Ag and Food Interprets . . .

- **High amylose corn close to commercial reality**
- **Liquid fertilizers face tough competition from bulk solids**
- **Minimum tillage encourages use of more fertilizer, pesticides**
- **Ammonia's place as dominant source of nitrogen seems secure**
- **12,000 tree farms constitute potential big market for chemicals**

High Amylose Corn

Possible industrial uses for linear amylose spur studies in growth and processing of new corn

USDA's F. R. Senti displays a film made of high amylose corn's whole starch. On the table is chemically modified amylose in fiber form. The ear of corn on the cover of this issue is the high amylose variety, which is similar in appearance to the more common dent corn

LAST YEAR'S PLEA for more industrial use of surplus crops (AG & FOOD, August 1957, page 565) has met largely with a cold shoulder from industry. Instead, more attention and enthusiasm are being given to developing new crops that industry can use. And one of these crops, high amylose corn, looks closer to commercial reality than any other.

The term high amylose corn means exactly that—the strain produces more amylose than does normal corn. And it's the amylose part of corn starch that has new industrial potentials. Most starches, including corn starch, consist of amylose and amylopectin fractions. Ratio of the two is about one part amylose to three parts amylopectin. Both substances are glucose polymers, but they differ in that amylopectin consists of glucose residues branched to form side chains at frequent intervals. By contrast, amylose's glucose residues are joined together end to end to form long linear chains.

Corn having an 82% amylose content, highest achieved yet, is claimed by USDA researchers at Northern Utilization Research and Development Division, Peoria, Ill., and by others at the University of Missouri. But amylose content may be limited by known genetic combinations. Purdue's Roy L. Whistler says one new gene is needed before amylose content can be hiked to 90% or higher.

The 82% amylose corn was obtained from crosses combining two genes, each known to increase amylose, says USDA. An extensive breeding program is under way to introduce both these genes into high-yielding hybrids. The Bear Hybrid Corn Co., Decatur, Ill., working with the Peoria group, discovered and introduced one of these genes into good-yielding hybrids to get corn having starch with amylose contents of 50% to 60%. These hybrids could be a commercial crop in 1961, says Robert P. Bear, if warranted by industrial uses.

According to a report given at the recent Council for Agricultural and Chemurgic Research conference in Chicago by Frederic R. Senti of the Peoria lab, potential uses for linear amylose include:

- Film making—for packaging uses.

If chemically cross-linked, the films have greater wet strength; if not, they look good for special applications in the food field—sausage casings, e.g. Slight chemical modifications would make soluble films for packaging preweighed items.

- Paper making—as a bonding agent between paper's pulp fibers. The paper industry could jack up total starch use by employing it for greater strength and flexibility.
- Textiles—as a permanent fabric finish, where other hydroxylated polymers are now used. In non-woven fabrics, it could serve as a solution type binder. Amylose triacetate fibers show promise, too.
- Molded plastics—possibly in the form of triester amylose.
- Detergent adjuncts—as carboxymethyl or similar derivatives which may have high soil-suspending properties.

Fractionation Costly Today

Getting amylose from usual starch sources involves a fractionation which leads to a more costly product than can be obtained by simple milling operations. Butyl alcohol selectively precipitates amylose, as do many polar organic solvents. But selective precipitation with solvents has never gone commercial. A fractionation process using inorganic salts was developed in The Netherlands in 1956, and Stein Hall, of New York, markets the amylose and amylopectin separated this way. More recently, USDA's Northern Laboratory has leached high purity amylose from starch with hot water after pretreating the starch with glycerol.

A high amylose starch would lessen the separation difficulties. Conventional milling equipment could then be used, although with some process differences.

In processing studies on Bear's hybrid that contains 50% amylose, the Peoria lab ran into difficulties. These may occur because high amylose corn's starch granules are smaller than normal and have an irregular shape. Thus protein and starch separation is more difficult than usual. The amylose fraction is the same as that of ordinary corn starch insofar as molecular structure and size are concerned, but the amylopectin is different. It is less soluble and has a different molecular structure—branches are longer, so the fraction has more of amylose's characteristics. More studies are now being made on larger quantities of the corn, available from the 1957 crop.

Another laboratory reports that new steeping techniques will have to be developed to produce a starch low enough in protein to be important in the films and fibers markets.

