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USSR: Developments in Chemical Pesticides and Their Impact on Crop Production [redacted] 25X1

A Research Paper

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A Research Paper

This paper was prepared by Office of Soviet Analysis. Comments and queries are welcome and may be directed to the Chief, Economic Performance Division, SOVA,

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USSR: Developments in Chemical Pesticides and Their Impact on Crop Production

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Summary

Information available as of 1 July 1985 was used in this report.

The Soviets lose an estimated one-fourth of the value of their total agricultural harvest to pests, diseases, and weeds each year. But they estimate that even the limited use of pesticides prevented the loss of 19 million metric tons of grain in 1983, an amount that would have cost Moscow nearly $3 billion in foreign exchange to import. If all other factors were held constant, Soviet officials believe that a complete prevention of losses of grain to pests, diseases, and weeds could provide as much as an additional 45 million tons of grain per year, almost as much as total grain imports in 1984. Although the benefits of the use of pesticides will be hampered by continuing shortages, General Secretary Gorbachev is focusing on pesticide application as a means of boosting agricultural yields.

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Soviet agricultural experts argue, and we agree, that the use of pesticides is the most cost-effective method of increasing agricultural yields. Specifically, pesticides, in addition to their control of pests, diseases, and weeds, provide a wide variety of benefits ranging from more efficient use of fertilizer to improvement in the quality of some crops. In spite of increased pesticide use, however, the overall index of crop yields has shown only slight improvement since 1970:

- Soviet farmers are plagued by shortages of equipment used in pesticide application and by the poor quality of equipment that is available. This limits the potential efficiency of existing application techniques, and the lack of suitable equipment retards the introduction of newer, more effective application methods.

- The adverse impact of poor equipment is compounded by the failure of Soviet farmers to use pesticides appropriately with respect to the amounts applied and the timing of their application.

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The main constraint to improved use of pesticides, however, is the limited amount and assortment made available to the farmer. Although the Soviets have followed Western trends toward replacement of older, less effective pesticides with newer synthetic compounds, the pace of substitution has been slower than in the West, and the output of the more effective types of pesticides compares poorly in structure and volume with that of most Western countries. Only through imports of Western technology, moreover, has it been possible for the Soviets to produce a substantial share of the modern pesticides that they do have.

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the range of products available satisfies only about one-third of agriculture's needs. Official concern about contamination of the environment by toxic preparations has limited the range of pesticides produced and slowed the introduction of new compounds. A continuing battle between the Ministry of Agriculture and government environmental officials, who have taken a consistently hard line on the registration of new pesticides, has intensified in the past few years.

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Soviet pesticide production in 1971-75 grew at an average annual rate of 8.4 percent, but in 1976-80 growth fell to an average of only 1 percent per year. As a result of this poor performance, the USSR was at roughly the same degree of self-sufficiency in 1980 as it had been at the beginning of 1976. Shortages of raw and intermediate materials were the major cause of the slowdown in growth. Other causes included obsolete plant and equipment, construction delays, underutilized production capacity, shortages of labor and equipment, and transportation and distribution problems.

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The resurgence of growth in production during the current five-year plan underlines the priority that the Soviets have accorded the pesticide industry as a major agricultural input to the Food Program. Output grew at an average annual rate of 5 percent during 1981-84. In 1982, when many sectors of the chemical industry did very poorly, pesticide output grew by nearly 6 percent. During the period, supplies of raw and intermediate materials appear to have improved because of the introduction of new capacities and more reliable deliveries from other ministries.

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Insufficient domestic output, coupled with a pressing need in recent years to provide additional support to the faltering agricultural sector, has prompted the Soviets to increase imports of pesticides, particularly from the West. About one-half of the $480 million worth of pesticides imported in 1984 came from the West, mainly from West Germany, Switzerland, and Belgium. Most of the balance came from East Germany and Hungary. In 1984 the Soviets stepped up dramatically purchases of herbicides from some Western firms, suggesting that they are making weed control, primarily in grain crops, a high priority in increasing production.

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some of the herbicides were to be used in 1985 in an experimental program, announced by General Secretary Gorbachev, to boost Soviet wheat yields.

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Increased production and imports enabled the USSR to deliver one-third more pesticides to agriculture in 1983 than in 1975, the earliest year for which Soviet data are available. The Food Program introduced in 1982 calls for deliveries to increase to 680,000 tons in 1985, 17 percent more than in 1983, and to between 750,000 and 790,000 tons in 1990. We believe that the Soviets can meet their 1985 delivery plan only by increasing imports. Although they may be able to provide the target quantity of pesticides in 1990—in part by importing Western equipment—they will not be able to supply the necessary assortment. Plans to become self-sufficient in pesticides are unlikely to be realized before 2000. We expect the Soviets to make up production shortfalls by continuing to rely on imports of modern, high-quality Western pesticides, particularly herbicides, as well as East European products.

25X1

Contents

Tables

Glossary

25X1

USSR: Developments in Chemical Pesticides and Their Impact on Crop Production

25X1

The Role of Pesticides in Increasing Agricultural Output

Chemical control of pests, plant diseases, and weeds makes it possible to grow more food on less land with less labor and at lower cost. The USSR, with a sown acreage more than three-fourths greater than that of the United States and agriculture characterized by low productivity, needs a large and modern pesticide industry.[1] The rapid adoption of pesticide technology permitted substantial changes in US agriculture, such as continuous cropping, increased crop yields per acre, greater regional flexibility in crop production, and decreased labor, energy, and machinery requirements. The consequences of most of these changes were higher levels of production at decreased costs, resulting in benefits to consumers and producers. Although expenditures for pesticides are relatively low compared to other production inputs, US studies made in the 1960s and 1970s estimated the return from the use of pesticides to range from $4 to $12 per dollar of expenditure.[2] More recent US studies indicate that if the use of 35 pesticides—a small proportion of those registered in the United States—were terminated, the economic impact on producers and consumers would be in excess of $6 billion annually.

Use of Pesticides

Soviet reports of the estimated savings of agricultural produce in recent years through the use of pesticides help to explain the current intensive efforts to expand the available supply. As a result of increased production and imports, deliveries of pesticides to agriculture have increased in recent years. In 1983 the Soviet agricultural sector was supplied with about 579,000 tons of pesticides, a 33-percent increase over deliveries in 1975. Herbicide deliveries increased by 57 percent, to 281,000 tons in the same period (see table 1). Despite this surge in pesticide deliveries, the average overall index of crop yields during this period showed only slight improvement over that of 1970.[3] Without the use of pesticides, however, agricultural output would have been far lower, and the Soviets would have had to import larger quantities of agricultural products. In spite of increased supplies, the ratio of organic pesticide application to fertilizer application reached only 5 kilograms per ton of fertilizer in 1980, well below the optimal ratio of 18 to 20 kilograms per ton. If the optimal ratio were achieved for all agricultural land in the USSR, sizable increases in crop yields could be obtained.

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Although Soviet agriculture has been supplied with increasing quantities of pesticides, consumption of pesticides is low compared to that in Western countries (see table 2). Moreover, a Soviet journal reports that expenditures for crop protection relative to total agricultural production costs are low even compared to those of some East European countries. In 1960 the share of Soviet agricultural production costs spent on crop protection was 0.4 percent; in 1975, 2.2 percent; and in 1980 it was scheduled to rise to 4 to 4.5 percent. In the late 1970s outlays for crop protection were 10 percent of the cost of agricultural production in Bulgaria and 13 percent in Hungary.

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The area treated with pesticides has also grown, especially that treated with herbicides (see table 3). In 1982 pesticides of all types were applied to 181.5 million hectares, nearly five times the area treated in 1960. Herbicides were applied to 71.1 million hectares compared to only 1 million hectares in 1960.[4]

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[1] The term pesticide includes not only the standard items mentioned in the glossary but also plant growth regulators for the acceleration or retardation of plant growth.

[2] Returns from pesticides in the United States are not as large now as in earlier years because of overapplication, changes in pest population, and pesticide resistance. Therefore, it is more accurate to compare US studies made in earlier years with current Soviet claims of economic benefits.

