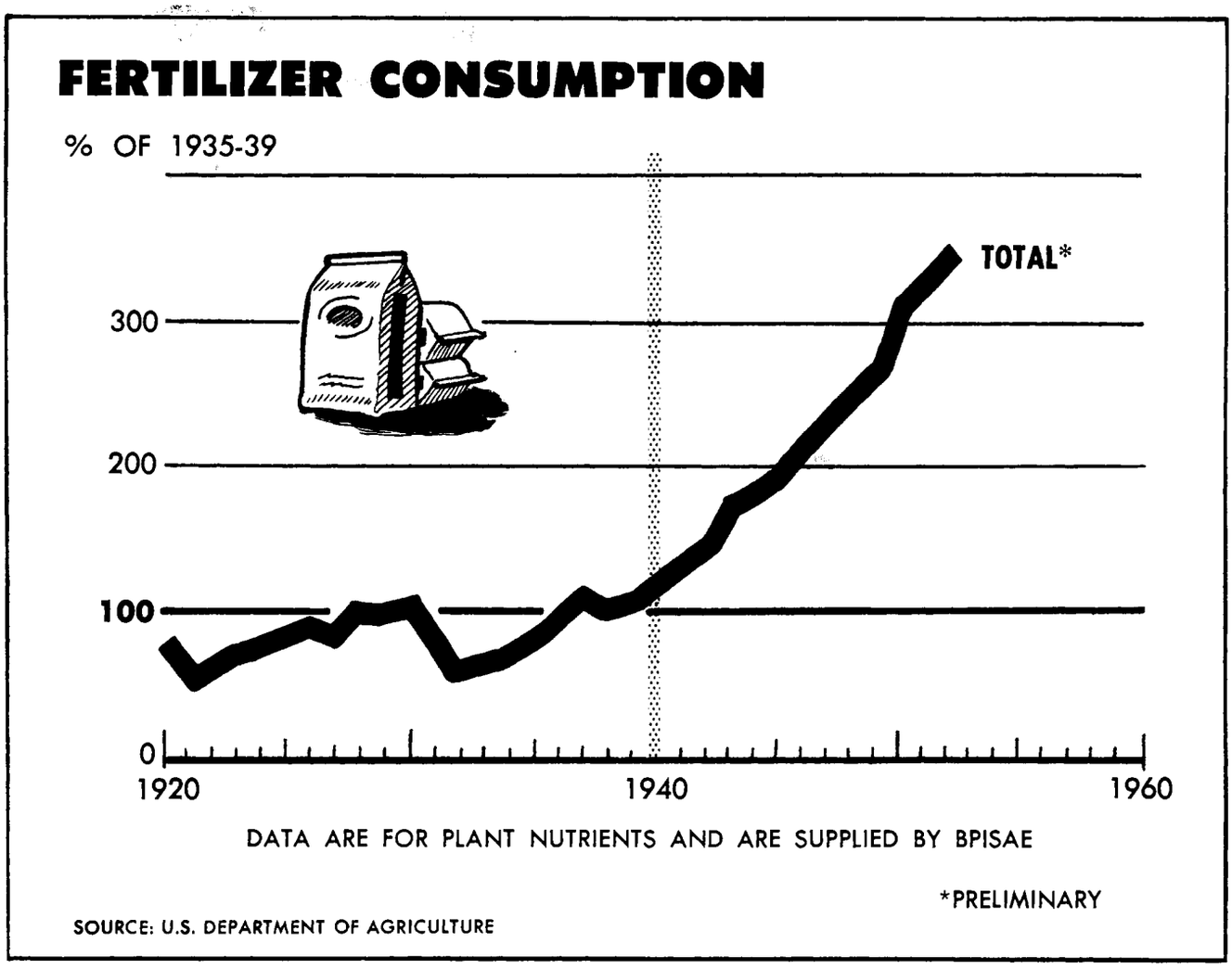


FERTILIZER OUTLOOK

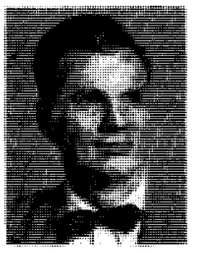
New Directions in a Major Chemical Process Industry

An industry in technological transition is the picture Ag and Food got by talking with leaders in the fertilizer industry. Anhydrous ammonia, nitrogen solutions, higher analysis materials, foliar applications, insecticide-fertilizer combinations, urea-formaldehyde fertilizers, and surfactants in fertilizer manufacture are some of the new directions which are influencing the present and future of the industry.

Another Good Year in the Fertilizer Business, Say Coleman and Allstetter

Q. *We understand that between the two of you, Dr. Coleman and Mr. Allstetter, you have been in just about every state in the union during recent months, talking to fertilizer manufacturers, state agronomists, and others about current problems. What impressions did you get of the farmer's attitudes and how will these affect the fertilizer industry?*

Russell Coleman



W. Raoul Allstetter

A. DR. COLEMAN: Probably the best word to describe the farmer's mood is "nervous." He has reduced spending far more than the cost-price squeeze would indicate. There is adequate evidence to indicate that the average farmer has money in the bank, but he probably won't spend it until he knows with some certainty just what the next few months will bring. In other words, he is going to "wait and see."

We've heard that farm machinery sales are off as much as one third from a year ago. Would you say this is a result of this "wait and see" attitude?

MR. ALLSTETTER: Probably so. However, the farmer doesn't exhibit as much reluctance to buy fertilizer as he does with regard to other production tools. Nevertheless, fall sales of fertilizer are somewhat lower in most areas this year than they were last year.

In New England, for example, autumn sales of fertilizer are off about 8% from last year. In Michigan, sales are reported down 15 to 20%. In California they are a little ahead of last year. Kansas reports an expected 15% drop for the first half of the fertilizer year. Manufacturers in the south report a 15 to 30% lag. Some drought areas are badly hit.

From the figures you cite, it looks like the drought is having a great effect on fertilizer usage. Is it a big factor?

DR. COLEMAN: Yes, in fact the drought is the principal sales factor, not farm income. There's no point in fertilizing if there is no ground water to make the nutrients available. The drought has caused a big drop in fall business. For instance, the big increase expected in fall application of anhydrous ammonia in the Midwest has not materialized, and the drought probably is chiefly to blame.

Fertilizer use on pastures also is down considerably, although the decline in cattle prices probably has contributed to this slump as well as the drought.

I would like to emphasize again, however, that farmer psychology is one of the major factors in the fall off in fertilizer sales—both in drought areas and where rainfall has been ample.

What about the effect of the impending acreage control on cotton and wheat and perhaps corn? What sort of problems will this create for the fertilizer industry next year?

MR. ALLSTETTER: The California-Arizona area will be most seriously affected by the acreage controls on cotton. There the farmers probably will be forced to cut their acreage by at least 50% unless Congress changes the law. Shifting to other crops will also be difficult for farmers in this area, because many of them cultivate cotton on high priced irrigated acreage. It is not too practical to shift that sort of land to low profit crops. Naturally the remaining cotton acreage will be more heavily fertilized. Likewise, the substitute crops will get a lot of fertilizer.

In the Southeast, the traditional cotton growing area, the acreage cuts will not be so great, perhaps 25%. Here, there is a strong likelihood that growers will shift a substantial part of the acreage diverted from cotton to forage crops and pastures.

DR. COLEMAN: One of the keys to the shift in the South will be the cattle price outlook. If the prospects for profitable cattle markets next year are good, we can expect a further expansion in livestock production in the South. This could mean a substantial increase in usage of fertilizer on pastures.

As you know, the acreage controls for corn, if announced, will only apply to the "commercial corn growing area," principally in the Midwest. Therefore, farmers outside the commercial area will be free to grow all the corn they wish, and many wheat and cotton growers will take advantage of this opportunity.

Are farmers going to be using a higher per-acre application of fertilizer on crops under acreage control to increase yields? Will the higher per-acre use balance out total sales of fertilizer?

DR. COLEMAN: Historically, cotton growers have increased their rate of fertilizer application in years when they were subject to acreage allotments. We don't have similar records for wheat and corn. However, I think we can safely predict that the average per-acre usage of fertilizer on these crops will be greater in 1954 than this year. This, of course, will tend to offset the potential drop in fertilizer sales due to the cut in acreage, particularly if we have favorable planting weather in the spring.

MR. ALLSTETTER: In a sense, the farmer can't afford not to purchase fertilizer—more fertilizer than ever before. Actually, the average farmer can make *more* money from a *smaller* acreage of the "surplus" crops—in fact, from a smaller total production—by following proper fertilization and other good farming practices recommended by his state agricultural experiment station.