Agriculturists Approve

Attempts at tailor-making a crop with an industrial outlet—in effect the reverse of classic chemurgy—are looked upon favorably by most of those engaged in agricultural work. A new corn crop developed with specific industrial applications could occupy some acreage which might otherwise be devoted to conventional corn, thus tend to prevent accumulating additional surpluses. (One scientist, though, notes that the corn surplus might disappear before new uses for corn or new types of corn are thoroughly worked out.) A further appeal is that a new corn variety such as this is suited for growth in the existing corn belt and other corn growing areas. And it requires no new equipment for planting, cultivating, or harvesting.

Several groups are now researching all the facets of high amylose corn. The USDA Peoria lab is cooperating with state corn breeders at the University of Missouri, as well as the Bear Hybrid Corn Co. Other major centers include Purdue University, American Maize-Products Co., Corn Industries Research Foundation, Corn Products Refining Co., and National Starch Co.

Economics of Solids *vs.* Liquids

Many economic comparisons are rough guesses at best, and even these do not hold in all cases

THE FERTILIZER YEAR just ended can easily be classed as one of the best yet for liquid fertilizer sales. True, in those areas where liquid fertilizer plants are concentrated (Midwest and California), total fertilizer sales were up anyway. But liquid's percentage of the market went up this year, and at least a part of the increase was won from solids. It is this share of the increase that spotlights, once again, the economics of liquid *versus* solid fertilizers.

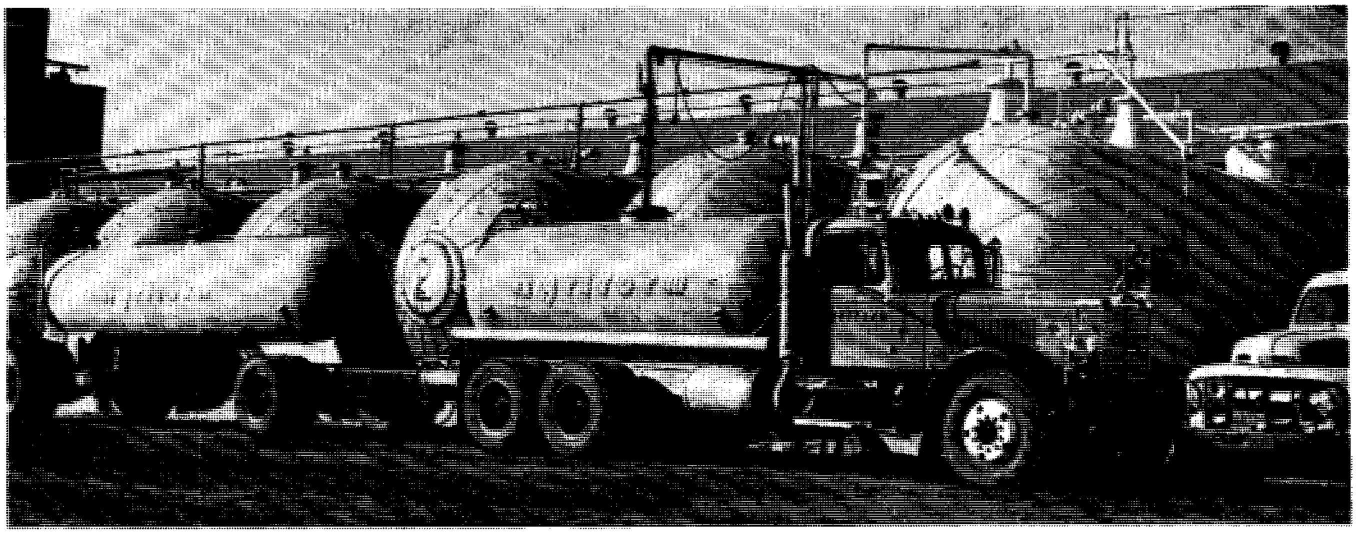
As far as the farmer is concerned, buying solid fertilizers is usually cheaper (on a plant food unit basis) than buying liquid, because application costs are included in the price of liquid mixes. No truly accurate measure of an individual grower's cost in terms of labor and time needed to apply bagged solid materials is available, although experiment stations publish estimates based on an "average" operation. Large amounts of liquid mixes (and bulk solids, too) are put on by applicators, so the markup for this service is readily measurable. End result of fertilizing properly with either form is the same, although liquids sometimes give a faster response because of their higher ratio of nitrogen to potash and phosphorus. Therefore, liquid fertilizers' biggest, and evidently most successful, selling point (compared to bagged solid mixed goods) is convenience.

