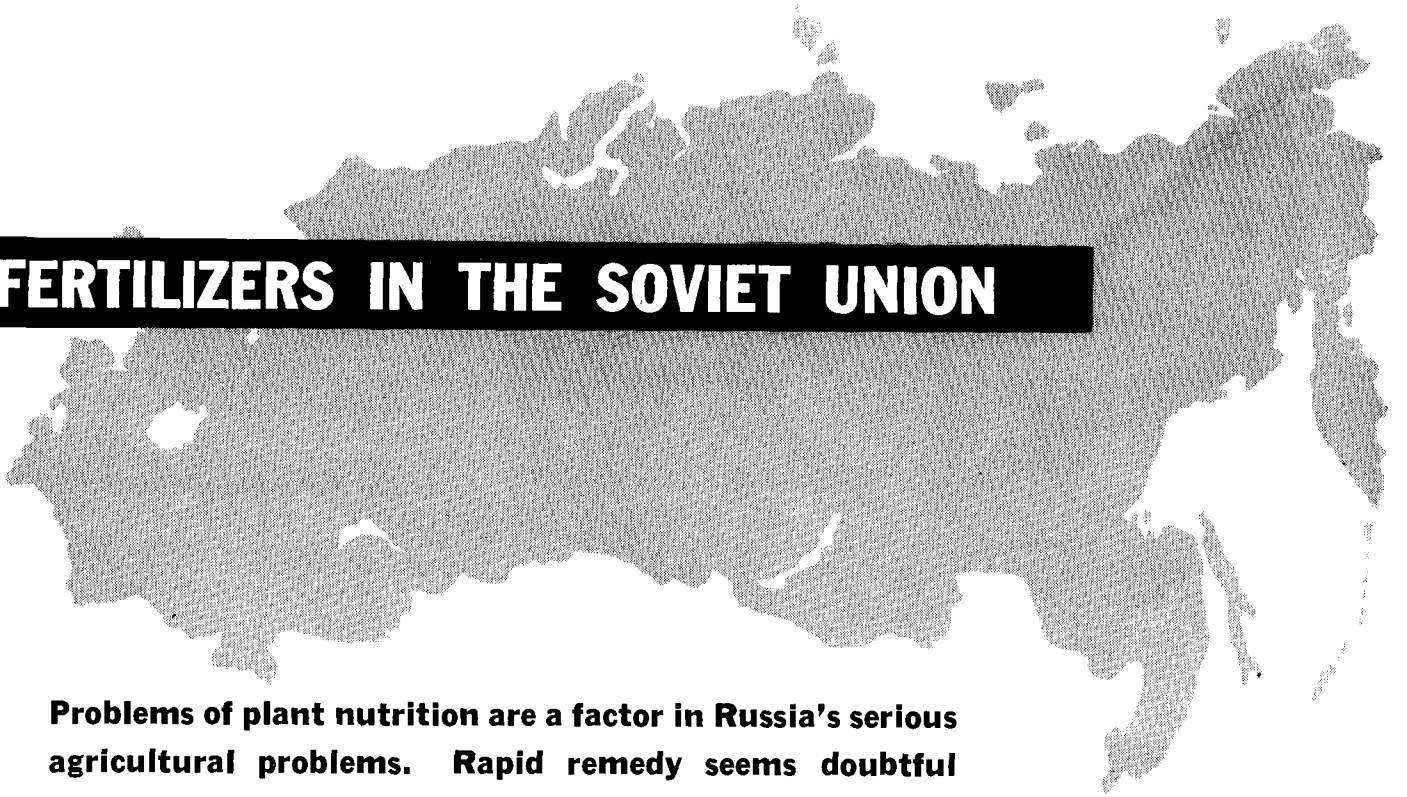

FERTILIZERS IN THE SOVIET UNION

Problems of plant nutrition are a factor in Russia's serious agricultural problems. Rapid remedy seems doubtful

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RECENTLY, measures for increased food supply became of acute importance in the Soviet Union not only for its peace economy but also for the war potential. The recent change in the Soviet Government has been officially motivated by the failure of Malenkov's agricultural policy, even though agriculture has been the special responsibility of Khrushchev, and by the necessity of an increased production of heavy industry instead of the manufacture of consumer goods. The increased international tension might be responsible for the emphasis on heavy industry, but food supply became of critical importance. An extension of acreages under grains in virgin lands of arid areas covering an enormous territory of approximately 32 million acres already was started in Malenkov's period, but a faster progress with this plan now has been demanded. Expansion of agriculture in territories east of Volga, in southwestern Siberia, and in Kazakhstan, and the transfer of large teams of workers and volunteers to new agricultural areas with lower productivity than the old agricultural areas, arouse special interest in certain questions: To what extent have manures and fertilizers assisted in increasing yields? To what extent has the Soviet fertilizer industry developed?

