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land availability, crop production, and fertilizer requirements in the united states

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LAND AVAILABILITY, CROP PRODUCTION, AND FERTILIZER REQUIREMENTS IN THE UNITED STATES

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for the Office of Solid Waste Management Programs
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PREFACE

The disposition of increasing quantities of municipal wastewater treatment sludges and animal waste is a subject receiving considerable attention by various Federal, State, and local representatives.

The Office of Solid Waste Management Programs is currently evaluating the reuse potential of municipal wastewater treatment sludges and animal waste as a soil conditioner and/or as a fertilizer supplement. The decision to dispose of these waste materials in a disposal site or by some other means should only be reached after all utilization opportunities have been thoroughly investigated and dismissed.

This report provides information on land availability, crop production, and fertilizer requirements in the United States as it relates to animal waste and sewage sludge utilization and disposal. Information on health effects, plant toxicity, metals content, and the relative economics of utilizing sewage sludge and animal waste on agricultural lands including collection, transportation, and application costs are not considered within the scope of this report. The Office of Solid Waste Management Programs, however, does intend to address these very important issues as part of its total effort on utilization of animal waste and sewage sludge.

INTRODUCTION AND SUMMARY

The question of what to do with the increasing amount of animal waste and sewage sludge generated in the United States annually is an extremely perplexing environmental problem of recent and great concern. The disposition of these solid waste residues has been commonly associated with problems of air and water pollution, odors, and other nuisance conditions considered to be of an adverse nature. The problems that arise are generally the result of mismanagement involving improper distribution and concentration of these waste products rather than an inability on the part of nature to fully assimilate the vast quantities of waste generated.

Until the mid-1940's, the disposition of animal waste presented few problems as the majority of the waste generated was recycled through its application to prime agricultural lands. It was used extensively for its fertilizer value and as a source of organic matter to improve the physical characteristics of cultivated soils. It was regarded by many as the mainstay of most soil fertility and improvement programs and as such was considered more of an asset to the average farmer than an economical liability, as it is commonly looked upon today.

Shortly after the conclusion of World War II, the agricultural industry experienced a tremendous increase in the production, utilization, and availability of low cost commercially produced nitrogen-containing fertilizers. This trend, spurred by greater demands for higher profits and productivity, resulted in animal waste being relegated to a much lesser role in the agricultural community. Recent shortages and higher fertilizer cost have had a significant impact that has not been fully assessed with regard to utilization of animal waste on land. However, it appears the majority of the animal waste is once again being applied to the land as a supplemental source of primary nutrients to help offset the increasing demand for higher cost commercially produced fertilizers.

Sewage sludge, on the other hand, has always been and in all probability will continue to be somewhat of a problem because of its inherent adverse qualities when not handled properly. Historically, the majority of the nation's population throughout the early 1900's resided on farms and was serviced by individual pit privies or septic tanks and tile fields. This resulted in relatively small and widely dispersed accumulations of sewage sludge that presented very few problems. Since that time there has been a significant increase in the U.S. population along with a general trend toward migration of the nation's population into the more urban and metropolitan areas. This, in addition to a relatively rapid growth in the construction of more and increasingly efficient wastewater treatment facilities, increased industrial waste loadings, and enactment of more stringent air and water pollution control legislation, has resulted in tremendous increases in the volume of wastewater treatment sludges generated as well as significant changes in its physical and chemical characteristics.

This report focuses on the nutrient value and soil improvement characteristics of animal waste and sewage sludge. Although purposely omitted, it is acknowledged that additional information must be obtained and thoroughly investigated relative to plant toxicity, metals accumulation, nitrate pollution, public attitudes, and the economics of transportation and application before formulation of any final conclusions or recommendations on how to best utilize animal waste and sewage sludge on land can be developed. Several of the above areas are currently under investigation by EPA's Office of Research and Development, Office of Water Programs, the U.S. Department of Agriculture, the Food and Drug Administration, and various private, State, Regional, and local government Agencies. It is not expected that any conclusive results will be available concerning the long-term effects of sludge application to soils within the next 3 to 5 years. Until such time that conclusive data are available, it is highly recommended that sludge be applied only in accordance with acceptable sludge management practices and that its application to cultivated soils be highly controlled or regulated and monitored to minimize any adverse environmental effects.

ANIMAL WASTE

The general nature of the animal production industry in the United States has changed dramatically over the past several decades. What was once considered a small, family-operated, diversified industry has evolved into a much larger, highly specialized, cost-effective business enterprise. The total number of animals on feed or held in confinement has nearly doubled since the mid-1940's.[1] Directly associated with these changes has been a tremendous increase in the amount of animal waste generated in confined and/or concentrated areas. It is currently estimated that 2 billion tons (wet weight) of animal waste is generated annually in the United States.[2] Table 1 presents data relative to the number of animals and their respective contributions to the total solid waste stream.

Nearly 80 percent of the animal waste generated falls on open pasture or grazing land and for all intents and purposes presents little or no problems due to its dispersed nature and remote location. The United States Department of Agriculture estimates at least one-half to two-thirds of the remaining animal waste generated in confined or concentrated areas is currently being recycled through its application to available croplands.[3] Although a detailed survey of recent practices has not been conducted that accurately reflects the real impact of today's tight energy supplies and high cost of commercial fertilizers, it has been reported that utilization is greatly increasing.[4]

The nutrient content and quantity of animal waste generated are highly dependent upon such factors as the type of animal, its age, size, sex, and breed, the type and amount of feed ration, the methods of storing, handling, and processing the waste, as well as a wide range of other environmental and physical considerations (e.g., soil types, climate, annual precipitation, animal density, etc.).

Typically 50 to 60 percent of the nitrogen, and 90 percent of the phosphorous and potassium contained in fresh animal waste is recoverable for possible reuse. The nutrient losses that normally occur are a result of long-term storage and handling of the material before it is ultimately applied to the land. It has been reported that 60 to 80 percent of the nitrogen losses that do occur are a direct result of leaching and volatilization while the remaining losses are primarily associated with surface water runoff.[5] A complete accounting of all nitrogen entering or leaving a particular feedlot is extremely difficult to predict because of the wide range of variables that can and do affect nitrogen availability. In addition to the nitrogen losses, it is estimated that only 30 to 50 percent of the nutrient value applied in the form of total nitrogen is available for crop utilization during the first year after application with progressively decreasing amounts of nitrogen becoming available in each successive year.[6]

TABLE 1

ANIMAL WASTE GENERATION FOR SELECTED ANIMALS IN CONFINED AND/OR CONCENTRATED AREAS (1974)

Animal Type	Average Size of Animal (lbs)	Total Number of Animals (Millions)*	Average Amount of Waste Generated/ Animal (lbs/day-wet)†	Total Amount of Waste Generated Annually (Million Tons)	Maximum Percent Confined (%)‡	Total Annual Generation of Confined Waste (Millions Tons)	Percent of Total Waste Generated (%)
Beef Cattle	800-1000	112.3	75.0	1540	12	185	44.8
Dairy Cows	1200-1400	15.2	100.0	280	50	140	33.4
Swine	150	59.4	8.5	95	50	48	11.5
Chickens	4	875.1	0.25	40	100	40	9.7
Sheep	100	16.5	4.0	12	20	2.5	0.6

*U.S. Department of Agriculture. Agricultural statistics, 1973. Washington, U.S. Government Printing Office, 1973. 617 p.

†Fogg, C. E. Livestock waste management and the conservation plan. In Livestock waste management and pollution abatement; Proceedings; International Symposium on Livestock Wastes, Columbus, Ohio State University, Apr. 19-22, 1971. St. Joseph, Mich., American Society of Agricultural Engineers. p.34-35.

‡Figures used for determining the maximum amount of animal waste generated in confined or concentrated areas have been developed based upon the general characteristics of the animal production industry and various statistical outputs revealing the total number of animals on feed or held in confinement at any one particular time.

Table 2 lists the average percent of elemental nitrogen, phosphorous, and potassium commonly found in the various types of animal waste. As indicated in Table 3 the maximum amount of nitrogen estimated to be recoverable for reuse from the animal waste generated in confined and concentrated areas is equal to approximately 1.5 million tons per year. Assuming one-half to two-thirds of the confined animal waste is already being returned to the land, only 500,000 to 750,000 tons of nitrogen could be considered as available for potential reuse on land. The effective nitrogen value of the confined animal waste as applied would only be equivalent to 100,000 to 300,000 tons of available nitrogen. This represents 1 to 4 percent of the total nitrogen consumed in the United States annually. If applied at an application rate such that 100 pounds of available nitrogen were applied per acre, animal waste could satisfy the nitrogen demand of 2 to 6 million acres of corn. Depending upon the plant requirements and soil fertility, the application rates may have to be adjusted. For example, the same amount of animal waste applied at a 50 pound per acre application rate of available nitrogen could satisfy the nitrogen demand of 4 to 12 million acres of wheat.

<u>TABLE 2</u>

AVERAGE PERCENT OF PRIMARY NUTRIENTS
CONTAINED IN FRESH ANIMAL MANURES*
(percent wet weight)

Animal Type	Average Moisture Content	Nitrogen (N)	Phosphorous (P)	Potassium (K)
Beef Cattle	80	0.70	0.20	0.45
Dairy Cows	79	0.56	0.10	0.50
Swine	75	0.50	0.14	0.38
Chickens	54	1.56	0.40	0.35
Sheep	65	1.40	0.21	1.00

*Peterson, J. R., T. M. McCalla, and G. E. Smith. Human and animal wastes as fertilizers. <u>In</u> Fertilizer technology and use. 2nd ed. Madison, Wis., Soil Science Society of America, 1971. p.557-596.

TABLE 3

MAXIMUM AMOUNT OF PRIMARY NUTRIENTS
ESTIMATED TO BE RECOVERABLE FROM
CONFINED ANIMAL WASTE
(thousand tons)

Animal Type	Nitrogen* (N)	Phosphorous+ (P_2O_5)	Potassium‡ (K_2O)
Beef Cattle	651	768	908
Dairy Cows	389	286	752
Swine	119	137	195
Chickens	314	332	152
Sheep	7	12	26
TOTAL	1490	1535	2033

*Nitrogen assumed to be 50 percent recoverable.

+Phosphorous assumed to be 90 percent recoverable.

‡Potassium assumed to be 90 percent recoverable.

SEWAGE SLUDGE

Currently there are on the order of 20,000 to 25,000 municipal sewage treatment plants in operation throughout the United States. These facilities service nearly 155 million people.[7] The remaining population is served by private collection and disposal systems ranging from individual pit privies to the more elaborate types of small, packaged sewage treatment plants.

The type of sewage treatment plant, its capacity, solids removal efficiency, and method of sludge handling and disposal varies considerably as does the character of the sewage being treated from one location to another. It is estimated there are in excess of 40,000 possible configurations or combinations of systems that can be derived utilizing current wastewater treatment practices and technology.[8] It is partly due to this extreme variability that it is very difficult to generalize about the character and quantity of sludge emanating from a "typical" sewage treatment plant. Table 4 lists, according to general classification, the number and type of sewage treatment plants in the United States and the estimated population served by each.

The quantity of sewage solids generated varies considerably with the type of sewage treatment process. Many secondary and tertiary treatment processes necessitate the addition of chemicals, thus greatly increasing the solids content and amount of sludge removed. This variation ranges from approximately 0.04 to 0.35 pounds of dry solids per capita per day.[9] Industrial waste loadings may increase the average sludge generation rate of a particular treatment plant 20 to 50 percent depending upon the type of industry and its percent contribution to the total daily flow of solids into the municipal treatment facilities. In many municipalities, the amount of industrial waste exceeds that of the municipal waste. Due to the extreme variation from one industrial waste to another, it was considered far beyond the scope of this report for industrial wastes to be included in the sludge generation figures and they were therefore omitted. Table 5 categorizes the various municipal treatment processes into one of three major classifications: (1) no treatment, (2) Category I (minor and primary treatment systems, and (3) Category II (intermediate, secondary, and tertiary treatment systems).

The total amount of raw undigested domestic sewage sludge currently generated in the United States from Category I and II type systems is calculated to be approximately 5.6 million dry tons per year. This material consists essentially of the settleable and dissolved solids removed from the raw sewage and any chemicals that were added as part of the treatment process. Raw sewage sludge having undergone practically no decomposition is highly unstable, putrescible, disagreeable in physical appearance, characteristically has a foul odor, and contains thousands of disease-carrying agents. It is for this reason that

TABLE 4

THE NUMBER AND TYPE OF MUNICIPAL WASTEWATER TREATMENT FACILITIES IN THE UNITED STATES AND POPULATION SERVED BY EACH*

Type of Treatment Process	Population Served	Number of Plants
Collection System Only - No Treatment	2,890,676	2,404
Minor Treatment - Screening and Chlorination Only	780,135	72
Primary Treatment - Sedimentation	37,904,943	2,714
Intermediate Treatment - Chemical	6,780,241	70
Secondary Treatment - Biological	2,506,245	1,980
Secondary - Activated Sludge	47,561,508	1,831
Secondary - Extended Aeration	3,963,602	2,694
Secondary - Trickling Filter	29,688,917	3,523
Secondary - Effluent to Land	410,444	144
Secondary - Oxidation Pond	7,680,982	5,031
Secondary - Filter	1,606,110	309
Secondary - Miscellaneous	10,798,203	1,245
Tertiary - Physical, Chemical	2,373,698	809
Total	154,945,105	22,054

*U.S. Environmental Protection Agency, Office of Water Programs. Unpublished Data, 1974.

TABLE 5

1974 U.S. DOMESTIC
SEWAGE SLUDGE GENERATION*
(DRY WEIGHT)

Treatment Classification	Population Served	Total Sludge Generation Before Digestion (Tons)	Total Sludge Generation After Digestion § (Tons)
No Treatment	2,890,676	---	---
Category I	38,695,078	843,546+	517,996
Category II	113,369,351	4,732,392‡	2,708,493
Total	154,945,105	5,575,938	3,226,489

* Data obtained from multiple sources.
\+ Solids generation calculated on the basis of 0.12 lbs/capita/day.
‡ Solids generation calculated on the basis of 0.23 lbs/capita/day.
§ Digestion is assumed to result in an approximately 40 percent reduction in total solids.

digestion or some further means of treatment or stabilization is generally required before the sludge is considered acceptable for utilization.

The two major objectives of sewage sludge digestion are to reduce the total volume of solids to be handled and to biologically stabilize the sewage solids for safe handling. High rate digestion of sewage sludge typically results in a 40 to 60 percent reduction in volatile solids, which generally yields a 30 to 40 percent reduction in total solids.[10]

Sewage sludge normally contains many of the elements that are known to be essential to all plant life such as nitrogen, phosphorous, potassium, calcium, magnesium, and a multitude of other minor and trace elements (Table 6).

Although essential to plant life, these elements are often found in concentrations known to be detrimental to plant life. In certain cases where the metals content of a particular sludge is known to be excessive, it may be necessary to establish pretreatment standards and require users to conform with the standard before discharging into the municipal sewer system. If a particular problem cannot be attributable to a specific user, some other way of removing or decreasing the concentration level of the element or elements in question must first be attained before further consideration is given to sludge application to crop or pastureland.

The nitrogen content of sewage sludge is relatively low when compared to that of most commercial grades of fertilizer. As displayed in Table 7, the nitrogen content of sewage sludge will vary from 1 to 6 percent. The actual nitrogen content of a particular sludge is highly dependent upon the unit processes involved in the treatment and character of the sewage coming into the plant. It has been reported that as much as 30 to 50 percent of the nitrogen contained in the raw sewage sludge is in the readily available ammonia or nitrate form.[11,12] The remaining nitrogen is in a lesser available organic form and is slowly released over a much longer period of time. Table 7 presents comparative figures on the nutrient content of several typical digested and undigested sludges. As indicated in the table, anerobic digestion greatly reduces the nitrogen content of sewage sludge by a factor of 30 to 40 percent on a dry solids basis. This is due primarily to solubilization of the nitrogen during the digestion process and its ultimate removal through dewatering of the sludge after digestion. From a nitrogen standpoint, heat-dried activated sludge is by far a superior product. This is because of the more advanced nitrification state of the activated sludge and the fact that very little nitrogen loss occurs through solubilization since the sludge is heat-dried rather than digested and dewatered.

TABLE 6

SUMMARY OF METALS CONTENT OF
DIGESTED DOMESTIC SEWAGE SLUDGES*

Metal	Observed Range (PPM)	Average Sludge (PPM)
Zn	500 - 50,000	2,000
Cu	250 - 17,000	800
Ni	25 - 8,000	100
Cd	5 - 2,000	---
Cd (as percent of Zn)	0.1 - 40	5.0
B	15 - 1,000	100
Pb	100 - 10,000	1,000
Hg	1 - 100	15
N	10,000 - 60,000	20,000
P	10,000 - 30,000	10,000
K	2,000 - 5,000	2,000

*Menzies, J. D. Composition and properties of sewage sludge. In Proceedings; 28th Annual Meeting of the Soil Conservation Society of America, Hot Springs, Ark., Sept. 30-Oct. 3, 1973. p.139-141.

TABLE 7

TYPICAL
PRIMARY NUTRIENT CONTENT OF
DOMESTIC SEWAGE SLUDGES*
(percent dry weight)

Type of Sludge	Nitrogen (N)	Phosphorous (P_2O_5)	Potassium (K_2O)
Raw Primary	3.2	2.2	-
Digested Primary	2.2	2.2	0.4
Trickling Filter Raw	4.2	-	-
Trickling Filter Digested	2.5	3.6	-
Raw Activated Sludge	4.1	4.6	0.5
Digested Activated Sludge	3.1	2.9	0.4
Heat Dried Activated	5.6	3.7	0.2
Heat Dried Primary	3.1	2.9	-

*Data obtained from multiple sources and represents average values reported.

It is estimated that approximately 100,000 tons of nitrogen are contained in the sewage sludge generated annually in the United States (Table 8). Approximately 20 to 50 percent of this nitrogen is readily available for crop production within the first year after application with smaller amounts becoming available in each successive year. A recent EPA survey reports that 25 percent of the sewage treatment plants in the United States are currently disposing of their sewage sludge by land-spreading.[13] The most common type of land application reported was utilization on cropland and pasturelands. Other types of land application included public parks, golf courses, airports, abandoned strip mines, cemeteries, plant grounds, highway median strips, woodlands, and sanitary landfills. Based upon its available nitrogen content, sewage sludge could satisfy 1 to 5 percent of the total non-agricultural demand for nitrogen-containing fertilizer materials. Currently it is estimated that 15 percent of the total annual national consumption of nitrogen is for non-agricultural purposes.[14]

TABLE 8

MAXIMUM AVAILABLE PRIMARY
NUTRIENT CONTENT OF SEWAGE SLUDGE
AFTER DIGESTION
(TONS)

Classification	Nitrogen (N)	Phosphorous (P_2O_5)	Potassium (K_2O)
Category I	11,200	15,500	2,100
Category II	83,600	98,700	11,100
Total	98,800	114,200	13,200

FERTILIZER REQUIREMENTS

Fertilizer consumption in the United States totaled 42.5 million tons in 1973.[15] The primary nutrient content (i.e., nitrogen, phosphorous, and potassium) exceeded 17.8 million tons, reflecting a 3.5 percent increase over that of the previous year.[15 p.8] Nitrogen and phosphorous consumption in 1973 were both up 4 percent, while potassium (potash) was up only 2 percent over the 1972 figures.[15] In general, the use of fertilizer has been increasing at a rate of 4 percent per year over the last 20 years as shown in Figure 1.[15 p.5] Projections for the year 1974 indicate nitrogen consumption will reach 9.3 million tons or about 12 percent above that consumed in 1973.[16 p.3] This is due primarily to an increase in the total acreage of major crops planted in the early spring of 1974 along with a slight increase in the amount of nitrogen applied per acre (Table 9).

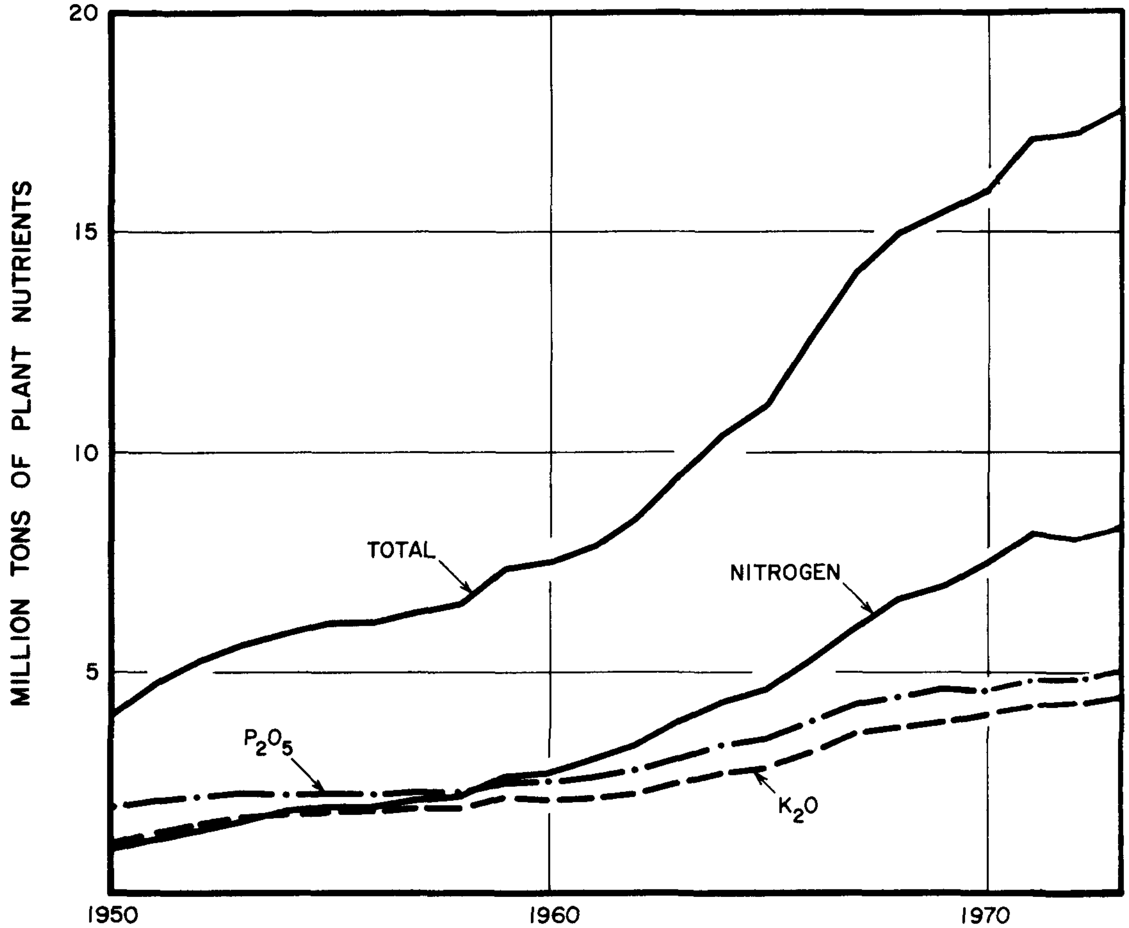
It has been reported that 18.5 million tons of nitrogen are required each year to sustain current levels of crop production and soil fertility in the United States.[12 p.67] Approximately 60 percent of this nitrogen demand is supplied by natural processes, while the remaining 40 percent is derived from commercially produced nitrogen-containing fertilizers. Rain and snow contribute 1.0 to 1.5 million tons of nitrogen to U.S. cropland each year, while nitrogen-fixing plants and soil bacteria supply the remainder of the naturally available nitrogen.[12 p.68]

The pathway nitrogen follows in nature, whether the nitrogen source is organic or inorganic, natural or commercially produced, is extremely difficult to predict. The processes that affect the form in which nitrogen is found in soils (i.e., mineralization, nitrification, denitrification, immobilization, fixation, absorption, volatilization, cation exchange, convection, dispersion, and plant uptake) take place concurrently and at different rates largely dependent upon the cropping practices, type of crop planted, soil characteristics, and climatic conditions (Figure 2). Several attempts have been made to establish a national nitrogen balance with little success. Gross estimates, however, indicate that approximately 3 million tons of nitrogen are depleted from the nation's soil each year.[12 p.70]

The commercial production of inorganic nitrogen has increased at an average rate of 7.8 percent per year over the past 10 years, and is expected to continue to increase at a rate of 6 percent through 1980.[15 p.4] Before World War II, most nitrogen was derived from the importation of Chilean ammonium nitrate, by-product recovery of ammonium sulphate from the coking of coal, natural organic nitrogen-containing materials, and, to a very limited extent, synthetically produced nitrogen. Table 10 lists some of the more common natural nitrogen-containing organic materials once used. Today these materials account for less than 1 percent of the total fertilizer market.[17] The main reason given by the fertilizer industry for the decreased utilization of natural organic nitrogen

PLANT NUTRIENT CONSUMPTION

UNITED STATES



U.S. Consumption of Fertilizers and Plant Nutrients

Fiscal Year	Total Fertilizer Material	Plant Nutrients Nitrogen (N)	Phosphates (P_2O_5)	Potash (K_2O)	Total
			(short tons)		
1950	18,343,300	1,005,452	1,949,768	1,103,062	4,058,282
1955	22,726,462	1,960,536	2,283,660	1,874,943	6 119 139
1960	24,877,415	2,738,047	2,572,348	2,153,319	7,463,714
1961	25,567,130	3,030,788	2,645,085	2,168,533	7,844,406
1962	26,615,037	3,369,980	2,807,039	2,270,537	8,447,556
1963	28,844,480	3,929,089	3,072,873	2,503,462	9,505,424
1964	30,681,016	4,352,809	3,377,841	2,729,693	10,460,343
1965	31,836,403	4,638,538	3,512,207	2,834,537	10,985,282
1966	34,532,215	5,326,303	3,897,132	3,221,245	12 444 680
1967	37,081,315	6,026,997	4,304,688	3,641,799	13 973,484
1968	38,552,044	6,693,790	4,451,980	3,792,013	14 937 783
1969	38,948,517	6,957,600	4,665,569	3,891,576	15,514,745
1970	39,588,637	7,459,004	4,573,750	4,035,511	16,068 274
1971	41,118,272	8,133,606	4,803,443	4,231,369	17,168,418
1972	41,205,839	8,016,007	4,873,053	4,332,016	17,221,077
1973	42,536,436	8,338,780	5,072,008	4 411,531	17,822,319

Figure 1. Average consumption of plant nutrients in the United States from 1950 to 1973. Source: Harre, E. A. Fertilizer trends, 1973. Bulletin Y-77. Muscle Shoals, Ala., Tennessee Valley Authority, Fertilizer Development Center, June 1974. 57 p.

TABLE 9

1974 PLANTED ACREAGE OVER
1973 FIGURES*

Crop Planted	Percent Change in Acreage Planted
Corn	+ 9
Cotton	+15
Wheat	+12
Soybeans	- 7
Sorghum	- 8
Tobacco	+ 9
Potatoes	+11

*Crop production. CrPr 2-2 (7-74). Washington, U.S. Department of Agriculture, Statistical Reporting Service, Crop Reporting Board, July 11, 1974. 40 p.

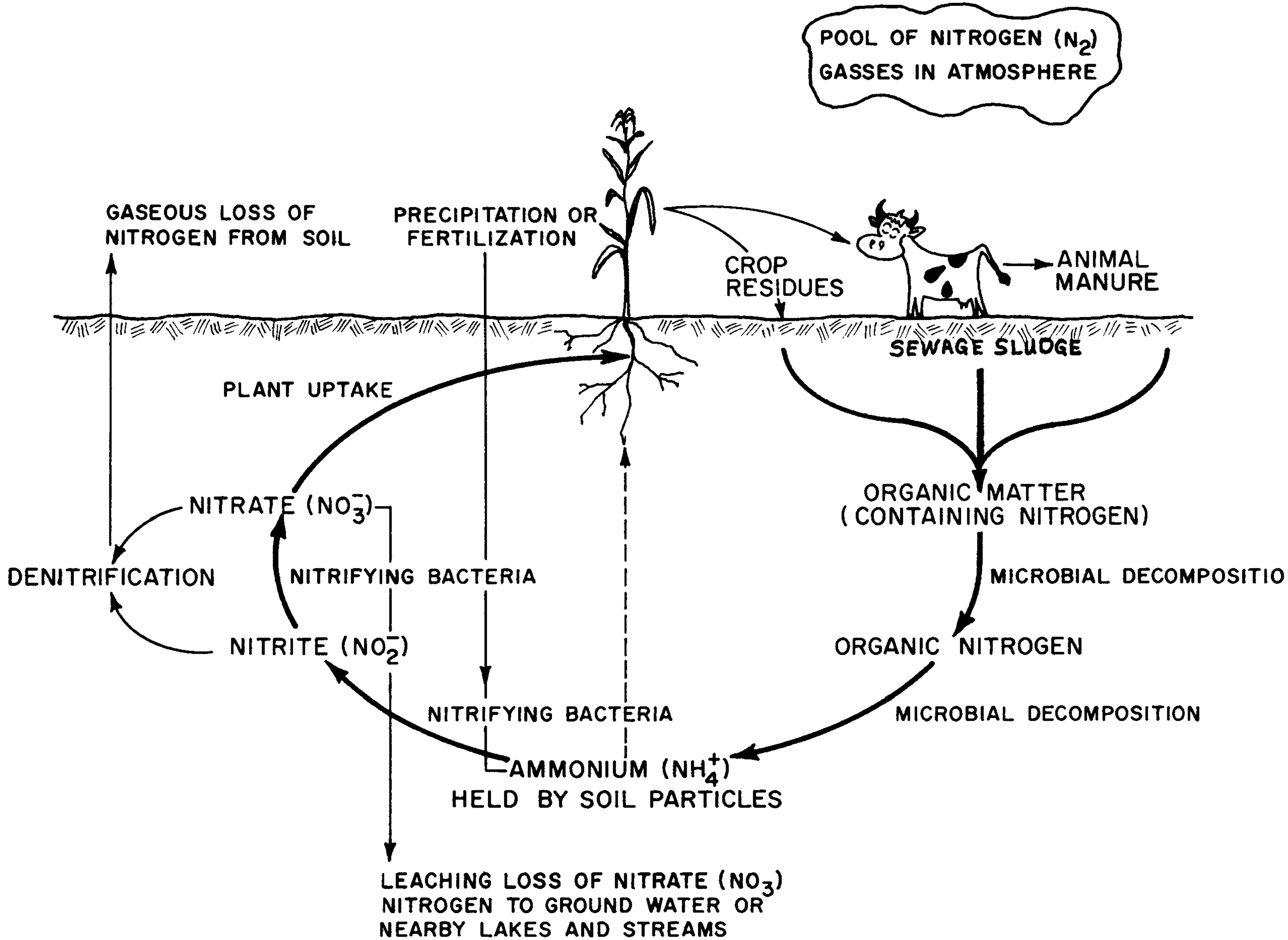


Figure 2. Illustrates the various stages of the nitrogen cycle through which all organic matter containing nitrogen passes in its decomposition on land.