When it comes to capital investment and other yardsticks the economics of solids *vs.* liquids are somewhat vague, often confusing, and always arguable. TVA's A. V. Slack says there are cost estimates which favor one or the other, and you can pick whatever answer you like best. Several generalizations, though, can be made. Slack estimates that investment in most liquid plants runs under $50,000 or only a bit more. Average capacity of these plants ranges from 3,000 to 5,000 tons a year. Actual cost depends on the type of unit (batch or semicontinuous), the formulations it makes, how extensively it is instrumented, and how many months of the year it operates. Dry plant tonnages are several times those of liquid plants.

Approximate capital investments for average modern fertilizer mixing plants, according to one source, compare this way:

Volume (tons)	Capital Investment: Solid	Capital Investment: Liquid
5,000	$100,000 (conventional)	$30,000
25,000	250,000 (conventional 350,000 (granulated)	50,000
40,000	300,000 (conventional) 450,000 (granulated)	75,000

But as far as individual cases are concerned, there are as many departures from these figures as there are plants in operation or on the drawing board. A southern manufacturer estimates that, considering fixed assets only, a solid fertilizer plant calls for an investment of about 2.5 times that of a liquid plant. Liquid's advantage, he points out, is partially offset by its complicated distribution costs. Adding storage to manufacturing costs reduces the 2.5 factor to 1.75.



Distribution can put a lid on a liquid fertilizer plant's capacity. It is generally more profitable to build another plant in another area than to expand a plant in the 5000 to 9000 tons per year range

Liquids More Sensitive to Process, Raw Materials Costs

A major consideration in liquid fertilizer economics is the type of process used. A batch type operation, at first glance, seems cheaper to set up than a semicontinuous one. The main differences in costs of plants depend on:

- How much used equipment is installed
- Amount of storage provided
- Amount of stainless steel used
- Type of acid storage tanks provided
- Whether or not a cooler is used
- Degree to which owner handles his own design, engineering, and construction supervision.

In batch operations, a reactor is set on scales, and the raw materials—phosphoric acid, ammonia or aqua ammonia, urea, and potash—are weighed into it. The system is considered economical, and is suitable when a relatively low production rate is called for. Measuring devices increase production rates and capital costs.

Semi-continuous operations require considerably more equipment and instrumentation. They offer high production rates, and production boosts make the cost of such a plant competitive with a batch type plant.

Among raw materials, the big item affecting solids *vs.* liquids economics is cost of P_2O_5. Nitrogen and potash are comparable for each type of plant. But a liquid operation nearly always has to use furnace grade phosphoric acid, which can cost from slightly more to 75% more than other P_2O_5 sources like superphosphates. In areas in which this price difference is marked, liquid fertilizers are placed at a distinct disadvantage.

Storage and Distribution Critical

The storage and distribution of liquid fertilizers are often the hooker when comparing them against solids on an economic basis. Storing solids is a relatively simple matter. But liquid materials call for large storage tanks and a considerably larger storage area because of their comparatively low plant food concentration.

When volume of a liquid fertilizer plant exceeds a certain point—9000 tons a year is one published figure (Ag and Food, June 1956, page 502)—percentage profits begin to tumble.

Here's how the arithmetic works. As capacity increases, capital investment goes up in a straight line proportion. Most of this increase is due to the need for additional storage, which one major fertilizer maker estimates as costing about $10 a ton. So for each 1000-ton increase in volume, the manufacturer needs to invest another $10,000. Investment in solid fertilizers, on the other hand, goes down (on a per-ton basis) as production increases, until maximum capacity is reached and the plant needs to be enlarged. Solids storage costs about a third as much as that for liquids. A liquid producer may find it more economical to put up a second plant rather than enlarge the original one and expand his distribution system.

Avoiding large-scale storage of liquid fertilizers doesn't mean all storage must be eliminated to achieve economical operation. In a study made two years ago, TVA used a storage figure of 20% of annual sales volume in its comparison of liquid and solid fertilizer economics. Another source says that a balance between costs on investment and operation is reached when a liquid plant with a good volume stores up to 40%. When a plant attempts to get by without any product storage at all, the makers of raw materials (phosphoric acid, ammonia, and others) have to assume storage responsibilities. Probable result of this, says TVA, is a premium price for in-season delivery. There is a trend, though, toward storage of raw materials by liquid manufacturers, to permit high production rates when demand warrants.

