Ag and Food Interprets . . .

- **Two U. S. firms buck trends with new plants for limed ammonium nitrate**
- **How to predict plant food use a year in advance**
- **States press to get F&D laws uniform with federal act**
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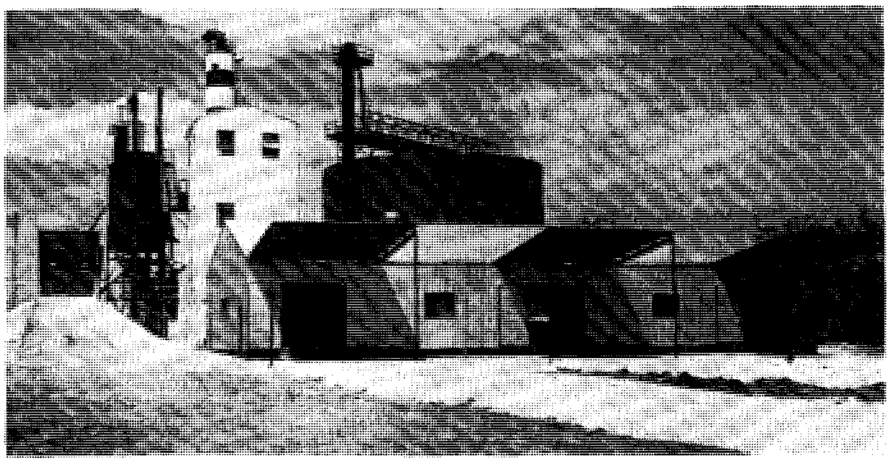
- **Valuable chemicals locked up in cactus plant and its relatives**

Ammonium Nitrate-Limestone

New production of this old-line fertilizer product expected to battle the imports and nitrate of soda



New solids plant of Ketona Chemical at Ketona, Ala.

WHY are two southeastern ammonia producers—Ketona Chemical and Southern Nitrogen—starting to make an old-line fertilizer product like ammonium nitrate-limestone? This question has been puzzling fertilizer industry observers in recent months, because of two trends this product seems to be bucking: the trend to higher and higher analysis materials, and declining demand for the product itself in recent years.

The answer seems to lie in the localized market these producers serve—a market characterized by farmers whose soil is acid and who have for many years used nitrate of soda or ammonium nitrate-limestone as their nitrogen fertilizer.

To those farmers who have been using nitrate of soda, the ammonium nitrate-limestone does represent a higher analysis product—20.5% nitrogen as compared with the 16% offered by nitrate of soda. Cost per unit of nitrogen is lower in ammonium nitrate-limestone than in nitrate of soda. And ammonium nitrate-limestone, like nitrate of soda, is a nonacid-forming fertilizer (according to the standard, but nevertheless arbitrary, test for residual acidity). Thus, it becomes competitive with nitrate of soda.

Until recently Allied Chemical was the only domestic producer of ammonium nitrate-limestone, which it has manufactured at Hopewell, Va., since 1938. Allied's product is called ANL; Ketona's is called L/AN. Some of the tradenames under which foreign producers sell it in this country are: Cal Nitro, Nitrolime, Nitrochalk, and Neutramon. Imported ammonium nitrate-limestone accounts for about 50% of the total U. S. use.

The total U. S. market for ammonium nitrate-limestone has dropped from 391,000 tons in 1953–54 to 300,000 tons in 1956–57, the latest year for which figures are available. Five states—Virginia, the Carolinas, Georgia, and Florida—consumed 256,000 tons in 1956–57. In the same year, those same states used over 280,000 tons of nitrate of soda, with which ammonium nitrate-limestone will be competing, also.

During this past season, demand for ammonium nitrate-limestone in the Southeast was said to be excellent at Hopewell and at Atlantic and Gulf ports. Next season should bring a real scramble as the imported products, which are said to contain no magnesium, battle it out with the domestically produced goods available in increased quantities. Obviously the new producers hope to take over a sizable part of the market now furnished by imports. In addition they doubtless hope that total use of the mixture will increase as a result of the additional sales pressure applied.

Ammonium Nitrate vs. the Mixture

Ammonium nitrate-limestone is a mixture of ammonium nitrate (about 60%) and finely powdered limestone (about 40%). If the limestone is of the dolomitic variety (which domestic producers use), the mixture offers as much as 7% magnesium oxide. In fact, the content and form of magnesium in the limed product is thought to be its only important agronomic advantage. For ammonium nitrate-limestone does not contain enough limestone to remedy the highly acid condition of southeastern U. S. soils, although it does avoid aggravating the condition. As for the fact that the product's nitrogen is half nitrate and half ammonia, exactly the same proportions exist in plain ammonium nitrate.