[3] Apparently, Soviet inefficiency in the application of agricultural chemicals arising from inadequate equipment and the failure to apply materials in optimal doses at optimal times have reduced the gains that US farmers would expect to receive. Furthermore, the gains were slowed by problems of increasing soil compaction from continuous use of the world's heaviest cultivation machinery. In addition there has been a decline in soil fertility caused in part by failure to follow proper crop rotation.

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[4] The area treated may include the double counting involved when the same area is treated more than once.

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Table 1
USSR: Deliveries of Pesticides to Agriculture

Thousand metric tons

	1975	1980	1981	1982	1983	Plan 1985	Plan 1990
Total standard units [a]	435	482	509	530 [b]	579 [b]	650-680	750-790
Of which:							
Herbicides	179	229	248	257 [b]	281 [b]	NA	NA
Total 100-percent active ingredient	248	279	293	305	333	NA	NA
Of which:							
Herbicides	92	127	137	142	155	NA	NA

[a] Standard units represent the standard content of active ingredient accepted for defined types of preparations. During 1978-83, Soviet production in terms of active ingredient averaged about 60 percent by weight of reported standard units.
[b] Estimated.

Source: *Narodnoye khozyaystvo SSSR,* various years.

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Table 2
Chemical Resources Used in Farming and Grain Yields, 1980

	Arable Land *(million hectares)*	Outlays per Hectare		Grain Yield *(tons per hectare)*
		Fertilizers *(kilograms)*	Pesticides *(US $)*	
World	1,452.2	80	8.3	2.2
USSR	232.0	81	2.3	1.5
United States	190.6	112	18.9	3.8
Canada	44.4	43	6.5	2.1
United Kingdom	7.0	294	68.6	5.0
West Germany	7.5	471	68.0	4.4
Japan	4.9	372	295.0	4.8

Source: *Zhurnal vsesoyuznogo khimicheskogo obshchestva im. D. I. Mendeleyeva,* No. 1, 1984, p. 161.

25X1

Thus far plant protection has focused largely on industrial crops. In 1980, 20.3 million hectares of industrial crops—mostly sugar beets and cotton—were treated for pests and diseases while only 11.8 million hectares of grain and leguminous crops were treated. A Soviet journal reported that in 1980 chemical weeding was performed on less than one-half of the area sown to grain and cotton, one-third of the area sown to vegetables, and one-fourth of the area sown to sugar beets because of shortages of herbicides. Since 1980 the Soviets have stepped up herbicide application on corn. In addition to standard

Table 3 *Million hectares*
USSR: Area Treated With Pesticides [a]

	1970	1975	1980	1982
Total pesticides	**111.0**	**151.2**	**161.1**	**181.5**
Insecticides/ fungicides:	71.9	98.9	88.0	103.5
Of which:				
Biological methods	4.0	10.9	15.5	NA
Herbicides	35.4	48.1	67.8	71.1

[a] The area treated may include the double counting involved when the same area is treated more than once.

Source: *Agrokhimiya,* No. 12, 1982, p. 121, *Zashchita rasteniy,* No. 6, 1983, p. 3.

chemical methods of plant protection, they have expanded their use of newer biological methods (see inset).[5] In 1982 biological methods were used on 1.5 million of the 14.3 million hectares of grain treated for pests and diseases.

The widespread use of chemical fertilizers has created favorable conditions for weeds, plant diseases, and pests. Soviet scientists estimated that during the 1970s annual harvest losses *in physical terms* averaged from 4 to 22 percent of potential crop yield and represented about one-fourth of the *value* of the actual harvest (see table 4). In some years Soviet agriculture loses as much as one-third of the harvest to pests, diseases, and weeds (see figure 1).

Economic Benefits

Since 1960 the economic significance of chemical plant protection has grown substantially because of the expansion in the use of pesticides and the use of more effective preparations and methods of application. For example, in 1976-80 the value of the harvest saved was more than three times that during 1961-65. Indeed, the Soviets claim, and we believe correctly, that the economic return from pesticides is larger than from fertilizers or any other yield-enhancing measures.

The Soviets claim that in 1983 pesticides provided a savings of 19 million tons of grain; 17 million tons of potatoes, vegetables, and fruit; 14 million tons of sugar beets; and 2 million tons of cotton. Savings were valued at more than 8 billion rubles, and outlays for pesticides were only 1.5 billion rubles. Imports of 19 million tons of grain would have cost the USSR nearly $2.9 billion in foreign exchange. If all other factors were held constant, complete prevention of

[5] Although chemicals remain the basic method for controlling pests, diseases, and weeds, the use of biological control has increased substantially in recent years. In 1960 biological methods were used on only 200,000 hectares, while in 1983 these methods were used on 31.5 million hectares. The USSR plans to treat 33 million hectares with biological methods in 1985. The use of biological methods varies from region to region in the USSR but is greatest in the cotton-growing areas of Central Asia, where strict regulations govern the use of pesticides in irrigated farming. In Uzbekistan, biological methods have replaced pesticides on 1 million hectares—20 percent of the area sown to cotton.

Biological Methods of Plant Protection

Biological control makes use of entomophages—predatory and parasitic insects that destroy pests—and bacterial and virus preparations. The most important insect used in biological control in the USSR is the trichogram, which is distributed on almost 10 million hectares annually. This small insect infects the eggs of cutworms and other agricultural pests, and the trichogram larvae develop in place of the pests. Microbiological means such as artificially bred pathogens also are used against various pests. The value of microbiological preparations is in their specific action—they destroy only pests without damaging useful insects. Other biologically active substances used to a lesser extent are artificially synthesized pheremones (sex attractants) that can provide information on pest population density and the most effective time for chemical treatment. As yet biological methods are not competitive with chemical pesticides either from an economic viewpoint or in terms of effectiveness of plant protection. Their principal drawback is that they are designed to control only one type of pest.

Table 4 *Percent*
USSR: Potential Crop Losses Due to Pests, Diseases, and Weeds, 1970-80

	From Pests	From Diseases	From Weeds
Grain	6.0	8.4	10.6
Flax	3.5	8.0	10.0
Cotton	11.0	9.0	7.5
Sugar beets	8.0	8.3	8.2
Potatoes	5.0	20.0	6.5
Vegetables	8.0	9.0	10.0
Fruits and berries	7.0	15.0	7.2
Grapes	5.0	22.0	7.2

Source: *Zaschita rasteniy,* No. 1, January 1983, p. 24.

Figure 1. Example of insect damage in the USSR.

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losses of grain from pests, diseases, and weeds could provide as much as an additional 45 million tons of grain per year, almost as much as total grain imports in 1984. Soviet data on the value of the harvest saved and the contribution made by different types of pesticides are presented in table 5.[6]

25X1

The increase in treated areas and the increase in the prices of pesticides have raised the need for economic justification of their use. Scientists at several Soviet research institutes have developed methods for evaluating economic effectiveness.[7] Experimental data reflecting the action of pesticides under favorable conditions on sowings with high or moderate levels of infestation are shown in table 6. According to a study prepared by these institutes, insecticides and fungicides had the greatest effect, saving an annual average of 4.1 billion rubles of crops during 1976-80. With total expenses for chemical protection of 797 million rubles, the net return was 419 percent (see table 7). The same study reports that in 1976-80 the use of herbicides on 59 million hectares provided average annual savings of nearly 1.8 billion rubles in crops and 436 million rubles in manual labor costs (see table 8). According to another Soviet report, the use of herbicides on cotton permitted a labor saving of 50 percent

Table 5 *Annual average, billion rubles*
USSR: Value of Crops Saved by Use of Pesticides [a]

	1961-65	1966-70	1971-75	1976-80
Total	**2.2**	**4.9**	**5.7**	**7.2**
Attributable to:				
Insecticides and disinfectants	1.9	3.9	4.5	4.6
Herbicides, defoliants, and desiccants	0.3	1.0	1.2	2.6

[a] Soviet claims may be subject to some margin of error because of the uncertainty inherent in estimates that attribute additional agricultural output to any single factor.

Source: *Agrokhimiya,* No. 12, 1982, p. 125.

25X1

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[6] Soviet claims may be subject to some margin of error because of the uncertainty inherent in estimates that attribute additional agricultural output to any single factor.