Another facet of distribution affecting liquids *vs.* solids economics is marketing area. Most liquid fertilizer plants sell within a 20- to 30-mile radius. Larger ones, like Davison's in Wakarusa, Ind., go up to 50 miles by installing bulk tank storage in fringe areas. A solid fertilizer mixing plant can distribute its production over a wider area, although it generally keeps within a 30- to 100-mile radius.

Where the marketing area for both a liquid and a solid fertilizer mixing plant is about the same, delivery costs (plant to farm) are determined by plant food concentration. Distribution costs decrease with increases in concentration, and liquid fertilizers are at a disadvantage in areas in which demand is for highly concentrated materials.

Future Indefinite

The position of liquid fertilizers vis-a-vis solids is a changing one, and is today more dependent on farmer acceptance of fertilizers in general than on almost anything else, economics included. In states like Illinois, where more than 40 liquid fertilizer plants are in operation, there isn't enough of a difference in price between the two forms to sway a farmer, as a rule. Convenience is still the biggest single factor that influences a farmer's decision to use liquid formulations. But within the next several years, liquids may have a tougher row to hoe. Reason: increase in bulk application of solid fertilizers.

In any cost comparison with bulk fertilizer materials, liquid fertilizers (and solid mixes, too, for that matter) suffer quite a bit. Difference in convenience is not so pronounced, either. And the biggest rise in bulk application is occurring in the North Central States, a comparative stronghold for liquid fertilizers.

How much more of the fertilizer market liquids will eventually capture is anybody's guess; no one can say if liquid's share will rise at all. But just as liquid mixes will never entirely replace solid materials, neither will they ever fade out of the picture completely.

To Till or Not to Till

Minimum tillage spreads in Midwest as farmers all across the country overhaul their thoughts on cultivation

THE OLD WARTIME SLOGAN "Is this trip necessary?" may be coming back into use. Growing numbers of farmers are asking themselves, each time they take out their tractors, "Is this trip to cultivate a field really necessary, or might I be better off to skip it?" Often the answer is, "Skip it."

At the University of Wisconsin's soil conservation station a corn plot yielded 123 bushels per acre when minimum tillage practices were followed. Conventional tillage methods turned up only 116 bushels. This difference in yields probably is not significant, but the cost saving is. And more important, say the agronomists who back minimum tillage, the soil remains loose, discouraging weeds and promoting excellent moisture retention.

"Minimum tillage" is a catch-all phrase which actually embraces many different farming practices. For any individual farmer, minimum tillage usually means less tillage than was regularly done in previous years.

On Midwest corn land, where minimum tillage has caught on most, several specific methods are used. One is wheel track corn planting. The farmer plows his land once, and follows up the same day with a planter, placing the seeds in the furrows left by the tractor wheels. Other variations of minimum tillage include plow-planting (the planter is attached to the plow or directly behind it), and using a leveling-packing tool behind the plow to prepare the seedbed. Whatever the method, minimum tillage cuts down on the number of trips a farmer makes across his fields.

The main aim of minimum tillage is to reduce the soil compaction which results from crisscrossing a field with heavy machinery. But also important to the farmer are labor savings, better moisture retention, less erosion, and fewer weeds between rows. True minimum tillage is not without some drawbacks, but agronomy experts agree that the average farmer tends to overcultivate, and that the least tillage consistent with good crops is desirable as a farming practice.

If widely adopted, minimum tillage could have significant overtones for producers of agricultural chemicals and equipment. To be effective the practice must be teamed up with the use of herbicides. And while it would not necessarily cause an over-all increase in the amount of fertilizer used, one man points out that minimum tillage makes the use of fertilizers more profitable—hence more attractive—to farmers, by giving better soil conditions for crops. Equipment manufacturers might suffer a loss in sales of discs and harrows, but at the same time they would find a new market for multipurpose items which would plow, prepare the seedbed, plant, and spray herbicides all in one operation.

