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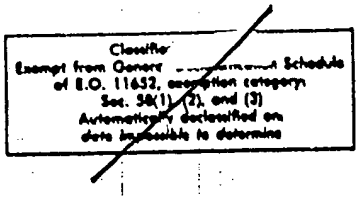


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# Agriculture-Related Pollution in the USSR

*Project Officer*

## PRÉCIS

The expansion and modernization of Soviet agriculture have increased food production but have resulted in serious environmental pollution. Furthermore, pollution from agricultural sources is on the increase and, despite expressions of concern at the highest levels of the Soviet Government, little is being done to control it effectively. Agricultural production requires the use of major pollutants such as mineral fertilizers and chemical pesticides. Because such production is so vital to the Soviets, it is unlikely that they will effect any significant changes in farming techniques that favor the environment at the expense of harvest goals.

*Note: As a result of a reorganization, effective 11 October 1977, intelligence publications formerly issued by the Directorate of Intelligence and by the National Intelligence Officers are now being issued by the National Foreign Assessment Center.*

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# PREFACE

Modern agriculture has a great impact on the environment. The basic purpose of agriculture, in fact, is to manage part of the environment in order to meet man's needs for food and fiber. It is the undesirable effects of this management—excess plant nutrients in water, residual chemicals in food, injury to nontarget species by chemical pesticides, increased erosion and sedimentation from intensive cropping—that are serious environmental problems.

The major forms of agriculture-related pollution are discussed in this report. Emphasis has been placed on chemical pesticides, however, because (1) they are the most dangerous to man and animals; (2) pesticide pollution is a global problem, regardless of the country of origin of the particular pesticide involved; and (3) there is a correlation between a country's level of agrochemical technology and that country's potential contribution to the world pesticide pollution problem. Thus, the attitudes and practices of the Soviet Union regarding the production and use of chemical pesticides affect not only the level of agricultural production but also are of international concern.

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# CONTENTS


| | Page |
|---|---|
| PREFACE | iii |
| PROBLEM | 1 |
| SUMMARY AND CONCLUSIONS | 1 |
| DISCUSSION | 2 |
| Introduction | 2 |
| Agricultural Chemicals | 3 |
| Pesticides | 3 |
| Water Contamination | 3 |
| Food Contamination | 4 |
| Aerial Application | 5 |
| Air Pollution | 5 |
| Toxicity and Requirements for Use | 6 |
| Fertilizer | 7 |
| Runoff | 7 |
| Groundwater Contamination | 8 |
| Irrigation and Drainage | 8 |
| Water Problems | 9 |
| Soil Salinization | 9 |
| Erosion | 10 |
| Animal Wastes | 12 |
| Pollution Controls and Standards | 13 |


# TABLES


| | Page |
|---|---|
| 1. Types and Toxicities of Soviet Pesticides, 1972 | 6 |
| 2. Reduction in Toxicity of Soviet Pesticides, 1960-1974 | 6 |

# AGRICULTURE-RELATED POLLUTION IN THE USSR

## PROBLEM

To determine the extent of Soviet agriculture-related pollution and its impact on the environment.

## SUMMARY AND CONCLUSIONS

Pollution from agricultural sources is a major cause of environmental disruption in the USSR. Moreover, such pollution is on the increase and, despite expressions of concern at the highest levels of government, little is being done to control this type of pollution effectively. No changes of consequence in Soviet farming methods that favor the environment are expected in the foreseeable future, thus assuring further agriculture-related environmental degradation. The Soviets are concerned about their environment, but their overriding priority is to increase agricultural production.

In terms of economic damage to the USSR, natural soil erosion and sedimentation, which are greatly aggravated by modern agriculture, probably account for the greatest losses, but water pollution is the most pressing environmental problem in the USSR. More Soviet research is needed in the specific area of agricultural pollutants.

Of the agriculture-related pollutants in the Soviet environment, chemical pesticides are the most hazardous to man, flora, and fauna. Soviet production and use of pesticides have increased yearly, and residual toxic chemicals such as dichlorodiphenyltrichloroethane (DDT) and hexachlorocyclohexane (HCCH) have been reported as contaminants in food, water, and soil at levels believed to be hazardous to the health of man and animals. Faced with evidence of the undesirable consequences of pesticide use, the Soviet Government has placed restrictions on applying compounds having proven environmentally disruptive side effects. These restrictions, however, are either inadequate or not always adhered to. Overuse and misuse of chemical pesticides appear to be common in the USSR. The Soviets are searching for alternatives to toxic agricultural chemicals and have a well-developed biological pest control program. Nevertheless, the chemical method for combating crop pests is the leading method now in use in the USSR and will remain so for the foreseeable future.

The Soviets claim that nutrient runoff from agricultural land is not now a major source of water pollution in the USSR. It soon will be, however, because both the use and loss of nutrients in the USSR are rising. Fertilizer consumption in the USSR is expected to increase greatly in the next decade, while the concentrations of livestock farms and feed lots will result in a concomitant waste disposal problem. At a time when US environmentalists stress the use of more animal wastes and less inorganic fertilizer, the USSR is making every effort to bring its chemical fertilizer production and application up to levels which have resulted in pollution problems in the United States. At present, however, both countries still use synthetic chemical fertilizers primarily.

The animal waste disposal problem in the USSR has grown phenomenally in the past decade as the numbers of livestock have increased greatly. A conservative estimate is that more than 600 million tons of manure accumulate annually on livestock farms and feedlots. These wastes are associated with eutrophication of rivers, fish kills, nitrate contamination of soils and aquifers, dissemination of agents infectious to man and animals, and reproduction of insect pests. Soviet scientists are stressing the use of animal waste as fertilizer and recycling it for use as

feed additive. The latter is preferable from the environmental standpoint because of the runoff problem from fertilized land. Manure recycling is in its infancy in the USSR, however, and it will be at least 5 to 10 years before it will contribute significantly toward reducing the animal waste problem.

Because of past Soviet neglect and misinanagement of the land, erosion by both wind and water is an immediate threat to vast areas of croplands and is probably the most urgent conservation problem facing Soviet planners. Dust storms annually blow away millions of tons of fertile soil and damage or destroy crops. Water erosion, while acting more slowly, is even more damaging. The Soviets estimate that erosion results in losses of 10 billion rubles a year in land, crops, and livestock as well as in damage caused by sedimentation and pollution in reservoirs and waterways. While climate is an important factor, poor planning and inferior scientific research and technology are major reasons for the present serious conditions in the USSR. The Soviets are estimated to lag the US 10 to 12 years in wind erosion research. Their approach to erosion control continues to be based on centralized directives rather than on encouraging a closer relationship between local scientific organizations and local level production units. The Soviets have been combating erosion for a number of years, and new control programs are being initiated under the latest 5-year plan. The sheer magnitude of cropland erosion in the USSR ensures that it will remain a serious problem for the foreseeable future.