TABLE 10

AVERAGE COMPOSITION OF SOME COMMON NATURAL ORGANIC NITROGEN CONTAINING MATERIALS*
(Percent)

Source	N	P_2O_5	K_2O
Activated Sewage Sludge	6.0	2.2	-
Dried Blood	13.0	-	-
Bone Meal, Raw	3.5	22.0	-
Castor Pomace	6.0	1.5	0.5
Cocoa Meal	4.0	1.5	2.5
Cottonseed Meal	6.6	2.5	1.5
Fish Scrap, Dried	9.5	6.0	-
Garbage Tankage	2.5	1.5	1.0
Peanut Meal	7.2	1.5	1.2
Peruvian Guano	13.0	12.5	2.5
Soybean Meal	7.0	1.2	1.5
Animal Tankage	7.0	10.0	-
Whale Guano	8.5	6.0	-

*Tisdale, S. L., and W. L. Nelson. Soil fertility and fertilizers. 2nd ed. New York, The Macmillian Company, [1966]. p.156.

fertilizers is the high cost per applied unit of nitrogen. In addition, commercially produced inorganic fertilizers can be produced more cheaply and in greater quantities, and can be formulated to provide a more regulated release of nitrogen than can natural organic nitrogen-containing fertilizers.

Overall, the commercial fertilizer industry consists of about 100 large primary producers of the basic NPK (nitrogen, phosphorous, and potassium) constituents.[16 p.6] A detailed listing of the primary producers and respective number of plants is summarized in Table 11. Many primary producers manufacture more than one type of fertilizer and therefore the number of firms and plants are not additive.

The average capital cost of constructing a 1,000 ton per day anhydrous ammonia plant ranges from $40 to $60 million and takes several years to construct.[18] The high capital investment and amount of lead time required to construct these facilities is one of the main reasons given by the fertilizer industry today for the lack of sufficient production capacity and inadequate supplies of nitrogen fertilizers.

In addition to the primary nutrient producers, there are thousands of smaller blending or mixing plants. These plants mechanically mix and formulate bulk quantities of the basic fertilizer ingredients according to predetermined specifications. Many of the large primary producers distribute their products directly through their own farm stores, while the majority sell their products to retailers or farm cooperatives. Bulk blended fertilizers are generally applied to the fields the same day they are mixed.

Approximately 50 percent of the commercially produced fertilizer materials consumed in the United States are applied to the soil as a mixture.[14 p.10] Anhydrous ammonia (the basic nitrogen source for over 95 percent of the nitrogen-containing fertilizers) accounts for nearly 40 percent of the nitrogen that is separately applied to the soil. In 1973 over 3 million tons of anhydrous ammonia were applied to the soil by direct application.

Anhydrous ammonia is produced by the ammonium fixation process utilizing air and natural gas as its basic raw materials in the presence of a catalyst at elevated temperatures and pressure (i.e., 700°C at 40 PSI). Air contains approximately 80 percent nitrogen by volume and therefore constitutes virtually an unlimited supply of nitrogen. Natural gas serves as a source of energy and hydrogen necessary to complete the reaction. The production of anhydrous ammonia requires approximately 40,000 cubic feet of natural gas per ton of nitrogen produced. Anhydrous ammonia is 82 percent nitrogen. It is estimated that 600 billion cubic feet of natural gas were consumed in the production of anhydrous ammonia in 1973. Approximately 75 percent of the anhydrous ammonia produced was consumed by the agricultural industry. This represents 450 billion cubic feet of natural gas or about 1.9 percent of the total natural gas consumed in the United States during the year 1973.

TABLE 11

FERTILIZER PRODUCTION AND MANUFACTURING PLANTS IN THE UNITED STATES* (1974)

Fertilizer Product	Number of Firms	Number of Plants	Maximum Rated Capacity (million tons)
Anhydrous Ammonia 82 percent (N)	63	96	17.9
Urea 46 percent (N)	36	46	5.2
Ammonium Nitrate 33 percent (N)	38	57	7.0
Phosphate Rock 30 percent (P_2O_5)	20	30	51.2
Phosphoric Acid 55 percent (P_2O_5)	28	35	6.8
Superphosphate 46 percent (P_2O_5)	15	16	2.2
Ammonium Phosphate 15 percent (N) 30 percent (P_2O_5)	32	42	3.8
Potash 60 percent (K_2O)	10	11	2.9

*Harre, Fertilizer trends, 1973.

The availability of an adequate supply of natural gas is therefore essential to the production of anhydrous ammonia in today's market. The fertilizer industry, however, is not limited to the use of natural gas in the manufacture of anhydrous ammonia. There are several alternate methods of production currently available. In Europe, for instance, fuel oil, coal, and naphtha are widely used. These methods, however, are far more expensive than natural gas.

As the cost of natural gas continues to climb upward and its availability becomes more limited, it is highly probable that localized shortages of anhydrous ammonia will occur. Few industry observers see the supply of natural gas being equal to the demand now or in the near future and therefore project that the United States will have to look more toward foreign imports of nitrogen to meet its fertilizer needs. Currently the United States is a net exporter of nitrogen by a ratio of nearly 1.5 to 1.[16 p.6] The United States exported 1.4 million tons of nitrogen in 1973 while importing only 0.9 million tons (Figure 3).

The 10 leading states in order of anhydrous ammonia production are listed in Table 12. Over 75 percent of the anhydrous ammonia produced in the United States is currently manufactured in the 10 states listed.

The United States produces over 25 percent of the total anhydrous ammonia consumed in the world.[16 p.49] Approximately 75 percent of the anhydrous ammonia produced in the United States is earmarked for agricultural purposes while the remainder is used in manufacturing plastics, explosives, food processing, additives, and for other miscellaneous non-agricultural purposes (Figure 4).

Tables 13 and 14 list by state in order of consumption, the total amount of fertilizer and primary nutrients consumed in 1973. Most of the major fertilizer and primary nutrient-consuming states (with the exception of Florida and California) fall within the areas referred to as the Corn, Cotton, and Wheat Belts. Corn, cotton, wheat, and soybeans account for over 50 percent of the total fertilizer consumed in 1973. Table 15 summarizes the respective amounts of primary nutrients applied to the four major crops produced in the U.S. in 1973. Table 16 reflects the total acreage fertilized and the average amount of fertilizer applied per acre over the past three years.

The U.S. produces nearly 40 percent of the total world supply of phosphorous rock.[16 p.54] Approximately 85 percent of the U.S. demand for phosphorous is used for agricultural purposes, while the remainder is used in the manufacture of detergents, food products, and explosives.[16 p.53] Over 80 percent of the phosphate rock mined in the U.S. (the basic source of phosphorous in the production of phosphatic fertilizers) is extracted from strip mines in the states of Florida, Tennessee, and North Carolina.[16 p.51] It takes approximately 3 tons of phosphate rock to produce 1 ton of phosphorous (P_2O_5).[19] The known reserves in the states of Florida and Tennessee represent nearly 40 percent of the

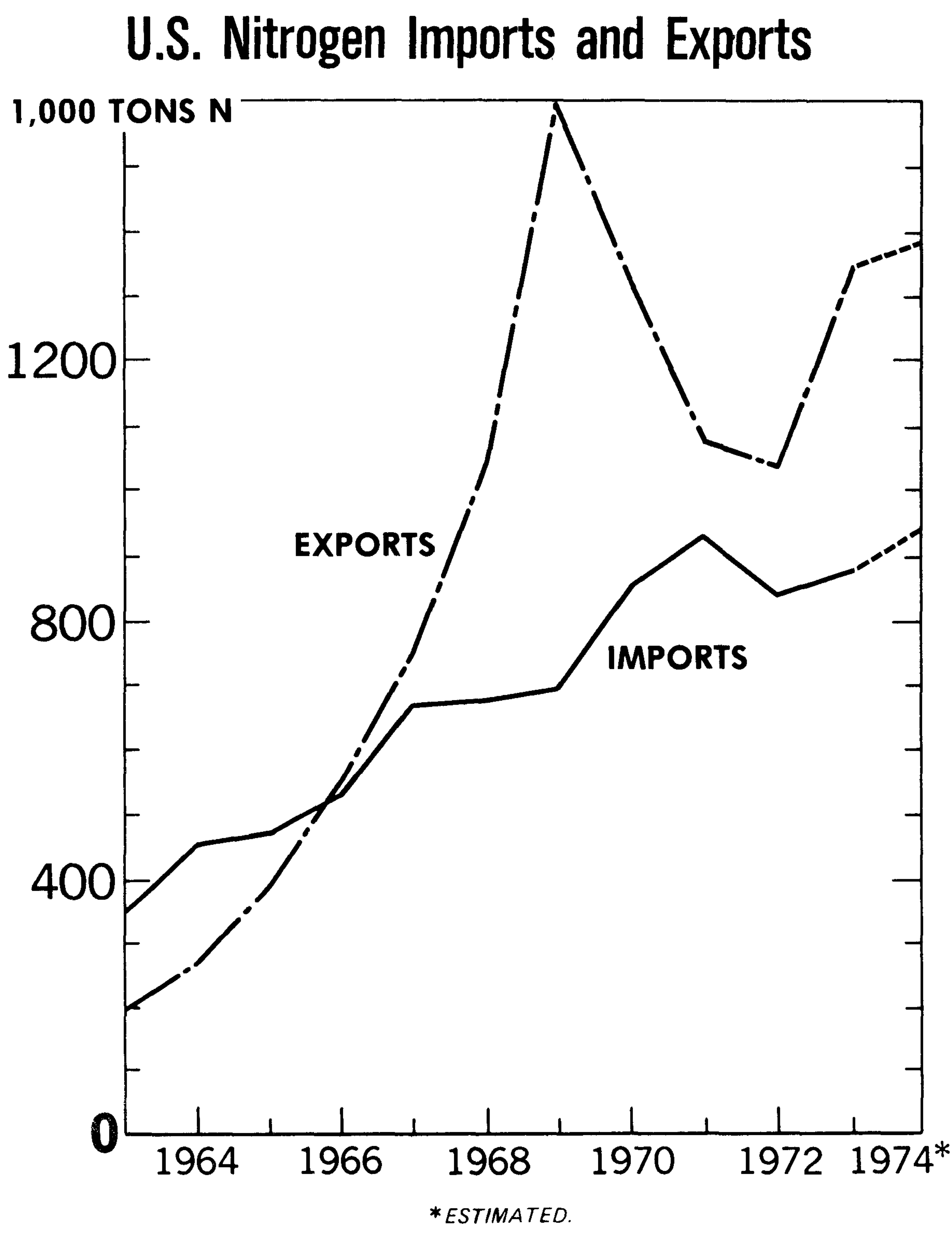


Figure 3. As illustrated, overexpansion of the fertilizer industry in the mid-sixties resulted in a tremendous increase in the export to import ratio which is now beginning to decline slightly. Source: United States and world fertilizer outlook, 1974 and 1980. Agricultural Economic Report No. 257. Washington, U.S. Department of Agriculture, Economic Research Service, May 1974. 65 p.

TABLE 12

TEN MAJOR PRODUCING STATES
OF ANHYDROUS AMMONIA*
(1974)

State	Anhydrous Ammonia Production (Million Tons)
Louisiana	3.660
Texas	3.092
Iowa	1.038
Mississippi	1.025
California	0.993
Nebraska	0.900
Virginia	0.680
Ohio	0.670
Arkansas	0.600
Kansas	0.577
All Others	4.727

*Harre, Fertilizer trends, 1973.

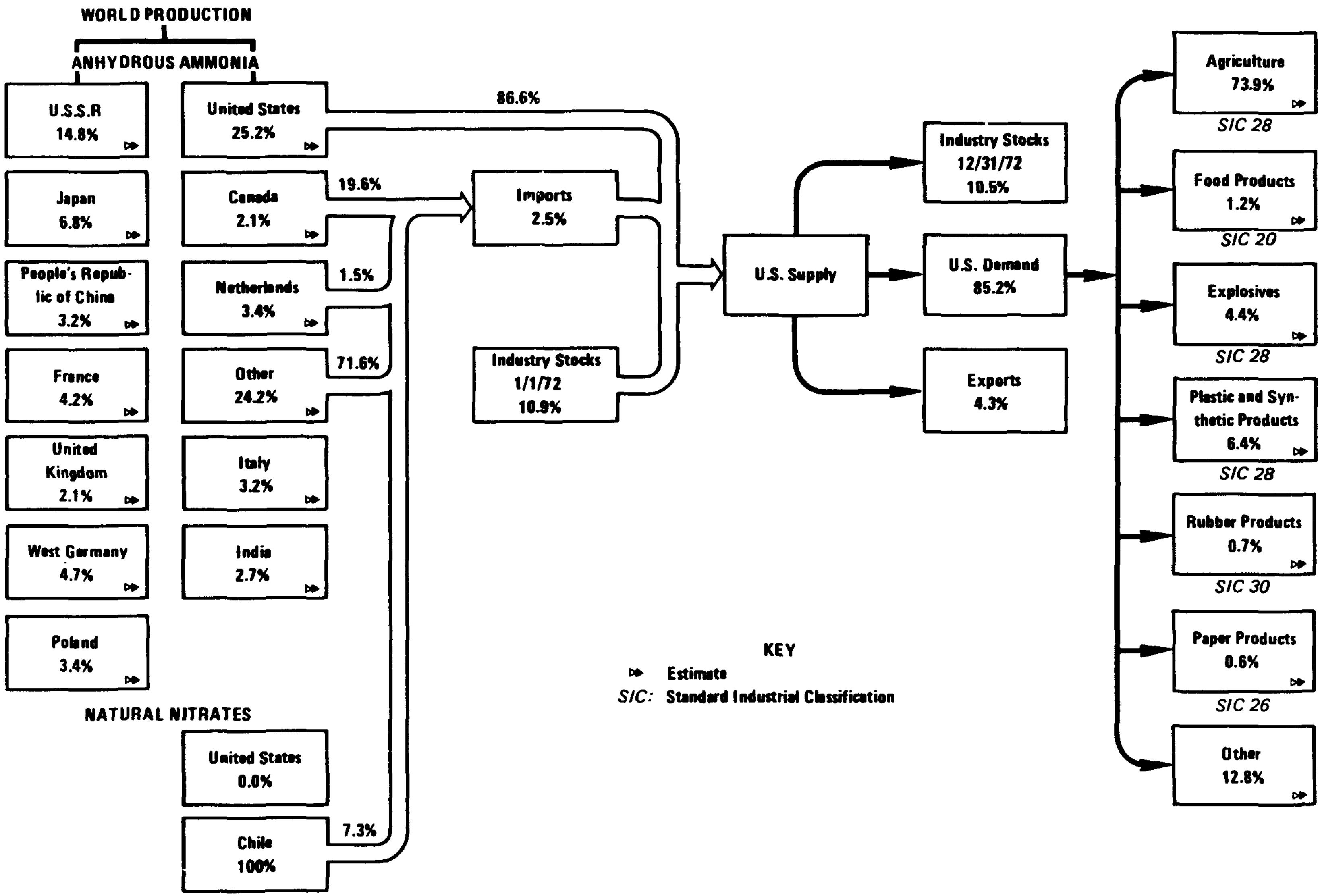


Figure 4. The United States produces 25 percent of the total world supply of anhydrous ammonia, of which approximately 75 percent is earmarked for the agricultural industry. Source: U.S. Department of Agriculture, United States and world fertilizer outlook, 1974 and 1980.

TABLE 13

TEN MAJOR FERTILIZER CONSUMERS
BY STATE*
(1973)

State	Consumption of Fertilizer (Million Tons/Yr)	Percent of Total Fertilizer Consumed
California	3.5	8.2
Illinois	2.9	6.8
Iowa	2.6	6.1
Texas	2.5	5.9
Georgia	2.1	4.9
Indiana	2.0	4.7
Florida	1.8	4.2
North Carolina	1.8	4.2
Minnesota	1.8	4.2
Ohio	1.5	3.5

*Commercial fertilizers; consumption in the United States, year ended June 30, 1973. SpCr 7 (5-74). Washington, U.S. Department of Agriculture, Statistical Reporting Service, Crop Reporting Board, May 7, 1974. 26 p.

TABLE 14

MAJOR CONSUMERS OF NPK
BY STATE*

Rank By State	Nitrogen (N)	Percent Of Total	Phosphorous (P_2O_5)	Percent Of Total	Potassium (K_2O)	Percent Of Total
1	Texas	8.6	Illinois	9.1	Illinois	10.2
2	Iowa	8.0	Iowa	8.1	Iowa	7.5
3	Nebraska	7.0	Texas	5.9	Indiana	7.3
4	Kansas	6.2	Minnesota	5.7	Minnesota	6.4
5	California	5.8	Indiana	4.9	Ohio	5.9

*Commercial fertilizers; consumption in the United States, year ended June 30, 1973.

TABLE 15

APPLICATION OF PRIMARY
NUTRIENTS TO MAJOR CROPS
1973*

Crop Fertilized	Pounds Applied Per Acre		
	Nitrogen (N)	Phosphorous (P_2O_5)	Potassium (K_2O)
Corn	114	64	71
Wheat	48	38	36
Soybeans	14	42	55
Cotton	73	53	62

*Fertilizer situation. FS-4. Washington, U.S. Department of Agriculture, Economic Research Service, Jan. 1974. 24 p.

TABLE 16

AMOUNT OF FERTILIZER APPLIED
PER ACRE OF CROPLAND HARVESTED*

Year	Acreage Planted (million acres)	Fertilizer Applied (lbs/acre)	Primary Plant Nutrients Applied (lbs/acre)
1972	334	210	88
1973	354	208	87
1974	360	222	91

*1975 fertilizer situation. FS-5. Washington, U.S. Department of Agriculture, Economic Research Service, Dec. 1974. 27 p.

nation's total available supply of phosphate rock, a quantity estimated to be sufficient to last 30 to 40 years.[16 p.51] The mining of phosphate rock, like anhydrous ammonia production, is an energy-intensive enterprise. It has been reported that 10 percent of the total electrical power sold in the State of Florida is consumed by the phosphate rock mining industry.[14 p.5] The majority of the phosphate rock mined in the State of Florida is strip mined with the use of large electric cranes requiring vast amounts of electrical power. It requires approximately 100 KWH of electrical power, 6 gallons of fuel oil, and 3,000 gallons of water to extract and process a sufficient volume of raw materials to produce 1 ton of available phosphate rock.[19 p.6] Additional power and natural resources are required to process the phosphate rock into a usable fertilizer product (e.g., phosphoric acid, ammonium phosphate, and elemental phosphorous). Therefore, it is projected that major cutbacks in the availability of adequate supplies of energy would have a significant impact on the phosphate rock producing industry. In addition to its basic power needs, more than 50 percent of the nation's sulphur is also consumed in the manufacture of phosphatic fertilizers.[17 p.366] Shortages of phosphatic fertilizers are expected through 1975 due to insufficient production capability within the industry. However, by the end of 1976, additional production capacity equal to 2 million tons of P_2O_5 is expected to come on line, thus alleviating somewhat the pressures upon the industry.

Approximately 95 percent of the potassium mined in the United States is consumed in the manufacture of fertilizer.[16 p.61] Nearly 100 percent of all potassium is obtained from underground sources through solution mining or by drilling and blasting. The U.S. imports nearly half of its potassium from Canada, while the remainder is extracted from domestic mines located in Carlsbad, New Mexico and southeastern Utah. The total U.S. reserves are expected to last 20 years. No shortage of potassium fertilizer is expected in the immediate future.

The cost of fertilizer has risen sharply since the lifting of Phase IV price controls on fertilizer products on October 25, 1973. The U.S. Department of Agriculture reports the average cost of a ton of fertilizer to have increased from about $75.00 per ton in mid-1973 to well over $140 per ton in the fall of 1974.[14 p.4] The price of anhydrous ammonia alone has nearly tripled over the same time span (Appendix G). If the cost of fertilizers continues to rise at the current rate, the total national expenditure to farmers for commercially produced fertilizer materials in 1975 could well exceed $6.5 billion--a dramatic increase of more than 120 percent above that spent in 1973. The average cost of fertilizer to the farmer per pound of equivalent N, P, and K delivered as of September 1974 was approximately 25, 40, and 5 cents per pound, respectively.[20]

In addition to the three primary nutrients already mentioned, there are several important secondary and micro plant nutrients that have been identified as essential to plant life. Several of the more important of these are listed in Table 17. The quantity of secondary and micro plant nutrients required for maximum plant development is not thoroughly understood at this time. It is known that the amount required varies with the type of plant, soil characteristics, climatic conditions, and the season of the year. Table 18 displays the average amount of primary, secondary, and micro plant nutrients required to produce a specified type and quantity of crop. The range between beneficial and detrimental effects to a plant with regard to many micronutrients is so very small that it is extremely difficult to determine. In various research efforts where such determinations have been attempted, it was found that the availability of a specific micronutrient was more important than the total quantity of the micronutrient present. This is also very important with regard to primary nutrients. Field experiments have shown plant uptake of nitrogen to range between 25 and 85 percent, depending upon specific site conditions and the type of crop harvested.

Table 19 lists the various compositions of materials commonly used in the production of commercial fertilizers. As few as one or as many as 10 may be used in the production of a specific grade of fertilizer. Often, a filler material such as sand, or more commonly limestone, is used to produce the desired concentration of nutrients in a mixed fertilizer.

TABLE 17

SECONDARY AND MICRO PLANT NUTRIENTS

1.	Calcium	5.	Iron	9.	Chlorine
2.	Magnesium	6.	Manganese	10.	Cobalt
3.	Sulphur	7.	Sodium	11.	Vanadium
4.	Boron	8.	Molybdenum	12.	Silicon

TABLE 18

APPROXIMATE POUNDS OF NUTRIENTS PER ACRE CONTAINED IN THE PORTION OF CROP OF THE AVERAGE SIZE SHOWN*

Type of Crop Harvested	Approximate Yield Per Acre+ (Units)	Nitrogen As N (lbs/acre)	Phosphorous As P_2O_5 (lbs/acre)	Potassium As K_2O (lbs/acre)
Barley (Grain)	40 bu.	35	15	10
Corn (Grain)	150 bu.	135	53	40
Oats (Grain)	80 bu.	50	20	15
Rice (Rough)	80 bu.	50	20	10
Rye (Grain)	30 bu.	35	10	10
Sorghum (Grain)	60 bu.	50	25	15
Wheat (Grain)	40 bu.	50	25	15
Alfalfa	4 tons	180	40	180
Soybean	2 tons	90	20	50
Cotton	1.5 tons	40	20	15
Apples	500 bu.	30	10	45
Potatoes (Tubers)	400 bu.	80	30	150
Turnips (Roots)	1- tons	45	20	90
Sugar Cane	30 tons	96	54	270
Tobacco (Leaves)	1 ton	75	15	120

*Our land and its care; the story of our soil and how to keep it productive. 4th ed. Washington, The Fertilizer Institute, [1967]. 72 p.

+These figures may vary with soil type, season, climate, and fertility level of the soil.

TABLE 19

COMPOSITION OF SELECTED FERTILIZER MATERIALS*

Fertilizer Product	Percent		
	Nitrogen (N)	Phosphorous (P_2O_5)	Potassium (K_2O)
Anhydrous Ammonia	82	--	--
Aqua Ammonia	16-25	--	--
Ammonium Nitrate	33.5	--	--
Diammonium Phosphate	16-21	48-53	--
Ammonium Sulphate	21	--	--
Bone Meal	2-4	22-28	0.2
Calcium Nitrate	15	--	--
Fish Scrap	6-10	7	0.8
Phosphoric Acid	--	52-58	--
Potassium Chloride	--	--	60-62
Potassium Nitrate	14	--	44-46
Rock Phosphate	--	30-36	--
Sodium Nitrate	16	--	0.2
Sewage Sludge, Digested	2	1.4	0.8
Sewage Sludge, Activated	5-6	2.9	0.6
Superphosphate, Normal	--	18-20	0.2
Superphosphate, Conc.	--	42-50	0.4
Animal Tankage	6-9	6-15	0.4
Urea	42-46	--	--
Urea-Formaldehyde	36-40	--	--

*Fertilizer Institute, Our land and its care.

LAND AVAILABILITY

Since land is our Nation's most valuable resource, it is appropriate to consider how much land there is available and how it is currently being used.

As demonstrated in Figure 5, the overall distribution of the Nation's land among the major land use categories has not changed significantly over the past several decades. The total land area of the United States consists of approximately 2 1/4 billion acres.[1 p.507] The 48 contiguous states alone account for nearly 85 percent of this total land area. Less than 20 percent of the Nation's land is currently under cultivation. It has been estimated that only 60 percent of the land that is considered suitable for regular or intermittent cultivation is actually being used for that purpose.[21] Almost 40 percent of the Nation's land is used for livestock grazing and an additional 30 percent is in forestland, wildlife refuges, and recreation areas. The remaining land falls into a miscellaneous category consisting of desert lands, mountainous regions, tundra, urban areas, and public lands (Table 20).

Cropland

The total land area available for cultivation in 1969 was approximately 472 million acres.[21 p.2] This figure includes all cropland harvested, not harvested due to crop failure, land used only for pasture, and land in summer fallow or otherwise lying idle and not being used (Figure 6).

Approximately 2 1/2 million acres of prime cropland are removed from production each year as a direct result of urban sprawl, highway and airport construction, strip mining operations, and a multitude of various other reasons. The net loss of available cropland, however, is partially offset by the addition of an estimated 1 1/4 million acres of reclaimed land each year of which approximately 60 percent consists of newly developed irrigated land. Although thousands of acres of cropland are permanently lost each year, agricultural experts do not foresee any great danger of the United States running out of available cropland to meet its ever increasing demand for food and fibre production.

If one considers the total amount of cropland or other lands that are potentially available for land application of sewage sludge and animal waste, it soon becomes apparent that more than enough available land exists to utilize safely all of the waste produced. It is estimated the total land area required for utilization of all the available sewage sludge and animal waste generated in the United States--assuming the soil has the capacity for assimilating up to 10 tons of dry solids per acre per year--is approximately equal to 1.3 percent of the total land area in crop production. As indicated previously, at least one-half of the confined animal waste and possibly as much as 25 percent of the sewage sludge generated is already being returned to the land. Depending upon

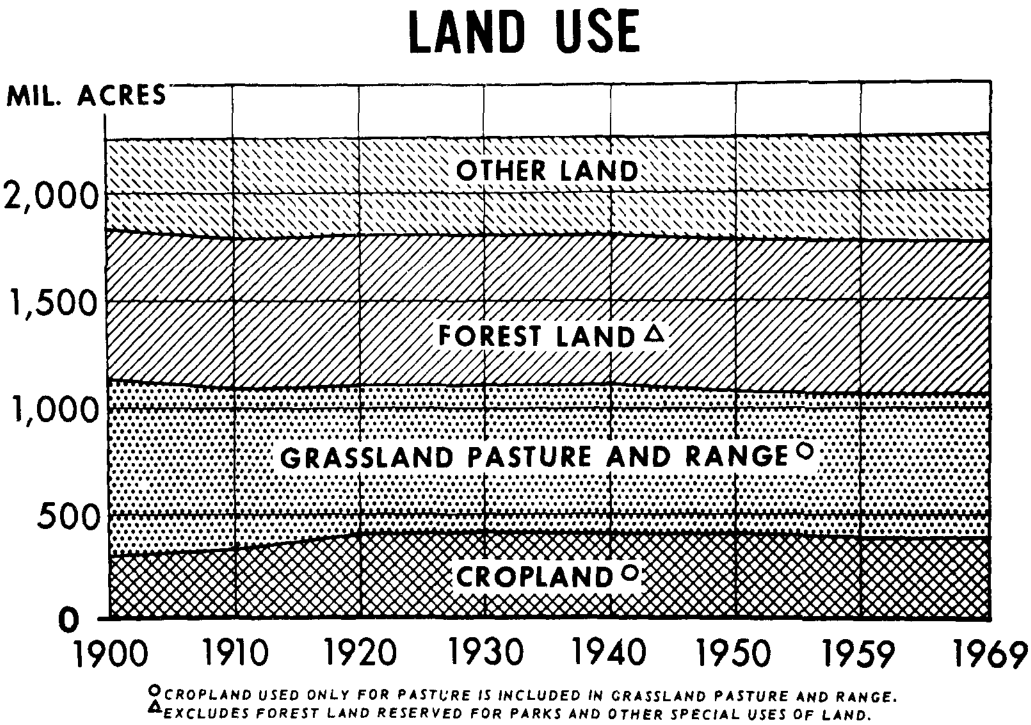


Figure 5. In spite of increased demands for food and fibre production in the United States over the past several decades, the major land use patterns of the nation have remained virtually unchanged. Source: U.S. Department of Agriculture, Economic Research Service. Our land and water resources; current and prospective supplies and uses. Miscellaneous Publication No. 1290. Washington, U.S. Government Printing Office, May 1974. 54 p.

TABLE 20

MAJOR LAND USE CATEGORIES*
1969

Land Use	Acreage (Millions)	Percent of Total Acreage
Agricultural Lands		
Cropland used for crops	333	14.7
Soil Improvement	51	2.3
Grassland & Pastureland	692	30.6
Forest Land - Grazed	198	8.7
Miscellaneous-Bldgs. etc.	9	0.4
Sub Total	1,283	56.7
Nonagricultural Lands		
Forest Land - Not Grazed	525	23.2
Urban Areas (not SMSA's)	61	2.7
Recreation & Wildlife	81	3.6
Public Lands	27	1.2
Miscellaneous-Mtns. etc.	287	12.6
Sub Total	981	43.3
TOTAL	2,364	100.0

*U.S. Department of Agriculture, Our land and water resources.