[7] The institutes involved included the All-Union Scientific Research Institute of Plant Protection, the All-Union Scientific Research Institute of Agricultural Economics, the All-Union Scientific Research Institute for Biological Methods of Plant Protection, and the Central Soil Scientific Research Laboratory. The evaluation of effective control measures is based on the ratio between the harvest saved and the cost for chemicals and their application.

Table 6
USSR: Potential Harvest Savings Under Experimental Conditions as a Result of Using Pesticides [a]

Percent

Crop	Insecticides	Fungicides	Disinfectants	Herbicides
Winter wheat	3-15	NA	4-22	5-25
Spring wheat	7-18	NA	5-26	11-22
Rice	8-18	3-17	NA	15-37
Corn for grain	2-19	NA	7-13	7-35
Corn for silage	18-43	NA	NA	18-55
Sugar beets	6-32	10-22	7-14	9-22
Cotton	9-26	13-16	8-13	12-18
Sunflowers	NA	NA	NA	11-34
Potatoes	11-32	18-42	5-34	12-48

[a] Share of average yields of various crops during 1976-80.

Source: *Zaschita rasteniy*, No. 1, 1983, p. 25; *Narodnoye khozyaystvo SSSR*, 1980; *Vestnik stastistiki*, various years; US Department of Agriculture, Foreign Agricultural Service, Foreign Production Estimates Division, March 1984.

25X1

Table 7
USSR: Annual Economic Effectiveness of the Use of Insecticides and Fungicides, 1976-80 [a]

Crop	Area Treated *(thousand hectares)*	Cost of Treatment *(million rubles)*	Yield Saved		Net Return *(percent)* [b]
			(thousand metric) tons	*(million rubles)*	
Total	**77,112**	**796.8**	**26,621**	**4,137.2**	**419**
Grain (excluding corn)	17,067	68.1	2,560	188.2	176
Corn for grain	4,310	18.1	712	59.2	227
Legumes	1,873	6.3	574	55.1	774
Flax	791	12.4	220	81.4	556
Cotton	10,226	144.6	1,262	741.0	412
Sugar beets	9,241	80.4	8,096	255.8	218
Oil-producing plants	1,131	13.7	203	40.8	198
Tobacco	464	19.2	37	90.4	370
Potatoes	11,806	79.6	5,810	615.9	674
Vegetables	3,092	72.6	2,664	386.3	432
Fruits	14,968	267.4	4,474	1,537.1	474
Perennial grasses	2,143	14.4	9	86.0	497

[a] Annual average for the period.
[b] Ratio of the yield saved to the cost of treatment.

Source: *Agrokhimiya*, No. 12, 1982, p. 124.

25X1

Table 8
USSR: Annual Economic Effectiveness of the Use of Herbicides, 1976-80 [a]

Crop	Area Treated *(thousand hectares)*	Cost of Treatment *(million rubles)*	Yield Saved		Labor Saved *(million rubles)*	Net Return [b] *(percent)*
			(thousand tons)	*(million rubles)*		
Total	**59,058**	**581.9**	**31,894**	**1,777.3**	**435.8**	**280**
Of which:						
Grain (small)	40,641	278.0	12,252	900.5		224
Corn for grain	2,973	38.7	1,402	116.5	84.0	418
Corn for silage	6,693	53.8	9,728	87.6	194.7	424
Rice	632	30.0	474	99.1		230
Flax	1,128	25.0	181	67.0	16.8	235
Cotton	1,501	34.8	219	128.0		269
Sugar beets	3,041	60.2	5,555	174.9	99.6	356
Sunflowers	254	2.6	34	6.2	3.4	269
Soybeans	277	8.6	64	14.0	9.4	173
Potatoes	698	9.0	679	72.0		678
Vegetables	490	25.5	693	67.0	20.7	244
Root crops for feed	154	2.7	308	6.4	2.4	226
Perennial grasses	192	4.0	243	12.0		200
Fruits and grapes	216	6.9	62	21.0	3.0	248

[a] Annual average for the period.
[b] Ratio of the yield and labor saved over the cost of treatment.

Source: *Agrokhimiya* No. 12, 1982, p. 124.

25X1

and reduced production expenditures by 30 percent compared with manual weeding.[8]

25X1

Other Benefits

The use of pesticides provides a wide variety of other benefits ranging from more efficient use of fertilizer to improvement in the quality of some crops:

- The Soviets claim that pests, diseases, and weeds reduce the effectiveness of chemical fertilizers by more than 25 percent and that the use of herbicides alone lowers fertilizer expenditures and increases their efficiency by 8 to 10 percent.

- The Soviets report that applying a mixture of a form of 2,4-D and Banvel-D increases the protein and gluten content of spring wheat.

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- Increased use of herbicides allows an increase in reduced-till farming, which saves time and fuel, reduces soil loss, and increases soil moisture.

- The use of defoliants on cotton for preharvest removal of leaves not only reduces expenditures for harvesting cotton but improves fiber quality.

- Seed disinfectants are particularly important in preventing rust in grain, a common problem in the USSR. A recent US study estimates that in the USSR losses due to rust diseases alone average about 6 percent of the potential total wheat crop and in years of serious infestation, at least 10 to 15 percent.[9]

- Application of growth retardants reduces crop losses due to lodging and freezing. The Soviets claim that annually grain lodges on 40 million hectares and winter grain crops freeze on as much as 8-10 million hectares.

Problems in Application

In the USSR only the basic processes of plant protection—spraying, dusting, and disinfecting—are mechanized. Pesticide solutions and emulsions are prepared manually. Shortages of equipment used in the application of pesticides and the poor design and quality of this equipment have lowered the return from resources invested in farming. The Soviets make few modern tractor sprayers, and existing machines use excessive amounts of pesticides. Newer methods of applying pesticides, such as in granulated form, in strips, in small volumes, and together with seed are being introduced slowly because of shortages of suitable equipment.

According to a Soviet agricultural journal, the country has only 52 percent of the machines that it needs for applying pesticides. Highly productive equipment for use in applying herbicides and fungicides and machines for disinfecting seed and mixing pesticide solutions are especially needed. More than one-third of the total volume of pesticides is currently applied by aircraft (see figure 2). Application of pesticides by

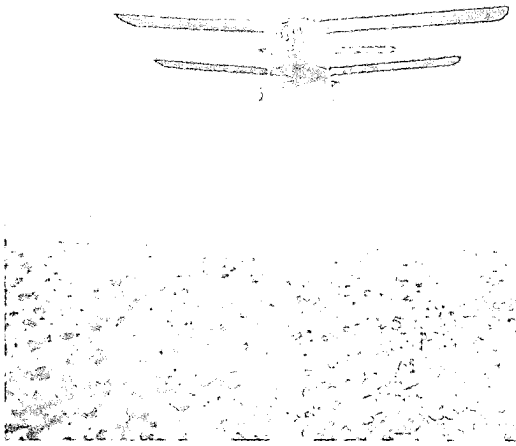

Figure 2. Aerial application of pesticides on cotton field in Azerbaijan.

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helicopter is more effective than that by the AN-2 airplanes now in use, but few helicopters have been allocated to agriculture. Servicing for aerial chemical operations also needs to be expanded.

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At the farm level, application directions frequently are not observed, and standard rates of application have not been developed for specific regions. The existing nationwide recommendations result in 20- to 30-percent overconsumption. Moreover, many Soviet farmers are not convinced that pesticides are required to increase their production.

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At the same time, the Soviets do not have enough personnel skilled in directing the preparation and application of pesticides. Only 12 percent of plant protection specialists in Moldavia, for example, have higher educations. Mikhail Gorbachev, then Secretary of the CPSU Central Committee, wrote in a 1983 press article:

25X1

> *The USSR Ministry of Agriculture must develop on an urgent basis a system of measures that will make it possible to improve the training of these specialists and must examine the problems of ensuring that such specialists are assigned to all farms having such a need.*

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To lower pesticide consumption, labor requirements, and environmental damage, the USSR is introducing several new methods of application. Long-term forecasting of the development of pests and diseases that is now being tested should make it possible to apply pesticides only on areas where there is a threat of substantial harvest losses. The use of low and ultra-low volume spraying, which reduces consumption of pesticides by 25 percent, is being introduced on a large scale. The USSR also is introducing combined application of fertilizers and pesticides, a method that will increase field productivity and save labor.