Four-row wheel track planting of corn in Wisconsin's Pacemaker corn program helps cut production costs. Seedbed preparation between tracks is not necessary

Not New

Minimum tillage is not a new idea. Back in 1912 two USDA workers concluded from a series of tests that "cultivation is not beneficial to the corn plant except insofar as removing weeds is concerned." Most of the present interest in minimum tillage stems from research started at Ohio State in 1936. This work showed that corn could be grown with no seedbed preparation beyond plowing the actual hill area. Wheel track planting got its start in 1946 at Michigan State, and in 1951 Cornell University was one of the first to introduce plowing and planting in a single step.

But despite this history, minimum tillage today is used on only a fraction of the country's farms. A Wisconsin agronomist says that wheel track planting is "growing by leaps and bounds" in his state, and that this year the number of farmers using it is up five to ten times over 1957. A man from Minnesota comments that nearly every farmer knows of someone who has tried it. However, even in the states that report the widest use of minimum tillage, the percentage of farmers involved is small.

The fact that minimum tillage is not widespread is due partly to the farmer's natural reluctance to accept a different farming practice. Also needed are more tests to give extension workers better ammunition when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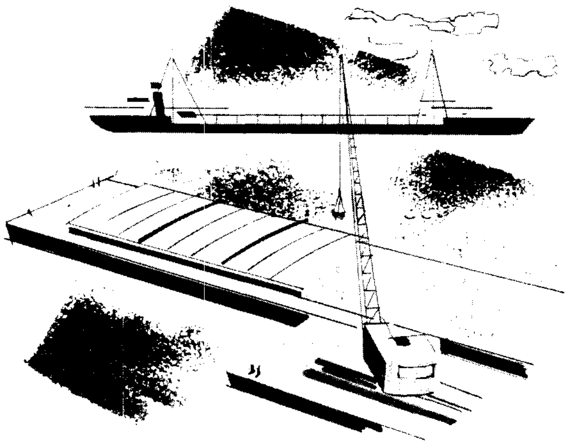

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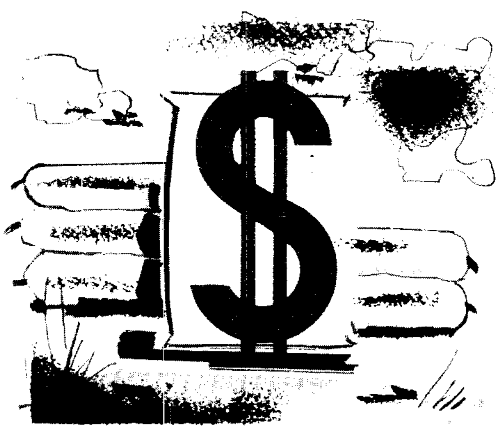

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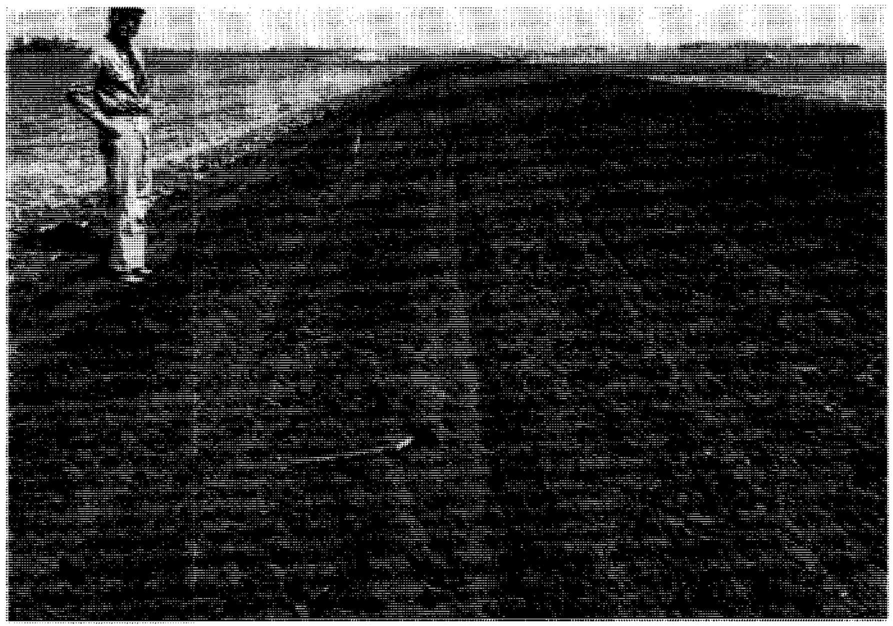

Illinois county agent examines a 1958 farm trial in a field of excellent tilth. Field was plowed and planted in a single operation

explaining the methods to farmers.

