REPORT TO THE CONGRESS

BY THE COMPTROLLER GENERAL OF THE UNITED STATES

Opportunities For More Effective Use Of Animal Manure

Environmental Protection Agency
Department of Agriculture
Energy Research and Development Administration

Manure is a valuable economic asset which can be used as fertilizer or from which by-products can be recovered.

The Department of Agriculture should increase its efforts to inform farmers of the benefits that can be achieved by more effectively using animal manure as a substitute for, or supplement to, commercial fertilizer and the proper methods of doing so. The Department should also consider a program to insure that farmers can rely on the soil and manure testing by laboratories which is critical in using any type of fertilizer. The Environmental Protection Agency should promote interagency agreements directed toward bringing animal manure use technology to a commercially viable level.

RED-76-101

JUNE 14, 1976

COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

B-166506

To the President of the Senate and the
Speaker of the House of Representatives

This report discusses opportunities for more effective use of animal manure.

The review was performed to determine the alternatives available for the use of animal manure. We made our review pursuant to the Budget and Accounting Act, 1921 (31 U.S.C. 53), and the Accounting and Auditing Act of 1950 (31 U.S.C. 67).

We are sending copies of this report to the Director, Office of Management and Budget; the Secretary of Agriculture; the Administrator, Energy Research and Development Administration; and the Administrator, Environmental Protection Agency.

Comptroller General
of the United States

Contents

ABBREVIATIONS

EPA	Environmental Protection Agency
ERDA	Energy Research and Development Administration
GAO	General Accounting Office
USDA	Department of Agriculture

COMPTROLLER GENERAL'S
REPORT TO THE CONGRESS

OPPORTUNITIES FOR MORE EFFECTIVE USE OF ANIMAL MANURE

Environmental Protection Agency
Department of Agriculture
Energy Research and Development Administration

D I G E S T

In 1971 U.S. livestock produced an estimated 1.74 billion tons of manure, or about 39 percent of the total solid waste (an estimated 4.45 billion tons) generated in the United States. In 1973, the Environmental Protection Agency estimated that about 2 billion tons of animal manure was generated annually in the United States.

About half of this manure is generated in feedlots or other confinement operations. Disposal of this manure can cause solid waste disposal and water pollution problems, but it has a great resource potential from which both energy and materials can be recovered or which can be used in producing food.

GAO's review of the disposal activities of 100 feedlot operators and farmers in four States showed that since mid-1973 operators have generally been able to readily dispose of accumulated manure to farmers for use as fertilizer on cropland. Three factors which contribute to this have been

--the worldwide shortages of commercial fertilizer,

--increases in the price of commercial fertilizer, and

--a reduction in the number of animals being kept in feedlots.

Stockyards and packing plants in urban areas have been less successful in disposing of animal manure. Also the larger feedlots (1,000 to 120,000 head of cattle), now operating at about 50 percent of capacity, may have disposal problems when operating at full capacity.

For these operations alternative methods of using manure as a resource should be developed.

The Environmental Protection Agency has determined that using manure as fertilizer is the best method currently available to dispose of the manure and to minimize its possible pollution. For this reason it has directed its research program in this area.

GAO found that using animal manure as fertilizer has not been effective. Many farmers not fully aware of the value of manure's fertilizer elements, often applied excessive amounts of manure or did not properly reduce the amount of commercial fertilizer used.

Overapplication results in unnecessary costs for fertilizer and possibly in reducing crop yield. To effectively use manure as fertilizer the farmer must know both its value and the needs of the land.

The Department of Agriculture said it had guidelines for land application of manure and supplementary requirements for commercial fertilizer but that farmers apparently were not using them to the extent possible. The Department said also that its Extension Service had been giving more attention to educating farmers on the benefits of the proper use of manure in crop production. (See p. 28.)

A followup with individuals contacted during GAO's review has not shown any major increase in the amount of effort devoted to getting such information to farmers.

Therefore GAO recommends that the Secretary of Agriculture require the Extension Service to conduct an aggressive program emphasizing to the agricultural community the benefits from more effectively using animal manure as a substitute for, or as a supplement to, commercial fertilizer and the proper methods of doing so.

Farmers and officials of agricultural cooperatives told GAO that they were not having manure and soil tested because laboratory test results could

not be relied upon. They gave GAO analyses of samples of the same soil being tested by different laboratories with different results.

GAO concluded that a program for certifying and monitoring testing laboratories would increase reliability and encourage farmers to use test results. The Department said that such a program would logically be a State responsibility and that it had no specific legal authority to certify soil testing laboratories or to establish testing standards.

Efforts toward standardization have taken place and a few States have soil testing laboratory programs, primarily for private and commercial testing laboratories. Testing of soil samples is not restricted to the State in which the sample was taken and, therefore, any solution must take the interstate nature of soil testing into consideration.

GAO recommends that the Secretary of Agriculture explore various alternatives for standardizing laboratory soil and manure testing, including the feasibility of a laboratory certification system, so that the agricultural community can use such testing to assist in operating in a more productive and economical manner.

Animal manure can be used or processed to produce energy (see p. 20) and certain industrial products (see p. 22) or to aid in the production of food (see pp. 9 and 23). Most of these processes, which include production of oil and gas, anhydrous ammonia for fertilizer (normally produced using natural gas), and various methods of refeeding manure to animals are not yet sufficiently developed for widespread use but they do offer an opportunity which should be explored further.

The Environmental Protection Agency was not convinced that resource recovery for animal manures, other than through land application, was economically and technically feasible at this time. The Department of Agriculture and the Energy Research and Development Administration believe there is a potential for

technology development to recover energy and material from manure and an interest in pursuing such developments. As pointed out by the Energy Research and Development Administration, the potential for overlapping programs exists.

While EPA's own research effort may be more profitably directed to land application, the Agency's responsibility to insure sound solid waste disposal methods including the utilization of waste, would make it responsible to coordinate the efforts of those agencies interested in and able to conduct research on alternative disposal methods such as those discussed in this report.

GAO recommends that the administrators of the Environmental Protection Agency and the Energy Research and Development Administration and the Secretary, Department of Agriculture, enter into a joint agreement delineating responsibilities for the disposal and utilization of animal manure and provide for adequate coordination of activities. The agreement should provide assurance that innovative research projects, such as those discussed in this report, will be given adequate consideration for development to a stage where the economic and technical viability of the technology can be determined.

CHAPTER 1

INTRODUCTION

Livestock in the United States produced an estimated 1.74 billion tons of waste in 1971--the latest date for which comparable data was available. This represented about 39 percent of the total solid waste generated in the United States in that year (estimated at 4.45 billion tons). In 1973 the Environmental Protection Agency estimated that about 2 billion tons of animal manure was generated annually in the United States. 24

Up to one half of this waste is produced in confinement areas, such as feedlots, from which it must be removed periodically. The remainder is produced by animals on pasture or rangeland where the manure is directly absorbed into the soil. Of the manure produced, 48 percent is from beef cattle and 37 percent from dairy cattle. The remaining 15 percent is broken down as follows: poultry 7 percent, hogs 6 percent, and sheep 2 percent. This manure represents a potential problem in terms of solid waste disposal and water pollution but at the same time has potential as a resource from which both energy and materials can be recovered and which can be used in the production of food.

During 1974, about 23.3 million cattle were marketed from 137,732 feedlots in the 23 major cattle feeding States. Of these feedlots 135,810 had a capacity of less than 1,000 head of cattle. These small feedlots marketed about 8.3 million head or an average of 61 per feedlot. Feedlot capacities range from only a few head in the smaller farmer operated feedlots, to in excess of 100,000 head in the larger lots.

Many of the small feedlots are operated in conjunction with, or in close proximity to, farming operations where the manure can be applied to crop land. However, a major portion of the manure is generated in the larger feedlots where the disposal of the manure on farmland, within an economically feasible hauling distance, is more difficult.

Manure not used, or improperly disposed of, presents a potential problem of ground and surface water pollution through runoff or from leaching of nitrates from the manure.

THE FEDERAL ROLE

EPA is responsible for establishing regulations for controlling pollution from animal feedlots and says that manure should be disposed of by applying it to productive farmland

at rates which will provide nutrients that can be utilized by the crops. EPA considers such land application to be the best practical method currently available for disposing of the material.

Under its Animal Feedlot Waste Research Program EPA is looking into methods of treating, disposing, and using manure with the objective of minimizing its pollution potential. Research is conducted primarily through grants to research organizations such as university research laboratories.

The Department of Agriculture (USDA) is responsible for insuring that the United States has an adequate supply of food. Within the Department, two constituent agencies perform or finance research on the use of animal manure. These agencies are the Agricultural Research Service, and the Cooperative State Research Service.

The Agricultural Research Service has conducted research projects in refeeding manure to livestock and in land application. The Service does most of its own research. The Cooperative State Research Service finances research through grants to university researchers. Both of these agencies do research based on the interest of those farm groups which use the results of their work. For this reason these efforts are concentrated in determining maximum and optimum manure application rates for various soils, climates, and crops to aid farmers and feedlot operators in disposing of wastes.

The Energy Research and Development Administration (ERDA) has the responsibility and a planned program for developing new sources of energy including recovering energy from wastes, such as manure.

SCOPE OF REVIEW

We reviewed current practices in animal manure use and current research efforts by EPA and USDA in more effective methods of applying animal manures and developing alternative uses.