Pesticide Production in the USSR

Background

Until World War II the USSR produced largely inorganic pesticide compounds of arsenic, copper, barium, sulfur, and chlorine. In the early postwar years the supply of inorganic preparations was supplemented by small-scale production of some of the newer and more effective organic pesticides, such as DDT and benzene hexachloride and later by organophosphorus insecticides, herbicides, and defoliants.[10]

In the 1950s the USSR followed the Western trend toward replacement of older inorganic pesticides with newer synthetic organic compounds. But the pace of substitution has been slower than in the West, and the output of the more effective types of pesticides compares poorly in structure and volume with that now found in most Western countries.[11]

The development of the pesticide industry was neglected until recent years, when Soviet planners became actively concerned with the potential benefits of adequate crop protection. After the March 1965 plenum of the CPSU Central Committee approved a resolution calling for the "chemicalization" of agriculture, the Soviets focused on increased output and deliveries of fertilizer. Recognizing the need for better use of pesticides, the USSR stipulated a more balanced production of fertilizers and pesticides in the basic guidelines for the 11th Five-Year Plan (1981-85). The Food Program of 1982 further emphasized pesticide production. At its introduction, former General Secretary Brezhnev commented that shortages of herbicides as well as fertilizers had slowed growth of agricultural production. Prompted by the poor harvests of recent years, the USSR has embarked on an ambitious program to expand production of pesticides and to provide for their more efficient use.

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The Chemical Warfare Connection

Organophosphorus and carbamate pesticides work in a way similar to that of chemical warfare agents such as Tabun, Sarin, Soman, and VX. They interfere with the action of acetylcholinesterase, an enzyme that is important in the transmission of nerve impulses. Nerve impulses normally cause a muscle to contract. This action is then halted by the enzyme, which instructs the muscle to relax. Nerve agents block this enzyme action so that body muscles that have been contracted cannot be relaxed, causing spasms, paralysis, and asphyxiation. Although carbamate compounds possess the same enzyme-inhibiting properties as the nerve agents, they are discounted as chemical warfare agents because they are not as lethal as organophosphorus compounds.

Facilities producing organophosphorus pesticides could be converted to nerve agent production if originally designed for dual use. The initial steps for the manufacture of organophosphorus pesticides and nerve agents are similar. More sophisticated equipment and more stringent controls usually are required for nerve agent production, but this does not preclude the possibility that pesticides and nerve agents could be produced in the same plant. We believe that two chemical complexes in the USSR have separate facilities for the production of both pesticides and nerve agents. Another pesticide plant probably has the capability of being converted to nerve agent production.

[10] Organophosphorus compounds are a very effective class of pesticides, with agricultural uses ranging from the protection of seed to the treatment of cotton, wheat, fruit, and other crops. In addition, organophosphorus compounds are the basis of a number of chemical warfare agents (see inset).

[11] Comparisons between Western and Soviet output of pesticides can be misleading, however, because of the difference in the mix of pesticides produced. While Soviet production of pesticides increased by nearly 60 percent between 1973 and 1982, to 316,000 tons of active ingredient, US production decreased 21 percent, to about 500,000 tons of active ingredient, mainly because of increased output of more effective compounds.

Table 9
USSR: Production of Pesticides

Thousand metric tons

	1960	1965	1970	1975	1980	1981	1982	1983	1984	Plan 1985
Standard units [a]	63	201	299	448	474	504	533	557	577	652
100-percent active ingredient	32	103	164	264	285	299	316	332	343	391 [b]

[a] Standard units represent the standard content of active ingredient accepted for defined types of preparations. During 1978-83, Soviet production in terms of active ingredient averaged about 60 percent by weight of reported standard units.
[b] Estimated.

Source: *Narodnoye khozyaystvo SSSR*, various years.

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The Soviet pesticide industry has grown rapidly in the last 25 years. Output in 1984 was more than nine times the 1960 level (see table 9).[12] Output in 1971-75 grew at an average annual rate of 8.4 percent, but in 1976-80 growth slowed to an average of only 1 percent per year. During 1981-84, pesticide production grew at an average annual rate of 5 percent, a marked improvement over the previous five-year period.

The 10th Five-Year Plan (1976-80)

Plans for 1980 called for a 40-percent increase in pesticide output to 628,000 tons, including 245,000 tons of herbicides, which would have made the USSR 80 percent self-sufficient compared with 75 percent at the end of the previous five-year period. Not only was an increase in output planned, but also new types of pesticides were to be introduced. Production was well short of the target, however, growing less than 6 percent over the period, to 474,000 tons in 1980.

[12] Soviet pesticide production data are given in terms of active ingredient (pure substance) and/or standard units (the standard content of active ingredient accepted for defined types of preparations). Few modern pesticides are suitable for use in pure, undiluted form. Preparation of compounds for use usually involves dilution of the active ingredient with some other material to facilitate handling and mechanical distribution. This process is known as "formulation." During 1978-83, total Soviet production in terms of active ingredient averaged about 60 percent by weight of reported standard units. Unless otherwise indicated, pesticide data in this report are given in standard units.

The most disappointing performances were in the production of fungicides and seed dressings; outputs were only 44 percent and 56 percent of plan, respectively. Moreover, increased production of organophosphorus pesticides was to have offset the cutback in the output of organochlorine pesticides. Although production of organophosphorus insecticides increased by nearly 30 percent during 1976-80, it was insufficient to make up for the cutback, and total insecticide production fell by 11 percent during the period. Only eight new types of pesticides were introduced, one-fourth the number originally planned.[13] As a result of this poor performance, the USSR was at about the same degree of self-sufficiency in 1980 as it had been at the beginning of the five-year plan.

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The sharp slowdown in the growth of the pesticide industry during 1976-80 had numerous causes, many of which were and continue to be inherent in Soviet industry as a whole. But discussions in Soviet literature lead us to believe that *shortages of raw and intermediate materials* probably were the major problem. Tire producers had priority and pharmaceutical plants competed for many raw and intermediate

[13] New products introduced during 1976-80 included heptachlor and phthalophos insecticides; phenazone, lenacils, triallate, cotoran, and acrex herbicides; and polycarbatsin fungicide.

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materials, leaving inadequate supplies for the production of pesticides. Ministries other than those with major responsibility for pesticide production often failed to provide needed products.[14] Other factors that contributed to the slowdown included:

- *Obsolete plant and equipment.* Capital expenditures and equipment were tied up in the production of material that was obsolete by world standards and did not provide the crop yield increases that the Soviets expected.

- *Protracted construction periods.* Lagging construction of new production capacity was a major factor retarding the introduction of new pesticides. Construction delays were caused by poor design documentation and shortages of building materials and labor.[15]

- *Equipment shortages.* Many types of equipment were in short supply, including compressors, air-handling devices, and seals, especially corrosion-resistant types that are needed for pesticide production. Moreover, because equipment was often operated without regard to proper procedure, it wore out prematurely.

- *Inadequate labor supply.* Shortages of skilled labor were particularly acute. Poor leadership caused the loss of specialists, and labor productivity was low at many plants because of the many manual operations.

- *Transportation, distribution, and storage problems.* Pesticides frequently were delivered in open trucks, a practice that resulted in losses and contamination. Unsupervised deliveries often resulted in an accumulation of pesticides that were stored for excessive periods and became unstable. Storage facilities were insufficient, and pesticides were sometimes stored with fertilizers and other foreign materials, resulting in contamination.

[14] For example, the Ministry of Nonferrous Metallurgy failed to increase output of zinc sulfate, which is used in fungicides. Shortages of orthocresol supplied by the Ministry of Ferrous Metallurgy and biodegradable surfactants supplied by the Ministry of the Petroleum Refining and Petrochemical Industry were particularly acute.

[15] For example, a shop for the production of geksilur, a herbicide for use on weeds in areas sown to sugar beets, was scheduled to go into operation in 1978, but only a foundation had been completed by 1979. A plant for the production of fenazone herbicide, originally scheduled for commissioning in 1968, began operation in 1977 with output only one-seventh of that planned.

- *Lack of packaging.* The growing output of pesticides was not provided with adequate packaging. Production operations at pesticide plants periodically had to be shut down because of the lack of containers for finished products.