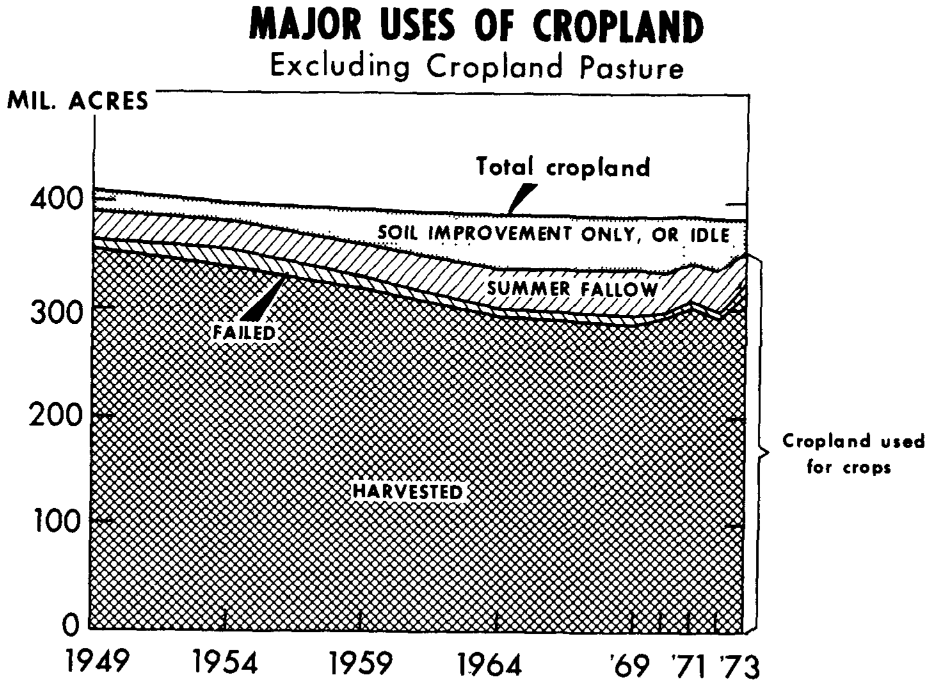


Figure 6. Over the past two decades, total cropland, excluding cropland in pasture, has declined about 6 percent or about one million acres per year. Source: U.S. Department of Agriculture, Our land and water resources.

the actual utilization rate or capacity of the soil to assimilate the animal waste and sewage sludge applied, this annual land requirement could be reduced significantly.

Agronomists have long recognized the potential benefits of applying animal waste and sewage sludge to cropland. Sewage sludge and animal waste, although very similar, do differ from one another in several respects. Sewage sludge generally has a much lower organic content, contains much higher concentrations of metals, and can harbor pathogenic organisms if not digested properly. The latter two are primarily responsible for the adverse reactions often generated in the general public when considering the use of sewage sludge on food-chain crops. Similar problems are not commonly encountered when attempting to apply animal waste to food-chain crops and, therefore, utilization of animal waste has greatly exceeded that of sewage sludge.

The U.S. Department of Agriculture maintains statistics on 79 different types of crops planted in the United States. Table 21 lists the total acreage planted in 1973 of each of the 20 principal crops. Corn, cotton, hay, soybeans, and wheat represent nearly 75 percent of the total acreage planted and are considered the major crops produced in the U.S.

Most animal waste is applied to feed grain crops grown in close proximity to the major animal-producing areas. Figure 7 displays the major land resource regions and crop production areas of the major crops produced in the United States. The feed grain, cotton, and wheat-producing regions are situated in the more rural areas, while dairy, truck, and specialty crops are typically located in the more populated areas of the United States.

Urban Areas

At the time of the 1970 census, 70 percent of the total United States population resided within the boundaries of the Nation's 242 Standard Metropolitan Statistical Areas (SMSA).[21 p.14] An SMSA is defined by the U.S. Census Bureau as a county of group of counties which contain at least one central city or twin cities with a combined population of 50,000 or more people (Figure 8). It is estimated that 80 percent of the sewage sludge generated in the United States emanates from within the confines of the Nation's SMSA's. The concentration of sludge varies directly with the population density. As indicated in Figure 9, the population density of the SMSA urban core averages 3,137 persons per square mile, while the population density of the more rural sections inside and outside of the SMSA's average 42 and 24 persons per square mile respectively.[21 p.17] The total land area within the Nation's 242 SMSA's in 1970 was approximately 255 million acres.

Approximately 25 percent of the land area surrounding the major urban areas within a 22.8 mile radius is classified as cropland and an

TABLE 21

1973 PLANTED ACREAGE OF THE
20 PRINCIPAL CROPS IN THE UNITED STATE*

Crop Planted	Acreage Planted (million)	Percent of Total Acreage
Corn	71.6	20.2
Hay	64.3	18.1
Wheat	59.0	16.6
Soybeans	57.3	16.2
Sorghum	19.3	5.5
Oats	19.2	5.4
Cotton	12.5	3.5
Barley	11.3	3.2
Rye	3.6	1.0
Rice	2.2	0.6
Flaxseed	1.8	0.5
Peanuts	1.5	0.4
Beans	1.4	0.4
Potatoes	1.3	0.4
Sugar Beets	1.3	0.4
Tobacco	0.9	0.3
Sugar Cane	0.8	0.2
Peas	0.2	0.1
Sweet Potatoes	0.1	---
Misc. (All Other Crops)	24.2	6.9
TOTAL	354.0+	100.0

*U.S. Department of Agriculture. Agricultural statistics, 1973.

+Total acreage planted includes all land harvested, not harvested due to crop failure, and land in summer fallow.

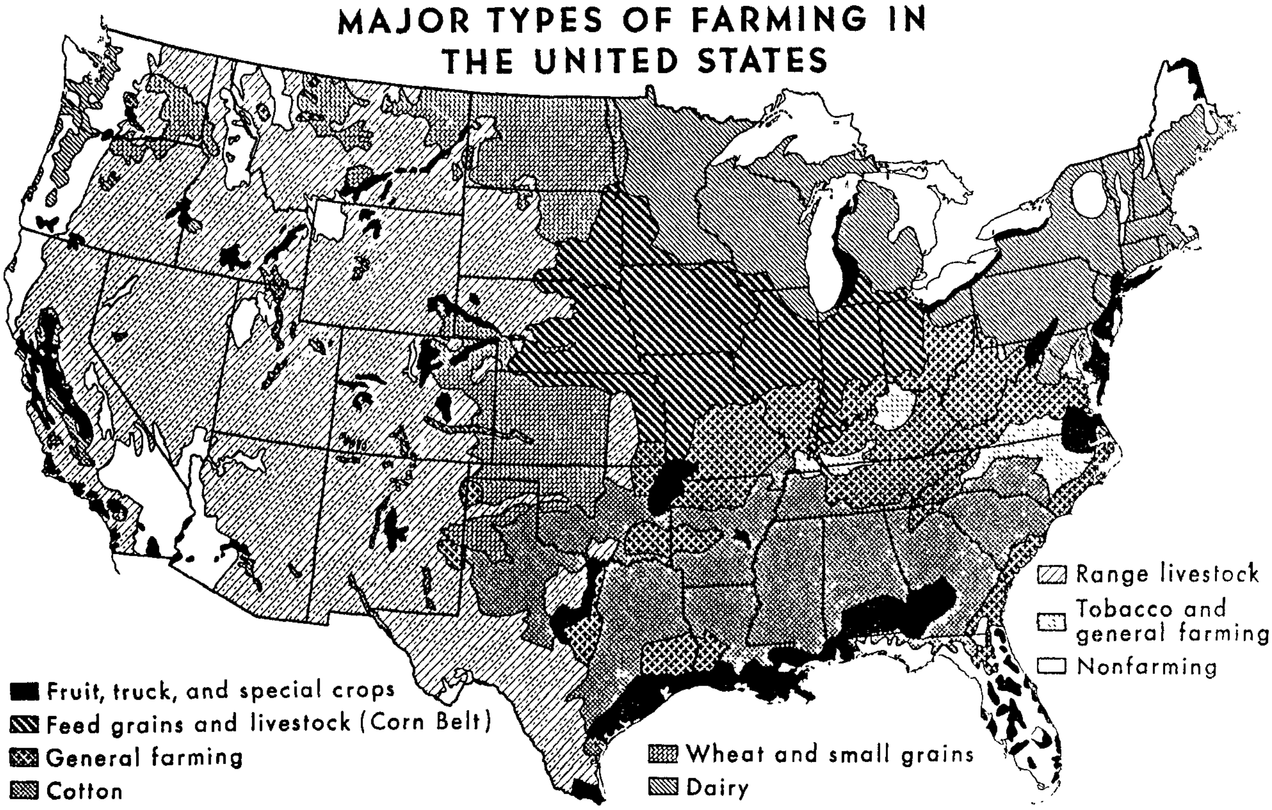


Figure 7. Identifies the eight major types of farming and geographical extent of each in the United States. Although each region, when described graphically, appears to end very abruptly, it in fact does not. Each region has a core in which the physical features and location has resulted in a homogeneous technology and economy with the outer fringes being transitional in nature. Source: Smith, G. Conservation of natural resources. 4th ed. New York, John Wiley & Sons, Inc., [1971]. p.17.

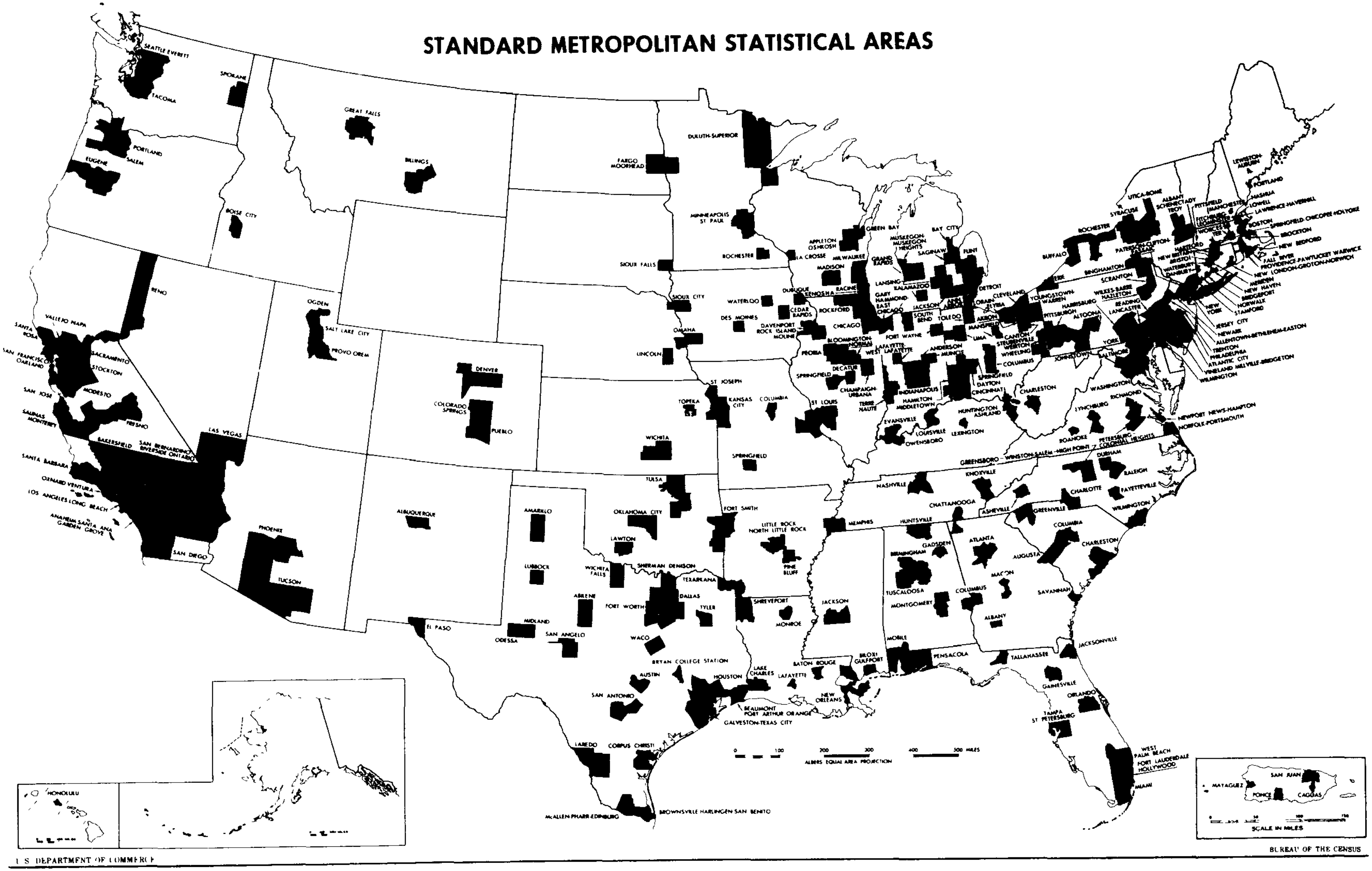


Figure 8. According to the 1970 Census, 70 percent of the population and 13 percent of the total land area of the 48 contiguous states lies within the confines of the 242 Standard Metropolitan Statistical Areas identified above. Source: U.S. Department of Agriculture, Our land and water resources.

STANDARD METROPOLITAN STATISTICAL AREA LAND USE, AVERAGE, 1970

Percent of Total Area

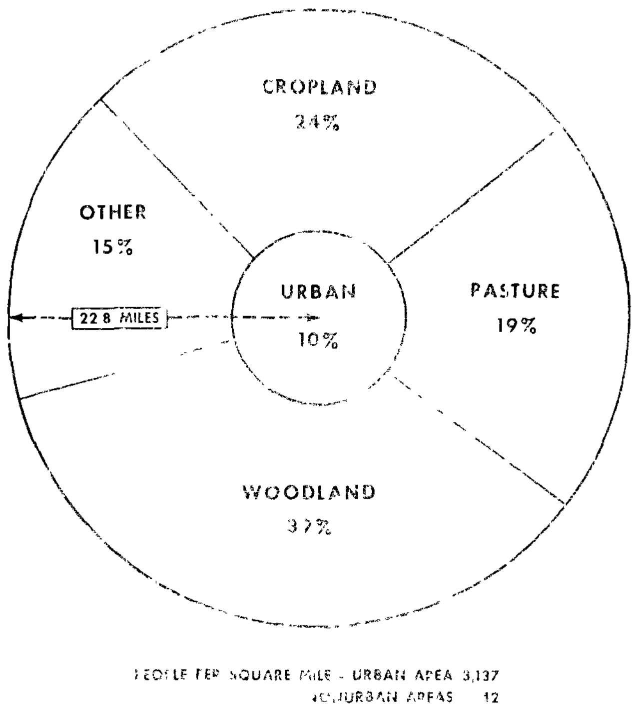


Figure 9. Although considerable regional variation exists between SMSA's, the use of land within an average SMSA is characterized by the above illustration. The total land area within the nation's 242 SMSA's is approximately 252 million acres. Source: U.S. Department of Agriculture, Our land and water resources.

additional 20 percent is in pastureland.[21 p.17] A large portion of this land is in dairy farms, horticultural specialty crops, and general farming, which together account for 17 percent of the national corn crop, 60 percent of the vegetables produced, and 43 percent of the fruit and nut crop.[21 p.16] Horticultural specialty crops such as sod, greenhouse vegetables, nursery products, bulbs, seeds, flowers, and mushrooms collectively account for more than 285,000 acres of the available cropland surrounding SMSA's (Table 22). Sod production and nursery products alone account for nearly two-thirds of the land in horticultural specialty crops. Although seemingly very small when compared to that of the total national acreage in corn, wheat, cotton, and soybeans, the total acreage in sod and nursery products represents a significant amount of land under cultivation surrounding the large metropolitan areas.

Sod and nursery product production is very closely related to the nation's housing industry and is extremely sensitive to the number of new housing starts and the overall economy of a particular region. The sod and nursery product industry as well as the nation's sewage sludge is primarily centered in and around the Northeastern, Great Lakes, and Southern Pacific States.

The application of sewage sludge to sod or nursery products appears to be an excellent means of recycling the nutrient content and soil improvement characteristics inherent in sludge. Both sod and nursery products are non-food chain crops and are located in close proximity to the sources of sludge generation. In addition to its soil improvement characteristics and nutrient content, sewage is an excellent source of organic matter that could replace the soil removed when a sod crop is harvested or when trees and shrubs are transplanted.

Strip Mined Land

In assessing the potential for utilizing sewage sludge or animal waste, one should not overlook the vast amounts of land that have been stripped as a result of surface mining operations. The soil-building characteristics of sewage sludge and animal waste appear to be excellent for reclaiming these wastelands. It is estimated by the U.S. Bureau of Mines that in excess of 3 million acres of land in the United States have been disturbed by surface mining.[22] The states of Pennsylvania, Ohio, and West Virginia account for over 25 percent of this total acreage (Table 23).[22 p.110] Only one-third of the total acreage disturbed by surface mining operations to date in the United States has been reclaimed, leaving approximately 2 million acres yet to be improved.[22 p.85]

Coal mining accounts for over 40 percent of the total stripped areas, while sand and gravel mining operations account for an additional 25 percent of the total disturbed acreage (Figure 10). Experts calculate that over 100,000 acres of land each year are disturbed by the coal mining industry alone and projections are this number will continue to increase paralleling the nation's greater needs for and dependence upon coal to meet its basic energy requirements.[21 p.13]

TABLE 22

ACREAGE IN HORTICULTURAL
AND SPECIALTY CROPS*
(1969)

Type of Crop	Acreage in Production
Nursery Products	145,948
Sod Production	59,116
Bulbs	7,025
Flowers	26,675
Seeds	38,724
Mushrooms	1,260
Greenhouse Crops	6,270

*Ornamentals production and marketing trends, 1948-72. Statistical Bulletin No. 529. Washington, U.S. Department of Agriculture, Economic Research Service, May 1974. 100 p.

TABLE 23

STATUS OF LAND DISTURBED BY STRIP AND SURFACE MINING OPERATIONS IN THE UNITED STATES BY REGION* (1965)

Region	Thousand Acres		
	Land Requiring Reclamation	Land Not Requiring Reclamation	Total Land Disturbed
Alaska/Hawaii	7.0	4.3	11.3
Pacific States	119.2	73.0	192.2
Mountain States	127.4	83.2	210.6
West South Central States	192.4	54.5	246.9
West North Central States	265.7	103.8	368.9
East South Central States	170.3	170.6	340.9
East North Central States	167.2	51.2	218.4
New England States	92.7	66.3	159.0
Appalachian States	898.8	541.0	1,439.8
TOTAL	2,040.7	1,147.3	3,188.0

*U.S. Department of the Interior. Surface mining and our environment. Washington, U.S. Government Printing Office, [1967]. 124 p.

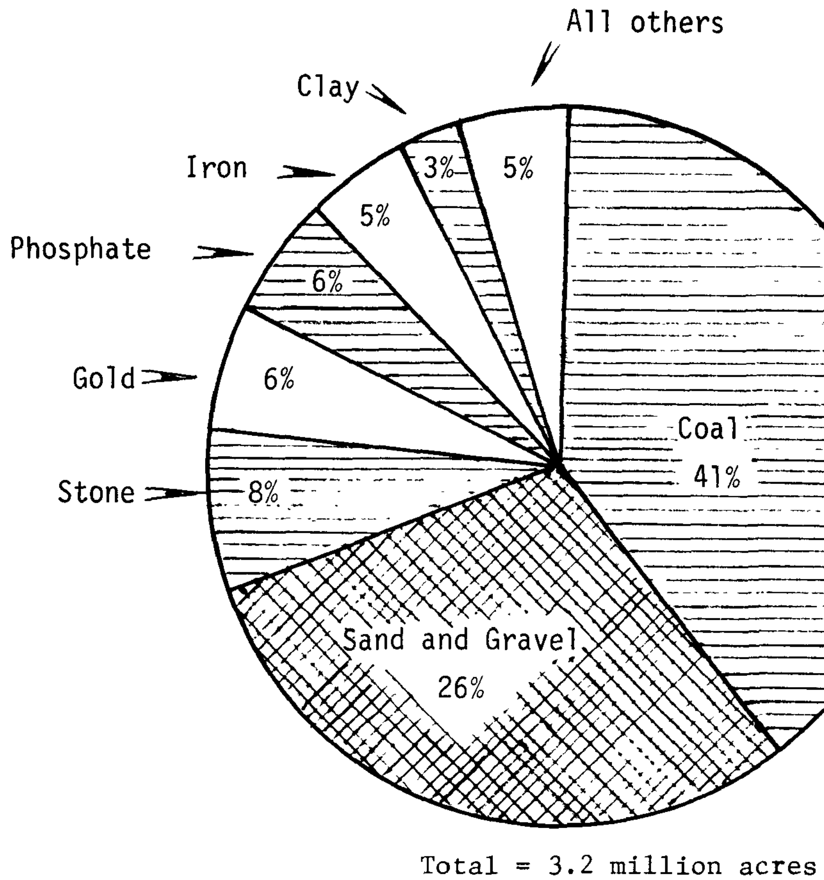


Figure 10. As displayed above, the mining of coal, sand, and gravel accounts for two thirds of the total land area disturbed by surface mining operations in the United States. Source: American Public Works Association. Rail transport of solid wastes. Environmental Protection Publication SW-22d. U.S. Environmental Protection Agency, 1973. 148 p. (Distributed by National Technical Information Service, Springfield, Va., as PB-222 709.)

For the most part, the Nation's coal reserves have remained untapped. Less than 5 percent of the total land reserves of this valuable resource lying within 100 feet of the earth's surface have been mined.[21 p.13] Approximately half of the coal consumed in the United States has been obtained through surface mining operations. The states of Montana, Illinois, North Dakota, and Wyoming account for over two-thirds of the Nation's total coal reserves; however, the most intensive mining operations to date have been east of the Mississippi River (Figure 11).

Land in Farms

Historically the United States consisted of a highly developed agricultural society in which farmers were in the majority, representing over 90 percent of the total population. Farming was once a way of life among the American people. Today farming is simply considered another big business. The United States is currently dependent upon less than 6 percent of the total population for its food and fibre production.

The trend over the last five years has been toward fewer and larger farms. Larger farms tend to be more productive than smaller farms due to their better management techniques and intensive fertility programs. The average size of farms has risen from 190 acres in 1945 to over 400 acres in 1970. The greatest decline in numbers has been in farms of less than 100 acres. In 1935 the number of farms peaked at approximately 6.8 million and has continued to decrease since to its current level of 2.5 million.[1 p.504] Projections indicate that this trend will continue and the current figure will fall below the 2 million mark by the year 1980 (Figure 12). Table 24 summarizes the total number, acreage, and average size of U.S. farms from 1900 through 1970. The distribution of U.S. farms is extremely widespread with very little concentration in any one specific area of the United States.

The most rapid decline in total number of farms since 1935 has occurred in the Northeastern, Southeastern, and Delta States. These areas experienced a 55 percent reduction in farms while the Great Lakes, Corn Belt, and Northern Plains States only experienced a 30 percent decrease over the same period of time.[21 p.25] Today 50 percent of the total land under cultivation is owned and operated by 5.5 percent of the farmers.[21 p.23] The trend toward further concentration of farms has, for the most part, subsided.

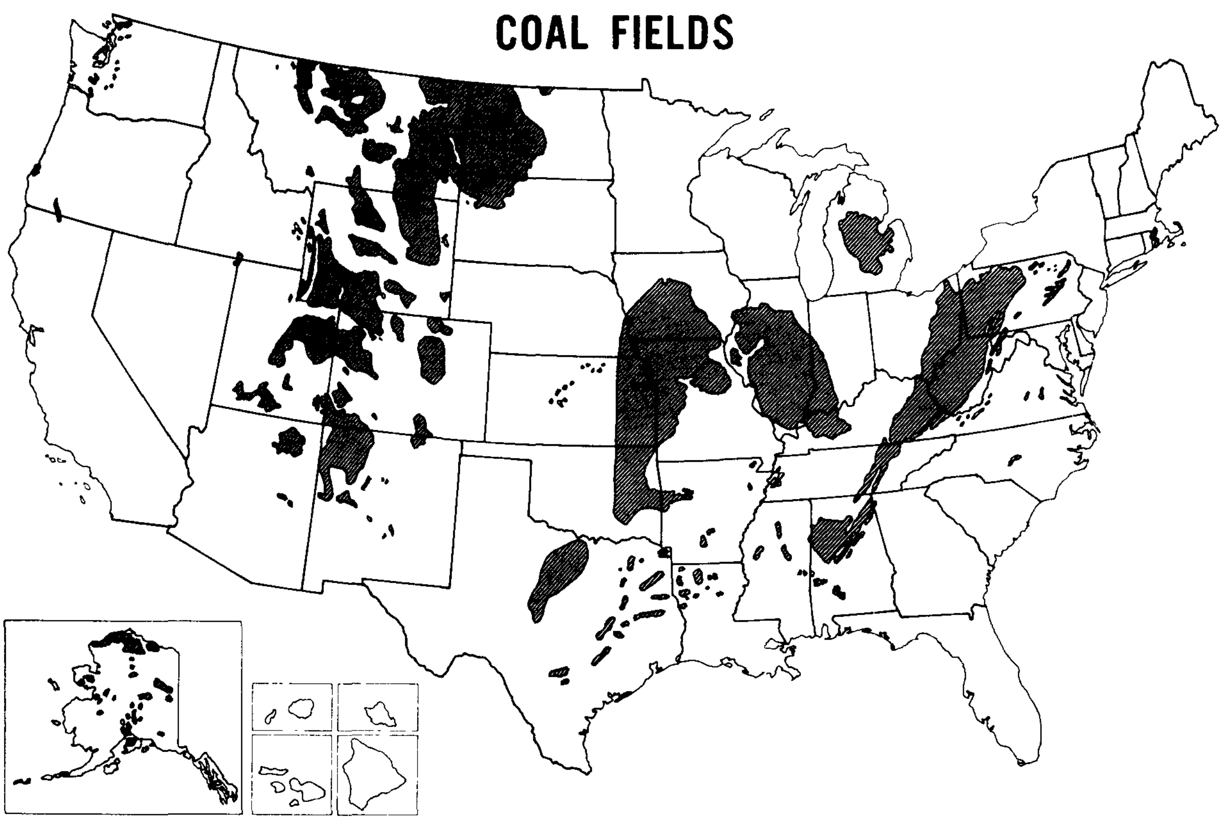


Figure 11. Over half of the nation's coal reserves lie west of the 100th meridian (Central United States), about one-fourth in the Midwest, and one-fourth in the Appalachian Region. Source: U.S. Department of Agriculture, Our land and water resources.

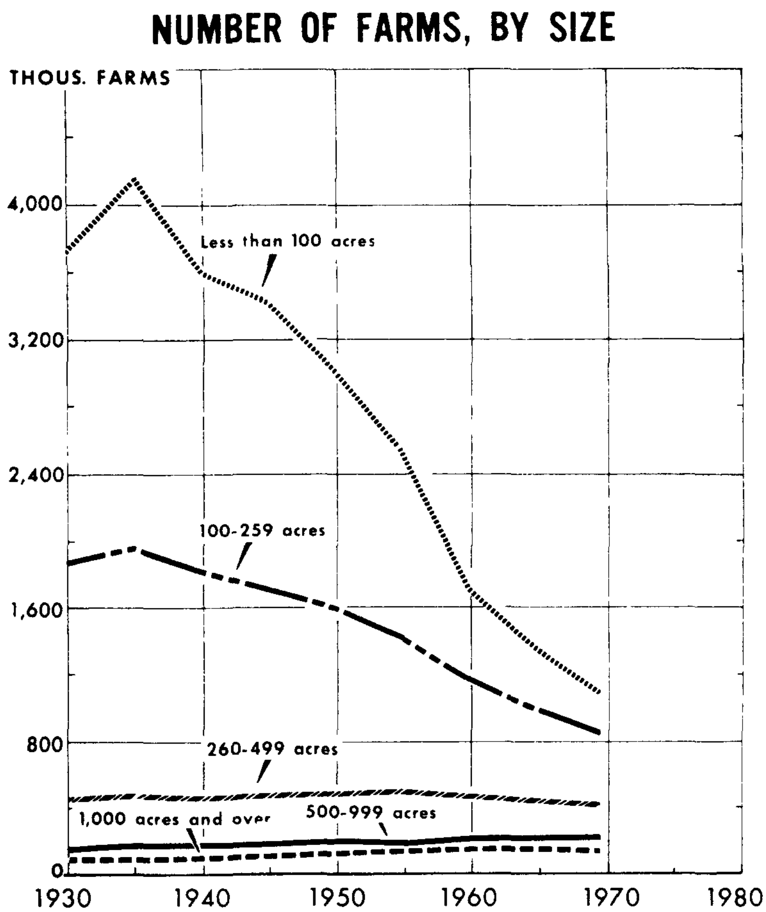


Figure 12. The number of farms exceeding 260 acres in size has remained basically unchanged since the mid 1930's, while a dramatic decline in the number of farms of 260 acres or less has occurred over the same time span. Source: U.S. Department of Agriculture, Our land and water resources.

TABLE 24

TOTAL NUMBER, ACREAGE, AND
AVERAGE SIZE OF FARMS*

Year	Number of Farms	Land in Farms (Acres)	Average Size (Acres)
1900	5,737,372	838,592,000	146
1910	6,361,502	878,798,000	138
1920	6,448,343	955,884,000	148
1930	6,288,648	986,771,000	156
1940	6,096,799	1,060,852,000	174
1950	5,382,162	1,158,566,000	210
1960	3,703,894	1,120,138,000	288
1970	2,585,051	1,063,347,000	410

*U.S. Department of Agriculture, Agricultural statistics, 1973.

