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THE MINERAL FERTILIZER INDUSTRY IN THE USSR

CIA/RR 97

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S-E-C-R-E-T

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(ORR Project 22.1566)

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THE MINERAL FERTILIZER INDUSTRY IN THE USSR*

Summary

The goal of the Sixth Five Year Plan (1955-60) for production of 19.6 million metric tons** of mineral fertilizers in the USSR in 1960 probably will not be achieved, despite the vital significance of mineral fertilizers to production of agricultural crops.

The annual production of mineral fertilizers in the USSR in 1960 is estimated at 16.8 million tons, an increase of about 75 percent over production in 1955. This was the rate of increase actually attained under the Fifth Five Year Plan (1951-55), when production fell short of the announced goal. During this period there were failures in adequately increasing Soviet capacity to produce phosphorus and potassium ores. Supplies of sulfuric acid and ammonia for production of phosphorus and nitrogen fertilizers probably were limited and also contributed to the failure to reach the goal. The causes of this failure apparently were not completely eliminated in 1956. Although the annual Plan for nitrogen and phosphorus fertilizers was overfulfilled, the Plan for phosphorite meal and potassium fertilizers was underfulfilled. This shortcoming will not be remedied in 1957, because an increase of only about 6 percent in production is planned. The increase in production achieved during the Fifth Five Year Plan, the increase in 1956, and the small increase planned for 1957 all indicate that the goal planned for 1960 will not be attained. Factors that may contribute to the failure to reach that goal are shortcomings in production of ammonia and sulfuric acid and the continuing shortages of mining equipment and corrosion-resistant materials needed for the construction of phosphoric acid plants.

Production of mineral fertilizers in the USSR in selected years, 1940-60, is shown (in thousand tons) in the following tabulation***:

* The estimates and conclusions contained in this report represent the best judgment of ORR as of 1 June 1957.

** Tonnages are given in metric tons throughout this report.

*** Except for 1960, figures are officially announced Soviet statistics. Estimates for 1960 have been rounded to three significant digits.

Fertilizer	1940	1950	1955	1960
Nitrogen (20.5 percent nitrogen)	971.7	1,908.3	2,984.0	5,300
Potassium (41.6 percent potassium oxide)	532.3	750.4	1,898.3	2,700
Phosphorus (18.7 percent phosphorus pentoxide)	1,351.9	2,350.5	3,833.7	6,600
Phosphorite meal (19 percent phosphorus pentoxide)	381.7	483.2	924.0	2,200
Total	3,237.6	5,492.4	9,640.0	16,800

In 1955, production of mineral fertilizers in the USSR reached 37 percent of production in the US. About one-half of the total supply was consumed by the principal industrial crops (cotton, sugar beets, flax, and hemp). By 1960 the percentage of the supply of mineral fertilizers used on these crops will decline to about one-third of the total, leaving a greater supply for use on other crops, principally grain, potatoes, and vegetables.

The capacity to produce mineral fertilizers has military as well as agricultural significance because production of the fertilizer plants can be diverted to production of important nitrogen chemicals for military uses. Moreover, the increased exploitation of deposits of phosphorite will provide a new potential source of uranium. The uranium content of some of the minable beds has been estimated at between 0.01 and 0.03 percent, well within practical limits of exploitation.

The level of Soviet technology in producing and applying mineral fertilizers varies with the type of fertilizer. In production of superphosphate, Soviet application of advanced technology surpasses that of the US, but in the production and application of concentrated phosphorus fertilizers and various types of nitrogen fertilizers, Soviet technology is inferior to that of the US.

The mineral fertilizer industry of the USSR is self-sufficient in raw materials and has no significant economic vulnerabilities which could be exploited from outside the USSR.

I. Introduction.

A. Significance.

The use of mineral fertilizers is essential to the increases planned for agricultural production in the USSR under the Sixth Five Year Plan (1955-60). The success of this program will depend largely on increases in the yields of agricultural crops, and a significant factor in achieving such increases is a more intensive application of fertilizers. The following extract from a recent Soviet article illustrates the importance of fertilizers to agricultural production:

> If all fertilizers will be rationally used by agriculture, then the country in 1960 will receive from the use of fertilizers alone the following additional amounts of products: grain, 27 million tons; potatoes (tubers), 22 million tons; sugar, 3 million tons; fibers (cotton, flax, and hemp), 2 million tons. 1/*

Mineral fertilizers constitute an important group of chemicals from the point of view both of their consumption in agriculture and of total production of chemicals. The value of the mineral fertilizers produced in the USSR in 1955 is estimated at about 1.5 billion rubles.** About 45 percent of production of sulfuric acid and about 85 percent of production of synthetic ammonia were consumed in the manufacture of phosphorus and nitrogen fertilizers in 1955. Mineral fertilizers probably account for at least 10 percent of the total value of all chemicals sold by the Ministry of the Chemical Industry to other Ministries.***

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** In prices of 1 July 1955. For a discussion of the ruble-dollar ratios for products of the mineral fertilizer industry, see IV, p. 20, below. For methodology, see Appendix D.

*** A recent article indicated that agricultural chemicals accounted for 15 percent of the value of all chemicals produced by the Ministry of the Chemical Industry and distributed to other ministries in 1955. 2/ Although the value of insecticides and certain other agricultural chemicals would be included in this group, mineral fertilizers probably account for a very substantial share of the total. It should be noted that these data are aggregates at the ministerial level and are not comparable with the usual data on "gross output" computed by the so-called factory method. Much of the double counting inherent in the use of the factory method is eliminated when the aggregates are computed at the ministerial level.

Soviet production of mineral fertilizers has significance beyond its importance in total production of chemicals and in the achievement of increased agricultural production. In the first place, production of the fertilizer plants can be diverted to produce vital nitrogen compounds for military explosives, rocket propulsion, and atomic energy. Secondly, the increased exploitation of the Kara-Tau deposits of phosphorite near Chulak-Tau will provide a new source of uranium. The uranium, which may be recovered as a byproduct while producing concentrated phosphorus fertilizers from some of the minable ores, has been estimated at between 0.01 and 0.03 percent.* 3/

The increased use of mineral fertilizers in agriculture may have two corollary effects in addition to the main benefit of increasing the yields of crops. The expanded use of mineral fertilizers will increase the productivity of farm labor and possibly release a supply of labor which could be channeled to the development of new lands or transferred to industrial activities. Moreover, the extensive distribution of fertilizers by the machine tractor stations, which the government plans to make the decisive force in agricultural production, will increase the dependence of the peasants on the state and will bring them more completely under the control of the Soviet system.

B. Administration.

According to a recent statement by the Minister of the Chemical Industry, S.M. Tikhmirov, enterprises of the Ministry of the Chemical Industry accounted for 91 to 92 percent of the mineral fertilizers produced in 1955. 4/ These enterprises are subordinate to the following administrations: nitrogen fertilizer plants (excluding plants producing ammonium sulfate as a byproduct of coke), to the Main Administration of the Nitrogen Industry; potassium, phosphorite, and apatite mines and refineries, to the Main Administration of the Mining Chemical Industry; and superphosphate plants, to the Main Administration of the Chemical Industry. 5/ Most of the remaining 8 to 9 percent of the mineral fertilizers produced in 1955 was supplied in the forms of Thomas meal and of ammonium sulfate (produced as a byproduct of coke) by plants of the Ministry of Ferrous Metallurgy. 6/ Industrial cooperatives produce some phosphorite meal, 7/ and at least one plant producing manganese microfertilizer is subordinate to the Ministry of the Petroleum Industry. 8/

* Uranium is recovered from ores of this concentration in the US, although the process is costly and the amount produced is small.

C. Technology.

Superphosphate, which has been a standard fertilizer in the US and in the USSR for many years, is produced by the decomposition of finely ground phosphate rock with sulfuric acid.

Soviet application of advanced technology in production of superphosphate appears to have surpassed that of the US. Most of the superphosphate plants in the US still operate on the early batch process. 9/ In recent years, US manufacturers have concentrated on the expansion of facilities for production of more concentrated fertilizers and have done little to construct or to modernize plants for production of superphosphate. Since World War II, the USSR has reconstructed and expanded its war-damaged superphosphate plants and installed several new plants which were designed to operate under the semicontinuous and continuous processes. The continuous process is superior to the batch process in that it requires less time and labor and results in a product of better quality. Of the total amount of superphosphate produced in the USSR in 1955, 30 percent was produced by the continuous process, 52 percent by the semicontinuous and only 18 percent by the batch process. 10/

Production of ammonium nitrate, ammonium sulfate, and potassium fertilizers is well established in the USSR, and the level of technology appears to be equal to that in the US.

The USSR lags behind the US in production of concentrated phosphorus fertilizers (double superphosphate, precipitate, and ammofos), and in production and application of some types of nitrogen fertilizers.* In 1955 the US produced about 3.3 million tons of concentrated phosphorus fertilizers,** and the USSR produced only small quantities. Soviet production is not scheduled to reach 1 million tons until 1960. 12/

* For example, urea, nitrogen solutions, and anhydrous ammonia for direct application to the soil.

** This figure includes all phosphorus fertilizers with a content of more than 25 percent P_2O_5 (phosphorus pentoxide) and has been estimated as 617,000 tons of 100 percent P_2O_5, 11/ equivalent to 3.3 million tons on the basis of 18.7 percent of P_2O_5, which is the basis generally used by the USSR in reporting production of phosphorus fertilizers.

Phosphoric acid is a raw material which is essential to production of concentrated phosphorus fertilizers, and it appears that the lack of phosphoric acid is limiting the expansion of production of concentrated phosphorus fertilizers in the USSR. The materials required to produce and handle the highly corrosive wet phosphoric acid include stainless steel, rubber, lead, carbon or karbate, and acid-resisting bricks or cement. 13/ According to a recent Soviet statement, the construction of phosphoric acid plants is being delayed by shortages of equipment and corrosion-resistant materials. 14/ These shortages probably account for recent Soviet efforts to purchase a plant abroad. 15/

Soviet technology also lags in production of defluorinated phosphates. [redacted] the first plant of this type was not yet in operation in February 1956, 16/ whereas a plant of this type has been operating in the US for several years. 17/ Early in 1956 the Minister of the Chemical Industry criticized the State Institute for the Planning of Basic Chemical Enterprises for taking excessive time in designing such a plant. 18/ 50X1

II. Supply.

A. Production.

Most of the mineral fertilizers used in prerevolutionary Russia were imported, as were the raw materials required for the small amount of domestic production. In 1919 the Scientific Institute of Fertilizers* was founded for the purposes of discovering deposits of raw materials for the fertilizer industry, studying the conversion of raw materials into fertilizers, and studying the use of fertilizers on various soils and crops. Geologic surveys led to the discovery of large deposits of apatite ore with a high P_2O_5 content on the Kola Peninsula, as well as deposits of potassium salt at Solikamsk in the Urals. These deposits were exploited, and production of phosphorus raw materials was adequate for domestic requirements by 1932. During the first three Five Year Plans, a large potassium mine and a concentration plant were constructed at Solikamsk, the apatite mines and the concentration plant on the Kola Peninsula were expanded, and a nitrogen fertilizer industry was established by the construction of nitrogen plants at Berezniki, Chirchik, Dneprodzerzhinsk, Gorlovka, Kemerovo, and Stalinogorsk. Production of

* Now called the Scientific Institute for Fertilizers and Insectofungicides.

mineral fertilizers increased from 68,800 tons in 1913 to more than 3 million tons in 1940. Reported production of mineral fertilizers in the USSR in 1913, 1928-40, and 1945-56 is shown in Table 1.*

During World War II, more than 50 percent of the facilities for production of mineral fertilizers were destroyed. 19/ The volume of actual production during the war years is not known but was probably very low.