- *Underutilized Capacity.* The industry had considerable untapped potential in plants producing pesticides. Enterprises of the Ministry of the Chemical Industry and the Ministry of Ferrous Metallurgy had particularly poor capacity utilization records.[16]

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The 11th Five-Year Plan (1981-85)

The USSR announced an ambitious pesticide production target for 1985, 652,000 tons, a 40-percent increase over 1980 output. During 1981-85 the USSR planned to produce 12 new pesticides, to develop the technology for industrial production of 13 other preparations, and to transfer nine new compounds to field testing. By the end of the plan period the Soviets hoped to start up 10 new pesticide plants and to broaden the assortment of pesticides produced to 100 separate compounds.

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The increased priority given to the pesticide industry as a major agricultural input in the implementation of the Food Program is paying off. Supplies of raw and intermediate materials appear to have improved because of the introduction of new capacities and more reliable deliveries from other ministries. Pesticide production has shown a marked improvement over the previous plan period, growing at an average annual rate of 5 percent in 1981-84. In 1982, when many sectors of the chemical industry did very poorly, pesticide output grew by a healthy 5.8 percent. Output of 577,000 tons in 1984 was almost on target, making the USSR about 80 percent self-sufficient in quantity.[17]

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[16] Until 1979 pesticide production units were administered by Soyuzchlor, the union of the chlorine industry. Following top-level criticism of the industry for poor performance during the 10th Five-Year Plan, production units were grouped into the Soyuzkhimzaschita association. In 1980 pesticide production was brought under the control of a new Ministry of Mineral Fertilizer Production, which accounts for more than one-half of pesticide output. The Ministry of the Chemical Industry supplies about 40 percent of total pesticide production and the Ministries of Ferrous and Nonferrous Metallurgy supply small amounts.

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Production of pesticides in the first half of 1985 was only 2 percent higher than in the same period of the previous year. Severe winter weather, which disrupted transportation and supplies of materials and electric power, was a major factor contributing to the poor performance. The USSR probably will produce about 600,000 tons of pesticides in 1985—short of target, but nevertheless a very good recovery from the previous five-year plan. It is doubtful, however, that the Soviets will meet their goal of doubling output of fungicides. They are also unlikly to produce the 100 different types of pesticides planned for 1985.

In spite of improved performance, many of the problems that plagued the industry in the 1976-80 period persist. Recent reports in the Soviet press cite construction delays caused by uncoordinated deliveries of building components and shortages of electricity and manpower as reasons for continued below-plan output.

Assortment and Quality

Because of the wide range of conditions that exist on Soviet farms and variations in precipitation and temperatures among growing areas, a large assortment of pesticides is necessary. The short growing seasons that exist in most grain-producing areas require the use of plant growth stimulants to hasten the maturing of grain as well as effective herbicides to substitute for cultivation that cannot be provided during such a short time. Failure to practice crop rotation necessitates the use of fungicides to prevent plant diseases. Despite the rise in output in recent years, the range of products available still does not satisfy the needs of Soviet agriculture. According to a Soviet agrochemical journal, only 35 percent of the required assortment of pesticides is currently being produced.

The Soviets claim that they need about 160 types of pesticides, but the industry currently produces only about 60. Not enough different types of pesticides are available for use on cotton, sugar beets, and certain grain crops. Moscow particularly needs a better assortment of herbicides for corn, soybeans, sunflowers, sugar beets, and vegetables, and effective preparations for combating pests and diseases of cotton, grain, potato, vegetable, and fruit crops. Larger supplies of plant growth regulators to increase the winter hardiness and drought resistance of grain and other crops are also needed. The limited assortment of pesticides, in addition to lowering the effectiveness of other agricultural measures such as fertilizer, promotes the appearance of resistant forms of harmful organisms.

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Environmental Concern

Official attitudes toward toxic preparations have limited the range of pesticides produced and slowed the introduction of new compounds into Soviet agriculture. A continuing battle has raged between the Ministry of Agriculture, which wants to increase the use of modern pesticides, and environmentalists led by the influential All-Union Scientific Research Institute of Hygiene and Toxicology of Pesticides, Polymers, and Plastics, who have taken a consistently hard line on the registration of new insecticides. This conflict has intensified in the past few years. Registration of a pesticide in the USSR requires extensive and specific testing on plants before it can be used commercially.

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Even in the best of circumstances, this process can take up to two years. With the pressure for improved yields in Soviet agriculture in recent years, the Ministry of Agriculture has gained considerably more clout.

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Concern about contamination of the environment has prompted the Soviets to alter the structure of pesticide production, emphasize proper use of pesticides, and expand the use of biological control. Requirements concerning the toxicity of preparations and their safety have become stricter, prompting the Soviets to stop production of 22 highly toxic pesticides in the last few years.[18] Residues of organochlorine insecticides build up in the environment, endangering wildlife and domestic animals. Ultimately this accumulation may result in a human health hazard.

The Soviets cut back production and use of these types of insecticides in the late 1970s. Output of organophosphorus insecticides has increased, while the use of dangerous organochlorine insecticides, including DDT, and highly toxic mercury seed dressings has declined (see table 10). Compounds containing arsenic and fluorine have been almost completely eliminated from the range of pesticides. In 1970 the USSR banned the use of DDT on food and fodder crops, and in 1984 it prohibited the use of all organochlorine pesticides in northern areas of the country following increased pollution of the Arctic Ocean. The use of soluble pesticides has increased, and the share of the more dangerous dusts has declined. Low-volume spraying of crops could curtail the environmental threat of the growing use of pesticides, but sufficient equipment for this purpose is not being produced.[19]

New pesticide compounds, which are less dangerous to man and the environment, are more expensive. Because of the inclusion of new groups of pesticides in the product assortment, the average price of insecticides increased by 50 percent during 1971-80, and for fungicides prices doubled (see table 11).

[18] In 1960 about 57 percent of the recommended insecticides were severely toxic, while by 1975 only 8 percent of the chemicals used were rated severely toxic by Soviet scientists.

Table 10
USSR: Production of Pesticides by Type

Thousand metric tons

	1970	1975	1980
Total	**299.0** [a]	**448.0**	**474.0** [a]
Insecticides	82.7	111.5	99.0
Organochlorine	46.6	43.0	10.4
Organophosphorus	36.1	68.5	88.6
Herbicides	99.5	171.6	206.2
Defoliants and desiccants	43.6	57.8	65.9
Seed disinfectants	22.3	26.9	18.5
Fungicides	16.6	51.1	55.9
Other	26.9	29.1	28.4

[a] Components do not add to total because of revised data for totals.

Sources: T. P. Unanyants, *Khimizatziya sel'skogo khozyaystva v SSSR i za rubezhom*, Moscow, Khimiya, 1981; L. A. Kostandov, *Khimicheskaya promyshlennost'-narodnomu khozyaystvu*, Moscow, Khimiya, 1981.

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Table 11
USSR: Average Prices of Pesticides

Rubles per ton

	1970	1980
Insecticides	1,911	2,794
Fungicides	236	485
Herbicides	1,908	2,183
Defoliants	487	788
Other	326	449

Source: *Agrokhimiya*, No. 12, 1982, p. 121.

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Trade in Pesticides

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Imports

Recent increases in the production of pesticides have not eliminated the need to purchase large quantities of

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Table 12
USSR: Imports of Pesticides

Thousand metric tons [a] (except where noted)

	1970	1975	1980	1981	1982	1983	1984
Total	**41.9**	**50.4**	**96.5**	**90.5**	**91.5**	**109.6**	**117.4**
Western countries	21.8	23.3	60.1	45.8	57.8	64.1	59.5
Belgium			18.8	12.1	14.6	13.3	7.1
France	1.7	1.6	4.0	4.7	6.8	7.7	5.3
Italy	0.3		5.0	2.8	1.3	9.0	4.3
Japan	3.7	0.8	4.6	2.6	4.9	2.9	2.7
Switzerland	1.3	5.3	12.4	10.6	9.2	4.6	8.4
United Kingdom	1.7	0.3	3.2	2.4	3.2	3.8	5.9
United States	4.0	3.6	0.1	0.1	0.4	2.3	NEGL
West Germany	6.2	7.6	8.4	4.4	7.4	7.2	14.9
Other [b]	2.9	4.1	3.6	6.1	10.0	13.3	10.9
Eastern Europe	20.1	27.1	36.4	44.7	33.7	45.5	57.9
Bulgaria	0.3						
Czechoslovakia	3.8	4.1	2.2	1.9	2.0	2.4	2.1
East Germany	8.4	15.8	21.9	23.6	21.1	21.7	22.8
Hungary			6.4	7.7	7.9	17.7	19.7
Poland	1.5						
Romania	0.8						
Yugoslavia	5.3	7.2	5.9	11.5	2.7	3.7	13.3
Total value *(million US $)*	47.7	148.3	369.0	339.0	332.9	398.8	479.9

[a] The quantities of pesticides reported in Soviet trade statistics are believed to represent a mixture of formulated pesticides and active ingredients. We cannot, therefore, derive a relationship between trade data and data on production or deliveries to agriculture.
[b] This category represents a residual that we believe consists of small quantities of pesticides imported from other Western countries.

