granulated. Acceptance came first in the East (except the Southeast), but now the greatest activity in installing granulation facilities is in the Midwest, especially in the Corn Belt. Iowa probably uses the greatest proportion of granulated plant food.

In the Southeast there are very few mixing plants using granulation equipment east of the Mississippi except in the New Orleans area, although there are some people in the industry who expect granulation eventually to take hold in the Southeast. The southern fertilizer industry has been well established for a long time and most mixing plants in the area have been written off company books for years, making it difficult for a new plant to compete.

Granulated material is especially adapted for airplane application, much used in the rice and sugar cane areas of Texas, Lousiana, and Arkansas. In Texas 75% of the mixed fertilizer plants have some granulating equipment. Texas ships a good deal of granular to California, but generally speaking the western states have not taken to granulation.

In sections where granulation has become widespread it is usually the larger companies which first make the switch. High investment costs make it difficult for small mixers to get started; the smallest will probably never set up granulation plants.

Variety of Process

The fertilizer manufacturer considering going into granulation is confronted with a wide assortment of possible processes ranging from multimillion dollar installations for special high analysis materials to more modest set-ups which can be added to an existing plant to granulate ordinary dry mixed material. TVA is responsible for much work on many processes now in use. High analysis product processes, most of them including granulation, are licensed by Dorr-Oliver, Chemical & Industrial Corp., Chemical Construction, General Industrial Development, and others.

Old stand-by for granulating mixed goods of all grades has been Davison's process which has been widely licensed. Davison also has a newer process now licensed to a few companies. Costs vary. A large company such as International Minerals might install $200,000 worth of granulation equipment at one of its mixing plants, while a small manufacturer might spend $30,000. For a plant, including building and storage facilities, making 100,000 tons per year of granulated fertilizer by the recently developed Link Belt–Martenet process, an investment of $1,275,000 is required. Operating and raw material costs as well as quality of product depend upon the process selected. A poorly granulated product may not have uniform particle size or homogeneity and may contain considerable reverted P_2O_5.

In a number of processes granulation is accomplished by adding water or some liquid fertilizer material to the dry mix and continuing mixing either in the original mixer or in some piece of special equipment until the particles agglomerate into little balls. These may be dried in a rotary dryer, or, if ammoniation or some other process involving the reaction of liquid fertilizers with dry materials is used, heat of reaction may be utilized to eliminate outside heat for the dryer. Classification by screening to remove oversized and fine material is usually but not always practiced.

A different kind of granulation process consists of recycling a large proportion of the granular material in process through a slurry of the fertilizer mixture. Each particle acquires a new layer on each pass and its size is thereby built up. Fine seed material is continually fed in and product-size material is continually screened out of the system.

Modification of basic processes for particular conditions gives the impression that no two processes are alike. The process used has to be selected carefully. In some areas competition may dictate a well granulated product; in others a material of lower quality made by a cheaper process may suffice. Availability of cheap liquid ingredients indicates one type of process, their absence another, or may even preclude going into granulation altogether. If the plant is located near a community, noise and fumes may be a problem. Ammonium chloride given off in some ammoniation processes may be controlled, but scrubbers cost money.

Increased Consumption Seen

Growing farmer acceptance points to consumption of more and more granulated goods, although decreasing farm income may cause the farmer to balk a little at paying a premium for granulation. Most agree on granulating high analysis materials, whose high hygroscopic salt content makes them difficult to handle, but there is a difference of opinion regarding granulation of low analysis goods. Granulated material has an advantage in that it can be applied with precision to give more uniform crops permiting operation of harvesting equipment. Application by airplane and new equipment like the 100-foot spreader now in use in New York State depends upon granular material. Conditioners and surfactants are also used to obtain free flowing material but if the industry is ever to realize the dream of some day being able to store fertilizers indefinitely in bulk and to handle them with conventional equipment such as that now used in the grain industries it will probably be a result of improved granulated fertilizers.

World Fertilizer

Annual increase of 6% in production and consumption predicted. Eight million tons each of N, P_2O_5, and K_2O by 1960

WORLD PRODUCTION of nitrogen and potash has more than doubled in the past 15 years and phosphoric acid has increased by 75%. Such an increase can be expected to continue, according to the UN Food and Agriculture Organization. Production and consumption increases at the annual rate of 6% are predicted, to give a doubling every 15 years under stable political and economic conditions.