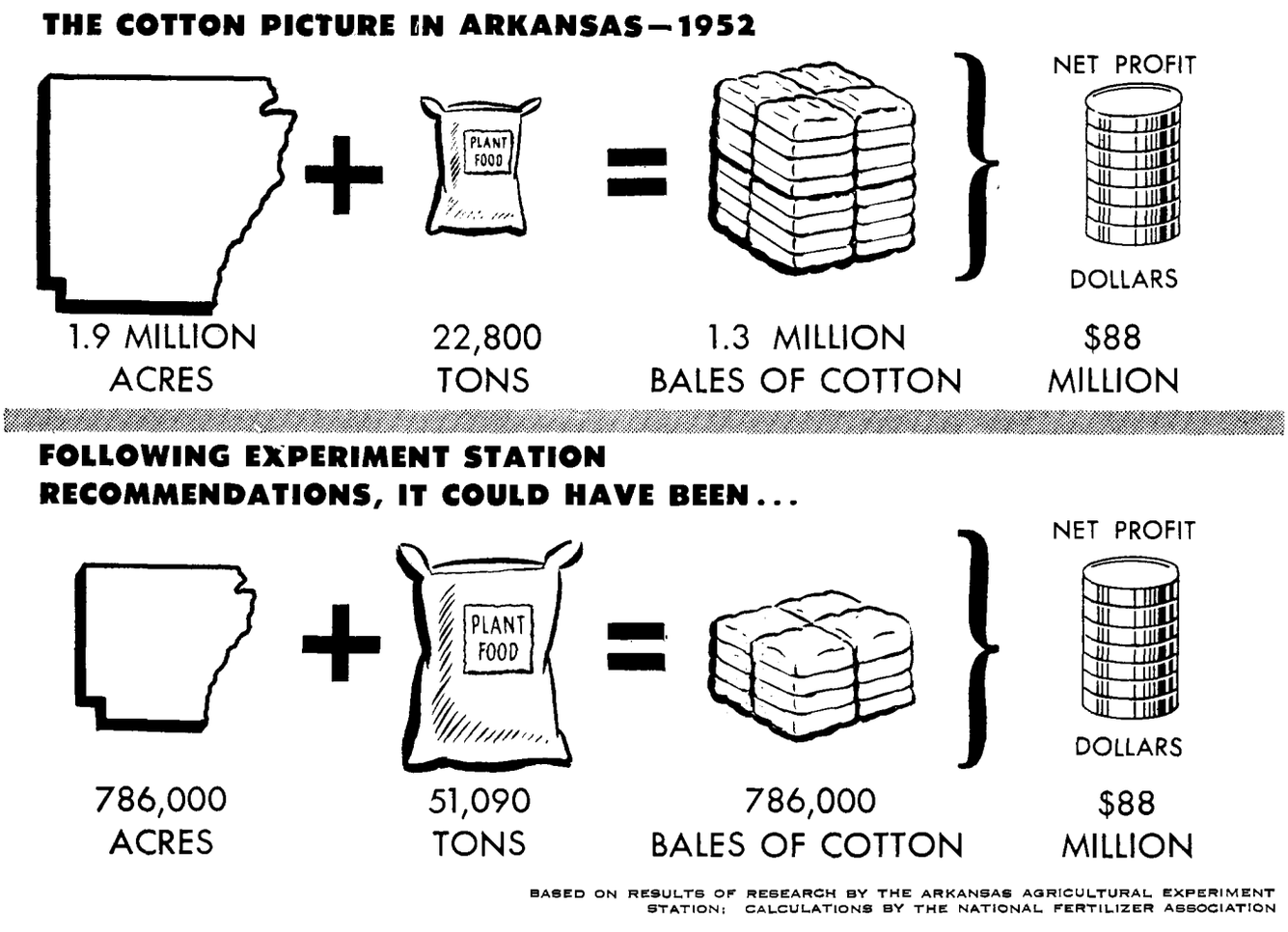
DR. COLEMAN: For example, when I was out in Arkansas recently, we took some data developed by the university and figured out for several important cash crops how much Arkansas farmers could reduce their plantings and still make as much net profit as they did last year—providing, of course, they were to adopt recommended fertilizer practices. The results were startling. In the case of cotton, Arkansas farmers could realize the same net profit on 786,000 acres as on the 1.9 million acres planted to cotton last year in that state. But perhaps more important is the fact that they would achieve this same net profit on a total production of only about 786,000 bales of cotton as compared with the 1.3 million bales harvested in 1952.

For corn, the figures show that Arkansas farmers could make the same net profit from 10.2 million bushels grown on about 255,000 acres as from the 13.9 million bushels output from the 929,000 acres in corn last year. Calculations for the other important cash crops showed the same relationship.

In other states where sufficient data are available to permit accurate estimates, the picture is the same. Nationally, farmers could have produced the same total number of bushels of corn this year on 20% fewer acres at an estimated net saving (or increase in net profit) of a half billion dollars from a smaller total output because their costs per unit of production are reduced substantially.

There has been much discussion recently to the effect that it isn't as easy to borrow from the banks now as it has been in the past. Is this tighter credit policy likely to have an effect on fertilizer consumption?

MR. ALLSTETTER: I would say that the tight money policy being talked about here in Washington is not likely to be as much of a factor in fertilizer consumption as one might expect. With regard to the rural banks, I think the situation is better described right now as tight on both sides. Farmers generally are not too anxious to expand their borrowing at the present time when they are so uncertain about the future. Likewise, there undoubtedly is a general tendency for



rural banks to scrutinize farmers' loan applications more closely now than may have been the case a year or two ago. Nevertheless, in my contacts with bankers recently, I have gathered that money can and will be made available to farmers who need it for the purchase of fertilizer if the banker is convinced that the farmer will make money from the loan.

Realizing that availability of credit could be a very important factor in fertilizer consumption if and when spendable income in the hands of farmers becomes really tight, the National Fertilizer Association and several of its member companies have been carrying on a concerted program to acquaint bankers with the advantages of proper fertilizer usage. This program is showing very encouraging results. It has aroused considerable interest among individual bankers, and several state and regional associations have "picked up the ball" and are carrying our message to their members.

Then you don't feel that farm credit is a serious factor at this time?

MR. ALLSTETTER: As a result of the drought and also the cattle price situation, some farmers have had trouble paying off loans. Fertilizer manufacturers report that fertilizer collections have been slow. Most people agree, however, that credit is not the major problem at present.

Actually, farm spending seems to have dipped considerably faster than farm income. This would appear to mean that farm cash reserves are up.

Is storage space for fertilizer going to be as big a problem as it has been in past years?

DR. COLEMAN: Storage space is one of the major problems in the fertilizer business at present. Farmers seem to have reverted to their prewar practice of seasonal buying. For several years there was quite an encouraging year-around market for fertilizer. Now farmers seem to be going back to the custom of buying the fertilizer just before they are ready to apply it. This means that with storage space limited, the industry may not be able to take full advantage of its increased production capacity. It may not be able to produce and ship against the full demand during the relatively short peak-demand periods.

In view of the smaller demand this fall, storage areas in many plants already are full. Without additional storage space, these plants can't produce more until they can ship what they have in storage. Production capacity of the fertilizer industry has tripled in the last 12 years. Naturally, more storage space is needed as total volume increases, and many plants are building more storage.

But this is not the only solution to this problem. Results of research by experiment stations in all parts of the country indicate that farmers' use of fertilizer can be spread throughout the year—that in fact, fall applications, for example, may be just as good or better than spring applications in the case of many crops. Education, of course, is the key to this problem.

What about higher-analysis fertilizers? Are farmers demanding more of them? What are the contributing factors to this development?

DR. COLEMAN: In the southeast sections, many farmers still buy fertilizer by cost per ton. Naturally the cost per ton is lower for the lower analysis products. In the Midwest and the Southwest, on the other hand, freight rates are more of a factor in the final cost to the user. Here the farmers realize more clearly the increased value of higher-analysis products. I would say that, in general, the newer fertilizer using areas show the most striking demand for higher-analysis products. This is particularly true in Wiscon-

sin, Minnesota, and the Great Plains areas.

Are mixers experiencing any demand for fertilizer-pesticide mixtures?

