Ag and Food Interprets . . .

- **Ammonia producers build urea plants in effort to upgrade ammonia**
- **An insect repellent for livestock is goal of screening laboratories**
- **Committee confirms industry complaints against TVA fertilizer**
- **Total plant nutrient use gained 4% in 1956–57**

Urea's Boom

Despite apparently plentiful supply, urea capacity will get a big boost in 1958

IN THE LAST HALF of 1957, three companies announced plans to build urea plants. These signs of activity were topped off by Hercules Powder's decision to double capacity at Hercules, Calif., even before laying the foundations for its originally planned plant of 10,000 tons per year capacity.

This new round of expansions brings into sharp focus the rapid rate at which urea consumption is expanding. Only two years ago, overcapacity plagued producers (AG AND FOOD, Oct. 1955, page 816). Yet, in 1958, new plants will raise domestic capacity by some 90,000 tons to a level of about 700,000 tons per year. Actual production, it is estimated, will be around 555,000 tons.

Urea goes mostly to three major uses—fertilizers (50%), animal feed supplements (20%), and plastics (30%). Chief stimulus among these for urea expansion is increasing use in fertilizers. Application of urea, both as a straight material and in solid mixes, is increasingly popular. The market for urea-containing fertilizer solutions is definitely expanding, too.

But despite these increases in consumption, capacity is still considerably greater than consumption. The reasons are these:

- Fertilizer demand is seasonal. Last spring, for example, demand outran supply and urea was short for a while. On economic balance, it is cheaper to invest in some overcapacity than to increase storage facilities.

- Urea plants usually do not run at rated capacity around the calendar. With planned and emergency shutdowns, they can be expected to operate at about 90% of design capacity.

Use of urea in fertilizers is not a new idea. It goes back, on a limited basis, to pre-World War II days. But it is only since about 1950 that urea fertilization has really caught on.

There are two basic reasons for the early lag. First, most potential users did not recognize its value. And second, urea cost too much until recently to offer much competition to other sources of nitrogen, such as ammonium salts.

Now, the price of urea has come down and transportation costs have gone up to the point where, per pound of nitrogen in the ground, urea sometimes costs less than ammonium nitrate. During the same period, more and more people have recognized urea's usefulness in fertilizers.

For the farmer, urea has several advantages over other solid nitrogenous materials. It contains 45% nitrogen, as compared to 33.5% for ammonium nitrate, its nearest rival as to nitrogen content. This means less handling, fewer refills of application equipment while the farmer puts on a given amount of nitrogen. At the same time, all urea nitrogen is in the nonleaching ammonia form. Thus it is retained longer in the soil near the plant.

It makes good high-nitrogen mixed solid fertilizers which, according to some, give granules as good as, if not better than, those made without urea.

In solution, it offers more advantages. By itself, it can be used in irrigation water and can be dissolved also in sprays and used for foliar feeding. This use originally engendered skepticism in some areas where yellowing of the treated leaves was encountered. This yellowing has been traced to the action of biuret, an impurity which, when present in large amounts (2% or more), can cause such yellowing on foliage of citrus, pineapple, coffee, and other plants.

In the recent past, California Department of Agriculture chemists have found some decrease in biuret content of most brands used in their state. Where biuret levels used to run above 1%, they were down to an average of 0.5% about a year ago, and the last dozen samples averaged 0.3%. However, this decrease is not uniform among manufacturers; the 0.3% average is made up of figures ranging from 0.06% to as high as 0.66%. Biuret level probably will not go much lower in run-of-the-mill production.

In solution with other ingredients,

Shell Chemical's new urea plant at Ventura, Calif., is adjacent to ammonia facilities, a pattern followed by all of the new urea plants going up

urea helps to make a wide variety of high-analysis fertilizer solutions. With urea, more nitrogen can be added to the solution without adding ions; hence, higher concentrations of nitrogen will remain in solution at lower temperatures.

Urea still cannot compete costwise with anhydrous ammonia, where conditions favor the latter. But many things must be considered in selecting a nitrogenous fertilizer—terrain, soil type, size of farm, cost of storage and application equipment, and rate of application, to name a few. When all costs of delivery, storage, and application are considered, urea looks good in many cases. For lower per-acre rates of application, the cost of applying anhydrous makes urea an even better bet. Also, urea is competing vigorously with ammonium nitrate for the direct application market.