Salinization of soils is a problem in all areas of irrigated farming in the USSR. It is a particularly serious problem in Turkmen, Uzbek, and other southern republics where natural drainage is poor, rainfall is low, and evaporation is high. Thousands of hectares of irrigated farmland periodically must be taken out of production, flooded, and drained in order to leach out millions of tons of contaminating salts. Soil salinity in the south is becoming more intense each year, causing reduced yields and salt-polluted waterways. Pollution in the Caspian Sea has affected the production of caviar and the fish industry in general. Agricultural chemicals are contributing to the high salt content of the Caspian Sea because of runoff from treated lands. Soviet industry also is largely responsible for decreasing the Caspian Sea water level, thereby raising the salt concentration, by diverting inflowing rivers for use in irrigation and production plants.

Legislative controls aimed at curbing environmental disruption in the USSR were initiated some years ago. In most instances, Soviet standards are much more stringent than those in the US. Enforcement of such strict standards, however, is almost impossible, and the Soviets are expending little or no effort in this direction. Strict enforcement is avoided to prevent the unacceptable losses in food and fiber that would occur, and protection of the environment is entrusted to the industrial and agricultural ministries whose activities are themselves the major polluters. Considering its recurring agricultural crises, the USSR cannot be expected to protect its environment from agricultural pollutants at the expense of food production. If realistic control standards are not established and enforced by the Soviets, little improvement can be expected in the present state of agriculture-related pollution.

# DISCUSSION

## INTRODUCTION

The USSR has environmental pollution problems that are as extensive and severe as those in the United States. The main source of this pollution probably is industrial and human wastes but, in both countries, the less obvious pollution from agricultural sources may exceed the aggregate from municipal and industrial sources.

The undesirable side effects of modern agriculture have become serious environmental problems. The USSR has the world's largest ongoing effort to modernize agriculture and increase food production. Basically, food production can be expanded by planting more hectares, by improving technologies for land-use, by harvesting greater yields from current croplands, and by using land-conserving technologies. The environmental problems associated with land-using technologies primarily involve wind and water erosion and damage to wildlife caused by drainage of wetlands. Nevertheless, land-conserving technologies create environmental problems because of the huge quantities of agricultural chemicals required and because irrigation results in a build-up of salts in soil

and water. To a limited extent, both are being practiced in the USSR and each has potentially detrimental consequences for the environment.

## AGRICULTURAL CHEMICALS

### Pesticides

The USSR is plagued with numerous agricultural pests and has developed extensive control programs, mostly based on chemicals. Between 150 and 200 different types of toxic chemicals are recommended for use in Soviet agriculture. This is only a fraction of the 900 or so types used in the United States, nevertheless, the USSR uses only slightly less tonnage of agricultural pesticides than the United States. The Tenth Five-Year Plan (1976-80) calls for 630,000 tons of toxic chemicals to be delivered to agriculture, up from 420,000 tons in 1975.[1 2]

Chemical pesticides protect the crops but are a very dangerous source of contamination for man and his environment.* Furthermore, chemical pesticides hold a unique position among the environmental contaminants in that they are produced for the sole purpose of injection into the environment as dusts, sprays, aerosols, granules, pellets, and baits. Adding to their negative impact in the environment, is the fact that pesticides are developed and valued for their deadly effect on living organisms. These toxic chemicals can be biologically active in extremely low concentrations. Evidence now exists that most plants will absorb and translocate residual pesticides indiscriminately from contaminated soils. Thus, it is necessary to consider not only the short-term effects of pesticides but also their residual properties, breakdown products, and eventual fate. The undesirable consequences of using pesticides have led to some government restrictions in both the United States and USSR on applications of compounds having proven environmentally disruptive side effects. Currently, and in the context of this report, the most difficult problem in modern agriculture is to protect food products—both plant and animal—and water resources from pesticide residues.[3-5]

*Other than the obvious dangers of highly poisonous materials to persons handling them, it is not known how pesticides bear directly on human health. The only sure consequence of long-term exposure to persistent pesticides at levels encountered by the general population is the acquisition of residues in tissues and body fluids. No reliable study has revealed a causal association between the presence of these residues and human ailments. The fact that some pesticides produce cancer and birth defects in experimental mammals is certainly cause for concern.

WATER CONTAMINATION—Soviet literature contains a number of reports concerning the presence of pesticides in sources of water supply. Most of the major waterways of the USSR carry persistent pesticides. The extent of this pollution, the trend in severity, and the probable effect on aquatic resources generally are unknown. Pesticide pollution of lakes, estuaries, and inland seas, such as the Baltic and Caspian, may be even more significant. Baltic seals contain 10 times the concentration of DDT as Canadian seals, and fish from the Baltic Sea have been found to have such a high concentration of dieldrin that a fishing prohibition was imposed in some areas. The future looks better insofar as these two pesticides are concerned since their use has been discontinued or limited by the USSR and other countries having Baltic coastlines. Other major pesticides used by the Soviets in large quantities, such as the carbamates 2,4-D and 2,4,5-T compounds, are not necessarily less toxic to marine life than the chlorinated hydrocarbons. For example, the dimethyl amine salt of 2,4-D is relatively safe at 150 mg/l, but the butyl, ethyl, and isopropyl esters are toxic to fish at about 1 mg/l.[3 6 7]

Contamination of irrigation systems in the USSR is widespread. Soviet investigations of the Kuban River irrigation system in southeast RFSFR show that herbicides and their toxic metabolites used for chemical weeding of rice, although applied to only one field, will circulate over the entire irrigation system in the course of one to three months.[8] In irrigation farming regions of the Tadzhik and Uzbek Republics, the pesticide content in the water of irrigation ditches and canals often exceeds the maximum permissible norms by 10 to 100 times. Considerable quantities of organochlorine and organophosphorus pesticide residues have been found in the water and in mud deposits in the Ukraine and Belorussia, and an ethyl ester of 2,4-D was discovered in a reservoir in Kazakh SSR.[1 9] Because of an uneven distribution of water resources in the Soviet Union, water pollution by pesticides in the south is much more serious than that in the north. Water resources per inhabitant of the USSR average a superfluous 20,000 $m^3$ per year. In the Ukraine, however, the average is 2,000 $m^3$, in Moldavia 300 $m^3$, and in the Central Asian Republics as little as 200 $m^3$ per person per year. The Soviets have stated that the reduction of water pollution by pesticides in these republics where farming is intensive is a matter of great urgency.[8]

Groundwater is not as frequently contaminated with pesticides as surface water partly because of the soil's absorptive properties and partly because of the

length of time it takes the pesticides to infiltrate into the soil. Nevertheless, according to the All-Union Plant Protection Research Institute, Leningrad, a number of cases have been noted in which preparations in the fumigant group—for example, chloropionim—have infiltrated deep into the soil and into wells. At the Institute for Colloidal Chemistry and Water Chemistry of the Academy of Sciences, Ukrainian SSR, research to develop a technology for removing pesticides from drinking water has been carried out for a number of years.[1 5]