MR. ALLSTETTER: The interest in these mixtures seems to be increasing especially in the Southeast. As a matter of fact there is interest in many parts of the country. However, the use of fertilizer-pesticide mixtures involves many problems—in production marketing, safety, and proper usage—and the industry is inclined to move cautiously. I think we can safely say, however, that if farmers want fertilizer-pesticide mixtures, the industry will provide them.

Has it been customary for food processors to make recommendations to farmers as to fertilizer application rates and other good farming practices in cases where they contract for produce?

DR. COLEMAN: This varies considerably by areas, but generally is the case. And of course, food processors who follow this practice have a considerable influence upon fertilizer usage by farmers with whom they contract. In some cases these instructions are very comprehensive and explicit—they not only tell farmers what kind and how much fertilizer to apply, but also just when to apply it, and they may even tell them what kinds of machinery to use. In the West, it is not unusual for beet sugar processors to recommend fertilizer application rates in excess of experiment stations' recommendations. In most of the eastern vegetable producing areas, it traditionally has been customary for food processors to recommend farming practices, and the custom is becoming more widespread.

We've talked about a lot of factors which relate to the fertilizer outlook for next year. Putting them all together, how would you summarize the situation?

DR. COLEMAN: It's pretty difficult because there are so many variables—factors that could swing either way. Generally, we are optimistic. While acreage and marketing controls will cut the acreage planted to some crops that use a lot of fertilizer, increased rates of application will partially offset this. Likewise, substitute crops will get a lot of fertilizer. The drought has seriously cut fall business. But much of this cut can be made up in the spring if weather permits.

Availability of credit is not a problem at this time. Moreover, farmers cash reserves are up somewhat—in other words, they have the money to buy the fertilizer that they need.

Adding all this to the more widespread awareness on the part of farmers of the potential savings in cost per unit of output through proper fertilizer utilization, I think that generally we can look forward to another reasonably good year in the fertilizer business.

AN AG AND FOOD STAFF SURVEY

Long-Term Trend for Fertilizer Use Should Be Up; More Attention to Costs Exhibited

A general trend toward increasing application of fertilizers has developed. It has been accompanied by a close watch of fertilizer costs, including application expense. This is leading toward higher analysis mixed materials and greater interest in the simple fertilizers, such as anhydrous ammonia and ammonium salts. With the farm income lower than it was a year ago, and with acreage controls becoming effective over some crops, there is more serious attention to costs. In some views this means increased use of fertilizer to step up yields; in other cases farmers have yet to be convinced of the wisdom of this approach and will cut expenditures directly by using less fertilizer. In general the opinion seems favorable for increase over-all.

With increasing fertilizer use, the seasonal surge in the purchase of fertilizers becomes a greater problem. Fertilizer companies are feeling more than ever the need to convince the farmer of the wisdom of buying ahead. This brings to the farmer storage problems. According to T. L. Jackson, Oregon State College, farm storage facilities for fertilizers may soon be as important as the once traditional hay barn if supplies are to move smoothly from manufacturers and retail distributors.

Methods of application constantly are being improved. Some fertilizer manufacturers claim that more effort is needed along those lines, and companies which produce better equipment than now is on the market should do very well. As higher analysis fertilizers are being applied at lower per-acre rates, more accurate application equipment is needed. One producer says "the applicators are going to have to get on the ball and come up with a good list of available equipment for sale to the grower."

Outstanding improvement of application techniques has been in the direction of "two-jobs-in-one." Successful coupling of fertilizer application with plowing, weeding, or cultivation is helping to push costs toward a minimum. These advances are leading farmers to depend increasingly on specialists who can give them advice on how to make use of technical advances.

Higher Analysis Is the Trend

The trend today definitely is toward the use of higher analysis fertilizers (AG AND FOOD, June 10, page 442). In the West, for example, one major producer says that there is a shift as follows:

Where formerly the analysis was	The product now being used is
3–10–10	6–20–20
4–12–4	8–16–8
8–8–4	12–12–6
10–10–5	14–14–7
10–10–10	13–13–13

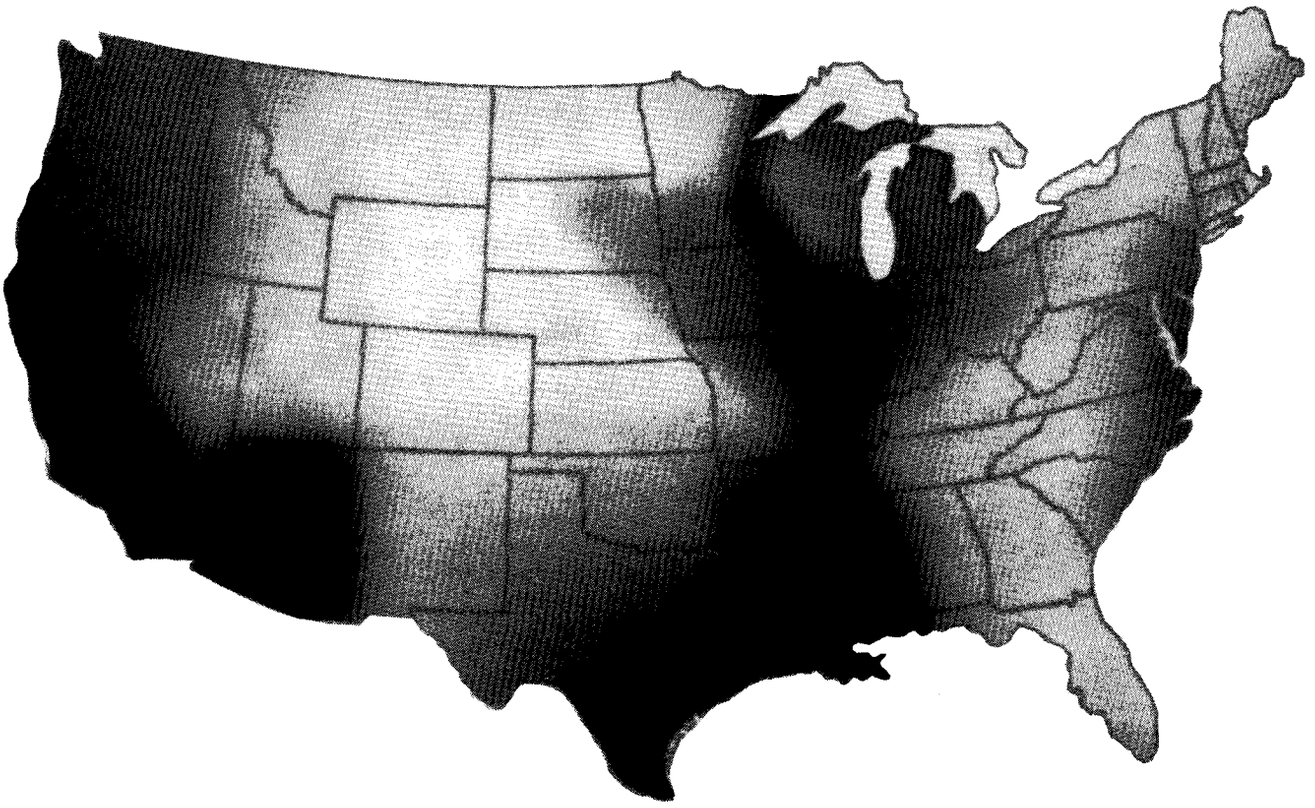
Another, in the Southwest, says that while 8–8–8 has been popular in the past, 10–10–10 is becoming more popular and he expects that farmers soon will be using 12–12–12 in large quantities. An important concrete expression of confidence in this trend is seen in Allied Chemical & Dye's Nitrogen Division's new $5 million 12–12–12 plant. The commenter from the Southwest says that 1–1–1 shows the greatest rate of growth, 1–3–1 ratios have declined, 1–2–1 held its own, and 1–4–4 has had tendency to increase.

With the increased use of high analysis there is increased danger that the farmer might neglect secondary and minor elements which are not usually included in proportion as high as formerly. For example, when a farmer buys double superphosphate in place of conventional superphosphate, he is getting a minimum of calcium sulfate. Both calcium and sulfur are needed by the soil. These elements can be added in forms less expensive than standard fertilizer—as limestone, particularly the dolomite type which contains magnesium.

With high proportions of major elements producing higher yields, minor elements may be depleted from the soil if their application is not stepped up. This calls for careful attention to the minor elements. In some cases they are being applied to the soil in mixtures and in others use is being made of foliar application.

An example of effect of correcting a trace or minor element deficiency: Where soil was deficient in molybdenum, the addition of a pound per acre of the sodium salt of that element increased alfalfa yields 13 to 28%.