A goal of producing 5.1 million tons of mineral fertilizers plus 400,000 tons of phosphorite meal was announced in the Fourth Five Year Plan (1946-50). 20/ The war-damaged plants were reconstructed, and new plants were built. The important Kara-Tau deposits of phosphorite were developed and provided raw materials for production of superphosphate in Central Asia (Economic Region Xb**). Production of all types of mineral fertilizers in 1950 amounted to about 5.5 million tons, essentially fulfilling the goal. The Plan for potassium and nitrogen fertilizers was exceeded; but production of phosphorus fertilizers did not reach the goal, 21/ apparently because of the limited supply of sulfuric acid.

The Fifth Five Year Plan (1951-55) provided for an increase in production of mineral fertilizers of 88 percent over that of 1950. 22/ Thus the goal for 1955 was about 10 million tons. New nitrogen fertilizer plants at Kirovakan, Lisichansk, and Rustavi; new superphosphate plants at Krasnoural'sk, Samarkand, and Sumy; and the first section of a new potassium combine at Berezniki were put into operation. Despite this new capacity and the expansion of existing facilities, production in 1955 amounted to 9.64 million tons, an increase of only 75 percent over production in 1950. The Minister of the Chemical Industry stated that plans for production of phosphorus fertilizers, phosphorite meal, and potassium fertilizers were not fulfilled under the Fifth Five Year Plan and criticized the Main Administration of the Mining Chemical Industry for not adequately increasing capacity for production of ore for apatite concentrates, phosphorite meal, and potassium salts. 23/ Production was limited by shortages of mining equipment and an inadequate supply of sulfuric acid and ammonia for the manufacture of phosphorus and nitrogen fertilizers. 24/

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* Table 1 follows on p. 8.

** The term region in this report refers to the economic regions [redacted] 50X1

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Table 1

Production of Mineral Fertilizers in the USSR a/*
1913, 1928-40, and 1945-56

Thousand Metric Tons

Year	Nitrogen b/	Potassium c/	Phosphorus d/	Phosphorite Meal e/	Total
1913 f/	13.8	0	47.1	0	68.8
1913 g/	13.8	0	67.3	7.9	89.0
1928	11.2	0	111.5	12.7	135.4
1929	16.6	0	145.1	46.5	208.2
1930	19.4	0	302.9	181.3	503.6
1931	27.5	0	361.4	312.1	701.0
1932	55.6	1.9	478.7	384.6	920.8
1933	110.9	45.8	545.0	332.0	1,033.7
1934	226.0	196.0	691.9	284.3	1,398.2
1935	374.5	291.6	1,125.8	530.9	2,322.8
1936	552.8	406.6	1,256.6	623.0	2,839.0
1937	761.6	355.8	1,472.7	649.9	3,240.0
1938	828.1	357.9	1,595.7	631.5	3,413.2
1939	958.8	383.2	1,637.9	582.2	3,562.1
1940	971.7	532.3	1,351.9	381.7	3,237.6
1945	744.7	130.7	233.6	10.1	1,119.1
1946	894.1	203.5	560.9	50.6	1,709.1
1947	1,123.8	357.1	798.8	75.6	2,355.3
1948	1,353.0	465.7	1,411.1	238.0	3,467.8
1949	1,685.7	594.1	1,930.2	375.3	4,585.3
1950	1,908.3	750.4	2,350.5	483.2	5,492.4
1951	2,078.6	820.4	2,472.1	553.6	5,924.7
1952	2,236.0	904.7	2,654.8	598.8	6,394.3
1953	2,355.6	1,048.4	2,918.7	645.1	6,967.8
1954	2,648.6	1,294.6	3,350.3	766.4	8,059.9
1955	2,984.0	1,898.3	3,833.7	924.0	9,640.0
1956 h/	3,400	2,200	4,300	1,000	10,900

* Footnotes for Table 1 follow on p. 9.

Table 1

Production of Mineral Fertilizers in the USSR a/
1913, 1928-40, and 1945-56
(Continued)

a. 25/
b. In terms of 20.5 percent N (nitrogen).
c. In terms of 41.6 percent K_2O (potassium oxide).
d. In terms of 18.7 percent P_2O_5 (phosphorus pentoxide).
e. In terms of 19 percent P_2O_5.
f. Figures cover the boundaries of the USSR up to 17 September 1939.
g. Figures cover the present boundaries of the USSR.
h. Production by type of fertilizer is estimated. The reported figure for total production is preliminary.

In 1956, the first year of the Sixth Five Year Plan, the annual Plan was overfulfilled with regard to production of nitrogen and phosphorus fertilizers but was underfulfilled with regard to production of phosphorite meal and potassium fertilizers. 26/ It appears that the problems of the Main Administration of the Mining Chemical Industry which limited expansion under the Fifth Five Year Plan were not solved in 1956.

A comparison of production of mineral fertilizers in the USSR with that in the US in 1955 is shown in Table 2.*

Before World War II, facilities for producing mineral fertilizers were concentrated almost entirely in the RSFSR and the Ukrainian SSR. Such facilities were practically nonexistent in the republics of Central Asia (Kirgiz SSR, Tadzhik SSR, Turkmen SSR, and Uzbek SSR) and of the Transcaucasus (the Armenian SSR, Azerbaydzhan SSR, and the Georgian SSR) and in other regions which consumed large amounts of fertilizers. This situation resulted in excessive shipments by rail. Reportedly, shipments totaling more than 1 billion ton-kilometers per year could have been avoided by constructing plants nearer to the consuming areas. 27/ Since World War II a considerable effort has been made to reduce the requirements for transportation of fertilizers. Many of the new plants producing fertilizers have been located in the consuming regions, so that by 1949 the average distance over which fertilizers

* Table 2 follows on p. 10.

Table 2

Comparison of Production of Mineral Fertilizers in the USSR with Production in the US
1955

Fertilizer	USSR (Thousand Metric Tons)	US a/ (Thousand Metric Tons)	USSR as Percent of US
Nitrogen b/	3.0	8.8	34
Potassium c/	1.9	4.0	47
Phosphorus d/	3.8	12.0	32
Phosphorite meal e/	0.9	1.3	69
Total f/	9.6	26.1	37

a. Reported for the period 1 July 1954 through 30 June 1955. 28/
b. In terms of 20.5 percent N (nitrogen).
c. In terms of 41.6 percent K_2O (potassium oxide).
d. In terms of 18.7 percent P_2O_5 (phosphorus pentoxide). Supplied by superphosphate and other forms of phosphorus fertilizers. Excludes phosphorite meal prepared for application (direct or in "compound" fertilizer mixtures) without further processing.
e. In terms of 19 percent P_2O_5. Used for direct application.
f. All figures have been rounded to three significant digits. Totals are derived independently from unrounded figures and do not always agree with the sums of the rounded components.

were transported had been reduced to 93 percent of that in 1940. 29/ By 1955, about 1.2 million tons of mineral fertilizers were produced in Central Asia, Kazakhstan (Xa), and the Transcaucasus (V), regions in which practically no mineral fertilizers were produced before World War II. It is planned that the annual production of mineral fertilizers in these regions by 1960 will exceed 2.4 million tons.

The reported production of mineral fertilizers in the USSR, by republic, in selected years from 1913 through 1955 and planned production in 1960 are shown in Table 3.

Table 3

Production of Mineral Fertilizers in the USSR, by Republic a/
Selected Years, 1913-60

Thousand Metric Tons

Republic	1913	1940	1950	1954	1955	1960 b/
RSFSR	33	2,164	3,088	4,326	5,236	9,930
Armenian SSR	0	0	58	176	190	304
Azerbaydzhan SSR	0	0	0	0	0	N.A.
Belorussian SSR	0	13	0	0	0	0
Estonian SSR	0	0	78	122	143	572
Georgian SSR	0	0	0	0.2	30	240
Kazakh SSR	0	0	22	323	346	692
Latvian SSR	0	47	177	272	286	400
Lithuanian SSR	0	0	11	46	46	N.A.
Turkmen SSR	0	0	0	0	0	N.A.
Ukrainian SSR	36	1,012	1,536	2,235	2,728	5,460
Uzbek SSR	0	2	522	560	634	1,200
Total	69	3,238	5,492	8,060	9,640	19,600

a. 30/. No production was reported for the other republics. Except for 1960, figures are officially announced Soviet statistics and have been rounded to the nearest thousand. Figures for 1960 have been rounded to three significant digits.
b. The total production planned for 1960 was announced. Other figures are estimates based on reported plans that the volume of production in 1960, in terms of 1955, will be as follows: the Armenian SSR, 1.6 times; the Estonian SSR, 4 times; the Georgian SSR, 8 times; Kazakh SSR, 2 times; the Latvian SSR, 1.4 times; the Ukrainian SSR, 2 times; and Uzbek SSR, 1.9 times. New fertilizer plants are planned for construction in Azerbaydzhan SSR and Turkmen SSR and will probably contribute to the total production in 1960. 31/

The economic regions which produced about 73 percent of the total production of mineral fertilizers in 1955 were the Central (VII), the Urals (VIII), and the South (III). Production of mineral fertilizers in the USSR, by economic region, in 1955 is shown in Table 4.

Table 4

Production of Mineral Fertilizers in the USSR
by Economic Region a/
1955

Region b/	Amount c/ (Thousand Metric Tons)	Percent
I (North and Northwest)	508	5
II (West)	475	5
III (South)	2,728	28
IV (Southeast)	0	0
V (Transcaucasus)	220	2
VI (Volga)	0	0
VII (Central)	1,702	18
VIII (Urals)	2,623	27
IX (West Siberia)	404	4
Xa (Kazakhstan)	346	4
Xb (Central Asia)	634	7
XI (East Siberia)	0	0
XII (Far East)	0	0
Total	9,640	100

a. 32/
b. The term region refers to the economic regions

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c. Reported figures have been rounded to the nearest thousand tons.