DISCUSSION AND IMPLICATIONS

Historically, animal waste and sewage sludge were once highly regarded by farmers as a primary source of plant nutrients and organic matter necessary to sustain adequate levels of soil fertility in cultivated lands. It has only been within the past few decades that animal waste and sewage sludge have gained national recognition as a waste disposal problem. The reason for this dramatic change in attitude toward utilization of animal waste and sewage sludge is due in part to the increased production, use, and availability of low cost, commercially produced nitrogen-containing fertilizers. Farmers have found it far more profitable to use commercially produced fertilizers than natural organic nitrogenous materials. Other factors that have served to compound or contribute to the problem of increasing volumes of animal waste and sewage sludge are: 1) the enactment and enforcement of more stringent Federal, state, and local regulatory controls on utilization and disposal of sewage sludge and animal waste, 2) the growing number and increasing size of animal feedlots, 3) the construction of an increasing number of more efficient secondary and tertiary sewage treatment plants, and 4) the increased concern generated by local residents relative to environmental matters. Many of the problems associated with the last of these have evolved as a result of urban sprawl and its impact upon rural areas.

Municipal sewage sludge and animal waste have been used for many years with varying degrees of success as a fertilizer supplement and as a soil conditioner to improve the fertility level and physical characteristics of cultivated soils. The use of organic waste materials as complete substitutes for commercially produced fertilizers, however, has been limited because of their low nutrient content, slow and virtually uncontrolled nitrogen release characteristics, and the high cost of distribution and application relative to synthetics. A farmer usually thinks in terms of adding pounds of nutrient per acre, but when contemplating the use of sewage sludge or animal waste, he must think in terms of adding tons of fertilizer material per acre to attain the same relative degree of applied nutrients.

In the United States the annual production of animal waste and sewage sludge totals approximately 2 billion wet tons per year. Animal waste is by far the greater of the two, accounting for over 99 percent of the total waste generated. Approximately 80 percent of the animal waste falls on open pasture or grazing land and presents few if any problems. The remaining 20 percent is found in highly concentrated quantities where animals are held in confinement for intensive feeding or marketing purposes. Recent estimates by the U.S. Department of Agriculture and others indicate that at least one-half to two-thirds of all the beef cattle waste generated in confined or concentrated areas is being returned to the land as a supplemental source of fertilizer or as a soil conditioner.

Utilization of sewage sludge on the other hand is extremely low when compared to that of animal waste. This is due primarily to an increased awareness of the general public concerning the adverse qualities commonly associated with sewage sludge when improperly handled or applied to the land (i.e., odor development, accumulation of toxic metals in soil, plant, and animal life, pathogen survival, and the potential that exists for disease transmission). In actuality, the fears of the public are not completely unfounded because many sludge utilization and disposal operations across the United States do have a track record of not being properly monitored and managed and problems have developed. If, however, sludge is properly handled and applied to the land in accordance with "accepted practices", there is little or no reason for the public to be alarmed. The Environmental Protection Agency is currently in the process of publishing a technical bulletin on acceptable methods of sludge utilization and disposal which should be of benefit in determining what would be considered an acceptable practice.[23]

According to a recent EPA report, fewer than 25 percent of all the sewage treatment plants in the United States of 1 million gallons per day capacity or more are currently landspreading their sewage on a routine basis. Approximately 68 percent of those landspreading their sludge have been doing so for less than 10 years. Furthermore, it was found that most sludge landspreading operations are conducted without any means of monitoring for environmental effects.

In view of recent shortages and higher cost of commercially produced fertilizers, it has been reported that utilization of sewage sludge and animal waste has increased and will likely continue to increase throughout the remainder of this decade. Utilization is expected to remain at a high level until the availability of abundant supplies of natural gas are once again restored or alternate sources of energy are found to replace natural gas as a cheap source of hydrogen in the production of anhydrous ammonia. Most industrial experts do not foresee the supply of natural gas being equal to demand now or in the near future and therefore predict even higher costs and increased demands for limited supplies of fertilizer products.

The nitrogen content of digested sewage sludge and animal waste typically ranges between 1 and 4 percent on a dry solids basis. It has been calculated that 40 to 50 wet tons of animal waste or dewatered sewage sludge have a nitrogen content approximately equivalent to that contained in an average ton of commercial fertilizer produced in 1973 (i.e., @ 20 percent nitrogen). Moreover, substituting organic waste for commercial fertilizer means that a farmer has to handle many times as much bulk material, thus greatly increasing his fertilizer handling and application costs. In addition to the added cost of application, sewage sludge and animal waste seldom contain nutrients in the proper ratio consistent with that of a farmer's specific needs. This becomes especially important when assessing the potential market value of a particular organic waste material as a low grade fertilizer. Fertilizer materials having different concentrations of nitrogen, phosphorous, and potassium, but similar ratios, can generally be used interchangeably as it is necessary to alter only the rate of application to attain the same relative degree of applied nutrients. If the ratio of primary nutrients differs significantly, however, excesses and/or deficiencies in one or more of the primary nutrients is likely to occur after prolonged application. Therefore, it is generally recommended that only enough organic waste material be applied to satisfy the demand of the most limiting nutrient being applied. Table 25 displays the typical ratio of primary nutrients among the various types of organic waste materials compared to that of the average commercial fertilizer produced in 1973.

In addition to its nutrient content, sewage sludge may also contain high concentrations of heavy metals which may restrict or inhibit its utilization on land. In general, sludges with extremely high concentrations of heavy metals should not be applied to agricultural lands. To assist in determining acceptable application rates or the utilization potential of a specific sludge based upon its metals content, the following formula has been developed by the U.S.D.A. Agricultural Research Service as a guide for limiting the toxic metal addition to soils.[23]

$$\text{TOTAL SLUDGE APPLIED (dry tons per acre)} = \frac{32{,}700 \times \text{C.E.C. of soil}}{\text{ppm Zn} + 2(\text{ppm Cu}) + 4(\text{ppm Ni}) - 200}$$

C.E.C. = Cation Exchange Capacity of the unamended soil in meg/100 g as determined by the sum of cations or equivalent method

ppm = mg/kg dry weight of sludge

The above equation takes into account the greater phytotoxicity of Zn, Cu, and Ni by converting each to its Zn equivalency. The - 200 adjusts for the increase in Cation Exchange Capacity of the native soil as a result of the added inorganic matter applied with the sludge. The soil C.E.C. relates to the characteristic of the soil to absorb excess metal ions. Soil pH is also a very important factor limiting the amount of sludge that can be applied to a specific soil. Generally speaking, a pH of 6.5 or greater is recommended for sludge applications.[24] In addition, the cadmium to zinc ratio should not exceed 1:100.[24]

Approximately 500,000 to 800,000 tons each of nitrogen (N), phosphorous (P_2O_5), and potassium (K_2O) are potentially available from that portion of the animal waste and sewage sludge not being applied to the land. If all the available waste were to be applied to the Nation's cropland and its total nutrient value realized, it would represent a potential national savings of 7, 15, and 18 percent in nitrogen, phosphorous, and potassium consumption annually. The energy implications of such a savings are significant; however, when placed in proper perspective, this savings has only a minor impact upon the overall national consumption of energy. According to Sweeten, a net energy savings of approximately 4.4 million BTU's per acre of harvested grain sorghum or

TABLE 25

TYPICAL RATIO OF PRIMARY NUTRIENTS AMONG VARIOUS TYPES OF ORGANIC WASTE MATERIALS

Fertilizer Material	Nitrogen (N)	Phosphorous (P_2O_5)	Potassium (K_2O)
Average Commercial Grade Fertilizer Produced in 1973	2	1	2
Digested Primary Sludge	1	1	0
Digested Secondary Sludge	1	1	0
Beef Cattle Manure	4	1	2
Dairy Cattle Manure	6	1	5
Swine Manure	5	1	2
Chicken Manure	4	1	1
Sheep Manure	7	1	5

or corn silage could be realized by using 10 dry tons of feedlot manure in lieu of commercial fertilizers (maximum haul distance was assumed to be 10 miles one way).[25] The 4.4 million BTU's of energy saved is approximately equivalent to that required in the commercial production of 200 pounds of anhydrous ammonia (the amount normally applied to grain sorghum and corn silage). Therefore it can be calculated that a net national savings of approximately 0.12 percent of the natural gas or 0.04 percent of the total energy consumed annually in the U.S. could be potentially realized if all the available animal waste and sewage sludge were used in lieu of commercially produced nitrogen.

Most of the problems commonly associated with utilization and disposal of sewage sludge and animal waste have been largely the result of improper distribution and handling, rather than an inability or capacity of nature to assimilate fully the vast quantity of waste generated. Assuming a very moderate application rate of 10 dry tons of solids per acre per year, it is calculated that less than 5 million acres of land would be required to handle adequately all of the available animal waste and sewage sludge generated in the United States each year. The land requirement for sewage sludge alone is less than 10 percent of this total acreage. The combined acreage for both sewage sludge and animal waste represents only 1.3 percent of the Nation's total land area currently under cultivation. On an assumed worst case basis, it is estimated that all of the Nation's municipal waste (i.e., garbage, sewage sludge, and food processing waste) could be disposed of on less than 5 percent of our Nation's cropland without harm to the environment or the crop.[26] Therefore, it does not appear that our Nation need be concerned about having sufficient land available to utilize fully the growing quantities of sewage sludge and animal waste being generated annually. The real problem is basically one of distribution, economics, and public acceptance.

All factors taken into consideration, it is highly unlikely that cities will be able to afford to continue to haul their sewage sludges greater and greater distances to "remote" areas; therefore, they will have to rely more heavily upon utilizing their sludge in urban areas. The use of composted, heat-dried, digested, or otherwise stabilized sludge should be encouraged on park land, playgrounds, turfgrass, nursery products, cemeteries, cropland, etc., whenever possible. The higher cost of fuel and the more stringent regulations being placed upon ocean dumping and incineration are making sewage sludge utilization practices more and more attractive to municipalities than ever before. In addition, feedlot operators should be encouraged to maximize the utilization of their animal waste on cropland as a partial substitute for commercially produced fertilizers. New feedlots should attempt to locate their businesses in areas that are considered to be more in step with animal waste supply-and-demand principles. Alternate and innovative ways to deal with these waste products should be developed (e.g., gasification, refeeding, pyrolysis, and energy recovery systems). Landspreading should only be considered as a partial solution to the waste disposal problems of our Nation to be used in conjunction with other means of utilization and disposal.

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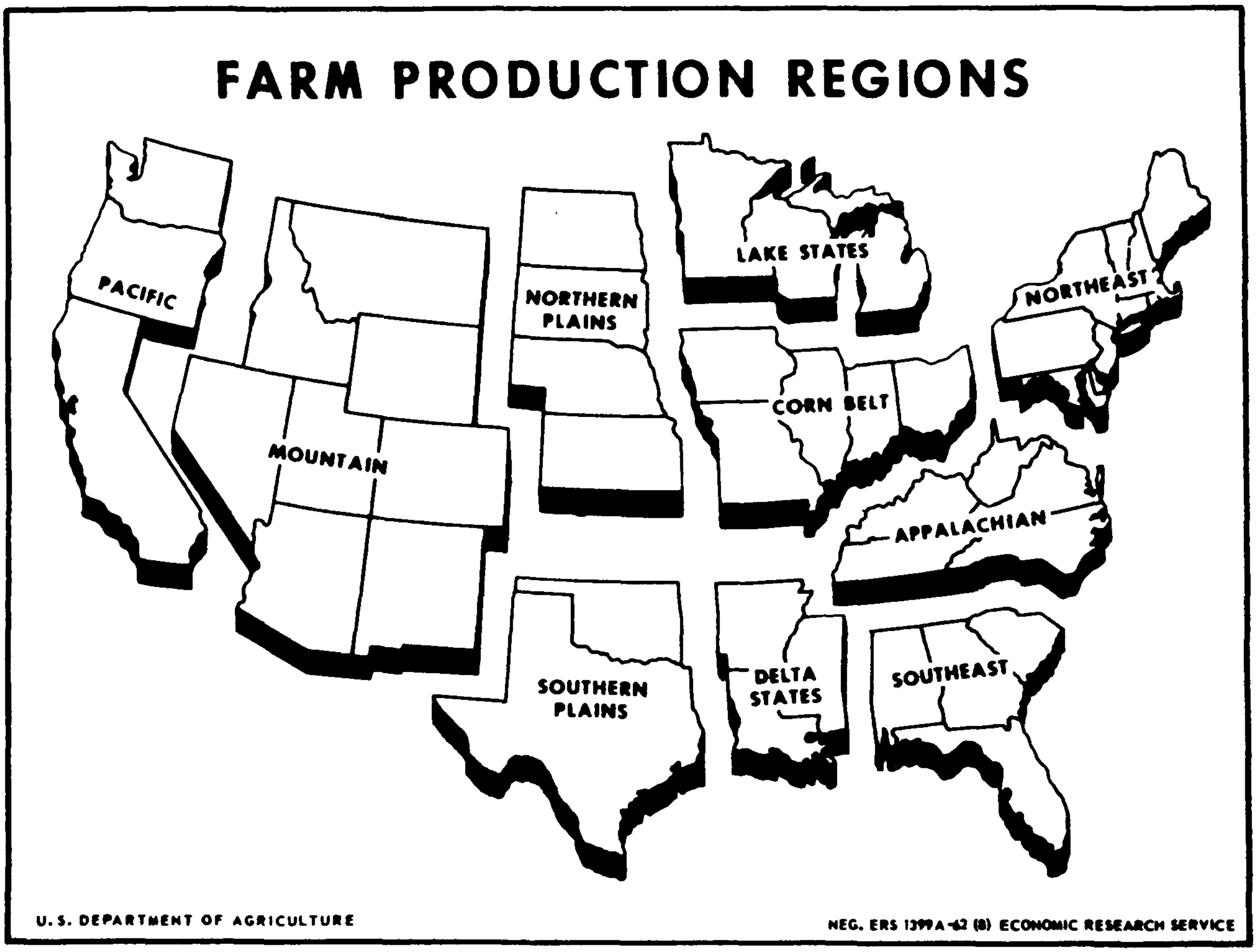
A P P E N D I X

APPENDIX A

Conversion Factors

To convert	To	Multiply by
P_2O_5	P	0.43642
P	P_2O_5	2.29137
K_2O	K	.83016
K	K_2O	1.20459
Anhydrous ammonia	N	.82
Urea	N	.46
Ammonium nitrate	N	.335
Ammonium sulfate	N	.205
Sodium nitrate	N	.16
Superphosphate:		
20 percent P_2O_5	P	.08728
46 percent P_2O_5	P	.20075
Potash:		
60 percent K_2O	K	.49810
62 percent K_2O	K	.51470
Potassium chloride	K_2O	.63177
Metric tons (tonnes, 2204.6 av. lbs.)	Short tons	1.10231
Long tons (2240 av. lbs.)	Short tons	1.12

APPENDIX B


FARM PRODUCTION REGIONS
PACIFIC
MOUNTAIN
NORTHERN PLAINS
LAKE STATES
CORN BELT
NORTHEAST
APPALACHIAN
SOUTHERN PLAINS
DELTA STATES
SOUTHEAST
U.S. DEPARTMENT OF AGRICULTURE
NEG. ERS 1399A-62 (8) ECONOMIC RESEARCH SERVICE

APPENDIX C
Anhydrous Ammonia Production Capacity

Company	Location	1972	1973	1974	1975	1976	1977	1978	1979	1980
					(000 short tons of material)					
		United States								
Agrico Chemical Co.	Donaldsonville, La.	340	400	400	400	400	400	400	400	400
	Blytheville, Ark.	340	390	390	390	390	390	390	390	390
	Tulsa, Okla.	–	–	–	425	425	425	425	425	425
Agway, Inc.	Olean, N. Y.	85	85	85	85	85	85	85	85	85
Air Products & Chem.	New Orleans, La.	210	210	210	210	210	210	210	210	210
	Pace Jct., Fla	100	100	100	100	100	100	100	100	100
Allied Chemical Co.	Geismar, La.	340	340	340	340	340	340	340	340	340
	Hopewell, Va.	340	340	340	340	340	340	340	340	340
	LaPlatte, Neb	202	202	202	202	202	202	202	202	202
	South Point, Ohio	80	160	160	160	160	160	160	160	160
American Cyanamid Co.	Fortier, La.	340	340	340	340	340	340	340	340	340
Amoco Chemical Co.	Texas City, Texas	720	720	720	720	720	720	720	720	720
Apache Powder Co.	Benson, Ariz.	15	15	15	15	15	15	15	15	15
Arkla Chemical Co	Helena, Ark.	210	210	210	210	210	210	210	210	210
Atlas Chemical, Inc	Joplin, Mo.	136	136	136	136	136	136	136	136	136
Beker Industries	Carlsbad, N.M.	–	–	–	200	200	200	200	200	200
	Conda, Idaho	–	–	100	100	100	100	100	100	100
Borden Chemical Co.	Geismar, La.	240	240	240	240	240	240	240	240	240
CF Industries, Inc.	Fremont, Neb.	48	48	48	48	48	48	48	48	48
	Donaldsonville, La.	680	750	750	750	750	750	750	750	750
	Terre Haute, Ind.	135	135	135	135	135	135	135	135	135
Cherokee Nitrogen	Pryor, Okla.	55	55	55	55	55	55	55	55	55
Chevron Chemical Co.	Richmond, Calif.	130	130	130	130	130	130	130	130	130
	Ft. Madison, Iowa	105	105	105	105	105	105	105	105	105
	Pascagoula, Miss.	510	510	510	510	510	510	510	510	510
	El Segundo, Calif.	4	20	20	20	20	20	20	20	20
Collier Carbon & Chem.	Kenai, Alaska	510	510	510	510	510	510	510	510	510
	Brea, Calif.	260	260	260	260	260	260	260	260	260
Columbia Nitrogen	Augusta, Ga.	122	122	122	122	122	122	122	122	122
Commercial Solvents	Sterlington, La	340	340	340	340	340	340	340	340	340
Diamond-Shamrock Co.	Dumas, Texas	160	160	160	160	160	160	160	160	160
Dow Chemical Co.	Freeport, Texas	115	115	115	115	115	115	115	115	115
E. I. DuPont Co.	Beaumont, Texas	340	340	340	340	340	340	340	340	340
	Belle, W. Va.	340	340	340	340	340	340	340	340	340
	Victoria, Texas	100	100	100	100	100	100	100	100	100
Duval Corp.	Hanford, Calif.	21	21	21	21	21	21	21	21	21
El Paso Products Co.	Odessa, Texas	115	115	115	115	115	115	115	115	115
Farmers Chemical Assoc.	Tunis, N.C.	210	210	210	210	210	210	210	210	210
	Tyner, Tenn.	170	170	170	170	170	170	170	170	170
Farmers National Chem.	Plainview, Texas	–	–	60	60	60	60	60	60	60
Farmland Industries	Dodge City, Kan.	210	210	210	210	210	210	210	210	210
	Ft. Dodge, Iowa	210	210	210	210	210	210	210	210	210
	Hastings, Neb.	140	140	140	140	140	140	140	140	140
	Lawrence, Kan.	340	340	340	340	340	340	340	340	340
	Enid, Okla.	–		425	425	425	425	425	425	425
First Mississippi Co.	Ft. Madison, Iowa	340	340	340	340	340	340	340	340	340
FMC Corp.	S. Charleston, W. Va.	24	24	24	24	24	24	24	24	24
Gardinier	Tampa, Fla.	120	120	120	120	120	120	120	120	120
Good Hope Refineries	Corpus Christi, Texas	–	–	–	–	850	850	850	850	850

Anhydrous Ammonia Production Capacity

Company	Location	1972	1973	1974	1975	1976	1977	1978	1979	1980
					(000 short tons of material)					
		United States								
Goodpasture, Inc.	Dimmitt, Texas	30	30	30	30	30	30	30	30	30
W. R. Grace & Co.	Woodstock, Tenn	275	340	340	340	340	340	340	340	340
	Big Spring, Texas	100	100	100	100	100	100	100	100	100
	Pt. Lisas, Trinidad	500	340	340	340	340	740	740	740	740
Green Valley Chem. Co.	Creston, Iowa	35	35	35	35	35	35	35	35	35
Hawkeye Chemical Co.	Clinton, Iowa	138	138	138	138	138	138	138	138	138
Hercules, Inc.	Hercules, Calif.	70	70	70	70	70	70	70	70	70
	Louisiana, Mo.	70	70	70	70	70	70	70	70	70
Hill Chem. (Camex)	Borger, Texas	340	400	400	400	400	400	400	400	400
Hooker Chemical Co.	Tacoma, Wash.	23	23	23	23	23	23	23	23	23
Kaiser Ag. Chem.	Savannah, Ga.	150	150	150	150	150	150	150	150	150
Mississippi Chem. Corp.	Pascagoula, Miss.	175	175	175	175	175	175	175	175	175
	Yazoo City, Miss.	340	340	340	340	340	340	340	340	340
Mobil Chemical Co.	Beaumont, Texas	300	300	300	300	300	300	300	300	300
Monsanto Co.	Luling, La.	450	450	450	450	450	450	450	450	450
New Jersey Zinc Co.	Palmerton, Pa.	35	35	35	35	35	35	35	35	35
Nipak, Inc.	Pryor, Okla.	105	105	105	105	105	105	105	105	105
	Kerens, Texas	125	125	125	125	125	125	125	125	125
Occidental Ag. Chem.	Lathrop, Calif.	96	96	96	96	96	96	96	96	96
	Plainview, Texas	52	52	52	52	52	52	52	52	52
Olin, Inc.	Lake Charles, La.	490	490	490	490	490	490	490	490	490
Pennsalt Chemical Co.	Wyandotte, Mich.	34	–	–	–	–		–		–
	Portland, Ore.	8	8	8	8	8	8	8	8	8
Phillips Pacific Chem.	Kennewick, Wash.	155	155	155	155	155	155	155	155	155
Phillips Chemical Co.	Beatric, Neb.	210	210	210	210	210	210	210	210	210
	Etter, Texas	210	210	–	–	–	–		–	–
	Pasadena, Texas	230	230	230	230	230	230	230	230	230
PPG Industries	Natrium, W. Va.	50	50	50	50	50	50	50	50	50
Reichhold Chemical	St. Helens, Ore.	90	90	90	90	90	90	90	90	90
Rohm and Haas	Deer Park, Texas	–	35	35	35	35	35	35	35	35
St. Paul Ammonia Prod.	E. Dubuque, Ill.	230	230	230	230	230	230	230	230	230
Shell Chemical Co.	Ventura, Calif.	60	–	–	–	–	–	–		–
J. R. Simplot Co.	Pocatello, Idaho	54	54	108	108	108	108	108	108	108
Sun Oil Co.	Marcus Hook, Pa.	133	133	–	–	–	–	–	–	–
Tenneco Chemical Co.	Houston, Texas	210	210	210	210	210	210	210	210	210
Tennessee Valley Authority	Muscle Shoals, Ala.	–	74	74	74	74	74	74	74	74
Terra Chemicals	Port Neal, Iowa	210	210	210	210	210	210	210	210	210
Triad Chemical Co.	Donaldsonville, La.	340	340	340	340	340	340	340	340	340
USS Agri-Chem.	Cherokee, Ala.	177	177	177	177	177	177	177	177	177
	Clairton, Pa.	–	325	325	325	325	325	325	325	325
	Geneva, Utah	70	70	70	70	70	70	70	70	70
Valley Nitrogen Prod.	El Centro, Calif.	210	210	210	210	210	210	210	210	210
	Helm, Calif.	176	176	176	176	176	176	176	176	176
	Chandler, Ariz.	–	–	33	33	33	33	33	33	33
Vistron Corp	Lima, Ohio	510	510	510	510	510	510	510	510	510
Vulcan Materials	Wichita, Kan.	23	23	23	23	35	35	35	35	35
Wycon Chemical Co.	Cheyenne, Wyo.	167	167	167	167	167	167	167	167	167
Total		**17,004**	**17,589**	**17,918**	**18,543**	**19,405**	**19,805**	**19,805**	**19,805**	**19,805**

Anhydrous Ammonia Production Capacity

Company	Location	1972	1973	1974	1975	1976	1977	1978	1979	1980
					(000 short tons of material)					
		Canada								
Alberta Ammonia Ltd.	Medicine Hat, Alta.	–	–	–	–	400	800	1,600	1,600	1,600
Beker Industries	Sarnia, Ont.	–	–	–	163	163	163	163	163	163
Brockville Chemical Ind.	Maitland, Ont.	88	88	88	88	88	88	88	88	88
Calgary Petrochemicals	Alberta	–	–	–	–	135	135	135	135	475
CIL Ltd.	Courtright, Ont.	340	340	340	340	340	340	340	340	340
CF Industries, Inc.	Medicine Hat, Alta.	–	–	–	–	400	400	400	400	400
Cominco, Ltd.	Calgary, Alta.	125	125	125	125	125	125	125	125	125
	Trail, B.C.	155	155	155	155	155	155	155	155	155
Cyanamid of Canada	Welland, Ont.	250	250	250	250	250	250	250	250	250
Imperial Chemical Co.	Redwater, Alta.	210	210	210	210	210	210	210	210	210
Northwest Nitro. Chem.	Medicine Hat, Alta.	65	65	65	65	65	65	65	65	65
Pan Canadian-Tyler	Medicine Hat, Alta.	–	–	–	–	400	400	400	400	400
Sherritt-Gordon Mines	Ft. Saskatchewan, Alta.	160	160	160	160	160	495	495	495	495
J. R. Simplot Co.	Brandon, Man.	110	110	110	110	220	220	220	220	220
Western Coop. Fert.	Calgary, Alta.	70	70	70	70	70	70	70	70	70
Total		**1,573**	**1,573**	**1,573**	**1,736**	**3,181**	**3,916**	**4,716**	**4,716**	**5,056**

Type of Plant	Location	1972	1973	1974	1975	1976	1977	1978	1979	1980
					(000 short tons of material)					
		Other Production Capacity Under Consideration[a]								
Conventional (U.S.)	Alabama	–	–	–	–	–	–	X	X	X
	Alaska	–	–	–	–	–	X	X	X	X
	Indiana	–	–	–	–	–	X	X	X	X
	Louisiana	–	–	–	–	X	X	X	X	X
	North Carolina	–	–	–	–	X	X	X	X	X
	Pennsylvania	–	–	–	–	–	–	X	X	X
	Texas	–	–	–	–	X	X	X	X	X
	Texas	–	–	–	–	–	X	X	X	X
Total		–	–	–	–	1,080	2,330	2,930	2,930	2,930
Coal Gasification (U.S.)	New Mexico	–	–	–	–	–	–	X	X	X
(Byproduct Ammonia)	North Dakota	–	–	–	–	–	–	X	X	X
	Wyoming	–	–	–	–	–	–	X	X	X
Total		–	–	–	–	–	–	235	235	370
Total		–	–	–	–	1,080	2.330	3,165	3,165	3,300
Conventional (Canada)	Alberta	–	–	–	–	–	X	X	X	X
	Alberta	–	–	–	–	–	X	X	X	X
	Ontario	–	–	–	–	–	X	X	X	X
	Ontario	–	–	–	–	–	X	X	X	X
Total		–	–	–	–	–	1,210	1,219	1,219	1,210
Total		–	–	–	–	1,080	3,540	4,375	4,375	4,510
Summary										
Total United States		17,004	17,589	17,918	18,543	20,485	22,135	22,970	22,970	23,105
Total Canada		1,573	1,573	1,573	1,736	3,181	5,126	5,926	5,926	6,266
Total North America		**18,577**	**19,162**	**19,491**	**20,279**	**23,666**	**27,261**	**28,896**	**28,896**	**29,371**

[a]Unconfirmed plants said to be in various stages of planning. Market conditions will affect future construction schedules of these or other plants currently under study. Many may not come into being until such time as the energy policy of the U.S. is more clearly defined.