FOOD CONTAMINATION—It has become almost impossible for man to avoid assimilation of a variety of pesticides, primarily by ingestion with food. Persistent pesticides and their attendant phenomena of dispersal, biological concentration, and concentration in food chains, share many features with radioactive materials. In the US, organochlorine pesticides are present at detectable levels in all human foods except some beverages. Even human milk has an average content of 0.1 to 0.2 parts of DDT per million parts of whole milk. Judging from some Soviet reports, the situation in the USSR is no better. Data on the pesticide content of certain fruits and vegetables on a farm in Tadzhik SSR show DDT in 49 percent of the grapes tested, 44 percent of the cabbage, and 59 percent of the melons; HCCH in 57 percent of the cabbage samples and 73 percent of the peaches; and Sevin in 100 percent of the onions and carrots tested. Produce in the markets of Dushambe, Tadzhik, also was found to be contaminated. Pesticide residues were detected in 19.7 percent of all vegetable samples analyzed. Analyses for DDT, HCCH, carbaryl, dimethoate, and trichlorfon showed residue levels ranging from 0.5 to 3.0 mg/kg. As for human milk, a report from the Crimea states that, on the average, the milk of women tending vineyards contains 4.8 times as much DDT and 6.2 times as much copper (presumably from copper-containing fungicides) as does the milk of Crimean milkmaids. In this connection, it should be emphasized that the pesticide food-contamination problem is not confined to plant products in the USSR. Although the Soviets offer no data, A. I. Shtemberg, et. al., Institute of Nourishment, USSR, pointed out that while plant products are subject to pesticide contamination more than other types of food, the level of build-up of toxic chemicals is higher in animal products (meat, milk, butter, eggs).[10 12]

The prolonged retention of organophosphorus pesticides in the soil creates a danger of their entry into plants, especially into root and tuber crops. It has been established that even the least persistent chemical pesticides move from the soil into roots and tubers and can accumulate and persist in them for long periods. The Soviet researcher Mayer-Bode cites information on the prolonged retention of pesticides in carrots: diazinone (up to 98 days), phosphamide (100 days), chlorophos (105 days), and thiophos—now banned in USSR—(more than 200 days). Residual quantities of thiophos (up to 1 mg/kg) were discovered in potatoes 12 weeks after planting of treated tubers. The Ukrainian Research Institute of Plant Protection, Kiev, reports that potatoes planted in the 3rd and 4th years after use of polychloripinene still showed the presence of this insecticide due to its retention in the soil.[13-14]

A number of Soviet authors note the high stability of some organophosphorus chemicals resulting from treating warehouse rooms and stored products, notably grains. Diazinone and Cidial have long retention periods in stored grain and in the flour produced from it. Carbophos is retained in insecticidal quantities in stored grain up to 13 months after treatment. The quantity of carbophos in the grain was from 3.3 to 3.6 mg/kg, in flour from 1 to 2 mg/kg, and in baked bread from 0.1 to 0.4 mg/kg. The high stability of pesticides in warehouses can be attributed to the low temperature and humidity, absence of light, and little movement of air.[14]

In addition to chemical residues in foods there are some undesirable nutritional effects of pesticides on crop plants. Pesticides that penetrate plant tissues can disturb the normal course of a number of physiological processes and change the plant's metabolism. Barley, which is particularly sensitive to herbicides of the 2,4-D type, is a good example. Soviet scientists report a reduction in protein content and amino acid composition of the grain following application of Banocide and Banvel-D to a barley crop.[15]

The Soviets claim that the number of cases of harmful contamination of food by pesticides is sharply decreasing. In the early 1960s, approximately 30 percent of Soviet farm production contained pesticide residues above the permissible hygienic norms. At present, the Soviets claim that the figure is about 4 percent. Economically, the Soviets believe it is better to reject that 4 percent than to reduce their chemical defense. They estimate that without at least present levels of chemical protection, crop losses from pests would be many times greater than a 4 percent rejection rate.[16] With perennial crop shortages creating overall food problems, however, it is doubtful that the

Soviets are actually rejecting this contaminated 4 percent.

AERIAL APPLICATION—Agricultural aviation in the Soviet Union is conducted on an enormous scale. Almost half of the country's agricultural area is treated with pesticides or fertilized from the air, a coverage of 80 to 100 million hectares. The Soviets claim that agricultural aviation in the USSR occupies first place in the world in terms of the numbers of hectares treated. Airplanes and helicopters now are included within the general system of machinery serving to mechanize agricultural production. Aviation is used in nearly 40 percent of all chemical operations in Soviet agriculture. In 1972, 59 percent of all weed control, and 40 percent of all plant protection was accomplished through the use of aircraft. In addition, more than 35 percent of all mineral fertilizers are applied from the air, and preharvest defoliation of cotton plants and certain other crops is carried out almost exclusively by aircraft.[17]

The most serious problem in agricultural aviation involves toxic chemicals that drift beyond the treated areas. Tiny particles of the chemicals are carried over distances ranging up to 30 or 40 km and eventually are deposited by rainfall in waterways or the soil. It has been estimated that even in good weather as much as 50 percent of the spray above agricultural fields does not reach the target crop. The increased use of herbicides in the USSR has resulted in a corresponding increase in damage to sensitive crops in the vicinity of areas that have been sprayed from the air. Also, accidental drift of a chemical such as endosulfan can entirely eliminate fish from a small body of water.[5 18]

In addition to damage to nontarget plants and animals, aerial spraying presents hazards to humans other than the agricultural workers themselves. Soviet investigations carried out in the cotton-growing regions of Tadzhik, SSR, revealed that particles of the organochlorine insecticide HCCH remained in the atmosphere five to six days after aerial spraying. Atmospheric concentrations varied from 1.30 mg/m$^3$ on the first day to 0.06 mg/m$^3$ on the fifth day. For comparison, spraying from the ground produced concentrations of only 0.58 and 0.03 mg/m$^3$, respectively. The threshold of the effect of this toxic chemical on the electric activity of the brain is 0.04 mg/m$^3$.[19]

Despite the obvious harmful side effects of aerial application of chemicals, there is no indication that the Soviets intend to reduce or even level off their use of this method. In fact, the Soviet program for full mechanization and chemicalization of agriculture has led to a rapid increase in the use of agricultural aviation, and it is likely to continue to increase. The Soviets are experimenting with new developments in spray nozzles, polymer thickening agents, and "superlow-volume spraying" in an effort to improve plant coverage and minimize drift. Apparently little can be done to solve the drift problem other than not spraying except under ideal weather conditions.[5 20]

AIR POLLUTION—Agriculture-related air pollution has received little attention in the Soviet press because agricultural practices contribute relatively little toward lowering the quality of the air. This is not to say that it is an insignificant form of pollution, but only that it is small in comparison with water and soil problems. Moreover, it is a problem primarily affecting agricultural workers and their families.[21]