B. Trade.

1. With the Free World.

Reported Soviet trade in mineral fertilizers with the Free World in 1955 consisted of imports of nitrogen fertilizers from Japan and West Germany; exports of nitrogen fertilizers to Afghanistan, Egypt, Finland, and the Netherlands; exports of superphosphate to Afghanistan; and exports of potassium fertilizers to Finland. Plans were made to export nitrogen fertilizers to Yugoslavia as well. The reported Soviet trade in mineral fertilizers with the Free World in 1955 is shown in Table 5.*

2. With the Sino-Soviet Bloc.

The reported Soviet trade in mineral fertilizers with the Sino-Soviet Bloc in 1955 consisted of imports of nitrogen fertilizers from East Germany; exports of nitrogen fertilizers to North Korea; and exports of superphosphates to Bulgaria, East Germany, North Korea, North Vietnam, and Rumania. The reported Soviet trade in mineral fertilizers with other countries of the Sino-Soviet Bloc in 1955 is shown in Table 6.**

In addition, the USSR exports apatite concentrate, but this material is not suitable for use as a fertilizer unless chemically converted.

3. Total.

In 1955 the USSR exported 30,300 tons of superphosphate, 32,200 tons of nitrogen fertilizers, and 90 tons of potassium fertilizers and imported 27,200 tons of nitrogen fertilizers. Net exports, therefore, amounted to 30,300 tons of superphosphate, 5,000 tons of nitrogen fertilizers, and 90 tons of potassium fertilizers. The amount involved in trade in 1955 is so small (0.3 percent of total production) that it is disregarded as a factor in the over-all supply of mineral fertilizers. The total supply of mineral fertilizers in the USSR in 1955, therefore, is considered equal to the total production of about 9.64 million tons.

* Table 5 follows on p. 14.
** Table 6 follows on p. 15.

Table 5

Soviet Trade in Mineral Fertilizers with the Free World a/
1955

Metric Tons

Country	Nitrogen	Potassium	Superphosphate
Exports			
Afghanistan b/	500	N.A.	1,000
Egypt c/	8,660	N.A.	N.A.
Finland d/	8,960	90	0
Netherlands e/	3,500	N.A.	N.A.
Yugoslavia	f/	N.A.	N.A.
Total	21,600	90	1,000
Imports			
Japan g/	3,060	N.A.	N.A.
West Germany h/	12,400	N.A.	N.A.
Total	15,400	N.A.	N.A.

a. Figures include reported shipments of identifiable types of prepared mineral fertilizers but exclude shipments of phosphate ores and concentrates. All figures have been rounded to three significant digits. Totals were derived independently from unrounded figures and do not always agree with the sum of the rounded components.
b. 33/
c. 34/
d. 35/
e. 36/
f. Exports totaling 20,000 tons were planned. 37/
g. 38/
h. 39/

Table 6

Soviet Trade in Mineral Fertilizers with Other Countries of the Sino-Soviet Bloc a/
1955

Metric Tons

Country	Nitrogen	Superphosphate
Exports		
Bulgaria b/	N.A.	N.A.
East Germany c/	N.A.	9,820
North Korea d/	10,600	10,000
North Vietnam e/	N.A.	9,500
Rumania f/	N.A.	N.A.
Total	10,600	29,300
Imports		
East Germany g/	11,700	0
Total	11,700	0

a. Figures include reported shipments of identifiable types of prepared mineral fertilizers but exclude shipments of phosphate ores and concentrates. All figures have been rounded to three significant digits. Totals were derived independently from unrounded figures and do not always agree with the sums of the rounded components.
b. 40/
c. 41/
d. 42/
e. 43/
f. 44/
g. 45/

III. Distribution.

A. By Crop.

In the USSR, cotton consumes more mineral fertilizers than any other crop. 46/ In recent years, mineral fertilizers have been applied at an average rate of 8 centners per hectare (about 330 pounds per acre) on the irrigated land sown to cotton. Both nitrogen and phosphorus fertilizers are required on all the main producing lands in Central Asia, Kazakhstan, and the Transcaucasus. Potassium fertilizers are not widely used in these regions because the soils contain assimilable potassium, but potassium fertilizers are required in small amounts to get yields above 25 centners per hectare (about 1,100 pounds per acre). The best types of fertilizers for cotton are granulated ammonium nitrate, granulated superphosphate, and precipitate. 47/

Sugar beets are the second largest consumer of mineral fertilizers in the USSR, although the amount of fertilizer used for this crop in recent years has not been reported. All types of mineral fertilizers may be used for sugar beets, but the preferred potassium fertilizer is a mixture of potassium chloride and 30 to 40 percent potassium salt, and the preferred nitrogen fertilizer is sodium nitrate. 48/

The Fourth Five Year Plan (1946-50) called for a supply of mineral fertilizers sufficient for the fertilization of industrial crops (cotton, flax, hemp, sugar beets, rubber bearing plants, tobacco, tea, and citrus fruits), as well as a large supply for other crops, especially potatoes and vegetables. 49/ It appears that these goals were realized at least in part by 1953 because the Minister of the Chemical Industry stated:

> The achieved level of production of mineral fertilizers supplies more or less sufficient amounts for the sowing of basic industrial crops -- cotton, sugar beets, tea, and others. Mineral fertilizers are still produced in small amounts for the sowing of food crops. 50/

Grain, potatoes, and vegetables almost certainly will receive a greater proportion of the supply of fertilizer than in the past. [redacted] production of phosphorus fertilizer will continue to consist principally of superphosphate, which is the most suitable fertilizer for use on large areas sown to grain. 51/ The

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fertilization of grain on a large scale will place heavy demands on the supply of fertilizer. If a minimum of only 0.5 centner per hectare (about 22 pounds per acre) had been applied in 1955, 6.5 million tons of superphosphate would have been required to fertilize the total area sown to grain.

In 1955, mineral fertilizers apparently were available in amounts sufficient for the fertilization of basic industrial crops and for the partial fertilization of grain, potatoes, and vegetables. The estimated distribution of mineral fertilizers, by crop, in the USSR in 1955 and 1960 is shown in Table 7.*

In 1955, about 50 percent by weight of the total supply of mineral fertilizers was used on the principal industrial crops (cotton, sugar beets, flax, and hemp). By 1960 the share used on these crops will drop to an estimated 33 percent of the total, leaving a greater proportion of the supply for application to grain, potatoes, vegetables, and other crops.

B. By Republic.

The Plan for the distribution of mineral fertilizers to various regions of the USSR in 1941 is the latest available complete Plan. This Plan, together with the reported receipts of mineral fertilizers by Azerbaydzhan SSR and the republics of Central Asia, was used to estimate the distribution of mineral fertilizers, by organization and by republic, which is shown in Table 8.**

In compiling Tables 7 and 8, it has been assumed that all of the mineral fertilizers produced in 1955 were distributed to agriculture. There has been evidence, however, that sizable losses of fertilizers occur during shipment and storage, and thus the amounts actually used on crops were considerably smaller. Such losses, which occur in the loading and unloading of railroad cars, during storage in open areas, and during haulage to the points of use, result primarily from deterioration due to rain. In several areas the losses have amounted to 15 to 25 percent of the total quantity allocated to agriculture. 52/

* Table 7 follows on p. 18.
** Table 8 follows on p. 19.

Table 7

Estimated Distribution of Mineral Fertilizers in the USSR, by Crop a/
1955 and 1960

Crop	Nitrogen b/		Potassium c/		Phosphorus d/		Total		Percent of Total	
	1955	1960	1955	1960	1955	1960	1955	1960	1955	1960
	Thousand Metric Tons									
Cotton	922	1,050	0	0	920	1,040	1,840	2,090	19.1	12.5
Sugar beets	515	585	211	240	753	856	1,480	1,680	15.3	10.0
Flax	289	371	178	228	396	508	863	1,110	9.0	6.6
Hemp	288	293	128	130	237	241	653	664	6.8	3.9
Potatoes and vegetables	124	3,000	94	2,100	418	6,150	636	11,300	6.6	67.0
Grain and other	842		1,290		2,040		4,170		43.2	
Total	2,980	5,300	1,900	2,700	4,760	8,800	9,640	16,800	100.0	100.0

a. For methodology, see Appendix D. All figures were rounded to three significant digits. Totals were derived independently from unrounded figures and do not always agree with the sums of the rounded components.
b. In terms of 20.5 percent N (nitrogen).
c. In terms of 41.6 percent K_2O (potassium oxide).
d. Includes all phosphorus fertilizers. Phosphorite meal is in terms of 19 percent P_2O_5 (phosphorus pentoxide) and all other phosphorus fertilizers are in terms of 18.7 percent P_2O_5.

Table 8

Estimated Distribution of Mineral Fertilizers in the USSR
by Organization and by Republic a/
1955

Ministry or Commissariat	Nitrogen b/		Potassium c/		Phosphorus d/		Phosphorite Meal e/		Total	
	Amount (Thousand Metric Tons)	Percent of Total	Amount (Thousand Metric Tons)	Percent of Total	Amount (Thousand Metric Tons)	Percent of Total	Amount (Thousand Metric Tons)	Percent of Total	Amount (Thousand Metric Tons)	Percent of Total
Agriculture										
RSFSR	423	14.2	623	32.8	667	17.4	482	52.3	2,195	22.8
Armenian SSR	36	1.2	9	0.5	23	0.6	0	0	68	0.7
Azerbaydzhan SSR	105	3.5	8	0.4	109	2.8	0	0	222	2.3
Belorussian SSR f/	45	1.5	106	5.6	50	1.3	90	9.7	291	3.0
Estonian SSR	39	1.3	32	1.7	96	2.5	0	0	167	1.7
Georgian SSR	107	3.6	27	1.4	73	1.9	16	1.7	223	2.3
Karelo-Finnish SSR	3	0.1	2	0.1	4	0.1	0	0	9	0.1
Kazakh SSR g/	83	2.8	17	0.9	69	1.8	0	0	169	1.8
Kirghiz SSR	65	2.2	11	0.6	87	2.3	0	0	163	1.7
Latvian SSR	125	4.2	70	3.7	241	6.3	0	0	436	4.5
Lithuanian SSR	39	1.3	55	2.9	172	4.5	0	0	266	2.8
Moldavian SSR	9	0.3	8	0.4	15	0.4	0	0	32	0.3
Tadzik SSR	71	2.4	9	0.5	76	2.0	0	0	156	1.6
Turkmen SSR	115	3.8	11	0.6	116	3.0	0	0	242	2.5
Ukrainian SSR	480	16.1	454	23.9	712	18.6	200	21.7	1,846	19.2
Uzbek SSR	803	26.9	63	3.3	840	21.9	0	0	1,706	17.7
Experimental use	18	0.6	48	2.5	19	0.5	5	0.5	90	0.9
Total	2,566	86.0	1,553	81.7	3,369	87.9	793	85.9	8,281	85.9
Food Industry.	191	6.4	139	7.3	188	4.9	17	1.8	535	5.6
Meat and Dairy Industry	15	0.5	42	2.2	31	0.8	32	3.5	120	1.2
State Farms	194	6.5	141	7.4	215	5.6	77	8.3	627	6.5
Other organizations	18	0.6	25	1.3	31	0.8	5	0.5	79	0.8
Grand total	2,984	100.0	1,900	100.0	3,834	100.0	924	100.0	9,642	100.0

a. For methodology, see Appendix D.
b. In terms of 20.5 percent N (nitrogen).
c. In terms of 41.6 percent K_2O (potassium oxide).
d. In terms of 18.7 percent P_2O_5 (phosphorus pentoxide).
e. In terms of 19 percent P_2O_5.
f. In 1953 the consumption of mineral fertilizers in Belorussia reportedly amounted to 331,000 tons. 53/
g. In 1953 the consumption of mineral fertilizers on the kolkhozes of Kazakh SSR amounted to 119,200 tons, divided as follows: nitrogen, 54,200 tons; potassium, 3,700 tons; and superphosphate, 61,300 tons. 54/