In 1956 and 1957 over 40 Minnesota farmers took part in minimum tillage field trials planned by the State University. Yields remained about the same; some farmers reported increases, others slight decreases. But even without any startling change in yield, all who took part were sold on minimum tillage after trying it. The men cut their farming costs by as much as $5.00 an acre—enough to pay for starter fertilizer. Weeds had trouble growing in the loose soil between the rows, and the first cultivation wasn't needed until corn was six to eight inches high.

Other Midwest states have conducted similar tests. After two years' experience, the University of Illinois says that "in general minimum tillage shows tremendous possibilities on many Illinois soils." At the end of last year the University of Wisconsin surveyed farmers in the state who had used wheel track corn planting one or more years. When asked if they planned to continue using the method, 70 out of 76 replied yes. Those who were uncertain were concerned mainly about machinery problems rather than the method itself.

9 Out of 10 Overwork Land

Walter Mumm, agronomist at Crow's Hybrid Corn Co., feels that nine out of 10 farmers work their land too much before putting seed into the soil. Tillage with heavy machinery, says Mumm, plugs soil pores, breaks down desirable structures, slows drainage and aeration, and makes it hard for roots to penetrate. On the 1800-acre seed farm Mumm directs at Milford, Ill., minimum tillage keeps topsoil loose down to a 12-inch depth. This soil can soak up a four-inch rainfall without runoff, while a field just across the fence has trouble absorbing a one-inch fall of rain, says Mumm.

Not Infallible

While the experts agree that many farmers over-till their soils, nobody suggests minimum tillage as a cure-all for every situation. It works best on soils of good texture, and with large-seeded crops like corn or potatoes. One man sums up the drawbacks by saying that a prerequisite for minimum tillage is a good job of plowing, and whenever it is impossible to do a good job of plowing the practice has not lived up to expectations.

Another comments that while minimum tillage does help to hold water after heavy rains, in dry periods the soil dries out faster. The University of Massachusetts observes that crops such as potatoes, onions, and tobacco when grown in light soils need cultivation not only for weed control, but also to break the surface crust and facilitate oxygen and carbon dioxide exchange.

A cotton specialist from Arkansas adds a final, encouraging note: "Cultivation on a schedule just for the sake of cultivation is costly and time consuming; it contributes nothing to yield, and in some cases may actually reduce yield."

New Sources of Fertilizer N

Costs and physical property shortcomings limit interest in development of new nitrogen materials

MANUFACTURED FORMS of inorganic nitrogen fertilizers had their beginnings long before the turn of the century. But use of these nitrogen fertilizers did not begin to accelerate until just before World War I. Principal products at the time were ammonium sulfate and sodium nitrate.

Between the wars, growth continued, although not at a spectacular rate. Then the end of World War II brought rapid increases in production of other nitrogen fertilizers as part of efforts to use wartime plants built to make ammonia and nitric acid for explosives.

A major stimulus to wide use of ammonia as a fertilizer was development of methods and equipment for applying anhydrous ammonia directly to soils. Anhydrous ammonia as a fertilizer boomed in the late '40's, and so did farmers' demands for nitrogen in almost any form. Almost as phenomenal as the growth of anhydrous ammonia has been growth of high analysis granulated mixed fertilizers since 1950.

These developments have not been without their problems—mostly economic, but also technological. Stimulated by these problems, fertilizer manufacturers and federal and state government agencies concerned with agriculture began to investigate processes to make other fertilizer materials, to determine their handling characteristics, and to measure crop responses to them.

Costs

Transportation cost looms importantly in any outlay for fertilizer. It is a limiting factor particularly in selling liquid fertilizers. Manufacturers of liquid fertilizers generally have a 100-mile maximum selling radius, with 25 to 30 miles the limit in many areas, particularly the West. The trend is toward higher N-P-K concentrations to offset transportation costs and extend the shipping area radius.

When liquid fertilizers are based on ammonia and potassium chloride, which are the cheapest forms of N and K, nutrient contents greater than 30% can seldom be obtained. Solubility is the limiting factor here.

