ENVIRONMENTAL OUTLOOK

OUTLOOK 73

UNITED STATES DEPARTMENT OF AGRICULTURE
Economic Research Service

U.S. AGRICULTURE--ENVIRONMENTAL CONTROLS AND ECONOMICS

Material for discussion by Velmar W. Davis, John Berry,
William Crosswhite, and Philip Dwoskin 1/
at the 1973 National Agricultural Outlook Conference
Washington, D.C., 11:00 a.m., Wednesday, February 21, 1973

1/ ERS Environmental Research Coordinating Team representing Office of Administrator and Farm Production, Natural Resources, and Marketing Economics Divisions, respectively.

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Introduction

We are especially pleased to have this opportunity to share with you some facts and opinions concerning the environment and economics as they relate to agriculture. For most farm commodities, as well as the future structure of agriculture, a discussion of outlook is not complete without recognition of some of the environmental factors.

Let us begin by distinguishing between ecology and environment. Both are much used terms nowadays. To many they are synonymous. But there is a difference. Ecology is a science of living things--including man--and their relationship to the air, water, and land about them. Environment in its broader sense extends beyond ecology to the interaction of living things, physical things--air, land, and water--and the institutions of society that attempt to deal with the problems of the living world.

Pollution is another term that needs clarification. It has been simply described as the problem of misplaced waste. Stated another way the physical causes of the pollution phenomenon are inefficiency of resource use and misplacement of spent resources [3]. Another concept relates pollution to disposal of residuals resulting from modern production and consumption activities. These residuals usually render disservices (like killing fish, increasing the difficulty of water treatment and reducing public health, etc.) rather than services [20].

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The concern about the ever-increasing pollution load and the desire for environmental quality is not a passing fad. Improving the quality of the environment is a national goal of the United States and many nations throughout the world. All U.S. industries contribute to our high standard of living measured in food, materials and services; but they are also contributing to the degradation of our physical environment at an increasing rate. Agriculture is certainly not excluded. Agriculture's major pollutants include chemicals (pesticides, fertilizers, feed additives, etc.), animal wastes, crop residues, soil sediment, and agricultural processing wastes. The USDA and ERS are also interested in environmental issues other than agricultural pollutions, i.e. land use, population distribution, rural development, recreation, aesthetics, wildlife, wetland use and conservation, and strip mine revegetation.

Our objective today is to provide you with a clearer perspective of the potential economic impact on agriculture of measures to improve the quality of our environment. We will begin by discussing why there is an apparent conflict within economics on environmental quality issues. Then, we will move to the real world to briefly review two major bills passed during 1972 concerning water pollution and the use of pesticides. In the remainder, and the major portion of the presentation, we will discuss the impact on farmers and agricultural processors of environmental controls and some issues agriculture will likely be concerned with as they relate to pesticides, plant nutrients, soil sediment, crop residues, animal wastes, feed additives, and agricultural processing wastes. 2/ As we discuss these agricultural pollutants, we should recognize that air, water, and noise quality controls will also have an impact on the cost structure and future organization of the input sector--for example, fertilizer, farm machinery and pesticides industries. The production costs of capital inputs are likely to be higher following implementation of pollution abatement standards.

Environmental Quality--In Perspective

Environmental problems are mainly caused because our market economy fails to reflect the cost of environmental damages. Producers have been able to take full advantage of the waste assimilative capacity of the environment. Such an approach is rational from the standpoint of producers and society only if the external costs do not exceed external benefits. In recognition of the social costs of pollution, legislation has been enacted to restrict practices which result in the degradation

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2/ The Economic Research Service has the responsibility, directed by Congress to the Department of Agriculture, "for investigation . . . . as to the effect upon the production of food and upon the agricultural economy of any proposed action . . . . pending before the Administrator of the Environmental Protection Agency (EPA)." The Food and Drug Administration (FDA) is responsible for regulations concerning use of feed additives.

of the environment. There is an urgent need for the public to understand the economic benefits that pollution abatement will achieve and the relationship of environmental benefits to costs.