IV. Prices.*

A comparison of the prices of selected mineral fertilizers in the USSR and in the US in 1955 is shown in Table 9. Ruble-dollar ratios for fertilizers range from about 4 rubles to US $1 to nearly 9 rubles to US $1.

Table 9

Comparison of Prices of Selected Mineral Fertilizers in the USSR and in the US a/
1955

Type	USSR (Rubles per Metric Ton) b/	US (Dollars per Metric Ton) c/	Ruble-Dollar Ratio
Ammonium nitrate	430	74.94	5.7 to 1
Ammonium sulfate	250	46.28	5.4 to 1
Superphosphate	161	18.45	8.7 to 1
Potassium chloride	95	22.57	4.2 to 1

a. Prices shown are f.o.b. factory.
b. 55/
c. 56/

The factory prices of fertilizers are relatively low in the USSR; the average ruble-dollar ratio for all chemicals in 1955 was between 10 rubles to US $1 and 15 rubles to US $1. The low relative prices reflect, in part, a level of technology and a scale of production which approach those in the US.

It is difficult to interpret small variations in ruble-dollar ratios from one chemical to another, but the ruble-dollar ratio of nearly 9 to 1 for superphosphate suggests that this is a high-cost fertilizer in the USSR. Although its high cost may result from a number of factors, the inordinately high cost of transporting raw materials is probably

* For methodology, see Appendix D.

most influential. Most of the ore is shipped by rail from the Kola Peninsula, the source of 85 percent of the phosphate ore used in the Soviet superphosphate industry,* over a long distance to the plants producing fertilizers in other regions. In the US, by contrast, most of the superphosphate plants are located at or near the important phosphate mines in Florida or along the eastern seaboard, thus taking advantage of the low costs of transportation by water. 57/

The factory or list prices shown for the USSR in Table 9 may not always be the actual selling prices, for Soviet writers have referred to preferential prices accorded to agriculture. 58/ The stated purpose of this price policy is to stimulate the use of mineral fertilizers in agriculture. 59/ Incentives to use fertilizers may be strengthened by offering discount price to offset the adverse effect of the low prices paid for agricultural products. As one Soviet expert on prices has stated, "the increase in income from the application of fertilizers must exceed the outlays for these purposes." 60/ Although the precise application and the importance of preferential pricing are not known, discounts probably are granted on a selective basis to compensate for relatively low prices paid for agricultural products.

V. Inputs.

Estimates of the major inputs required for production of 9.64 million tons of mineral fertilizers in the USSR in 1955 are shown in Table 10.**

The estimated Soviet supply of the materials required for production of mineral fertilizers in 1955 was sufficient to satisfy the requirements for inputs. In 1955, the USSR produced about 3.8 million tons of sulfuric acid, about 1.5 million tons of nitric acid, about 753,000 tons of synthetic ammonia, 61/ and about 170 billion kilowatt-hours (kwh) of electricity. 62/ Thus, in 1955 the mineral fertilizer industry consumed about 45 percent of the sulfuric acid, 73 percent of the nitric acid, 85 percent of the synthetic ammonia, and 2 percent of the electricity produced in the USSR. Although the amounts of phosphate rock and potassium salts produced in the USSR in 1955 are not known, the reserves are huge and could easily have provided the quantities required for fertilizers in 1955. These reserves are also considered ample for the future production of mineral fertilizers as given in existing Plans.

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* For methodology, see Appendix D.

** Table 10 follows on p. 22.

Table 10

Estimates of the Inputs Required to Manufacture Mineral Fertilizers in the USSR a/
1955

Input	Unit	Amount
Apatite concentrate	Million MT b/	1.65
Phosphorite ore	Million MT	1.28
Potassium salts (crude)	Million MT	5.70
Sulfuric acid (100 percent H_2SO_4)	Million MT	1.73
Nitric acid (100 percent HNO_3)	Million MT	1.11
Ammonia c/	Million MT	0.64
Steam	Million MT	3.78
Electricity d/	Billion kwh e/	3.36

a. For methodology, see Appendix D.
b. Metric tons.
c. Excludes byproduct ammonia for ammonium sulfate fertilizers but includes ammonia required for the manufacture of nitric acid used for fertilizers.
d. Includes the power required to produce the ammonia needed for the manufacture of nitric acid used for fertilizers.
e. Kilowatt-hours.

VI. Future Expansion.

A. General.

One of the chief tasks of the chemical industry as set forth in the Sixth Five Year Plan is to increase production of the chemical products needed for raising the yields of agricultural crops. According to the Plan, production of mineral fertilizers in 1960 is scheduled to reach 19.6 million tons, or 204 percent of production in 1955. 63/ This goal for the Sixth Five Year Plan is consistent with the long-range goal for production of 28 million to 30 million tons of mineral

fertilizers in 1964.* There is considerable doubt whether either goal will be attained. This conclusion is based on the past performance of the industry, the reported increase in production of 13 percent in 1956, and the planned increase of only 6.5 percent in 1957.

It is estimated tentatively that 16.8 million tons of mineral fertilizers will be produced in 1960. If production were to reach this level the increase over production in 1955 would be 75 percent, the same rate of increase achieved between 1950 and 1955.

An increase in production from 9.6 million tons of mineral fertilizers in 1955 to 16.8 million tons in 1960 will provide an increase of 7.2 million tons in the amount available for agricultural crops. The full impact of this increased amount of mineral fertilizers on the yields of agricultural crops cannot be accurately assessed because of a number of complex variables, such as the type of soil, the type of crop, the extent of fertilization, the amount of rainfall, and the efficiency of distribution of mineral fertilizers from the producing plants to the fields. [redacted] 50X1
mineral fertilizers are produced in sufficient amounts for the fertilization of industrial crops in the USSR. Because the acreage scheduled to be sown to these crops in 1960 is not significantly larger than in 1955, these crops will probably require only a small portion of the additional 7.2 million tons of mineral fertilizers which it is estimated will be available in 1960. A large part of this additional amount, therefore, will be available for the increased fertilization of other crops, principally grain, potatoes, and vegetables.

The estimated production of mineral fertilizers, by type, in 1956-60 and planned production in 1960 are shown in Table 11.**

B. Nitrogen.

It is estimated that production of nitrogen fertilizers in 1960 will be 2.3 million tons greater than in 1955. This increase will consist of about 270,000 tons of ammonium sulfate (the byproduct of coke) and about 2 million tons of other nitrogen fertilizers, chiefly ammonium nitrate but also potassium nitrate, sodium nitrate, calcium-ammonium nitrate, liquid ammonia, and ammoniates.

* This goal was announced by Khrushchev at the Party Plenum in September 1953.
** Table 11 follows on p. 24.

Table 11

Estimated and Planned Production of Mineral Fertilizers in the USSR by Type a/
1956-60

Million Metric Tons

Year	Nitrogen b/	Potassium c/	Phosphorus d/	Phosphorite Meal e/	Total
1956	3.4	2.2	4.3	1.0	10.9
1957	3.6	2.3	4.6	1.1	11.6
1958	4.1	2.4	5.2	1.4	13.1
1959	4.7	2.5	5.9	1.7	14.8
1960	5.3	2.7	6.6	2.2	16.8
1960 f/	6.2	3.0	7.7	2.7	19.6

a. For methodology, see Appendix D.
b. In terms of 20.5 percent N (nitrogen).
c. In terms of 41.6 percent K_2O (potassium oxide).
d. In terms of 18.7 percent P_2O_5 (phosphorus pentoxide).
e. In terms of 19 percent P_2O_5.
f. Plan figures. 64/

A large nitrogen fertilizer plant is being constructed at Nevinnomyssk, Stavropol'skiy Kray, RSFSR, and production of ammonium and sodium nitrate is scheduled to begin in 1959. 65/ In Central Asia the expansion of production of nitrogen fertilizers is planned at the Stalin Electrochemical Combine in Chirchik. In addition, a new nitrogen fertilizer plant, with a projected capacity exceeding that of the plant in Chirchik, is being constructed in Angren. 66/

C. Potassium.

The USSR has adequate deposits of potassium ores to satisfy the greater demands imposed by an increase of 800,000 tons in production of potassium fertilizers. Expansion may continue to be hampered, however, by the lack of mining equipment needed for the extraction of the ore. The expansion of the coal, iron, and electric power industries will place increased demands on the economy for this same equipment, and the shortage of excavators, drills, and transporting equipment may continue.

The various types of potassium fertilizers scheduled for production include potassium chloride, kainite, kalimag, and concentrated sylvinite. Production of potassium sulfate in the western Ukraine will be expanded to provide a chlorine-free potassium fertilizer that is required for certain agricultural crops such as tobacco, grapes, potatoes, and citrus fruits. 67/ A large part of the planned increase probably will be produced at the Voroshilov Potassium Combine in Berezniki, where a second production section probably will be built.