Pesticides, directly or indirectly, are the main source of air pollution in agriculture. When vast areas of crops are chemically treated, air pollution is unavoidable; the danger to plants, animals, and man is well documented. In the southern cotton-growing regions of the USSR, it has been determined that the air is polluted by phosphorganic and chlororganic pesticides—methylmercaptophos, phosphamidon, DDT, and others. Moreover, evidence is accumulating that particles of toxic agricultural chemicals are commonly found in the atmosphere and are carried throughout the world by air currents.[10 12] A 1970 Soviet study of chemical pollutants in the air and their effect on embryogenesis showed that the intensive use of chemicals for crop protection has increased the risk of harmful effects to people living in the immediate vicinity of treated fields. A relationship was established between the degree of atmospheric pollution by organophosphorus pesticides and the number of abnormal pregnancies.[22]

Dust is one of the principal unfavorable factors in mechanized agricultural production, and that dust contains pesticide residues. The Soviets report that during the harvesting of sugar beets the persistent chemical hexachloran, which was used against insect pests of sugar beets as much as five months before harvest, may be found in air samples in a quantity from 0.008 to 0.21 mg/m$^3$. Nosebleeds of agricultural workers have been observed that are associated with the presence of hexachloran in the dust. The effect of the dust on the eyes can result in conjunctivitis, and edema of the eyelids may occur when mineral fertilizers are present in the dust. The reaction of the membranes of the upper respiratory passages in the workers is seen in the form of hypertrophic catarrh and

the secretion of sputum which continues for three to four days after the harvest has ended.[23]

In the arid Central Asian republics and in the semiarid steppes of the USSR, pollution by natural, wind-eroded, chemical-containing dust is as harmful as industrial contamination if not worse. The dust can be contained only if the soil is stabilized, and stabilization may not be realized on marginal land that is sown to crops every year.

Toxicity and Requirements for Use—In 1972, 130 pesticides were approved for use by the Soviets (in 1976 the figure was more than 200), in addition, 70 pesticides were being used experimentally. Chemically, they may be grouped as follows: 45 organochlorines, 28 organophorphorus compounds, 19 nitrocompounds, 12 sulphur compounds, 18 were of mineral origin, 6 carbamates, 12 were of vegetable origin, and the remaining were of other groups or were biological products. All of these pesticides have been divided into four groups according to their degree of toxicity ($LD_{50}$)* for humans and warm-blooded animals (Table 1).

It can be seen that of the various types of pesticides used by the Soviets, the insecticides are the most toxic for warm-blooded animals. The figures in the table are not fully applicable to other groups of organisms, however, including marine life. The lethal doses and concentration for many of these organisms must be ascertained individually before it can be determined what danger a given pesticide represents to the living organisms of an ecosystem, particularly those that are useful to man. This is one of the main problems of chemical plant protection now being worked on by scientists in the USSR and other countries.

*The $LD_{50}$ value is a statistical estimate of the number of mg of toxicant per kg of body weight required to kill 50 percent of a large population of test animals.

In the efforts now being made by Soviet chemists and agriculturists to increase the number of pesticides available to agriculture, the objective is to reduce toxicity indices for nontarget organisms as much as possible. According to Soviet data (table 2), fewer and fewer pesticides having a high toxicity for warm-blooded animals are being recommended for use in the USSR.

The danger of environmental pollution from a given pesticide cannot be measured by the $LD_{50}$ toxicity index alone. Other extremely important factors are the chronic toxicity of a chemical compound; and the value of the "accumulation coefficient," i.e., the extent to which prolonged exposure to small concentrations of the pesticide affects the condition of organisms and, in particular, their reproductive capacity. Soviet scientists have done little work in this area, and extensive research will be required to study the effects of all of the most widely used pesticides on all organisms exposed.[8 24]

The Soviets like to call attention to their imposition of stringent requirements for the use of chemical pesticides in agriculture, their banning of some of the more persistent or highly toxic materials, and their increasing emphasis on a search for biological control methods that will eliminate or reduce the need for

Table 2

Reduction in Toxicity of Soviet Pesticides, 1960-1974

| Toxicity Levels $LD_{50}$ | 1960 | 1968 | 1974 |
|---|---|---|---|
| (mg/kg) | (%) | (%) | (%) |
| <50 | 55 | 20 | 8 |
| 50-200 | 35 | 20 | 12 |
| 200-1000 | 10 | 43 | 46 |
| >1000 | 0 | 17 | 34 |

Table 1

Types and Toxicities of Approved Soviet Pesticides, 1972

| Toxicity Group | $LD_{50}$ | Numbers of Compounds | | | |
|---|---|---|---|---|---|
| | | Insecticides | Fungicides | Herbicides | Zoocides |
| | (mg/kg) | | | | |
| Strong | <50 | 11 | 4 | 0 | 3 |
| High | 50-200 | 11 | 4 | 0 | 2 |
| Medium | 200-1000 | 19 | 17 | 20 | 0 |
| Low | >1,000 | 9 | 14 | 26 | 0 |

chemicals. They have done all of these, which is to their credit, but not to the extent that their statements on the subject would lead us to believe. The stringent requirements are relaxed when there is a need for an undesirable but particularly effective chemical, and "banned" chemicals such as DDT and parathion, are merely limited in use. For example, the US herbicide treflan had been unacceptable to the Soviets until recently because of its persistence in the environment and questions concerning its effects on humans. Nevertheless the Soviets are now negotiating with the US for a plant that will have a capacity of 5 million liters of treflan per year because they have a very serious weed problem with soybeans and vegetables.[25] DDT was banned in 1970 but was used in 1973 and in 1974 when sugar beet weevil infestations were particularly severe. The users of DDT, however, had to meet one restriction, viz., all spraying was to be completed 70 to 80 days prior to harvest; such a restriction is of no consequence insofar as protection of the environment from this most persistent of pesticides is concerned.[13]

In general, most types of pesticides are widely used in the Soviet Union, and numerous environmental accidents due to pesticides have already occurred. Soviet scientists, however, are greatly concerned about the long-term effects of the continued use of these toxic chemicals and are actively searching for alternatives. Barring a major breakthrough in other methods of pest control, pesticides will continue to play the main role in Soviet protection. As the Soviet population grows, agriculture will be intensified and hundreds of thousands of hectares of land now unsuitable for farming will be cultivated. The area treated with toxic chemicals will increase, and stress on the flora and fauna in all agricultural areas will intensify. In the opinion of some of the most prominent scientists in the world, including an authoritative commission of the Soviet Academy of Sciences, pesticides will play a major role for the next 20 to 30 years in protecting crop plants from insects, diseases, and weeds. The most environmentalists can hope for in this area is the development and judicious use of less toxic, more selective, and rapidly biodegradable compounds.[21 26 27]

## Fertilizer

The science of agronomy has established the fact that among the three decisive factors for raising crop yields—fertilizer, breeding, and cultivation—fertilizer accounts for up to 50 percent of an increased yield. This fact has not been lost on the Soviets. In the last 10 years, Soviet agriculture has been supplied with a sharply increasing amount of mineral fertilizer. The totals, in million of tons, are 27 in 1965, 45.6 in 1970, and 72.4 in 1975. Total mineral fertilizer availability to agriculture in 1976 is projected at 78.6 million tons, and is scheduled to reach 115 million tons by 1980. Also, with each year, the concentration of nutrients in this fertilizer increased from 25 percent in 1965 to 29 percent in 1970 and 37 percent in 1975. This ever increasing tonnage of chemical fertilizer spread on Soviet fields is in keeping with agricultural practices worldwide and may be defended on the basis of food needs. It is, however, a definite hazard to the environment.[28 29]