How the cost per unit of nitrogen compares between the limed product and the plain ammonium nitrate depends on the overland distance between producing plant and point of use. F.o.b. prices per unit of nitrogen are about the same for the two items, but as distance between plant and point of use increases, cost per unit of nitrogen goes up more for the limed product than for plain ammonium nitrate.

Ammonium nitrate-limestone may have a slight edge over plain ammonium nitrate in the matter of safety. Ammonium nitrate can explode and burn, whereas the mixture cannot. However, safety precautions for ammonium nitrate are so well known and so generally practiced that any advantage for the mixture is nearly nullified.

Limed ammonium nitrate was first introduced in this country in 1928 by Synthetic Nitrogen Products Corp., which imported the product from Germany. Badische Anilin & Soda-Fabrik took out the U. S. patent for making it. Allied began to make it here in 1938 under license from Synthetic Nitrogen, which held U. S. patent rights. In return, Allied supplied Synthetic Nitrogen with 70,000 tons of the product each year. Those 70,000 tons kept Synthetic Nitrogen in the ammonium nitrate-limestone market during the war, when it could not get the material from its German supplier. The original patent has now run out, but patents on some refinements of the process are still in effect.

How It's Made

In general, the process for making ammonium nitrate-limestone involves passing a slurry of finely powdered limestone in molten ammonium nitrate through a prilling tower. Ketona's plant, designed, engineered, and built by Chemical & Industrial Corp., dehydrates the ammonium nitrate solution to a 99.5% concentration. Pulverized limestone (−60 mesh) is mixed with the nitrate melt in steam-heated tanks that keep the temperature at 350° F. The mixture then goes to the top of a C&I-designed short prilling tower, where it drops countercurrent to an air stream, forming prills as it falls.

Europeans have developed an advantageous way of making ammonium nitrate-limestone in conjunction with phosphate fertilizer. According to F. B. Grosselfinger of Hoechst-Uhde Corp., the calcium nitrate by-product of treating phosphate rock with nitric acid is caused to react with carbon dioxide and ammonia to produce a mixture of ammonium nitrate and limestone. This mixture is then prilled to produce ammonium nitrate-limestone with 20.5% nitrogen. Mr. Grosselfinger suggests that his process may be advantageous in the U. S. in conjunction with diammonium phosphate production. And where calcium nitrate is a product in the treatment of uranium ores with nitric acid, he feels, production of ammonium nitrate-limestone by this process might be locally advantageous.

Elsewhere in the U.S.

There seems to be little interest in ammonium nitrate-limestone in other areas of the country. Most producers agree there would be little or no market for it in the Southwest or Midwest, where plain ammonium nitrate is well accepted and the soils are neutral or alkaline. In the Pacific Northwest, which has patches of acid soil, some imported ammonium nitrate-limestone is used, but the amounts are nearly negligible. In the West, Calspray has been making a 17% nitrogen solution with properties similar to those of ammonium nitrate-limestone, in that it contains soluble calcium, said to improve water penetration in alkaline soils.

Thus, this new production of ammonium nitrate-limestone is widely interpreted as taking the line of least sales resistance. Its use is not expected to spread to other parts of the country, and its significance, although of interest, is considered mostly local.

Predicting Plant Food Use

Formula holds promise of year-ahead forecasts with slim margin of error

How many tons of plant nutrients will U. S. farmers buy and use in 1959–60? How many of those tons will be used in the Midwest? In the Southeast? In other major farming areas?

These are questions all forward-looking fertilizer producers would like to be able to answer—with confidence in the accuracy of their predictions. Most producers already make their own estimates, but all would welcome an equation—based on measurable factors—that would reduce the margin of probable error, and raise the dependability of year-to-year predictions.

Just such an equation has been worked out. It is the product of a research project initiated two years ago at North Carolina State College, under sponsorship of the National Plant Food Institute. In a progress report to the NPFI last month at its 4th annual convention, R. A. King, NCSC Professor of Agricultural Economics, cautioned that "in its present stage of development the equation will not necessarily reflect all the factors that influence fertilizer consumption, particularly in an unusual year." He indicated, however, that with proper understanding of the method's limitations, it can be quite helpful to the fertilizer industry in planning its operations. And the study is being continued to refine the method further.