Our review was made at EPA, USDA, Energy Research and Development Administration, and Food and Drug Administration headquarters in Washington, D.C., and at the Robert S. Kerr Environmental Research Laboratory in Ada, Oklahoma. We visited five States--California, Colorado, Iowa, Minnesota, and Texas--where we discussed current practices and problems in animal manure use with farmers and feedlot operators.

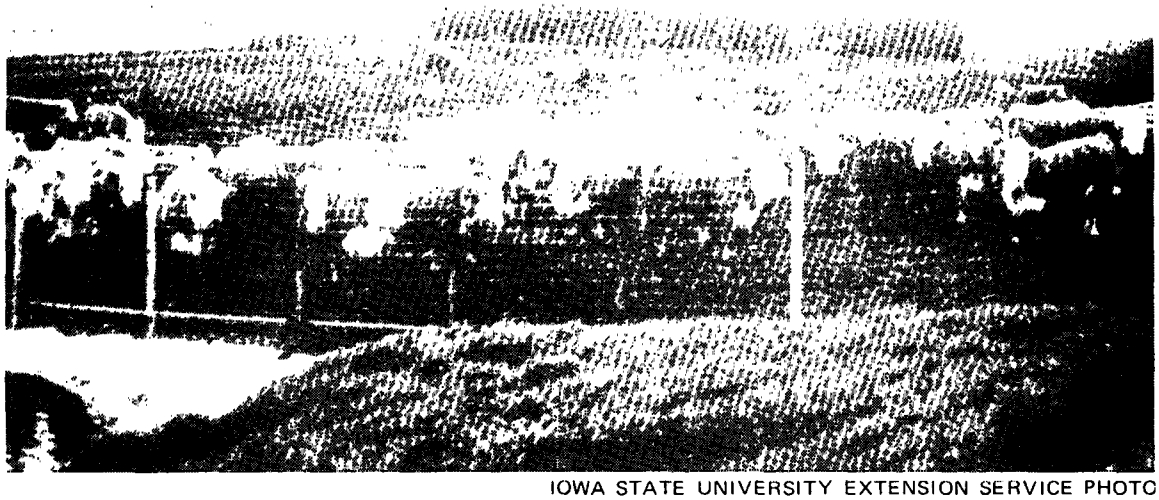
We reviewed documents and reports on alternative methods of manure use and their potential for commercial use.

CREDIT: EPA-DOCUMERICA–GENE DANIELS

AERIAL OF CATTLE ON HUGE FEEDLOT. COALINGA, CA. 5/72

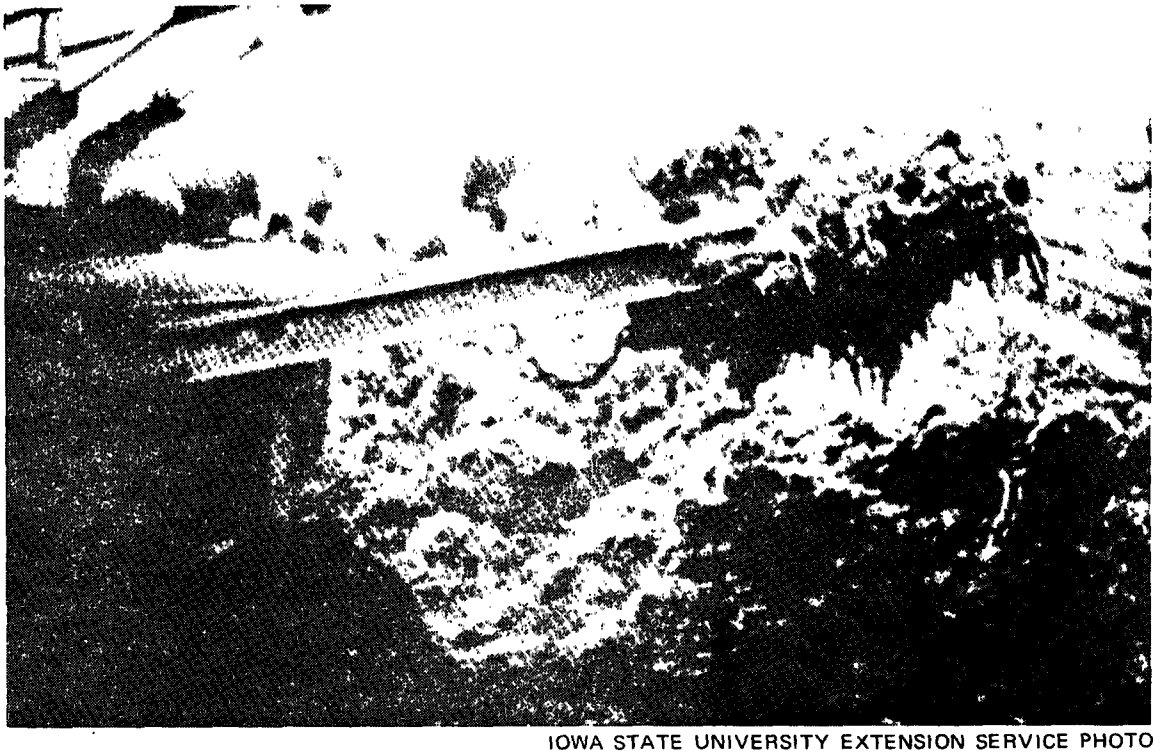
IOWA STATE UNIVERSITY EXTENSION SERVICE PHOTO

SMALL IOWA FEEDLOT



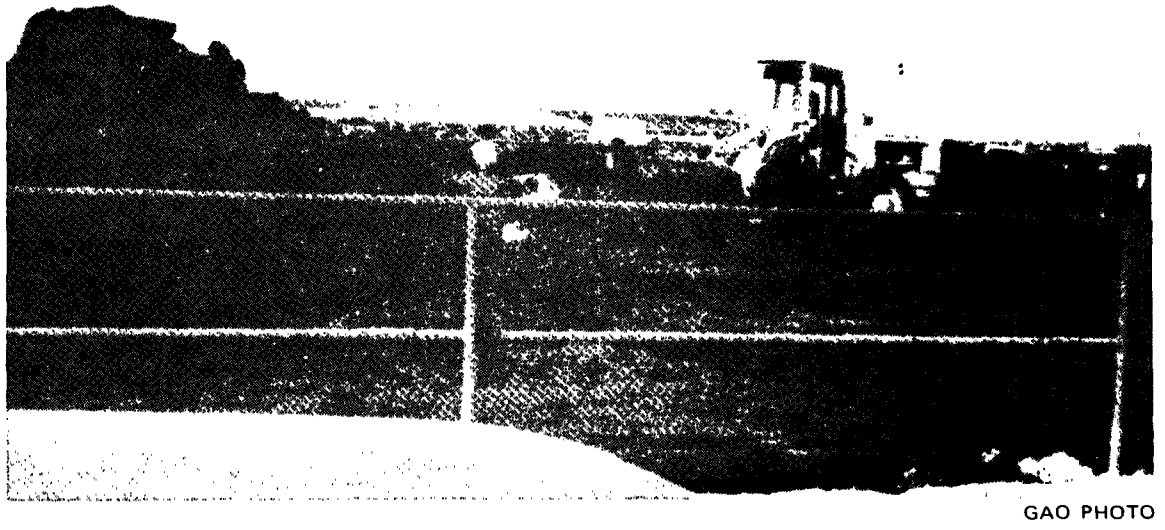
IOWA STATE UNIVERSITY EXTENSION SERVICE PHOTO

CATTLE ON FEEDLOT IN IOWA



IOWA STATE UNIVERSITY EXTENSION SERVICE PHOTO

MANURE BEING REMOVED FROM AN IOWA FEEDLOT



GAO PHOTO

MANURE BEING REMOVED FROM A TEXAS FEEDLOT

CHAPTER 2

NEED TO IMPROVE USE OF MANURE AS FERTILIZER

Three factors which have aided in disposing of animal manure to farmers for use on cropland have been the (1) worldwide shortage of commercial fertilizer, (2) increases in the price of commercial fertilizer, and (3) reduction in the number of animals being maintained in feedlots. However, our visits to over 100 feedlot operators and farmers showed that in many instances the manure was being applied in excessive amounts and without reduction in the amount of commercial fertilizer used.