Importance of Fertilizers

The small addition of plant nutrients for raising crop yields forces U.S.S.R. agriculture to increase production by expansion of agricultural area to feed the growing U.S.S.R. population which was about 131 million in 1920 and is roughly over 200 million today. The agricultural area rose from 240 million acres (grains, potatoes, vegetables, industrial crops, and temporary grass and other feed crops) in 1920 to 338 million acres in 1938 within post-World War I boundaries. The area increased to 385 million acres in 1952 with a target of 417 million acres in the plan of 1955 within the post-World War II boundaries. There were 216 million head of cattle, sheep, goats, horses in 1916 and 207 million in 1952 (*35*). During the forced collectivization and during World War II the number of livestock declined considerably. About 220 million tons (all tons metric unless otherwise indicated) of manure was applied in European Russia 1926-27 (*21*), but only 74.5 million tons in 1933. In 1940, only 125 million tons of manure was used in the whole U.S.S.R., 100 million in 1946. A level of 200 million should have been reached in 1950 (*35*). The production of manure did not keep pace at all with the extended agricultural area.

Fertilizer Production and Consumption

In 1913 only about 600,000 metric tons of fertilizers was consumed in the Russian Empire (about 5.2 pounds per acre) (*21*). These fertilizers were mostly imported and only small quantities of superphosphate were produced in Ukraine and basic slag in Poland. Until 1930, the Soviet Union remained an importer of phosphate rock, superphosphate, ammonium sulfate, Chilean sodium nitrate, and potash fertilizers. A significant change occurred around the thirties, when large deposits of apatite were discovered on the Kola Peninsula, potash minerals at Solikamsk in the Urals, and several large synthetic ammonia plants were established.

In 1927–28, 12,800 metric tons of ammonium sulfate was produced, while 10 years later about 706,000 tons; the production of phosphate rock and apatite rose in the same period from 58,000 tons to 3.4 million tons, that of ground phosphate rock from 13,500 tons to 670,000 tons, and of normal superphosphate from 152,000 tons to 1.6 million tons. Potassium sylvinite (22% KCl) production started in 1931 with 120,000 tons and reached 1.5 million tons in 1938, from which muriate of potash was produced in amount of 55,000 tons in 1933 and 587,000 tons in 1938 (*34*).

In 1938, the total application of all fertilizers was 3.2 million tons, including 606,000 tons of ground phosphate rock. In 1940, the consumption was 3.1 million tons with ground phosphate rock and 2.6 million tons without it. The vigorous increase of fertilizer production before World War II declined to about 700,000 tons of all fertilizers in 1944 and

1.1 million tons in 1945 but rose rapidly afterwards. The table on page 492 shows the development of fertilizer production after World War II. The absolute data on fertilizer production have been derived from percentages of the production in previous years. 1940 has been taken as a basic year, because absolute figures were not published by the U.S.S.R. after the war. Furthermore, it should be remembered that fertilizer production does not include pure content of plant nutrients but fertilizers are presented in total tonnage. The last breakdown of data was in the *Plan of 1941* (in which the breakdown was given as nitrates 27.2%, phosphates 53.0%, potash 19.8% of total). The fourth Five Year Plan reported in its summary for 1950 that nitrates increased 2.2 times, phosphates 1.9 times and potash 1.4 times over the level of 1940 (*13*). Thus, production of nitrogenous fertilizers has been given leading importance, but phosphates make up more than half of the total production of fertilizers. Fertilizer production had a rapid rate of increase immediately after the war but slowed down between 1951 and 1953, while a greater increase was noticeable in 1954.