Source: *Vneshnyaya torgovlya SSSR*, various years.

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pesticides abroad as well as to import technology and complete production facilities. The Soviets imported more than 117,000 tons of pesticides in 1984, nearly three times the volume reported in 1970.[20] The value of these imports rose to $480 million, 10 times the 1970 level (see table 12). The poor performance of the domestic industry, especially in the area of herbicide production, led to a sharp increase in imports in 1980. High levels of imports have continued, reflecting the Soviet inability to meet demand from domestic production. They also indicate that Soviet leaders have been sufficiently concerned by the lack of progress in agricultural production to approve fairly large hard currency expenditures for the purchase of pesticides.

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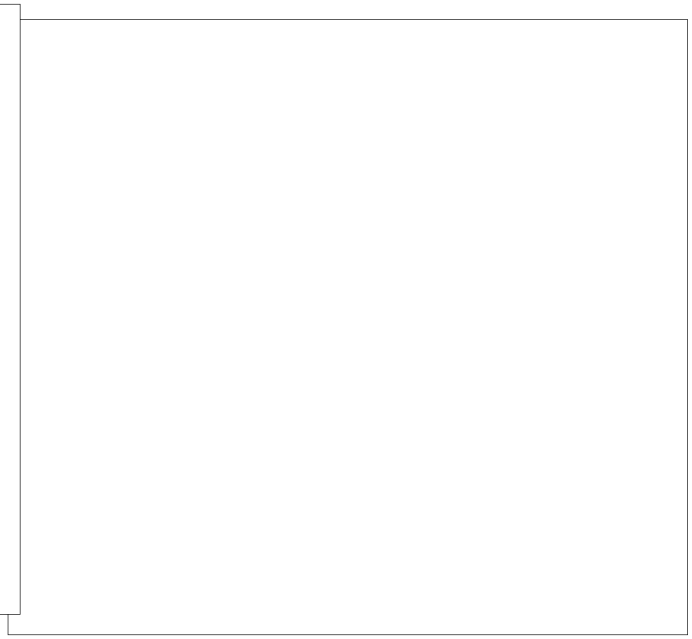
From the West. The Soviets believe it is more economical to purchase some pesticides from the West than

[20] The quantities of pesticides reported in Soviet trade statistics are believed to represent a mixture of formulated pesticides and active ingredient. We cannot, therefore, derive a relationship between trade data and data on production or deliveries to agriculture.



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In addition to buying pesticides in the West for hard currency, the USSR has countertrade agreements with Western firms. An agreement in effect from 1983 through 1985 provides for countertrade of Soviet ammonia to a US firm's West European subsidiary in exchange for various chemicals including pesticides. Under the arrangement the USSR agreed to minimum annual purchases of 5,000 tons of alachlor and 1,000 tons of glyphosate by 1985. A separate agreement in effect from 1983 through 1988 provides for annual Soviet purchases of a minimum of 10,000 tons of Eradicane herbicide and the sale of 20,000 tons of low-density polyethylene to another US firm.

the Soviets stepped up dramatically purchases of herbicides from Western firms in 1984-85:

- In 1984 the USSR purchased from a Western chemical firm 750 tons of a herbicide valued at nearly $26 million, about 13 times the amount purchased from the firm in 1983.[22]

- Soviet purchases of a sugar beet herbicide from a US firm were about $20 million in 1984, a return to the high level of 1981 imports after a sharp drop in 1982-83.[23]

- In early 1985 the Soviets contracted with a Western firm for the purchase of 5,000 tons of herbicides and an option to buy an additonal 5,000 tons at a total cost of $33-35 million. The order represented a 50-percent increase over the previous year's imports of rice herbicides and also included herbicides for sugar beets and corn.

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- The USSR agreed to purchase $15 million worth of herbicides from a US firm in 1985, a 66-percent increase in the amount purchased from the firm in 1984.

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[21] The Soviets apparently prefer US pesticides because of better technology, competitive pricing, and the willingness of US firms to work with the USSR in product development.

[22] This amount of herbicide is sufficient to treat more than 2.5 million hectares of crop. The herbicide is suitable for use in dry areas and can control a broader spectrum of weeds than the 2,4-D types of herbicides generally used in the USSR.

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[23] A similar downturn in trade in 1982-83 was noted by West German firms that regularly sell sugar beet herbicides to the USSR. Members of the US herbicide industry suspect that the USSR was attempting to produce its own material by using an unlicensed patent and was unsuccessful.

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These purchases suggest that Moscow is making weed control, primarily on grain crops, a high priority in increasing production.

The USSR also relies on the West for certain types of insecticides:

- The Soviets are increasing the use of pyrethroid insecticide, and in 1983 they placed their first sizable order with a Western firm for 200 tons valued at $35 million.
- The USSR also purchases about 4,000 tons of carbaryl insecticide annually from the West—about one-half comes from US sources.

In addition to direct purchases and countertrade, the USSR is involved in several cooperation agreements with Western firms:

- In 1984 the USSR and the British firm, ICI, began a three-year experiment aimed at increasing wheat yields using minimal cultivation of soil, British pesticides, and Soviet seed and fertilizer on 2,000 hectares of land in Moscow Oblast. The goal is to increase output to 10 tons per hectare from the present level of about 2 tons per hectare.
- Moscow signed a cooperation agreement with Shell International in 1984 for the development of a new pyrethroid insecticide. The pyrethroid is to be field-tested in Azerbaijan, the RSFSR, and the Ukraine on a variety of crops including cotton, fruit, and vegetables.

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The Soviets also have indicated recently that they would like to purchase from US producers pesticides in the developmental stage that would require field testing and on-site inspection by company personnel. This is a reversal of Soviet policy, which generally has restricted imports to products that have proved effective on crops and that are already widely used in the United States and other countries. Increased needs probably have caused Moscow to become less conservative in its approach to the use of new compounds.

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From Eastern Europe. Most imports of pesticides from Eastern Europe fall under a 1973 agreement within the framework of Interkhim, an organization for cooperation in the production of small-tonnage chemicals among CEMA members. Imports from East European countries accounted for nearly one-half the total volume of pesticide imports in 1984. East Germany, the major source, supplies the USSR with an organophosphorus insecticide, methyl parathion, as well as other pesticides. Under a long-term agrochemical exchange agreement, Hungary supplies Moscow with pesticides and in return receives fertilizers and other chemicals, including intermediates for pesticide manufacture. Although Hungary exports a smaller quantity of pesticides to the USSR than East Germany, it provides Moscow with some that are equivalent to Western products. Pesticides are also imported from Yugoslavia and Czechoslovakia.

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Equipment and Technology From the West

In addition to importing large quantities of finished pesticides, the USSR has purchased production facilities and technology from the West. Imports of technology and equipment have not been as widespread as in other sectors of the chemical industry such as fertilizers, plastics, and fibers, but they have provided the pesticide industry with the capability to manufacture modern, more effective preparations. The value of pesticide equipment and technology imported from the West has increased in recent years. Orders, which totaled $22 million in 1971-75, reached $148 million in 1976-80. In 1981 the Soviets ordered one plant valued at $165 million (see table 14).

