be acceptable for the crop named.

There is no "grandfather" clause—no provision for blanket approval of prior registrations—under the Miller Amendment. In fact, it is the older poisons, registered prior to the amendment, that make up most of the unapproved uses (about 1000). USDA says many of these chemicals—some have been in use 20 to 30 years—are just now being checked. These are the problem registrations—the most difficult to bring into compliance with the law. Chemicals registered since passage of the amendment present little problem. Most of these have had tolerances established, and their labels conform to the law.

Unapproved registrations in another group that USDA calls "critical" involve direct applications to animals or forage crops, in which there is the possibility of milk contamination. Infractions in other cases may stem from multiple crop use recommendations. For example, on a label showing six uses for a chemical, a tolerance may be lacking for only one of the crops named. This one flaw makes the entire label illegal, says USDA.

No Petitions for Tolerance Filed for Some Chemicals

In preparing its report, USDA noted many pesticides missing because no action has ever been taken on them. Petitions for tolerances have not been filed, or use specifications have not been submitted for approval. These omissions lead USDA to believe the industry does not fully understand the law. Many seem to think a tolerance for one crop covers all crops or all similar crops. This is not true. For example, tetramethylthiuram disulfide has only one tolerance legally established. Any other use, and there are many uses registered, is illegal.

USDA's charts include some 4500 uses for 200 chemicals—about 70% of the uses now registered. Cutoff date for preparation of the report was Feb. 15, 1957, and, as the department points out, some uses not listed may have been legalized since then.

Some chemicals manufacturers have promised USDA they will act promptly to halt any violations that are revealed by the report, and will send to their formulators and distributors recommendations for bringing labels into compliance. Otherwise formulators and distributors who find their recommended crop uses among those missing from the lists must take steps on their own to work out new patterns and submit them for registration. If the basic chemical producer is not available for consultation, a state agency or experiment station will generally be able to advise the formulator on registration problems.

No Time Limit Set For Compliance

USDA has set no time limit for revising labels to comply with the Miller Amendment. Neither has it decided on an approach to the problem of obtaining compliance or on the methods it will use in enforcement. First policing actions taken undoubtedly will involve the most poisonous chemicals, but no definite time has been set to begin pulling pesticides or herbicides from the market. USDA says its decisions on enforcement will be influenced largely by the industry's response to the listings.

Manufacturers and formulators may take one or more of the following actions to correct labels for chemical uses not covered by USDA's list:

- Obtain a statement from FDA that the pesticide is a "safe" chemical. FDA has a category of "safe" chemicals that may be used at any time.
- Submit adequate information to USDA showing that the chemical leaves no residue.
- Obtain an exemption from the tolerance requirement. FDA has a list of pesticide chemicals that are called basically "unsafe" but that may be exempted from tolerances if used "in good agricultural practice." Exemptions for these chemicals apply only for use during production stages—not at harvest.
- Establish a tolerance for the chemical in the prescribed use.

Copies of the USDA's survey will be distributed to 3500 registrants. Also, about 1550 copies will go to interested Department of Agriculture groups, and 1800 to trade associations for distribution to their members.

USDA expects the report to have a strong impact on the trade and on recommenders of uses for pesticides, such as the experiment stations. The report, however, is not intended to supersede state recommendations. Federal and state agencies can still suggest spray programs and increased uses at any time, so long as they can support their claims concerning residues.

USDA researchers administer radioactive Dow ET-57 to a test animal. In this way they can keep track of the grub killer's progress throughout the animal

Chemicals vs. Internal Parasites

Livestock industry leans more heavily toward chemicals to help cut down losses due to internal parasites

MORE AND MORE, the livestock industry is looking toward chemicals for an assist in beating losses caused by internal parasites. Estimated annual loss due to internal livestock parasites: $500 million, and up. Most expensive offenders are worms. Also big despoilers are cattle grubs, which take a bite estimated variously at $100 to $200 million each year. Internal parasites in swine alone cost $277 million annually, says USDA; in poultry, about $4 million.

In the cattle industry, nematodes of the gastro-intestinal tract are probably the most important internal parasites. Following closely are grubs, and then lungworms. For sheep and goats, again gastro-intestinal nematodes. The nose bot—closest in analogy to cattle grubs—comes in below lungworms. Number-one parasite in swine is the large intestinal roundworm, but in areas where kidney worms occur, they top the roundworms as a hog ailment. Liver flukes are fairly prevalent in cattle and sheep.