Nitrogen

U.S.S.R.'s main synthetic ammonia plants were constructed between 1926 and 1933, five of them put into operation by American engineering skill and methods. The first was started in 1926 by Russian engineers at Chernorechensk, near Gorki, but Du Pont, which had just completed its Belle, W. Va., plant, was contracted with to finish it. In production since 1928, this plant, according to an American chemical consultant in Russia for several years (*4*), had equipment of American manufacture throughout. Nitrogen Engineering Co. built two plants between 1930 and 1933, one in Berezniki in the Urals and the other at Stalinogorsk (*4, 7, 15, 41*). Potash has also been produced at Berezniki since 1935. Equipment for both plants was imported from U. S., Great Britain, and Germany. C. O. Brown, an American expert, worked out the problems of producing adequate catalysts for nitric acid at Stalinogorsk (*30*). Koppers designed and built the coke-oven batteries for a large integrated steel plant at Magnitogorsk in the Urals and Soviet engineers built the chemical unit, construction of the latter being delayed for two years which resulted in some "25 million gold dollars worth of chemicals" being lost every year (*24*). Freyn Engineering Co. was active in constructing the Kuznetskstroy plant in Stalinsk in western Siberia.

Most of the Soviet nitrogen plants are situated near coal regions in order to use coal as the hydrogen source. Several plants were constructed in the Donbas coal region, some in the Urals, and also in western Siberia.

The nitrogen plant at Chirchik, near Tashkent, was built by Russian engineers to utilize electrolysis of water. Construction took 10 years, while U. S. engineers, here and in Russia, built similar plants in two to three years. The plant produced calcium cyanamide, which was not suitable for the soils in the area, and after World War II it was reconverted to produce ammonium sulfate. In 1953, the plan was that this plant would produce 30,000 tons of mineral fertilizers (*17*).

Nitrogen plants in European Russia suffered heavy damages during the war, and equipment of some plants in the occupied area was shipped behind the Urals for new nitrogen centers, but nitric acid produced was mostly for munitions (*39*). After the war, the Soviets rebuilt nitrogen plants at Gorlovka, Dneprodzershinsk, and Stalinogorsk, and new plants were being constructed in the Ukraine, western Siberia, Armenia, and Georgia (*12*).

One aspect of the postwar construction of nitrogen industry in the U.S.S.R. is rather surprising. Coal still remained the source of hydrogen instead of cheaper natural gas.

In the U.S.S.R. there are ample reserves of natural gas in the Caucasus. But the new plant at Rustavi in Georgia (90,000 tons ammonium sulfate with 20% N) uses coke oven gas from a metallurgical plant (*40*). The older plant at Derbent on the Caspian Sea (built by the Nitrogen Institute in Moscow) also uses coal as a source (*30*).

The fact that natural gas is not used for ammonia production in the U.S.S.R. might be due to lack of a complete "know-how" of this new process on the part of Russian experts, or it is possible that natural gas in economic planning has a priority for other purposes and not for ammonia.

Data about capacity of nitrogen plants are not available from U.S.S.R. sources. In 1934 the U. S. Tariff Commission estimated the capacity of all plants constructed and in construction at 350,000 to 400,000 short tons of nitrogen annually. However, several plants were not included and others were built afterwards; the author estimates the total capacity between 450,000 and 500,000 short tons before World War II. The plants constructed after World War II seem, according to all indications, to have considerably smaller capacity than prewar plants. Therefore, the present total capacity does not appear to be larger than 700,000 to 800,000 short tons of nitrogen.

This growth compares poorly with that in the U. S.: from 540,000 tons N in 1934 to 1.8 million tons N in 1953 and an expected 3.6 million tons by 1957.

Phosphates

Superphosphate is manufactured from phosphate-bearing minerals. The reserves of phosphate rock and apatite in the U.S.S.R. are large, but not as large as usually stated because total reserves include great quantities of low grade rock which is not suitable for superphosphate production. A comparison of the United States reserves of 13 billion metric tons with U.S.S.R. reserves, appraised often at 16.0, 9.0, or 7.6 billion tons, is incorrect, because they have different contents of phosphoric acid in rocks. The author was able, on the basis of Russian data, to distinguish deposits which contain more than 20% P_2O_5 and are suitable for superphosphate production (*3, 37*). Such reserves range between 2.3 to 3.8 billion tons.

There are considerable deposits of low-grade phosphate rock, which is used in ground form. Such deposits are found mostly in the European Russia and in Belorussia. Richer deposits are between the cities of Voskresensk and Yegoryevsk, south of Moscow, and between the rivers Vyatka and Kama, near Kirov; they are used for superphosphate. The rich Podolsk deposits in the Ukraine are exhausted, having been mined since the last century.

The superphosphate industry in the U.S.S.R. developed after the discovery of apatite on the Kola Peninsula in 1929. According to one estimate (Prianishnikov) the mineable reserves are about 530 million tons, of which 140 million have a content above 28.5% phosphoric acid (*21*) and in another estimate, 377 million tons have a content of over 20% (*3*).