Urea Production Capacity

Company	Location	1972	1973	1974	1975	1976
				(000 short tons of material)		
	United States					
Agrico Chemical Co.	Donaldsonville, La.	200	200	340	340	340
	Blytheville, Ark.	–	–	–	340	340
	Tulsa, Okla.	–	–	–	215	215
Agway, Inc.	Olean, N.Y.	60	60	60	60	60
Air Products & Chem.	Pace Jct., Fla.	23	23	23	23	23
Allied Chemical Co.	Geismar, La	230	230	230	230	230
	LaPlatte, Neb.	125	125	125	125	125
	South Point, Ohio	190	100	100	100	100
American Cyanamid Co.	Fortier, La.	145	145	145	145	145
Arkla Chemical Co.	Helena, Ark.	70	70	70	70	70
Atlas Chemical Ind.	Joplin, Mo.	64	64	64	64	64
Borden Chemical Co.	Geismar, La.	165	165	165	165	165
CF Industries, Inc.	Fremont, Neb.	20	20	20	20	20
	Donaldsonville, La.	–	–	340	340	340
Cherokee Nitrogen	Pryor, Okla.	45	45	45	45	45
Collier Carbon & Chem.	Kenai, Alaska	350	350	350	350	350
	Brea, Calif.	55	55	55	55	55
Columbia Nitrogen	Augusta, Ga.	30	30	30	30	30
E.I. DuPont Co.	Belle, W. Va.	100	40	40	40	40
Farmers Chemical Assoc.	Tunis, N.C.	165	165	165	165	165
	Tyner, Tenn.	45	45	45	45	45
Farmers National Chem.	Plainview, Texas	–	–	60	60	60
Farmland Industries	Lawrence, Kan.	76	76	286	286	286
W. R. Grace & Co.	Woodstock, Tenn.	140	140	140	140	340
Hawkeye Chemical Co.	Clinton, Iowa	61	61	61	61	61
Hercules, Inc.	Hercules, Calif.	40	40	40	40	40
	Louisiana, Mo.	95	95	95	95	95
Kaiser Ag. Chem.	Savannah, Ga.	80	80	110	110	110
Mississippi Chem. Co.	Yazoo City, Miss.	85	153	153	153	153
Mobil Chemical Co.	Beaumont, Tex.	49	49	49	49	49
Nipak, Inc.	Pryor, Okla.	100	100	100	166	166
	Kerens, Texas	86	86	86	86	86
Olin Inc.	Lake Charles, La.	160	160	160	160	160
Phillips Pacific Chem.	Kennewick, Wash.	43	43	43	43	43
Phillips Chemical Co.	Beatrice, Neb.	56	56	56	56	56
Premier Petrochemical	Pasadena, Tex.	75	103	103	103	103
Reichhold Chemical	St. Helens, Ore.	55	55	55	55	55
SunOlin Chemical Co.	Clayton, Del.	90	–	–	–	–
Tennessee Valley Auth.	Muscle Shoals, Ala.	–	66	66	66	66
Terra Chemicals	Port Neal, Iowa	123	123	170	170	170
Triad Chemical Co.	Donaldsonville, La.	420	420	420	420	420
U.S.S. Agri-Chem.	Cherokee, Ala.	25	25	25	25	25
Valley Nitrogen Prod.	El Centro, Calif.	155	155	155	155	155
	Helm, Calif.	35	35	35	35	35
Vistron Corp.	Lima, Ohio	238	238	238	238	238
Wycon Chemical Co.	Cheyenne, Wyo.	50	50	50	50	50
Total		**4,419**	**4,341**	**5,168**	**5,789**	**5,989**

Urea Production Capacity

Company	Location	1972	1973	1974	1975	1976
				(000 short tons of material)		
		Canada				
Brockville Chemical Ind.	Maitland, Ont.	50	50	50	50	50
Calgary PetroChemicals	Alberta	–	–	–	–	136
CIL Ltd.	Courtright, Ont.	70	70	70	70	70
CF Industries, Inc.	Medicine Hat, Alta.	–	–	–	–	510
Cominco, Ltd.	Calgary, Alta.	90	90	90	90	90
Cyanamid of Canada	Welland, Ont.	99	99	99	99	99
PanCanadian Petro.	Alberta, Canada	–	–	–	–	. . .
Sherritt-Gordon Mines	Ft. Saskatchewan, Alta.	100	100	100	100	400
J. R. Simplot Co.	Brandon. Man.	33	33	33	33	33
Total		**442**	**442**	**442**	**442**	**1,388**

Ammonium Nitrate Production Capacity[a]

Company	Location	1972	1973	1974	1975	1976
		United States				
Agrico Chemical Co.	Tulsa, Okla.	–	–	–	265	265
Agway, Inc	Olean, N.Y.	69	69	69	69	69
Air Products & Chem.	Pace Jct., Fla.	100	100	100	100	100
Allied Chemical Co.	Geismar, La.	290	290	290	290	290
	Hopewell, Va.	95	95	95	95	95
	LaPlatte, Neb.	112	112	112	112	112
	South Point, Ohio	100	–	–	–	–
American Cyanamid Co	Hannibal, Mo.	132	132	132	132	132
Apache Powder Co	Benson, Ariz.	66	66	66	66	66
Arkla Chemical Co.	Helena, Ark.	96	96	96	96	96
Atlas Chemical Ind.	Joplin, Mo.	233	233	233	233	233
	Tamaqua, Pa.	40	40	40	40	40
Carolina Nitrogen	Wilmington, N.C	188	188	188	188	188
CF Industries, Inc	Fremont, Neb	32	32	32	32	32
	Terre Haute, Ind.	160	160	160	160	160
Cherokee Nitrogen	Pryor, Okla.	85	85	85	85	85
Chevron Chemical Co.	Richmond, Calif.	41	41	41	41	41
	Ft. Madison, Iowa	78	78	78	78	78
	Kennewick, Wash	83	83	83	83	83
Collier Carbon & Chem.	Brea, Calif.	60	60	60	60	60
Columbia Nitrogen	Augusta, Ga.	208	208	208	208	208
Cominco-American	Beatrice, Neb.	175	175	175	175	175
Commercial Solvents	Sterlington, La.	187	187	187	187	187
Farmers Chemical Assoc.	Tunis, N.C.	165	165	165	165	165
	Tyner, Tenn.	165	165	165	165	165
Farmland Industries	Lawrence, Kan.	270	270	270	270	270
Goodpasture, Inc.	Demmitt, Texas	100	100	100	100	100
Gulf Oil Co	Pittsburg, Kan.	360	360	360	360	360
	Henderson, Ky.	112	–	–	–	–
Hawkeye Chemical Co.	Clinton, Iowa	147	147	147	147	147
Hercules, Inc.	Hercules, Calif.	80	80	80	80	80
	Louisiana, Mo.	460	460	460	460	460
	Donora, Pa.	137	137	137	137	137

Ammonium Nitrate Production Capacity[a]

Company	Location	1972	1973	1974	1975	1976
				(000 short tons of material)		
		United States				
Illinois Nitrogen Co.	Marseilles, Ill.	99	99	99	99	99
Kaiser Ag. Chem.	Savannah, Ga.	198	198	198	198	198
	Tampa, Fla.	54	54	54	54	54
	North Bend, Ohio	96	96	96	96	96
	Bainbridge, Ga.	48	48	48	48	48
Mississippi Chem. Co.	Yazoo City, Miss.	400	400	400	400	550
Mobil Chemical Co.	Beaumont, Texas	195	195	195	195	195
Monsanto Co.	Luling, La.	275	275	275	275	275
	El Dorado, Ark.	350	350	350	350	350
Nipak, Inc.	Kerens, Texas	51	51	51	51	51
Nitram, Inc.	Tampa, Fla.	132	132	132	132	132
Phillips Pacific Chem.	Kennewick, Wash.	50	50	50	50	50
Phillips Chemical Co.	Beatrice, Neb.	68	68	68	68	68
	Etter, Texas	168	168	–	–	–
	Pasadena, Texas	16	16	16	16	16
Reichhold Chemical	St. Helens, Ore.	22	22	22	22	22
St. Paul Ammonia Prod.	Pine Bend, Minn.	88	88	88	88	88
Terra Chemicals	Port Neal, Iowa	137	137	137	137	137
U.S.S. Agri-Chem	Cherokee, Ala.	90	90	90	90	90
	Geneva, Utah	100	100	100	100	100
	Crystal City, Mo.	92	92	92	92	92
Valley Nitrogen Prod.	El Centro, Calif.	41	41	41	41	41
Vistron Corp.	Lima, Ohio	75	75	75	75	75
Wycon Chemical Co.	Cheyenne, Wyo.	75	75	75	75	75
Total		**7,446**	**7,234**	**7,066**	**7,331**	**7,481**
		Canada				
Brockville Chemical Ind.	Maitland, Ont.	30	30	30	30	30
CIL Ltd.	Courtright, Ont.	135	135	135	135	135
	McMasterville, Que.	79	79	79	79	79
Cyanamid of Canada	Welland, Ont.	170	170	170	170	170
Exxon Chemical Co.	Redwater, Alta.	120	120	120	120	120
Northwest Nitro. Chem.	Medicine Hat, Alta.	66	66	66	66	66
Total		**600**	**600**	**600**	**600**	**600**

Phosphate Rock Production Capacity

		United States				
Agrico Chemical Co.	Pierce, Fla.	6,100	6,100	6,100	8,600	9,100
American Cyanamid Co.	Brewster, Fla.	1,300	1,300	1,300	1,300	1,300
	Bradley, Fla.	1,500	1,500	1,500	1,500	1,500
Beker Industries	Dry Valley, Idaho	–	1,800	1,800	2,000	2,000
Borden Chemical Co.	Teneroc, Fla.	1,000	1,000	1,000	1,000	1,000
Cominco-American	Garrison, Mont.	750	750	750	750	750
Gardinier	Ft. Meade, Fla.	2,000	2,000	2,000	2,000	2,000
W. R. Grace & Co.	Bonny Lake, Fla.	2,300	2,300	2,300	2,300	2,300
Hooker Chemical Corp.	Columbia, Tenn.	750	750	750	750	750

Phosphate Rock Production Capacity

Company	Location	1972	1973	1974	1975	1976
				(000 short tons of material)		
		United States				
IMC Corp.	Kingsford, Fla.	2,000	2,000	2,000	2,000	2,000
	Bonnie, Fla.	6,700	6,700	7,700	9,000	9,000
Mobil Chemical Co.	Mt. Pleasant, Tenn.	200	200	200	200	200
	Ft. Meade, Fla.	4,500	4,500	4,500	4,500	4,500
Monsanto Co.	Columbia, Tenn.	1,000	1,000	1,000	1,000	1,000
	Ballard, Idaho	1,000	1,000	1,000	1,000	1,000
Occidental Ag. Chem.	White Springs, Fla.	2,600	2,600	3,100	3,100	3,100
	Columbia, Tenn.	750	750	750	750	750
Presnell Phosphate	Columbia, Tenn.	700	700	700	700	700
George Relyea Co.	Garrison, Mont.	100	100	100	100	100
J. R. Simplot Co.	Conda, Idaho	1,000	1,000	1,000	1,000	1,000
	Fort Hall, Idaho	1,000	1,000	1,000	1,000	1,000
Stauffer Chemical	Mt. Pleasant, Tenn.	600	600	600	600	600
	Leefe, Wyo.	500	500	500	500	500
	Melrose, Mont.	600	600	600	600	600
	Cherokee, Utah	400	400	400	400	400
	Vernal, Utah	300	300	300	300	300
Swift and Co.	Watson, Fla.	3,000	3,000	3,000	3,000	3,000
Tennessee Valley Auth.	Franklin, Tenn.	200	200	200	200	200
TGS Inc.	Lee Creek, N.C.	3,000	3,000	3,000	3,000	4,000
U.S.S. Agri-Chem.	Ft. Meade, Fla.	2,800	2,800	2,800	2,800	2,800
Florida & North Carolina		*38,800*	*38,800*	*40,300*	*44,100*	*45,600*
Tennessee		*3,450*	*3,450*	*3,450*	*3,450*	*3,450*
Western States		*5,650*	*7,450*	*7,450*	*7,650*	*7,650*
Total		**47,900**	**49,700**	**51,200**	**55,200**	**56,700**

Wet-Process Phosphoric Acid Production Capacity

				(000 short tons P_2O_5)		
		United States				
AFC, Inc.	Bena, Calif.	7	7	7	7	7
Agrico Chemical Co.	Donaldsonville, La.	–	–	–	400	400
	Pierce, Fla.	240	280	280	280	280
Allied Chemical Co.	Geismar, La.	160	160	160	160	160
Arkla Chemical Co.	Helena, Ark.	50	50	50	50	50
Beker Industries	Conda, Idaho	–	100	256	256	256
	Marseilles, Ill.	–	104	104	104	104
	Taft, La.	207	207	207	207	207
Borden Chemical Co.	Piney Point, Fla.	175	175	175	175	175
Bunker Hill Chem. Co.	Kellogg, Idaho	32	32	32	32	32
CF Industries, Inc.	Bonnie, Fla.	630	630	630	630	630
	Plant City, Fla.	250	250	250	625	625
Collier Carbon & Chem.	Pittsburg, Calif.	15	15	15	15	15
Conserve, Inc.	Nichols, Fla.	–	150	150	150	150
Duval Corp.	Hanford, Calif.	15	15	15	15	15
Farmland Industries	Pierce, Fla.	455	455	455	455	455
First Mississippi Co	Ft. Madison, Iowa	190	190	190	190	190

Wet-Process Phosphoric Acid Production Capacity

Company	Location	1972	1973	1974	1975	1976
				(000 short tons P_2O_5)		
	United States					
Freeport Minerals	Uncle Sam, La.	600	750	750	750	750
Gardinier	Tampa, Fla.	544	544	544	544	544
W. R. Grace & Co.	Bartow, Fla.	300	315	315	315	565
IMC Corp.	Mulberry, Fla.	–	–	–	750	750
Mississippi Chem. Co.	Pascagoula, Miss.	160	160	160	160	160
Mobil Chemical Co.	Depue, Ill.	–	125	125	125	125
Occidental Ag. Chem.	Lathrop, Calif.	17	17	17	32	32
	White Springs, Fla.	230	230	230	580	580
Olin Inc.	Pasadena, Texas	210	210	210	210	210
	Joliet, Ill.	127	127	127	127	127
Phosphate Chemicals	Pasadena, Texas	50	50	50	50	50
Royster Company	Mulberry, Fla.	135	135	135	135	135
J. R. Simplot Co.	Pocatello, Idaho	180	180	180	180	180
Stauffer Chemical	Garfield, Utah	100	100	100	100	100
TGS Inc.	Lee Creek, N.C.	346	346	516	686	686
U.S.S. Agri-Chem.	Bartow, Fla.	90	90	90	90	90
	Ft. Meade, Fla.	176	176	176	176	176
Valley Nitrogen Prod.	Helm, Calif.	50	50	50	150	150
Total		**5,741**	**6,425**	**6,751**	**8,911**	**9,161**
	Canada					
Belledune Fertilizer	Belledune, N.B.	149	149	149	149	149
Border Fertilizer	Winnipeg, Man.	17	17	17	17	17
CIL Ltd.	Courtright, Ont.	90	90	90	90	90
Cominco, Ltd.	Trail, P.C.	80	80	80	80	80
	Kimberley, B.C.	120	120	120	120	120
Exxon Chemical	Redwater, Alberta	127	127	127	127	127
IMC (Canada) Limited	Pt. Maitland, Ont.	124	124	124	124	124
Northwest Nitro. Chem.	Medicine Hat, Alberta	70	70	70	70	70
St. Lawrence Fert.	Valleyfield, Que.	45	45	45	45	45
Sherritt-Gordon Mines	Ft. Saskatchewan, Alta.	60	60	60	60	60
Western Coop. Fert.	Calgary, Alberta	90	90	90	90	90
Total		**972**	**972**	**972**	**972**	**972**

Concentrated Superphosphate Production Capacity

Company	Location	1972	1973	1974	1975	1976
	United States					
Agrico Chemical Co.	Pierce, Fla.	161	161	276	276	276
Beker Industries	Conda, Idaho	–	–	156	156	156
Borden Chemical Co.	Piney Point Fla.	33	33	33	33	33
CF Industries, Inc.	Plant City, Fla.	243	243	243	427	427
Farmland Industries	Pierce, Fla.	87	87	87	87	87
Gardinier	Tampa, Fla.	375	375	375	375	375
W.R. Grace & Co.	Bartow, Fla.	320	320	320	320	320
	Joplin, Mo.	45	45	45	45	45
IMC Corp.	Mulberry, Fla.	–	–	–	...	...
Mississippi Chem. Co.	Pascagoula, Miss.	–	126	126	126	126

Concentrated Superphosphate Production Capacity

Company	Location	1972	1973	1974	1975	1976
				(000 short tons P_2O_5)		
	United States					
Occidental Ag. Chem.	White Springs, Fla.	78	78	78	78	78
Royster Company	Mulberry, Fla.	97	97	97	97	97
J.R. Simplot Co.	Pocatello, Idaho	55	55	55	55	55
Stauffer Chemical	Garfield, Utah	41	41	41	41	41
TGS Inc.	Lee Creek, N.C.	164	164	164	164	164
U.S.S. Agri-Chem.	Ft. Meade, Fla.	121	121	121	121	121
Total		**1,820**	**1,946**	**2,217**	**2,401**	**2,401**
	Canada					
IMC (Canada) Limited	Pt. Maitland, Ont.	69	69	69	69	69
St. Lawrence, Fert.	Valleyfield, Que.	17	17	17	17	17
Total		**86**	**86**	**86**	**86**	**86**

Ammonium Phosphate Production Capacity[b]

Company	Location	1972	1973	1974	1975	1976
	United States					
AFC, Inc.	Bena, Calif.	7	7	7	7	7
Agrico Chemical Co.	Donaldsonville, La.	322	322	322	713	713
Allied Chemical Co.	Geismar, La.	135	135	135	135	135
Arkla Chemical Co.	Helena, Ark.	50	50	50	50	50
Beker Industries	Conda, Idaho	161	161	147	147	147
	Marseilles, Ill.	87	87	87	87	87
	Taft, La.	200	216	216	216	216
Borden Chemical Co.	Piney Point, Fla.	85	85	85	85	85
Brewster Phosphates	Geismar, La.	50	50	50	50	50
	Luling, La.	110	150	150	150	150
Bunker Hill Chem. Co.	Kellogg, Idaho	21	21	21	21	21
CF Industries, Inc.	Bonnie, Fla.	450	450	450	450	450
Chevron Chemical Co.	Richmond, Calif.	17	17	17	17	17
	Ft. Madison, Iowa	30	30	30	30	30
	Kennewick, Wash.	13	13	13	13	13
Collier Carbon & Chem.	Pittsburg, Calif.	25	25	25	25	25
Conserve, Inc.	Nichols, Fla.	–	110	110	110	110
Farmers Chemical Assoc.	Tunis, N.C.	45	–	–	–	–
Farmland Industries	Joplin, Mo.	92	92	92	92	92
	Lawrence, Kan.	61	61	61	61	61
	Pierce, Fla.	92	92	92	92	92
First Mississippi Co.	Ft. Madison, Iowa	170	170	170	170	170
Ford Motor Co.	Dearborn, Mich.	10	10	10	10	10
Gardinier	Tampa, Fla.	170	170	170	170	170
W.R. Grace & Co.	Bartow, Fla.	105	105	105	105	105
Kaiser Steel Crop.	Fontana, Calif.	15	15	15	15	15
Mississippi Chem. Co.	Pascagoula, Miss.	153	153	153	153	153
Mobil Chemical Co.	Depue, Ill.	125	125	125	125	125
Nipak, Inc.	Kerens, Texas	33	33	33	33	33
Occidental Ag. Chem.	Lathrop, Calif.	18	18	18	18	18
	White Springs, Fla.	115	115	115	276	276

Ammonium Phosphate Production Capacity[b]

Company	Location	1972	1973	1974	1975	1976
				(000 short tons P_2O_5)		
		United States				
Olin Inc.	Pasadena, Texas	198	198	198	198	198
Phosphate Chemicals	Pasadena, Texas	50	50	50	50	50
Royster Company	Mulberry, Fla.	45	45	45	45	45
J.R. Simplot Co.	Pocatello, Idaho	106	106	106	106	106
Stauffer Chemical	Garfield, Utah	56	56	56	56	56
Tennessee Valley Auth.	Muscle Shoals, Ala.	20	20	–	–	–
TGS Inc.	Lee Creek, N.C.	101	101	101	101	101
U.S.S. Agri-Chem.	Cherokee, Ala.	75	75	75	75	75
	Bartow, Fla.	14	14	14	14	14
Valley Nitrogen Prod.	Helm, Calif.	35	35	35	105	105
	Chandler, Ariz.	12	12	12	12	12
Total		**3,679**	**3,800**	**3,766**	**4,388**	**4,388**
		Canada				
Belledune Fertilizer	Belledune, N.B.	147	147	147	147	147
Border Fertilizer	Winnipeg, Man	30	30	30	30	30
CIL Ltd.	Courtright, Ont.	90	90	90	90	90
Cominco, Ltd.	Trail, B.C.	115	115	115	115	115
	Kimberley, B.C.	115	115	115	115	115
Cyanamid of Canada	Welland, Ont.	35	35	35	35	35
Exxon Chemical	Redwater, Alta.	152	152	152	152	152
Northwest Nitro. Chem.	Medicine Hat, Alta.	50	50	50	50	50
St. Lawrence Fert.	Valleyfield, Que.	30	30	30	30	30
Sherritt-Gordon Mines	Ft. Saskatchewan, Alta.	55	55	55	55	55
J.R. Simplot Co.	Brandon, Man.	104	104	104	104	104
Western Coop. Fert.	Calgary, Alta.	79	79	79	79	79
Total		**1,002**	**1,002**	**1,002**	**1,002**	**1,002**

Potash Production Capacity

				(000 short tons K_2O)		
		United States				
Amax Corp.	Carlsbad, N.M.	320	320	320	320	320
Duval Corp.	Carlsbad, N.M.	240	240	240	240	240
IMC Corp	Carlsbad, N.M.	300	300	300	300	300
Kaiser Ag. Chem.	Wendover, Utah	55	55	55	55	55
Kerr-McGee, Inc.	Trona, Calif.	235	235	235	235	235
	Carlsbad, N.M.	326	326	326	326	326
Lithium Corp.	Salt Lake City, Utah	120	120	120	120	120
National Potash Co.	Carlsbad, N.M.	350	350	350	350	350
Potash Corp. of America	Carlsbad, N.M.	620	620	620	620	620
Teledyne, Inc.	Carlsbad, N.M.	200	–	–	–	–
TGS Inc.	Moab, Utah	350	350	350	350	350
Total		**3,116**	**2,916**	**2,916**	**2,916**	**2,916**

Potash Production Capacity

Company	Location	1972	1973	1974	1975	1976
				(000 short tons K_2O)		
		Canada				
Allan Potash Mines	Saskatoon, Sask.	900	900	900	900	900
Alwinsal Potash Co.	Lanigan, Sask.	600	600	600	600	600
Noranda Mines	Viscount, Sask.	900	900	900	900	900
Cominco, Ltd.	Delisle, Sask.	(720)	(720)	(720)	(720)	(720)
Duval Corp.	Saskatoon, Sask.	730	730	730	730	730
IMC Corp.	Esterhazy, Sask.	2,330	2,330	2,330	2,330	2,330
Kalium Chemicals	Belle Plain, Sask.	937	937	937	937	937
Potash Corp. of America	Lake, Patience, Sask.	460	460	460	460	460
Sylvite of Canada	Rocanville, Sask.	732	732	732	732	732
Total		**7,589**	**7,589**	**7,589**	**7,589**	**7,589**

[a]Includes some ammonium nitrate for industrial uses.
[b]Includes mono and diammonium phosphate and nitricphosphate producers.

UNITED STATES

TYPE TREATMENT	TOTAL	POPULATION SERVED	SEWER SYSTEM SEPARATE	COMBINED	BOTH	UNKNOWN	# FAC W FLOW	FLOW MGD
BEING SERVED	3,428	41,316,064	2,184	276	223	745	361	829.515
PLANNED FACILITY	4,147	25,415,720	659	215	97	3,176	472	538.042
UNDER CONSTRUCTION	384	2,266,067	278	12	4	90	282	140.558
NOT INDICATED	611	2,534,048	87	10	18	496	132	366.788
NONE	2,425	2,907,123	441	71	22	1,891	207	163.300
MINOR	72	780,135	60	4	3	5	39	176.354
PRIMARY	2,592	37,904,943	1,701	216	224	451	2,025	6,278.380
INTERMEDIATE	72	6,781,441	36	6	21	9	66	980.893
SECONDARY	16,107	104,215,412	13,352	628	376	1,751	14,156	16,524.655
TERTIARY	812	2,374,398	580	61	16	155	764	552.659
TOTAL	33,650	226,495,351	19,378	1,499	1,004	8,769	18,504	26,551.144
NONE	2,404	2,890,676	423	70	21	1,890	206	163.000
MINOR	72	780,135	60	4	3	5	39	176.354
PRIMARY-SET TANK,NO DETAIL	203	2,930,648	144	12	11	36	167	708.422
PRIMARY - SEPTIC TANKS	668	1,100,573	346	11	4	307	263	93.561
PRIMARY - IMHOFF TANKS	672	1,855,773	570	56	29	17	634	207.087
PRIMARY-MECH.CLEANED TANKS	847	21,563,150	535	128	167	17	826	3,623.274
PRIMARY-PLAIN,HOP-BOTM TNK	56	1,585,318	47	4	4	1	54	293.870
PRIMARY - UNKNOWN	146	8,869,481	59	5	9	73	81	1,352.166
INTERMEDIATE	70	6,780,241	35	6	20	9	64	980.255
SECONDARY	1,930	2,506,245	1,262	17	8	643	1,561	2,716.072
SECONDARY-ACTIVATED SLUDGE	1,831	47,561,508	1,451	128	102	150	1,727	7,007.941
SECONDARY-EXTEND.AERATION	2,094	3,963,002	1,755	118	27	194	1,932	526.380
SECONDARY-HI RATE TRCK FLT	1,776	19,393,615	1,594	79	64	39	1,713	2,178.364
SECONDARY-STAND.RATE TR FL	1,747	10,295,302	1,505	108	72	62	1,677	1,184.429
SECONDARY-INTERMIT.SAND-FL	568	467,418	387	2	5	174	497	48.877
SECONDARY-APPLICA.TO LAND	144	410,444	119	1	0	24	81	41.275
SECONDARY - OXIDATION POND	5,031	7,660,582	4,477	133	62	359	4,109	1,250.145
SECONDARY - FILTER UNKNOWN	309	1,606,111	267	6	6	30	275	344.556
SECONDARY - UNKNOWN	677	10,330,785	535	36	30	76	584	1,226.616
TERTIARY	809	2,373,698	577	61	16	155	763	552.654
TOTAL	22,054	154,545,105	16,148	985	660	4,261	17,253	24,675.298

APPENDIX D

APPENDIX E

LAND USE (1969)

TOTALS	Total Land 10³Acres	Total Land in Farms 10³ Acres	Croplands 10³ Acres	Forestland 10³ Acres	Pastureland 10³ Acres
1. Alabama	34,452	13,654	5,828	5,320	2,506
2. Alaska	362,516	1,604	18	34	1,552
3. Arizona	72,587	38,203	1,685	5,071	31,447
4. Arkansas	33,245	15,695	10,105	3,239	2,351
5. California	100,071	35,722	11,245	2,038	22,439
6. Colorado	66,410	36,697	11,497	1,479	23,721
7. Connecticut	3,112	541	268	192	81
8. Delaware	1,268	674	533	121	20
9. District of Columbia	39	-	-	-	-
10. Florida	34,618	14,032	3,828	3,814	6,390
11. Georgia	37,167	15,806	7,150	6,958	1,698
12. Hawaii	4,112	2,058	375	167	1,516
13. Idaho	52,913	14,417	6,204	972	7,241
14. Illinois	35,679	29,913	25,470	2,296	2,147
15. Indiana	23,102	17,573	14,246	2,141	1,186
16. Iowa	35,802	33,570	28,459	1,630	3,481
17. Kansas	52,344	49,390	32,890	777	15,723
18. Kentucky	25,376	15,968	10,023	3,823	2,122
19. Louisiana	28,755	9,789	5,932	1,916	1,941
20. Maine	19,789	1,760	794	876	90
21. Maryland	6,330	2,803	1,957	627	219
22. Massachusetts	5,009	701	301	310	90
23. Michigan	36,363	11,901	8,994	1,844	1,063
24. Minnesota	50,745	28,845	23,863	2,844	2,138
25. Mississippi	30,269	16,040	8,256	4,841	2,943
26. Missouri	44,157	32,420	21,414	5,847	5,159
27. Montana	93,176	62,917	16,376	1,752	44,789
28. Nebraska	48,949	45,834	23,774	490	21,570
29. Nevada	70,328	10,708	749	74	9,925
30. New Hampshire	5,777	613	224	360	29
31. New Jersey	4,813	1,036	725	186	125
32. New Mexico	77,703	46,791	2,410	2,943	41,438
33. New York	30,612	10,148	6,633	2,190	1,325
34. North Carolina	31,231	12,734	6,502	5,053	1,179
35. North Dakota	44,339	43,118	29,819	442	12,857
36. Ohio	26,724	17,111	12,533	2,179	2,399
37. Oklahoma	44,020	36,008	15,653	2,757	17,598
38. Oregon	61,557	18,018	5,291	2,030	10,697
39. Pennsylvania	28,778	8,901	6,222	1,961	718
40. Rhode Island	671	69	36	26	7
41. South Carolina	19,344	6,992	3,663	2,747	582
42. South Dakota	48,611	45,584	20,993	288	24,303
43. Tennessee	26,450	15,057	8,982	4,375	1,700
44. Texas	167,766	142,567	39,945	8,713	93,909
45. Utah	52,541	11,313	1,996	230	9,087
46. Vermont	5,931	1,916	916	792	208
47. Virginia	25,459	10,650	4,945	3,912	1,793
48. Washington	42,605	17,559	8,485	3,108	5,966
49. West Virginia	15,405	4,341	1,763	1,663	915
50. Wisconsin	34,857	18,109	12,359	4,161	2,384
51. Wyoming	62,210	35,476	2,894	504	32,078
→ 52. Guam					
53. Puerto Rico					
54. Virgin Islands	2,263,587	1,063,346	475,223	112,013	476,110

PHS-24-3 STATISTICAL WORK SHEET
REV. 7-61

(1971) ACREAGE PLANTED OF FOUR MAJOR CROPS

TOTALS	Corn 10^3 Acres	Wheat 10^3 Acres	Soybean 10^3 Acres	Cotton 10^3 Acres	Total 10^3 Acres
1. Alabama	686	164	700	579	1,443
2. Alaska	-	-	-	-	-
3. Arizona	25	189	-	286	500
4. Arkansas	48	368	4,305	1,180	5,853
5. California	405	502	-	760	1,667
6. Colorado	719	2,816	-	-	3,535
7. Connecticut	50	-	-	-	50
8. Delaware	216	27	155	-	398
9. District of Columbia	-	-	-	-	-
10. Florida	421	77	211	12	721
11. Georgia	1,751	242	660	426	3,079
12. Hawaii	-	-	-	-	-
13. Idaho	105	1,059	-	-	1,169
14. Illinois	10,470	1,027	7,190	2	18,689
15. Indiana	5,679	781	3,400	-	9,860
16. Iowa	12,231	40	5,456	-	17,727
17. Kansas	1,660	9,593	880	-	12,133
18. Kentucky	1,377	247	768	6	2,398
19. Louisiana	143	98	1,695	510	2,446
20. Maine	22	-	-	-	22
21. Maryland	605	120	222	-	947
22. Massachusetts	34	-	-	-	34
23. Michigan	2,253	590	561	-	3,404
24. Minnesota	6,572	1,536	2,889	-	10,997
25. Mississippi	325	203	2,429	1,355	4,312
26. Missouri	3,332	974	3,652	343	8,301
27. Montana	75	4,516	-	-	4,591
28. Nebraska	5,958	2,644	650	-	9,252
29. Nevada	2	13	-	3	18
30. New Hampshire	16	-	-	-	16
31. New Jersey	115	40	54	-	209
32. New Mexico	52	347	-	156	555
33. New York	915	141	7	-	1,063
34. North Carolina	1,725	318	1,059	194	3,296
35. North Dakota	569	9,307	211	-	10,087
36. Ohio	3,767	1,004	2,507	-	7,278
37. Oklahoma	108	4,875	155	445	5,583
38. Oregon	43	809	-	-	852
39. Pennsylvania	1,469	295	34	-	1,798
40. Rhode Island	5	-	-	-	5
41. South Carolina	510	134	1,084	381	2,109
42. South Dakota	3,939	2,412	243	-	6,594
43. Tennessee	801	290	1,371	447	2,909
44. Texas	709	3,512	262	5,265	9,748
45. Utah	75	212	-	-	287
46. Vermont	86	-	-	-	86
47. Virginia	670	212	384	5	1,271
48. Washington	114	2,584	-	-	2,698
49. West Virginia	101	16	-	-	117
50. Wisconsin	3,074	47	130	-	3,251
51. Wyoming	70	262	-	-	332
-> 52. Guam					
53. Puerto Rico					
54. Virgin Islands	74,097	54,643	43,176	12,355	184,271 *