D. Phosphorus.

The phosphorus fertilizers scheduled for production in 1960 include superphosphate, precipitate, double superphosphate, ammofos, defluorinated phosphates, and metallurgical slags. The estimated production of phosphorus fertilizers in 1960 will be 2.8 million tons greater than in 1955. Most of the estimated increase will be in the form of superphosphate. Superphosphate plants are planned or are under construction in Azerbaydzhan SSR, the Belorussian SSR, the Estonian SSR, the Lithuanian SSR, and Turkmen SSR. The first large plant for production of fluorine-free phosphates from apatite concentrate will soon start operating, and installation of a plant for production of double superphosphate is reported under way. 68/

E. Phosphorite Meal.

The deposits of phosphate rock in the USSR are ample to satisfy the greater demands placed by an increase of 1.3 million tons in production of phosphorite meal. As in the case of potassium fertilizer, the expansion of production may continue to be hampered by the lack of mining equipment. The construction of new facilities is planned or is in progress at Tallinn, Estonian SSR, and at Marusinsk, Tambovskaya Oblast, RSFSR. 69/ Under the Sixth Five Year Plan the extraction of phosphorite ore from the Kara-Tau deposits is scheduled to be doubled. 70/

VII. Capabilities, Vulnerabilities, and Intentions.

A. Capabilities.

In order to fulfill the goal of the Sixth Five Year Plan for mineral fertilizers, production in 1960 will have to reach 19.6 million tons, or 204 percent of production in 1955. Fulfillment of this Plan is possible; but on the basis of the record of the industry during 1950-56 and of the Plan for 1957, it is estimated tentatively that

production in 1960 will not exceed 16.8 million tons, or 175 percent of production in 1955.

The chronic shortage of mining equipment probably will contribute significantly to the failure of the Sixth Five Year Plan. Increased demands for this type of equipment by industries carrying higher priorities (coal, iron, and electric power) are expected to result in a shortage of mining equipment in the fertilizer industry and thus in the underfulfillment of the goals for production of phosphorite meal and potassium fertilizers. Possible failures in achieving the increases planned in production of ammonia and sulfuric acid, shortages of which have been reported recently, also may contribute to the failure of the Plan, as would a shortage of corrosion-resistant materials and special equipment required for the construction of plants for production of phosphoric acid, which is needed for production of concentrated phosphorus fertilizer. In recent years these materials have been reported to be scarce in the USSR. 71/

B. Vulnerabilities.

The mineral fertilizer industry is self-sufficient in raw materials and has no significant economic vulnerabilities which could be exploited from outside the USSR. The outstanding weakness of the industry is its dependence on the apatite deposits of the Kola Peninsula for phosphorus fertilizers. This situation results in high costs for the transportation of raw material and requires the use of much railroad equipment that is needed elsewhere. It is estimated that 1.65 million tons of apatite concentrate were shipped in 1955 from the Kola Peninsula to many regions of the USSR for the manufacture of superphosphate. New methods of utilizing local deposits of phosphorite may alleviate the problem of transportation, but the isolated location of the deposits of high-grade apatite on the Kola Peninsula precludes the possibility of entirely eliminating this weakness.

50X1

50X1

APPENDIX A

TYPES OF MINERAL FERTILIZERS IN THE USSR

Mineral fertilizers may be classified into simple fertilizers, which contain only one nutrient element, and multiple fertilizers, which contain two or more nutrient elements. Multiple fertilizers may be divided into mixed and complex fertilizers. Mixed fertilizers are prepared by the mechanical mixing of various fertilizers, and complex fertilizers are those in which the nutrient elements are chemically bound either by fusion or by crystallization.

The nutrient elements in fertilizers that promote the growth of plants include nitrogen, potassium, phosphorus, boron, copper, and others. Nitrogen, potassium, and phosphorus fertilizers are the most important types. Microfertilizers, which contain boron, copper, manganese, and other elements needed by plants in small amounts, are less important types.

1. Simple Fertilizers.

a. Nitrogen.

The principal nitrogen fertilizer used in the USSR is ammonium nitrate, which is produced by the reaction between ammonia and nitric acid. Ammonium nitrate is used also in military high explosives, which may explain partially the Soviet preference for developing this type of nitrogen fertilizer. According to the "perspective plan" for the nitrogen industry, production of ammonium nitrate will constitute 77 percent of the total production of nitrogen fertilizers. 72/

Ammonium nitrate is a concentrated fertilizer that contains about 35 percent nitrogen, is highly hygroscopic, and has a tendency to cake. These physical properties, however, may be improved by granulation. Production of noncaking ammonium nitrate increased from 49.8 percent of the total in 1950 to 68.1 percent of the total in 1955. 73/ All ammonium nitrate intended for use as a fertilizer was to be produced in granulated form in 1956. 74/

Ammonium sulfate was the other important nitrogen fertilizer produced in the USSR in 1955. This fertilizer contains about

21 percent nitrogen and is produced in the USSR mainly by the reaction between sulfuric acid and ammonia from coke gases. 75/

A widely used fertilizer in the USSR is a simple mixture or fusion mixture of ammonium nitrate and ammonium sulfate. Depending on the method of production, this mixture is called Leuna saltpeter (a mechanical mixture of ammonium nitrate and ammonium sulfate) or Montan saltpeter (the product manufactured by the reaction between ammonia and mixed nitric and sulfuric acids). Each of these mixtures contains 25 to 27 percent nitrogen, cakes less, and is less explosive than simple ammonium nitrate.

Nitrogen fertilizers that are believed to have been produced on a relatively small scale or that are planned for future production in the USSR include the following:

(1) Sodium nitrate containing 16 to 17 percent nitrogen is produced by the absorption of residual nitrous oxide gases (at nitric acid plants) in a solution of soda ash or caustic soda. The shortage of soda will limit further increases in production of this fertilizer. 76/ A few deposits of natural sodium nitrate occur in Central Asia, in the Caucasus, and in the Crimea, but these deposits have no commercial importance. 77/ Sodium nitrate is particularly effective in the USSR for sugar beets; it has been estimated that the increase in the yield of sugar beets from the use of sodium nitrate is 40 percent higher than from the use of other nitrogen fertilizers. 78/

(2) Calcium cyanamide containing 18 to 24 percent nitrogen is produced by the reaction between nitrogen and calcium carbide. Although it is a good fertilizer, calcium cyanamide is produced on a limited scale in the USSR and is used chiefly for industrial purposes and also as a defoliant for cotton. 79/

(3) Urea containing 46 to 47 percent nitrogen is produced by the synthesis of ammonia and carbon dioxide at high pressure and temperature. At present, urea is used chiefly as an intermediate product for industrial purposes, 80/ but large-scale production in the future probably will lead to its use as a fertilizer.

(4) Calcium nitrate, which is important as an alkaline form of nitrogen fertilizer, is produced by many methods. By one process, calcium nitrate is produced together with precipitate by the decomposition of phosphates with nitric acid. One ton of precipitate and two tons of calcium nitrate are produced from one ton

of apatite concentrate. By another process, calcium nitrate is produced together with nitrophoska. One ton of apatite concentrate can be used to produce 2.5 tons of nitrophoska and 1.4 tons of calcium nitrate. Calcium nitrate contains 13 to 15 percent nitrogen and is particularly effective on acid soil. 81/

(5) Calcium-ammonium nitrate is ammonium nitrate that has been neutralized by fusion with limestone. The continued use of ammonium nitrate or ammonium sulfate on the acid soil of the podzolic zones, which make up about one-third of the sown lands in the USSR, leads to an increased soil acidity and a decrease in the harvest. Calcium-ammonium nitrate is a valuable nitrogen fertilizer for acid soil. 82/

b. Potassium.

The natural deposits of potassium salts located in the northern Urals at Solikamsk and in the Ukrainian SSR at Kalush and Stebnik are the principal sources of potassium fertilizers in the USSR. The deposits at Solikamsk are the most important and occur in the form of sylvinite and carnallite. Sylvinite is a complex salt consisting of sodium and potassium chlorides, whereas carnallite contains magnesium chloride in addition to sodium and potassium chlorides. The deposits in the western part of the Ukrainian SSR occur in the form of kainite and langbeinite. Kainite is a complex salt consisting of potassium chloride and magnesium sulfate, whereas langbeinite consists chiefly of potassium sulfate and magnesium sulfates. The latter salt is of particular importance for the preparation of chlorine-free potassium fertilizers, such as kalimag, which are especially suitable for certain crops. Other deposits of potassium salt have been discovered in the Ukrainian SSR and in the southern Volga (VI), the Central Asia (Xb), and the Central (VII) Regions of the USSR. 83/ At present, however, these deposits have no commercial importance.

The principal forms of potassium fertilizers produced in the USSR are potassium chloride (60 percent K_2O -- potassium oxide), mixed salt (40 percent K_2O), kainite (10 to 11 percent K_2O), and kalimag (17 percent K_2O). 84/ The first two forms are produced from the deposits at Solikamsk and constitute the greater portion of production of potassium fertilizers. Kainite and kalimag are produced from the deposits in the western Ukrainian SSR. High-quality sulfate forms of potassium fertilizers (50 percent K_2O) are produced in small amounts.

c. Phosphorus.

Phosphorus is an important nutrient element needed for the growth and development of plants. A deficiency of assimilable phosphorus in the soil causes poor development of plants, a delay in flowering and ripening, and poor yields. Although the supply in the soil is generally considerable, phosphorus usually exists in a form that cannot be assimilated by plants. The nutrient value of a phosphorus fertilizer depends on its content of assimilable P_2O_5 (phosphorus pentoxide). Phosphorus fertilizers are classified into three types: the water-soluble type, from which the P_2O_5 can be assimilated easily by the plant; the water-insoluble type, from which the P_2O_5 is assimilated slowly by the plant; and the citrate-soluble type, from which the P_2O_5 is assimilated at a speed intermediate between that of the water-soluble and the water-insoluble types.*

At present, phosphorus fertilizers, including phosphorite meal, constitute about one-half of total production of mineral fertilizers in the USSR and will probably continue to do so. Among the phosphorus fertilizers produced in 1955 the most important were superphosphate and phosphorite meal. These two fertilizers, particularly superphosphate, will be the predominant types in the future. 85/

Superphosphate, the principal phosphorus fertilizer produced in the USSR, may be used on many different soils and crops. This fertilizer is produced by the decomposition of phosphate rock with sulfuric acid, is a water-soluble type, has a P_2O_5 content ranging from 14 to 20 percent, has low hygroscopicity, and is easily stored. The preferred raw material is apatite concentrate, although phosphorite or a mixture of phosphorite and apatite concentrate may be used.

The agrochemical properties of superphosphate may be improved by granulation. The resulting granulated superphosphate has a higher assimilable P_2O_5 content and does not cake or dust. Although

* Fertilizers of the water-insoluble type may be used effectively only in podzolic, acid soil where the acid content of the soil can slowly break down the chemical structure of the fertilizer to release the P_2O_5. Fertilizers of the citrate-soluble type may be used on all kinds of soil, but are of particular value on the acid soil of the northern USSR.

