Ag and Food Interprets . . .

- **Granular herbicides following trail blazed by insecticides**
- **Tissue analysis can pin down plant's fertilizer needs**
- **Most of this year's world nitrogen surplus may be in U. S.**
- **Atomic research tools may accent U. S. farm surplus, says panel**
- **Ag chemicals industry takes harder look at its bright prospects**

Granular Herbicides

Commercial future assured for herbicides in granular form, following trail blazed by granular insecticides

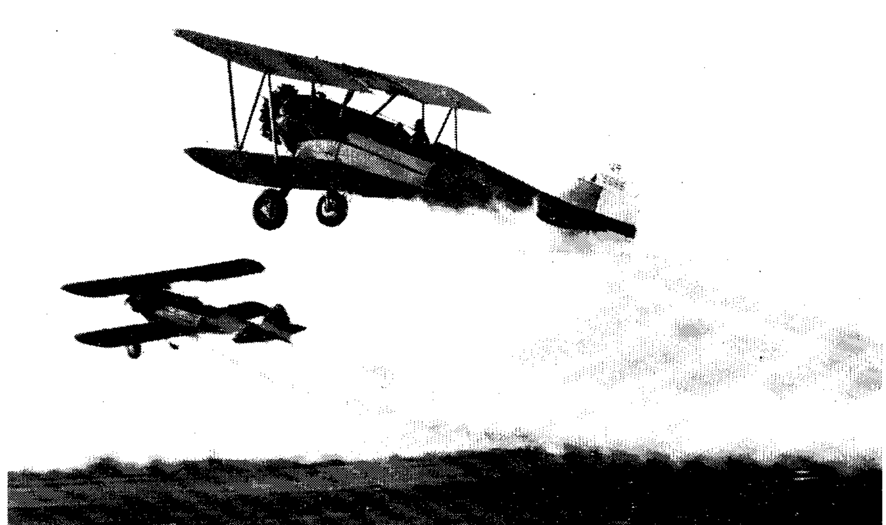
Considerable progress has been made in recent years in the development of insecticides in granular form, and fairly wide-spread commercial use against the corn borer is expected this year (Ag and Food, December 1955, page 988). Granular herbicides, although trailing somewhat in development and field testing, have demonstrated certain advantages over dusts or sprayed herbicides for weed control in some crops, and appear now to be well on their way toward commercialization.

Field testing has indicated that increased selectivity may be obtained by granular materials as compared with the same herbicides in spray form. Thus some herbicides which are phytotoxic in spray form (and are thus limited to pre-emergence application) may in granular form be used to control germinating weed seeds in established crops. Chloro IPC in granular form, for example, may be used for weed control in peppers, tomatoes, or sweet potatoes, while in spray form the same chemical would kill or damage the economic plants. Physical selectivity, added to the herbicide's inherent chemical selectivity, promises to increase the range of crop plants to which the herbicide is applicable, and may also provide a greater margin of safety on tolerant crops.

The physical characteristics of granular herbicides offer a number of other benefits in the economically significant realm of materials handling. Considerable weight savings are possible with granular materials in contrast to sprays, since no water or other liquid is required. In pre-emergence application on direct seeded crops, water hauling is eliminated, and planting and herbicide application can even be made a single operation.

The weight problem is especially important in connection with aerial application; in some instances an aerial payload of granular material may cover several times the area that can be treated with an equal weight of liquid spray based on the same herbicide. At the same time, the danger of aerial drift—another bugaboo in airplane spraying of dusts or liquids—is greatly reduced. Height of release

One advantage of granular herbicides is in application. In aircraft application, risk of drift to sensitive crops is minimized, and the payload can cover more acreage



above the treatment area is less critical with granular materials, while relatively uniform particles will improve distribution on the ground and give a much higher yield of effectively applied material. (In some instances, as much as 80% of a liquid spray cannot be accounted for following aerial application.)

A special advantage may accrue in connection with bushy crop plants; a high percentage of granular material sifts down to the soil readily, whereas sprays are intercepted by the foliage and give relatively poor soil coverage directly beneath the crop plants. This advantage in favor of the granular form may be particularly significant with transplanted crops.