PHS-24-9 STATISTICAL WORK SHEET
REV. 7-61

1973 FERTILIZER CONSUMPTION

TOTALS	Total Fertilizer 10^3 Tons	N 10^3 Tons	P_2O_5 10^3 Tons	K_2O (Tons)	Total NPK (Tons)
1. Alabama	1,123	171,123	116,289	121,445	408,857
2. Alaska	5	1,168	686	477	2,331
3. Arizona	335	102,513	39,011	1,476	142,999
4. Arkansas	634	122,690	77,325	82,282	282,297
5. California	3,510	479,631	178,799	61,512	719,941
6. Colorado	320	97,170	48,037	7,802	153,009
7. Connecticut	70	9,018	6,703	6,821	22,542
8. Delaware	129	15,062	15,860	20,432	51,353
9. District of Columbia	8	620	597	417	1,634
10. Florida	1,893	209,995	111,028	231,840	552,863
11. Georgia	2,145	285,405	161,342	238,628	685,375
12. Hawaii	171	27,995	19,411	24,014	71,421
13. Idaho	509	124,917	74,780	5,251	204,949
14. Illinois	2,907	465,384	434,860	508,864	1,409,108
15. Indiana	2,039	326,771	261,765	336,246	924,783
16. Iowa	2,666	643,696	380,301	391,041	1,415,038
17. Kansas	1,448	503,422	199,466	90,941	793,829
18. Kentucky	845	113,302	112,156	122,848	348,305
19. Louisiana	590	118,072	61,659	61,191	240,922
20. Maine	137	16,128	18,657	18,421	53,206
21. Maryland	444	54,996	55,583	61,427	172,005
22. Massachusetts	77	10,,095	7,726	6,899	24,720
23. Michigan	897	143,847	139,655	164,944	448,445
24. Minnesota	1,781	423,958	280,320	288,688	992,966
25. Mississippi	916	205,144	87,751	83,498	376,394
26. Missouri	1,418	276,181	177,184	200,485	653,850
27. Montana	246	52,840	62,346	2,983	118,169
28. Nebraska	1,468	566,943	157,782	53,167	777,893
29. Nevada	25	4,160	3,073	180	7,413
30. New Hampshire	18	2,468	1,894	2,309	6,671
31. New Jersey	217	26,355	22,411	21,125	69,891
32. New Mexico	113	30,854	21,813	1,835	54,503
33. New York	627	87,988	83,747	78,725	250,460
34. North Carolina	1,845	203,219	144,721	187,833	535,773
35. North Dakota	484	133,512	107,960	13,495	254,966
36. Ohio	1,552	237,835	244,567	271,617	754,020
37. Oklahoma	719	202,566	109,099	39,029	350,694
38. Oregon	536	113,939	49,099	20,098	183,135
39. Pennsylvania	681	90,968	96,429	77,142	264,538
40. Rhode Island	17	1,789	1,576	1,516	4,881
41. South Carolina	902	97,300	74,874	103,897	276,071
42. South Dakota	366	98,835	62,230	13,755	174,819
43. Tennessee	767	104,195	99,556	107,140	3110,890
44. Texas	2,557	711,613	288,910	115,486	1,116,008
45. Utah	121	22,341	27,583	819	50,744
46. Vermont	55	7,011	6,834	7,653	21,498
47. Virginia	823	86,352	76,799	89,018	252,169
48. Washington	701	190,443	63,171	23,912	277,576
49. West Virginia	69	8,191	10,927	6,484	25,601
50. Wisconsin	908	116,673	137,189	228,493	477,356
51. Wyoming	90	22,589	14,502	1,922	39,013
→ 52. Guam					
53. Puerto Rico	140	19,633	7,803	14,697	42,133
54. Virgin Islands	43,060	8,188,914	5,038,845	4,622,220	17,849,977

PHS-24-3 STATISTICAL WORK SHEET
REV. 7-61

1974 ANIMAL MANURE TONNAGES (WET)

TOTALS	Cattle 10^3 tons	Hogs 10^3 tons	Sheep (Tons)	Chickens 10^3 tons	Total (Tons)
1. Alabama	30,688	1,536	3,220	3,756	35,983
2. Alaska	122	2	9,800		134
3. Arizona	19,043	130	347,900		19,521
4. Arkansas	29,318	437	4,200	4,670	34,429
5. California	71,925	229	785,400	2,906	75,845
6. Colorado	51,293	464	805,000		52,502
7. Connecticut		11			11
8. Delaware	438	88	1,400	1,039	1,566
9. District of Columbia					-
10. Florida	34,113	486	3,010	1,190	35,792
11. Georgia	28,811	2,803	2,660	4,812	36,429
12. Hawaii	3,288	98		73	3,459
13. Idaho	27,756	184	465,500		28,406
14. Illinois	44,525	11,760	176,400		56,461
15. Indiana	28,770	7,800	141,400	868	37,579
16. Iowa	104,942	23,520	371,700	566	129,400
17. Kansas	95,763	3,200	203,000	166	99,332
18. Kentucky	44,046	2,048	35,000	221	46,350
19. Louisiana	23,906	272	12,600	592	24,783
20. Maine		13		961	974
21. Maryland	5,644	360	12,600	1,444	7,461
22. Massachusetts		96		360	456
23. Michigan	21,810	116	141,400		22,067
24. Minnesota	58,088	6,362	290,500	734	65,475
25. Mississippi	35,757	768	5,250	2,320	38,850
26. Missouri	84,940	6,920	156,800	527	92,544
27. Montana	46,306	376	555,800		47,238
28. Nebraska	101,517	5,528	231,000	238	107,514
29. Nevada	9,097	16	121,100		9,234
30. New Hampshire		15			15
31. New Jersey	1,699	146	5,950	183	2,034
32. New Mexico	22,126	112	495,600		22,734
33. New York	24,496	149	60,900	578	25,284
34. North Carolina	14,659	3,120	8,400	2,980	20,767
35. North Dakota	36,100	598	262,500		36,961
36. Ohio	29,455	3,638	407,400	568	34,068
37. Oklahoma	82,474	504	72,800	299	83,349
38. Oregon	20,139	162	339,500		20,641
39. Pennsylvania	25,098	930	100,800	1,326	27,455
40. Rhode Island		14			14
41. South Carolina	9,179	1,040	840	589	10,809
42. South Dakota	68,500	3,480	683,200		72,663
43. Tennessee	36,853	1,504	14,700	652	39,024
44. Texas	222,625	1,680	2240,000	1,953	228,498
45. Utah	11,398	62	547,400		12,007
46. Vermont		5			5
47. Virginia	22,084	1,006	122,500	795	24,008
48. Washington	18,906	120	81,900	418	19,526
49. West Virginia	6,918	86	95,200	179	7,278
50. Wisconsin	60,280	2,520	78,400	161	63,039
51. Wyoming	21,920	70	1053,500		23,044
-> 52. Guam					
53. Puerto Rico					
54. Virgin Islands	1,736,815	96,584	11,554,830	38,124	1,883,078

PHS-24-3 REV. 7-61 STATISTICAL WORK SHEET

1974 SEWAGE SLUDGE GENERATION (DRY)

TOTALS	Cat. I Population (10^3)	Cat. I Sludge (Tons)	Cat. II Population (10^3)	Cat. II Sludge (Tons)	Sludge Total (Tons)
1. Alabama	622	13,684	1,101	46,242	59,926
2. Alaska	143	3,146	30	1,260	4,406
3. Arizona	-	-	1,626	68,292	68,292
4. Arkansas	157	3,454	755	31,710	35,164
5. California	7,755	170,610	10,538	442,596	613,206
6. Colorado	18	396	2,314	97,188	97,584
7. Connecticut	976	21,472	968	40,698	62,170
8. Delaware	19	418	442	18,564	18,982
9. District of Columbia	-	-	1,780	74,760	74,760
10. Florida	584	12,848	3,091	129,822	142,670
11. Georgia	959	21,098	1,363	57,246	78,344
12. Hawaii	116	2,552	206	8,652	11,204
13. Idaho	158	3,476	265	11,130	14,606
14. Illinois	669	14,718	8,362	351,204	365,922
15. Indiana	321	7,062	3,077	129,234	136,296
16. Iowa	334	7,348	1,424	54,808	67,156
17. Kansas	227	6,994	1,534	64,428	69,422
18. Kentucky	672	14,784	813	34,146	48,930
19. Louisiana	684	15,408	1,016	42,672	58,080
20. Maine	80	1,760	111	4,662	6,422
21. Maryland	344	7,568	2,237	93,954	101,522
22. Massachusetts	2,557	56,254	952	39,984	96,238
23. Michigan	3,214	70,708	2,271	95,382	166,090
24. Minnesota	228	5,016	1,601	67,242	72,258
25. Mississippi	4	88	991	41,622	41,710
26. Missouri	2,667	58,674	1,413	59,346	118,020
27. Montana	163	3,586	268	11,256	14,842
28. Nebraska	292	6,424	942	39,564	45,988
29. Nevada	5	110	509	21,378	21,488
30. New Hampshire	171	3,762	64	2,688	6,450
31. New Jersey	3,306	72,732	3,072	129,024	151,756
32. New Mexico	1	22	884	37,128	37,150
33. New York	4,130	90,860	9,737	408,954	499,814
34. North Carolina	43	946	2,269	95,298	96,244
35. North Dakota	8	176	389	16,338	16,514
36. Ohio	676	14,872	8,146	342,132	357,004
37. Oklahoma	168	3,696	1,634	68,628	72,324
38. Oregon	597	13,134	980	41,160	52,294
39. Pennsylvania	1,205	26,510	11,649	489,258	515,768
40. Rhode Island	110	2,420	602	25,284	27,704
41. South Carolina	215	4,730	1,125	47,250	51,980
42. South Dakota	47	1,034	369	15,498	16,537
43. Tennessee	79	1,738	1,512	63,504	65,242
44. Texas	108	2,376	11,050	464,100	466,476
45. Utah	13	286	972	40,824	41,110
46. Vermont	154	3,388	75	3,150	6,538
47. Virginia	977	21,494	2,003	84,126	105,620
48. Washington	1,444	31,768	833	34,986	66,754
49. West Virginia	373	8,206	356	14,952	23,158
50. Wisconsin	503	11,066	2,710	113,820	124,886
51. Wyoming	47	1,034	244	10,248	11,282
-> 52. Guam					
53. Puerto Rico					
54. Virgin Islands	138,343	843,596	112,676	4,732,392	5,575,938

PHS-24-3 STATISTICAL WORK SHEET
REV. 7-61

APPENDIX F

GENERAL INFORMATION

Animal Manure (1,883,078,000)

		TONS
1. Texas		228,498,000
2. Iowa		129,400,000
3. Nebraska		107,514,000
4. Kansas		99,332,000
5. Missouri		92,544,000
	Total	657,288,000

Sewage Sludge (5,575,938)

		TONS
1. California		613,206
2. Pennsylvania		515,768
3. New York		499,814
4. Texas		466,476
5. Illinois		365,922
	Total	2,461,186

Fertilizer Consumption (43,060,000)

		TONS
1. California		3,510,000
2. Illinois		2,907,000
3. Iowa		2,666,000
4. Texas		2,557,000
5. Georgia		2,145,000
	Total	13,785,000

Nitrogen Consumption (8,188,914)

			TONS
1.	Texas		711,613
2.	Iowa		643,696
3.	Nebraska		566,943
4.	Kansas		503,422
5.	California		479,631
		Total	2,905,305

Total NPK Consumption (17,849,977)

			TONS
1.	Iowa		1,415,038
2.	Illinois		1,409,108
3.	Texas		1,116,008
4.	Minnesota		992,966
5.	Indiana		924,783
		Total	5,857,903

Total Land In Farms (1,063,346,000)

			TONS
1.	Texas		142,567,000
2.	Montana		62,917,000
3.	New Mexico		46,791,000
4.	Nebraska		45,834,000
5.	South Dakota		45,584,000
		Total	343,693,000

Leading States In Phosphorous Consumption

1.	Illinois	9.1%	4.	Minnesota	5.7%
2.	Iowa	8.1%	5.	Indiana	4.9%
3.	Texas	5.9%	6.	Total	33.7%

Sewered Population (151,019,000)

1.	California	18,293,000
2.	New York	13,867,000
3.	Pennsylvania	12,854,000
4.	Texas	11,158,000
5.	Illinois	9,031,000
	Total	65,203,000

Corn Production (74,097,000)

		ACRES
1.	Iowa	12,231,000
2.	Illinois	10,470,000
3.	Minnesota	6,572,000
4.	Nebraska	5,958,000
5.	Indiana	5,679,000
	Total	40,910,000

Wheat Production (54,643,000)

		ACRES
1.	Kansas	9,593,000
2.	North Dakota	9,307,000
3.	Oklahoma	4,875,000
4.	Montana	4,516,000
5.	Texas	3,512,000
	Total	31,803,000

Leading States In Potassium Consumption

1.	Illinois	10.2%	4. Minnesota	6.4%
2.	Iowa	7.5%	5. Ohio	5.9%
3.	Indiana	7.3%	6. Total	37.3%

Soybeans (43,176,000)

		ACRES
1.	Illinois	7,190,000
2.	Iowa	5,456,000
3.	Arkansas	4,305,000
4.	Missouri	3,652,000
5.	Indiana	3,400,000
	Total	24,003,000

Cotton Production (12,355,000)

		ACRES
1.	Texas	5,265,000
2.	Mississippi	1,355,000
3.	Arkansas	1,180,000
4.	California	760,000
5.	Alabama	579,000
	Total	9,139,000

Surface Mining Acreage Disturbed (3,187,825)

		ACRES
1.	Pennsylvania	370,202
2.	Ohio	276,700
3.	West Virginia	195,500
4.	Florida	188,800
5.	California	174,020
	Total	1,205,222

Major Producers Of Anhydrous Ammonia

1. Louisiana
2. Texas
3. California
4. Nebraska
5. Iowa
6. Mississippi

APPENDIX G

Fertilizers and Agricultural limestone: Prices paid by farmers per ton for selected commercial fertilizers, United States, September 15, 1974, with comparisons

Item	1972	1973		1974	
	Sept. 15	Apr. 15	Sept. 15	Apr. 15	Sept. 15
	Dollars				
Mixed fertilizers:					
0-20-20	66.30	69.70	71.80	108	129
3-9-9	66.20	68.50	70.70	93.80	112
3-9-18	57.40	59.10	60.70	83.00	100
4-8-12	60.00	65.80	64.90	90.50	108
4-12-12	49.50	52.80	54.40	84.30	101
5-10-10	55.90	59.80	61.50	89.50	106
5-10-15	51.90	54.50	56.70	88.00	104
5-20-20	75.20	81.60	83.50	125	151
6-12-12	56.00	61.40	62.60	96.40	110
6-24-24	81.60	88.00	90.80	139	164
7-21-7	71.10	80.10	82.60	136	155
8-8-8	55.30	58.80	60.20	86.50	100
8-24-24	77.00	79.20	81.20	122	149
8-32-16	88.80	96.50	99.50	155	184
9-30-0	92.40	96.70	102	167	194
10-10-10	63.90	68.20	70.80	103	123
10-20-10	73.70	77.70	80.60	131	154
10-20-20	86.70	92.30	95.00	140	173
10-34-0	92.10	102	108	170	205
11-48-0	102	109	117	183	234
12-12-12	70.10	75.30	78.90	123	147
13-13-13	67.80	70.50	72.30	110	134
15-10-10	74.00	75.00	78.00	115	145
15-15-15	86.30	91.90	95.80	147	175
16-20-0	79.40	83.90	88.60	146	178
18-46-0	98.70	109	119	181	228
19-9-0	76.00	79.00	78.00	145	165
Fertilizer material:					
Nitrate of soda	69.70	77.40	81.80	131	168
Sulphate of ammonia	53.00	55.20	59.50	110	137
Ammonium nitrate	65.40	71.40	77.30	139	170
Ammonium nitrate-limestone mixture	57.10	61.00	62.70	102	126
Anhydrous ammonia	80.80	87.60	92.50	183	229
Urea	82.70	90.30	96.20	183	232
Superphosphate					
20 percent P_2O_5	51.20	53.70	56.00	91.40	104
46 percent P_2O_5	79.00	87.50	94.10	150	188
Phosphate rock	25.50	26.50	26.70	38.50	42.00
Muriate of potash, 60% K_2O	58.70	61.50	63.60	81.30	91.00
Agricultural limestone (spread on field)	6.19	6.68	6.84	7.99	8.43
Gypsum (land plaster)	17.10	22.00	19.50	23.40	33.70
Nitrogen solutions:					
28 percent N	52.20	57.50	61.00	115	137
30 percent N	55.90	58.30	60.80	111	136
32 percent N	63.50	66.80	72.10	127	153

Mixed fertilizers: Average price per ton paid by farmers for principal grades used in specified States, September 15, 1974, North Central States

State	5-20-20	6-24-24	7-21-7	8-32-16	10-34-0	11-48-0	12-12-12	16-20-0	18-46-0
ILL	160	175	150	200	190	--	155	--	230
IND	150	165	155	185	200	--	150	--	220
IOWA	165	180	155	190	220	--	165	--	235
KANS	--	--	155	185	205	200	--	165	215
MICH	140	160	135	170	180	--	135	--	215
MINN	155	160	175	185	210	--	150	--	245
MO	145	160	145	180	190	--	140	--	260
NEBR	--	--	150	185	205	225	--	190	225
N DAK	--	--	145	175	190	205	--	160	215
OHIO	155	165	160	180	200	--	150	--	220
S DAK	--	--	160	200	205	240	--	180	225
WIS	150	165	145	185	185	--	140	--	230

Mixed fertilizer: Average price per ton paid by farmers for principal grades used in specified States, September 15, 1974 Continued

Northeastern States

State	0-20-20	5-10-10	10-10-10	10-20-10	10-20-20	15-15-15
			Dollars			
CONN	140	125	145	170	185	180
MAINE	140	125	145	170	185	180
MASS	140	125	145	170	185	180
N H	140	125	145	170	185	180
N J	150	120	140	180	190	175
N Y	155	115	140	170	180	175
PA	145	120	140	170	180	185
R I	140	125	145	170	185	180
VT	140	125	145	170	185	180

Southeastern States

State	3-9-9	3-9-18	4-8-12	4-12-12	5-10-10	6-12-12	8-8-8	10-10-10	10-20-20	15-10-10
					Dollars					
DEL	--	--	100	--	105	--	--	125	170	145
FLA	--	--	88	95	--	110	96	110	--	--
GA	--	--	90	97	--	105	89	115	--	--
MD	--	--	100	--	105	--	--	125	170	145
N C	115	105	125	105	105	--	100	120	170	--
S C	110	96	105	105	99	--	96	115	160	--
VA	98	95	105	105	97	--	96	115	160	--
W VA	--	--	--	--	105	--	--	125	160	--

South Central Part I

State	0-20-20	4-12-12	6-24-24	8-8-8	8-24-24	10-20-10	10-20-20	12-12-12	13-13-13
					Dollars				
ALA	120	100	140	105	150	--	--	--	135
ARK	130	--	155	--	170	140	155	135	140
LA	130	--	155	--	165	145	155	140	145
MISS	125	100	140	110	135	--	--	--	130

South Central Part II

State	5-10-15	5-20-20	6-12-12	6-24-24	10-10-10	10-20-10	12-12-12	16-20-0	18-46-0
					Dollars				
KY	130	150	115	160	125	1/170	2/170	--	--
OKLA	--	--	--	155	--	155	145	170	225
TENN	125	150	110	175	125	1/165	2/165	--	--
TEX	--	--	--	175	--	155	140	165	235

1/ 10-20-20 2/ 15-15-15.

Western States

State	9-30-0	10-34-0	11-48-0	16-20-0	18-46-0	19-9-0
			Dollars			
ARIZ	205	210	245	175	260	--
CALIF	195	--	265	190	250	165
COLO	195	235	250	190	245	--
IDAHO	195	205	220	175	225	--
MONT	--	200	205	165	215	--
N MEX	150	200	195	170	225	--
NEV	--	--	200	195	195	--
OREG	190	--	220	180	235	165
UTAH	--	--	215	175	230	--
WASH	190	--	260	200	240	--
WYO	--	210	--	200	230	--

Fertilizer materials and agricultural limestone: Average price per ton paid by farmers for specified materials, by States, September 15, 1974

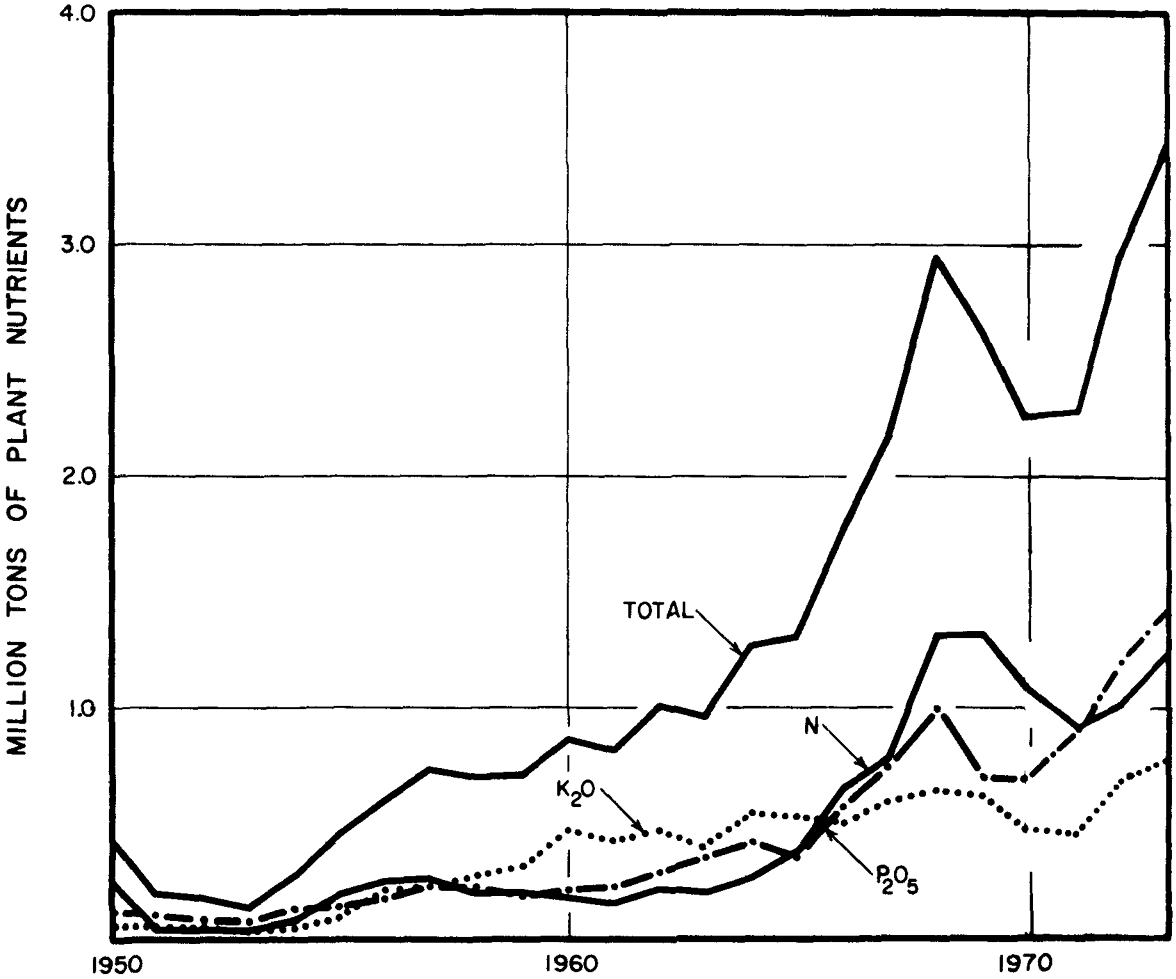
State	Nitrate of soda	Sulphate of ammonia	Ammonia nitrate	Anhydrous ammonia	Urea 45-46% N	Superphosphate 20% P_2O_5	Superphosphate 46% P_2O_5	Phosphate rock	Muriate of potash 60% K_2O	Agricultural lime-stone 1/
	Dollars									
ALA	150	140	155	200	160	110	--	--	91	12.50
ARIZ	--	160	220	205	250	140	210	--	93	--
ARK	--	110	180	205	195	87	180	--	96	9.30
CALIF	--	130	175	225	215	100	--	--	83	--
COLO	--	175	185	245	245	140	210	--	110	--
CONN	--	170	240	--	280	125	--	--	150	18.00
DEL	175	115	205	310	275	125	--	--	110	13.00
FLA	150	105	185	250	250	84	--	40	91	15.00
GA	175	100	175	235	200	75	--	48	94	15.00
HAW	--	--	--	--	--	--	--	--	--	--
IDAHO	--	145	180	315	235	110	180	--	100	--
ILL	--	110	170	235	220	120	190	43	90	5.40
IND	--	110	175	230	230	120	185	65	84	5.90
IOWA	--	125	170	225	220	110	190	70	96	7.00
KANS	--	145	160	210	215	135	175	--	84	4.45
KY	190	--	185	225	225	110	180	60	97	5.00
LA	--	130	180	230	235	83	170	--	93	13.00
MAINE	--	170	240	--	280	125	--	--	150	18.00
MD	175	115	205	310	275	125	--	--	110	13.00
MASS	--	170	240	--	280	125	--	--	150	18.00
MICH	--	130	170	240	290	100	180	60	86	9.90
MINN	--	155	180	240	225	140	190	70	90	10.00
MISS	140	100	135	145	140	95	--	--	100	12.00
MO	--	105	160	225	225	78	180	38	98	5.00
MONT	--	135	170	385	240	--	170	--	89	--
NEBR	--	130	160	210	235	125	185	--	96	8.00
NEV	--	150	200	250	250	--	--	--	--	--
N H	--	170	240	--	280	125	--	--	150	18.00
N J	--	130	205	250	300	115	--	--	135	17.00
N MEX	--	150	180	240	230	145	185	--	90	--
N Y	--	110	145	250	260	110	--	--	140	14.00
N C	175	--	180	270	240	100	170	--	110	14.50
N DAK	--	140	160	240	215	--	180	--	76	--
OHIO	--	120	170	225	250	110	180	70	85	6.60
OKLA	--	145	170	220	215	90	180	48	84	7.40
OREG	--	150	185	350	235	95	--	--	96	--
PA	--	125	215	300	300	100	--	--	125	12.00
R I	--	170	240	--	280	125	--	--	150	18.00
S C	180	--	175	350	230	85	165	--	86	13.50
S DAK	--	155	165	230	225	135	185	--	93	--
TENN	150	--	175	225	200	105	190	58	105	5.90
TEX	--	140	175	235	230	98	210	50	91	8.90
UTAH	--	130	180	190	225	100	--	--	95	--
VT	--	170	240	--	280	125	--	--	150	18.00
VA	175	--	175	250	260	94	185	--	105	12.00
WASH	--	165	205	330	265	110	--	--	96	--
W VA	--	--	165	--	220	85	--	--	105	12.00
WIS	--	125	175	220	220	110	185	65	82	11.00
WYO	--	150	165	235	--	--	170	--	110	--
U S	168	137	170	229	232	104	188	42	91	8.43

1/ Spread on field.