The study was started to answer the question: Can fertilizer consumption be predicted from year to year with a reasonable degree of accuracy? North Carolina State College was chosen to handle the work because of its outstanding agricultural economics and statistics departments. The project was set up to provide answers on both a national and a regional basis, in order that its findings would be of maximum usefulness to fertilizer producers, many of whom operate on a local or regional basis.

It was recognized at the outset that a great many factors influence the demand for plant foods. Among the leading influences are these: total planted crop acreage; acreage planted to major crops; the current economic position of farmers; the availability of commercial fertilizer; the level of fertilizer prices relative to prices paid for other farm inputs; technological changes; weather; expenditures for promotion and advertising; and government actions and regulations. Trying to incorporate all these factors into a single equation, however, would have led to something too complicated to be useful. Through intensive study and a fair amount of trial and error, it proved possible to work out a relatively simple mathematical equation, based on four major factors:

- Plant food consumption in the previous year
- Changes in acreage of major crops
- Changes in price of fertilizer per unit of contained nutrient
- Changes in cash sales of crops in the previous year.

While acknowledging the difficulty of securing sufficient basic data, King says that data available relative to these four influences permit reliable results at both national and regional levels. At least, when applied to data for actual performance in past years, the formula has given "predictions" which closely coincided with actual consumption.

For the 1957–58 fertilizer year, for example, the State College-developed method gave a predicted consumption of 6,462,000 tons; actual use in that year was 6,358,000 tons. Thus the formula-produced estimate was within 1.6% of the actual value. When applied to data covering the past 46 years, the estimating equation has a praiseworthy accuracy index of 99.3%. In 42 of those 46 years, it correctly predicted the direction of the change in fertilizer consumption. And in 3 out of 5 key years in which a reversal of trend occurred, the formula predicted the reversal in direction.

Trend is the dominant factor in predicting consumption changes, carrying some 97% of the weight in the new formula. However, trend alone is not sufficient, since it would never be able to predict a year-to-year reversal in direction. It is in this area that other factors in the formula take on significance.

The new formula has not yet been applied so extensively to regional data as to national. However, work on statistics available for the South Atlantic and the East North Central regions, covering fertilizer seasons since 1930, has given an accuracy index of 95% for the South Atlantic and 99.1% for the East North Central states.

In commenting on the NCSC study, M. S. Williams, NPFI's chief agricultural economist, stated that the Institute now plans to seek assistance from market research personnel of member companies, in an effort to make the new technique more exact and more useful. Conferences already scheduled to be held in Raleigh will deal with possible mechanisms for supplying the yearly predictions to NPFI members. Goal is to have in each member's hands, each year, a prediction for the next season which will be reliable enough to serve as a basis for planning, and early enough to allow time for planning and execution.

How to Predict Fertilizer Use

$$Y_T = 0.050 - 1.256C + 0.516T - 0.825P + 0.745S + 1.061Y_{T-1}$$

where:

Y is the quantity of plant food nutrients consumed (in millions of tons);
C is the change in corn acreage planted;
T is change in tobacco acreage planted;
P is the change in price of fertilizer per nutrient unit;
S is the change in cash sales of crops in the preceding year.