Once out of the applicator, granular materials may prove superior to sprays in the matter of volatility losses, and early work has indicated that undesirable decomposition of herbicides —IPC, for instance—by soil microorganisms is greatly reduced with granular materials.

Granulated or pelleted materials appear to be uniquely qualified for control of aquatic weeds in fish ponds, irrigation ditches, and drainage canals, since they sink quickly to the bottom, releasing a high concentration of herbicide near the roots, and causing rapid destruction with a minimal waste of chemical. Such materials should also be useful for weed control in flooded crops such as rice.

Granular herbicides are not without their disadvantages, most important of which currently appears to be price. Estimates vary widely, but generally place the basic price of a granular material at "slightly higher" to as much as a third higher than that of the same amount of herbicide in sprayable form. Some if not all of the difference can be made up through reduced handling costs in most situations, however, and the greater convenience of dry, granular materials is considered by many to be well worth any cost differential that might remain.

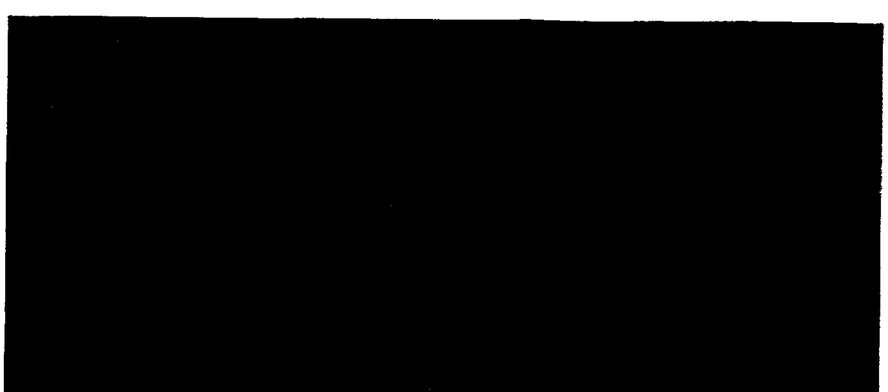
Cost Not Limiting Development

Certainly it does not appear that granular herbicides are being held back unduly by cost considerations. Granular herbicides are already in use in Hawaii for aerial application in sugar cane, and they are considered attractive possibilities for early commercial application in the growing of tomatoes and sweet potatoes. In the past year or two in California, control of rye grass in clover by means of granular herbicides has entered the commercial stage. "Very promising" results were obtained with pelletized monuron and fenuron on mesquite and other woody species in Texas in 1955.

Trial commercial batches of various materials have been produced by a sizable number of agricultural chemicals manufacturers—Veg-Acre Farms, Forrestdale, Mass.; Miller Chemical, Baltimore, Md.; Carolina Vermiculite, High Point, N. C.; Florida Agricultural Supply, Jacksonville, Fla.; Liqui-Lawn, New York, N. Y.; Jack Wilson Chemical, Stockton, Calif.—to name but a few. These and many other companies are busy with their own market research, and also are working with agricultural experiment stations to determine what herbicides are most likely to prove commercially profitable.

Thus far, the herbicides which have shown greatest commercial progress in granular form are IPC and chloro IPC, but a number of other herbicides —for instance, CMU, dalapon, Sesin, Crag, Natrin—have also been studied in varying degrees. As with granular insecticides, the granular carriers generally are tobacco stem particles, attapulgite or bentonite clays, vermiculite, perlite, or diatomaceous earth.

Doubtless the chief deterrent at present to rapid commercialization of the granulars is the paucity of reliable field test data. But this drawback is being overcome to an accelerating pace. Obviously much research work lies ahead before general recommendations can be made for use of granular materials in general field crops. However, grower acceptance of the granular herbicide concept has been described as very good, even with the development still in its very early stages, and increasing accumulation of data on various herbicide-weed-crop relationships should lead to increasing commercial progress for granular herbicides.



Tissue Analysis

Quantitative tissue analysis can pin down fertilizer needs

Foliar or tissue analysis is one of three general methods of measuring a crop's nutrient needs and setting up a sound fertilization program. While the least used of the three, it has been raised to a high level of efficiency in several instances and offers certain inherent advantages.