In Central Asia there was a difficult situation with fertilizers which are applied on cotton—a crop much fostered by the Soviet Government—because all fertilizers had to be shipped over thousands of miles from European Russia. In 1929, the situation improved somewhat with the discovery of deposits of phosphate rock at Aktyubinsk (Northwestern Kazakhstan). However, these deposits are not rich in phosphoric acid and are distant from the Uzbek cotton region. A great change occurred when the phosphate rocks were discovered on the Kara-Tau mountain range in South Kazakhstan in 1936. These deposits are large, being estimated at 1 billion metric tons, and with a rich content (26 to 33 %) of phosphoric acid (*37*). They are more important than apatite on the Kola Peninsula, and permitted the development of the superphosphate industry in central Asia after World War II.

During World War II, all the plants in the European part of the Soviet Union suffered heavy damages, but they were reconstructed afterwards and also few new ones established of which the plant at Mardu in Estonia had a capacity of 100,000 tons (*31, 36*). The most im-

Postwar Production of Fertilizers in the U.S.S.R.

(in comparison with some prewar years)

(1000 metric tons)

	Production	Consumption	
1937	3,360[a]	3,150[b]	
1938	3,600[a]	3,220[c]	
1939	n.a.	3,140[d]	
	Production		
	Alternative I[e]	Alternative II	Goal
1940	3,100[f]	2,600[a,s,t]	
1945	1,100[h]		
1946	1,630[k]	1,200[a,s]	
1947	2,200[j]	1,600[k,s]	2,160[g]
1948	3,147[i]	2,300[j,s,t]	3,130[g]
1949	4,123[h]	3,000[i,s,t]	
1950	4,906[l]	3,600[l,t] (or 5,200[t])	5,500[g]
1951	5,249[m]	3,900[m] (or 5,450[u])	
1952	5,669[n]	4,200[n]	
1953	6,179[o,r]	4,600[o]	
1954	7,168[p]	5,300[p]	
1955			9,220[v] or 9,590[u]
1959			16,500–17,500[z]
1965			28,000–30,000[z]

Note on Alternatives

In both alternatives 1940 was used as the basic year.

In alternative I, the *absolute figure* of fertilizer application in 1940 was used (source *f*), and the consumption in 1949 was determined by percentage given in another source (*h*). Of course, this is not a completely satisfactory method to determine the production, which was 200,000 to 400,000 tons more than consumption in 1937 and 1938. After World War II, the difference between output and input of fertilizer should be very small, since exports and imports are very insignificant.

In alternative II, the output of fertilizers in 1940 was computed from percentages supplied in the speech of Pervukhin (source *g*). But the output of 2.6 million tons in 1940 appears to be low in comparison with production and consumption between 1937 and 1939. It is possible that about 500,000 tons was used as ground phosphate rock, but usually the Soviet fertilizer statistics also contain this output. The construction of time series in the second alternative reaches lower output data after 1950 as it can be presumed.

United Nations used the second alternative, but apparently gave it up in 1950, in which year it used two different figures of outputs (3.6 and 5.2 million tons).

Favoring alternative I is the fact that consumption of fertilizers in 1953 was given in absolute figures (source *r*). The second alternative could not supply this consumption. European Division, Bureau of Foreign Commerce, U. S. Dept. of Commerce came to same results as in alternative I for years 1950 to 1953 as published in "Trends in Economic Growth" (A Comparison of the Western Powers and the Soviet Bloc), a study prepared for the Joint Committee on the Economic Report by the Legislative Reference Service of the Library of Congress (page 262, Washington, 1955). However, some experts consider that consumption was larger than production in the U.S.S.R. owing to some imports of fertilizers from Poland and East-Germany.

(*a*) Unaniants, T. P., *Khimizatsiia sotsialisticheskogo zemledelia*, **49,** No. 1, (1940). This study contains production figures of phosphatic and potassic fertilizers while consumption figures for nitrogen were used for 1937 (source *b*) and 1938 (source *c*).

(*b*) "SSSR i kapitalisticheskie strany," (ed. by Ia. A. Ioffe), p. 289, Moscow, 1939; *Planovoe khoziaistvo*, **1939,** No. 3, 45.

(*c*) "Sotsialisticheskoe selskoe khoziaistvo SSR: Statisticheskii spravochnik, 1938," p. 25, Moscow, 1939 (preliminary data).

(*d*) Korolev, L. I., *Khimizatsiia sotialisticheskogo zemledelia*, **1940,** No. 8, 11.