Agricultural plant nutrients that are washed into waterways stimulate the growth of aquatic vegetation. This causes an overgrowth resulting in the obstruction of canals, rivers, and reservoirs. Even an insignificant amount of phosphorus in runoff water is sufficient to create favorable conditions for the development of microflora that are capable of disrupting the oxygen regime in a body of water. One pound of phosphates can grow 700 pounds of algae provided other nutrients also are present. The actual amounts of nutrients lost depend primarily on the type and mechanical composition of the soil, the amount and character of precipitation, the type of plants cultivated, the use of agrotechniques, and the type, amount, and method of application of fertilizer.[30]

RUNOFF--The pollution of waterways by chemical fertilizers as a result of runoff from agricultural lands has attracted considerable attention in the USSR. Unfortunately, the problem of runoff has not been treated sufficiently in Soviet scientific and technical literature. According to data from Leningrad State University, no washing out of nitrogen (N), phosphorus (P), or potassium (K) from several types of fertilized soils has been noted in the USSR. The All-Union Institute of Fertilizer is in agreement on P and K, and believes that the washing out of N into drainage waters does not exceed one percent.[30] While it is agreed that nutrient runoff from agricultural land is probably not now a significant problem in the USSR overall, it almost certainly contributes more to the pollution of some Soviet waterways than such data indicate. In the first place, agricultural drainage contains a certain amount of nutrients even where fertilizer is not used. Secondly, the Soviets arrive at their conclusions largely on the basis of theoretical data concerning agronomic chemistry and some experimental data on drainage water analysis. Thirdly, and perhaps most important, as a result of

shortages of fertilizer in the USSR, application rates of fertilizer fluctuate, depending on the priority of the crop and available moisture. For example, highest application rates occur in the irrigated areas of Uzbek, Tadzhik, and Turkmen where cotton, which receives top priority, is the major crop. The next largest application rates occur in the Baltic Republics—Estonia, Latvia, and Lithuania—and in Belorussia, followed by the Ukraine and Moldavia, for sugar beets, corn, and small grains in that order. Lowest application rates are noted for Kazakhstan, which is to be expected for a grain-growing area with low precipitation. Only in Kazakhstan, is the Soviet conclusion on N washout believable. Cotton and sugar beets are believed to receive fertilizer at rates sufficiently high to produce significant N, P, and K pollution of drainage water. The true figure for N loss is probably between the Soviet figure of 1 percent and Dr. Barry Commoner's estimate that 15 percent of all fertilizer N is lost to surface waters in general.[31–33]

Nonetheless, if inorganic fertilizer is not now a significant source of water pollution in the USSR, it almost certainly will become so in the near future as nutrient levels of Soviet fertilizer and application rates continue to rise. Ironically, while US environmentalists call for the use of more organic wastes on farms and less chemical fertilizer, the Soviets are making every effort to bring their use of N, P, and K up to the "problem pollutant" levels found in the United States. Soviet concern for future water pollution from fertilizers was brought out by a delegation of Soviet water pollution specialists that visited a US laboratory in October 1975.[34] The Soviets are particularly concerned about eutrophication of rivers and are studying the relationship of agricultural chemicals to this problem. Concern for the future also is seen in the planned research of the Siberian Division, Institute of Chemistry, Academy of Sciences, USSR. Despite the fact that very little fertilizer is being used now in Siberia, the research program of this institute includes studies to determine (1) how crop yields can be maximized with minimum pollution, (2) how to increase N without increasing pollution, and (3) whether some crop varieties can make better use of P than others, thus permitting a reduction in the rate of application of P.[35]

GROUNDWATER CONTAMINATION—No reporting has been seen on possible nitrate contamination of well water from fertilizer N in the Soviet Union. It is known to be a problem in other parts of the world, however, and was the subject of a recent conference in Europe. It is a fairly safe assumption that groundwater also is known in certain rural areas of the USSR where fertilizer applications have been the highest. Organochlorine insecticides have been detected in Soviet ground water in isolated instances, and it is believed that nitrates also are present.[36] [37] Nitrate appears to be relatively innocuous in the human body, but it can be converted to poisonous nitrite by the action of certain intestinal bacteria that are often more active in infants than adults. Infant poisoning from excessive nitrate (methemoglobinemia) in drinking water has been reported in France, Germany, Czechoslovakia, and Israel. In the United States, fertilizer drainage has raised the nitrate level of drinking water in some farming areas above the safe limit (45 ppm) recommended by public health authorities.[10]

## IRRIGATION AND DRAINAGE

Water projects unprecedented in scale anywhere in the world are being carried out in the Soviet Union. In the past decade, the area of newly reclaimed lands was doubled and now exceeds 25 million hectares. These areas, which occupy about 8 percent of the croplands and orchards, account for a quarter of the country's crop production. Land reclamation is an important focus of Soviet agricultural investment. Approximately US$8 billion a year is being expended for water and land resource development projects. More than a million hectares of newly irrigated land was put into use in 1974, about half of which was improved pasture. Also, an area only slightly less in size was drained, and water for livestock was provided on about 10 million hectares. In 1975, plans called for another million hectares to be irrigated and more than a million hectares to be drained. If these goals were achieved, a total of 3.7 million hectares was irrigated, and 4 million drained during the Ninth Five-Year-Plan (1971-75). The long term plan for land reclamation for the period 1976-85 is to bring the country's total reclaimed area up to 48 million hectares. Much of this reclamation is taking place in the non-Chernozem Zone of the RSFSR.[38–42]

In addition to its many positive results, land reclamation is one of the most effective forces encroaching upon nature. It leads to unfavorable changes in bodies of water, soil processes, and flora and fauna in surrounding areas. Agricultural drainage water—containing the nutrients conducive to eutrophication—fouls streams, lakes, and reservoirs. Small rivers and streams may disappear, or become parts of canals, and thus upset the ecological balances. In the development of irrigation in the Soviet Union,

some of the principal problems are unfavorable consequences to the rivers and lakes from which the water was taken, losses and waste of the diverted water, and the salinization of soils. The latter, together with raised ground water levels, causes an average of over 170,000 hectares of irrigated land to be taken out of cultivation each year in the USSR.[43 44]

## Water Problems

Agriculture is the largest consumer of water in the USSR primarily due to the irrigation of croplands. About three times as much water is used in agriculture as is used in industry.[45] This amounts to some 150 $km^3$ at present, and consumption is expected to almost double in the next 10 to 15 years. Plans call for the area of irrigated land in the USSR to reach 21 million hectares by 1985.[7 40 45]