Although the three methods often supplement each other, consider them separately and solely as a measure of nutrient status. The field trial, while it remains the standard test, is inherently limited in that its results apply only to the particular time and place of its execution. Soil analysis, while faster and cheaper than field trials, doesn't consider climate and other factors that affect a crop's use of the nutrients present.

Tissue analysis, on the other hand, can have the speed and convenience of the soil test, and it reflects more adequately than either of the other methods all the factors that have influenced the crop's nutrition up to the time of sampling. Furthermore, once the proper correlations are set up, tissue analysis results for a particular crop can be used for that crop under widely differing soil and climatic conditions.

There are two kinds of tissue analysis: "quick testing" and quantitative analysis. Quick testing, pioneered by G. N. Hoffer of Purdue University and the American Potash Institute, is a fast field test based on colorimetric methods. It shows the concentration of the given nutrient in the plant's cell sap and, while only roughly quantitative at best, will detect severe deficiencies and can be a handy survey tool.

Quantitative tissue analysis, done in the laboratory, shows the total amount of the given element present in the part of the plant being analyzed, and results in general are reproducible to an accuracy of 3 to 10%. Once correlations have been worked out between these results and plant behavior, analyses can be made and their results interpreted in terms of action to be taken in a time not significantly longer than needed for quick testing.

Correlations Are the Key

Correlations are the key to a successful tissue analysis program. Take the "crop logging" system, based essentially on tissue analysis, which is used on Hawaiian sugar cane and was worked out by Harry F. Clements of the Hawaii Agricultural Experiment Station and his associates. The first step is to determine which plant tissues, upon analysis, give the best indication of the plant's nutritional status. In 1938, sugar cane test plots were set out in Hawaii to get this information.

With the correct tissues and sampling techniques worked out, nutrient levels must be correlated with crop behavior when particular nutrients are added to or withheld from the soil. A "critical level" for various nutrients is established, tissue analyses are made periodically, and fertilizer is used as necessary to keep nutrient content at the desired level relative to the critical level.

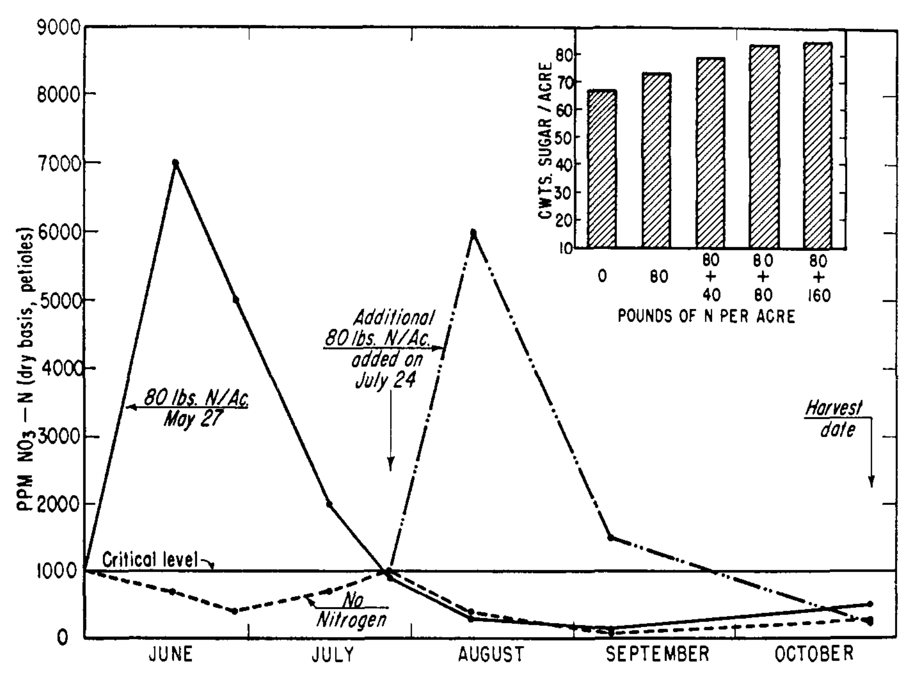
Today, this system is used on a large part of the 200,000 acres of Hawaiian sugar cane. Tissue samples are taken at 35-day intervals from the time the proper tissues are available until harvest. Crop logs for each field show, among other things, running records of N, P, and K levels, temperature, sunlight, moisture level, and sugar level. Growers are ready at any time to apply fertilizer by irrigation water, machine, or airplane, as indicated. Also, a tissue moisture system, with weekly sampling, is used to ripen the crop. Water is withheld before harvest to hold tissue moisture at a predetermined level which restricts growth while photosynthesis continues, producing more sugar. The total cost of operating this program runs about 20 cents per ton of sugar which is worth about $130 per ton.