APPENDIX H

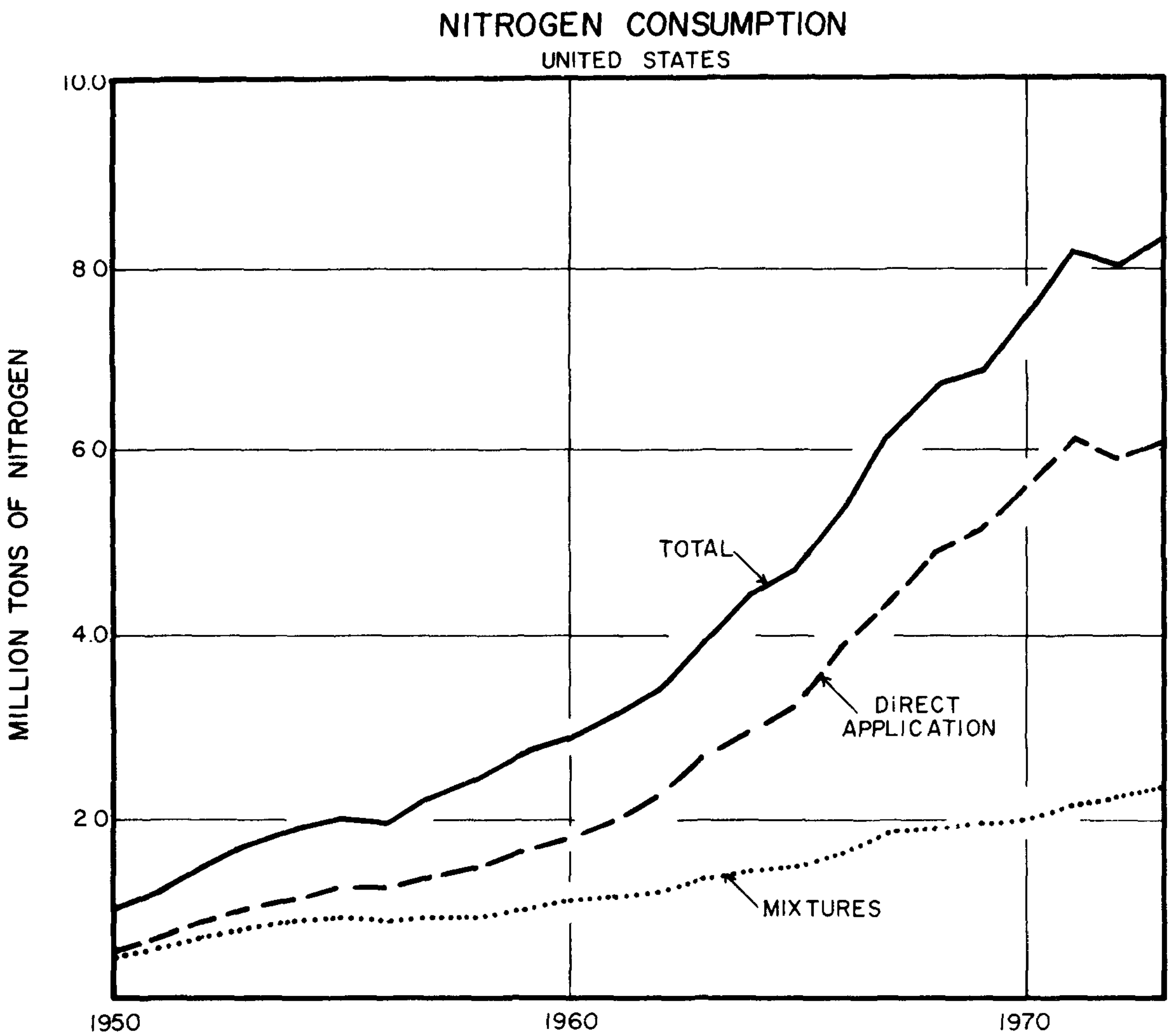
EXPORTS OF PLANT NUTRIENTS

UNITED STATES



U.S. Fertilizer Foreign Trade

Year	Exports Nitrogen	Exports P_2O_5	Exports K_2O	Imports Nitrogen	Imports P_2O_5	Imports K_2O
	(000 short tons)					
1950	238	139	55	247	46	178
1955	202	155	118	360	103	145
1960	185	221	469	268	53	197
1961	159	238	433	314	50	199
1962	229	307	482	376	71	278
1963	213	369	398	399	58	526
1964	286	474	552	353	43	718
1965	397	390	548	528	76	1,068
1966	657	650	512	549	79	1,430
1967	790	862	604	668	93	1,629
1968	1,310	1,108	643	642	107	2,134
1969	1,311	780	620	706	120	2,297
1970	1,105	781	476	879	200	2,554
1971	907	920	453	868	202	2,729
1972	1,066	1,202	680	888	220	2,906
1973	1,234	1,406	780	874	172	3,300

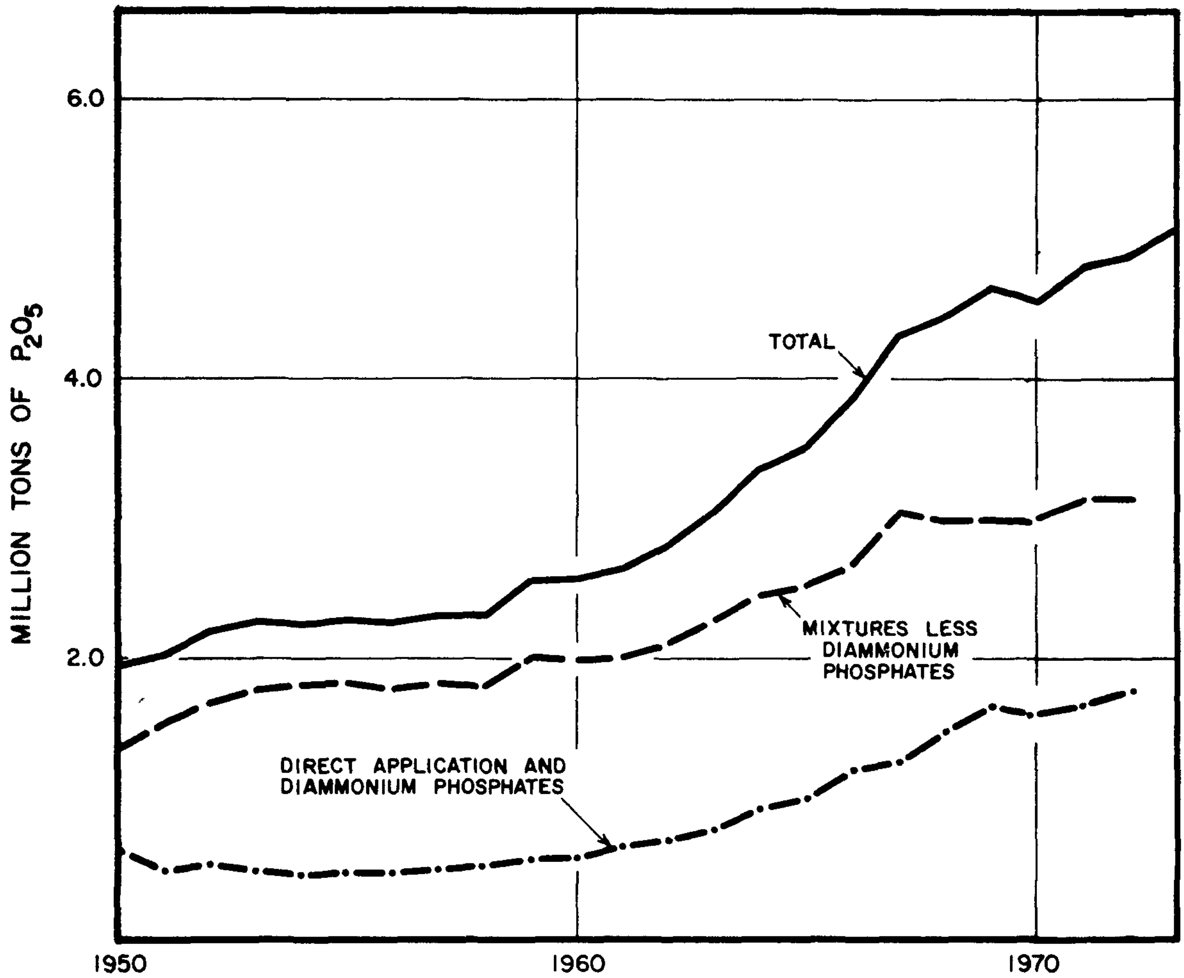


U.S. Nitrogen Consumption

Fiscal Year	Total Nitrogen Consumption	Nitrogen in Mixtures	Direct Application Materials		
			Fluid	Solid	Total
		(short tons of nitrogen)			
1950	1,005,452	495,360	75,556	434,536	510 092
1955	1 960,536	803,541	375,316	781 679	1,156,995
1960	2,738,047	1,017 415	862,044	858,588	1 720,632
1961	3,030,788	1,071,224	1,045 289	914,275	1 959 564
1962	3,369,980	1,147,266	1 238 587	984,127	2 222 714
1963	3 929,089	1,263 641	1,594,602	1 070 846	2 665 448
1964	4,352,809	1,377,033	1,832,357	1 143 419	2,975 776
1965	4,638,538	1,452,084	2,041,760	1 144,694	3 186 454
1966	5,326,303	1 591 927	2,520,131	1 214,245	3 734 376
1967	6,026,997	1 764,372	2,935,163	1,327,462	4 262 625
1968	6,693,790	1,867,091	3,423,400	1 403,299	4,826 699
1969	6,957,600	1,901 393	3,560,071	1 496,136	5,056,207
1970	7,459,004	1,939 077	3 957,718	1,562 209	5 519 927
1971	8,133,606	2,062,782	4,441,979	1,628 845	6 070 824
1972	8,016,007	2,135,921	4,141,558	1 738 582	5 880 085
1973[a]	8,338,780	2,278,270	4,168,644	1,891 866	6 060 510

[a]Preliminary

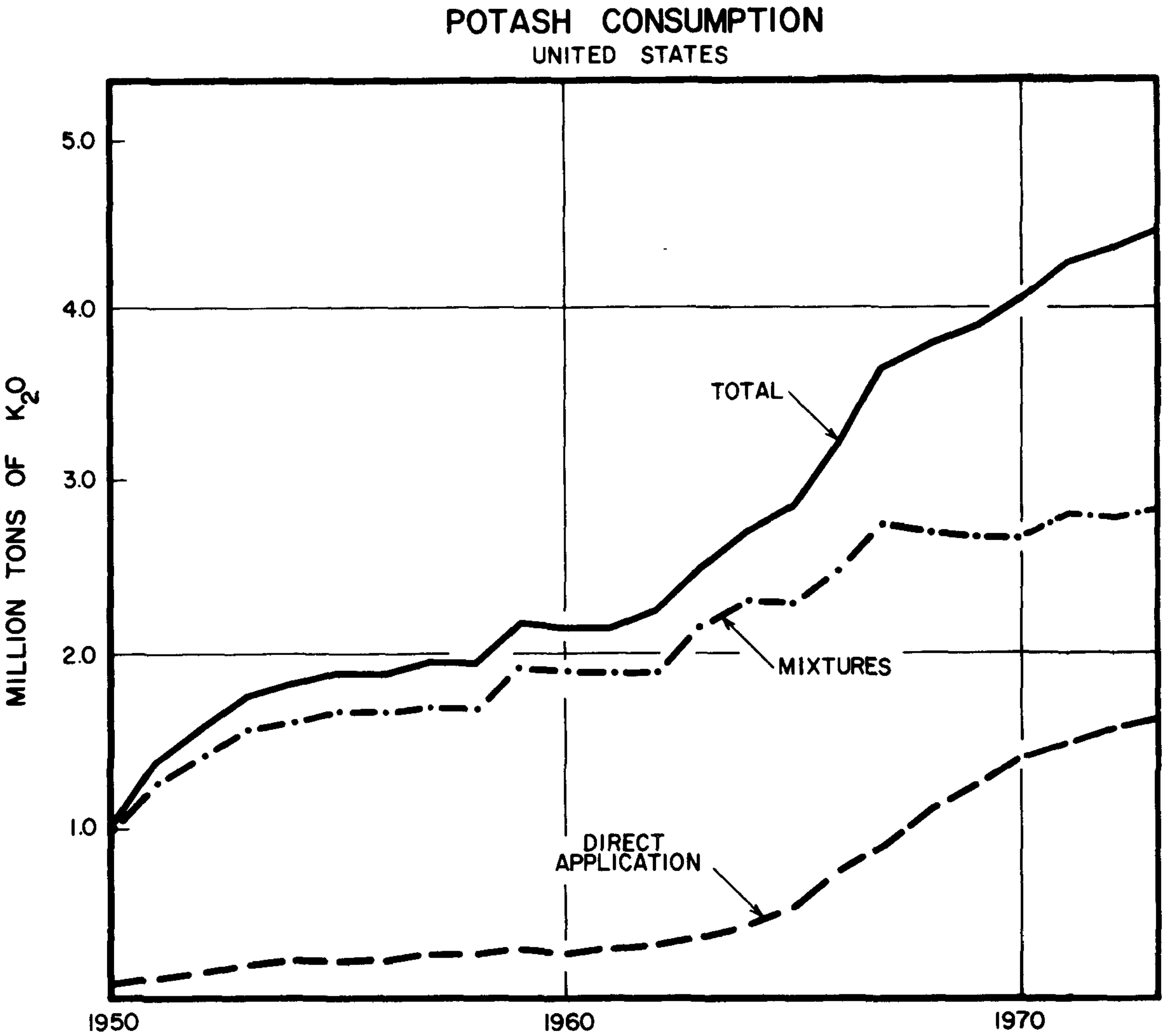
PHOSPHATE CONSUMPTION
UNITED STATES



U.S. Phosphate Consumption

Fiscal Year	Total P_2O_5 Consumption	P_2O_5 in Mixtures	Direct Application Materials		Total	Diammonium Phosphates[b]
			Superphosphates	Ammonium Phosphates[a]		
			(short tons of P_2O_5)			
1950	1,949.768	1,344,295	490,605	34,243	605,473	
1955	2,283,660	1,821,087	291,406	84,617	462,573	113
1960	2,572,348	2,033,316	287,335	171,329	539,032	35,278
1961	2,645,085	2,069,425	303,256	188,398	575,660	63,482
1962	2,807,039	2,219,444	313,860	204,768	587,595	110,074
1963	3,072,873	2,473,599	318,415	205,457	599,274	177,487
1964	3,377,841	2,704,985	382,287	215,604	672,856	244,271
1965	3,512,207	2,816,056	403,403	204,401	696,151	302,088
1966	3,897,132	3,110,784	506,351	220,908	786,348	417,821
1967	4,304,688	3,502,897	517,470	223,761	801,791	451,452
1968	4,451,980	3,579,140	566,120	227,288	872,840	608,296
1969	4,665,569	3,724,237	656,713	207,448	941,332	723,786
1970	4,573,758	3,709,062	608,338	183,688	864,697	726,486
1971	4,803,443	3,943,372	610,969	178,878	860,071	814,938
1972	4,873,053	4,006,595	620,059	174,277	866,458	883,795
1973[c]	5,072,008	4,199,566	604,681		872,442	

[a]Includes grades 11-48-0 13-39-0, 16-20-0, 21-53-0, and 27-14-0
[b]Includes 18-46-0 and 16-48-0 classified as mixed fertilizer
[c]Preliminary.

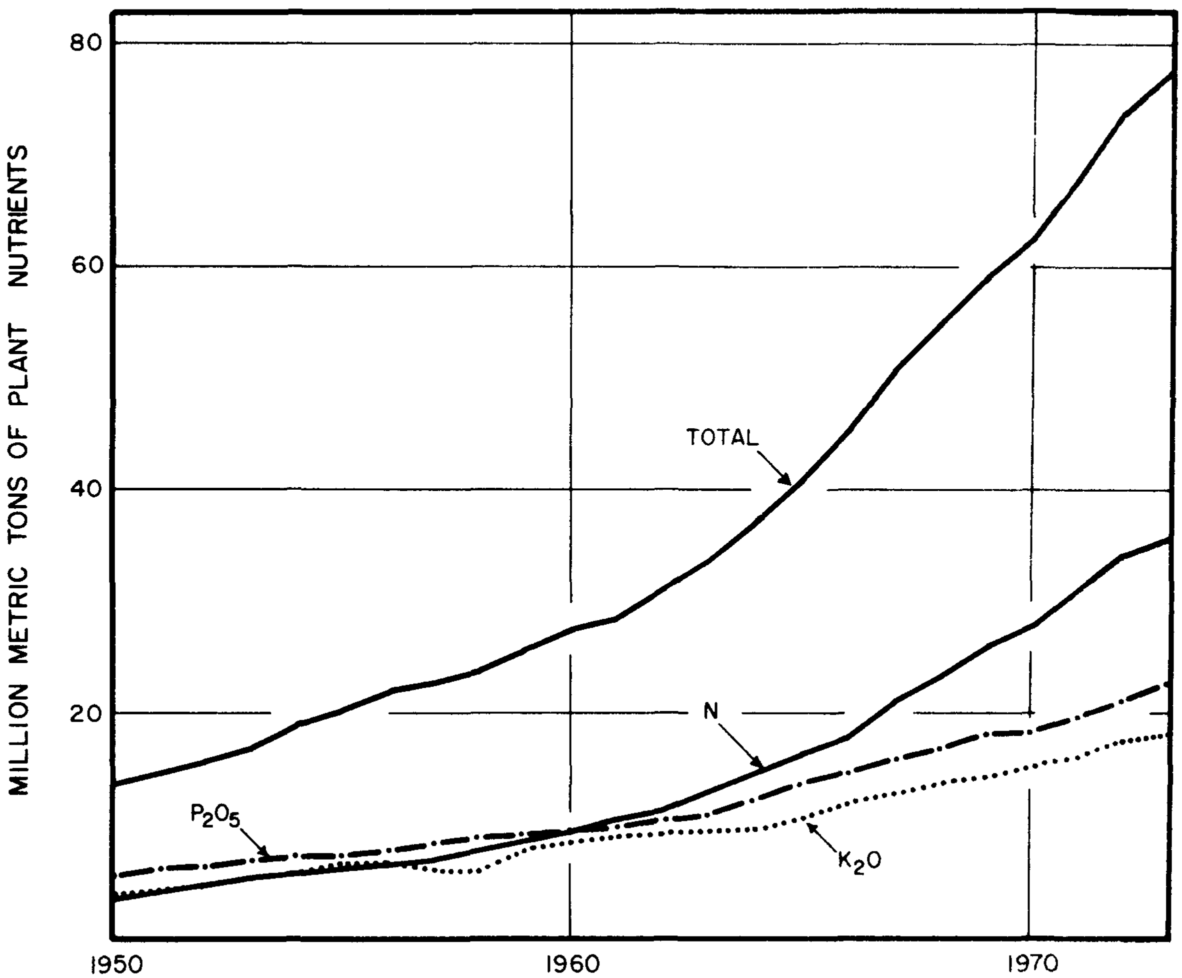


Potash Consumption (U.S. and Canada)

Fiscal Year	United States			Canada		
	Mixtures	Direct Application	Total	Mixtures	Direct Application	Total
			(short tons of K_2O)			
1950	1,018,174	84,888	1,103,062	54,063	1,924	55,987
1955	1,657,864	217,079	1,874,943	71,219	3,120	74,339
1960	1,886,798	266,521	2,153,319	84,888	4,387	89,275
1961	1,883,111	285,422	2,168,533	96,514	5,404	101,918
1962	1,973,149	297,388	2,270,537	99,934	6,558	106,492
1963	2,148,434	355,028	2,503,462	102,285	9,704	111,989
1964	2,294,618	435,075	2,729,693	106,609	14,087	120,696
1965	2,300,209	534,328	2,834,537	117,142	18,264	135,405
1966	2,478,084	743,161	3,221,245	135,695	20,644	156,339
1967	2,750,954	890,845	3,641,799	150,336	27,806	178,142
1968	2,697,201	1,095,371	3,792,572	148,329	34,771	183,100
1969	2,660,854	1,230,722	3,891,576	144,560	40,967	185,527
1970	2,663,457	1,372,054	4,035,511	152,004	40,475	192,479
1971	2,795,668	1,435,701	4,231,369	156,362	46,831	203,193
1972	2,782,454	1,549,562	4,332,016	158,568	48,340	206,908
1973[a]	2,806,513	1,605,018	4,411,531	181,500	48,500	230,000

[a]Preliminary

WORLD FERTILIZER CONSUMPTION

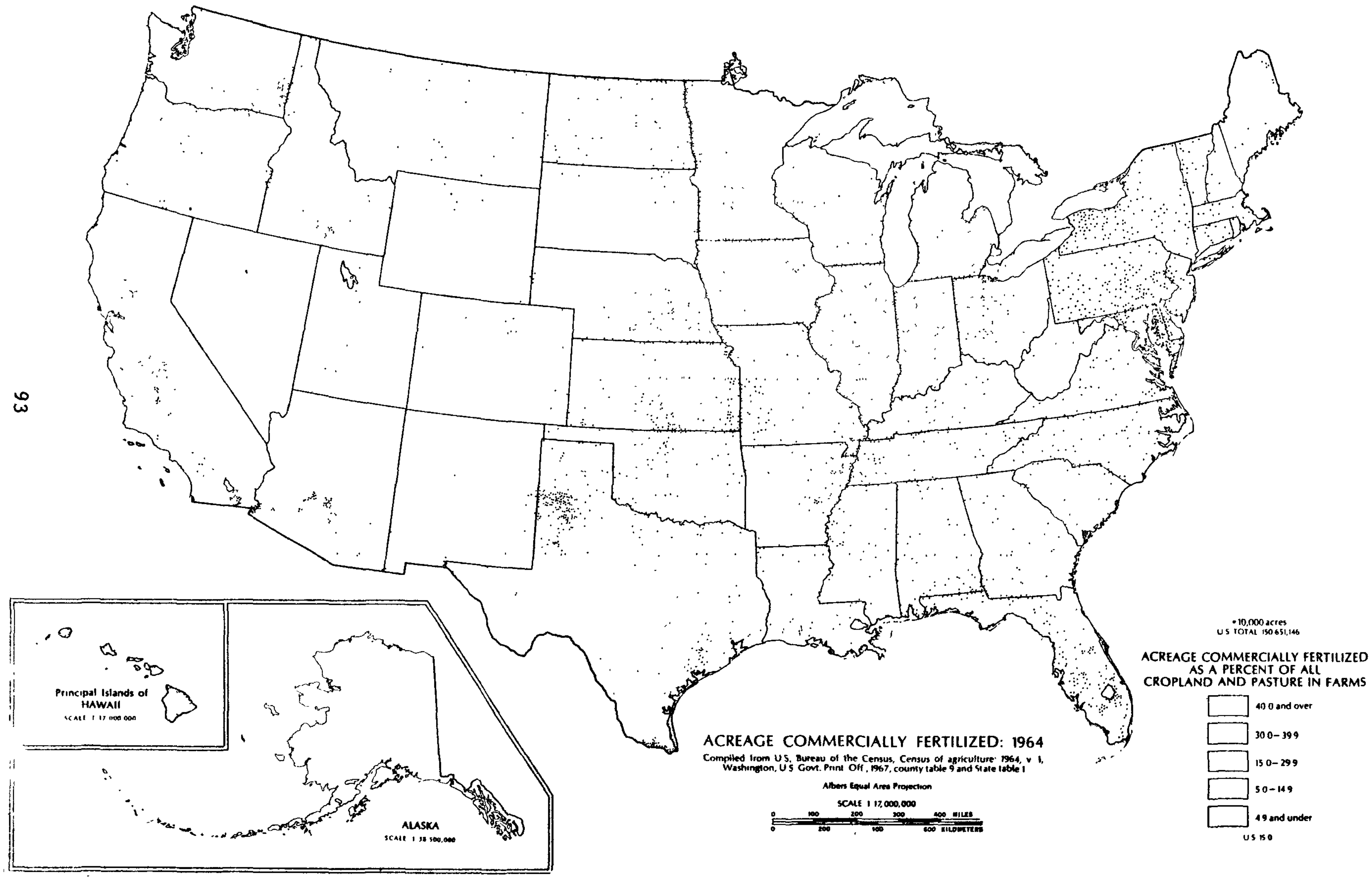


World Plant Nutrient Consumption

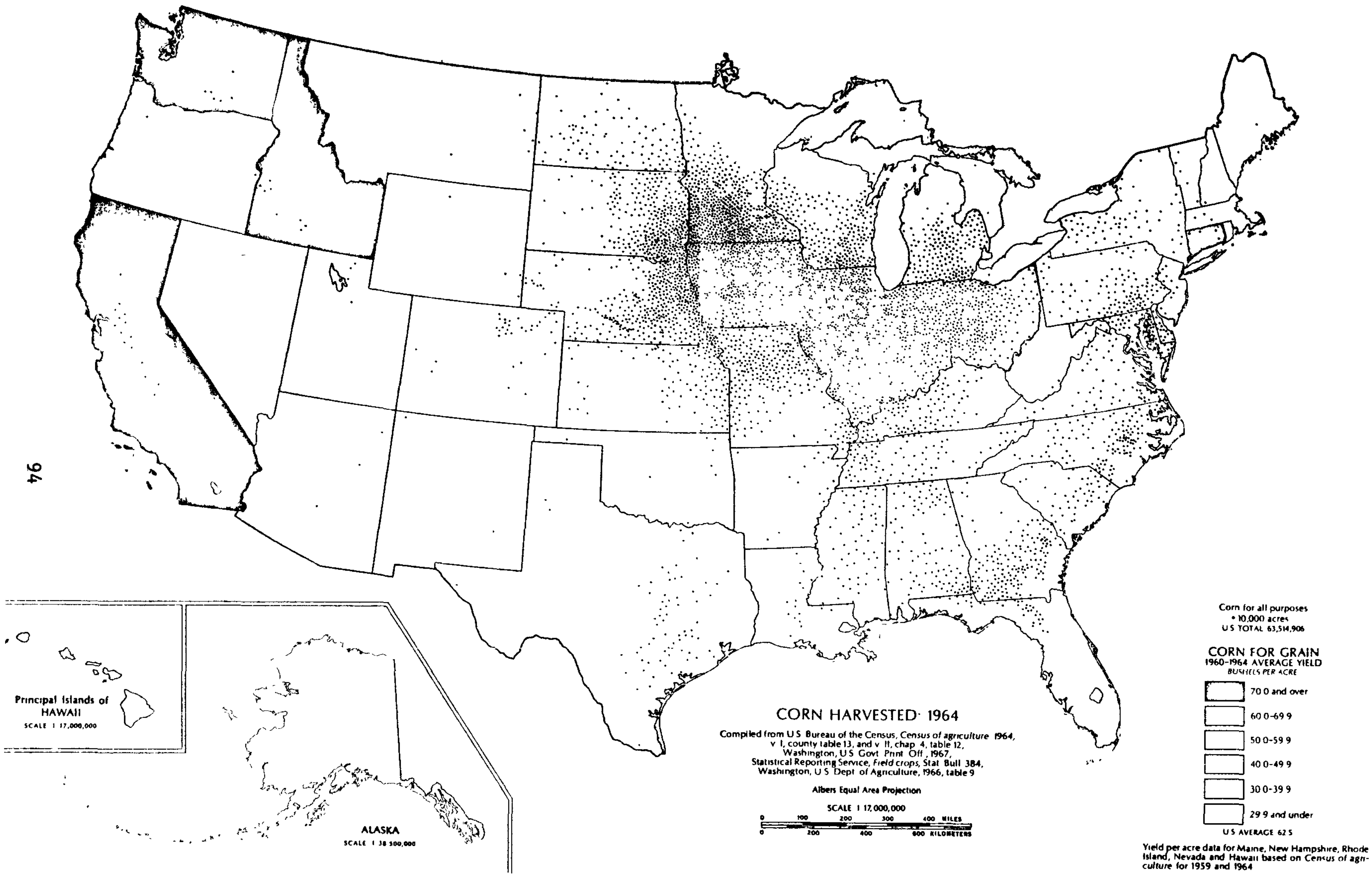
Fiscal Year		Nitrogen (N)	Phosphate (P_2O_5)	Potash (K_2O)	Total
			(metric tons)		
1950		3,639,000	5,864,000	3,994,000	13,497,000
1955		6,521,309	7,552,948	6,438,865	20,513,122
1960		9,626,357	9,531,905	8,109,038	27,267,300
1961		10,800,870	10,047,939	8,435,626	29,284,435
1962		11,868,776	10,517,746	8,783,042	31,169,564
1963		13,430,491	11,310,505	9,347,466	34,088,462
1964		14,822,959	12,334,088	10,083,784	37,240,831
1965		16,404,014	13,634,393	11,031,100	41,069,507
1966		18,841,520	14,772,286	12,179,519	45,793,325
1967		21,778,393	16,129,403	12,978,005	50,885,412
1968		23,938,254	16,986,561	13,950,337	54,873,989
1969		26,618,116	18,197,663	14,631,618	59,446,322
1970		28,652,789	18,809,668	15,441,913	62,903,469
1971		31,720,898	19,868,084	16,504,912	68,092,851
1972		33,700,259	21,090,163	17,480,094	72,270,516
1973[a]		36,023,000	22,766,000	18,704,000	77,493,000
			Forecast		
1975	Low	39,600,000	22,900,000	19,000,000	81,500,000
	High	44,300,000	26,800,000	21,800,000	92,900,000
1980	Low	53,100,000	28,300,000	23,500,000	104,900,000
	High	60,800,000	34,100,000	27,800,000	122,700,000

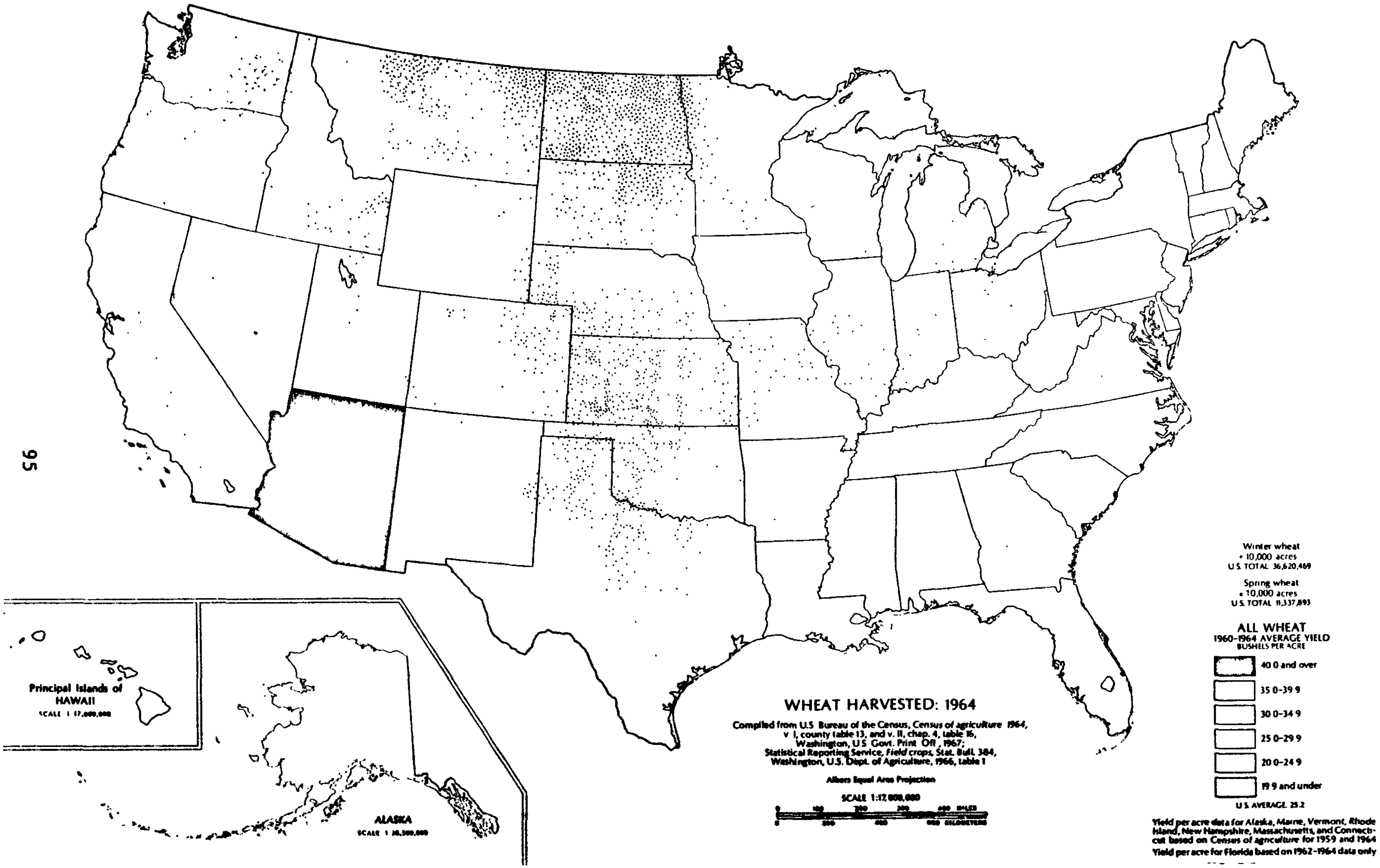
[a]Preliminary.