Urea Capacity

Domestic capacity now runs about 610,000 tons per year. Newly onstream in 1957 were Shell with capacity for 100 tons a day, Spencer with 30 tons a day, and Southern Nitrogen with 30 tons a day. Already announced as entering the derby in 1958 are Spencer with an additional 100 tons a day at Henderson, Ky., Monsanto with 100 tons a day at El-dorado, Ark., and Hercules Powder, 55 tons a day at Hercules, Calif.

Also of importance is the import picture. For the past four years, imports have ranged around 70,000 to 80,000 tons per year, mostly from West Germany, Norway, and United Kingdom. About half of this has come in through West Coast ports, where until this year, local production capacity has not been great enough to supply local demand.

In 1958, North American Cyanamid will put a 66,000-tons-per-year plant onstream in Hamilton, Ontario. This installation, plus Hercules' and Shell's California plants, will cut deeply into imports through both West and East Coast ports, domestic producers feel. One West Coast importer, however, maintains that it expects to bring in more urea in 1958 than it did in 1957.

Urea's Future

Producers across the country agree that urea will soon be ammonium nitrate's biggest competitor, and that in several years it will begin to compete vigorously with anhydrous ammonia. And since urea is made from ammonia, its production is considered a good method to use in upgrading ammonia—now in surplus supply and expected to stay that way for two to four years.

Urea Capacities

Company	Capacity, Tons/Yr.
Grace	53,000
Du Pont	150,000
Grand River Chemical	90,000
Allied	220,000
Sohio	44,000
Spencer	10,000
Shell	35,000
Southern Nitrogen	10,000
	612,000
Due in 1958:	
Spencer	33,000
Hercules	20,000
Monsanto	35,000
Total Domestic	88,000
North American Cyanamid (Hamilton, Ontario)	66,000

This is one additional reason why ammonia producers are the ones building new plants to make urea; Shell, Spencer, Monsanto, and Hercules, like all other urea producers, have or will have their urea plants integrated with their ammonia facilities.

Pest Repellents

A good insect repellent for use on livestock is the goal of laboratories screening chemicals for repellency, but there are also large potential markets for pest repellents in crops, rangeland, and forests

It might seem simpler just to kill agricultural pests than to seek ways of repelling them. But through use of repellents, some objectives can be accomplished without harming desirable forms of wild life. This helps maintain local biological balance. It protects from extermination such necessary but susceptible insects as the bee. It permits man to employ profitably such creatures of ambiguous virtue as the white-footed deer mouse, a pest when it eats viable forest seeds but a staunch ally when it devours harmful insects found in forest litter.

The biggest current developmental push seems to be on insect repellents for use on cattle. When combined with proper insecticides, these repellents provide a remarkably high degree of insect control.

It has been estimated that 20 biting horn flies can drink a pint of a cow's blood in a week, and cause her to give three pints less milk per day. Keeping flies away allows animals to feed without annoyance. They put on more weight, faster, and dairy cows give more milk.

In tests conducted by the New Jersey Agricultural Experiment Station, an emulsifiable concentrate containing butoxypolypropylene glycol (Crag fly repellent) and methoxychlor—sprayed weekly for a month and a half—increased milk production by well over 200 pounds per cow. This amounted to nearly $10 more profit per animal, above the cost of the spray. On another farm with a less severe fly problem, nearly 100 pounds more milk per cow netted an additional $3.50 each.

Researchers at the University of Minnesota treated four beef cattle, by means of a treadle sprayer, with another formulation of the same chemicals. In 91 days the average weight gain was 451 pounds—70 pounds more per animal than that of untreated cattle in adjoining pastures—for an added profit of about 10 cents per day per animal beyond the 2-cents-per-day cost of spraying.