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Environmental problems are mainly rooted in the way that our market economy has traditionally operated--its failure to reflect the cost of environmental damages [12]. This has enabled producers to take full advantage of the waste assimilative capacity of the environment. We would expect producers to use this capacity and society to allow its use as long as it was benefit maximizing.

Some costs are not considered in price determination and include, for example, the cost to society for damage to wildlife population or to human health from the use of pesticides. It follows then that agricultural products on which pesticides are used are underpriced and consumption of these products is higher than if all costs were included. As a result, too many resources are devoted to production of those items of food and fiber on which pesticides are used as compared with production on which there are fewer or no external social costs.

Another way of attempting to place the environmental quality issue into perspective is to outline conceptually the difference between farmers' and society's view of the pollution question. When we consider restricting farmers' use of pesticides or the way in which they dispose of animal waste, we are implicitly saying that the social costs (hazards to health and natural environment) of these practices have exceeded the social benefits (larger supplies of food and fiber and protection from the adverse effect of the natural environment). We are implying that we no longer have an optimal use of pesticides or optimal manure disposal practices from the standpoint of society. We are saying that it is no longer acceptable for farmers to apply pesticides or to dispose of their livestock manure without regard to the effect of these practices on the quality of the farm environment or total environment.

Let us illustrate the conflict between farmers and society in the use of pesticides by examining a typical production-price relationship (Figure 1). The pesticide input is shown on the x axis and the output of the crop is shown on the y axis. The slope of the price line CD is the price of the pesticide divided by the price of the crop. Its tangency with the production function at point I indicates that the optimum quantity of pesticides from the farmers' point of view is OB since he does not include the social costs in his computations. This may be substantially in excess of the socially optimal level OA. By including social costs, as well as the costs of pesticides, in computing the slope of our price line EF, the price line becomes steeper and thus our socially optimal level of pesticide usage is considerably lower. Only if there are not externalities or social