(*e*) All numbers are production figures, except those of 1940 and 1949 under Alternative I, both of which are consumption figures.

(*f*) *Planovoe khoziaistvo*, **1947,** No. 3, 34.

(*g*) The planned output for 1948 with 3,130,000 tons was 20% more than before the war (1940); the planned output for 1947 (2.16 million tons) was 185% of the actual production in 1946, according to M. G. Pervukhin, *Pravda*, April 3, 1947.

(*h*) In 1949, agriculture was receiving 33% more than in 1940; in 1948, agriculture was receiving 18.3% less than in 1949; in 1948, production was 50% above that of 1947; in 1947, the amount produced was twice that of 1945. S. Gurevich and S. Partigul, "The New Economic Upswing of the U.S.S.R. in the Postwar Five-Year Plan Period," p. 145, Moscow, 1950.

(*i*) 1949 was 131% of 1948; *Pravda*, Jan. 18, 1950.

(*j*) 1948 was 143% of 1947; *Pravda*, Jan. 20, 1949.

(*k*) 1947 was 135% of 1946; *Pravda*, Jan. 18, 1948.

(*l*) 1950 was 119% of 1949; *Pravda*, Jan. 26, 1951.

(*m*) 1951 was 107% of 1950; *Pravda*, Jan. 29, 1952.

(*n*) 1952 was 108% of 1951; *Pravda*, Jan. 23, 1953.

(*o*) 1953 was 109% of 1952; *Planovoe khoziaistvo*, **1954,** No. 1, 6.

(*p*) 1954 was 116% of 1953; *Pravda*, Jan. 21, 1955.

(*r*) "In 1953, the kolkhozes and sovkhozes used more than 6 million tons of mineral fertilizers and 15% more than in the preceding year," *Planovoe khoziaistvo*, **1954,** No. 1, 11.

(*s*) United Nations, "Economic Survey of Europe in 1949," Geneva, 1950, pp. 14, 232. Actual production was stated as 2.6 million tons in 1940, source for which, *Khimicheskaia promyshlennost*, **1947,** No. 4, 1, gave identical data as source *g*. Years 1946–49 based on percentages of Gosplan fulfillment.

(*t*) United Nations, "Economic Survey of Europe in 1950," Geneva, 1951, pp. 39, 228. Years expressed in percentages of Gosplan fulfillments; 1947 used as a basic year. The second figure (5.2) was computed as twice that of 1940, according to the statement by N. A. Bulganin in *Bolshevik*, **1950,** No. 21.

(*u*) United Nations, "Economic Survey of Europe, 1952," p. 43, Geneva, 1953.

(*v*) *Planovoe khoziaistvo*, **1952,** No. 4, 5; the production of mineral fertilizers in 1955 should be 88% above that of 1950.

(*z*) *Pravda*, Sept. 21, 1953.

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portant postwar development is the new superphosphate center in Central Asia, where the first plant at Kokand in Uzbek S.S.R (annual capacity 200,000 tons) has been operating since 1946 (*16*). In the same year, construction of a superphosphate plant for Alaverdy Chemical Combine was started in Armenia; superphosphate plants at Dzhambul in Kazakhstan, at Samarkand in Uzbekistan, and a plant in Turkestan were constructed. Kara-Tau phosphate rock is the supplier of these plants.

In the Soviet Union the transportation costs play an important role because the plants are thinly scattered over the vast territory of the U.S.S.R; there were only seven superphosphate plants before World War II; poor comparison with the situation in the United States, where two hundred plants are dispersed over the country. A further contributor to the increased transportation costs of superphosphate is its low content in phosphoric acid, which ranged from 12 to 17%, and only the Nevsk Chemical Combine at Leningrad produced superphosphate with 18 to 19% (*1*).

Lowering of transportation costs would be possible with a large production of double superphosphate, which contains 45% of phosphoric acid. In the U.S.S.R. this industry has not developed and only two smaller pilot plants are on the Kola Peninsula. A remark from S.I. Volfkovich, a noted Soviet phosphate scientist, perhaps explains the situation when he says that sufficient experience and experimentation regarding double superphosphate is missing in the U.S.S.R. (*37*).

In the U.S.S.R. there is a large consumption of ground phosphate rock, the use of which is controversial. Some authors [Jasny (*6*), Shimkin (*26*)] consider

that ground rock has not an adequate nutritional and economic value but is used because superphosphate is not produced in sufficient quantities. However, many phosphate experts (Engelhardt, Prianishnikov, Samoilov, Sokolov), through several decades of investigations, came to the conclusion that ground rock is even more favorable on acid soils than superphosphate.