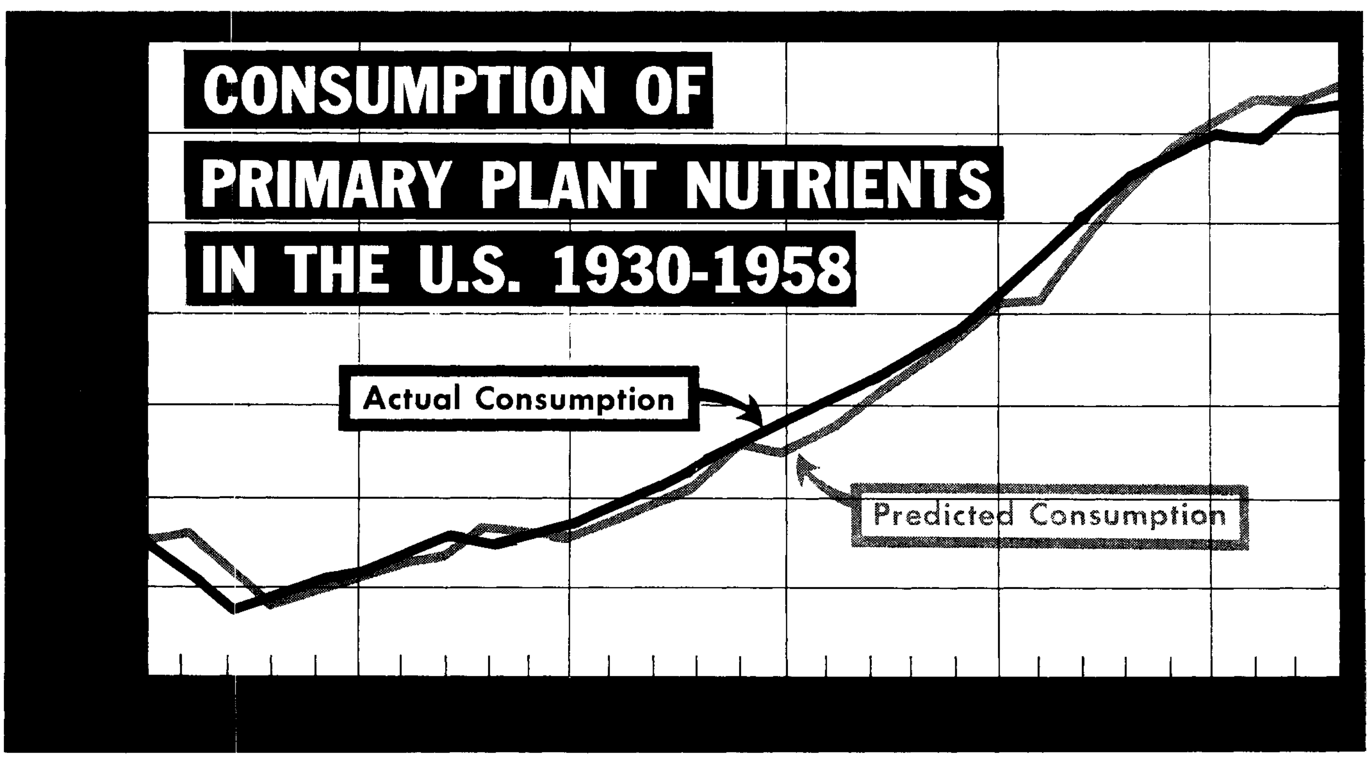
C, T, P, and S are each expressed as a fraction of the year before.

Data needed to formulate an estimate for the 1959–60 fertilizer year are not yet available. However, King did "stick his neck out" with some estimates for the 1958–59 season, now barely completed. For total 1958–59 consumption of plant foods in the United States, says King, the formula gives a value of 6,711,000 tons. For the South Atlantic states, the estimate is 1,393,000 tons. And for the East North Central states, it is 1,630,000 tons. Actual consumption figures, as tabulated by USDA, will not be available for several months.

State Food And Drug Laws

Federal law's inadequacies, localized problems shift heavy burden to state and local regulatory agencies; but states face stiff legal and financial hurdles in drive for uniform laws consistent with the federal act

The long-awaited and highly controversial Food Additives Amendment to the Food, Drug, and Cosmetic Act of 1938 finally went into the federal books last fall. Many hail it as the most significant single legis-



lative act to affect food and allied fields in the past decade. Others are far less enthusiastic. Still others are using it to beam new attention on food and drug legislation and enforcement at the state level.

It is now nearly 21 years since the Federal Act was passed, and 19 years since the Association of Food and Drug Officials of the United States (AFDOUS) published its Uniform State Food, Drug, and Cosmetic Bill. Yet, only 32 states (including newcomers Alaska and Hawaii, as well as the territory of Puerto Rico) have enacted all or part of the Uniform Bill. Only 21 of these adopted it substantially as written. And this breakdown doesn't even consider the three major changes to the Federal Act—the Durham-Humphrey and Miller Pesticide Amendments, and the new food additives modification—that have been signed into law since 1938 with relatively little follow-up by the states. Several states have food and drug legislation pending, but only a few have taken action.

Why this sluggishness by the states to adopt these measures, to firm up and make their laws uniform? Mainly because there are just too many factors involved over which state food and drug officials have little or no control. Items:

- Enforcement difficulties
- Divided authority
- Lack of support
- Local opposition to state legislation
- Nature of state laws and regulations.

Major deterrent to more vigorous state action is the lack of funds and facilities. Most states don't have the money to back up their present laws adequately, let alone to take on new ones. Even if they had the funds and all other problems were resolved, many states lack the manpower or facilities to take on the responsibilities that go with adopting these amendments—particularly those involving laboratory analyses. To adopt the food additives and pesticide amendments, in these states, would mean heaping more burdens on already understaffed and underequipped departments.