OPTIMAL USE OF PESTICIDES
by
FARMERS AND SOCIETY

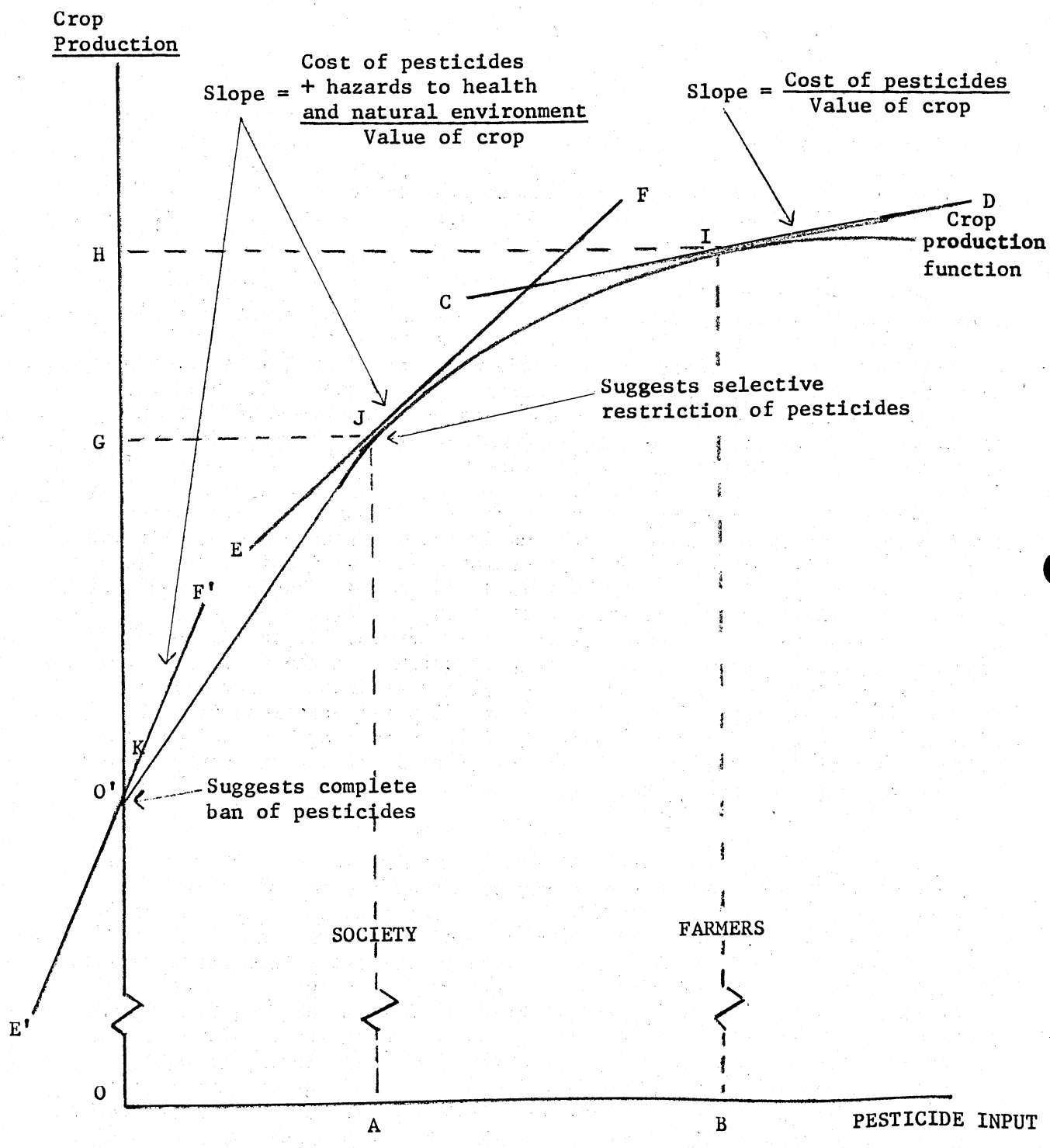

Figure 1

costs would the optimum levels of pesticide use for these two groups coincide. The socially optimal level of OA would suggest selective restriction of pesticides rather than a complete ban. The price line, E'F', influenced by extreme external costs, suggests that all pesticides should be banned.

The value of social costs from the use of pesticides varies with the economic development of the country, U.S. vs India, for example, because of different levels of technological development and input use. In a developing country such as India, the actual use of pesticides by farmers may be less than optimal from the standpoint of society.

One caution is that society is composed of individuals, many of whom do not recognize the social costs. If they do not recognize these social costs, they may compute their optimal level similar to farmers and feel disadvantaged by the restriction if it results in higher prices for needed items, food in particular. One solution to this problem is to increase the awareness of members of society to these social cost factors. This indicates the need for a more open flow of information to people concerning both the hazards and benefits of pesticides and other farm practices.

In an attempt to recognize the social costs of pollution in the United States, legislation has been enacted or proposed to restrict the uses of selected resources and the practices used in disposing of agricultural wastes. We have not been very successful in quantifying hazards or social costs from agricultural pollutants. And as a result, proposed actions to abate pollution have been described as inadequate, expensive and even unnecessary. Measures of agricultural pollution are, therefore, needed for an understanding by society of the costs and benefits of environmental controls.

1972 Water and Pesticide Laws

During 1972, two important environmental bills were enacted to control water pollution and the use of pesticides. The objective of the Water Act is to restore and maintain the chemical, physical and biological integrity of the Nation's water. The Act specifies that point sources of pollution, e.g., feedlots and meat product processing and dairy product processing industries, must apply the "best practical" control technology by July 1, 1977 and the "best available technology, economically achievable," by July 1, 1983. The new Pesticide Act will affect both the use and availability of pesticides to farmers and other users. The new law substitutes use classification and regulation for the labeling scheme of the Federal Insecticide, Fungicide and Rodenticide Act. Some pesticides will be placed in a "restricted use" category thus subjecting

them to controls in distribution and ultimately requiring their use by certified applicators. Overall, the two bills should result in safer use of fewer pesticides and a reduction in the pollution of water from agricultural practices. However, implementing the two bills will increase costs for many farmers and agricultural processes without corresponding increases in net income. Many small and/or marginal firms--livestock operations and processing plants--will be forced out of business.