Important work relative to trace elements is being done with chelating agents, such as ethylene-diaminetetraacetic acid, which holds iron in a form readily available to plants.



Density of use of direct-application ammonia throughout the U. S.

Anhydrous Ammonia Is a Leader in Growing Fertilizer Developments

Probably the most important single development in the fertilizer field today is the increasing direct application of ammonia. According to Charles R. Downs, New York chemical engineer, who is a director of Chemical Enterprises, Inc., formed recently to promote the financing and development of agricultural ammonia, there is no question as to the future of the direct ammonia application idea in agriculture. This seems to be the general tenor of opinion in the industry. With the past fertilizer year showing an increase in consumption of 15% over the previous year, anhydrous ammonia certainly seems a safe bet for some time to come.

Use Spreading

Mississippi and California were the regions in which direct application of ammonia started to develop and they are still leading areas. Louisiana, also a leader, used 26,000 tons of ammonia for direct application last year. That was 40% of the state's total of fertilizer nitrogen. Use is being taken up increasingly in the Midwest. The practice is spreading.

This is strikingly true in the corn and wheat areas, where almost no nitrogen fertilizer previously was used. It is there that the growth now is most rapid. The area concerned is beginning to spread across the Dakotas and into Washington. Knowledge of the benefits of nitrogen application is spreading. Having a nitrogen content of 82%, as compared with, for example, 21% of ammonium sulfate, it has an advantage. As anhydrous ammonia is the cheapest source of nitrogen and provides that element in a readily available form for rapid uptake, it is finding favor with farmers.

Growth of direct application of ammonia has been impressive. The original application through irrigation systems was made by Shell Chemical on the West Coast in the early thirties. Application directly beneath the soil began in Mississippi, reaching a commercial stage first in 1947. The consumption was about 20,000 tons in 1946, 120,000 tons in the 1950–51 fertilizer year, and more than 230,000 tons in 1952–53. Some well-informed men in the field think that the figures for the past two years are as much as 10% lower than actual consumption. For the current year 300,000 tons would not be surprising. Direct application is being used also in Norway, Sweden, Hawaii, and probably some other countries.

Application of anhydrous ammonia is still the subject of a great deal of experimentation and it appears that much is yet to be learned about effective application. This applies both to placing the material in the soil and also timing. In the western and northern parts of the United States, the nature of the soil makes autumn application practical, while the sandy soil in the East and South calls for spring application.

Climate Is Important

Fall application is best where winters are cold. Nitrification stops when the temperature is below 60° and the ammonia is held until spring. In warmer winter climates there is some loss by leaching of the nitrates formed. There is some unfavorable evidence on fall application. At Mississippi State agricultural experiment station, it has been found unsatisfactory for small grains, while in Indiana, unsatisfactory results came from fall application to wheat. Wet or dry extremes offer physical problems—fall or spring. Some experts suggest that fall application will supply nitrogen to soil microorganisms allowing them to multiply and give a more desirable decomposition of crop residues. Whatever the time may be, direct application is the method used at present and it seems likely that it is here to stay.

At present, there is a trend, in regions where it is practical, to supply the ammonia at the same time and as a part of

Storage is a big problem for anhydrous ammonia fertilizer. It must be kept at a pressure of about 250 pounds which introduces a hazard which the farmer may not always be ready to cope with. Tanks are expensive. Distributing stations are the answer offered by some and a number of companies operating such stations are servicing farms in the South. Field tank requirements for ammonia have been estimated by the USDA at 164,500 tons for 1953 and 216,200 tons for next year. The greatest number are those ranging in size from 100 to 300 tons.

Storage of ammonia at the plant in such quantities as to meet rush season surges is very difficult. This was described recently in a speech by A. M. Smith, Mathieson Chemical Co.: "It is impossible, both practically and financially, to build at a big plant enough tanks to store the production of weeks and months. At Morgantown at present, at the rate of 700 tons per day, there is sufficient storage for only three days of production. Sales departments work mostly five days a week, except during rush periods. The ammonia has to be moved; but the delivery and application of anhydrous ammonia to soils has been even more seasonal in many respects than with other fertilizers, because it has not been stored quite so cheaply."

Hazards have been a subject of concern. But the problems are mostly those involved in handling any compressed gas, and applicators and farmers have learned rapidly. The development of state regulations which may vary has offered some problems, but the opinion on this matter seems optimistic at present. To date, five states have gone so far as to assign the administration of their regulations to a specific body: Arkansas, Georgia, Louisiana, Mississippi, and Tennessee. Some others appear ready to follow soon.

Nitrogen Solutions Showing Promise In Competition with Anhydrous NH_3

Application of aqua ammonia is showing an upward trend in competition with the anhydrous material, according to optimistic backers of the former, particularly in the West. The aqueous material is being applied not only through irrigation systems but also with solution applicators.

Aqueous solutions of nitrogen compounds are showing strong promise in direct application uses and there appears to be growing interest. One producer says that in some areas of the country application is being limited only by the availability of nitrogen compounds. Another producer predicts a 20% increase during the coming year.

These solutions of ammonium products in some cases are applied from a small tank attached to a tractor with a pipe running back to a plow. Each plow tooth or shear has an injector located behind it through which the solutions enter the soil. A method of application now giving a big advantage to the solutions is simple spraying on the ground. Satisfactory results are reported.

Nitrogenous fertilizer solutions for direct application are mostly of three types: ammonium nitrate with or without added ammonia, ammonium nitrate and urea, and sodium nitrate. The Nitrogen Division of Allied Chemical & Dye is a very strong figure in this picture. The area of highest use now is in the corn regions of the Midwest. The Southeast, particularly North Carolina and Virginia, is showing an increasing interest for corn, cotton, and pastures. A third important area where nitrogen solutions are being pushed is in New York in the vicinity of Ithaca.

A strong talking point for these materials is the absence of high pressure. While some of them contain some ammonia, those used have a pressure of no more than 10 pounds per square inch at 104° F. Others, containing no ammonia, are referred to as "nonpressure solutions." The absence of pressure gives the solutions a competitive advantage over liquid ammonia, as no high pressure equipment is required. However, the solutions are corrosive and cannot be stored in ordinary concrete tanks. Aluminum tanks appear to be the best answer at the present time, although steel can be used for short periods, where the corrosion problem is taken into consideration.

The use of nitrogen solutions in the corn belt has been greater this fall than predicted. The "nonpressure" solutions can be applied to the surface, followed immediately by plowing under. This overcomes two disadvantages of injection-type direct application fertilizers: hard ground problems resulting from lack of rain and the clogging caused by crop residues. In the South, solutions are finding increasing use for fall applications on pastures.

As the fertilizer mixing companies have been using ammoniating solutions for many years, they are acquainted with the handling techniques and are acting as distributors. They often furnish equipment for application and even apply the solutions for the farmer. As the solutions can be applied in the spring after the rush of the mixing season for spring sale has slowed, the handling is a convenient addition to the mixers' activities. While application techniques still are in somewhat of an experimental stage, it appears that with growth of the use of solutions, there will be some tendency for farmers to acquire their own equipment and do their own application. An increasing practice is the temporary use of animal watering tanks by farmers for handling solutions.

A very interesting new material being developed as a fertilizer at present is ammonium phosphate solution. This has been announced by the Agriform Co.

Looking down row of aldrin-treated corn into untreated lodged corn

Storage is a big problem for anhydrous ammonia fertilizer. It must be kept at a pressure of about 250 pounds which introduces a hazard which the farmer may not always be ready to cope with. Tanks are expensive. Distributing stations are the answer offered by some and a number of companies operating such stations are servicing farms in the South. Field tank requirements for ammonia have been estimated by the USDA at 164,500 tons for 1953 and 216,200 tons for next year. The greatest number are those ranging in size from 100 to 300 tons.

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Demand for More Fertilizer-Insecticide Combinations Grows

Although the fertilizer industry is generally apathetic and, in some cases, even antipathetic to the practice of mixing fertilizer and pesticide, growing pressure from the farmer is forcing formulators into the business. So far, most of the mixes have been prepared on a custom basis to the grower's specifications. Most of the demand has been in the Midwest and Southeast for use on corn, a crop that is often seriously damaged by rootworms, wireworms, and cutworms, which live in the soil and off corn roots and the lower areas of the corn stalk.