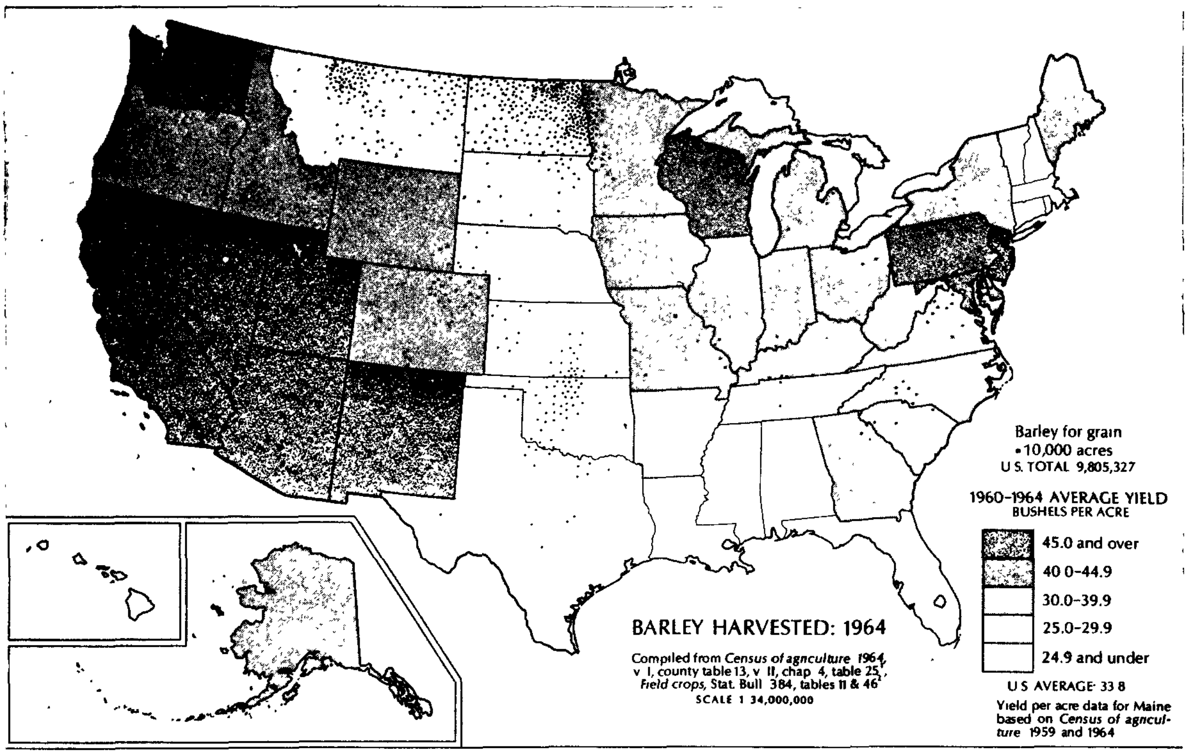
APPENDIX I

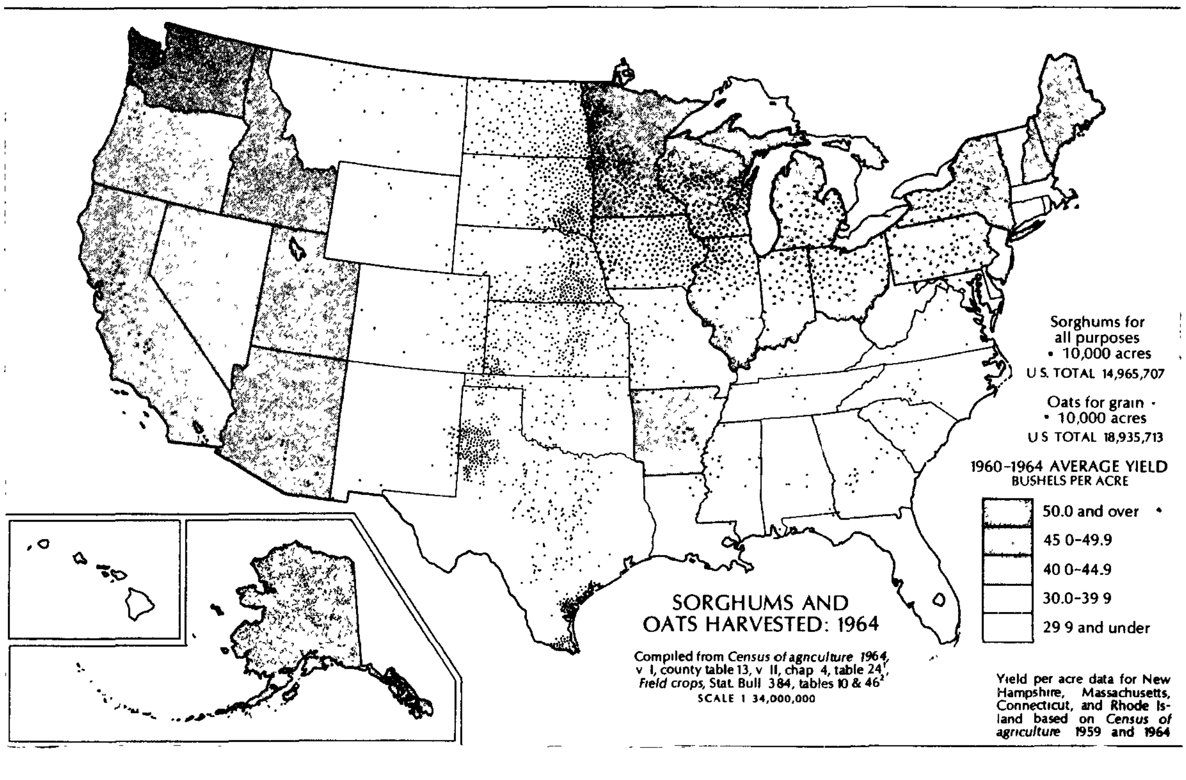


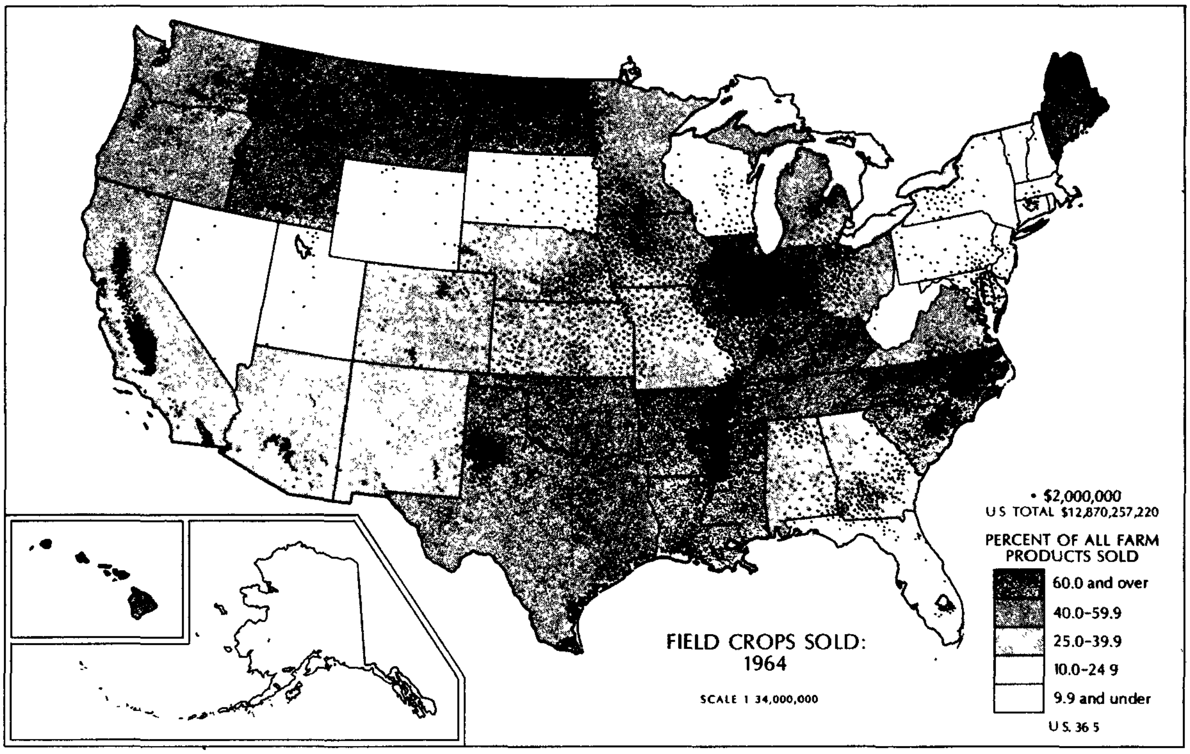
ACREAGE COMMERCIALLY FERTILIZED: 1964
Compiled from U.S. Bureau of the Census, Census of agriculture: 1964, v. 1, Washington, U.S. Govt. Print. Off., 1967, county table 9 and State table 1
Albers Equal Area Projection
SCALE 1:17,000,000
0 100 200 300 400 MILES
0 200 400 600 KILOMETERS
• 10,000 acres
U.S. TOTAL 150,651,146
ACREAGE COMMERCIALLY FERTILIZED AS A PERCENT OF ALL CROPLAND AND PASTURE IN FARMS
40.0 and over
30.0–39.9
15.0–29.9
5.0–14.9
4.9 and under
U.S. 15.0
Principal Islands of HAWAII
ALASKA

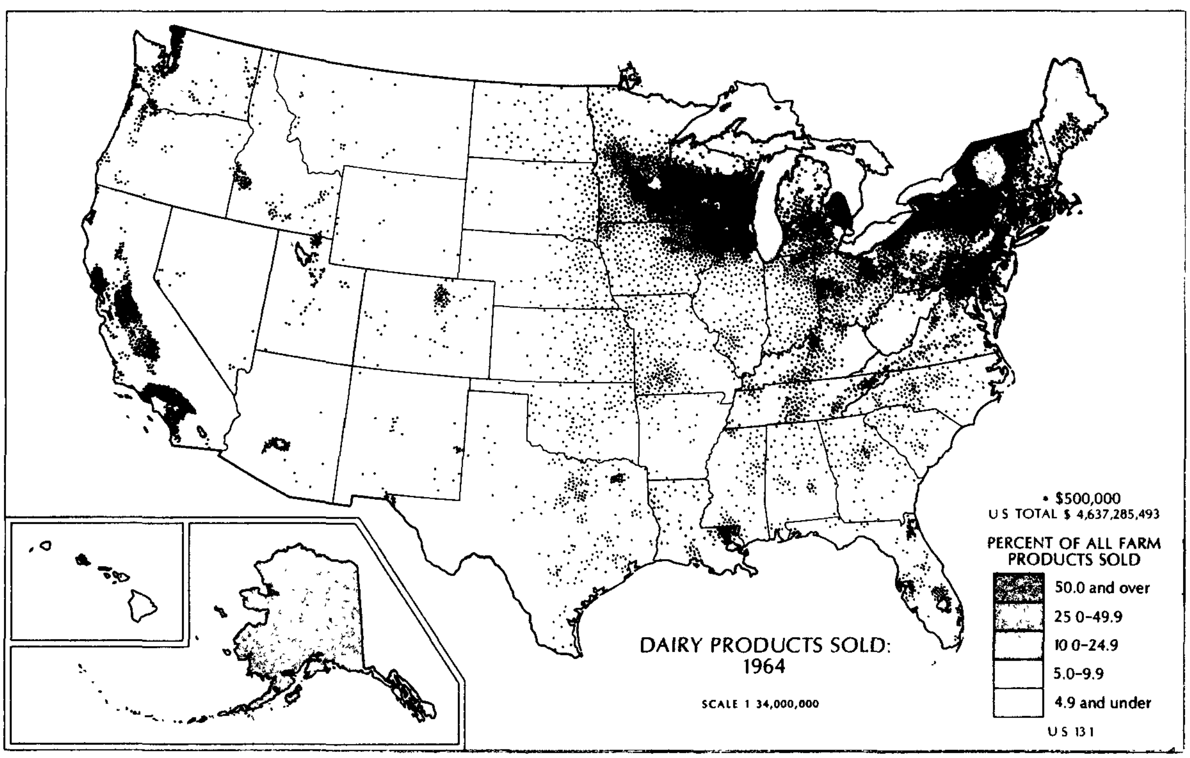

CORN HARVESTED 1964
Compiled from U S Bureau of the Census, Census of agriculture 1964, v I, county table 13, and v II, chap 4, table 12, Washington, U S Govt Print Off, 1967, Statistical Reporting Service, Field crops, Stat Bull 384, Washington, U S Dept of Agriculture, 1966, table 9
Albers Equal Area Projection
SCALE 1 17,000,000
0 100 200 300 400 MILES
0 200 400 600 KILOMETERS
Corn for all purposes
• 10,000 acres
U S TOTAL 63,514,906
CORN FOR GRAIN
1960-1964 AVERAGE YIELD
BUSHELS PER ACRE
70.0 and over
60.0–69.9
50.0–59.9
40.0–49.9
30.0–39.9
29.9 and under
U S AVERAGE 62.5
Yield per acre data for Maine, New Hampshire, Rhode Island, Nevada and Hawaii based on Census of agriculture for 1959 and 1964
Principal Islands of HAWAII
SCALE 1 17,000,000
ALASKA
SCALE 1 38 500,000

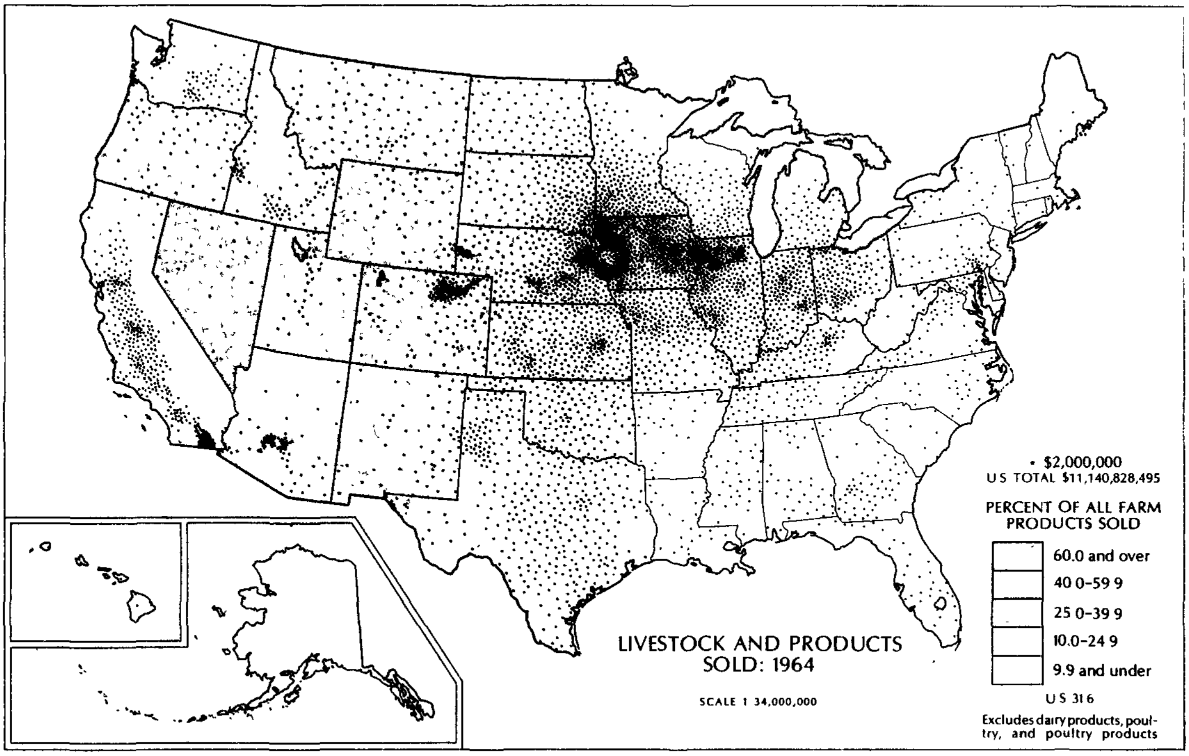

WHEAT HARVESTED: 1964
Compiled from U.S Bureau of the Census, Census of agriculture 1964, v I, county table 13, and v. II, chap. 4, table 16, Washington, U.S Govt. Print Off., 1967; Statistical Reporting Service, Field crops, Stat. Bull. 384, Washington, U.S. Dept. of Agriculture, 1966, table 1
Albers Equal Area Projection
SCALE 1:17,000,000
Winter wheat
• 10,000 acres
U.S TOTAL 36,620,469
Spring wheat
• 10,000 acres
U.S TOTAL 11,337,893
ALL WHEAT
1960-1964 AVERAGE YIELD
BUSHELS PER ACRE
40.0 and over
35.0-39.9
30.0-34.9
25.0-29.9
20.0-24.9
19.9 and under
U.S AVERAGE 25.2
Yield per acre data for Alaska, Maine, Vermont, Rhode Island, New Hampshire, Massachusetts, and Connecticut based on Censuses of agriculture for 1959 and 1964
Yield per acre for Florida based on 1962-1964 data only
Principal Islands of HAWAII
ALASKA

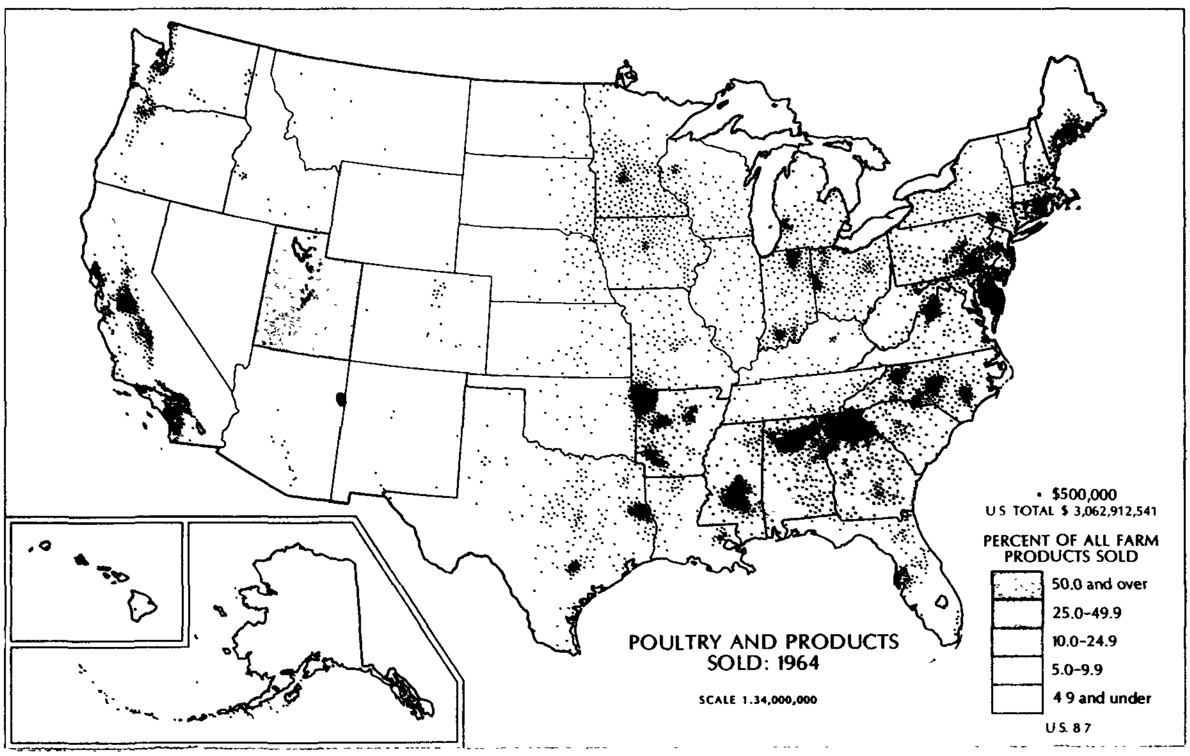

BARLEY HARVESTED: 1964
Compiled from Census of agriculture 1964, v I, county table 13, v II, chap 4, table 25, Field crops, Stat Bull 384, tables 11 & 46
SCALE 1 34,000,000
Barley for grain
• 10,000 acres
U S. TOTAL 9,805,327
1960-1964 AVERAGE YIELD
BUSHELS PER ACRE
45.0 and over
40 0-44.9
30.0-39.9
25.0-29.9
24.9 and under
U S AVERAGE 33 8
Yield per acre data for Maine based on Census of agriculture 1959 and 1964

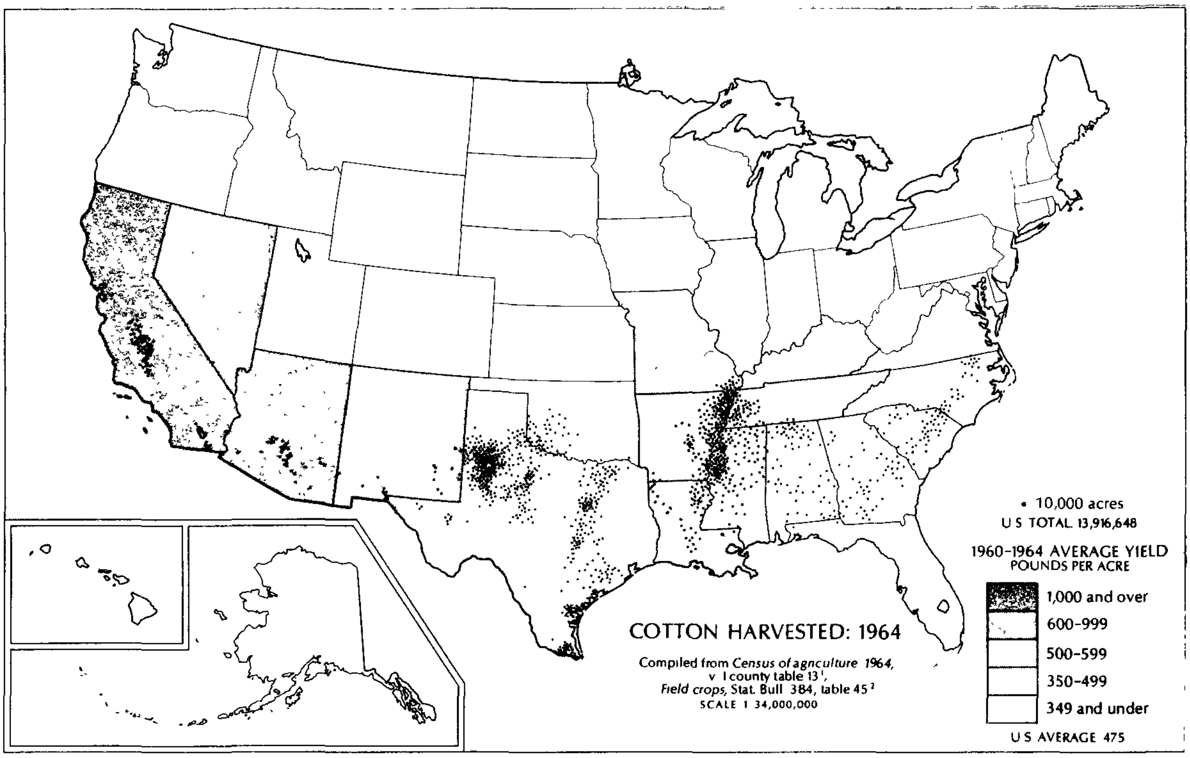

SORGHUMS AND OATS HARVESTED: 1964
Compiled from Census of agriculture 1964, v I, county table 13, v II, chap 4, table 24, Field crops, Stat Bull 384, tables 10 & 46
SCALE 1 34,000,000
Sorghums for all purposes
• 10,000 acres
U S. TOTAL 14,965,707
Oats for grain
• 10,000 acres
U S TOTAL 18,935,713
1960-1964 AVERAGE YIELD
BUSHELS PER ACRE
50.0 and over
45 0-49.9
40 0-44.9
30.0-39 9
29 9 and under
Yield per acre data for New Hampshire, Massachusetts, Connecticut, and Rhode Island based on Census of agriculture 1959 and 1964

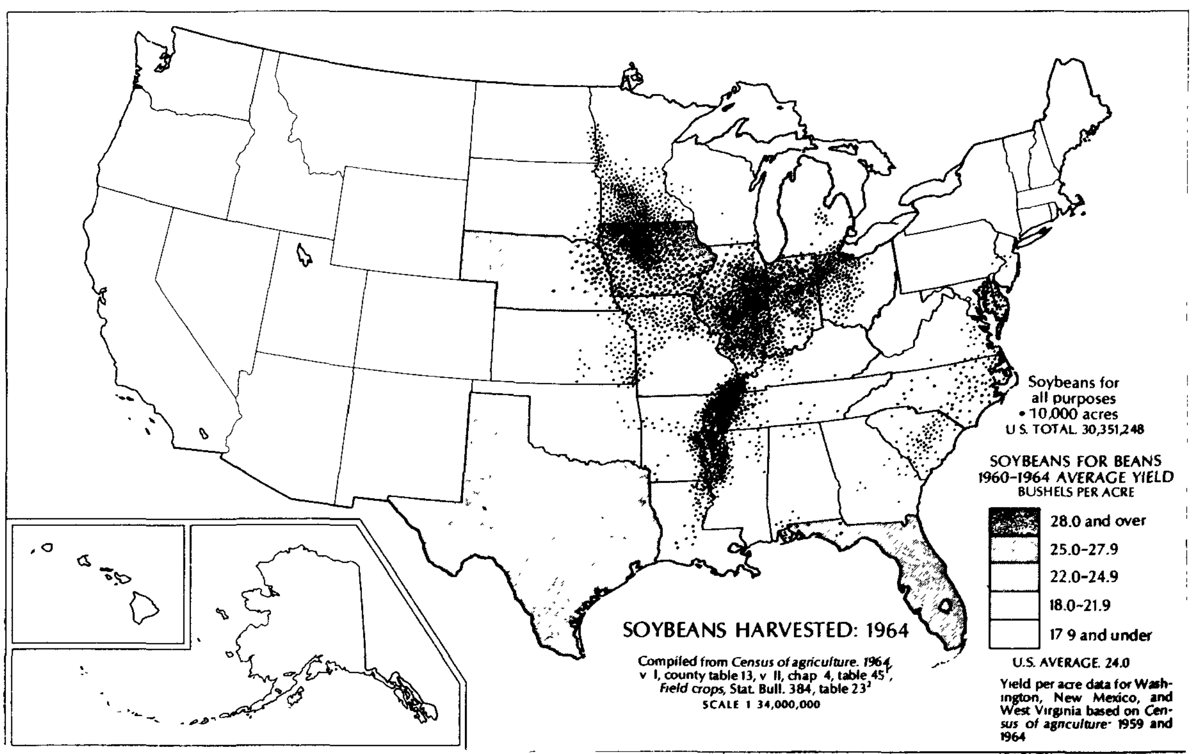

• $2,000,000
U S TOTAL $12,870,257,220
PERCENT OF ALL FARM PRODUCTS SOLD
60.0 and over
40.0-59.9
25.0-39.9
10.0-24 9
9.9 and under
U S. 36 5
FIELD CROPS SOLD: 1964
SCALE 1 34,000,000


• $500,000
U S TOTAL $ 4,637,285,493
PERCENT OF ALL FARM PRODUCTS SOLD
50.0 and over
25 0-49.9
10 0-24.9
5.0-9.9
4.9 and under
U S 13 1
DAIRY PRODUCTS SOLD: 1964
SCALE 1 34,000,000


• $2,000,000
U S TOTAL $11,140,828,495
PERCENT OF ALL FARM PRODUCTS SOLD
60.0 and over
40 0-59 9
25 0-39 9
10.0-24 9
9.9 and under
LIVESTOCK AND PRODUCTS SOLD: 1964
SCALE 1 34,000,000
U S 31 6
Excludes dairy products, poultry, and poultry products


• $500,000
U S TOTAL $ 3,062,912,541
PERCENT OF ALL FARM PRODUCTS SOLD
50.0 and over
25.0-49.9
10.0-24.9
5.0-9.9
4 9 and under
POULTRY AND PRODUCTS SOLD: 1964
SCALE 1.34,000,000
U.S. 8 7


COTTON HARVESTED: 1964
Compiled from Census of agriculture 1964, v I county table 13[1], Field crops, Stat. Bull. 384, table 45[2]
SCALE 1 34,000,000
• 10,000 acres
U S TOTAL 13,916,648
1960-1964 AVERAGE YIELD
POUNDS PER ACRE
1,000 and over
600-999
500-599
350-499
349 and under
U S AVERAGE 475


SOYBEANS HARVESTED: 1964
Compiled from Census of agriculture. 1964, v I, county table 13, v II, chap 4, table 45[1], Field crops, Stat. Bull. 384, table 23[2]
SCALE 1 34,000,000
Soybeans for all purposes
• 10,000 acres
U S. TOTAL 30,351,248
SOYBEANS FOR BEANS
1960-1964 AVERAGE YIELD
BUSHELS PER ACRE
28.0 and over
25.0-27.9
22.0-24.9
18.0-21.9
17 9 and under
U.S. AVERAGE 24.0
Yield per acre data for Washington, New Mexico, and West Virginia based on Census of agriculture 1959 and 1964

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