* * * *

During 1972, Congress and the President completed action on several new environmental bills. The most important: the Federal Water Pollution Control Act Amendments of 1972 and the Federal Environmental Pesticide Control Act of 1972. Both laws give new responsibilities to the Environmental Protection Agency and pose important implications for agriculture.

Water 3/

P.L. 92-500, Federal Water Pollution Control Act of 1972, has extraordinary implications for the quality of the Nation's waters. In addition, it has implications for nearly every sector of the economy.

The objective of this Act is to restore and maintain the chemical, physical and biological integrity of the Nation's waters. To achieve this objective, it declares:

1. A national policy to eliminate pollutants from navigable waters by 1985.

2. An interim goal of making waters safe for fish, shellfish, wildlife, and recreation by July 1, 1983.

3. A national policy to prohibit the discharge of toxic pollutants in toxic amounts.

4. A national policy of providing financial assistance to construct publicly owned waste treatment works.

3/ The review of the provisions of the Federal Water Pollution Control Act was prepared by Joseph P. Biniek, Natural Resource Economics Division.

5. A national policy to develop and implement area-wide waste treatment management planning processes.

6. A national policy to develop technology through research and development to eliminate discharge of pollutants.

7. A national policy to act with foreign countries to ensure comparable pollution control efforts.

8. That public participation in the development, revisions and enforcement of regulations, standards, plans and programs will be encouraged.

9. A national policy to encourage the minimization of paperwork and interagency decision procedures and to encourage the best use of funds and manpower.

This summary highlights items of extreme interest to Agriculture and the rural sector of the Nation. The Act:

1. Authorizes comprehensive studies of pollution in estuaries and estuarine zones of the United States. Studies will be cooperative efforts of Agriculture, Army, Water Resources Council, et al.

2. Authorizes comprehensive study and research programs to determine new and improved methods, and better application of existing methods, for reducing and eliminating pollutants from agriculture, including the legal, economic, and other implications of the use of such methods.

3. Authorizes a comprehensive program of research, investigation, and pilot project implementation to eliminate pollution from sewage in rural areas.

4. Authorizes grants, in consultation with Secretary of Agriculture, for R&D, for new and improved methods of reducing, eliminating, or preventing pollution from agriculture and rural sewage and to disseminate information and encourage adoption of these methods.

5. Encourages waste treatment management facilities that provide for recycling of potential sewage pollutants through agriculture and forestry.

6. Authorizes development of areawide waste treatment management plans that include identification of nonpoint sources of pollution from agriculture and forestry, and procedures and methods to control such sources.

7. Specifies that the President, acting through the Water Resources Council, shall complete Level B plans for all basins in the United States by January 1, 1980. Priority is to be based on areawide needs.

8. Specifies that point sources of pollution must apply the "best practical" control technology by July 1, 1977.

9. Specifies that effluent limitations for categories and classes of point sources shall use the best available technology, economically achievable, by July 1, 1983.

10. Specifies that EPA shall enter into agreements with the Secretaries of Agriculture, Interior and Army to maximize the utilization of appropriate programs to achieve objectives of the Act.

11. Specifies that EPA shall develop, in consultation with appropriate agencies, (including Agriculture), appropriate guidelines for identifying and evaluating the nature and extent of nonpoint sources of pollution and processes, procedures and methods to control pollution from agriculture and forestry, including runoff from fields.

12. Requires a list of categories of sources that, at minimum, will include feedlots and 26 agriculture-related industries. Regulations establishing standards of performance will be published in 1 year.

Implementing the provisions of the Water Act will result in substantial costs to many farmers and agricultural processors without increases in net income. The economic implications are discussed more fully under each of the agricultural pollutants.

Pesticides

The new pesticide law will make it possible for EPA during the next 4 years to exercise increasing control over chemicals that may be needed by farmers and others. Now, EPA will be able to regulate uses of these chemicals. Under the old Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), EPA was able only to regulate their interstate marketing.

Briefly, the new law:

1. Substitutes a use classification and regulation scheme for the labeling scheme of the Federal Insecticide, Fungicide and Rodenticide Act.

2. Gives EPA the authority to proceed against persons or individuals who engage in misusing pesticides by applying them in a manner "inconsistent with their labeling."