Probably the insecticide finding the widest use in these mixtures at present is aldrin. Others of promise are dieldrin, heptachlor, chlordane, isodrin, and endrin; BHC, DDT, toxaphene, and methoxychlor have also been used successfully.

Last year, Iowa corn farmers used a mixture of aldrin and fertilizer at the rate of about a half pound of aldrin to the acre. Results there last season were so satisfactory that use of the mixtures are expected to skyrocket next year to about half a million acres.

So far, the Southwest has not been important as a market for the mixtures, but one source in that area says that crop failures in the Rio Grande Valley, attributed to poor seed germination, may be due to wireworms eating the seeds. If this observation proves to be correct, the Rio Grande Valley may become a sizable market for mixtures.

Legal Problems

The fertilizer industry's apathy toward mixtures of fertilizer and insecticides is, in general, caused by some large problems in law, safety, manufacturing, application, and economics.

Fertilizer manufacturers are familiar with the various state regulations concerning the labeling and analysis of their products, but the additional and more complex regulatory problems which would be attendant with mixing their products with insecticides has somewhat dampened their enthusiasm.

Distribution and sale of insecticides in the U. S. is regulated by the Federal Insecticide, Fungicide, and Rodenticide Act. This act rigidly proscribes the labeling, use, and distribution of insecticides in interstate commerce. In addition to the federal act, various states have additional regulations concerning pesticides made or sold within the state. It is generally conceded that any effective pesticide-fertilizer mixture would come under the regulation not only of fertilizer laws but also of the various pesticide acts, and if prepared for interstate distribution would be subject to inspection by USDA.

Pesticide regulations, both state and federal, differ fundamentally from the laws concerning the sale and distribution of fertilizers in the liability provisions. Pesticide manufacturers are liable if their preparations do not give the results claimed on the label. And to make label claims the manufacturer must usually offer adequate proof for them. In the case of mixtures the fertilizer manufacturers would in many cases be forced to enter into expensive field testing operations to prove claims they might want to place on the label. In addition to labeling claims, the manufacturer must provide directions for safe and effective use of the pesticide preparation. And the manufacturer is often liable if harm results following these directions.

The liability and labeling provisions are among the major headaches for any fertilizer manufacturer contemplating the production of pesticide fertilizer mixtures.

Regulatory officials, those charged with enforcement of the pesticide and fertilizer laws, are also unenthusiastic over mixtures. They have developed accurate analytical techniques for fertilizers and pesticide preparations, but to attempt to analyze mixtures of the two presents new headaches. Prepared mixtures of fertilizer and pesticide would be predominantly fertilizer with added traces of pesticides. To determine these trace amounts of pesticides present in a mixture will call for the development of more sensitive analytical techniques.

The uniform distribution of trace amounts of pesticide in fertilizers will call for increased efficiency on the part of the manufacturer and also bring new problems to the analytical laboratories of the regulatory agencies. In sample lots thus far produced in commercial plants there is often a wide variation in the analysis prepared by the regulatory officials and the manufacturer. This is usually explained by incomplete mixture of the pesticide throughout the fertilizer.

In manufacture, the biggest problem is in getting a uniform mix. Such small amounts of insecticide are used relative to the large bulk of fertilizer that thorough distribution of the insecticide throughout the fertilizer is difficult. Efforts to develop pelletized insecticides and granular materials may overcome some of these problems. Another problem from the manufacturing point of view is equipment. Most fertilizer plants are not equipped to do the mixing, which would require separate facilities.

In addition, personnel in fertilizer plants would have to be trained in the safety precautions of handling poisonous materials. However, the farmer using a mixture of fertilizer and insecticide is submitted to less danger than he is with the more concentrated insecticidal materials.

Application-wise, the fertilizer-insecticide combinations are attractive to the farmer. The economy of applying the two in one operation appeals to him, and this factor probably accounts for most of the demand. However, one drawback is that the combination can only be applied to one crop, whereas a specific fertilizer formulation can be applied to several crops.

Many fertilizer manufacturers frankly question whether the economy of a one-time application would remain if the industry decides to go into mixing on a large scale. The cost of new facilities, the industry's increased liability, and storage problems would eventually have to be paid for by the farmer in the price he pays for the combination.

Another problem for the fertilizer industry is that of storing the combinations. The variety of insecticides which could be mixed with fertilizer means that mixers would have to make and store a multiplicity of different grades. Also, the possibility of a decrease in insecticide effectiveness over long storage periods presents another problem.

Added to this are the economic vicissitudes of the insecticide business, which the fertilizer industry does not wish to accept. Compatibility of insecticides and fertilizer is another question which has not been fully answered.

The insecticide industry is quite frankly enthusiastic about combinations. The large potential market for its products is naturally appealing, and soil insects are one of the biggest problems in American agriculture.

Responsibility to the Farmer

In between the enthusiasm of the insecticide industry and the apathy of the fertilizer industry are those who feel that demand will grow and that the two industries have a responsibility to see that farmers get the best possible products and use them in the proper way. As George Decker of the Illinois Agricultural Experiment Station put it in a recent issue of *Fortune:* "Whether we like it or not, there's going to be a shotgun wedding, and the farmer holds the shotgun. He isn't going to fertilize today and dust next week if he can do the two at once." Those who take this more realistic view say that research is needed—on compatibility, uniform mixing, residues, analytical techniques, and other questions. Some thought is also being given to the possibility of combining other agricultural chemicals with fertilizer. A combination fertilizer-soil conditioner is a possibility, although it will probably be some time before this becomes feasible. One company is also said to be mixing fertilizers and weed retardants.

Enthusiasm for Surfactants in Fertilizer Mixing Wanes

The original enthusiasm generated for surfactants or wetting agents in processing phosphate rock and fertilizer mixing seems to have subsided somewhat since a year ago. Present attitude in the industry can be best expressed as one of "wait and see."

Early publicity for these agents was presented without adequate experimental backing.

Many processors were quick to pick up the original news and tried various test lots of the surface active agents to see if they would actually be effective in reducing curing time for phosphate rock, increase the efficiency of existing ammoniation techniques, and reduce caking in mixed fertilizers.

A year later representatives of the fertilizer industry met in Chicago during the recent AMERICAN CHEMICAL SOCIETY meeting for a round-table discussion on the status of surfactants. Representatives of the various companies who had had experience testing surfactants on trial lots of various types of rock and for the formulation of mixtures were present at this meeting.

Companies from eight different states reported on their trials of the materials and the results were generally inconclusive. In some cases an increase in curing time or higher efficiency of conversion with the same acid-rock ratio was reported. Increased efficiency of ammoniation in the manufacture of mixed fertilizer was also noted in specific cases. There was, however, a general unanimity of opinion of those present at the round-table discussion that there might be possible benefits derived from the use of surfactants in the industry but that the results reported so far were not sufficiently consistent to establish the value of the materials.

Although the improvements noted did occasionally occur, positive benefits were in no case consistently obtained. Thus, although the industry has by no means abandoned the use of surfactants it does not seem that a boom is presently under way.

The acidulation of phosphate rock seems to be the most promising potential field of application for these materials. At present the only method for selecting an agent is trial and error. However, the Chicago round table was agreed that a research program is needed to determine what surfactants to use in various situations for consistent results.

The USDA research station at Beltsville is the only source making basic research information public for the industry at present. E. J. Fox of the Bureau of Plant Industry presented a paper at the recent ACS meeting surveying the use of surface active agents in the acidulation of phosphate rock.

In only one case did he report an increased efficiency of conversion of rock as a result of addition of a surface active agent. In all cases the surfactant appeared to reduce the hardness of denned superphosphate. In general the nonionic surfactants were more effective in reducing this hardness than the anionic.

The effect of a given surfactant seemed to vary widely with different types of commercial rock. Dr. Fox and his coworkers believe that this might be due to the possibility that spent sulfuric acid used in the industry may contain surface active agents which have measurable effects on the manufacturing process. This could perhaps explain the wide variation in the results reported by industrial workers.

J. O. Hardesty, also at Beltsville, has been investigating the effect of surface active agents in fertilizer manufacture. He reports that his work, concerned with the effects of surfactants on ammoniation for mixed fertilizers, is still incomplete. In some cases the addition of a surfactant will increase ammoniation efficiency, but in other cases no effect can be noted.