45 percent of the superphosphate produced in 1955 was scheduled to be in granulated form, only 22 percent of the superphosphate supplied to the kolkhozes was of this type. 86/ According to the Plan, 60 percent of the superphosphate produced in 1958 is to be in granulated form. 87/

Phosphorite meal is the second most important type of phosphorus fertilizer produced in the USSR. Production in 1955 was reported to amount to about 20 percent of the total production of phosphorus fertilizers. 88/

Phosphorite meal is produced by the grinding of phosphorite ores or concentrates, and is used for direct application to the soil and for the preparation of other fertilizers. Since 1951 it has been produced in three grades with a P_2O_5 content ranging from 19 to 25 percent. 89/ It is a water-insoluble fertilizer and, as a direct fertilizer, is effective on podzolic, leached, and acid soils. It is applied to the northern soils on which rye, wheat, and sugar beets are cultivated. 90/ The widespread deposits of phosphorite in the USSR and the low cost of manufacture ensure the increased production of this fertilizer.

Production of concentrated phosphorus fertilizers* is scheduled to reach 1 million tons in 1960. 91/ The advantages of concentrated phosphorus fertilizers over normal superphosphate include the following:

(1) The cost is less for transporting, loading and unloading, packaging, storing, and application in the fields.

(2) It is possible to use low-concentrate phosphorite mixed with apatite concentrate as a raw material. Such a raw material generally cannot be used to produce superphosphate.

(3) In many cases the concentrated phosphorus fertilizers are more effective than superphosphate. For example, precipitate is more effective than superphosphate on acid soil and on chernozem.

* Concentrated phosphorus fertilizers include double superphosphate, precipitate, ammofos, and defluorinated phosphates.

Phosphorus fertilizers that are believed to have been produced on a relatively small scale in 1955 or that are scheduled for future production in the USSR include the following:

(1) Double superphosphate containing 45 to 50 percent P_2O_5 is prepared by the decomposition of natural phosphates with phosphoric acid. In the order of importance of phosphorus fertilizers, double superphosphate will compete with precipitate for third place. 92/ A plant to produce double superphosphate is reported to be under construction. 93/

(2) Precipitate, or dicalcium phosphate, containing 27 to 40 percent P_2O_5 in a citrate-soluble form may be produced from phosphoric acid or from water-soluble phosphates produced by the action of nitric acid or hydrochloric acid on natural phosphates. These acid solutions are neutralized with lime or an alkali, and dicalcium phosphate is precipitated and separated. Production of precipitate, together with calcium nitrate, by the conversion of apatite concentrate with nitric acid, was mastered in 1955 at an experimental installation at the nitrogen fertilizer plant in Dneprodzerzhinsk. 94/

Precipitate was produced in the USSR before World War II, but there is no evidence of large-scale production in the postwar years. Eventually, the scale of production of precipitate is scheduled to be about the same as that of double superphosphate. 95/

(3) Metallurgical phosphate slags, which are produced during the conversion of phosphoric pig iron by the Martin or the Thomas process, may be used on all types of soil, but their effectiveness varies. Such slags are more effective than superphosphate on acid soil but less effective than superphosphate on neutral chernozem.

Before World War II, Thomas slag was produced in the USSR at the plant in Kerch' at a rate of 90,000 tons per year. In recent years the conversion of phosphorus pig iron has been conducted in Martin furnaces. 96/ A shop was constructed at the Azovstal' Plant near Zhdanov for production of 340,000 tons of fertilizer annually, and the equipment was being tested in 1955. 97/ It is probable that production of this material in 1955 was small but that it will gain in importance. It has been claimed that the USSR has the potential to produce 10 million tons of Thomas steel, which would yield 1.8 million tons of phosphate fertilizers, by the end of the Seventh Five Year Plan (1961-65). 98/

(4) Thermophosphates containing about 27 to 30 percent P_2O_5 are produced by the fusion of natural phosphates with alkaline salts (soda ash or alkaline sulfates). In 1954, 300 tons of thermophosphates were produced by heating the Kara-Tau phosphorites with sodium sulfate from the Aral Sea. 99/ Future production of this type of fertilizer may take place near the deposits of sodium sulfate located in the Central Region, in Kazakhstan (Xa), and in Altayskiy Kray of East Siberia (XI). 100/

(5) Fluorine-free phosphate fertilizers are produced by the treatment of natural phosphates with steam at a high temperature and are characterized by the small amount of fluorine contained in the product (0.1 to 0.3 percent). The first Soviet factory for the commercial production of these fertilizers soon will start operation. 101/

d. Microfertilizers.

In addition to the basic plant nutrients, nitrogen, phosphorus, and potassium, microfertilizers are used for increasing the harvest. Microelements (boron, copper, manganese, cobalt, molybdenum, iodine, and others) usually are contained in plants in very small amounts. At present the microelements boron, copper, and manganese, are used in small amounts in microfertilizers. An expansion in production and in the use of microfertilizers, particularly boron, is planned. 102/

(1) Boron microfertilizers are prepared from the boron ores in the region of Lake Inder in Kazakhstan. These fertilizers are produced in the form of boron-superphosphate, which contains 5 to 16 percent P_2O_5 and 1.5 percent boric acid, or of boron-magnesium, which contains 5 to 10 percent boric acid and 70 to 85 percent magnesium sulfate. 103/ Boron microfertilizers are used on about 100,000 hectares (about 247,000 acres) of agricultural land in the USSR. The research investigations at the Scientific Institute for Fertilizers and Insectofungicides noted that the minimum yearly demands of agriculture for boron fertilizers in the next 1 to 2 years would be about 100 tons of boron; in 1960, about 3,000 to 4,000 tons; and in 1964, about 5,000 to 6,000 tons. 104/

(2) Copper fertilizers are used chiefly in the Belorussian SSR in the form of ground pyrite cinders, which are produced as a by-product during the manufacture of sulfuric acid and contain 0.3 to 0.8 percent copper. The rate of application is about 5 to 8 centners per

hectare (450 to 710 pounds per acre) once every 4 to 5 years. 105/ In producing copper fertilizers, copper ores of low quality may be used instead of pyrite.

(3) Manganese fertilizers contain 15 to 30 percent manganese and are available in the form of slags which are byproducts of the concentration of manganese ores. These fertilizers are not widely used but are effective on winter wheat, sugar beets, corn, hemp, and tobacco. 106/

2. Multiple Fertilizers.

a. Mixed Fertilizers.

Fertilizers can be produced in a variety of mixtures. The principal ingredients used in the USSR for the preparation of mixed fertilizers are superphosphate, ammonium nitrate, ammonium sulfate, and potassium chloride. Small amounts of bone meal, phosphorite meal, and limestone often are added to prevent the loss of nitrogen resulting from a combination of superphosphate and ammonium nitrate. The following formulas are typical of Soviet mixed fertilizers:

(1) Superphosphate, 47.1 percent; ammonium sulfate, 42.9 percent; and bone meal, 10 percent.

(2) Superphosphate, 58.6 percent; ammonium nitrate, 31.4 percent; and limestone, 10 percent.

(3) Superphosphate, 44.3 percent; ammonium nitrate, 23.7 percent; chloride, 20 percent; and bone meal, 12 percent.

The first two mixtures have a nitrogen-to-P_2O_5 ratio of 1 to 1; the third mixture has a nitrogen-to-P_2O_5-to-K_2O ratio of 1 to 1 to 1. The recommended nitrogen-to-P_2O_5-to-K_2O ratios for various regions of the USSR are as follows: 1 to 1 to 1 or 1 to 1 to 1.5 or 1 to 1.5 to 1 or 1 to 2 to 1. 107/

b. Complex Fertilizers.

(1) Ammoniated superphosphates, which contain 14 to 14.5 percent P_2O_5 and about 2 percent nitrogen, are produced from the Kara-Tau phosphorites. The process of ammoniation of superphosphate

has been mastered in an experimental unit at the superphosphate plant in Kokand. This process is a valuable means of improving poor physical properties of the superphosphates* and of supplying another nutrient element. Ammoniation is also cheaper than the process of granulation. It is probable that the superphosphate plants of Central Asia and Kazakhstan will convert to production of ammoniated superphosphate. 108/

(2) Ammofos, which contains 47 to 48 percent assimilable P_2O_5, and 12 to 13 percent ammonia, is produced by the saturation of phosphoric acid with ammonia. Production of this material is planned. 109/

(3) Potassium nitrate, which is a combined potassium and nitrogen fertilizer containing 46.5 percent K_2O, and 13.7 percent nitrogen, is produced principally by the double decomposition of sodium nitrate and potassium chloride. This fertilizer is extremely costly and therefore is rarely used. 110/

(4) Nitrophoska, a fertilizer containing all three nutrient elements, is produced in many ways. One method is the fusion of ammonium phosphate, ammonium nitrate, and potassium chloride. The ratio of nutrients can be varied to suit different crops and soils. In recent years this product has been considered the only triple fertilizer of practical importance. 111/

(5) Sulfoammofos, which consists of ammonium sulfate and ammonium phosphate, contains 16 to 17 percent P_2O_5 and 18 to 19 percent nitrogen. This fertilizer is prepared by the decomposition of natural phosphate with a mixture of sulfuric acid and ammonium sulfate.

The complex fertilizers described above consist mainly of phosphorus-nitrogen or potassium-nitrogen compounds, and it appears that the USSR does not plan to produce complex fertilizers containing potassium and phosphorus. 112/

* The superphosphates produced from the Kara-Tau phosphorites are oily, hygroscopic, and of poor dispersibility.

APPENDIX B

MINERAL FERTILIZER FACILITIES IN THE USSR

The principal mineral fertilizer facilities in the USSR which are subordinate to the Ministry of the Chemical Industry and which are either in operation or planned for construction are shown in Table 12 and on the accompanying map.*

Table 12

Mineral Fertilizer Facilities of the Ministry of the Chemical Industry, USSR a/
1955

Economic Region and Location	Facility	Product
I (North and Northwest)		
Kirovsk	Apatite Combine	Apatite concentrate
Leningrad	Nevskiy Chemical Combine	Superphosphate
II (West)		
Klaypeda	Artoyas Mineral Fertilizer Plant	Superphosphate
Riga	Superphosphate Plant	Superphosphate
Tallinn	Maardu Chemical Combine	Phosphorite meal Superphosphate (planned)
III (South)		
Dneprodzerzhinsk	Nitrogen Fertilizer Plant	Nitrogen fertilizer
Drogobych	Potassium Combine	Potassium fertilizer

50X1

* Following p. 42.