3. Authorizes EPA to place pesticides in a "restricted use" category, thus subjecting them to controls in distribution and ultimately requiring their use only by trained applicators.

4. Federal authority is also extended to the use and shipment of all pesticide products.

5. Authorizes registration of pesticide-producing establishments and the requirement that they maintain books and records.

6. Authorizes payment of indemnities to farmers and manufacturers who, without notice, are left holding a product which is suspended because it creates an imminent hazard.

7. Gives the government authority to allocate the cost of research necessary to satisfy the requirements of product registration where two manufacturers are seeking a registration to sell the same basic product.

8. Obligates the government to assist in disposal of pesticide containers.

9. Authorizes cooperation with States in the training of applicators and an obligation to establish criteria for their certification.

10. Gives authority to certify States to permit them to register certain products to meet "special local needs."

11. Makes substantial amendments to the registration procedures and the mechanisms for administrative hearings on refusals to register, changes in classification, suspension and cancellation.

All provisions of the new pesticide law must become effective within 4 years. Although it is too soon to adequately evaluate the implications of the new law, a few implications seem obvious.

1. Because of more stringent registration procedures, farmers can expect to have fewer chemicals in their pest control arsenal. Pesticide manufacturers will find that it is not economical to register pesticides for minor use on major crops or for use on minor crops.

2. New pesticides will be limited to major crops and will be higher in cost.

3. Higher cost and fewer available pesticides will be an incentive for farmers to adopt better pest management practices--cultural and biological controls as well as spraying on the basis of economic threshold damage levels.

4. Farmers will be required to take training in order to be certified to apply restricted pesticides. This provision should result in more efficient and safer use of pesticides. However, it is likely that operators of small farms will be forced to consider custom services.

5. Overall, the new law should result in safer use of pesticides, fewer pesticides applied, but higher costs for pest control.

Pesticides

Most uses of DDT were banned effective December 31, 1972 based on the conclusion that it "poses an unacceptable risk

to man and his environment." The effective date of cancellation was delayed to permit an orderly transition to substitute pesticides, including the initiation of "Project Safeguard" designed to help farmers in 14 southern States to safely use chemical alternatives to DDT. The pending ban on DDT provided part of the impetus behind the multimillion dollar USDA pest management program initiated early in 1972. We expect all the organochlorine insecticides to be reviewed by EPA followed by selected herbicides and fungicides. ERS estimated that banning DDT would double cotton pest control cost, $55 million to $110 million--$10 to $20 per acre treated. Other studies of banning pesticides show that production cost would increase as follows: aldrin-dieldrin, $48 million, primarily in corn production; 2,4,5-T, $4.5 million in rice production; and chlordane and heptachlor, $2 million each mainly affecting corn production. Pest control costs will climb as farmers substitute nonchemical methods of control and less persistent pesticides for those which are determined harmful to the environment.

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In the last 10 years, particularly since the publication of Silent Spring, the public has expressed concern over the long-term effects of pesticides on the environment. Some pesticides have been found to remain in soil and water for long periods of time. And, some of these chemicals have been shown to accumulate in the tissues of living organisms. In some cases, the harmful effects of this accumulation have threatened the extinction of certain species of wildlife. Awareness of possible hazards from the use of pesticides has resulted in public discusssions and hearings on pesticides, and legislation has been enacted in an attempt to safeguard the environment as well as pesticide handlers and food consumers.

The first pesticide to be reviewed in a public hearing was DDT. The hearing examiners recommended that DDT continue to be available for use on cotton. On June 14, 1972, EPA cancelled interstate shipment of DDT for all uses except public health and a few minor agricultural uses effective December 31, 1972. The order was based on the conclusion that DDT poses "an unacceptable risk to man and his environment" [13].

The effective date of the EPA June cancellation action was delayed until the end of 1972 to permit an orderly transition to substitute pesticides, including the development of a special program to instruct farmers on the safe use of the substitutes, such as the organophosphate

compounds. On January 5, 1973, USDA and EPA jointly announced "Project Safeguard," designed to help farmers in 14 southern States--especially those on small acreages--to safely use chemical alternatives to DDT. The project will be supported by $750,000 from EPA and $350,000 from State Extension Service funds. Both USDA and EPA will make available additional funds for education and training phases of the project as needed [11].