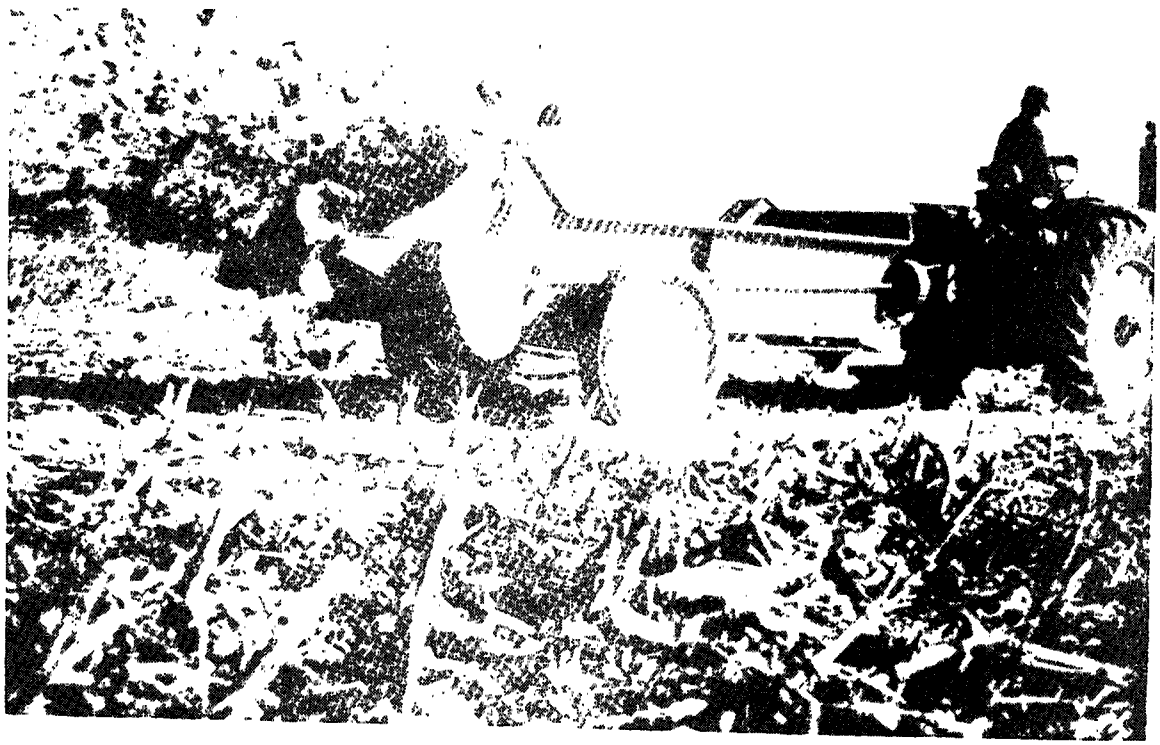
For example, in Iowa 55 operators were using manure as fertilizer but 21 operators did not reduce their applications of commercial fertilizer. We identified 10 of these operators whose applications of manure alone exceeded the State university's recommendations for good management and maximum net profit per acre.

Such overapplication of fertilizer results in excessive costs to the farmer, contributes to the existing shortage of commercial fertilizer and may diminish crop yield with increased applications as had occurred in a sugar beet farming area of Texas. In addition, it may result in pollution of ground or surface water.

A major problem is that many farmers are not having their soil tested to determine its nutrient value and the additional nutrients needed to grow crops. Also, the manure is not generally tested but should be because its nutrient value will vary according to the type of animal and the feed used and the manner in which the manure is collected and applied. Farmers tell us that they cannot rely on the test results.

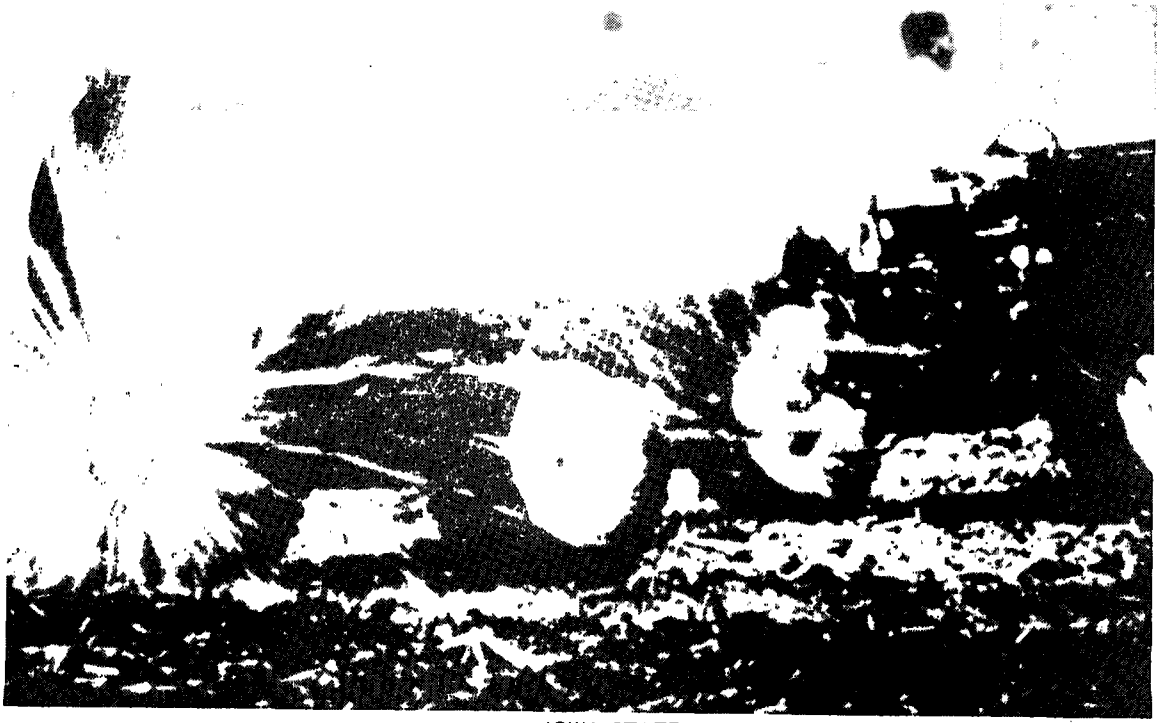
This is not surprising because samples of the same soil have been sent to different laboratories and the results, which included recommended amounts of nutrients needed, varied greatly. There are no Federal guidelines, regulations or monitoring of laboratories that perform soil and manure testing.

USDA's Agricultural Extension Service which, among other things, is responsible for providing information to farmers on the use of waste, such as manure, needs to better inform the agricultural community of (1) the benefits of utilizing manure as a fertilizer, (2) the potentially harmful effects of putting too much fertilizer and/or manure on cropland, and (3) the proper method of applying manure as a fertilizer substitute.



IOWA STATE UNIVERSITY EXTENSION SERVICE PHOTO

MANURE BEING SPREAD FOR USE AS FERTILIZER



IOWA STATE UNIVERSITY EXTENSION SERVICE PHOTO

LIQUID MANURE BEING APPLIED FOR USE AS FERTILIZER

Also, there is a need to assure the agricultural community that soil and manure test results can be relied upon.

AVAILABILITY OF FERTILIZER

In the past, the supply of commercial fertilizer was abundant and manure was viewed more as a disposal problem than as a substitute for fertilizer. This disposal attitude is reflected in a 1973 EPA report entitled "Demonstration of Waste Disposal System for Livestock Wastes" which states:

> "* * *With increasing concentration of livestock and alternative sources of fertilizer, the practice of distributing the manure on the land has become questionable from a profits standpoint. Livestock producers are faced with large volumes of wastes having low value and physical, social and economic restrictions which limit the feasibility of recycling animal wastes through the soil.* * *"

This attitude has been changing, however, with the rise in price and limited supply of commercial fertilizer. Interest has been renewed in using manure as fertilizer. Increased substitution of manure for commercial fertilizer has potential for reducing domestic commercial fertilizer consumption and thereby increasing fertilizer exports to less-developed countries that may be encountering severe shortages of fertilizer and food.

Use of commercial fertilizer in the United States reached a record 46.6 million tons for the year ending June 30, 1974. This was due primarily to an increase of crop acreage. The three major fertilizer elements are nitrogen, phosphorus, and potassium. The supply of nitorgen and phosphate fertilizers, both in the United States and the world, is currently tight and nitrogen is expected to remain so until 1977 or 1978.

In October 1973, the retail price of anhydrous ammonia fertilizer (nitrogen) was about $103 per ton and the price of potassium chloride fertilizer was about $68 per ton. By September 1974 the price of anhydrous ammonia had increased to about $247 per ton or about a 140 percent increase. Phosphate fertilizer had increased by 85 to 91 percent (to a range of $179 to $229 per ton); and potassium chloride fertilizer had increased by 51 percent (to $103 per ton).

The 1974 world nitrogen production was 40.7 million tons, and consumption was 38.8 million tons. The narrow margin between supply and demand may cause shortages because of logistic problems, delays, and other market imperfections.

Developed regions of the world produce more than they need, while the less-developed countries in Latin America, Africa and Asia must import nitrogen. The United States is currently a net exporter of nitrogen. Expansion of domestic production is expected to be limited because of the short supply of natural gas used in the production of anhydrous ammonia, the primary form in which nitrogen fertilizer is applied to the soil.

In 1974 an estimated 2 million tons of nitrogen was available from manure in the United States. However, in the handling and application of the manure about half was lost before becoming available for use on cropland.

World phosphate production was 25.2 million tons for 1974 with demand at 24.2 million tons. As with nitrogen, the tight supply will keep upward pressure on phosphate prices. The main exporters of phosphate are Eastern Europe, Russia, and the United States, and the importing areas are Latin America and the developing countries in Asia. The United States accounted for over 30 percent of the world's phosphate exports in 1972.

Potash, as with phosphate and nitrogen, was in tight supply--21.0 million tons--to meet 1974 world demand of 20.6 million tons. Production of potash is concentrated in North America, Europe, and Russia. Significant importers of potash are Latin America, developing Asia, Japan and the United States. Over one-half of the potash used in the United States is imported from Canada.

The recent United Nations' World Food Conference in Rome identified fertilizer shortages as one of the factors contributing to the world food shortage and hindering efforts to increase food production. It suggested increased use of organic fertilizers, such as animal manure, as one means of alleviating the fertilizer shortage.

It has been estimated that for each $1 worth of fertilizer developing countries are unable to import they will have to import $5 worth of food a year later. With world food and fertilizer supplies tight, the efficient use of manure becomes increasingly important.