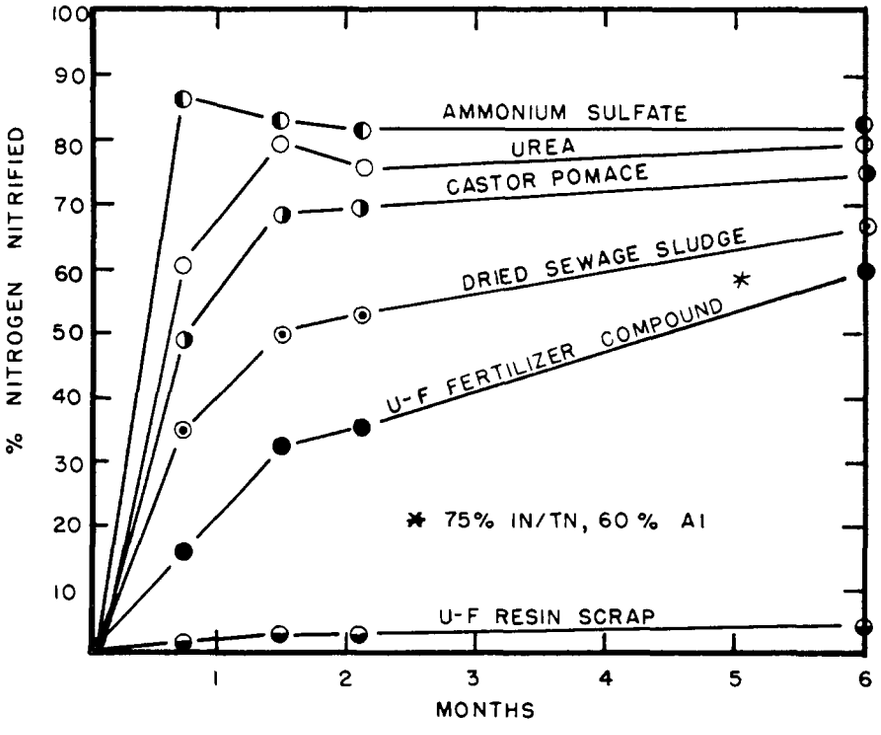
The Beltsville researchers agree with industry that more basic, controlled research is needed before recommendations for the use of surfactants can be advanced.

Urea-Formaldehyde a Promising Specialty

A relatively new fertilizer material being watched with special interest is prepared from condensation of urea with formaldehyde. The development is not entirely new; since 1939 some mixed fertilizers have been ammoniated with ammonia liquor containing a small amount of formaldehyde with urea. The result is formation of water-insoluble nitrogen during ammoniation and subsequent storage of the fertilizer. Only small amounts of nitrogen have been incorporated in this fashion. For example, only 1% is put into a 10–10–10 grade of fertilizer.

These new urea-formaldehyde fertilizer compounds have basic advantages, notably the slow release of the high nitrogen content of the product. Because of cost, present potential use seems limited to specialty products, such as flowers, nursery plants, and turf. But one university research specialist has estimated that if the products were commercially available, annual consumption by the ornamental industry would amount to

NITRIFICATION RATES OF NITROGENOUS FERTILIZERS



FROM A PAPER BY R. D. KRALOVEC AND W. A. MORGAN, DU PONT CO.

about 1000 tons a year, once growers became familiar with its advantages.

Another interesting and possibly important use of urea-formaldehyde fertilizers is in irrigated crops. The product is effective in that use as it is highly hygroscopic. It is now on trial in rice fields. Farmers are using all they can get, it is reported, and would like to have more.

The only marketer at present is Warwick Chemical Co. Du Pont is the big figure and is still doing research and development work. The USDA group at Beltsville, Md., is doing research and made many of the original contributions.

Manufacturers and others interested are of the opinion that the product should not be pushed too rapidly and that well-rounded understanding of the compounds as fertilizers should be gained before moving into large-scale marketing. User education is important in order to avoid inferior materials and discouraging results which might damage the future of the development.

An essential step for the protection of users is the working out of standards for the relatively easy measurement of urea-formaldehyde fertilizer quality through established agencies. Work on quality measurement now is being pressed by Du Pont and others with the aim of avoiding repetition of events which have hampered the progress of some colorful developments: appearance of hastily produced and low quality or unsatisfactory materials.

Differ from Plastics

The present interest took flight from work reported by Yee and Love, USDA, at Beltsville, in 1946. They showed that water-insoluble nitrogen fertilizer with exceptional controlled availability for plant growth could be made by the reaction of urea with formaldehyde.

The fertilizer compounds are made by the acid-catalyzed reaction between the two components. The products differ from the highly insoluble plastic resins in that a higher ratio of urea to formaldehyde is employed in the fertilizers. The plastics materials cannot be used satisfactorily as fertilizers.

Products prepared to date showing the most satisfactory qualities for fertilizer use contain about 38% nitrogen. About three fourths of the nitrogen is in the slowly available form generally referred to as water-insoluble nitrogen. By controlling reaction conditions, products can be made to give 55 to 60% nitrification of the water-insoluble nitrogen in six months in an average soil. The nitrification rate is affected by type, pH, and other plant nutrient content of the soil.

Agronomic availability of urea-formaldehyde nitrogen is directly proportional to the rate at which the nitrogen is converted to nitrates by soil microorganisms. Experiments with sterilized soil have shown very little ammonia and no nitrate formed in decomposition of urea-formaldehyde products in that medium. This indicated that strictly chemical hydrolysis assists only to a minor extent in the decomposition of urea-formaldehyde compounds to ammonia. Hydrolytic enzymes are necessary for the liberation of that ammonia. No formaldehyde was detected in water extracts of soil treated with urea-formaldehyde fertilizer compounds.

The most outstanding practical results to date have been achieved with turf, especially on golf courses. Ordinarily, a golf course may require three to five applications of fertilizer a year. With urea-formaldehyde, only one application may be necessary. Investigations at the University of California with flowers, nursery plants, and turf have given favorable results. Some important advantages found: (1) initial low solubilities minimized damage from excessive soluble salts; (2) larger amounts of nitrogen can be applied at one time; and (3) the level of soluble nitrogen in the soil solution can be maintained more uniformly over a period of time.

Foliar Application Can Meet Special Needs

The foliar application of plant nutrients is receiving considerable attention and is being put into practical use in a number of specialized operations, particularly in applying minor elements. The most significant use at present probably is in growing fruit and other high unit value crops. It is used relatively little in extensive cultivation. To try to supply the fertilizer needs of fruit trees entirely through the leaves would be impractical. Proper treatment would require too many applications. Certainly the application of solids through the soil will continue to be the predominant method for the time being as well as the foreseeable future. However, where a quick shot of fertilizer is essential, foliar application can be of value.

At present, foliar application is finding appreciable use in the treatment of deficiencies of minor elements, as indicated by A. F. Camp in AG AND FOOD, May 13, page 294. Where soil applications would have to be large and over prolonged periods, sprays sometimes give quicker and comparable results from smaller quantities of rather expensive salts, according to Dr. Camp.

Dr. Camp reported that in Florida minor elements often are simply added to applications of spray that will be put on anyway and in this fashion are used rather extensively, particularly in the fruit regions. Zinc deficiency has been treated on a commercial scale in the coffee regions of Costa Rica.

In a discussion before the recent meeting of the Association of American Fertilizer Control Officials, Jackson B. Hester, Campbell Soup Co., reviewed some current uses. Foliar application can be used effectively, for example, on extremely acid soils where there is a deficiency of such elements as molybdenum with toxic concentrations of manganese or iron. The former can be improved and the latter offset by balanced application to the leaves, of the proper elements. Certain root crops require a high concentration of boron. In farm practices these crops may be followed by others which have a low boron requirement and may be subject to boron toxicity. To overcome this condition, stated Dr. Hester, it has been customary to use a limited amount of borax per acre in soil application and to supplement it with foliar spray.

Secondary elements also can be provided through foliar spray. In certain areas in the Northwest, sulfur deficiencies have been remedied by use of soluble salts, such as magnesium sulfate.

According to Dr. Hester, considerable interest has developed recently in the use of complete fertilizers as a spray. Highly water-soluble compounds, such as ammonium phosphate and potassium phosphate are combined to form mixtures of N–P–K ratios such as 10–52–17 or 15–30–15 which have been applied successfully as sprays.

Urea is the form of nitrogen used most effectively in this way to date. Tolerance varies with crop and as a result only a part of the nitrogen can be applied economically to the leaves in some cases. As urea is compatible with a number of fungicides and insecticides, combinations can be used.