The USSR has revived a plan to set up a major complex at Ufa to produce 10,000 tons per year of modern pesticides—in terms of active ingredients—in more than 10 different formulations. Moscow recently issued inquiries for the project—to be built on a turnkey basis—which would produce the following Western products: Ciba-Geigy's Dual, Monsanto's Lasso and Acetochlor, ICI's Reglone, and Dow's Lontrel herbicides; and ICI's Ambush, Roussel-Uclaf's Decis, Sumitomo's Sumicidin, and Shell's Ripcord pyrethroid insecticides.

Moscow is interested in building other large-capacity herbicide plants in the 12th Five-Year Plan (1986-90).

Exports

The USSR exports pesticides mainly to Communist and developing countries. In 1984 it exported about 31,000 tons of pesticides (see table 15). About 37 percent of these exports went to other CEMA countries. Only about 15 percent of total pesticide exports consisted of herbicides; the remainder was mostly insecticides, including DDT. Although the USSR uses little DDT domestically because of its adverse impact on the environment, it exported about 6,600 tons in 1984, most of it to India. 25X1

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Outlook

The Soviets have accorded a new priority to the pesticide industry that should permit a relatively high rate of growth in pesticide output and use and could result in considerable increases in crop yields over the next decade. Much will depend, however, on improved agrochemical procedures such as application of optimal amounts of pesticides at appropriate times and on the availability of effective application equipment. The Soviets plan to increase output of application equipment, particularly those types that will permit a lowering of pesticide consumption. They have announced plans to build new pesticide plants and expand and remodel existing facilities. But Soviet planners must allocate the resources necessary to solve industry-wide problems such as shortages of construction materials, skilled labor, and transport services. Progress will also depend on access to basic raw and intermediate materials such as chlorine, phosphorus, and petrochemicals, as well as the availability of essential corrosion-resistant equipment.

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Research and development of new production technology for plant protection agents probably will be expanded and intensified. The CPSU Central Committee and the government decided in October 1984 to raise the efficiency of reclaimed land by providing adequate quantities of pesticides, fertilizers, equipment, and highly productive seeds. Of primary interest are herbicides, plant growth regulators, and insecticides that are less toxic to man and animals. The

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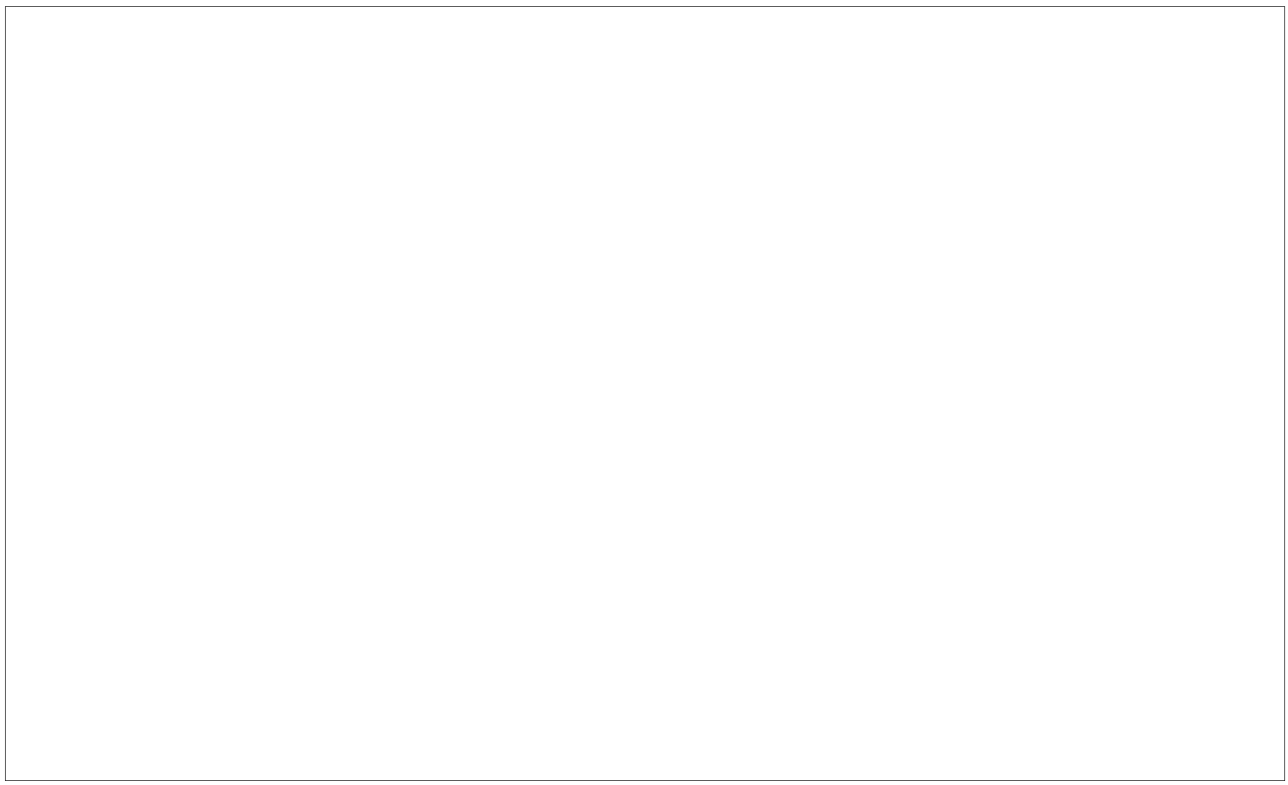

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Table 15
USSR: Exports of Pesticides

	1970	1975	1980	1981	1982	1983	1984
Amount *(thousand metric tons)* [a]	11.9	17.2	23.0	28.7	31.5	31.8	31.2
Value *(million US $)*	3.8	17.8	25.7	33.9	40.3	41.0	37.8

[a] The quantities of pesticides reported in Soviet trade statistics are believed to represent a mixture of formulated pesticides and active ingredients. We cannot, therefore, derive a relationship between trade data and data on production or deliveries to agriculture.

Source: *Vneshnyaya torgovlya SSSR*, various years.

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Soviets will emphasize weed control for grain in support of their long-term goal to become self-sufficient in grain production. Scientists at the Ministry of Mineral Fertilizer Production have already developed new herbicides for sugar beets, grain, vegetables, and cotton and an insecticide for vegetable crops.

The 1982 Food Program calls for deliveries of pesticides to agriculture to increase to 680,000 tons in 1985, 17 percent more than in 1983. The Soviets can meet this goal only by making up the shortfall in

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production through imports. They have not yet announced a production target for pesticides in 1990, but lags in the construction of new facilities and difficulties in operating existing facilities suggest that desired levels of output of the more effective, modern pesticides probably will not be met. Plans to supply agriculture with 750,000 to 790,000 tons of pesticides in 1990 could be met from domestic production, but the necessary assortment and quality would still be lacking. The Soviets' long-term goal is to achieve self-sufficiency by increasing domestic production and making up any shortfalls with imports from Eastern Europe. Soviet planners foresee supplies of pesticides becoming sufficient only toward the end of the 1990s, with an annual production of about 1 million tons.

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For at least the next several years, imports of pesticides probably will remain substantial. The USSR will continue to rely on modern, high-quality Western pesticides—particularly herbicides—as well as East European products. To conserve hard currency, the Soviets will try to arrange barter deals for Western pesticides, but, if necessary, they will use foreign exchange to pay for those that they really need. The USSR will continue to rely on imports of certain Western technology to modernize the pesticide industry as evidenced by recent requests for turnkey plants. The Soviets will also emphasize integrated systems of plant protection including resistant strains, pesticides with low toxicity including synthetic pyrethroids, and biological and microbiological methods of control as well as conventional means.