In many states food and drug regulations are introduced and sponsored by agencies other than the one that administers the food, drug, and cosmetic law. And it's not too uncommon to find legislation introduced by the state food and drug commissioner opposed and defeated by another state agency. Many state officials are badly hampered by a lack of adequate support within the state and the need for outside help. Often an administrator is accused of being arbitrary, of trying to "build an empire." In these cases, or in matters of a local controversial nature, he could use some outside help—advice or recommendations made at the right time and place by a recognized authority.

Industry, too, can be, and sometimes is, a big thorn in the sides of state and local officials. On the whole, industry is a strong supporter of efforts to enforce food and drug laws, most state officials agree. But it is not without its groups motivated by selfish interests, they hasten to point out. And these groups can carry a great deal of weight within the state. They sometimes exert their influence to push through laws or standards that conflict with other state, or even federal acts.

States which have not adopted the Uniform Act in toto use their original acts. Most of these are patterned after the 1906 Federal Food and Drug Act. Power to promulgate the regulations varies as do the acts. Even the states that now have the Uniform Act face the tough problem of keeping it uniform in the face of ever-increasing amendments to the Federal Act. Some of these amendments directly conflict with provisions of the uniform state acts. For example, uniform state laws include the so-called "per se" rule: an ingredient poisonous in any quantity may not be added to a food unless its use cannot be avoided, or is required by good manufacturing practice. But the new Food Additives Amendment to the Federal Act permits specified amounts of such ingredients. States with the "per se" clause must either change their laws or be in the awkward position of allowing violations of their laws on foods that meet the federally authorized tolerances.

But States Have Vital Role

The Federal Act covers only foods, drugs, cosmetics, and therapeutic devices that move in interstate commerce. Unless satisfactory proof of

Status of Uniform State Food, Drug, Device, and Cosmetic Bill

Enacted into law substantially as written:

Arkansas (1953)	Missouri (1943)	Oklahoma (F-1949, DDC-1953)
Colorado (1957)	Nevada (1939)	Tennessee (1941)
Connecticut (1939)	New Hampshire (F-1947, DDC-1953)	Utah (1957)
Florida (1939)		Washington (1945)
Indiana (1939)	New Jersey (1939)	Alaska (1949)
Kansas (1953)	New York (1939) (2 acts)	Hawaii (1941)
Louisiana (1936)	North Carolina (1939)	Puerto Rico (1940)
	New Mexico (1951) (2 acts)	

Food, Drug, Cosmetic (but not device) sections enacted into law:
Virginia (F-1938, D&C-1940); Ohio (1957)

Food, Drug, and Device (but not cosmetic) sections enacted into law:
California (1939)

Food sections only enacted into law:
Maine (1953); Oregon (1941); Georgia (1956)

Drug, Device, and Cosmetic (but not food) sections enacted into law:
Iowa (1949)

Cosmetic sections only enacted into law:
Alabama (1947); Wyoming (1939); North Dakota (1937)

Food and drug laws materially amended by incorporation of many of the advanced provisions of the Uniform Bill:
Massachusetts (1948); Montana (1955); North Dakota (1937)

such movement can be presented to a court, Federal regulatory action cannot be taken no matter how dangerous, repugnant, or fraudulent the item may be. And between 25 and 40% of the foods, drugs, devices, and cosmetics used by the public never enter interstate commerce. Since they are used in the producing state, they do not fall under federal control. Here, responsibility for consumer protection shifts to the states.

Many small, localized companies need close surveillance for food and drug violations, officials warn. And the states will have to absorb the major share of this work. Although total business volume of these small companies may not match that of the relatively few large companies, it carries a big impact in the local market place. Many of these smaller outfits operate on tight budgets, but still must maintain an equitable position in the market with their larger competitors. It is much more difficult to secure and maintain good sanitation and product wholesomeness standards with small companies than it is with the larger ones, according to the majority of food, drug, and cosmetic officials contacted. This is in no way a blanket condemnation of all small companies; some of them turn out some of the finest products. But limited finances cause others to cut corners. They may lower the quality of the ingredients, trim their quality control or sanitation maintenance crews, and in other ways try to bring their costs into line, even at the sacrifice of product quality. Other factors, such as type of buildings, out-dated equipment, misbranding, and short weights compound the small-company problem. All this points up the need for adequate state and local food and drug programs to oversee this large amount of purely intrastate commerce and thus ensure consumer protection.

What To Do?

While most officials recognize the need for uniformity and updating of food and drug laws at the state and local levels, many simply do not know how best to tackle the job or whom to ask for guidance. The federal Food and Drug Administration can offer only technical assistance. It set up an office of state cooperation in 1913 at the request of the states. Now the Division of Federal-State Relations, it functions primarily to maintain cooperative relationships between FDA and the state and local agencies for complete understanding of the objectives of each agency, and to give assistance whenever possible.