A tissue analysis system used to guide fertilization of sugar beets has been developed by Albert Ulrich of the University of California and his associates. As in Hawaii, the technique is also useful in harvesting the beets at the most profitable time. Fields shown by analysis to have been low in nitrogen the longest are harvested first, since sugar beets allowed to remain low in nitrogen for a few weeks prior to harvest are somewhat smaller, but markedly higher in sucrose. Ulrich's system is rapidly gaining popularity for sugar beets in California and elsewhere, and development of a similar system for beans is in the discussion stage.

Michigan State University offers local fruit growers routine tissue

R. O. Schade of Brea Chemicals runs a tissue analysis "quick test" on celery in Orange County, Calif. Such tests are used to spot check severe nutrient deficiencies

Effects of fertilization on the nitrate-nitrogen content of sugar beet petioles can be seen in this chart which is based on the tissue analysis system developed by Albert Ulrich and his associates at the University of California at Davis



analyses and is presently running 500 to 1000 samples per year. The service costs $5 per sample and has been self-supporting in the past two years. Considerable tissue analysis work has been done on Florida citrus to measure both nutrient and toxicant (chlorides, sodium salts) levels, and the Western Washington Experiment Station is at work on sampling techniques and critical levels for red raspberries and strawberries. The latter has already used tissue analysis as a nutrient status survey tool on peas and potatoes to outline areas and soils where deficiencies exist or are most apt to occur and thus to provide a basis for more specific fertilizer recommendations.

Some Limitations

Tissue analysis does have limitations. One of them is the time needed to get results and act on them, although the experience of Clements and Ulrich indicates that this need not necessarily be a hindrance. Also, it takes time and money to work out critical levels and sampling techniques. Finally, tissue analysis in general will probably work better on perennial than on annual crops. Where fertilizer is best applied at or before seeding on an annual crop, for instance, soil testing can be useful initially, although when that crop (in a particular field) has a history of tissue analysis, results from previous years can obviate the need for soil tests.

Commercial tissue analysis laboratories are apparently few nationwide, compared to the number offering soil and similar tests. But in California, at least, their number is increasing and service is not confined to orchard crops (including citrus) for which tissue analysis was first accepted as a diagnostic tool in the state. One such laboratory at Santa Paula, for instance, offers a systematic sampling (usually five times a season) and analysis service largely on field and vegetable crops. It served about 2500 acres last year and expects acreage to double this year.

Tissue analysis does appear to have taken hold more firmly in the past few years as a practical agricultural tool. The real question now, in fact, appears to be not whether it is practical but whether or not it will return more value per dollar than other methods of measuring nutrient needs.

Nitrogen Surplus

World surplus of nitrogen may hit 407,000 tons for 1955–56, with most of it in U. S. storage

The surplus of productive capacity for nitrogen seems no longer to be doubted; the question remaining is how long will it take consumption to catch up. Several reports on the nitrogen situation issued early this year give the data on which to base an answer.

Aikman, Ltd., whose figures are generally believed to be the most reliable indicators, said in its year-end report on the world nitrogen situation that unless consumption increases at a much greater rate than it has recently a reduction in output from that presently planned is essential. Aikman estimates potential surplus next June at about 407,000 short tons, most of which will be in the U. S. interior.

In its report a year ago, Aikman foresaw a possible shortage of nitrogen for 1956 for the world outside the U. S. This most recent report then reflects an almost complete change of attitude, with Aikman now calling for a reduction of world output.