Another source of phosphatic fertilizers is basic slag, which is obtained in the steel production as a by-product from iron ores rich in phosphorus. In the U.S.S.R. the iron ores on the Kerch Peninsula in Crimea are rich in phosphorus. At Krivoy Rog, it is estimated that 250 million tons of basic slag as by-product could be produced (*21*); however, the output of Kerchenski Zavod ranged between 40,000 and 70,000 tons before World War II. An additional producer was added in Galitia, when this part of Poland was annexed to the U.S.S.R. The locations of iron ores in the U.S.S.R. are spread in several places but not used. This fertilizer would be very beneficial on acid soils because it contains calcium.

Potash

Potash production was started in the U.S.S.R. in 1927, when large deposits were discovered at Solikamsk on the Western slopes of the Urals. They cover an area of 1500 to 1800 square kilometers but are not yet completely investigated. Prianishnikov estimated them at 16 billion metric tons of potash (K_2O) (*21*), while Gimmel'farb, Unaniants (*3*) and Serdobolskii (*25*) value them at 18.370 billion tons. These deposits appear to be the largest in the world; the reserves in the United States are, at the highest appraisal, around 325 million metric tons of K_2O.

Russian engineers started the mining of potash, but soon could not cope with the problems. At first the Soviet Government entered into negotiations with American firms, but concluded an agreement with a German mining construction company in 1929.

The mine at Berezniki, 35 kilometers from Solikamsk, was built by Russian engineers on the basis of acquired experience. The first shaft at Solikamsk has operated since 1931 and the mine at Berezniki since 1935.

Potash is used partly in the semimanufactured state as sylvinite and refined as potash muriate. Russian muriate has a content of 40% potash (K_2O); American has 60 to 62%.

Potash fertilizers have also transportation difficulties because, although they are produced in the center of the U.S.S.R. territory, they are far from principal agricultural areas. The Ukrainian situation improved after the annexation of Polish deposits in the Carpaths after World War II. Before the war the production there amounted to 100,000 tons and deposits are estimated at 50 to 100 million metric tons.

Various investigations show large deposits of potash at Ozinki near Saratov, on the numerous lakes between the Urals and the Caspian Sea, and in Southern Uzbekistan, but these deposits are not yet being mined.

After the war both plants at Berezniki and Solikamsk were re-equipped, and a new potash plant, which uses organic sources as raw material, was opened in the Caucasus. Ashes from deciduous and coniferous trees, rye and buckwheat straw, sunflower stems, algae, and peat are equal or even larger suppliers of potash in the U.S.S.R. than mineral fertilizers.

Use of Fertilizer

In the use of specific kinds of nitrogenous fertilizer, at first only sulfate of ammonia was used (18 to 20% nitrogen), but a gradual growth of the use of ammonium nitrate was noticeable before the war. After the war, ammonium nitrate seems to be the predominant nitrogenous fertilizer and they experienced great difficulty with caking of this fertilizer. However, Russian ammonium nitrate often contains 26% nitrogen and American, 33.5%. The quantities of calcium cyanamide, ammonium phosphate, synthetic sodium nitrate (Chilean has not been imported since 1930) and urea were small. Anhydrous ammonia with 82% nitrogen and liquid fertilizers are not used in the agriculture of the U.S.S.R.

Among phosphatic fertilizers, ordinary superphosphate and ground phosphate rock made up the main bulk of fertilizers used. About 8% of total phosphoric acid was double superphosphate, but these data from Russian sources (as well as 10% of basic slag) on total use of phosphoric acid appear to be too high in relation to our investigation of production.

In potassic fertilizers, muriate of potash was used as main fertilizer and sylvinite to some extent, while sulfate of potash accounted for only 5% of potassic fertilizers used. It is possible that its use increased after World War II owing to annexation of Polish potash mines which produce sulfate of potash.

Fertilizers and Crops

The data on the successive annual consumption of fertilizers by crops are not available, but the data for main crops by Makhov (*11*) for 1940 and 1941 illustrate sufficiently the general situation. The consumption was as follows in thousand metric tons:

Crop	1940			1941		
	Ammonium sulfate[a]	Superphosphate	Potash	Ammonium sulfate	Superphosphate	Potash
All crops	638	1,836	637	680	1,710	512
Sugar beets	160	565	212	150	570	170
Irrigated cotton	320	480	98	320	360	90
Flax	60	320[b]	81	60	250[b]	80

[a] Includes also ammonium nitrate.
[b] Includes also basic slag besides superphosphate and ground rock.