The Citizens Advisory Committee, appointed by the Secretary of the Department of Health, Education, and Welfare to study FDA's operations and resources, reviewed the relationship existing between the federal and the state and local agencies. Its 1955 report pointed out that one of the big obstacles to more effective cooperation and coordination is the lack of uniformity between the Federal Act and state laws. The committee also recommended that HEW work to remove the obstacles to greater cooperation. Greatest obstacle to uniform enforcement, again, is all-around lack of funds. With uniform state and federal laws and sufficient funds for uniform enforcement, the Federal Government could abandon to the states some of its present functions, and thus devote more attention to violations of all sections of the federal law. Even so, strong laws efficiently enforced at both the federal and state levels would be needed to ensure adequate consumer protection.

HEW and FDA continue to assist state agencies with state legislation in fields of mutual interest, but in a manner consistent with their long-standing policy of not interfering in internal state matters. When requested by committee chairmen, employees of FDA furnish state legislative committees with all the information available to aid them in their legislative programs. FDA staff members are eligible for membership in AFDOUS, and work through it for uniform laws and uniform interpretation and enforcement of the laws. FDA participated in the drafting of the proposed Uniform Bill, and at the request of the president of AFDOUS, two FDA employees serve on the association's committee to obtain funds for a comprehensive study of state and local laws and programs. This study was started by the association almost three years ago, and has the support of the Secretary of HEW and of the Commissioner of FDA.

State Amendment Called For

It is not practical for each of the states having uniform laws to amend its law immediately each time the Federal Act is modified. Lengthy preparation and justification are sometimes beyond the facilities of the state agency, and often cause long delays. And occasionally, when an act is thrown open for needed amendments, legislators seek to add undesirable amendments, too.

States with the Uniform Law need a provision making it unnecessary to take legislative action each time a Federal amendment is adopted, most food and drug officials agree. Some states already have such an act. A similar clause in all states would go a long way toward solving the problem. There may be constitutional or other barriers to this provision. Other plans might be more practical. But whatever the answer, the problem is there and needs a solution.

Rhodesian Tobacco

Tobacco is one of the few African crops that get large amounts of fertilizers and pesticides. If Africa's agriculture can be raised even slightly above present levels, market for agricultural chemicals could be enormous

LISTENING to the southern accents of the auctioneers' chants at the world's largest individual tobacco market, one might feel sure he was in one of the Virginias or the Carolinas. However, the "world's largest" is not in the U. S. at all, but in Africa—at Salisbury, Southern Rhodesia. Output of Virginia flue-cured tobacco produced in Southern and Northern Rhodesia has risen from 83 million pounds in 1949 to an estimated 185 million in 1959.

Reason for the accents of the auctioneers is that some of them work both the Rhodesian and the American markets, taking advantage of the fact that the seasons are opposite in the northern and southern hemispheres. A great deal of information on growing tobacco has reached Rhodesia from the United States, and the amount of information exchanged remains considerable.

All the flue-cured tobacco raised in Southern Rhodesia is sold in Salisbury in three big auction floors. These are modern and highly efficient. In a matter of minutes after his crop has been sold, a farmer can pick up his check for the proceeds.

Often there are deductions for fertilizers and pesticides. Placing a stop order on the grower's proceeds from the sale of his crop is a common method of obtaining payment for these items in Rhodesia. Tobacco is an expensive crop and the mainstay of the economy of Southern Rhodesia; tobacco farmers there spend a great deal on fertilizers and pesticides.

Fertilizer practices are roughly the same as those in the United States insofar as phosphorus and potash are concerned. Nitrogen use varies, depending upon the natural fertility of the soil. Application rates of compound fertilizers on tobacco farms are from about 600 to 700 pounds per acre. Most fertilizer is applied before planting.

The most popular grades are 2-18-15, 3-18-15, 4-18-15 and 6-18-12. At least 25% of the nitrogen must be as nitrate. Potash can be either muriate or sulfate, although there is an approximate limit of 3% for chloride content. Recently, some concern has been shown about possible harm from chloride. This year there will be two new grades of 2-18-15 and 4-18-15, with all the potash as sulfate. Seed beds take 5-25-5 with one fourth of the nitrogen in the form of nitrate, and potash as sulfate. Urea may soon be used in larger quantity, since a new plant going up in South Africa will make it a cheaper form of nitrogen. (Transportation costs are high in this area.) Investigations on the use of urea as a possible source of nitrogen are being carried out.