For a variety of reasons, water in the USSR has been treated as free and consumed without regard for future consequences. The Soviets, until recently at least, have not cared how much water they used for irrigation. Consequently, the conservation of irrigation water—once it has been diverted from the rivers—is now a major problem for the Soviets. Only about 60 percent of the water diverted for irrigation reaches the fields, and as little as one-fifth of all Soviet irrigation water actually is used by crops. The main causes of water loss are seepage from irrigation canals; evaporation from canals, aqueducts, reservoirs, and fields; and the growth of water-consuming plants which grow along the waterways. Seepage is perhaps the greatest source of loss. The Kara Kum Canal in the Turkmen Republic, one of the largest irrigation diversion schemes in the country, is a case in point. Water loss from this canal almost equals the annual discharge of the Murgab and Tedzhen Rivers. This lost water forms a whole series of lakes and seepages along the canal that are overgrown with reeds known for their tremendous and useless evaporating capacity. The seepage from irrigation canals and over enthusiastic use of water for irrigation also has caused a rise in the water table in many areas. This has facilitated salinization of the soil, especially in dry areas of the USSR.[44-46]

The Soviets recognize that it is essential to increase considerably the proportion of enclosed drainage system construction. The technical, economic, and environmental advantages are unquestionable. A particular feature of Soviet land reclamation in the 1970s is that it will go "underground." Plans call for three-fourths of the irrigation and collection-drainage network and the entire drainage system, except water intake points, to be converted to closed pipe. A closed-pipe system eliminates soil losses, creates better conditions for the mechanization of field work, and sharply reduces losses of water in the irrigation process.[47]

The water for Soviet irrigation is diverted primarily from the surface flow; underground waters account for only about 2 percent. The Soviets are now seriously concerned about a definite decrease in the basic source of water. Some Soviets believe the Don River is going dry. One reason is that rivers such as the Usmanka, a small tributary of the Voronezh River which empties into the Don, have all but disappeared because of improper soil conservation, poorly planned timber removal, and indiscriminate swamp drainage. Also, the levels of the Aral and Caspian Seas have been lowered considerably. The Aral Sea has dropped by nearly 3 meters in the past 10 years and has been predicted to drop another meter by 1980. Both the Caspian and Aral Seas are in arid regions, and large quantities of their waters have been diverted for crop irrigation.[7 40 44 45]

Another major problem facing the Soviets is the availability of water in the major agricultural areas of Soviet Central Asia, North Caucasus, and Transcaucasus. Land is still available in these areas, but the rivers are just about committed both in terms of environment and total water available. Thus, the Soviets will have to bring water in from northern rivers by transplace and diversion. These rivers flow to the north as does the entire land form, which greatly complicates the task of bringing water south. The environmental disruption from such a massive undertaking will be enormous.[39]

## Soil Salinization

One of the unfortunate economic consequences of man's influence on natural landscapes is salinization of soils in the regions of irrigated farming. Irrigation inevitably leads to a build up of salts in the soil that must be removed to maintain soil fertility. In the USSR, soil salinity is a particular problem in southern areas where natural drainage is poor, rainfall is low, and evaporation is high.[18]

In Turkmen SSR, for example, the Kara Kum Canal brought about the development of more than 100,000 hectares of irrigated cotton plantings alone on virgin land. The amount of irrigated land increased from 522,000 hectares in 1955 to 830,000 hectares in 1974. The increased water intake (about 2.5 fold) and

Inadequate drainage caused a mass rise in the ground water level and an increase in the area of salined and swampy soils. As a result, in 1966-68 tens of thousands of hectares of irrigated land had to be taken out of production. It was necessary to construct a drainage network of about 15,000 kilometers that removed harmful ground water from the irrigated areas. In 1975, 3 billion cubic meters of mineralized water were drained off "beyond the borders of the irrigated zone"—2.2 billion cubic meters more than in 1965. More than 19 million tons of harmful salts were removed from the fields, three times as much as in 1965, and the official call is for stepping up the rates of leaching of the land. Salinization in the Turkmen region has resulted in the accumulation of tremendous supplies of salts on the surface and in the profiles of the soil, and it is becoming more intense each year. According to Soviet computations, the potential supplies of these salts in the upper 8- to 10-meter layer amount to 600 to 1500 tons/hectare; the major portion is in the 3- to 5-meter layer. Yields of most crops are not adversely affected by salt content in the soil solution up to about 0.9 gm/l. For greater salt content, however, yields decrease continuously, and crop production seldom has been successful when the only source of irrigation waters contained more than 5 gm/l of salt.[31 48]

In Uzbekistan, a project was begun in 1962 to flush chemical salts as high as 40 gm/l from the rich loess soils. To date, 280,000 hectares have been reclaimed. The Soviets plan to reclaim a total of 1 million hectares at a cost of US$50 billion. In this particular project, the salt water resulting from leaching the soils is carried off through a drainage network to an old lake bed. If the drainage water is returned to natural waterways, the usual method of disposal, it becomes a serious pollutant. Pollution in the Caspian Sea is partly the result of high salt content, which affects the production of caviar and the fish industry in general.[49]

The usual approach to controlling salt is to use water with a low salt content and to flush accumulations of salt into the ground water, which ideally should be at least 2 meters below the soil surface. The concentration of salt in irrigation water typically increases greatly as it flows downstream through the irrigation system, as water is evaporated or transpired. There are no known Soviet studies on this subject, but US studies on the effects of irrigation on salt in streams show how the concentration of salts increases in waters of a river. One such study showed a 20-fold increase in concentration of salt in water in the stream channel over a 200-mile area. The transition was from a fully satisfactory rating for agricultural use to one totally unsatisfactory.[19 31]

As the water becomes more salty, more water must be used to flush salts into the subsoil. Attempts to economize water under such conditions, as by wetting only the top 1 or 2 meters of soil, inevitably lead to increased salt concentrations. "Success" in flushing salts into the groundwater also has its price. It is possible for nitrates to build up in the groundwater to such an extent that the water is toxic to man and livestock. The application of inorganic fertilizers aggravates the situation even further, as discussed elsewhere in this report.

## EROSION

Protection of the soil from erosion plays a vitally important role in maintaining the effectiveness of agriculture worldwide, but it is a particular problem in the Soviet Union. Because of Soviet neglect and mismanagement of the land in the past, erosion by both wind and water is an immediate threat to vast areas of croplands in the USSR and is probably the most urgent conservation problem facing Soviet planners.