From this tabulation it is evident that irrigated cotton and sugar beet were the main consumers. These crops plus flax used about three fourths of the fertilizers. Among the other crop consumers of fertilizer were citrus fruit, tea, tobacco, rice, kok-saghyz (rubber plant), and potatoes, while grains received practically none until the most recent period.

Cotton has an exceptional role in the agricultural policy of the U.S.S.R. because this fiber is promoted not only for civilian use, but also for military purposes. The cotton area expanded from 494,000 acres in 1923 to 3.8 million acres of irrigated and 1.3 million acres of nonirrigated cotton in 1940 (*9*). Irrigated area was 4.6 million acres in 1953 (*28*), while the plans were set to reach 7.7 million acres. Irrigated cotton in Central Asia is about four fifths of total cotton area, and the greatest portion is in Uzbekistan. The application of fertilizers on cotton in republics of Central Asia and in Azerbeidzhan S.S.R. show the following figures (*10*):

Years	Nitrogenous fertilizers (1000 metric tons)	Phosphate fertilizers (1000 metric tons)
1935	122.8	176.6
1940	256.0	345.0
1950	586.9	682.5
1952	692.1	700.4
1953	850.4	897.2

Since the total consumption of fertilizers was about 6 million tons in 1953, (*14*) and the cotton area in Central Asia consumed 1,748,000 tons, and an additional consumption was in non-irrigated and irrigated cotton area of the Ukraine, it can be concluded that cotton consumed more than one third of all fertilizers in the Soviet Union. The application of nitrogenous fertilizers rose from 80 pounds per acre of irrigated cotton in 1935 to 347 pounds in 1952 and 1953, and of superphosphate from 107 pounds to 365 pounds in respective years.

Sugar beets use the greatest portion of total superphosphate, but according to investigations of Prianishnikov and Makhov the rates of phosphoric acid were too high in relation to nitrogen and potash; consequently a great portion of it has no physical and economic effect and it is wasted and fixed in soils (*11*, *21*).

The application of fertilizers on flax was very unevenly divided among collective farms so that some obtained large allocations, while the majority of kolkhozes received small amounts or none at all (*11*).

In 1938, large scale experiments with the use of fertilizers on grains were started, and showed most favorable results. In 1947, an Order of the Council of Ministers provided for the application of fertilizers on an area of 1.6 million acres of winter wheat in the nonblack soil zone. But this area is small compared with the total grain area, which exceeded 250 million acres. Therefore, fertilization of grains for increased food supply is one of the great tasks in the Soviet Union because further pioneering or the "hypertrophy of grain production," as V. P. Timoshenko calls it in his book "Agricultural Russia and the Wheat Problem," is nearing its limits.

However, the Soviets are continuing with a further expansion of grain area because low yields of present areas could not supply sufficient quantities. This is shown by the recent grandiose "Khrushchev Agricultural Plan" decided upon at the Plenary Meeting of the Central Committee of KPSS on March 2, 1954. This plan provides an expansion of 32 million acres in 1954 and 1955, which would give additional grains of 18 to 20 million tons. This planned area is as large as the combined wheat acreages of Great Britain, Belgium, Holland, Denmark and Austria, and will take place on virgin and fallow soils in West Siberia, Ural, North Caucasus, and particularly in Kazakhstan. To what extent it will be possible to carry out such a large plan in two years is to be seen; however, this plan uses up the last areas available for expansion on soils of the semiarid area, and any new acquisition of land has to turn to podzol and podzolized soils.

Lime and Gypsum

The application of fertilizers on podzol soils requires a previous heavy use of lime to reduce soil acidity. Lime is used now in extremely small quantities, while the area which should be limed comprises 74 to 91.4 million acres in the U.S.S.R., according to Kedrov-Zikhman, a leading lime expert. Data about the application of lime are very scant, but Chernavin states that it was applied on an area which "did not exceed half a million hectares" (about 1.2 million acres) in 1948. The rates per acre were between 0.4 and 0.8 tons.

The same problem applies also to gypsum. The building industry in the U.S.S.R. absorbs all produced quantities of lime and gypsum so that no excess remains for agriculture. Transportation costs for this heavy material are also an obstacle. But without lime on acid soils and gypsum on alkaline soils the applied fertilizers are wasted instead of increasing yields.