According to Aikman, U. S. producers were operating at about 80% of capacity during the last six months of 1955, but it expects producers here to be operating close to capacity this year. Aikman figures that in the 1954–55 year, U. S. consumption topped the previous year's by 13% (an 8.5% increase for fertilizer and a 25% increase for industrial and military purposes). USDA's estimate of U. S. increase in nitrogen consumption for fertilizer in 1954–55 was 7.4%.

Both Aikman and the Food and Agriculture Organization of the United Nations predict a 5% increase in nitrogen fertilizer consumption for the world as a whole. Aikman's forecast of the increase in world consumption for all purposes is 6%.

Aikman's forecast also includes a prediction that the U. S. will increase its exports of nitrogen to about 209,000 short tons this year (slightly more than USDA's 198,000 tons prediction) compared with 154,000 short tons last year. U. S. imports, meanwhile, are expected to decrease from 406,000 tons last year to about 330,000 this year. Although U. S. remains a net importer of nitrogen, its 1955–56 exports, if Aikman proves to be correct, will put it second only to Western Germany as the biggest exporter of nitrogen. In 1952–53, the U. S. ranked ninth.

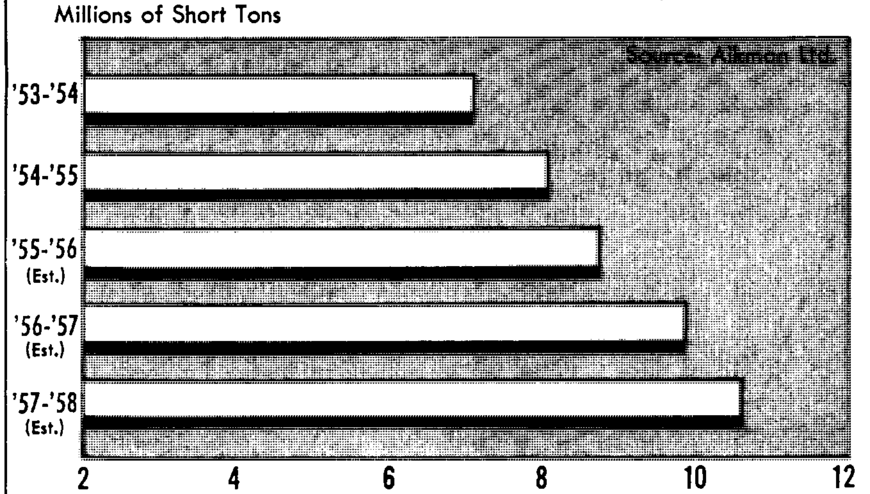
The more conservative FAO roundup of fertilizer reports that world consumption gained 6% last year (Aikman says 9.3%). World production, according to FAO, also increased 6%, but production is expected to take an 8% jump this year.