To get around the solubility problem, although at higher cost, urea and potassium nitrate are used. Urea's price differential is not especially serious, and rapid increases in tonnage use have been registered. But very little fertilizer potassium nitrate is used today; it is not manufactured in large commercial quantities in this country because of its high cost.

Lower cost potassium nitrate has been the objective of research by several fertilizer manufacturers. Profitable utilization of the co-product chlorine seems to be the key to an economical process. Only in a few limited instances, such as in fertilizers for tobacco, where chloride content needs to be kept low, has the material been used even on a semicommercial scale. And at present there are few other crops, mostly small-volume ones such as some vegetables and tree grown fruits, on which potassium nitrate would be expected to show significant advantages over presently used fertilizers—assuming competitive prices. Still, it is recognized by experts as an excellent material for both solid and liquid formulations; it has a very promising future if its cost can be made competitive.

Combinations with Sulfate

Although tonnage of ammonium sulfate has followed an upward trend, its percentage of the fertilizer nitrogen market has shown a continuous general decline over the past five years as anhydrous ammonia and ammonium nitrate passed it by in supplying the market. But combinations of ammonium sulfate with other nitrogen materials could halt its decline. One of these—known in Europe as Montansalpeter—is a mixture of ammonium sulfate and nitrate that contains 26% nitrogen. This double salt, then known as Leunasalpeter, was promoted in this country some years ago by the German producers. It found poor acceptance, and does not now appear to have any large U. S. market potential. It has, however, been suggested for possible use in special situations where regulations limit shipping of nitrate.

Use of sulfate-nitrate mixtures has been suggested also in areas in which sulfur is needed. Mixtures with a 32% N content are being tested by TVA. Other combinations of the ammonium nitrate-sulfate mixture with diammonium phosphate have been proposed and tested. A 20–20–0 mixture could be either used directly or further upgraded.

Other Forms

Other nitrogen materials in varying degrees of limited use now, but which might become more important, include ammonium chloride, the nitric phosphates, and various urea derivatives.

Ammonium chloride, as a nitrogen source under test in Ohio to determine effects of chloride on yields, gave the same yield as ammonium nitrate or ammonium sulfate for such crops as corn, wheat, oats, and bluegrass. Ammonium chloride likewise produced rice yields equivalent to those from ammonium sulfate and urea in Arkansas tests. In Europe, some fertilizer ammonium chloride is being used commercially. Under study at various times for more than 20 years in the U. S., however, it has so far failed to carve out a large niche in the nitrogen market.

Nitric phosphates are being manufactured commercially in the South and West, but their volume still remains small. How wide a swath the nitrics will cut depends to some extent on sulfur prices. And again comparable costs between ammonium phosphates and nitric phosphate must be considered.

The slowly soluble carriers of nitrogen, notably the ureaforms, fill a distinct need among fertilizers. Their price is relatively high, and quantities used are now small. But production continues to increase significantly each year, and price is expected to drop with increased demand. The materials are now limited primarily to lawn, turf, and specialty crops.

While not yet beyond experimental stages, nitrogen dioxide (or nitric acid, in solution form) remains a possibility as a fertilizer material. Production and handling costs and nitrate toxicity are stumbling blocks.

Whether these or other forms of nitrogen as fertilizers will significantly change demand for the forms in wide use today depends on many economic factors. Most observers believe that over the near term, ammonia will remain dominant as the nitrogen basis for fertilizers. Specialization will certainly spur demand for other, newer materials such as urea derivatives, and could cause them to show spectacular percentage gains in sales. These possible changes in forms of nitrogen materials are but part of the continuing technological evolution in fertilizer materials and application methods.

Lower-cost potassium nitrate is the goal of several manufacturers. If achieved, it would be a boon to liquids manufacturers. Fertilizer ranks third in tonnage use of potassium nitrate, little of which is made in commercial quantities

Tree Farming

Now well established on some 46 million acres, the tree farm system is an attractive market for fertilizers and pesticides, but the cold test of economics has to be passed first

For many years, American forests were going downhill. Lumbermen were hauling timber out of the woods faster than it was being grown. Now, however, for the first time in this century, the forest situation has improved to the point where growth rate outstrips rate of removal. In 1957, over a billion trees were planted on about a million acres of forest land.