Future Outlook

The present output of fertilizers, in spite of its great development in the last two and a half decades, is still very far from covering the requirements of various crops and the whole output does not cope even with the requirements of two fertilized crops (cotton and sugar beet). This means that the fertilizer output is not adequate to crop requirements and should increase much more. The reserves of raw material for fertilizer production are abundant in the U.S.S.R. Fertilizer output has risen continually since the thirties, with an interruption during World War II. However, the great rush in construction of nitrogen, superphosphate and potash plants around the thirties has not been followed with the same tempo afterwards. During the war the nitric acid industry developed behind the Urals, but for munition and not for fertilizer purposes. After World War II a new fertilizer center was created in Central Asia and in the Caucasus, but this will be of benefit for cotton, tobacco, tea, citrus fruit, and rice and not for staple food crops.

In the postwar years it is difficult to follow the changes in crop yields owing to scarce data and to the presentation of "biological yields" which are determined before the harvest and make no allowance for harvesting loss (15 to 20%). According to the investigations of Jasny, the yields of grain were 790 pounds per acre in 1950 (*5*), and an increase over the level of prewar yields was due to climatic conditions and not to fertilizers. The application of fertilizers increased the yields of sugar beets to 14400 pounds per acre in 1950, according to revised figures of production given in Khrushchev's speech (*17*). Fertilizers were also responsible for a rise in yields of irrigated cotton from 1200 pounds in 1940 to 1800 pounds in 1953 (*19*) even though these yields are lower, being based on unginned cotton including seeds and fiber.[a]

The low-grade fertilizers discussed earlier, together with the thinly scattered location of fertilizer plants over the vast territory of the U.S.S.R., greatly increase the transportation costs of these commodities to agricultural regions. Therefore, fertilizers "at farmers gate" in the U.S.S.R. are proportionately much more expensive than in other countries. A comparison is difficult because data on fertilizer costs and prices are not available, but, from various indications, it is obvious that they belong among "luxury goods" for general kolkhoznik; and kolkhozes and sovkhozes obtain allocations of fertilizers only for specific crops and purposes. For general use of fertilizers in Russian agriculture, construction of plants in a denser network over the territories, and production of highly concentrated products are necessary.

Further neglect of the fertilizer field could become an obstacle to the rate of industrial development because the failure to raise the yields of staple food crops may with time lead to serious difficulties in food supply. It is possible that the awareness of these obstacles could induce a "fertilizer consciousness" in political circles of the U.S.S.R. This is noticeable in the ambitious plan for production of fertilizers announced in the Decisions of the Plenary Meeting of the Central Committee of KPSS of Sept. 7, 1953. According to this plan fertilizer production should reach 16.5 to 17.5 million metric tons in 1959, and 28 to 30 million tons in 1964 (*17, 18*). This project does not appear, however, "realistic" (*38*). The production increased from 4.9 million tons in 1950 to 7.2 million in 1954, while no new plants were constructed which could raise the output suddenly to 17 million tons in 1959. The switch to large scale fertilizer production would necessitate the establishment of many new fertilizer plants throughout U.S.S.R. It is doubtful that such a switch is possible in the present period of industrial mobilization and established goals in the development of heavy industry. Such a deviation from the present schedule of industrial development is easier in a peace economy.

It should be kept in mind, however, that the crop yields in Russia can be significantly raised by the use of fertilizers, lime, and gypsum, all of which can be produced on a large scale in the country. But the adequate output and input of fertilizers depend upon the coordination of various features of economic policy and the reshaped goals of Russian economy.

(*a*) Above data calculated from metric system; grains, 8.9 quintals; sugar beets, 161.5 quintals; cotton, 13.5 quintals and 20.5 quintals per hectare.

Literature References

(1) *Chemische Industrie, Die*, Berlin, Jan. 1939.
(2) Dmitriev, V., *Planovoe khoziaistvo*, 1947, No. 3, 34.
(3) Gimmel'farb, V. M., and Unaniants, T. P., "Syrevaia baza tukovoi promyshlennosti, S. S. S. R.," Moscow-Leningrad, 1937.
(4) Hirsch, Alcan, "Industrialized Russia," New York, 1934.
(5) Jasny, Naum, *International Affairs*, October, 1952, 459.
(6) Jasny, Naum, "The Socialized Agriculture of the U. S. S. R.," Stanford, 1949.
(7) Kapitonov, S., "Bobriki energokhemichnii tsentr," Kharkiv, 1932.
(8) "Khimicheskaia promyshlennost S. S. S. R.," (B. S. Blinkov and M. N. Burow, editors), Moscow-Leningrad, 1933.