FAO, in its yearly report on the world fertilizer situation "Annual Review of World Production and Consumption of Fertilizers" predicts that by 1960 the world may produce and use approximately equal tonnages of N, P_2O_5, and K_2O, at the rate of about 8 million tons each.

World production of fertilizer elements (N, P_2O_5, and K_2O) in 1952–53 was about 17,800 tons, an increase of almost 6% over the figures for 1951–52. In 1954–55 world production of fertilizers is expected to increase about 4.5%; consumption may go up about 4.9% over 1953–54. Greatest increases this year are expected in nitrogen, production may go up about 6.3% and consumption forecast calls for an increase of 5.5% over 1953–54.

Production of phosphoric acid is expected to increase about 4% in 1953–54, with an increase of 3.6% in consumption forecast. Potash production and consumption are expected to increase 3.5% and 6.1% respectively. This expansion of phosphate production reflects the effects of recent phosphate mining schemes in Africa, Asia, and South America.

Ammonium sulfate and ammonium nitrate are the principal world sources of nitrogen, accounting for 32 and 22% of total production respectively. The report comments on the trend toward higher analysis fertilizers citing the increasing production of ammonium ni-

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THE FIRST SUCCESSFUL CONTROL FOR MANY PLANT DISEASES AND BLIGHTS—NOW READY FOR USE THIS SPRING

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FIRE BLIGHT OF APPLE AND PEAR (use as a blossom and post-blossom spray)

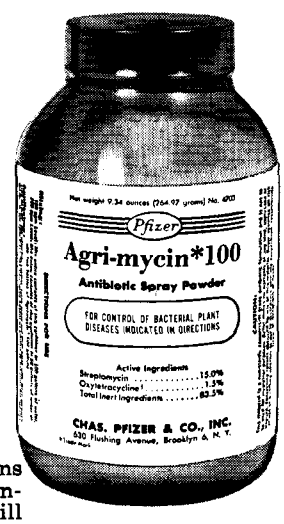
BLACKLEG & SOFT ROT OF POTATO (treat seed pieces in solution)

BACTERIAL SPOT OF TOMATO AND PEPPER (spray seedling or transplant beds)

WALNUT BLIGHT (use as a pre-bloom and post-bloom spray)

Highly encouraging preliminary results with Agri-mycin have been reported in Agricultural Experiment Station Tests on bacterial spot of *peach*, wildfire of *tobacco*, halo blight of *snap beans*. Proper control measures are now being developed.

Laboratory work has shown that Agri-mycin 100 is active against microorganisms causing Bacterial Wilt of *corn, cotton, tobacco, peas;* Bacterial Pustule of *soybeans;* Bacterial Canker of *stone fruit, cucumber, tomato,* Common Blight of *beans;* Crown Gall; Bacterial Rot of *cabbage* and *carrots;* Black Spot of *lemon.* Field work is now in progress to determine proper controls.



One jar makes up to 300 gallons of spray. Water soluble, noncorrosive and nonclogging. Will not cause russeting of fruit.

With three full years of large-scale field tests behind it, Agri-mycin 100 is now being made available to all orchardists and vegetable growers.

The effectiveness of Agri-mycin 100 as a control for fire blight of apples and pears has been proved in nationwide tests involving *more than 100 thousand* trees in over 400 locations in 42 states and Canada. This last season Florida tomato and pepper growers used it to save the crop of *thousands of acres* threatened by an epidemic of the dreaded bacterial spot disease. Wide-scale tests on many other crop diseases (see list at left) have been completed. Still more are in progress.

Agri-mycin is the *only* antibiotic plant spray containing *Terramycin® to retard development of resistant bacterial strains.* It will be distributed by leading manufacturers of fruit and vegetable sprays, *under the name "Agri-mycin."* Write for technical bulletin and other information.

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trate as an example. Production and use of high analysis nitrogen materials in liquid form is, apparently, confined to the U. S.