But the forest industry still cannot sit back and rest on its laurels. In the next 40 years, population in the U. S. is expected to increase by 100 million people; the USDA's Forest Service estimates that as a result the country will have to grow over 80% more timber. Many large forest owners say they can increase their timber yields considerably, but the Forest Service feels that many of the nation's farm and small forest properties must be improved if the demand is to be met.

In the U. S. today, there are some 4.5 million small woodlot owners whose individual holdings are under 500 acres. They hold 61% of the country's commercial forest land, and annually sell about $700 million worth of sawlogs, pulpwood, posts, Christmas trees, and other forest products. It is these small woodlots, says the Forest Service, which need the most improving. The larger holdings are generally better managed and thus in better shape.

Most of the lumbermen and foresters contacted by AG AND FOOD list the biggest enemies of the forest as fire, disease, insects, and poor management. The relative ratings of these trouble sources vary from area to area. Improper management is actually a catch-all which includes lack of good fire-prevention practices and proper disease and insect control. But it goes beyond that, and is one of the big reasons for the relatively poor condition of small forest tracts.

Uncontrolled cutting, without regard for the future, is a common malpractice. Many small woodland owners, and some large ones, too, cut all of their best quality trees without bothering to plant new seedlings. This practice is known as "high grading." Its results: much good growing space is taken over by cull trees and therefore wasted. Little effort is taken to remove these cull trees and return the land to profitable growths.

Although great progress has been made in fire prevention and control in the past two decades, fire is still a major problem. Some areas—Minnesota, for one—call fire their number one forest menace. In 1931, fire destroyed over 500 million acres of timberland. This waste has steadily diminished until, in 1955, there was a record low of only 8 million acres of forest burned. Still, there were more than 145,000 fires that year.

Today there are about 390 million acres of state and private forests in the continental U. S. under organized fire protection. This program costs more than $42 million to administer. The figure does not include the millions spent by individuals and companies outside the cooperative program and not reported to the government.

Thanks to programs such as the tree farm system, timber growth rate now exceeds the removal rate—for the first time in this century

Tree Farm Program

To help promote better forest management, American Forest Products Industries, Inc., sponsors the American Tree Farm System. This program was organized and is supported by the country's wood-using industries. In most states, the tree farm system operates under the leadership of representatives of the forest industries, with the cooperation of government agencies and state forestry associations. Since 1942, the number of certified tree farms has mushroomed from less than 1000 to nearly 12,000. Of the 490 million acres of commercial forest land in the U. S., about 46 million acres is owned by members of the American Tree Farm System. And this amount is increasing by about 4 million acres per year.

Just what is a tree farmer? He may be a "weekend woodsman" with a few acres of land which he operates for fun and profit. Or a pulp company with hundreds of thousands of wooded acres may qualify. Some states set the minimum at five acres. There is no upper limit. The important thing is that a tree farmer agrees to manage his land according to accepted forestry practices. Accordingly, he must:

- Protect his wood from fire, destructive grazing, insects, and disease.
- Harvest when his trees are ready, but in such a way that seed sources remain for continuing crops.
- Plant seedling trees on idle acres.

When a landowner feels that he is managing his woodlot properly, he may contact his state tree farm committee to have his holdings inspected. This inspection is made by a competent forester; if it shows that the owner's management practices measure up to the standards of the tree farm system, he receives his membership certificate. Thereafter, periodic inspections are made to see that good forestry practices are maintained.

How do agricultural chemicals fit into the picture? Most of the chemicals in tree farm use today are insecticides and herbicides. DDT and benzene hexachloride are the big movers. Where the future is concerned, comments obtained by AG AND FOOD run from "little chance" to "great potential." A closer look indicates that the need for agricultural chemicals—including fertilizers—is there, but that economics must be proved first.

Many research projects are under way, and more are in prospect, to measure the value of fertilizer for forest use. But little fertilizer is now used commercially for forestry, except in nurseries. Most tree farmers cannot yet justify the economics of using fertilizer, and in many places, it is not yet needed. In the West and Northwest, for instance, much of the commercial forest acreage still supports old growth timber. There the first concern is converting old growth wild forests to managed stands.

More and better insecticides and herbicides are needed, most foresters say. Agricultural chemicals may also fill the bill as fire retardants, defoliants, or other special purpose items. But, before they are used in volume, they will have to pass the test of cold, hard economics.