Last summer, tests were run over an eight-week period at Pennsylvania State University, using two types of insecticide-repellent sprays successively. Average daily weight gain of treated Aberdeen Angus cows exceeded that of controls by one-half to two-thirds of a pound each. A water emulsion containing 15% *N*,*N*-diethyl-*m*-toluamide plus 1% methoxychlor was employed for the first three weeks. After a one-week lay-off, a petroleum-distillate spray—containing 0.4% 2,3,4,5-bis(Δ 2-butylene)tetrahydrofurfural (MGK R-11 repellent), 0.2% N-octyl bicycloheptene (MGK 264 insecticide synergist, to increase and prolong repellency), 0.1% piperonyl butoxide, and 0.035% pyrethrins—gave equally good results for the last four weeks. Both formulations were applied at the rate of 75 ml. daily per animal. Cost of spray material ran about a cent a day per cow.

The only other FDA-approved repellent commercially available last year for spraying cows is di-*n*-butyl succinate (Tabutrex), also used as a roach repellent. And di-*n*-propyl isocinchomeronate (MGK R-326) has now been registered with the USDA as a premise spray as well as a fly repellent for dairy or beef cattle.

USDA scientists, however, take a rather dim view of these insect repel-

Livestock protection is the goal of most labs searching for repellents

lents for livestock. USDA is seeking formulations that will last longer than the day or two it finds present repellents to be effective. None has been found superior to its standard pyrethrum recommendations. These are said to provide highly effective protection for a day or two under severe insect conditions, partial protection for three or four days where insect populations are light. As the best it has to offer today, USDA suggests:

- One to two quarts of emulsion spray (containing 0.05% to 0.1% pyrethrins, plus 0.5% to 1.0% synergist) applied every two or three days.
- One to two ounces of oil solution (containing 1% pyrethrins, plus 10% synergist) mist-sprayed every three to seven days.

It is not known why even the repellents which are best for use on humans won't work well on livestock. USDA suspects it may be because of too rapid absorption and/or volatilization on the hair of animals.

It is felt unlikely by some biologists that research will turn up compounds or formulations which are intrinsically more repellent than present ones. They do expect, however, that effectiveness can be maintained for longer periods of time.

Other Applications Vital, Too

A big and growing field for pest repellents is in reforestation. U. S. Department of the Interior, through its Wildlife Research Laboratory in Denver, reports that chemical protection of seed is revolutionizing reforestation and range revegetation. Normally seedlings are laboriously replanted by hand after forest fires or logging operations. This is slow and expensive. But until effective seed-protectant formulas were developed, direct seeding proved unsuccessful.

Rodents and birds are the culprits so far as broadcast seeding is concerned. The U. S. Fish and Wildlife Service has examined some 5000 chemicals since 1951 to find a good mouse repellent. Tetramine was successful, but became "unavailable" in 1954. An endrin formulation, developed as a substitute, appears satisfactory for seed protection in western reforestation efforts.

Last year, in the state of Washington, more acreage was seeded from helicopters than was planted in nursery-grown seedlings. This is the first time such large-scale broadcast seeding has been undertaken there. And USDA's Southern Forest Experiment Station in Alexandria, La., reports that in Louisiana light planes are sowing 1000 acres per day, the equivalent of a whole winter's work with a planter.

But birds seem to be a big problem in the South. They frequently destroy more than 95% of untreated seed in southern pine reforestation. Anthraquinone is a proved bird repellent and is excellent for this purpose. It is presently available in this country as a bird repellent only by license because of patent restrictions, and it does not protect against rodents. Tetramethylthiuram disulfide (Arasan, also known as thiram), sold as a fungicide, seems to provide good protection against rodents as well as birds.

In one rather unusual case in which chemically protected seed is effectively replacing other means of rodent control, repellent-treated seed has been successfully sown in the 100,000-acre watermelon section of Florida.

Some of these same compounds serve in formulations to protect trees, seedlings, shrubs, and growing plants from rabbit damage. USDA highly recommends thiram or nicotine mixtures in spray or brush-on consistency. A commercial compound (Z.I.P.) containing a complex of zinc dimethyldithiocarbamate and cyclohexylamine with polyethylene polysulfide as a sticker claims main use as a rabbit repellent for deciduous trees and shrubs, and is sold as a crow and deer repellent as well.