Most Widely Used Chemicals for Treatment of Internal Parasites

Chemical	Chiefly used against:
Phenothiazine	Gastro-intestinal nematodes in sheep and cattle
Piperazine salts	Ascaris and nodular worms in swine; ascaris in poultry, and ascaris and pinworms in horses
Nicarbazin, sulfaquinoxaline, nitrophenide, nitrofurans	Coccidia in poultry
Lead arsenate (sometimes in combination with phenothiazine)	Tapeworms in cattle, sheep, and goats
Copper and nicotine sulfates (dilute solution used as drench)	Stomach worms and tapeworms in sheep
Toluene, tetrachloroethylene, *n*-butyl chloride	Intestinal roundworms, including hookworms, in dogs
Sodium fluoride, cadmium anthranilate and other cadmium compounds	Ascaris in pigs
Carbon tetrachloride	Liver flukes in sheep
Hexachloroethane	Liver flukes in cattle
Dibutyltin dilaurate	Some tapeworms in chickens
Rotenone	Cattle grubs

Coccidia infect cattle, sheep, and poultry.

Most widely used chemicals for control and treatment include:

- Phenothiazine for fighting nematodes in sheep and cattle.
- Piperazines for ascaris in swine, poultry, and horses. Cadmium anthranilate and oxide and sodium fluoride are also used as treatments for swine.
- Nicarbazin, sulfaquinoxaline, nitrophenide, and the nitrofurans as coccidiostats in poultry.

According to some workers, treatment of light worm infections in cattle has increased profit as much as $2 to $12 per head. And with hogs, merely an intermediate level of infection can sometimes cut a herd's production materially. Actually, according to Donald C. Boughton of Du Pont, mild parasitic infections are of greater practical significance when production is the chief consideration than are acute infections. Du Pont is the biggest phenothiazine maker today. Also, mild infections have additional economic signficance because they can be evidence of more serious trouble coming up soon.

Currently, 17 states have issued recommendations for chemical control of internal parasite infections. Most of these are concerned with preventive control. Recommended state control measures with phenothiazine in cattle and sheep, e.g., are:

- Therapeutic treatment of animals with spring and fall medication
- Low-level feeding of medication to prevent parasite build-up
- Herd sanitation and pasture management to prevent intake of parasite larvae.

Use of piperazine as an anthelmintic has grown during the past two years. And with FDA's recent approval of piperazine-medicated feeds, growth should continue. Jefferson Chemical, a major piperazine producer, estimates that about a million pounds of the chemical will be used in making anthelmintics in 1957. Other producers include Union Carbide and Dow.

Piperazine salts are usually used as anthelmintics. Salts include the citrate, tartrate, adipate, and dihydrochloride. Proportionally, more chickens are treated with piperazine than are swine, but its greatest market is for the latter.

During the past two years, the antibiotic hygromycin has been showing promising results as an anthelmintic. Eli Lilly chemists have been able to synthesize the antibiotic, so a chemical method for producing it is evidently possible. It may be marketed as a hog dewormer late this summer. A. C. Todd of the University of Wisconsin says that hygromycin is effective against six major forms of swine roundworms, whereas the piperazines are effective against two of the major groups.

Other chemicals being used, but in lesser amounts, include lead arsenate (sometimes in combination with phenothiazine) for tapeworms in cattle, sheep, and goats, and a solution of copper and nicotine sulfates as a drench for removing internal parasites in sheep.

All told, current annual value of parasiticidal agents for animal use is estimated at about $8 million at manufacturer's price. This figure may double in the future, according to one source.

Cattle Grubs

Cattle grubs—larval stage of the heel fly—have raised havoc with cattle hides for many years. The heel fly eggs, deposited on the hair of livestock, hatch into larvae which bore into host animals through the skin. After 8 to 9 months, during which they migrate to the back, the larvae—now greatly enlarged—emerge by puncturing the skin. Rotenone, used as a spray, dust, or wash is currently the recommended method of control. But the chemical is used after the grubs have done their damage. However, some new insecticides show much promise of effecting more complete control of the pest. According to USDA, most promising of these is Dow-ET-57, a phosphate compound given to cattle by mouth as a drench or in a large cylindrical pill. The chemical, O,O-dimethyl O-2,4,5-trichlorophenyl phosphorothioate, acts as a systemic insecticide. Grubs are reached before they can emerge; damage to the flesh is prevented and no holes are made in the hide.

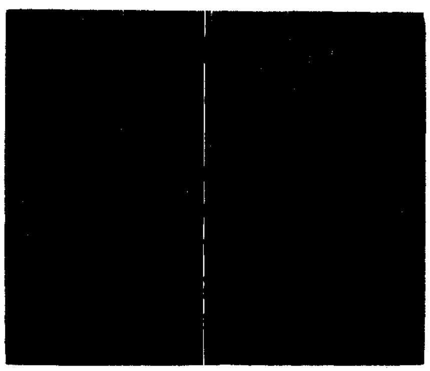
Another systemic which has shown good performance against cattle grubs, says USDA, is Bayer 21/199. Also a phosphate compound, the chemical is administered by spray. Mode of entry of the chemical into the body has not been fully determined, but some of it is known to be absorbed through the skin. USDA points out that an insecticide such as 21/199 which can be sprayed is easier to use (especially on range cattle) than one that must be given by mouth. Neither compound is commercially available. Phenothiazine has also shown some promise against cattle grubs, but results are not consistent, according to Livestock Conservation, Inc.