About 300 million hectares of land are used for agricultural purposes in the USSR at present, exclusive of desert pastures. About two-thirds of the cultivated lands lie in areas particularly susceptible to erosion. An estimated 5 to 6 million hectares of sown land are damaged by wind erosion alone every year and a rough average of 0.5 to 1.5 million hectares of cropland are ruined annually. Furthermore, these losses occur on the best agricultural soils of the country—chernozems, chestnut browns, and grey-brown podzols.[40 46]

Water erosion, a particularly intensive problem in the North Caucasus, the Transcaucasian republics, and Central Asia, causes arable fields and pastures to be less productive. In old descriptions, areas along the Don River were "level as a table." Recent studies of 9 million hectares of soil in these areas show 0.5 million hectares unsuitable for use because of gullies and ravines. Every year 27 million tons of black earth go down the Don. In some regions soil loss has reached 40 to 45 percent. In 1970 it was reported that the arable lands in the Georgian Republic had decreased by 38,000 hectares in the past 10 years as a result of water erosion. Georgia is the only major subtropical agricultural area in the USSR, and thus it is of particular importance to the Soviet economy.[40 46 60–63]

Whereas water erosion acts slowly to decrease the amount of arable land, wind erosion is a more immediate threat. Certain portions of the agricultural lands of Western Siberia and Northern Kazakhstan, an area that was developed in the virgin lands program of the 1950s, average more than 20 days of dust storms per year. During one of these storms as much as 18 tons per hectare per hour of sandy loam topsoil may be blown away. As with water erosion, dust storms are the product of natural conditions that often are worsened by agricultural practices. A veteran Soviet agriculturalist, Yuriy Chernichenko, argues that neglect of antierosion measures—especially those in connection with clean fallow—in the virgin lands was the key to crop failures. He further states that the same processes that led to disastrous wind erosion and declining crop yields in the virgin lands are being repeated in the black earth zone of European RSFSR. As a result of pressure imposed by Party officials, clean fallow in the RSFSR was reduced by 4.2 million hectares in the last four years, 1972-75.[46 84 88]

The drier steppe regions of the Ukraine and the North Caucasus also are very prone to dust storms. In 1960, a storm damaged more than 4 million hectares of crops, of which 612,000 hectares were destroyed completely. Crops either were blown away, left to die with roots exposed, or covered by the drifting soil. Dust reached depths of 3 to 5 feet at some points, and fallout was evident as far away as Warsaw, Budapest, and Belgrade. Other less severe storms in this area were reported in 1964, 1965, 1969, and 1970. Since 1970 the storms have occurred almost every year. The annual loss of topsoil can reach astronomic figures. In such erosion-prone areas, a loss of 50 tons of soil per year from each hectare of plowed land is a conservative estimate. At that rate it takes only 50 years to lose a minimum of 6 inches of productive topsoil and less than 80 years to lose the whole fertile top layer. In reality, it is likely that the loss is much more rapid. Soviet authorities estimate that erosion costs the USSR in excess of 10 billion rubles a year for losses in land, crops, livestock, and for damages caused by sedimentation and pollution in reservoirs and waterways. The latter largely occurs through drainage, but one of the worst cases of agriculture-related pollution of a body of water in the USSR occurred when dust storms blew fertilizer mixed with topsoil off of land in the Krasnodar Kray into the Sea of Azov.[83 84]

The loss of nutrients by wind and water erosion is very difficult to measure and no work is known to have been done in the USSR on this subject. Most streams, however, contain considerable quantities of suspended soil material especially after heavy winter rains. As a prominent Soviet soil scientist recently stated: "If radical measures are not taken in the near future to regulate the run-off of thaw and torrential waters over large areas, the problem of protecting water resources from pollutants from the fields and farms will be more complicated than the problem of industrial discharges."[11] The run-off water carries away more N, P, or K than Soviet industry produces. In addition, a tremendous quantity of other elements of plant nourishment is lost.[36 80]

The seriousness with which the Soviets view the erosion problem is seen in urgent calls from the Party and the highest level of government in 1967 and again in 1971 for the implementation of antierosion measures. It was officially stated then that "the struggle against wind and water erosion is one of the most important State tasks." Yet today, eight years later, relatively little has been accomplished. The Soviet approach to combating soil erosion continues to be based on directives from Moscow rather than on a closer relationship with scientific organizations at the local level.[46 83]

Among antierosion measures, protective forestation is extremely important. In 1960 the Soviet Government drew up an ambitious "shelterbelt" plan for reforestation to stabilize the soil and temper the wind. Neither this plan nor a subsequent plan announced in 1967 has been implemented with any success. Because of Soviet preoccupation with large-scale mechanized farming, the more labor-intensive contour strip cropping—an effective control for water erosion—is dismissed by Soviet experts as not applicable. Special plows and machinery that proved to be greatly effective in controlling erosion are produced in insignificant quantities. Questions of land reclamation are worked out mainly from engineering and technical positions, without integrated validation by life scientists. Even basic agricultural practices such as crop rotations for field protection are being conducted poorly and insufficiently. The battle against soil erosion in the USSR is not being conducted in a manner commensurate with its importance to the nation.[45 46 50 51 53 56]

Directives of the 24th Party Congress set forth a number of antierosion objectives for 1976-80, including the planting of 350,000 hectares of windbreaks, and stepped-up production of special agricultural machines and equipment used in erosion-control work. It remains to be seen if these plans will be implemented any more successfully than those in the past. In any case, the sheer magnitude of cropland

erosion in the USSR ensures that it will remain a serious problem indefinitely.[44]

## ANIMAL WASTES

The wastes of farm animals are a concern in the reduction of water, air, and soil pollution. Animal wastes are associated with eutrophication of waterways, fish kills, nitrate contamination of soils and aquifers, off flavors, annoying odors and dusts, dissemination of agents infectious to animals and man, and reproduction of insect pests. The United States and the USSR are the nations most involved in the problem because of the size of livestock production and the feeding systems. The Soviets estimate that in a year's time up to 600 million tons of manure are accumulated on livestock farms and feed lots in the USSR.* The daily discharge of effluents in large Soviet livestock complexes is as high as 3,000 cubic meters. Soviet scientists have established, for example, that for every liter of milk, a cow excretes approximately 1.4 kg of manure; in the fattening up process, cattle excrete 6-24 kg of manure per kg of weight gain.[6 57]

The animal waste disposal problem in the USSR has grown phenomenally in the past decade as their numbers of livestock greatly increased. Between 1964 and 1974 the number of cattle increased by 18.8 million head (30 percent) sheep and goats by 16.6 million (16 percent), and poultry by 274 million, or about a threefold increase.[59] But the problem is more than numbers. Because of the climatic conditions and location of feed supplies, most Soviet livestock are concentrated in western USSR. The problem is further compounded by the trend in modern animal husbandry to concentrate livestock in industrial units or complexes, which are being constructed near large population centers.[60] In accordance with the April 1971 decree of the USSR Council of Ministers entitled, "Developing the Production of Livestock Products on an Industrial Basis," 22 State pig farming complexes were built throughout the country during the 1971-73 period. At least four of these complexes each have a capability for fattening 108,000 pigs. In 1972 the Soviets contracted with a US firm, Ceres International, for the construction of three cattle feedlots: a 30,000-head facility near Krasnodar, and 20,000-head facilities near Tbilisi and Volgodonsk. The latter went into full operation in 1974. The USSR plans to build over 1,000 of these feedlots by 1980.[61] The Soviets claim that at the present time more than 13 million head of cattle, 20 million hogs, and 142 million head of poultry are being maintained on farms which are completely mechanized. While this ensures economical production of meat, milk, and eggs, a major drawback is the necessity for collecting, treating, and utilizing huge amounts of animal waste.[57 62]