FARMERS ARE NOT REALIZING THE FULL POTENTIAL OF USING MANURE AS FERTILIZER

To determine current waste practices we interviewed livestock operators and farmers in Iowa, Texas, Minnesota, and California. These States were selected because of their

large livestock production and varied climate. Meat processors in Iowa and Minnesota were also contacted along with stockyards in St. Paul, Minnesota, to determine use of manure at these facilities. Our review showed that many farmers are not sufficiently aware of the value of manure's fertilizer elements or of the methods of using it effectively.

Iowa

Agriculture is the main industry in Iowa and in 1973 it led the Nation in corn production for use as feed grain. Iowa was second to Texas in the number of cattle and calves on feed as of January 1, 1975.

We obtained information on 55 beef and swine feeding operations. Manure was being used on cropland farmed by the feedlot operators in all 55 operations. Application of commercial fertilizer, however, was not reduced when manure was used in 21 (38 percent) of the operations. Therefore, the full potential of the manure nutrients was not being realized.

For 9 of the above 21 operations, we estimated the amount of nutrients in the manure being applied to the soil based on information obtained from livestock producers. The amount was then compared by a professor at Iowa State University to the University's recommended nutrients for good management and maximum net profit per acre. In all instances the application of manure exceeded the recommended amounts of phosphate and potash fertilizer. Nitrogen recommendations were exceeded in two of the nine operations.

These levels were exceeded by just manure applications. The overapplication of manure was compounded by the application of commercial fertilizer--also in all instances. With application of commercial fertilizer, eight of the nine operations exceeded the recommended nitrogen application level. These examples are significant because they illustrate inefficient use of nutrients in manure and application of commercial fertilizer when not needed.

This lack of consideration for manure nutrients was demonstrated by a feedlot operator who raised an annual average of 450 beef cattle. Manure from the lot was spread on 70 acres of land and no reduction was made in applying commercial fertilizer. The nutrient levels of manure and commercial fertilizer applied in pounds per acre and those recommended by Iowa State University are presented below:

	Nitrogen	Phosphorus (phosphates)	Potassium (potash)
Manure nutrients	105	265	175
Commercial fertilizer	80	40	20
Total nutrients applied	185	305	195
Recommended application for soil testing very low in phosphates and potash	150	120	100

Standard recommendation for soil planted in corn.

From questioning livestock operators, we found that 36 or about 65 percent of the 55 livestock operators received no waste utilization information from USDA's Agricultural Extension Service and 91 percent did not know the contents of the manure, which is essential for efficient application. In the surveyed area, the Extension Service had one person providing waste utilization information to operators. This specialist was responsible for a 10-county area and had other areas of responsibility besides waste use. Hence, only a small percentage of his total time was spent in this area.

California

In January 1974, California ranked fourth in the United States in the total number of cattle and calves on feed. In the first part of 1973, it had almost 4 million head of beef cattle of which about 1.2 million were kept in confined feedlot facilities. As of January 1975, the number of cattle in feedlots had dropped to about 600,000.

We visited 10 feedlots in the Imperial and San Joaquin Valleys and obtained information from 5 farm operators who were using manure from the feedlots. Manure from all 10 feedlots was being applied to the cropland of 11 farming operations owned either by the feedlots or by farmers obtaining manure from the feedlots. As in Texas, middlemen now purchase and remove manure from feedlots whereas, in the past, feedlot operators had to pay for removal of the manure. Feedlot operators were receiving $1 to $4 a ton for manure.

A bulletin from the University of California Extension Service recommends that no more than 10 to 15 tons of manure (dry weight basis) per acre be applied per year in the Imperial Valley. We used this as a guide to determine the effectiveness of operators' applications of manure. For the 11 farming operations where the manure was spread, 4 operators stated that they applied more than 15 tons. One operator

told us he simply disposed of manure on the land available which resulted in applications of 30 to 50 tons per acre. Of the 11 farm operators, 4 made no reduction in their commercial fertilizer.

Three operators stated that they rely on past experience in applying the amount of manure to cropland, and 6 of the 11 operators said that USDA or the State Extension Services were not their main source of information on waste utilization. The operator mentioned above who was applying 30 to 50 tons of manure per acre had no contact with the Extension Services.

Texas

As of January 1, 1975, there were 1,327,000 cattle and calves on feed in Texas feedlots. Texas ranks first in the United States with 3,899,000 marketed in 1974. In 1973 feedlots in the Texas High Plains region produced over 3 million tons of manure--sufficient to meet the estimated fertilizer requirements for 300,000 irrigated acres.

In the High Plains region of Texas, as in Iowa, the practice of spreading manure on land was the general utilization method; however, the large feedlot operators often did not have enough land for spreading. In these cases, manure was often hauled by middlemen from the feedlots and sold to farmers. Until mid-1973, feedlots paid to have manure hauled away, but the rising price of commercial fertilizer increased the value of manure. Now middlemen are paying feedlot operators for the manure.

We found feedlot operators and farmers who used manure were making overapplications of manure in 4 out of 14 cases. In 2 of the 4 cases of overapplication, use of commercial fertilizer had not been reduced. Five operators were making applications consistent with USDA recommendations. At another five operations we were unable to determine the efficiency of the practices of the operators. In 10 of the 13 cases, the manure had been analyzed for nutrient value.

The efforts to provide information on animal manure use by the Extension Service in this area have been mainly through an association for the cattle-feeding industry. This association's most recent effort was an information program in late 1973 to advise operators on the use of manure.

Minnesota

During 1973, Minnesota led the Nation in turkey production by raising 23,323,000 turkeys, and 520,000 turkey breeder hens. These birds produce over 19 million cubic feet of

manure for disposal in 1 year. Poultry manure contains about twice the nutrients of other livestock manures.

We were able to calculate the approximate nutrient value of manure applied by 10 of the 17 operators and farmers contacted by us. Of these 10, half were exceeding the University of Minnesota's recommendations for nitrogen and potash. Phosphate levels were exceeded in 9 of 10 instances. One operator stated that his corn yield had actually been retarded by high levels of phosphate. All but one of the farmers contacted reduced or eliminated application of commercial fertilizer when manure was used.

It is difficult to estimate the specific amount of nutrients in turkey manure because of moisture content, amount of litter used, and manure application methods. One turkey manager told us research needs to be done in the value of manure as it comes out of the barn, and the value of manure has to be demonstrated to the farm operators.

Over half of the 17 farmers and growers surveyed received no waste utilization information from the Extension Service.

Meat processors and stockyards

Manure is generated at processing plants by animals awaiting slaughter and at stockyards where animals are sold. We contacted four meat processors in Iowa, two in Minnesota, and a stockyard in Minnesota.

Various byproducts, such as sausage casings and animal feed supplements, are produced when cattle and hogs are slaughtered and processed. One processing plant manager told us byproducts are very important to the overall profit of his plant, and they could mean the difference between profit and loss. Manure, however, was not one of the byproducts being used at the plants. One plant paid a contractor to haul manure away and the contractor then dried and bagged the manure to be sold as fertilizer. At another plant, the manure was used as fertilizer by a farmer who had fields located nearby. The four other meat processing plants simple disposed of the manure in local landfills, dumps, or the local sewer system or had the manure hauled away and therefore did not obtain any benefit from the manure nutrients.

Officials of the St. Paul stockyards estimated that 30,000 tons of manure are generated each year. A large portion, 90 percent, of this manure is straw and hay which comes from bedding and feed used at the stockyards. About

8,000 tons of this manure is given away to local truckers who supply it to vegetable gardeners. The truckers who haul the manure to the vegetable gardeners are paid between 75 and 80 cents a ton. Any other potential users can get it free at the stockyards where it is loaded for them by the firm's equipment. Manure that is not hauled away is stockpiled for an average of 2 years thereby increasing the potential for pollution from runoff from the manure. The stockyards have tried to incinerate some manure but the manure was not being burned at a fast enough rate to justify the cost of the fuel. Refeeding manure was also tried at the stockyards, but this also was determined to be uneconomical. The operators of the stockyards and processing plants viewed manure as a disposal problem rather than an underutilized resource.

NEED TO IMPROVE THE RELIABILITY OF SOIL AND MANURE TESTING

Because of the variabililty of the fertilizer nutrient value of manure and the need to use the most effective and economical levels of manure application, soil and manure testing are essential.

Our review has shown that the results of soil and manure analysis received from different laboratories vary greatly. Recommendations for fertilizer applications based on the soil test also vary by laboratory. The Federal Government has not addressed this problem.

Soil testing laboratories can be classified as either public, commercial, or private. The public laboratories are those affiliated with a university or educational institution which tests soils and conducts soil research. Private laboratories are those owned by companies which usually sell fertilizer.

Laboratories classified as commercial rely on fees charged for their soil testing. Although not owned by fertilizer companies, commercial laboratories may rely on them as their main customers. There has been a trend away from soil testing at public laboratories to commercial and private laboratories.

The methods used to extract amounts of a nutrient from a soil may vary between laboratories. For example, there are at least four different chemical solutions for extracting phosphorus from test soils. Because of such variations, test results vary among laboratories.

The most serious type of variation occurs when laboratories give recommendations for amounts of fertilizer based on soil test results. Checks have been made by farmers'

cooperatives and at the University of Minnesota on variations in recommendations by splitting soil samples between laboratories and comparing laboratory analyses of the same sample. Recommendations sometimes varied significantly and, in some cases, fertilizer was recommended when the soil test showed that high levels of fertilizer elements already existed in the soil.