Part of the impetus behind the multi-million dollar USDA pest management program initiated early in 1972 was the pending ban on DDT. The pest management program was established to "help farmers to control pests more economically and effectively" [27]. This program is conducted jointly by the USDA, Environmental Protection Agency and the National Science Foundation in cooperation with State Departments of Agriculture, State Agricultural Experiment Stations and Extension Services.

The initial thrust of the pest management program was to encourage crop producers to use cultural practices and biological pest control measures in coordination with chemicals to protect their crops from costly insect damage. This program can work on some of the problems such as excess use of pesticides and insecticide resistance. However, the success of the program is dependent upon substantial new interdisciplinary systems research. The development of economic and other data is necessary to convince farmers that their net income from crops will increase if they adopt new practices and spray pesticides only when needed; or economic incentives will be necessary to motivate farmers to use chemicals more effectively.

The direct costs of the pest management program and of "Project Safeguard" are excellent examples of social costs that can be attributable to improving the quality of our environment through a ban on the use of pesticides such as DDT. But there are a number of other economic considerations to be evaluated in this kind of legislative action.

One consideration is the change in production costs incurred directly by farmers. The Economic Research Service estimated that a ban on the use of DDT in the production of cotton could double the cost of pest control [7]. Using 1969 as the base, the ERS study showed that the total pest control cost would have increased from $55 million to $110 million, or from $10 to $20 an acre treated. Although DDT use would have declined by 19 million pounds, use of toxaphene would have increased two-fold and the more toxic methyl parathion, four-fold.

One of the problems in estimating the economic impact on farmers of banning specific pesticides is determining what chemicals can be used as substitutes and are not likely to be considered for future bans. For example, in the study of banning DDT, ERS assumed that toxaphene and methyl parathion could be used as substitutes. If either one or both of the chemicals were subsequently banned, the estimated control cost would have been much higher.

Even if these substitutes can be used, new problems may develop. For example, in 1972 there were some reported shortages of methyl parathion. And, the availability problem for 1973 production is seriously being considered now by the U.S. Department of Agriculture and the Environmental Protection Agency.

A further problem is determining the longer-term effects of banning the uses of specific pesticides. Carlson concluded that "disallowing toxaphene-DDT mixes on cotton pests may rapidly influence the resistance build-up of the replacement chemicals like methyl parathion" [4]. Thus, insecticide resistance, as well as pollution, is a major factor that needs to be considered in determining the socially optimum use of pesticides.

Although the costs of banning pesticides such as DDT are difficult to estimate, the benefits are almost impossible to quantify in economic terms. If the number of accidents should increase from the greater use of the more toxic organophosphate substitutes for DDT, social cost would increase still further. However, if programs like the pest management program and "Project Safeguard" result in fewer pesticides used and fewer pesticide accidents, farmers and society would reap windfall benefits from the DDT ban. We are left with the assumption that the benefits from banning the use of DDT will equal or exceed the costs. Like the adoption of a new technology, the banning of DDT will probably result in unexpected and unintended costs and benefits. Time will tell!

Advisory committees and review committees have been appointed for other pesticides--2,4,5-T, aldrin, dieldrin, chlordane, heptachlor, endrin, lindane, benzene hexachloride (BHC), toxaphene. We expect all of the organochlorine insecticides to be reviewed followed by selected herbicides and fungicides.

To further illustrate the economic impact of banning the use of selected pesticides, we would like to cite results of additional studies by the Economic Research Service. The only food crop affected by a possible ban on the use of 2,4,5-T is rice. Using 1971 production, ERS estimated that a suspension in the use of 2,4,5-T would reduce growers' net income about $4.5 million because of reduced yields and lower quality of rice [16]. The suspension in the use of 2,4,5-T would have affected rice growers primarily in Arkansas, Mississippi and Louisiana.

We have been waiting for several months for the beginning of a public hearing on the herbicide 2,4,5-T. Because of several injunctions by industry in an attempt to force EPA to make a decision based on the advisory committee report on 2,4,5-T, it is uncertain when we will have a public hearing on this pesticide.