In general, most environmental problems associated with animal wastes arise on confinement farms on which the numbers of livestock are so great that more manure is generated than can be spread on crops and pastureland in the area. The problems are greater when the farms with a manure surplus are located in "sensitive" areas, i.e., densely populated areas, recreational areas, and areas from which drinking water supplies are drawn. The arable lands in the vicinity of Moscow and Leningrad, for example, receive 10 to 20 tons of organic wastes per hectare, while farmland in oblasts such as Orel, Pskov, and Astrakhan receive only 2 tons or less.[64] River water that is polluted with large quantities of runoff from manured land, feedlots, swine houses, and the like is characterized by a low or zero dissolved oxygen content and a high ammonical N content that are detrimental to fish. In 1975, sewage from the "Soviet Power" State pig-breeding farm near Moscow killed tens of thousands of fish along an 8-mile stretch of the Protva River.[21 65] The ammonical N content of the direct runoff from livestock complexes is so high (180 mgs/l) that it can cause ammonia poisoning of crops unless diluted before application to farmland of crops. An acre-foot of runoff from a large cattle feedlot may contain 2 to 35 kgs of ammonia-nitrogen, 1 to 10 kgs of nitrate-nitrogen, and about 45 kgs of P. These amounts are up to 15 times the ammonia, 2 times the nitrate, and 35 times the P content of runoff from fallow land.[66]

The Soviets have begun to realize the seriousness of animal waste management now that their program for modernization of agriculture is in full swing. The US Waste Management Team, part of the US/Soviet science and technology exchange, during a visit to the USSR in 1975 was briefed on the pressing problems of waste management in the USSR. The Soviets are concentrating their attention on (1) environmental pollution control, (2) disinfection and decontamination of manure, and (3) treatment of waste waters so they can drain into natural waterways. The US and Soviet representatives exchanged proposals outlining specific areas for cooperation for the 1976-1980 period.

*This figure is believed to be highly conservative. The US and USSR have almost equal numbers of livestock, particularly cattle and swine, and the amount of solid manure from US animals is estimated at 1.1 billion tons annually plus 450 million tons of mixed liquid and solid waste. Animal waste in such quantities is equivalent to that produced by 1.9 billion humans, or roughly half the population of the world.[21 57 66]

The common goal is to develop management practices for more efficient waste utilization while maintaining a clean and safe environment.[67]

Soviet scientists are stressing two approaches to the use of animal waste (1) utilization as fertilizer, and (2) recycling as feed additive. Thirty-two specialized organizations have been set up to engage in this work. Treatment designs generally include liquid-solid separation, biological treatment of the effluent, and use of the solids for fertilizer, and the treated effluent for irrigation. Liquid-solid separation is usually accomplished by using vibrating screens or an auger press. In some designs, both are used in series to lower the water content of the solids. Centrifuge and electrocoagulation methods also are being evaluated. Liquid treatment often involves aeration of the secondary effluent. Facilities are similar to those commonly used for treatment of municipal and industrial sewage. When the US team questioned the necessity for such thorough treatment, especially since the final use is for land application, the Soviets pointed out the severe environmental restrictions that they must work under. They stated that all industrial complexes, including livestock, must have treatment facilities. Furthermore, if effluent is returned to streams, the chemical oxygen demand (COD)* must be less than 10 mg/l. There is considerable concern, too, on the part of the Soviets about worm eggs (parasites), which could not be identified by US scientists. Some Soviet scientists indicated that control of worm eggs had a higher priority than COD reduction.[67] [67]

The Soviets are interested in recycling wastes for feed purposes particularly a manure recycling process developed by Ceres International. The process can produce silage, pellet feed for range cattle, and a protein supplement feed. A Ceres official estimates that if the manure produced annually by only one-half of Soviet cattle were processed by the Ceres method, the protein produced would be equal to that of the annual US soybean crop. The Soviets are also investigating some types of direct refeeding, but this is not looked on with favor by most Soviet agricultural scientists.[67]

## POLLUTION CONTROLS AND STANDARDS

It is easy to get the impression from Soviet reporting that the USSR is a model nation in preventing, reducing, or eliminating environmental disruption. They have a plethora of stringent antipollution laws, a great many government organizations in several ministries involved in the administration of these laws, and many environment-minded citizens. But the acid test of any legislation is its effectiveness, and the Soviet record of failure to control pollution is similar to that found in advanced Western countries.[63]

In most instances, Soviet pollution control standards are much more stringent than US standards. Their health standards, for example, for maximum allowable exposure to environmental poisons are one-fifth to one-tenth those of the US. The Soviets cannot enforce such strict standards, however, and they are making little effort to do so. In the area of land improvement, neither the machine operators, the agronomists, nor the farm managers bear responsibility for protecting the land and its fertility. Not even a token fine is known to have been levied against anyone for neglect of the land resulting in soil erosion. The strict guidelines for using pesticides are not always followed. Overuse and misuse of chemicals appear to be as common in the USSR as they are in the US. The Soviets apparently do not possess the equipment or technology to achieve their standards. Visiting US scientists report a total lack of sophisticated monitoring and test equipment, particularly for monitoring water pollution. Moreover, pollution research is being conducted by small and scattered groups who have inadequate experimental facilities.

The Soviets are believed to be very serious with regard to controlling pollution. Environmental exchange agreements have been reached with the US involving visiting US scientists in such areas as integrated pest management, animal wastes, and wind erosion. Also, the wealth of government-sanctioned literature confirms that there is an increasing awareness in the USSR of the problem of agriculture-related pollution. The Soviets, however, must be finding it very difficult to give priority attention to agriculture-related problems of the environment considering their agricultural production problems.[70]

The many Soviet organizations involved in protecting the environment are largely uncoordinated advisory bodies. To monitor and control their efforts, the Soviets recently established a new organization under the administration of the Hydrometeorological Service (Hydromet), the agency primarily responsible for coordinating the US-USSR environmental exchange agreement. Although the new move is further evidence of high-level concern, it fails to ensure effective controls as Hydromet was not granted

*COD is a measure of the oxygen required to oxidize all organic compounds and thus is an indication of the load being placed on natural waterways pollutants. COD in runoff from a large feedlot could range from less than 500 to more than 6,700 mgs/l.

any regulatory powers. Thus the Soviet Government continues to entrust pollution control to the industrial and agricultural ministries that are the major pollutors. Unless substantial penalties are developed and enforced, the Soviet environment will continue to suffer from agriculture-related pollutants as those charged with agricultural production strive to meet or surpass harvest goals.[44 63]

*This report was prepared by the Office of Scientific Intellig*

## REFERENCES

*The source references supporting this paper are identified in a list published separately. Copies of the list are available to authorized personnel and may be obtained from the originating office through regular channels. Requests for the list of references should include the publication number and date of this report.*

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