We contacted officials of 22 farmers' cooperatives and grain elevator companies in Iowa and Minnesota and found that 10 of the cooperatives and elevators that send samples to more than one laboratory noticed variations in the recommendations received. Seven cooperatives and elevators sent split samples to different laboratories. All seven of these had noticed variations in recommendations received. Below are the recommendations from one of these tests:

Fertilizer Recommendations

Lab	Nitrogen	Phosphate	Potash
1	158	65	38
2	170	95	185
% difference	7.6	46.2	386.8

The elevator official who received the above results felt that there was little use in soil testing if the anlyses were not accurate. Another elevator official informed us that as a service to farmers, the elevator advertized it would pay for soil testing. The elevator representative felt this program has not been very successful; farmers had lost faith in soil testing because of the variations in analyses and recommendations.

We examined the soil test reports for eight of the nine Iowa operations, which had not reduced commercial fertilizer application when applying manure to their land. In six of the eight reports, fertilizer was recommended although it was not needed according to Iowa State University. For example, a commercial laboratory analysis of four of these samples showed that very high levels of phosphate and potash were in the soil and, according to the University laboratory, no additional phosphate or potash was needed. The commercial laboratory, however, recommended additional applications of phosphate and potash.

If the recommendations are followed, and if the University laboratory's findings are correct, the farmer is likely wasting his money and fertilizer element levels may build up and retard crop growth.

Effective soil testing is needed for efficient application of commercial fertilizer and the absence of such tests may result in overapplication of fertilizer. In Texas a voluntary soil testing program was started by a sugar beet plant in 1970. Some initial tests showed the nitrogen content of the soils tested at levels of 2,000 pounds per acre with 360 pounds per acre being the maximum needed.

The technical advisor for this program indicated most growers had never had the soil tested before the program and in the past there has been extensive overapplication of fertilizer on Texas soils he is familiar with. He also stated that overapplication of nitrogen will result in reduced yields of sugar content in beets.

CONCLUSIONS

Inefficient manure use practices were observed in Minnesota, Iowa, Texas and California. Specifically, these practices were overapplication of manure to cropland and wasteful application of commercial fertilizer on manured land. Correction of these inefficiencies could help ease the tight fertilizer supply, result in more efficient and less harmful use of current fertilizer supplies, and help avoid decreases in crop yield.

At a minimum those farmers in a position to use manure as fertilizer should have (1) clear knowledge of the nutrient benefits that will be realized from applying manure to cropland, (2) knowledge of the potentially harmful effects, such as retarded crop growth, from putting too much fertilizer or manure on cropland, and (3) knowledge on how to determine the proper amount of manure to be used as fertilizer for crops and whether supplemental commercial fertilizer is necessary.

Because there is no control over soil testing laboratories' analysis methods and recommendations, the analysis results and recommendations vary. Our review has shown that because of these variances many farmers apply both manure and highly priced commercial fertilizer, without basic data essential in applying fertilizer efficiently, effectively, and safely. There is a need to assure the farmers that soil and manure testing can be relied on. This assurance could be provided through certification of laboratories and a standardized program of laboratory procedures.

AGENCY COMMENTS AND OUR EVALUATION

In a preliminary report, we suggested that the Secretary of Agriculture require the Extension Service to conduct an aggressive program emphasizing to the agricultural community the benefits that can be achieved by more effectively using animal manure.

In a letter dated January 29, 1976, USDA stated that it has reasonably good guidelines for land application of manure and supplementary requirements for commercial fertilizers. It said that a significant amount of data was available on the nutrient content of manures but unfortunately farmers do not use these data to the extent possible.

USDA also stated that:

> "As the cost of commercial fertilizer has increased and there has been increased concern about pollution from animal waste, the Extension staff has devoted more attention to educating farmers on the benefits of proper utilization of manure in crop production."

We recognize that there is good data available to aid the farmer in making decisions regarding the management of manure. During our review, however, we concluded that the efforts of the USDA Extention Service to provide these data to farmers were inadequate considering the practices observed and the lack of knowledge of the value of manure. Waste use was only one of several agricultural topics in which the Extenstion Serivce was involved. A USDA official had informed us that, because the Department has an educational responsibility, increased effort by the Extension Service to inform the farmer of the value of manure and the methods of using it as fertilizer might be possible.

After receiving USDA's comments, we again contacted some of the individuals we had interviewed during our review; we were told that little or no action had been taken to provide farmers with better manure management information. We continue to believe that the Extension Service should conduct a more aggressive outreach program to provide such data to the farmer.

We also believe that the Secretary of Agriculture should promulgate guidelines for operating soil and manure testing laboratories and consider the need for a laboratory certification system which would enable the agricultural community to rely on certified soil and manure testing laboratories.

In commenting on our suggestion, USDA stated that there may be some basis for the attitudes of farmers and officials of agricultural cooperatives who do not have their manure or soil tested because the tests cannot be relied upon. USDA pointed out that laboratories use different methods to arrive at recommendations, that there was considerable judgment involved, and that consequently some variability would be expected in recommendations.

USDA stated, however, that it had no specific legal authority to certify soil testing laboratories or to establish standards for testing and that a program for certifying and monitoring testing laboratories was a logical State responsibility. USDA pointed out that efforts toward standardization had taken place, particularly on a regional basis, and that a few States have soil testing laboratory certification programs, primarily for private and commercial soil testing laboratories. Our review has shown that testing of soil samples was not restricted to the State in which the sample was taken and therefore any solution must take the interstate nature of soil testing into consideration.

We believe that USDA needs to further study the question particularly in view of its statement that there may be some basis for the reluctance of farmers to have their soils tested. During its consideration it should study and build upon these ongoing efforts at standardization. Upon conclusion of its study, USDA should seek appropriate legislative authority from the Congress if it is deemed necessary.

RECOMMENDATIONS

We recommend that the Secretary of Agriculture:

--Require the Extension Service to conduct an aggresive outreach program to emphasize to the agricultural community the benefits that can be achieved by more effectively using animal manure as a substitute for, or supplement to, commercial fertilizer and the proper methods of doing so.

--Explore various alternatives for standardizing laboratory soil and manure testing, including the feasibility of a laboratory certification system, so that the agricultural community can use such testing to assist in operating in a more productive and economical manner.

CHAPTER 3

ALTERNATIVE USES OF MANURE NEEDED

Although the primary use of animal manure has been as a fertilizer, it is a valuable byproduct and offers potential as a source of energy and as feed for cattle, sheep, and poultry.

Our visits to over 100 feedlot operators and farmers showed that, since mid-1973, operators have generally been able to dispose of accumulated animal manure to farmers for use on cropland. Disposal by this method can become a problem, however, when there is an excess supply of manure or too little land for application as occurs at meat processing plants and stockyards in urban areas. In addition, the larger feedlots (up to 120,000 head of cattle), now operating at about 50 percent capacity, may have a disposal problem when operating at full capacity.

For these reasons we believe that there is a need to develop alternative disposal methods whereby manure can be used as a resource. One of the purposes of the Resource Recovery Act of 1970 (Public Law 91-512) was to promote a national research and development program for, among other things, the recovery of energy and materials from solid waste. Responsibility for the administration of activities under this act was placed with the Administrator of EPA.

The Energy Reorganization Act of 1974 (Public Law 93-438) placed responsibility for development of new sources of energy with ERDA. In commenting on our preliminary report, ERDA informed us that it's energy-from-waste program has been funded and that it intended to pursue development of processes to generate energy from solid wastes including manure.

EPA has recognized on a number of occasions the need to develop alternative uses but has expended only minimal research effort toward this end. During fiscal years 1973 and 1974, EPA funded projects totaling about $1.1 million under its Animal Feedlot Wastes Research Program. Of this amount about $170,000 or 15 percent of the funding was for five projects, all of which were laboratory type studies concerned with using animal wastes for purposes other than for land application. These projects dealt with the nutritional and pathological effects of feeding feedlot wastes to beef cattle, the conversion of cattle feedlot waste to ammonia synthesis gas, the production of methane gas from feedlot wastes, and the conversion of cattle manure to useful

products through pyrolysis. EPA does not plan to fund these projects in the pilot and demonstration stage, which is necessary to fully develop these promising methods.

An official of EPA's Office of Research and Development informed us that, because of the designation of land application as the best practical control technology currently available to abate pollution from animal waste, EPA's future research and development efforts in the animal waste program would be on environmental effects of land application of manure.

Broken down, the 14 land application projects funded during fiscal years 1973 and 1974 were for treatment and disposal of animal wastes ($268,000 for 4 projects), information dissemination activities ($107,000 for 2 projects), development of waste management systems ($190,000 for 2 projects), pollution and runoff abatement studies ($125,000 for 2 projects), and studies relating to land application of manure as a fertilizer ($180,000 for 4 projects).

In some cases land application of manure is not a viable option because of a lack of adequate farm land within an economically feasible distance of the feedlot, stockyard or meatpacking plant. In these instances an alternative method of using the manure should be developed. Some potential alternatives are discussed in the following sections of this chapter.

METHANE GENERATION

Anaerobic (oxygen free) fermentation of animal manure produces methane gas. When this process is carried out under controlled conditions the gas can be collected, cleaned to remove carbon dioxide and hydrogen sulfide which are also produced, and compressed for use as a substitute for natural gas. After fermentation the residue remaining retains most of the fertilizer value and can be dried and used as fertilizer or soil conditioner.