Room for More

New chemicals as well as new uses for established ones are coming up. Piperazine citrate has shown some favorable activity in cattle. Morton Salt has developed a trace mineral and phenothiazine containing salt for animal feeding. Hardy Salt and International Salt have new phenothiazine-carrying mixtures. Other applications of these chemicals are being studied.

Being sought at one university is a better tapeworm treatment. No reliable remedy for lungworms is available.

But no chemical by itself or in combination with others can ever be a panacea. Scientists are quick to point out that sanitation, good husbandry practices, research in physiology of parasites and on chemicals' effects on parasites, and other phases are essential. Only in this way, says one veterinary parasitologist, will the parasite problem be solved on a more permanent and economical basis.



ANALYTICAL METHODS for determining pesticide residues are becoming increasingly important in qualifying new materials for registration under the Miller Pesticide Residue Amendment. The Food and Drug Administration must, with a few exceptions, establish a tolerance for each pesticide use which is to be registered. In establishing this tolerance FDA considers principally two factors: the toxicity of the residue and the amount which will result from proper use of the chemical. The latter point often proves to be the more difficult on which to obtain adequate data, and may then be the limiting factor.

It is USDA policy to accept for registration only those pesticide formulations which, when used in accordance with label directions, can be expected to leave no residue or to leave legal residues. How much work is necessary and how much data are required to assure conformance with this policy?

Basically, convincing evidence of no residue or enough test information on which to base a residue limit is required for each pesticide formulation for each crop on which it is recommended for use. There are certain cases—early season use of nonsystemic pesticides, soil treatments with chemicals which are not translocated, applications of pesticides which are known to be destroyed by the plant metabolism before harvest—in which it may be comparatively easy to establish that no residues will be left at harvest. In general, however, the experimental work needed to provide USDA with satisfactory proof of no residue is likely to be difficult and time-consuming.

In those cases in which a residue will remain and a tolerance must therefore be set, field trials and analytical methods become of major importance. First, an analytical technique must be developed, if one does not already exist. Estimates for the cost of this analytical research range from $10,000 to establish a rather simple determination to as high as $150,000 for a complex method.

With a suitable analytical method in hand, field trials must then be carried out to determine the amount of residue left by usage in the recommended manner. How much data are needed by the USDA on this point? Thomas H. Harris of USDA says: "For each raw agricultural commodity, 10 results each on treated samples, on untreated samples (blanks), and on untreated samples to which known quantities of the pesticide have been added, have generally been regarded as the minimum quantity of data necessary for consideration."

Costs May Run as High as $350,000

The cost of this phase of the testing program will, of course, depend on the number of crops for which the pesticide is to be registered, but estimates run as high as $350,000—occasionally even more.

Methods of reducing these costs to the pesticide manufacturer have been discussed in government and trade association circles, and several concrete suggestions have been made. One such suggestion is that several crops, all of the leafy vegetables, for example, might be grouped; complete field tests on one member of the group might then be accepted as valid for all, with or without a limited amount of supporting data for each specific crop in the group. Another approach, particularly for those crops with total acreages too small to justify the cost of extensive testing programs on the part of the pesticide manufacturer, would be to have the tests done by a land grant college. This approach is based on the argument that if such a crop is of economic importance to a state, then the state should be prepared to pay for the development of an insecticide for that crop.

Another suggestion has its roots in the principles used by the Food and Drug Administration in establishing residue tolerances. Briefly these principles are:

- If the quantity that may be contributed to the diet from all sources is greater than that estimated to be safe, the tolerance is set at the point of estimated safety.
- If the amount which may be ingested is below the estimated safety level, the tolerance is based on the quantity of residue needed to protect the crop.

Joseph A. Noone of the National Agricultural Chemicals Association suggests that perhaps in the latter case the stringent requirements could be relaxed without endangering the public safety. He raises the questions: "How important is it to know whether the residue level is 2 p.p.m. rather than 4 p.p.m. when a tolerance much higher is warranted on a toxicity basis? How much effort should be devoted to ascertaining this point?"

Whatever the answer to these questions, and whether or not suggestions for reducing the amount of residue data required are put into effect, analytical methods will remain a most important consideration in the enforcement of the Miller Amendment. The law does not specify whether the analytical method shall be simple or complex, manual or instrumental; but obviously it must be adequately sensitive and reproducible to justify the tolerance under petition.

Answers to questions concerning the biological or physiological significance of residues must ultimately be mediated by a toxicologist or pharmacologist, but the necessity of having reliable data for their mediation demands that a competent analytical chemist assist in every phase of the planning and execution of the residue program.