At Riverside, Calif., it was found feasible and economical to feed nitrogen directly to orange trees through foliar sprays, although care was necessary to prevent leaf burn. Urea at five to seven pounds per 100 gallons of water was preferred. The same strength was applied satisfactorily to apple trees in eastern U. S. The British are studying foliar application of urea with interesting results. Workers there caution that timing of the spray is very important and warn that urea sprays are not yet to be recommended universally.

Combination of urea and ammonium nitrate can be used effectively, according to Dr. Hester, as toleration is almost doubled over that for urea alone. However, insecticide compatibility is reduced. Dr. Hester believes foliar application is a fertile field for research.

Applying plant nutrients with foliar sprays

Rising Imports of Ammonium Sulfate Causing Concern

Imports of fertilizer raw materials received an airing in Congress last spring. At that time the House agriculture committee investigated imports of potash from East Germany. The committee hearings revealed that during a strike in the Carlsbad potash mines in the summer of 1949 there was an influx of Red potash to the east coast of the U. S. Prices charged for the imported material were much higher than the price which consumers had paid for the domestic product when it had been available. Following settlement of the potash strike in New Mexico the export of potash from East Germany continued but at prices competitive with the domestic material.

The potash producers presented evidence to show that the East German producers were attempting to undersell the domestic American producers. This year there has been a considerable improvement in the supply of potash. Domestic production has been at a high level and total value of imports has dropped about 25%. Present indications are that supplies of potash for the present are adequate with imports augmenting the domestic production, but not noticeably competing with the domestic material.

Biggest increases in imports for the first six months of this year compared with the same period in 1952 were nitrogen sources, ammonium nitrate and ammonium sulfate.

The increase in imports of ammonium nitrate by about 100% over the first six months of '52 has been in response to an increasing demand for this material by fertilizer manufacturers. These imports and an increasing domestic production are being absorbed by the market and indications are that, if these sources of supply can be maintained, the demand for ammonium nitrate can be met.

One interesting development in the import picture is the increasing importance of West Germany as a source of fertilizer raw materials. The tonnage and dollar value of ammonium nitrate imports from this area has shown a six-fold increase for the first half of this year. Last year's imports of ammonium nitrate from West Germany were valued at about $1.2 million. The first half of this year we imported almost $7 million worth from West Germany. Imports from Austria on the other hand showed about a 10% decline in tonnage.

Ammonium Sulfate in Oversupply

The supply situation with regard to ammonium sulfate is regarded throughout the industry as one of surplus. Domestic production has been at a high level, perhaps in excess of demand. Imports have also boomed. The dollar value of ammonium sulfate imports has increased from about $5 million for the first half of last year to $12 million for the same period this year.

Japan has been exporting large amounts of the material to the U. S. this year. In 1952 imports of sulfate from Japan were insignificant, but for the first half of this year the Japanese sulfate accounted for almost 10% of the total U. S. imports.

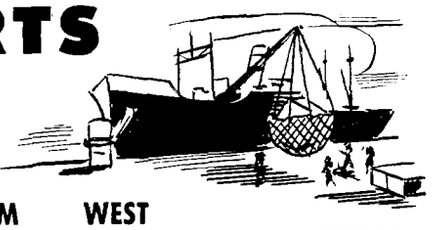
Fertilizer processors in the U. S. have apparently shifted to purchasing the cheaper imported material to such an extent that domestic sulfate is piling up. Sulfur producers are not alarmed by the decline in demand for ammonium sulfate, for there are other more profitable markets for sulfur. Domestic sulfate producers on the other hand seem to be hard hit; in Houston two ammonium sulfate production plants have closed in the last week. Phillips Chemical Co. has closed a major production unit and shifted workers to other production plants. The Best Fertilizer Co. has also suspended operations, laying off the majority of its 150 employees.

Manufacturers of fertilizer grade sulfate expect further price drops and will cut production so that they won't be caught with sulfate in storage at a price too high to sell.

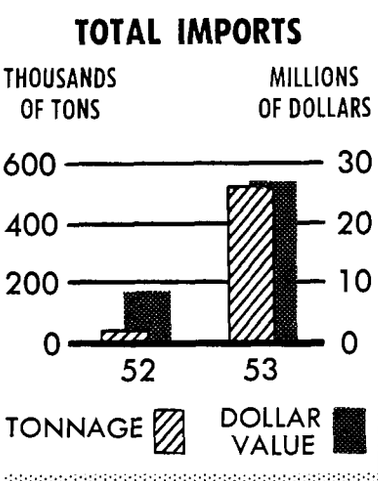
From the fertilizer mixers' point of view the supply situation with regard to sulfate seems to look good with a strong possibility of further price reductions. Sulfate producers on the other hand seem to be caught in a squeeze.

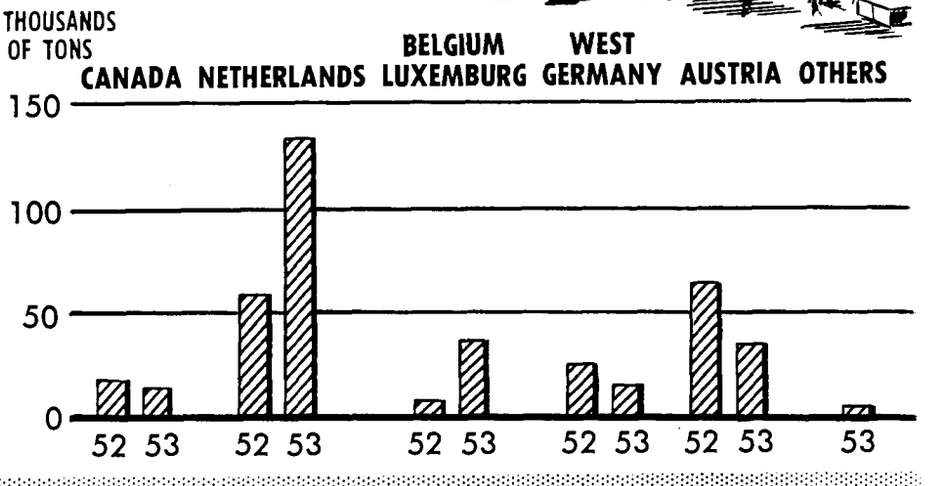
Last year much of the Japanese production of ammonium sulfate was being sold in the Far East, principally