From 60 to 125 cubic feet of methane gas, having a heating value of about 600 Btu per cubic foot, can be produced from 100 pounds of fresh manure. Methane production plants have been used for many years, particularly in Europe during World War II fuel shortages. Use of such systems has been decreasing primarily because of the high initial cost of the plants and the supervision required. However, with the current shortage and increased cost of natural gas, and the increasing cost of fossil fuels, methane gas generation may warrant further consideration and development.

Two privately financed methane generation plants are being planned. One is to be constructed in Deaf Smith County, Texas in 1976. Contracts have been negotiated with several feedlots in the county to provide manure for the plant. The other plant is to be built in Western Oklhoma by 1976 and is expected to produce 640 million cubic feet of methane from 73,000 tons of manure annually. A commitment has been obtained from a gas pipeline company to purchase the gas. Plans for a third methane generation plant to be built near a large feedlot in Colorado have been delayed and will probably be canceled because of the inability to sell necessary revenue bonds. This plant was to have used solar energy to provide the heat needed in the methane generation process and was to have also used sewage sludge from a small community near its proposed location. Necessary approvals had been acquired from the State and purchase commitments for the gas produced had been negotiated. Options were acquired on the necessary land; however, these have now expired. With the failure to sell the revenue bonds because of market conditions, sufficient capital was not available.

ERDA and USDA are jointly sponsoring a project at Clay Center, Nebraska, to build a pilot plant which will use animal manure to produce methane gas and a cattle feed supplement. During fiscal year 1976 ERDA provided $150,000 and USDA provided $50,000 for this project. ERDA expects to provide an additional $150,000 during fiscal year 1977.

PYROLYSIS

When manure is subjected to high temperatures for a period of time in the absence of oxygen it can be converted to gases, oil, and a residual solid all of which can be used to generate energy. This process is called pyrolysis. The oil produced in this manner is low in sulphur and has a heating value of about 15,000 Btu per pound. The low level of sulphur in this oil would make it valuable in firing boilers or in other situations where a potential for air pollution exists. The gas produced has a heat value of about 500 Btu per cubic foot and can be used to provide the heat required for the pyrolysis system or can be used as an industrial heat source. The gas cannot be used for home heating because it does not burn properly when mixed with natural gas and has a carbon monoxide content exceeding current safety standards.

The residual solids have a heating value of up to 13,000 Btu per pound, which is similar to many coals and, as with the oil and gas produced, is low in sulphur.

INDUSTRIAL PRODUCTS

The quantities of gas, oil and residue produced by pyrolysis can be varied by changing the temperatures at which the manure is pyrolyzed. At higher temperatures more gas is produced, less oil is produced and the residue has a higher carbon content. Experiments have been conducted at the University of California at Los Angeles in producing industrial products from the residue. Carbon black, which is normally produced from natural gas, can be made from carbon residues and used in the manufacture of such commodities as ink and rubber products. Other industrial products, such as foam insulation and ceramic tile, can be manufactured using the residue and crushed glass.

EPA provided partial support for this project during fiscal year 1974 with a grant of $29,453. However, an EPA official informed us that no further support will be given to this project because of the current emphasis being placed by the agency on land application of wastes.

At the present time the laboratory pyrolysis unit at the university is operating on a batch basis and can pyrolyze only a small amount of manure at one time. The next step in this research would be to convert to a continous process which could process about 50 pounds of manure in an 18 to 24 hour period. Using 50 pounds of manure the system should produce 10 pounds of oil, 30 pounds of residue and an aqueous solution high in nitrogen which could be made into fertilizer. With these larger quanties of oil and residue produced from a demonstration project larger quantities of products could be produced for testing and market development.

HIGH PRESSURE CONVERSION TO OIL

Experiments have been conducted by the Bureau of Mines, Department of Interior which produces oil from organic wastes including manure, by subjecting the wastes to high temperatures, (350 to 400 centigrade) and high pressure (about 2000 to 5000 pounds per square inch) with carbon monoxide, water, and various catalysts. Using this process about two barrels of low-sulphur oil having a heating value of 14000 to 16000 Btus per pound can be produced from a ton of dry organic material. About three-fourths of a barrel of the oil produced would be used in providing heat for the system.

While this system has been used to process manure on a laboratory basis the pilot plant which is currently being built is primarily designed to process waste from the lumber industry.

AMMONIA PRODUCTION

Anhydrous (water free) ammonia is a major form in which nitrogen fertilizer is applied to the land. Almost all ammonia is produced from a synthesis gas manufactured from natural gas. This synthesis gas can also be produced from manure by a process which is still in the laboratory stage of development. This process could produce about 700 pounds of ammonia from a ton of manure. The residue remaining after ammonia production consists mostly of potassium, calcium, and phosphate salts which could also be recovered for use as fertilizer.

Research in developing this process had been conducted at Texas Technological University with support from EPA grants of $23,960 in fiscal year 1973, $39,000 in fiscal year 1974, and $40,000 in fiscal year 1975. EPA support for this research terminated with the 1975 grant. An EPA official informed us that this project has reached the stage where pilot plant testing would be desirable.

MANURE AS ANIMAL FEED

Numerous experiments have been conducted in the feeding of treated manure as a portion of the animal feed for cattle, sheep, and poultry. EPA has recognized three refeeding technologies which the agency feels may be available to aid in properly disposing of animal manure. These technologies are:

"Wastelage-A technology in which cattle manure is ensiled along with standard feed ingredients and refed to cattle. This is a partial treatment utilizing 40%-50% of the available waste. The required land for spreading of the remaining waste is reduced and there is the potential for reducing the cost of production. The technology of wastelage has been demonstrated over the past eleven years with a total of over 300 head of cattle. The lack of Food and Drug Administration (FDA) approval for the use of manure or the products from manure for refeeding is a restraint upon the large scale commercial acceptance of this technique."

"Dehydration With Refeed-A technology in which poultry manure is thermally dried and used as a feed ingredient in the diet fed to poultry. This is a partial treatment utilizing 50%-75% of the available waste. The land required for spreading of the remaining waste is significantly reduced and there is the potential for reducing the cost of production. The technology has been demonstrated by refeeding for over one full year with a 400 bird flock of laying hens."

"Oxidation Ditch With Refeed-A technology which utilized the mixed liquor from cattle and swine oxidation ditches as an animal feed ingredient. This is a partial treatment utilizing about 40% of the oxidation ditch effluent. The required land for spreading of the remaining waste is reduced and there is the potential for reducing the cost of production. This technology of oxidation ditch mixed liquor refeed has been demonstrated over the past two years in five feeding trials and over 400 animals."

In addition, the following refeeding technologies represent potential alternatives for using manure.

Manure has been processed by being seeded with fly eggs and aerated with heated, dried air. During a period of about 5 days the fly eggs hatch and the larvae tunnel through the manure using it as food. The manure is then spread on a screen and the surface is exposed to a bright light, which drives the larvae through the screen into a dark box where they pupate (enter a nonfeeding, immobile state of development). They are then ground and dried to form a high protein meal which can be used for animal feed. The material remaining can be marketed as a soil conditioner. The protein meal is about 63.1 percent protein, 15.5 percent fat, 3.9 percent moisture, 5.3 percent ash and 12.2 percent other constituents. The process has been sucessfully applied to manure from several types of animals in the laboratory.

All of the refeeding technologies mentioned above are limited in their potential for large scale use because the Food and Drug Administration has not approved manure or manure products as animal feed.

During fiscal year 1973, EPA expended $7,500 for a project at Oklahoma State University to determine the nutritional and pathological effects of feeding feedlot waste to beef cattle. In fiscal year 1974, EPA expended $30,934 at the same university, on a project to study the accumulation of indigestible residue and nutritive value of recycled animal waste.

COMPOSTING

Composting is a method of decomposing organic wastes which produces a pathogen free, humus-like product that can be used as a soil amendment to improve soil qualities. The process reduces the weight of the manure with one ton of manure producing about 745 pounds of compost. The compost is of uniform consistency, retains much of the fertilizer value of the manure, and can take place under either anaerobic

(oxygen free) or aerobic (oxygen present) conditions.

In anaerobic composting the decomposition of the wastes is accomplished by bacteria which grow when oxygen is not present. In this type of composting the manure is stacked in piles and left to decompose. In aerobic composting the decomposition process is performed by bacteria which require oxygen to live. Aerobic composting is accomplished by stacking the manure in rows and turning the rows periodically to add air or by forcing air through the manure with pumps.

Anaerobic composting results in less loss of nitrogen and organic matter than does aerobic composting; however, a strong odor is produced which makes aerobic composting a more desirable procedure. An additional advantage of the aerobic method is that the higher temperature developed during decomposition destroys any weed seeds which may be present in the raw manure. This makes the compost more acceptable to those farmers reluctant to use raw manure because of the possiblility of weed seeds being present.

CONCLUSION

EPA's animal waste research program has been concentrated on the land application of the manure both as fertilizer and as a means of disposal. Although EPA has recognized the existence of various potential alternatives to land application it has expended only minimal effort in developing these alternatives through small grants for laboratory research.

An EPA official responsible for the Animal Feedlot Waste Research Program told us that EPA funded projects for ammonia synthesis gas production and production of useful products through pyrolysis were both at a stage where pilot plants have become necessary to test on a larger scale the results achieved in the laboratory. However, EPA officials said that EPA does not plan to proceed further with these methods.