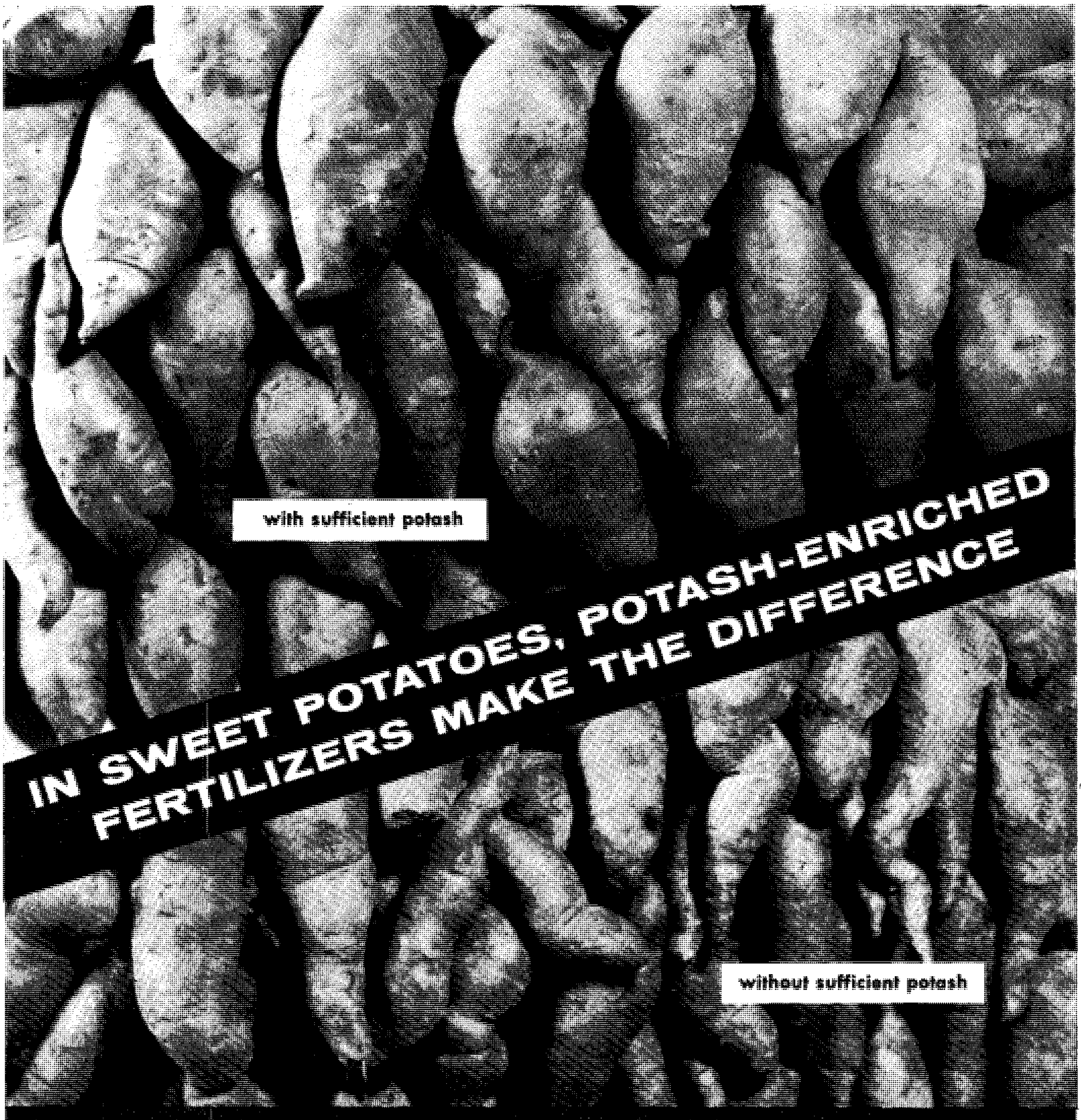
The British Sulphate of Ammonia Federation, Ltd., concludes in its report that world production increased 14% last year and consumption 13%. Fertilizer nitrogen consumption also went up 13%, according to it.

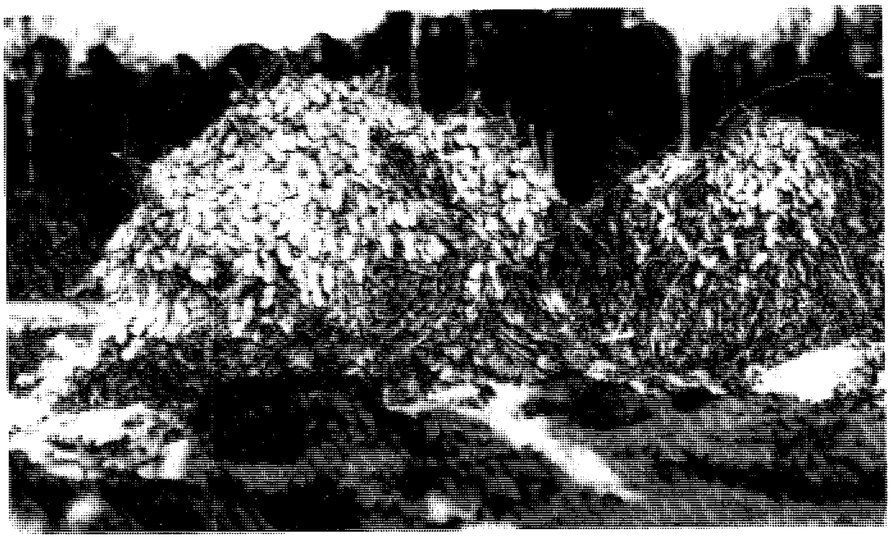
The chart shows Aikman's estimates of world nitrogen production in the years ahead. Besides U. S. capacity increases, the Aikman report cites new plants being planned for South America, India, Pakistan, Formosa, Egypt, South Africa, and Turkey. Also helping to bring up the 1957–58 estimate are plants now being discussed in Italy, France, Spain, Yugoslavia, Poland, and the United Kingdom.