Bone-tar oil, though injurious to plants and trees, repels deer from orchards and fields when mixed with water and sprayed in a band around the areas to be protected. It offends the animal's delicate sense of smell, and is said to remain effective for about a month.

And workers at the Agricultural Experiment Station at Oklahoma State University in Stillwater have found one chemical, out of 700 tested, which may save the lives of millions of "workers." They hope that 2-hydroxyethyl *n*-octyl sulfide may discourage industrious bees from trying to gather nectar out of blossoms treated with residual insecticides.

How Do Repellents Work?

Relationships between repellency and chemical structure have not yet been clearly defined. In the case of insect repellents, some researchers believe there is a common peak in the infrared absorption spectra of most successful mosquito repellents. Others grant that such a correlation between infrared data and biological activity would indeed be significant, but they do not believe the evidence supports such a conclusion.

Repellents may work by way of specialized chemoreceptors. Though some sort of interaction between insect and chemical must exist, the physiology of chemoreceptors needs much more study before any reasonable hypothesis can be reached. In the case of animal repellents it may be merely bad taste or smell that makes the materials literally repulsive.

Market Picture Foggy

Few experts will estimate markets for repellents. One manufacturer hazards a guess of about $200,000 annually for the present agricultural market alone, but most people in the field say that there are not yet any products effective enough to permit good estimates. Few dispute that the potential market is enormous. Monsanto quotes industry estimates of $500 million at the manufacturers' level. USDA figures that a really effective insect repellent for cattle would sell five or ten times as much as all present materials combined. Also, USDA feels more "inclusive" formulations could treble the present market, and calls this the "cheapest kind of insurance policy" for any future planting programs—crops, to range grass, to forest trees.

Most sources say that insect repellents will continue to command the biggest share of the market, if only because there are so many more insects than other pests. Nevertheless, repellents generally should share very profitable markets.

Although Monsanto doubts the commercial feasibility of repellents to protect growing plants, the Wildlife Research Lab calls this "an enticing market of the future!" Its researchers are developing systemic chemicals to modify the palatability of plants so that deer and other pests as well as cattle will not eat them. Test plants to which they applied research chemicals over a year and a half ago are still protected. New chemicals and techniques should eventually permit one application to last three to five years.

Among interesting new repellents, four-way formulations are now in the hands of foresters. Developed by Wildlife, these protect against fungi, insects, rodents, and birds. This is one of the latest results of WRL's extensive program evaluating about a thousand new organic chemicals per year.

Pressed by the appetites of a growing population, most other labs in the field—both government and industrial—are working to find an answer to the biggest need of all: a good insect repellent for use on livestock.

"Personal" Repellents Came First

Not so many years ago, insect repellent meant—to most people—the lemon-sweet odor of citronella. But despite its odor, citronella seldom seemed to eliminate all need for scratching.

Today's generation need not scratch so much nor smell so highly, thanks to odorless new "personal" insect repellents introduced during and since World War II. Frantic evaluations during the war revealed insect repellency in such unlikely compounds as alkyl phthalates, used as chemical intermediates and plasticizers.

These effective, odorless synthetic fluids were immediately drafted for military service, for in jungle fighting, the penetrating odor of citronella or the sound of slapping at insects could reveal vital positions to snipers. And malaria—usually the other alternative—was frequently as devastating as enemy bullets.

Continuing research in recent years has resulted in several repellents for personal use. The newest important one is *N,N*-diethyl-*m*-toluamide (known as meta-Delphene), discovered by USDA scientists. USDA terms this the best all-purpose repellent ever developed. It is being manufactured commercially now by Hercules Powder, Cowles Chemical, and others, and Du Pont is coming out with two personal products containing the compound—one a 50% lotion, the other a 15% aerosol.

TVA's Fertilizer Program

Evaluating committee confirms industry complaints against TVA in fertilizer business . . . recommends continuing program on strictly educational basis

TVA SAYS it is moving to reorganize its fertilizer distributor-demonstration program as recommended by its re-evaluation committee. This means conducting a clearly defined educational program—with closer controls on production, distribution, and prices of TVA fertilizers.