As discussed in chapter 2, our review identified several confinement operations, particularly holding pens for several meat packing plants which, because of their location in an urban area, were unable to dispose of accumulated manure to farmers for use as fertilizer. For these operations and for the large feedlots which may have disposal problems when operating at full capacity (currently operating nationally at about 50 percent) the various experimental technologies for manure use represent potential methods of solving the disposal problem. We believe that more research effort should be directed toward bringing such technologies to a

commercially acceptable level of development including the determination of economic feasibility of the various alternatives. Of particular importance is the development and acceptability of those technologies, such as ammonia synthesis, which have shown promise in the laboratory but must now be tested on a larger scale to prove their practical commercial value.

AGENCY COMMENTS AND OUR EVALUATION

In commenting on our report (see app. II) EPA stated that:

> "We support the general concept of resource recovery from all waste products, not just animal manures. However, we are not convinced that resource recovery for animal manures, other than through land application, is economically and technically feasible at this time."
>
> "Our research program, as pointed out in the study, has supported development of resource recovery technology. An ongoing technical review and analysis, however, continues to support our decision to place a majority of our resources in development and demonstration of environmentally acceptable land application management tools The two basic reasons for this emphasis are (1) our studies indicate the majority of the animal manure problem will probably be solved using the land application approach and (2) our preliminary studies have not seen any major technological breakthroughs which overcome the problems associated with the new technology required for the resource recovery alternatives."
>
> "In our judgment, the large investment required for the development and demonstration of these resource recovery alternatives is not justified at this time. We recognize the forces external to our program, such as increased natural gas and/or fertilizer prices could change the economic and technology factors governing our decision. However, until a clear signal is received, either from our own or knowledgeable outside studies, we will continue to restrict the allocation of our limited resources in this area. It is imperative that over the short range we utilize our limited resources in a manner that will provide the most comprehensive and useful program output, i.e., management criteria for land application of animal and poultry wastes."

ERDA concurred (see app. III) with our conclusion that experimental technologies for manure use should be considered for further development and stated that:

"In consideration of the distinct mission of ERDA, created to provide national leadership for energy-related research programs and their development through commercial scale demonstrations, the appropriate location for reserarch continuance or furtherance of energy-from-wastes programs is in the ERDA. Since EPA's stated best research effort in this area is on land disposal, consistent with its distinct mission to protect the environment, I believe a satisfactory partitioning of potentially overlapping programs may be achieved."

USDA pointed out in its comments that its Agriculture Research Service and Cooperative State Research Service, and State experiment stations have expertise, trained scientists, and experience to do research on alternative uses.

Comments by officials of USDA and ERDA indicate a belief in the potential for development of technologies for recovery of energy and materials from manure and an interest in pursuing such development. The development to a commercially viable stage of any of the various alternative technologies to land application would provide, in addition to energy and materials recovery, alternative disposal methods for those operations currently unable to dispose of their manure through land application.

While EPA's own research effort may be more profitably directed to land application, the Agency's responsibility to insure sound solid waste disposal methods including the utilization of waste, would make it responsible to coordinate the efforts of those agencies interested in and able to conduct research on alternative disposal methods such as those discussed in this report.

RECOMMENDATION

GAO recommends that the Administrators of the Environmental Protection Agency and the Energy Research and Development Administration and the Secretary, Department of Agriculture enter into a joint agreement delineating responsibilities for the disposal and utilization of animal manure and provide for adequate coordination of activities. This agreement should provide assurance that innovative research projects, such as those discussed in this report, will be given adequate consideration for development to a stage where the economic and technical viability of the technology can be determined.

APPENDIX I

UNITED STATES DEPARTMENT OF AGRICULTURE
EXTENSION SERVICE
WASHINGTON, D.C. 20250

Cooperating with Land Grant Colleges and Universities

January 29, 1976

Mr. Henry Eschwege, Director
Resources and Economic
Development Division
General Accounting Office
Washington, D. C. 20548

Dear Mr. Eschwege:

The GAO draft report entitled "Use of Manure as an Alternative to Disposal" has been reviewed by staffs of ES, ARS, and SCS. The following comments are submitted for your consideration in preparation of your final report.

On Page i, we concur in the statement that manure represents a potential problem in terms of solid waste disposal and water pollution but at the same time has significant potential as a resource from which both energy and materials can be recovered and which can be used in the production of food. Also, we concur that feedlot operators and farmers, since mid-1973, have generally been able to readily dispose of accumulated animal manure to farmers for use as fertilizer on cropland. Three factors which contribute to this have been (1) the world-wide shortages of commercial fertilizer, (2) increases in the prices of commercial fertilizer, and (3) a reduction in the number of animals being maintained in feedlots.

GAO note: Material has been deleted because of changes in final report or because of reference to material not included in our report.

We do have reasonably good guidelines for land application of manure and supplementary requirements for commercial fertilizers. [See note above.]

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A significant amount of data are available on nutrient content of manures as demonstrated by the exhibits. Manure samples can be readily analyzed in many testing laboratories.

Farmers have access to these data and laboratory services, but unfortunately, they are not using them to the extent possible. The major problem, however, lies in the great variability and the composition of manures and the soils to which they are applied. To adequately analyze these materials for the purpose of making recommendations would be expensive and require more extensive analytical facilities than we presently have. There has to be a moderate approach.

State Extension Services carry on a vigorous educational program on the fertilizer value of manures; guides are published on the nutritive value and rates of application. These are discussed in meetings, news releases, and other educational methods.
[See note on page 28.] In addition, the Soil Conservation Service provides technical assistance which includes application of manure in accordance with crop needs.

[See note on page 28.]

Page iii, and Page 5, last paragraph, and Page 7, state that farmers and officials of agricultural cooperatives do not have their manure or soil tested because the tests cannot be relied upon.

There may be some basis for this attitude; however, the soil test is the best tool available to determine the nutrient levels in the soil. It should be remembered that these laboratories use different methods to arrive at recommendations. These recommendations are based on data relating to laboratory test analyses with actual field responses. There is considerable judgement involved, and consequently some variability would be expected in recommendations. Soil is quite variable and it may be affected by other factors. It may be nearly impossible to obtain the same results from one standard soil testing procedure and testing method from all

soils across the country. In general, a soil test is used to determine the amount of nutrient available for the plant, not the total amount of nutrient in the soil. Field history is important in conjunction with the test to make fertilizer and lime recommendations which also take into account yield goals of the farmer. All the nitrogen present in manure is not immediately available for plant use

[See note on page 28 .]

There has been and is continuing to be a strong effort to improve the standardization of soil testing procedures and methods and to correlate fertilizer and lime recommendations based on these tests and field histories. The Council on Soil Testing and Plant Analysis, 2400 College Station Road, Athens, Georgia 30601, has published and distributed a handbook (November 1974), Reference Methods for Soil Testing [See note on page 28 .] Some 300 copies of this handbook have been distributed. Also, NCR-13 (North Central Region Experiment Station Committee on Soil Testing) has published a bulletin on methods for soil testing [See note on page 28 .] Standardization of fertilizer and lime recommendations has been discussed by many, particularly on a regional basis. There has been some progress in similarizing recommendations across state lines and in regions. The Southern Regional Committee published procedures used by state soil testing laboratories in the region [See note on page 28 .]

Page iii, indicates that EPA should provide increased support for innovative research projects on disposal alternatives for animal manure.

The USDA (ARS and CSRS) and the state experiment stations have expertise, trained scientists, and experience to do this research.

Page iv, recommends USDA consider the need for laboratory certification and a monitoring system which would enable the agricultural community to rely on certified soil and manure testing laboratories to aid them in increasing the productivity of their land in an economical manner.

USDA has no specific legal authority to certify soil testing laboratories or establish standards for testing. However a few states have a soil testing laboratory

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certification program. These certification programs are primarily for private and commercial soil testing laboratories, tests and recommendations. Certification and monitoring of testing laboratories is a logical state responsibility.

Page 2, first paragraph, states a major portion of the manure is generated in the larger feedlots where disposal of the manure on the farmland, within an economically feasible hauling distance, is more difficult.

Sweeten, et al., report Feedlot Manure as an Energy Source (October 1974, enclosed as Exhibit 6A, pages 2 and 8) indicates that the use of feedlot manure, where available, can also result in a significant monetary savings. These savings could amount to $15 to $20 per acre for farmers within 10 miles of a feedlot.

[See note on page 28 .]

Page 5, last paragraph states that a major problem is many farmers are not having soils tested.... also, the manure is not generally tested but should be because its nutrient value will vary by type of animal and the feed used.

It is estimated that about 25 percent of the farmers regularly test soils. According to a national survey the following table shows numbers of soil samples tested by farmers in the United States by public and private laboratories.

Year	Number of Samples Tested
1955	1,350,000
1957	1,862,463
1960	2,059,280
1968	3,537,531
1973	2,092,000
1975	2,251,277

[See note on page 28.]

Pages 7 and 8 of the report indicate that USDA's Agricultural Extension Service, which is responsible for providing information to farmers on the use of waste such as manure, needs to better inform the agricultural community of (1) the benefits of utilizing manure as a fertilizer....