Shifting to another major agricultural region, the Corn Belt, we find producers concerned about the loss of aldrin and dieldrin which they use to control soil insects in corn production. ERS researchers estimated that discontinuing the use of aldrin and dieldrin could increase farmers' costs of production as much as $48 million [2]. This includes increases both in cost of pest control and losses in income from crop yield. Since most of the aldrin is used for control of soil insects in corn production, a large share of the increase in cost, about $30 million, would be incurred by corn farmers.

An advisory committee on aldrin and dieldrin has completed its review and submitted a report to EPA. We expect a public hearing to follow.

In separate reports to an EPA pesticides review committee, ERS studies showed that farmers' costs of production would increase about $2 million if the use of chlordane was discontinued and an equal amount if heptachlor was banned [8 & 19]. The loss of chlordane and heptachlor would mainly affect corn producers.

One can conclude from the concern about pesticides and the environment that reviews and hearings will continue. Also, pest control costs will climb as farmers substitute nonchemical methods of control and less persistent pesticides for those which are determined harmful to our environment.

Plant Nutrients

Major sources of plant nutrients in streams, lakes and groundwater include domestic and industrial effluent, rural and urban runoff, animal wastes and rainfall. Nitrates and phosphates are the nutrients of primary concern in water pollution. Alternatives for reducing pollution from fertilizer include technological changes in the production and application of fertilizers and direct limitations or restrictions on fertilizer use. There is insufficient information on the fate of inorganic nitrogen compounds to provide a satisfactory basis for limiting fertilizer use. Research efforts are concentrated on developing systems that improve plant uptake and use of nutrients. Sediment control is important in reducing plant nutrient losses from cropland.

* * * *

During the last two decades, economic returns from the use of fertilizer have been unusually favorable and U.S. farmers have increased their use of fertilizer almost 4 1/2 times. The higher use of fertilizer is one of the major reasons U.S. farmers are producing 40 percent more food and fiber on 11 percent fewer acres than in 1950. However, there is increasing concern

for the "spill over" effect of agricultural chemicals on the environment and on persons who have no choice in their use. Thus, conflicting objectives exist and we have choices and decisions to make that range from those affecting individual farmers to those concerning total society.

The Problem

Fertilizers are only one source of pollution from plant nutrients. Major sources of plant nutrients in streams and groundwater include domestic and industrial effluent, rural and urban runoff, animal waste and rainfall. Attempts at determining the contribution from the various sources have not been conclusive. Wadleigh [31] has estimated that more than 50 million tons of primary nutrients are lost from our agricultural and forested lands each year through sediment delivery. Land runoff and sediment related nutrients are major factors in stream pollution in many areas of the country.

Nitrates and phosphates are the major plant nutrients of concern in water pollution. Phosphate is extremely immobile in the soil since it is absorbed by soil particles. If fertilizer phosphate is not removed in the harvested crop or by soil erosion, it remains in the soil. It appears safe to assume that if phosphate is getting into streams from agricultural production, it is being carried there by soil erosion.

Nitrate is not absorbed to an appreciable extent by soil particles. Nitrates are removed through crop growth, leaching, denitrification and conversion to humus by soil microorganisms. Nitrates are formed in soils by natural processes including nitrogen-fixing bacteria and blue-green algae. Nitrates move in the direction of soil moisture movement including percolation to groundwater. The amount of nitrogen removed by all harvested crops is greater than the amount applied as fertilizer N.

High nitrate levels in drinking water and food products have undesirable effects on human and animal health especially for babies up to about 4 months of age because they are unable to detoxify nitrate. Nitrogen and phosphorus compounds are associated with eutrophication and algae growth which impair the productivity and usefulness of water resources.

Alternatives for Reducing Pollution From Fertilizer [10]

There are some positive alternatives which can be considered to reduce environmental deterioration. They range from various ways of reducing the quantities of fertilizer moving into the environment to removal of plant nutrients from bodies of water by membrane techniques and biological treatment. Our discussion of alternatives focuses primarily on ways of reducing quantities of fertilizer used for crop production.