Table 12

Mineral Fertilizer Facilities of the Ministry
of the Chemical Industry, USSR
1955
(Continued)

Economic Region and Location	Facility	Product
III (South) (Continued)		
Gorlovka	Sergo Ordzhonikidze Nitrogen Fertilizer Plant	Nitrogen fertilizer
Konstantinovka	Stalin Chemical Plant	Superphosphate (granulated)
Lisichansk	Unknown	Nitrogen fertilizer
Odessa	Superphosphate Plant	Superphosphate
Stebnik	Potassium Combine	Potassium fertilizer
Sumy	Superphosphate Plant	Superphosphate
Vinnitsa	Superphosphate Plant	Superphosphate (granulated)
IV (Southeast)		
Nevinnomyssk	Nitrogen Plant	Nitrogen fertilizer (planned)
V (Transcaucasus)		
Alaverdi	Alaverdi Chemical Plant	Superphosphate
Kirovakan	Myasnikyan Chemical Combine	Nitrogen fertilizer
Rustavi	Rustavi Nitrogen Fertilizer Plant	Nitrogen fertilizer
Sumgait	Superphosphate Plant	Superphosphate (planned)

Table 12

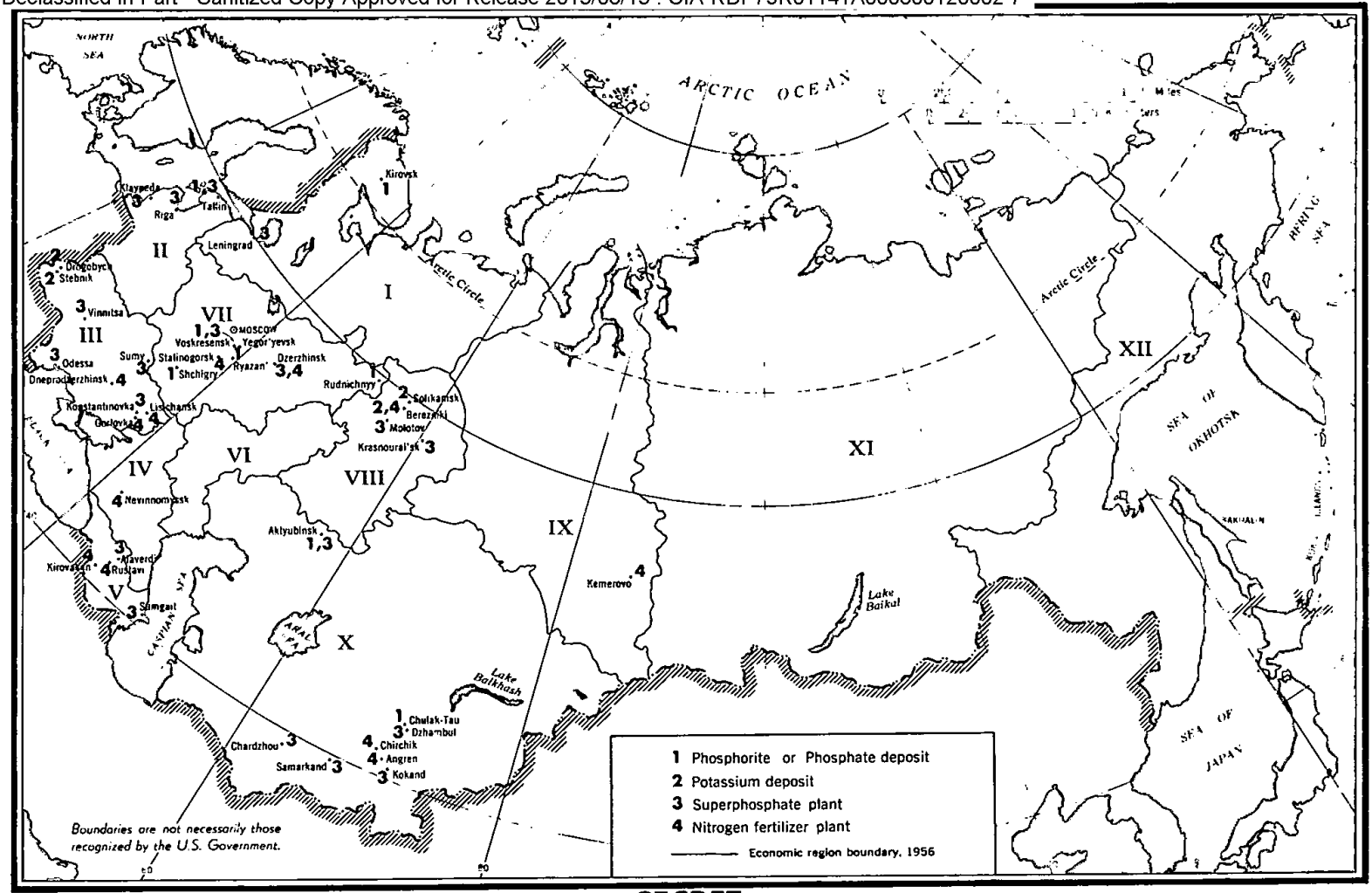
Mineral Fertilizer Facilities of the Ministry
of the Chemical Industry, USSR
1955
(Continued)

Economic Region and Location	Facility	Product
VII (Central)		
Dzerzhinsk	Kalinin Chemical Plant	Nitrogen fertilizer, superphosphate
Moscow	Ryazansk-Yegor'yevsk Mines	Phosphorite ore
Rudnichnyy	Vyatsko-Kamskiye Mines	Phosphorite ore
Shchigry	Phosphorite mines	Phosphorite ore
Stalinogorsk	Stalin Chemical Combine	Nitrogen fertilizer
Voskresensk	Kuybyshev Chemical Combine	Phosphorite meal, superphosphate (regular and granulated)
VIII (Urals)		
Berezniki	Voroshilov Chemical Combine	Nitrogen fertilizer
Berezniki	Potassium Combine	Potassium fertilizer
Krasnoural'sk	Chemical Plant	Superphosphate
Molotov	Ordzhonikidze Superphosphate Plant	Superphosphate
Solikamsk	Potassium Combine	Potassium fertilizer
IX (West Siberia)		
Kemerovo	Nitrogen Fertilizer Combine	Nitrogen fertilizer

Table 12

Mineral Fertilizer Facilities of the Ministry
of the Chemical Industry, USSR
1955
(Continued)

Economic Region and Location	Facility	Product
Xa (Kazakhstan)		
Aktyubinsk	Kirov Chemical Combine	Phosphorite concentrate, superphosphate, boron-magnesium fertilizer, boron superphosphate
Aktyubinsk	Phosphorite Mines	Phosphorite
Dzhambul	Dzhambul Superphosphate Plant	Superphosphate (regular and granulated), ammofos (planned)
Chulak-Tau	Kara-Tau Mining and Chemical Combine	Phosphorite fertilizer
Xb (Central Asia)		
Angren	Nitrogen Fertilizer Plant	Nitrogen fertilizer (planned)
Chardzhou	Superphosphate Plant	Superphosphate (planned)
Chirchik	Stalin Electrochemical Combine	Nitrogen fertilizer
Kagan	Fertilizer Mixing Plant	Mixed fertilizers
Kokand	Superphosphate Plant	Superphosphate (regular and granulated), ammoniated superphosphate
Samarkand	Superphosphate Plant	Superphosphate



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APPENDIX C

PRINCIPAL DEPOSITS OF PHOSPHATE ROCK IN THE USSR

The deposits of apatite and phosphorite in the USSR are estimated in billions of tons. 113/ The most important deposits in the USSR used for production of phosphorus fertilizers are the deposits of apatite (generally in the form of fluorapatite) located on the Kola Peninsula in the Khibiny Mountains near Kirovsk. The ore is concentrated by a process of flotation, and the resulting apatite concentrate, which contains 39 to 40 percent P_2O_5, is the preferred raw material for the preparation of superphosphate. 114/

The second most important deposits of phosphate rock in the USSR are the Kara-Tau deposits of phosphorite in southern Kazakhstan. These deposits, which contain 26 to 28 percent P_2O_5, have provided raw material for production of phosphorus fertilizers in the cotton-producing regions of Central Asia, which are large consumers of mineral fertilizers. This phosphorite may be used without further concentration to produce superphosphate. The superphosphate produced from this phosphorite is inferior to that produced from apatite concentrate. The presence of magnesium and dolomite in the phosphorite ore causes a high consumption of sulfuric acid, and the resulting superphosphate is oily, hygroscopic, and low in P_2O_5. Ammoniation of the product, however, improves its quality. Until recently the phosphorite from this deposit was not suitable for the preparation of the phosphoric acid needed to prepare the concentrated phosphorus fertilizer, double superphosphate. Recent research conducted at the Scientific Institute for Fertilizers and Insectofungicides, however, has resulted in the development of a chemical method of concentrating these ores which solved this problem. 115/

Other deposits of phosphorite are located in the Central Region (Moskovskaya, Kirovskaya, Kurskaya, and Bryanskaya Oblasts), in the Urals (Chkalovskaya Oblast and Bashkirskaya ASSR), in Kazakh SSR (Aktyubinskaya Oblast), in the Estonian SSR, and in the Ukrainian SSR (Vinnitskaya Oblast). 116/ The reported content of the principal ores and concentrates is shown in Table 13.*

* Table 13 follows on p. 44.

Table 13

Reported Phosphorous Pentoxide Content of Principal Deposits of Phosphate Rock in the USSR a/

Deposit	Type	Product	Phosphorus Pentoxide Content (Percent)
Khibiny	Apatite	Ore	20.8 to 34.6
		Flotation concentrate	38.8 to 40.2
Kara-Tau	Phosphorite	Ore	24.0 to 30.0
Vyatsk	Phosphorite	Ore (washed)	23.5 to 26.0
		Flotation concentrate	28.0 to 28.3
Yegor'yevsk	Phosphorite	Ore (washed)	21.2 to 23.7
		Flotation concentrate	27.5 to 31.0
Aktyubinsk	Phosphorite	Ore (washed)	17.5 to 19.0
		Flotation concentrate	25.0 to 26.0

a. 117/

Concentrates of the phosphorite at Aktyubinsk (Aktyubinskaya Oblast), Shchigry (Kurskaya Oblast), and Vyatsk (Kirovskaya Oblast) can be used to produce phosphoric acid only in mixture with apatite concentrate. The flotation concentrates of this phosphorite, however, can be used to produce phosphoric acid suitable for production of double superphosphate, ammofos, and precipitate. The phosphorite from the deposits at Ryazan-Yegor'yevsk (Moskovskaya Oblast) cannot be used for acid decomposition until a method for their concentration is developed. This phosphorite, in the form of phosphorite meal, is used exclusively as a direct fertilizer. 118/ The apatite from the Kola Peninsula and phosphorite from the Kara-Tau deposits cannot be used as a direct fertilizer, because the P_2O_5 is insoluble in the soil. 119/

APPENDIX D

METHODOLOGY

1. Distribution of Mineral Fertilizers, by Crop, 1955 and 1960.*

Statements that have been made in recent years indicate a sufficient supply of mineral fertilizers for industrial crops. Although the required amount of fertilizer varies for each crop, depending on the type of soil, the climatic conditions, and the crop yield planned, the consumption of fertilizers in cultivating the industrial crops (sugar beets, flax, and hemp) was estimated by assuming the complete fertilization of the areas sown to these crops in 1955 120/ and by use of a rate of application which was estimated from data given in a handbook on mineral fertilizers. 121/ The amount of fertilizers used for cotton in 1955 was estimated by inflating the reported consumption of mineral fertilizers for cotton on collective farms in 1954. 122/ This inflation was accomplished by assuming that collective farms produce 95 percent of the cotton in the USSR and that the amount of mineral fertilizers used for cotton in 1955 was the same as the amount used in 1954. (The total acreage sown to cotton did not change.)