The committee, made up of industry and college leaders, has proposed a 32-point plan for TVA's guidance in carrying on the program. TVA says it will follow most of the suggestions. But it is hedging on a few.

Industry Complains

The fertilizer industry has for some time, and increasingly during the past year, complained openly of TVA's competition in the fertilizer business. Sharply denounced were ammonium nitrate production and sales (AG AND FOOD, August 1957, page 570). Some in the industry declared that the government program should be discontinued entirely. Others conceded that its technological and research phases served a useful purpose, but objected seriously to the quantities of fertilizers TVA put on the market without—according to industry spokesmen—adequate control over sales.

Faced with this criticism, TVA appointed a committee to survey its fertilizer operations and chart a future course for using the program "to the best interest of the farmer, the fertilizer industry, and the nation generally."

Committee Confirms Complaints

The main criticisms of TVA's committee follow closely those made most often by the fertilizer industry. The committee says in its final report:

- In some instances the tonnage of TVA fertilizer sold to an individual farmer has been much larger than can be justified from an educational point of view.
- Some farmers have been sold TVA fertilizers for a greater number of years than educational objectives warrant.
- A few large farm units have used TVA ammonium nitrate and other TVA materials in amounts far in excess of those which might be required for educational applications.
- Although the fertilizer distributed by TVA is less than 2% of the national production, its unwarranted concentration in certain geographic areas has, in some cases, resulted in extreme competition with commercial concerns.
- The recently stated policy of TVA is to tailor its fertilizer production to fit educational needs. However, it is evident that TVA's production capacity and break-even point have been overriding considerations in establishing the amount of fertilizer to be distributed in its program.
- A few flagrant violations of program procedures have shaken confidence in the distributor-demonstration program in some localities and have resulted in justified criticism, especially by some individuals in the fertilizer industry.
- A few dealers have insisted on the purchase of non-TVA fertilizer by farmers as a basis of eligibility to purchase TVA fertilizer.

TVA Comments on Report

In a general statement issued with the committee report, TVA holds that allocations of its fertilizers each year have been less than the distributors' total estimates of their requirements under the program.

It points out further that as supplies of commercial fertilizers have increased over the past years, TVA production and distribution of the better known and more widely available materials have declined. For instance, 1957 production of TVA concentrated superphosphate was one-sixth its 1949 peak. TVA ammonium nitrate production has declined more than one third since its 1952 peak. And TVA also feels that production capacity and, in turn, the financial results of the program need to be considered, although the controlling factor in determining fertilizer production, it says, is the amount of fertilizer that can reasonably be used in bona fide educational programs consistent with the objectives of the distributor-demonstration program.

TVA says it accepts without question 26 of the evaluation committee's 32 recommendations for bringing the program back to its educational aims.

It has some reservations or comments on the remaining six:

Geographic Spread

Because of wide variations among areas as to agriculture and fertilizer use, TVA says generalized limits on amounts of fertilizers distributed cannot be fixed. Instead it believes the program must be geared to the requirements of particular areas.

Time Limits

TVA does not believe hard-and-fast time limits can be placed on the distribution of a new material in the program nor on an individual farmer's participation. It says product and use differences and the nature of fertilization problems preclude such limits. For example, ammonium nitrate became popular quickly, though its effective use is still a matter for investigation and farmer education in many areas. On the other hand, calcium metaphosphate, widely tested and demonstrated for years, is only now finding its place in the commercial field.

Inferior Products

TVA expects "within a reasonable time" to improve the quality of its ammonium nitrate through process improvements. It says quality differences result from its producing the material by vacuum crystallization instead of by the prilling process, as used generally in the industry.

Mixing with TVA Materials

Improved mixing technology and more efficient use of raw materials in the manufacture of high analysis mixtures, TVA says, offer inviting possibilities for reducing the cost of plant nutrients to farmers. In TVA's opinion, these opportunities should not be overlooked.

Program Violations

TVA concurs that two recommendations dealing with detection and correction of violations are necessary where there is convincing evidence of deliberate misapplication of TVA materials or disregard of program requirements. But it believes that more precise definition of state programs and better communications will reduce these cases to a minimum.