Most mixtures contain 0.35% borax for boron requirements. Dolomite limestone, containing 20% magnesium oxide, is usually added separately at about 100 pounds per acre.

There are three big fertilizer companies in Southern Rhodesia: Fisons, Rodia, and Windmill. Fisons is a subsidiary of the English Fisons, and Windmill is a subsidiary of a Dutch company. Rodia is a subsidiary of the South African company, African Explosives & Chemical Industries, which is jointly owned by the Anglo-American Mining Group and Britain's Imperial Chemical Industries.

Until recently manufacture was largely confined to mixing, but Rodia has just completed a $10-million plant to make superphosphate. Phosphate rock is imported from North Africa, and sulfuric acid is made from locally mined pyrites. Some time ago an American nitrogen producer made a survey of Rhodesia to see if an ammonia plant would be feasible, but decided that a plant was not warranted at the time. Nitrogen is imported from South Africa, Europe, and elsewhere. Potash comes mostly from Germany.

Pests on Rhodesian tobacco differ somewhat from those in the United States, and are generally less severe. Cutworm, white grub, and wireworm are the main soil pests. Leaf eating is usually a minor problem. Hornworm, a big American problem, is not serious in Rhodesia. It is present, but does not seem to attack the tobacco—probably because at the time the tobacco is growing there are plenty of other plants for it to eat in Rhodesia.

Tobacco auction at Salisbury, Southern Rhodesia, is larger than any single market in the United States

Aphids are a big problem because they carry the virus for rosette disease. This is one of the problems being investigated by the Tobacco Research Board—a group supported by tobacco growers and the government. The board is experimenting with systemic insecticides, as well as early planting dates which would give the plants a chance to develop before the aphids arrive.

Fumigation of seed beds to control nematodes is universal. Ethylene dibromide and dichloropropene are widely used. There is now a swing toward methyl bromide, which kills weeds as well as nematodes, and also makes unnecessary any further soil treatment against the fungus disease, anthracnose. This does not, however, do away with the need for spraying the growing plants with fungicides such as tetramethyl thiuram disulfide (thiram) or zinc ethylene bis-dithiocarbamate (zineb). None of the major pesticide chemicals is manufactured in Rhodesia. Imports are chiefly from the United States and Europe.

Weed killers are not used in tobacco. Tobacco itself is too susceptible to the broad-leaf herbicides.

The Tobacco Research Board, with headquarters at Kutsaga, outside Salisbury, and sub-stations at Trelawney, Southern Rhodesia, and Broken Hill, Northern Rhodesia, is carrying out research in all phases of tobacco growing and processing. In the past, one of the observations on Rhodesian tobacco has been that it contains more sugar, and perhaps slightly less nicotine, than American tobaccos of the Virginian type. These differences may be due to the fact that Rhodesian tobacco grows during a season of slightly declining temperature, with increasing humidity, and with day length approximately constant during the season. In the United States, tobacco grows during a season of increasing day length, with a build-up in temperature and humidity. Instead of planting in April or May, Rhodesian tobacco farmers plant at the end of October, slightly before, or at the beginning of, the rainy season. The first reaping takes place about eight or nine weeks after planting, and the last after about eight weeks more. Varieties grown are about the same as those in the United States. The Rhodesians have not taken up some of the newer ones, however, because of taste preferences in Great Britain and Australia, where most Rhodesian tobacco goes.

As an expensive cash crop tobacco is one of the few crops in Africa which receive high rates of fertilizer and pesticide application. Most agriculture in Africa is at the subsistence level. But if this can be improved—even slightly—the market for agricultural chemicals in a continent larger than North America would be enormous.

Xerophytic Plants

Drugs and other valuable chemicals locked up in the cactus and its relatives point to agricultural future for this lowly plant

CACTUS would hardly be the choice of many farmers as their next crop. But growing xerophytic plants such as cacti, yuccas, and agaves may become highly profitable in the not-too-distant future. So predicts Robert R. Cruse, associate industrial chemist at Southwest Research Institute.

Actually, these drouth-resisting plants are cultivated profitably today in several areas of the U. S. Southwest and Mexico. Agave plantations supply many a quart of tequila for thirsty Mexicans, and in California a farmer grows cactus apples for the market. Yet, says Cruse, the surface has hardly been scratched.

Two developments may help make

xerophytic plants more attractive agriculturally than they are today. First, more and more people are moving into "suburbia." This trend is taking much good farm land out of circulation. In fact, several large population centers now border on arid and semiarid regions.