The amount of fertilizers used for potatoes and vegetables was estimated from a statement that an average of 60 kilograms of mineral fertilizers per hectare (about 54 pounds per acre) was used for kolkhoz potato and vegetable crops in 1955 123/ and a report that the total area sown to these crops in 1955 was 10.6 million hectares (26.2 million acres). 124/ The total amount of fertilizers by type was estimated to be in about the same proportion as that given for potatoes and vegetables in the Plan for 1939. 125/

The amounts of fertilizers used for grain and other crops in 1955 were obtained by subtracting the estimated requirements given above from the estimate of the total supply of each type of mineral fertilizer in 1955.

The amount of mineral fertilizers that will be distributed to cotton, sugar beets, flax, and hemp in 1960 was estimated by assuming that the rate of fertilization for each of these crops in 1960 will

* See Table 7, p. 18, above.

be the same as in 1955 and by applying these rates to the estimated areas sown to these crops in 1960. The residual amount of fertilizer (obtained by subtracting the estimated requirements given above from the estimated total production of mineral fertilizers in 1960) is the estimated amount of mineral fertilizers that will be available for the fertilization of potatoes, vegetables, grain, and other crops in the USSR in 1960.

2. Distribution of Mineral Fertilizers, by Economic Region, 1955.*

In 1953, Azerbaydzhan SSR in Region V and the Central Asian republics in Region Xb reportedly received 850,400 tons of nitrogen fertilizers and 897,200 tons of phosphorus fertilizers. 126/ The amounts of fertilizers received by these areas in 1955 were estimated at 1.16 million tons of nitrogen fertilizers and 1.23 million tons of phosphorus fertilizers. These estimates were derived by assuming that the increase in receipts of these fertilizers was directly proportional to the increase in production of mineral fertilizers in these years. The percentage distribution in the Plan for 1941 127/ was then used to estimate the distribution of nitrogen and phosphorus fertilizers to Azerbaydzhan SSR and to the Central Asian republics.

The Plan for 1941 also was used to estimate the distribution to other regions of the remaining 1.44 million tons of nitrogen fertilizers and 3.37 million tons of phosphorus fertilizers produced in 1955 and to estimate the distribution, by economic region, of the total amounts of potassium fertilizers and phosphorite meal produced in 1955.

3. Value of Production of Mineral Fertilizers, 1955.**

The following prices went into effect on 1 July 1955 128/:

Fertilizer	Price (Rubles per Ton)
Ammonium sulfate	250
Superphosphate	161
Potassium chloride (56.9 percent K_2O)	95

* See Table 8, p. 19, above.
** See IV, p. 20, above.

The price of phosphorite meal was estimated at 53 rubles per ton on the basis of a statement that its cost is 30 to 35 percent of that of superphosphate. 129/ The price of potassium chloride was adjusted from 95 rubles to 70 rubles to put it on a basis of 41.6 percent K_2O (instead of 56.9 percent K_2O). By using this information on prices, together with the estimated production of various types of mineral fertilizers, the value of production was then estimated to be as follows:

Fertilizer	Amount (Tons)	Price (Rubles per Ton)	Value (Million Rubles)
Nitrogen	2,984,000	250	746
Potassium	1,898,300	70	133
Phosphorus	3,833,700	161	617
Phosphorite meal	924,000	53	49
Total	9,640,000	Not applicable	1,545

4. Input Requirements.*

a. Nitrogen.

In 1955, 2.98 million tons of nitrogen fertilizers (20.5 percent nitrogen) were produced in the USSR. Of this total, it is estimated that 558,000 tons of ammonium sulfate were produced from coke ovens and that the remaining 2.43 million tons of nitrogen fertilizers consisted principally of ammonium nitrate.**

A Soviet text has reported the inputs required to produce 1 ton of ammonium sulfate from coke ovens as follows: sulfuric acid (100 percent H_2SO_4), 0.765 ton; steam, about 5 tons; and electricity, 30 kwh. 130/ The reported requirements per ton of ammonium nitrate are as follows: nitric acid (100 percent HNO_3), 0.79 ton; ammonia, 0.219 ton; steam, 0.7 ton; and electricity, 22.5 kwh. 131/

* See Table 10, p. 22, above.

** This is a maximum estimate of ammonium nitrate produced in 1955 for use as a fertilizer and includes small amounts of synthetic ammonium sulfate, sodium nitrate, and perhaps other nitrogen fertilizers.

The inputs required to produce ammonium sulfate in the USSR in 1955 are estimated to have been as follows: sulfuric acid, 430,000 tons; steam, 2.8 million tons; and electricity, 16.7 million kwh.

The inputs required to produce ammonium nitrate* in the USSR in 1955 are estimated to have been as follows: nitric acid, 1.11 million tons; ammonia, 640,000 tons; steam, 980,000 tons; and electricity, 3.25 billion kwh. Of these amounts, 330,000 tons of ammonia would have been required to produce the 1.11 million tons of nitric acid, 132/ and 3.22 billion kwh of electricity would have been required to produce the needed total of 640,000 tons of ammonia. 133/

The total requirements for production of nitrogen fertilizer in the USSR in 1955 are estimated to have been as follows:

Input	Unit	Amount
Sulfuric acid	Million tons	0.43
Nitric acid	Million tons	1.10
Ammonia	Million tons	0.64
Steam	Million tons	3.78
Electricity	Billion kwh	3.27

b. Potassium.

In 1955, 1.9 million tons of potassium fertilizers (41.6 percent K_2O) were produced in the USSR. There are probably no major requirements for chemical or electrical inputs for potassium fertilizers. To produce 1.9 million tons of potassium fertilizers, about 5.7 million tons of crude potassium salts (sylvinite) would have been required. 134/

c. Phosphorus.

In 1955 the USSR produced 924,000 tons of phosphorite meal and 3.8 million tons of superphosphate. About 85 percent of production of superphosphate (3.2 million tons) was made from apatite concentrate, 135/ and the remaining 15 percent (600,000 tons) was

* On the basis that 2.43 million tons of nitrogen fertilizer (20.5 percent nitrogen) are equivalent to about 1.4 million tons of ammonium nitrate.

made from phosphorite ore. A Soviet text reports that production of 1 ton of superphosphate requires 0.588 ton of phosphorite ore or 0.515 ton of apatite concentrate. In addition, each ton of superphosphate requires 0.371 ton of sulfuric acid if phosphorite ore is used or 0.35 ton of sulfuric acid if apatite concentrate is used. 136/

On the basis of these data the inputs required to produce superphosphate in the USSR in 1955 are estimated to have been as follows:

Input	Amount (Million Tons)
Apatite concentrate	1.65
Phosphorite ore	0.35
Sulfuric acid	
Using apatite concentrate	1.12
Using phosphorite ore	0.22
Total sulfuric acid	1.34

The amount of power required to produce superphosphate in the USSR, based on the reported US requirements for 24 kwh per ton of superphosphate, is estimated at 91 million kwh. 137/

The total requirements for production of phosphorous fertilizers in the USSR in 1955 are estimated to have been as follows:

Input	Unit	Amount
Apatite concentrate	Million tons	1.65
Phosphorite ore	Million tons	1.28*
Sulfuric acid (100 percent H_2SO_4)	Million tons	1.34
Electricity	Million kwh	91.0

* This figure includes 924,000 tons to be used for direct application as fertilizer.

5. Production of Mineral Fertilizers, by Type, 1956-60.*

Production of mineral fertilizers in 1960 is scheduled to be as follows: potassium, 1.6 times that of 1955; phosphorus, twice that of 1955; and phosphorite meal, 2.9 times that of 1955. 138/ By using these figures, together with the reported production of various types of mineral fertilizers in 1955 and the total production of all types planned for 1960, the planned production of various types of mineral fertilizers in 1960 was estimated.

Production of mineral fertilizers in 1960 is estimated tentatively at 16.8 million tons, an increase of 75 percent above that of 1955. This is the same rate of increase that was achieved under the Fifth Five Year Plan (1951-55), and such a rate is believed to be more realistic than the planned increase of 104 percent. The estimated increase of 7.2 million tons is 72 percent of the planned increase of 10 million tons. Estimates of production of each type of mineral fertilizer in 1960 were made by assuming that in each case the increase in production will be about 72 percent of the planned increase. Production of mineral fertilizers in 1960 then was estimated as follows (in million tons): nitrogen, 5.3; potassium, 2.7; phosphorus, 6.6; and phosphorite meal, 2.2.

Production of mineral fertilizers in 1956 amounted to 10.9 million tons, 139/ and production of 11.6 million tons in 1957 is planned. 140/ The small increase of about 6 percent planned for 1957 probably will be achieved, and this figure was used as the basis for estimating production in 1957. Production in 1958 and 1959 was estimated by interpolating between the estimates of production in 1957 and in 1960, which indicated an annual increase of 13.3 percent.

Production of various types of mineral fertilizers in 1956 and 1957 was estimated by assuming that production of each type is increasing at the same rate as the total production of mineral fertilizers. Production of various types in 1958 and 1959 was estimated by interpolating between the estimates for 1957 and 1960.

6. Production of Nitrogen Fertilizers, by Type, 1955 and 1960.**

Figures for total production of nitrogen in 1955 and production planned for 1960 were derived in 5, above.

* See Table 11, p. 24, above.
** See VI, B, p. 23, above.

Ammonium nitrate and ammonium sulfate are the principal nitrogen fertilizers, so that once an estimate of production of ammonium sulfate is made, production of ammonium nitrate can be estimated by subtracting production of ammonium sulfate from total production of nitrogen fertilizers. Production of coke amounted to 43.6 million tons in 1955 and is scheduled to reach 64.6 million tons in 1960. 141/ By using a coefficient of 0.0128 ton of ammonium sulfate per ton of coke, 142/ it was estimated that production of ammonium sulfate amounted to 558,000 tons in 1955 and will reach 827,000 tons in 1960.

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