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Appendix

USSR: Pesticide Plants

Plant	Product
Abovyan Biochemical Factory	Microbiological pesticides
Aktybinsk Chromium Compounds Plant	Sodium fluorosilicate insecticide
Alaverdi Copper and Chemical Combine	Copper sulfate fungicide
Almalyk Mining and Metallurgical Combine	Copper sulfate fungicide
Bagley Coke Chemical Works	Dicyclopentadiene, insecticide intermediate
Batumi Chemical Plant	Keim insecticide, other nonspecified toxic pesticides
Berezniki Chemical Combine	Chloropicrin, thiuram fungicides
Chapayevsk Chemical Fertilizer Plant	Dalapon herbicide Benzene hexachloride insecticide Chloroacetic acid herbicide Magnesium chlorate defoliant
Chardzou Superphosphate Plant	Benzene hexachloride insecticide
Cheboksary Chemical Combine [a]	Khlorofos organophosphorus insecticide Simazine herbicide
Chimkent Chemical and Pharmaceutical Plant	Anabazine sulfate insecticide
Chirchik Electrochemical Combine	Magnesium chlorate defoliant Insecticide
Dneprodzerzhinsk Nitrogen Fertilizer Plant	Aldrin insecticide Dialdrin insecticide Heptachlor insecticide
Dzerzhinsk Chernorechensk Chemical Plant "Kalinin" [b]	Benzene hexachloride insecticide Cyanogen fumigant Chlordane insecticide Ethyl mercuric chloride fungicide DDT insecticide Simazine herbicide Fenuron herbicide Propazin herbicide Orthocresol herbicide intermediate Calcium cyanamide defoliant
Dzerzhinsk Caprolactam Plant	Benzene hexachloride insecticide
Dzerzhinsk Oka Plant	Ethyl mercuric chloride fungicide Granosan seed dressing

USSR: Pesticide Plants

Plant	Product
Dzhambul Superphosphate Plant	Sodium fluorosilicate insecticide
Fergana Hydrolysis Plant	Endothal plant growth regulator Magnesium chlorate defoliant Uzgen fungicide Cyanamide defoliant
Izyum Chemical Plant	Benzene hexachloride insecticide
Kalinin Coke and Chemical Plant (Dnepropetrovsk)	Herbicides
Kaluga	Pesticides
Kalush Chemico-Metallurgical Combine	Zineb fungicide
Karabogaz Sulfate Combine	Magnesium chloride defoliant
Kemerovo Aniline Dye Plant	DET mosquito repellant
Kemerovo Nitrogen Fertilizer	TUR growth regulator
Kiev Chemical Compounds Plant	DDT and other insecticides, herbicides
Kivoli Chemical Combine	Carbolineum insecticide
Kutaisi Lithophone Plant	Copper sulfate fungicide
Moscow Chemical Plant "Voykov"	Copper sulfate fungicide
Mozyr Chemical Combine	Pesticides
Navoi Chemical Combine	Phosalone insecticide Kotoran herbicide Treflan herbicide Akreks herbicide Isophene herbicide Benzotrifluoride insecticide intermediate Cyanamide defoliant
Nevinnomysk Chemical Combine	Aerosol pesticide sprays
Novomoskovsk Chemical Combine	Dinoseb herbicide Karbophos organophosphorus insecticide Simazine herbicide
Odessa Superphosphate Plant	Copper sulfate fungicide
Olaine Chemical Plant	Fenazon herbicide
Ordzhonikidze Electrozinc Plant	Copper sulfate fungicide
Pavlodar Chemical Combine	Herbicides
Perekop Bromine Plant	Avenin insecticide

USSR: Pesticide Plants

Plant	Product
Perm' Chemical Combine	Herbicides
Pervomaysk Chemical Plant	Atrazine herbicide Simazine herbicide Dalapon herbicide Cuprosan fungicide Seed treating agent for cotton
Riga Chemical Plant	MG-T herbicide Aerofos insecticide
Rozdol Chemical Complex	Sulfur wettable powder
Rubezhnoye Chemical Plant	Dinitro-o-cresol herbicide intermediate Sodium pentachlorophenate herbicide Avenin insecticide Dinok insecticide
Rustavi Chemical Plant	Cyanogen salts for herbicides
Saki Chemical Plant	Methyl bromide soil fumigant Trichlorophenol herbicide, fungicide, defoliant
Severodonetsk	Metaldehyde pesticide
Salavat Petrochemical Combine	Mercaptan fungicides
Shchelkovo Chemical Plant	Benzene hexachloride insecticide DDT insecticide Calcium arsenate insecticide Calcium arsenite insecticide Fenson acaricide Para-dichlorobenzene insecticide Diethyltoluamide insecticide Fosamid Heptachlor insecticide Karbotion (VAPAM) soil fumigant Paris Green larvicide Fosamid (Roger) Metilnitrofos organophosphorus insecticide Methyl ethyl parathion organophosphorus insecticide Thiofos (Parathion) organophosphorus insecticide Trikhlormetafos organophosphorus insecticide Trikhlorthiofos organophosphorus insecticide
Sterlitamak Chemical Combine	Triallate herbicide
Sumgait Chemical Combine	Benzene hexachloride insecticide DDT insecticide 2,4-D herbicides 2,4,5-T herbicides Efiran Triallate herbicide Butapon herbicide Lindane insecticide
Tol'yatti Chemical Plant	Ftalotos (Imidan) organophosphorus insecticide Karbofos organophosphorus insecticide Nitrofen herbicide

USSR: Pesticide Plants

Plant	Product
Ufa Chemical Plant	Aldrin insecticide Atrazine herbicide Butapon herbicide 2,4-D herbicides MCPA herbicide Dialin herbicide Lenatsil herbicide Linuron herbicide Simazine herbicide Metakson Trichlorophenate (copper salt) Trichlorophenol fungicide
Vinnitsa Chemical Combine	DDT insecticide Polychloropine insecticide Sodium fluorosilicate insecticide
Volgograd Chemical Plant [b] (Beketova)	Butifos defoliant Khlorofos organophosphorus insecticide Mercaptofos organophosphorus insecticide Metafos organophosphorus insecticide Metilatsetofos organophosphorus insecticide Diazinon organophosphorus insecticide Stenazone herbicide Fenazone herbicide Fluorosilicate insecticide
Vurnary Chemical Plant	Benzene hexachloride insecticide
Yavan Electrochemical Combine	Gelecron Defoliants Pesticides
Yerevan Kirov Synthetic Rubber Complex	Benzene hexachloride insecticide 2,4-D herbicides Krotolin herbicide
Zaporoznye Coke Chemical Plant	Herbicide
Zhdanov Coke Chemical Plant	Simazine herbicide Sulfur wettable powder fungicide

[a] This plant probably could be converted to the production of nerve agents.

[b] This plant probably has separate facilities for the production of nerve agents.

25X1

Glossary

Active ingredient	The pure chemical in a pesticide that produces the desired result.
Biological control	The use of predatory or parasitic insects, bacterial or viral preparations, or sex attractants—rather than chemicals—to control pests.
Defoliant	A chemical sprayed or dusted on plants to cause the leaves to fall off prematurely.
Desiccant	A substance that has a high affinity for water and is used as a drying agent.
Formulation	The mixing of an active ingredient with other materials to facilitate handling and application.
Fumigant	A gaseous or volatile chemical used as a pesticide or disinfectant.
Fungicide	A substance that destroys or inhibits the growth of fungi.
Growth regulator	A substance used to retard or stimulate plant growth.
Herbicide	A substance used to destroy plants, especially weeds.
Industrial crops	Crops that generally require extensive processing before use, especially sugar beets, cotton, tobacco, sunflowers, soybeans, flax, and tea.
Inorganic compound	A compound composed of matter not of plant or animal origin.
Insecticide	A substance used to kill insects.
Lodging	The falling or leaning of grain crops or grasses as a result of heavy rain and/or high winds that makes harvesting difficult.
Nematodes	Unsegmented worms that attack certain crops.
Organic compound	A chemical compound composed of matter of plant or animal origin, that is, containing the element carbon.
Organochlorine compound	A group of organic compounds containing chlorine, many of which are highly toxic.
Organophosphorus compound	A group of organic compounds containing phosphorus, used as pesticides and the basis of certain chemical warfare agents.
Pesticide	A general group of chemicals used to control or kill pests, normally including insecticides, acaricides (for the control of mites), fungicides, herbicides, rodenticides (for the control of rodents), nematocides (for the control of nematodes), seed dressings, fumigants, defoliants, and desiccants.

Preemergence herbicide	A compound that is applied before the emergence of seedlings above the ground to prevent the growth of weeds.
Rust	A plant disease caused by parasitic fungi, characterized by reddish or brownish spots on leaves, stems, and other parts.
Seed dressing	A substance that kills harmful microorganisms in seeds.
Standard unit	The standard content of active ingredient for specific pesticide preparations.

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