Irrigation is one alternative, of course, but water supply is often critical; the city or farming area without a water problem today is the exception, and the country as a whole is expected to face a water emergency by 1975. Xerophytic plants, however, fare well with little water. They thrive so well, in fact, that some states have eradication programs for certain species.

Yield Many Products

Although it is conceded that xerophytic plants will grow readily on land that is good for little else, there would be no sense in cultivating them unless they contained useful materials. But researchers have found many useful chemicals locked up in these plants. Probably the most important are pharmaceuticals; certainly they have been the target of most of the past utilization research efforts.

USDA research groups have intensively studied the steroids contained in xerophytic plants. Many steroidal sapogenins, which are convertible to cortisone, have been found in yucca and agave ("century plants"). They are also contained in some true cacti, especially the prickly pear and cholla. These drugs are being screened as both cancer and tuberculosis therapeutics. Indications are that extracts of yucca roots also inhibit tumor growth.

Anhalonium alkaloids are finding new potential in treating mental disorders. These drugs were first discovered in cacti (primarily the Mexican "organ pipe"). Depending upon structure, similar basic types of molecules can be used to treat, as well as detect, schizophrenia. Pilocereine, a higher molecular weight alkaloid, shows some antimalarial properties.

Oral antidiabetics are other potentially valuable drugs found in the extract of prickly pear cactus. The extractives, in tablet form, are reported to be as effective as insulin in doses of 200 units or less. In the Mexican States of Coahuila and Jalisco, diabetes is practically unknown, says Cruse. Other possibilities from xerophytic plants: cardiac therapeutics and drugs to combat *Staphylococcus aurens.*

Besides drugs, extracts from various species of xerophytic plants offer several other items of potential industrial interest. Prickly pear mucilage is an excellent flocculating agent which could be used in the mineral dressing industry. This same mucilage is also an excellent adhesive or sticking agent for insecticides and fungicides.

In Mexico, a water conditioner which uses agave extract is being marketed. This same material also serves as a cleanser, rust inhibitor, detergent, and protective coating. Other drouth-resisting plants may yield flavonosides, waxes, and soil conditioners.

Use It All

But Cruse feels that xerophytic plants cannot be grown for their extracts alone. In order to be profitable, the complete plant must be used with as little waste as possible. The pineapple industry in Hawaii is a good example of such an operation.

The same thing could be done with xerophytic plants, says Cruse. Applications could be found for the fibers and pulp. The plants could supply food and feed stock. Indeed, many food products from these plants can be found in the market place in Mexico and the southwestern U. S. And the Council of Scientific and Industrial Research in India has been investigating an east Indian agave (Agave Vera Cruz) as a source of food to forestall starvation.

The prickly pear has been used as stock feed. South Texas ranchers realized its value during the drouth of 1949–56. As a result, they have spurned federal subsidies to clear the prickly pear from their rangeland.

Growing xerophytic plants for profit is not a project for the small farmer, advises Cruse. It must be a big operation. The best bet would be to place as close as possible to the plantation a processing plant which could recover all the extractives of value, and utilize by-products as completely as possible. One processing unit could, of course, serve several plantations.

Although the plants themselves may not require water for growth, some domestic water is a must. And heat for power is also necessary. Here Cruse says that solar heat may be a possibility because the regions in which these plants grow are usually blessed with abundant sunshine.

Actually, it could do more harm than good to hasten growth of these plants by irrigation. For some of the useful extracts appear to be formed as a result of a drouth-resisting mechanism. However, crossbreeding may be one answer to the problem. Trace elements, gibberellins, and plant-growth hormones may also be beneficial, adds Cruse.

One big problem is the lack of suitable equipment for harvesting xerophytic plants. USDA's Belle Glade, Fla., research station is working on an improved fiber-recovery machine. A harvester which will both collect and decorticate the leaves would be ideal, says Cruse. But the differences in sizes among various species are a roadblock.

Other research efforts are being directed toward the practical growing of xerophytic plants. Two Mexican research institutes are working on both producing methods and product utilization. The prickly pear is being cultivated experimentally on the King Ranch in Texas, and Southwest Research Institute is about to start utilization studies on xerophytic plant extracts.

Of the 15,000 species of plants which are native to North America, fewer than 200 species are grown in enough quantity to supply car lot amounts. Perhaps xerophytic plants will some day add to the number.

Agave plants are cultivated in Mexico for use in making tequila. Such drouth-resistant plants are known to contain a host of useful chemicals