World Production of Nitrogen

Millions of Short Tons




with sufficient potash
IN SWEET POTATOES, POTASH-ENRICHED
FERTILIZERS MAKE THE DIFFERENCE
without sufficient potash



One of the most beneficial uses of atomic energy to farmers is the aid it gives to plant breeders. Radiation helped to produce the superior yielding peanut variety shown on the left. Control at right

Atom's Impact on the Farm

Atomic tools may accent U. S. surplus problem, but help undernourished areas to abundance

INCREASED PRODUCTIVITY and lower costs for individual farmers, and an intensified farm surplus problem for the nation as a whole—this mixed blessing will be the eventual result of the atom's application to agriculture, says the McKinney panel on the impact of the peaceful uses of atomic energy.

However, in underdeveloped nations, atomic tools will help bridge the gap between scarcity and abundance. But technological assistance must be provided by the U. S. Toward this end the panel recommends:

•That technological resources be fully explored, with high priority, to obtain the humanitarian benefits which can result from the applications of atomic energy to agriculture.

•That agencies and departments concerned with assistance to foreign countries develop a coordinated and vigorous program with technical assistance from the Atomic Energy Commission. The program should be focused on those areas of atomic research that will lead to rapid utilization in undernourished countries.

The extent of the atom's impact will depend largely upon the rate of development and the extent of application. One basic application of atomic energy in agriculture is in the use of atomic radiation to speed the evolution process. This is essentially an extension of the work which has been going on for three decades using x-rays to increase genetic mutation rates. The coming of atomic energy means radiation sources of greater and more flexible uses in connection with plant breeding. Through radiation regional, climatic, and seasonal variations, which have in the past limited the entire character of agriculture, can be eliminated. At least on a laboratory scale, continues the McKinney report, the day of the tailor-made plant seems close at hand. In the long run, we can expect many new variants of current horticultural types—perhaps even varieties which lend themselves more readily to mechanical harvesting and processing.

Radioisotopes are additional tools readily available to agricultural research and nuclear reactors in operation today make them relatively cheap. Use of tracer tools puts research and development in agriculture on a large and rapid scale. Radioisotope studies of photosynthesis, states the McKinney panel, hold far-reaching promise. According to the report, it is within the realm of possibility that ultimately man will not have to depend on plants for edible energy.

Radioactive isotopes and atomic radiation both contribute to new methods of blight and pest control. Farmers may be given new plants which can remain disease-free longer; but in the long run, natural evolution of new diseases and insect varieties will catch up with these new types. Natural evolution is a continuing process, and only by continuing this kind of research can we keep ahead.

For example, the plant breeder develops a wheat strain having a high resistance to black stem rust. But this work is suddenly undone by the spontaneous emergence of a new rust. Recent work has shown that radiation will produce new varieties of blights with increased virulence. By developing these varieties under controlled conditions, geneticists may be able to breed plants resistant to them before the new blights appear in the field. Relatively few applied agricultural research centers are devoted to this work, even in the U. S. In other countries, where the need for increasing food production is even greater, such work is still in the basic research stage, or nonexistent.

Other applications of the atom include crop storage and irrigation. Radiation techniques are beginning to go into commercial practice and may substantially reduce food losses due to spoilage in storage. Irrigated lands produce a substantial percentage of the world's foodstuffs. But the most imaginative examination of the uses of atomic energy, either for pumping irrigation water or for desalting sea water, are thus far discouraging. The most optimistic estimates of atomic capabilities do not as yet afford hopes of commercial feasibility in this field.

The future of atomic agricultural results must be tempered by comparison with tangible current accomplishments, says the report. Applications now in practical, commercial, dirt-farmer use are still few in number The greatest impact of peaceful uses of atomic energy on agriculture will come from its importance as a tool for the agricultural researcher.