As the cost of commercial fertilizer has increased and there has been increased concern about pollution from animal waste, the Extension staff has devoted more attention to educating farmers on the benefits of proper utilization of manure in crop production. If this audit were conducted today, the findings would be quite different. The Extension staff is generally equipped to help farmers solve crop and livestock production problems such as the management of manure to meet pollution control guidelines; and the utilization of manure to enhance the efficiency and economics in crop production. Examples of Extension educational materials are included in the exhibits.

Page 7, first paragraph, indicates the variability of recommended amounts of nutrients needed.

This section needs clarification. The report does not indicate whether the laboratories were in one state or different states. Different laboratories have different methods of analyses and reporting and different standards for recommendations based on local crops and conditions. (Refer to Exhibit No. 17 on uniformity, standardization, and technology: our problems and progress with soil testing and plant analysis.)

[See note on page 28.]

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[See note on page 28 .]

We sincerely appreciate the opportunity to review this draft report.

Edwin L. Kirby

EDWIN L. KIRBY
Administrator

Attachments - 1-28

APPENDIX II

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

JAN 15 1976

OFFICE OF
PLANNING AND MANAGEMENT

Mr. Henry Eschwege, Director
Resources and Economic Development Division
U.S. General Accounting Office
Washington, D. C. 20548

Dear Mr. Eschwege:

We have received GAO's proposed report to Congress entitled "Use of Manure as an Alternative to Disposal" and the following are EPA's comments on its conclusions and recommendations:

Approximately, one million dollars of our agricultural research effort is allocated for the development and demonstration of environmentally acceptable management tools for the utilization of animal and poultry production wastes. The report addresses this subject in two general areas: (1) "Need to Improve Utilization of Manure as a Fertilizer," and (2) "Need to Develop Alternatives to the Use of Manure as a Fertilizer."

With regard to item (1), we strongly agree and endorse the conclusions and recommendations set forth by the GAO reviewers. Improved uniformity in soil and manure sample analyses coupled with an intensified program for information transfer and education are consistent with our ongoing research effort. We currently have a good cooperative research program with the Department of Agriculture on animal waste studies and expect to complete within 18 months a detailed manual under an Interagency Agreement with the Agricultural Research Service for the purpose of providing planners/decision-makers and the producers information on acceptable manure management practices including an evaluation of the associated environmental impacts.

Our position relating to item (2), needs to be clearly delineated. The GAO study ".... recommends that the Administrator of EPA provide increased support... (to) develop the potential for recovery

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of energy and materials from animal manure...." We support the general concept of resource recovery from all waste products, not just animal manures. However, we are not convinced that resource recovery for animal manures, other than through land application, is economically and technically feasible at this time.

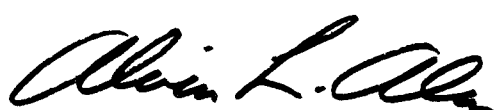
Our research program, as pointed out in the study, has supported development of resource recovery technology. An ongoing technical review and analysis, however, continues to support our decision to place a majority of our resources in development and demonstration of environmentally acceptable land application management tools. The two basic reasons for this emphasis are: (1) our studies indicate the majority of the animal manure problem will probably be solved using the land application approach and (2) our preliminary studies have not seen any major technological breakthroughs which overcome the problems associated with the new technology required for the resource recovery alternatives.

We are continuing to maintain technology awareness in this area, and will complete a current summary of these resource recovery alternatives in the Spring of 1976. This study will review the technology and economics of the most promising alternatives under development or in use.

In our judgment, the large investment required for the development and demonstration of these resource recovery alternatives is not justified at this time. We recognize that forces external to our program, such as increased natural gas and/or fertilizer prices could change the economic and technology factors governing our decision. However, until a clear signal is received, either from our own or knowledgeable outside studies, we will continue to restrict the allocation of our limited resources in this area. It is imperative that over the short range we utilize our limited resources in a manner that will provide the most comprehensive and useful program output, i.e., management criteria for land application of animal and poultry wastes.

I appreciate the opportunity you have given EPA to review and comment on this report prior to its submission to Congress.

Sincerely yours,



Alvin L. Alm
Assistant Administrator
for Planning and Management

APPENDIX III

UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
WASHINGTON, D.C. 20545

DEC 29 1975

Mr. Henry Eschwege, Director
Resources and Economic Development
Division
U. S. General Accounting Office
Washington, D. C. 20548

Dear Mr. Eschwege:

Thank you for the opportunity to review the draft report, "Use of Manure as an Alternative to Disposal," enclosed in your letter of December 8, 1975.

The report was found to be a concise, useful compilation and review of current information, practices, and data covering the subject and related matters.

My comments pertain to three distinct areas: (1) the likely quantity of manures as an available raw material for proposed utilization processes; (2) the appropriate location of federally funded energy process research, and (3) ERDA's current level of funding for agricultural wastes research.

Quantities

The report states that due principally to higher costs and lower availability of commercial (synthetic) fertilizers, satisfactory land spreading--hence utilization of nutrients--for agricultural purposes has been reinstituted. Indeed, this may be the highest use in the case of many developing countries--as was indicated. In addition, it was observed that the larger feedlots are now operating only at 50 percent capacity and the redevelopment of range-fed cattle has yet to produce its full effect on industry practices. Thus, it appears that the likely sources of "reliable" quantities of manures allocatable for utilization processes may contract to the few concentrations of urban stockyards and packing plants and some few large feedlots. Some quantification of this likelihood, if tenable, might be considered for inclusion in the final version of the report.

APPENDIX III

Mr. Henry Eschwege

Research

I concur with the the report's conclusion in which it was stated that methane generation, pyrolysis, hydrogenation, ammonia synthesis, and other "experimental technologies for manure utilization" are good candidates for development to commerical-scale demonstration. ERDA, in fact, has jurisdiction over one of the projects mentioned (hydrogenation) and is evaluating one whose sponsorship under EPA is to be terminated (pyrolysis). Our waste utilization programs are directed also at methane generation and ammonia synthesis--from manures as well as other organic waste forms.

In consideration of the distinct mission of ERDA, created to provide national leadership for energy-related research programs and their development through commerical scale demonstrations, the appropriate location for research continuance or furtherance of energy-from-wastes programs is in the ERDA. Since EPA's stated best research effort in this area is on land disposal, consistent with its distinct mission to protect the environment, I believe a satisfactory partitioning of potentially overlapping programs may be achieved.

Funding

Subsequent to the time ERDA was contacted by GAO relative to this draft report, our wastes-to-energy programs have been formulated and funded. Consequently, we are in a position to move forward at a substantial and sustained level of research effort to develop and demonstrate selected processes at a commerical scale of operations.

I hope that these comments will be of use to you in the revision of the draft report. Please do not hesitate to contact me if you have any questions.

Sincerely,

Lawrence G. Stewart, Acting Director
Division of Interprogram Applications
Office of Conservation

APPENDIX IV

Mr. Henry Eschwege

[See note on page 28 .]

We appreciate the opportunity to review this draft report and trust that our comments will be useful to you in preparation of the final report. If you have any questions, please do not hesitate to contact my office.

Sincerely,

M. C. Greer
Controller

APPENDIX IV

UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
WASHINGTON, D.C. 20545

JAN 22 1975

Mr. Henry Eschwege, Director
Resources and Economic Development Division
U.S. General Accounting Office
Washington, D.C. 20548

Dear Mr. Eschwege:

This is to supplement Mr. Lawrence G. Stewart's letter to you dated December 29, 1975, in response to your letter of December 8, 1975, which enclosed a copy of a draft report entitled "Use of Manure as an Alternative to Disposal."

As indicated in Mr. Stewart's letter, subsequent to the time ERDA was contacted by GAO relative to this draft report, our wastes-to-energy programs have been formulated and funded. We are, therefore, not in agreement with GAO's recommendation that EPA should develop alternative disposal methods, including energy and industrial uses, when land application is not practical or economical. We believe that this is the responsibility of ERDA and not that of EPA.

GAO note: Material has been deleted because of changes in draft report.

PRINCIPAL OFFICIALS OF THE ENVIRONMENTAL PROTECTION AGENCY THE DEPARTMENT OF AGRICULTURE AND THE ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION RESPONSIBLE FOR ADMINISTRATION OF ACTIVITIES DISCUSSED IN THIS REPORT

	Tenure of Office	
	FROM	To
ADMINISTRATOR, EPA:		
Russell E. Train	Sept. 1973	present
John R. Quarles, Jr. (acting)	Aug. 1973	Sept. 1973
Robert W. Fri (acting)	Apr. 1973	Aug. 1973
William D. Ruckelshaus	Dec. 1970	Apr. 1973
ASSISTANT ADMINISTRATOR FOR RESEARCH AND DEVELOPMENT, EPA:		
Dr. Wilson K. Talley	Dec. 1974	present
Dr. Albert C. Trakowski, Jr. (acting)	May 1974	Dec. 1974
Dr. Stanley Greenfield	Feb. 1971	May 1974
SECRETARY, USDA:		
Earl L. Butz	Dec. 1971	present
ADMINISTRATOR, EXTENSION SERVICE, USDA:		
E. L. Kirby	Feb. 1970	present
ADMINISTRATOR, AGRICULTURAL RESEARCH SERVICE, USDA:		
Talcott W. Edminster	Aug. 1971	present
ADMINISTRATOR, COOPERATIVE STATE RESEARCH SERVICE, USDA:		
Dr. Roy L. Lovvorn	June 1969	present
ADMINISTRATOR, ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION:		
Dr. Robert C. Seamans, Jr.	Jan. 1975	present