Developed from material presented by Francis A. Gunther, University of California Citrus Experiment Station; Thomas H. Harris, U. S. Department of Agriculture; Joseph A. Noone, National Agricultural Chemicals Association; C. H. Van Middelem, University of Florida; and Louis Lykken, Shell Chemical Corp., in the Symposium on Methods for Analysis of Pesticide Residues, sponsored by the Divisions of Analytical Chemistry and Agricultural and Food Chemistry at the 131st National Meeting of the AMERICAN CHEMICAL SOCIETY, *Miami, Fla., April 1957.*

Mineral Nutrition For Animals

Interrelationships among trace elements and macroelements are coming to light as mineral studies begin to get in step with other nutritional advances

Birds fed a 1922-type ration consumed 4.16 pounds of feed per pound of gain. In 1956, 2.2 pounds of ration produced a pound of gain. If improvement in feed efficiency is to continue more research attention must be given to mineral nutrients and the interrelationships among them

THE WIDELY ADVERTIZED discovery of the nutritional worth of vitamins, antibiotics, and hormones, has overshadowed the importance of minerals in animal diets in recent years. But with the forcing of animals for greater and greater production, mineral needs of animals have become accentuated.

This is the view propounded by M. E. Ensminger of the State College of Washington at the Symposium on Mineral Nutrition, sponsored last month by International Minerals & Chemical Corp. at Lakeland, Fla.

What Dr. Ensminger referred to as an "appalling" lack of knowledge in the field of animal nutrition needs to be corrected soon. He says animal scientists need to:

- Know more about the relationship of soil nutrients to chemical composition of plants and to animals' well-being.
- Examine systematically the soil, crops, and animal tissues from various parts of the country.
- Follow certain soil fertility programs from the standpoint of possible animal hazards.
- Analyze more than the ash in feeds, especially those from plant materials.
- Re-evaluate the place of trace minerals, and to know more about the requirements of each.
- Know more the function of minerals, and about the interrelationships of minerals to one another and to other nutrients.
- Know more about toxicities.
- Establish and follow a code of ethics in advertizing and selling commercial mineral mixtures.

The interrelationships among minerals have received much emphasis in the past few months. Several speakers at the Lakeland symposium stressed the point, as did some at the AMERICAN CHEMICAL SOCIETY meeting in Miami. Some of these interrelationships are already known, such as that of calcium-phosphorus-vitamin D, cobalt-vitamin B_{12}, and copper-molybdenum. Others, such as phosphorus-nitrogen and zinc-calcium are just coming to light.

George K. Davis, professor of animal nutrition at the University of Florida, observed that his work has had increasingly to do with interrelationships between the various mineral elements and that he has found it impossible to study the trace elements individually without considering their relationships to other trace elements and to the macroelements. He said his most recent work in this area indicates that at low levels of cobalt intake, increased molybdenum may suppress vitamin B_{12} synthesis. He has also been concerned with the copper-to-molybdenum and copper-to-sulfate relationships. Because copper is deficient in many mineral soils and must be added to rations, copper toxicity in livestock has been studied by Davis and his associates, who have found that 0.25 grams of copper per day per 100 pounds of live weight produces toxicity in something over half of the cattle within 90 to 120 days.

What appeared to be molybdenum toxicity in Florida cattle led to investigations that proved it impossible to produce molybdenum toxicity unless protein intake was inadequate. Sulfate and manganese also seem to be related to molybdenum toxicity, a problem the Florida workers are now trying to unravel.

Work on fluorosis by E. W. Crampton of McGill University in Quebec led him to the conclusion that fluorine in soft tissues and body fluids tends to inactivate certain heavy metals, such as manganese, which normally function as parts of enzyme systems. Such a metabolic disturbance may lead to an accumulation of acetone and hence to acetonemia; or it may produce a precarious appetite.

Crampton said there is no satisfactory evidence that fluorine ingested through a meal mixture is any different in its consequences from the same amount ingested in contaminated forage. He feels that maximum tolerated legal limits of fluorine in meal mixtures are probably too high to avoid damaging fluorosis with most working herds. Animals can tolerate moderate intakes of unbalanced nutrient assortments or of toxic substances for considerable periods of time without showing clinical evidence of ill health. Under these conditions the derangement is chronic rather than acute, and the damage may be subclinical for a year or more. It is because of the insidious nature of the effects of levels of fluorine intake in contaminated forage or in mineral supplements containing fluorine, that we find ourselves in trouble with fluorine.

These and other problems in mineral nutrition can and should be met. Radioisotopes and other modern research tools are opening up new approaches to many minerals research problems, some of which were considered unsolvable before World War II. Animal nutrition experts are now in a position to study the particular paths that minerals follow in the body until they are either incorporated in the tissue or excreted; rapid progress can be expected in the years ahead.