Committee Survey

TVA's evaluating committee reported it had found that two thirds of TVA's dealers are satisfied with the distributor-demonstration program. Methods of improving the program were suggested by more than half the dealers. Needs most often cited were: better product quality, more meetings and demonstrations, and more publicity.

The committee says at least 33% of the dealers participating in the TVA program do not keep records on farmers who purchase TVA materials. About 15% do not explain the special uses of TVA materials to farmers. Some 25% of the dealers indicated they have no specific understanding or agreement with farmers on the use of TVA materials.

Among the farmers sampled by the committee, both TVA and non-TVA farmers said they increased total use of nutrients by some 20% between 1954 and 1956. Those who participated in the TVA program increased their use of both TVA materials and commercial fertilizers but did not substitute TVA materials for commercial ones.

Only 46% of TVA farmers reported that their dealers had explained the special uses or the conditions of use of TVA materials. Slightly over 60% of TVA farmers indicated the dealer had explained the kind of TVA material purchased.

In the sample of TVA farmers, 18% insisted they were not participating in a particular TVA fertilizer program. Concentration of these "no program" farmers, those who were unaware they were in a special fertilizer-use program, is particularly high in the Midwest, averaging 31%. Obviously, the committee says, attainment in the program was highest for those farmers who had agreements with their dealers and understood the program in which they participated.

TVA says action already is in progress toward implementing the committee recommendations; planned consultations with its cooperating organizations in the program should allow TVA to adopt policy and procedure revisions to put new rules in effect in the near future. TVA believes its major needs are improved communications and general strengthening of the procedures used by TVA, distributors, and dealers. It feels plans for enlarg-

Major Recommendations for Remodeling TVA Distributor-Demonstration Program:

Define program clearly as "educational"

Distribute materials on basis of educational merit only

Do not relate distribution to production capacity

Price materials consistently with educational aims

Equalize geographic spread of fertilizer distribution

Set upper limits on quantities sold to individual farmers

Set a limit on length of time a new product is included in program and farmer can obtain special-use materials

Mention TVA materials and uses they qualify for in all advertising

Emphasize conservation aims of program

Do not use materials inferior in quality to commercial products

Discontinue use of TVA materials in mixed fertilizers of types available on the market

Hold distributors responsible for program compliance by their dealers

Detect distributor violations and act on them promptly

Clarify the program for distributors and retailers

Clarify state programs and review them annually

Increase field staff to control program

Improve liaison between TVA and fertilizer industry

Note: TVA does not accept fully the recommendations printed in red.

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ing and decentralizing its field organization will contribute toward meeting both these shortcomings. Five TVA agents are now established in field headquarters. More field offices will be set up as TVA increases its field staff to twice its 1956 size.

The evaluation committee says its recommendations represent changes that will allow the distributor-demonstration program to conform more nearly to needs of the current situation (fertilizer production and demand) and to the outlook for farming and the fertilizer industry. In making the recommendations, it considered the objectives of the program as legally rigid. But procedures and means of attaining the goals were regarded as flexible or subject to change. The recommendations, the committee says, might well be different if the aims of the program also were subject to change.

TVA administrative officials, the committee says, are to be commended for requesting an evaluation of their program that will enable them to adapt it more closely to the prospective needs of the farming and fertilizer industries and the American public.

Fertilizer Use In 1956–57

USDA's preliminary figures show 4% increase in tonnage of nutrients sold, and a slight increase in tonnage of fertilizer materials

FERTILIZER CONSUMPTION started up again in 1956–57, after the nosedive of 1955–56. Total use in the U. S. and Territories was 22,485,000 tons, up 1.3% from the previous year. This good news comes from the preliminary report of Walter Scholl's group in USDA. (The final figures will be out about the middle of 1958.)

Although total tonnage set no new records for the industry (the record year for total tonnage was 1952–53, when 23,412,608 tons was used), in terms of primary nutrients, 1956–57 was the best fertilizer year yet—6,303,000 tons, a 4% increase over the previous year.