Ag Chemicals Growing Up

Pesticides industry coming out of its slump takes a harder look at bright prospects

THE AGRICULTURAL CHEMICALS industry, obviously floundering a couple of years ago, lifted its head from hard labor last month to see what it had accomplished. The results were more pleasing than it had been accustomed to seeing, and the future looked good. As Carbide & Carbon's Jack Field said, it is a teen-

ager growing up. But the teen-ager has learned from some of its follies and looks at the future with colder calculation than it had in the days when DDT and BHC looked like profits forevermore.

The general atmosphere was certainly brighter at the 1956 spring meeting of the National Agricultural Chemicals Association that it had been in 1953 or 1954. But it wasn't one of gay abandon. An impressive number of company representatives were after a hard-headed evaluation of the future outlook and the sound business-like basis for company decisions. How good do products have to be? How much money should a company have for research and development before going into the business? These were questions that popped up often.

There is no doubt that some facts and figures on the industry make an attractive picture.

George McNew, Boyce Thompson Institute's managing director, showed the NAC group that a successful scientist can have a flair for sales; he pricked up many an ear with his evaluation of the future of fungicides. Reporting the loss estimate for 1942–51 at $2.8 billion a year for crops and forests, and adding a figure for materials deterioration, he reckoned that half of this could be eliminated to save $1.7 billion a year. Using 10 to 1 as the odds a farmer demands on his investments, McNew estimated the annual market for chemical fungicides to the consumer at $175 million. That should give the primary producer a sales volume of $85 million.

Promising Directions

McNew says the $85 million potential annual market justifies $3 million a year for research and best directions lie toward: soil fungicides and nematocides, bactericidal chemicals, rust and powdery mildew eradicants, and systemic protectants to eliminate infections inaccessible to surface agents.

Root rots are labeled as the most under-evaluated problem facing the farmer today, with perhaps 5% of many crops being lost to the soil fungi, nematodes, and bacteria that cause such maladies. Millions of acres could be treated with profit at a cost of $35 per acre—repeated every third year—but not at $200 or up.

Antibiotics have shown impressive strength recently in controlling bacterial disease. But the antibiotics are expensive, so expensive that there is still plenty of room for synthetic organic chemicals to come into the picture at a profit—if they are good.

Plant diseases aren't the whole story. Insects continue to cost a lot. Grasshoppers still are expensive pests. According to H. L. Haller, USDA, they are likely to be a serious threat this year to cropland in more than 15 states and 20 million acres of range.

Haller points to such pests as nematodes, European chafer, and Khapra beetle as some of the most formidable threats against which USDA is directing emphasis. Soil insects (such as wire worms, Japanese beetles, white-fringed beetles, and other root feeders) stand high in the list of problems. Grassland insects also rate particularly high, as do mites.

Such an array of pests and losses to the farmer look attractive to the agricultural chemicals producer. But the question that rises in every discussion today is: "Can we afford to try?"

J. A. Field and R. H. Wellman of Carbide & Carbon gave the NAC session some expert opinion on what to expect in investment required to get a good pesticide on the market successfully. According to their observations, about 1800 prospective compounds must be screened to find one that eventually will be successful. And the average cost for synthesis and biological screening is $350, giving a total of $10,500 on the first step, all of which must be borne by the successful agents.

By the time further expensive testing has cut the number to 10, each prospect will be carrying a debt of $115,000. The total cost of getting down to the two best chemicals will amount to about $600,000 each. Only one is likely to be a success on commercial markets. That means it must pay back $1.2 million before reaching the profit stage.

A lot of factors beyond the plant and laboratory are involved in this stepwise process. If any are ignored, they may mean loss of that high investment at a late stage. Market research must show plenty of potential use. Timing is very important as are formulation and satisfactory application techniques. The Miller Pesticides Amendment makes thorough knowledge of toxicology and residues important and sound labeling vital to a product's success.

There were plenty of golden opportunities dangled before the pesticides men at their recent meeting, but the glitter was toned down by a screen of tough problems. And as never before, the industry is giving those problems careful consideration before jumping for the rainbows.