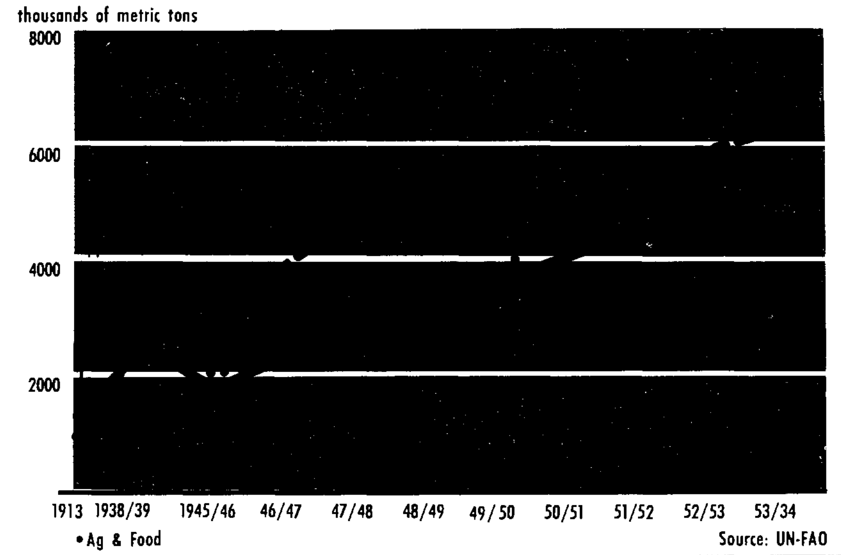
Superphosphate continues to dominate the P_2O_5 picture, supplying about 73% of world phosphoric acid. Basic slag and ammonium phosphate are the only other major phosphate sources, supplying 13 and 4% of the total respectively.

Patterns of consumption of fertilizer nutrients generally follow production. North American consumption of all nutrients exceeds production, resulting in deficits which are reported by FAO as 282,000 tons of N, 6500 tons of P_2O_5, and 218,000 tons of K_2O. Europe on the other hand had production surpluses of: 460,000 tons of N, 11,000 tons P_2O_5, and 1.1 million tons K_2O. A production surplus of about 200,000 tons of N for South America was offset by imports of 48,500 tons P_2O_5 and 33,000 tons K_2O. Asia, Africa, and Oceania are importers of all three basic fertilizer elements.

The wartime drop in production was not made up until 1949 and the annual rate of increase in fertilizer production was maintained until about 1950. Since 1950 the annual rate of increase has remained relatively steady at about 7%. This year (1953–54) world fertilizer production was more than double that of 1945–46. More than twice as much nitrogen and potash and about 75% more phosphoric acid were produced this year than in 1938. Nitrogen and potash production have increased at a greater rate in recent years than phosphoric acid production. If this trend is maintained, it is likely that in a few years tonnage production of N, P_2O_5, and K_2O will be equal.

In 1952–53, Europe dominated nitrogen production, producing at 52% of the world total, with the U. S. producing about 30% of the total world supply. However, from 1951 to 1954, European production increased 18.2% while U. S. production went up more than 36%.

World Production of Fertilizers



There appears to be no letup in the increase of world production of phosphate. In recent years, Israel, Jordan, South Africa, and French West Africa have become significant producers of this material. In addition, FAO believes that recently discovered deposits in South America may contribute to future production totals.

In 1946, FAO published a prediction for future world fertilizer production and consumption entitled "World Fertilizer Production and Consumption and Targets for the Future." The target date for the FAO study was 1960. By 1953–54 world consumption of nitrogen and phosphate had reached 80% of the targets set for 1960, and the target for potash had practically been achieved. Since 1946 several important factors have developed which were not anticipated at that time and which may seriously alter the position of world fertilizer consumption and production in 1960. These factors, according to FAO, include: the continued rapid growth of fertilizer usage in North America; tendency for rapid increase in potash consumption in Europe and North America, rapid recovery and expansion of European industry; the difficulties of establishing chemical industries for production of fertilizers in nonindustrial regions of Asia; and the difficulties in getting peasant farmers to use fertilizers even when supplies are available.

The expansion of fertilizer usage in underdeveloped countries is, according to FAO, still a major world problem. Field experiments and demonstrations to determine the most effective application rates and techniques are urgently needed as a prerequisite for getting fertilizer into these areas. Another major problem is lack of capital for fertilizer production plants. There is little doubt that there are sufficient world mineral reserves to supply increased amounts of fertilizer. Action by national governments and international agencies may, however, be necessary to get the funds to construct fertilizer plants in these areas.

International agencies and assistance programs can also help to educate the farmers to use fertilizers correctly.

Despite the lack of application in many areas of the world, the original somewhat optimistic forecasts of fertilizer consumption made by FAO in 1946 have already

Production and Consumption of Fertilizers in Major Continents 1953-54