Mixture use dropped from 14,776,000 tons in 1955–56 to 14,575,000 tons in 1956–57, but direct application materials gained 493,000 tons for a total of 7,910,000 tons. Here's the breakdown for the various nutrients in mixtures and in direct application materials:

	N	P_2O_5	K_2O
Mixtures (tons)	841,000	1,772,000	1,683,000
% change from 1955–56	+5.5	−0.7	+1.7
Direct application materials	1,284,000	471,000	252,000
% change from 1955–56	+13	−1.9	+14.5
Total tonnage	2,125,000	2,243,000	1,935,000
% change	+9.9	−0.2	+3.2

Materials for Direct Application

Use of chemical nitrogen materials increased 392,000 tons (12%) over the year before. Of the liquid types, nitrogen solutions showed the highest proportional increase (87%) from 109,000 tons in 1955–56 to 204,000 tons in 1956–57. Aqua ammonia and anhydrous ammonia use increased 21 and 12%, respectively. Solid chemical nitrogen products showed large consumption increases—ammonium sulfate, up 25%; urea, up 16%; and ammonium nitrate, up 15%. Sodium nitrate use slipped 11%.

Of the direct application phosphate materials, only ammonium phosphates use increased—from 362,153 tons in 1955–56 to 387,000 tons in the '57 year for a 7% increase. Phosphate rock and colloidal phosphate tonnage dropped 11% to 829,000 tons, while 22%-and-under superphosphates decreased 7% and those analyzing over 22% dropped 14%.

The change in consumption of potash materials was principally the result of a greater use of potassium chloride which increased from 322,411 tons to 373,000 tons (16%).

Regional Patterns

Although national consumption of plant food increased in 1956–57, 18 of the 48 states used less fertilizer in 1956–57 than they did in the previous year. Outstanding for their reduced consumption of fertilizer were: Oklahoma (down 21%), North Carolina (down 14%), Utah (down 15%), South Dakota (down 16%), and Arkansas (down 10%). Bright spots were the Pacific and West North Central States. They increased their fertilizer consumption by 9% and 5%, respectively. Although not large buyers of fertilizer, the Mountain States and Hawaii and Puerto Rico all increased fertilizer use by hefty percentages. In the Mountain States, consumption was up 12%, Puerto Rico consumed 24% more fertilizer in 1956–57 than in the previous year, and Hawaii registered a 14% gain. The biggest fertilizer-consuming state was California, with just over 2 million tons. Among individual states that polled big percentage increases were: Oregon (up 31%), North Dakota (up 34%), Idaho (up 29%), New Mexico (up 28%), and New Hampshire (up 21%).

The national weighted average of primary plant nutrients contained in mixed fertilizers in 1956–57 was: for nitrogen 5.77%; for available P_2O_5, 12.16%; for K_2O, 11.55%; and for the total of these nutrients, 29.48%. Corresponding values in the previous year were 5.39, 12.08, 11.20, and 28.67%. The proportionate increase was highest for nitrogen and lowest for phosphate.

Consumption of mixed fertilizers was found to have increased in all but 23 of the tabulated areas (the 48 states, the District of Columbia, Puerto Rico, and Hawaii). Most of the decrease occurred in the states of the South Atlantic, East South Central, East North Central, and West South Central regions. The biggest increases in mixture use were registered in the Territories, the Pacific and the West North Central regions, in that order.

The 10 grades of mixtures most popular in 1955–56 retained their top-10 status in 1956–57. The grades and their tonnage use are:

5-10-10	(1,355,000 tons)
3-12-12	(912,000 tons)
4-12-12	(882,000 tons)
5-20-20	(788,000 tons)
10-10-10	(685,000 tons)
12-12-12	(612,000 tons)
5-10-5	(588,000 tons)
4-16-16	(528,000 tons)
3-9-9	(511,000 tons)
4-10-7	(364,000 tons)

Together they accounted for 50% of the total tonnage of mixtures sold. In all regions except the New England, Pacific, and Mountain, their tonnage represented 40% or better of the total tonnage of mixtures consumed. The trend in New England is toward grades with a higher proportion of nitrogen than those in the top 10, while the Mountain and Pacific states tend toward mixtures with less potash than those in the top 10.

Use of secondary and trace nutrient materials increased by 139,000 tons or 17% in 1956–57 for a total of 929,000 tons.