U.S. FERTILIZER IMPORTS

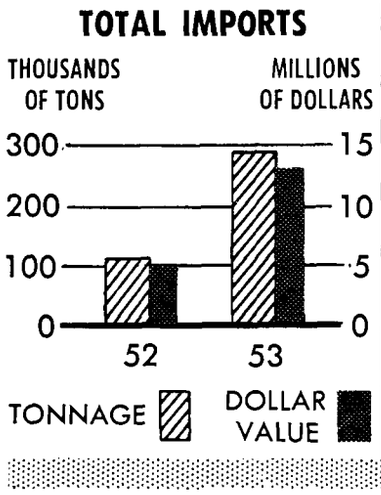


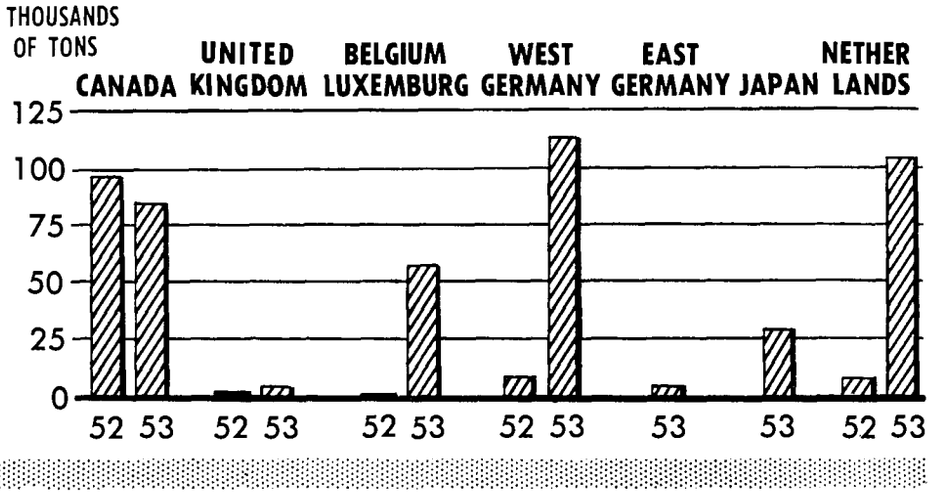
AMMONIUM NITRATE



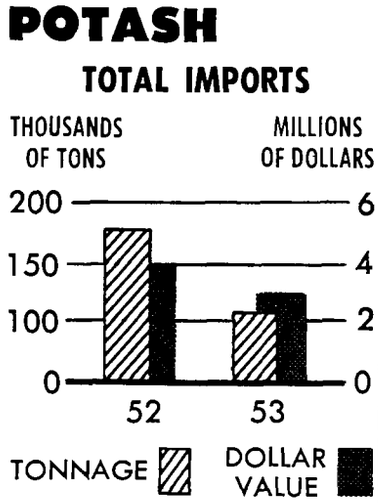


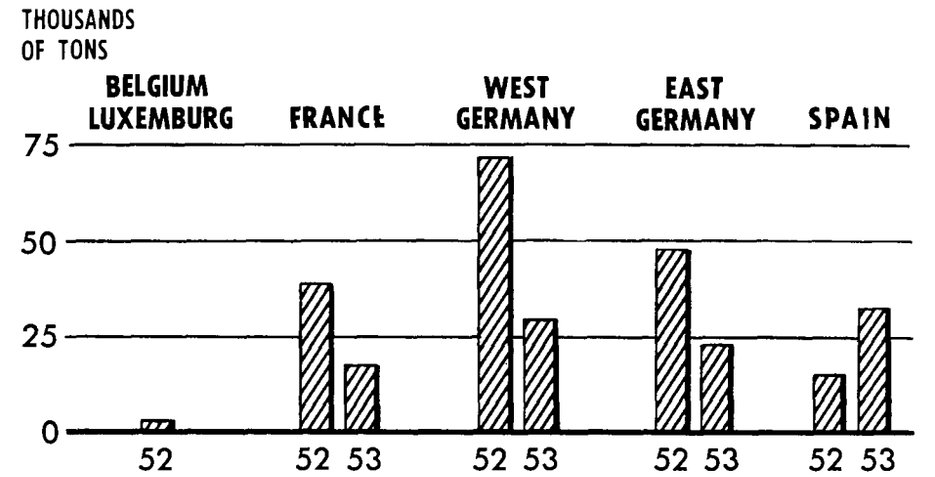
AMMONIUM SULFATE



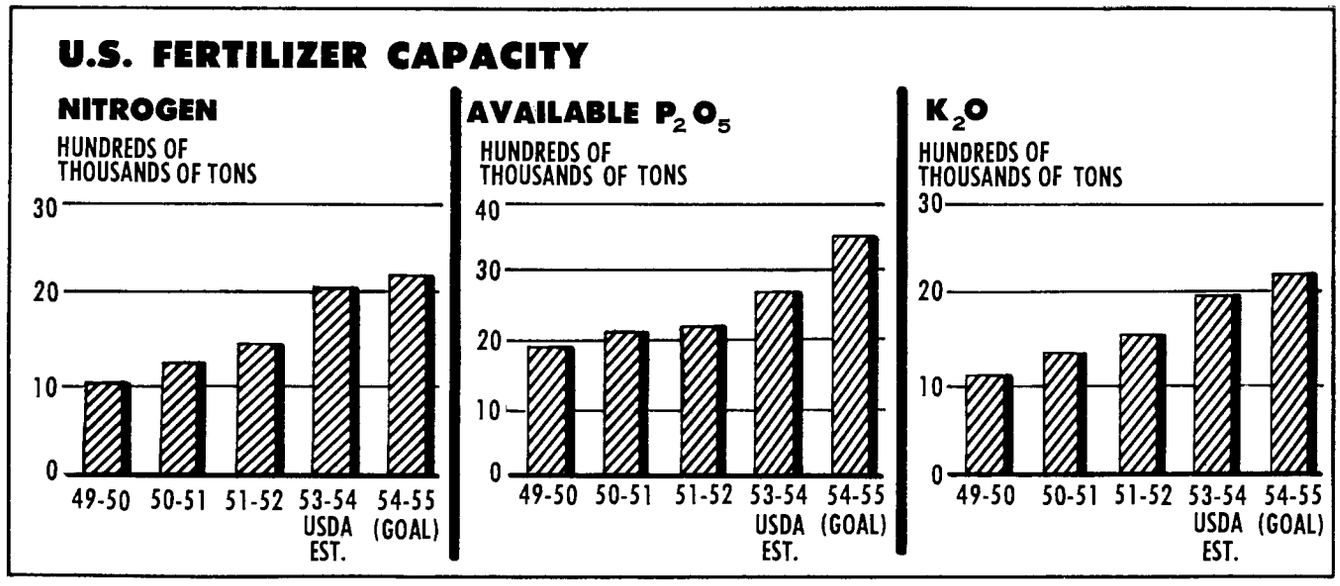


POTASH





SOURCE: OFFICE OF INTERNATIONAL TRADE, U. S. DEPARTMENT OF COMMERCE



India. With the development of fertilizer production facilities in India the Japanese have, apparently, now shifted their selling to the U. S.

Belgium, Luxembourg, and West Germany have also greatly increased their shipments of ammonium sulfate to the U. S. We paid out almost $5 million to the West Germans the first half of this year for sulfate, a tenfold increase over the same period in 1952. Belgium and Luxembourg increased the dollar value of their exports almost 800 fold, from about $3000 for the first half of 1952 to $2 million so far this year.

Representatives in American industry, both coke and fertilizer processors, say that the present high levels of imports of ammonium sulfate are hurting domestic producers.

The port price of sulfate has dropped from $50 to $47 per ton in the last few months, and now coke oven sulfate has dropped down to $44 per ton.

There seem to be rather widespread rumors that ammonium sulfate sent overseas under the Marshall Plan is now returning to the U. S. A more logical explanation is that, with the recovery of European industry, a surplus of ammonium sulfate is being built up in industrial nations overseas. This, coupled with the trend toward ammonium nitrate and other high nitrate fertilizers, has caused a comparative shrinkage in demand for ammonium sulfate.

Will Nitrogen Be Short or Long? Opinion Divided

The tremendous expansion period now in progress throughout the basic plant nutrients manufacturing industry should make it easier for fertilizer formulators, who have been used to scrambling for raw materials.

Probably the most dramatic of the expansion programs now under way is that of nitrogen. Opinion seems to be divided on the question of whether there will be a shortage or an oversupply of that plant food during the next year or so. Some say there will be a shortage of ammonia, some say supply is catching up with demand, others say the situation will be oversupply. The answer probably depends on the area.

One executive of a major company producing ammonia is of the opinion that the current expansion program in ammonia producing capacity will temporarily end the current nitrogen shortage and probably will balance demand for the next year or two. He does not foresee any serious oversupply in the next five years and doubts that anything of the kind is in sight in the foreseeable future. Some are less optimistic.

There is a strong possibility that more new capacity for nitrogen will come into production during the next two years than has been estimated by the industry. Production was 1,876,000 tons last July. By 1955, capacity is expected to reach 3,332,000 tons.

In the potash industry, expansion has proceeded. Supplies seem to be catching up with demand after a period of shortage occasioned by the long strike in Carlsbad, location of the greater part of the potash industry.

In phosphates, if construction proceeds in accordance with certificates of necessity, the balance sheet will show a total production by 1955 of 3,550,000 tons P_2O_5, an expansion over 1951 capacity of 1.4 million tons. Over half of the expansion will be triple or other concentrated forms of superphosphate. Other large participators in the phosphate expansion program are ammonium phosphates, nitrophosphates, and normal superphosphates.

Superphosphates Grow

The high analysis trend is showing in superphosphates, where production on a considerable scale is under way for materials analyzing more than 50% P_2O_5. Most of the high analysis material is being produced in Florida, but will be shipped out of the area in taking advantage of the lower freight cost per ton of nutrient.

One big new plant not in Florida is Phillips', the second largest triple superphosphate unit in the country, now under construction at Pasadena, Tex. The superphosphate capacity will be much greater next year. Davison's 200,000-ton super triple plant, the largest, is scheduled to operate this winter. Others entering the triple super field or expanding production are International Minerals and Chemical, Virginia-Carolina, F. S. Royster, Armour, and U. S. Phosphoric, a subsidiary of Tennessee Corp.

The shortage of sulfur during the war stimulated development of phosphate fertilizer processes not dependent on sulfuric acid. A considerable amount of progress has been made by TVA (this issue, pages 1050–9) but the availability of sulfur makes the processes' commercial prospects doubtful for the immediate future. Nitric phosphate processes are in operation in several European countries, including Holland, Norway, Germany, and France.