Implicit in what follows is the assumption that pollution is directly related to the quantities used. Alternatives for reducing pollution from fertilizer are of two kinds: (1) technological changes in the production and application of fertilizer, and (2) direct limitations or restrictions on use. In the first general category, we could include:

1. Development of fertilizer having slower release of nutrients to enable more complete utilization of nutrients by plants.

2. Improvement in cultural practices and timing of applications to prevent leaching and erosion.

3. Improvement of methods of application such as placement of fertilizer closer to the plant root zone to improve utilization.

4. Attainment of lower levels of pollution through smaller but more frequent applications of fertilizer.

The second category of ways of reducing the potential pollution from fertilizer includes direct limitations on the use of fertilizer. It is important to recognize that farmers will be affected differently depending on their normal use. For example, in 1970, Corn Belt farmers applied an average of 110 pounds of nitrogen per acre on about 31 million acres of corn land. But, on 34 percent of the corn acreage, they applied less than 101 pounds of nitrogen; on 24 percent of the acreage, they applied more than 150 pounds.

A policy of complete restriction on the use of fertilizer is untenable even though it would presumably improve the quality of the environment. A limited restriction on the use of fertilizer could be accomplished with negligible increases in costs and prices of farm products. For example, a limitation of 150 pounds of nitrogen per acre of corn in the Corn Belt would affect 24 percent of the acreage, reduce the quantity of nitrogen used by 7 percent, reduce corn production 2 percent and have little effect on production costs per bushel.

Research Needs

Plant nutrient control is a complicated problem. Research on the behavior of such nutrients as phosphorus and nitrogen in soils and soil solutions has been underway for over a century. There is still inadequate evidence on the fate of surplus inorganic nitrogen compounds to provide a satisfactory basis for limiting fertilizer use. More attention is being given to developing systems that improve the uptake and use of plant nutrients. Sediment control has a major role to play in reducing plant nutrient losses.

Increased research input can be expected in a number of areas. Much of the research will be complementary to other needs such as the development of high-yielding varieties of crops that are pest and disease resistant, the effects of fertilizer use on nutritional and market quality of food and fiber products and establishing limits on the nitrate content of different foods. Production systems research will focus on more suitable forms of fertilizer, methods and timing of fertilizer application, nutrient removal from irrigation return flows, crop requirements and soil management.

Environmental impact of the undesirable effects of fertilizer on the physical environment should be more fully identified and examined. Economic impacts will receive greater attention as food and fiber production is influenced by actions to improve the environment. The Nation will continue to produce the necessary food and fiber but with greater concern and awareness of the potential environmental damage. The options available to our farmers must be improved.

Sediment

Sediment control emphasizes the downstream effects on people and resources rather than maintenance of soil productivity for food and fiber production. Because of the nature of nonpoint sources of sediment, reductions in soil losses must be achieved through the modification and improvement of production processes. Improved tillage, conservation practices, crop rotations and management practices provide a range of alternatives for producers. While individual conservation practices may be profitable, the implementation of a system of conservation measures to achieve desired levels of sediment control may increase production costs and reduce farm income. Key economic questions involve the economic feasibility of sediment control and the distribution of costs associated with improving stream quality.

* * * *

Sediment is the soil materials carried to streams by land runoff. Streams carry a suspended sediment load as a crucial part of their total energy balance. If this load is reduced, the stream will erode its bed or banks to pick up sediment to reestablish an energy balance.

Sediment is a pollutant because it affects the uses of streams as water supplies, recreational resources and natural environments. Sediment has an additional importance because of its dominant physical effect on the transport of other pollutants. Jan van Schilfgaarde [24] notes that recent research results indicate that the losses of plant nutrients in runoff were directly related to the amount of soil loss. Systems of land runoff and erosion control become increasingly significant in view of the important

interrelationships between soil losses and the control of numerous pollutants such as sediment, pesticides, salts, plant nutrients, animal waste, crop residues, and infectious organisms.

Soil erosion on cropland results in the loss of productivity due to the removal of plant food and organic matter. Wadleigh [17] of our Agricultural Research Service has estimated that 4 billion tons of soil reach streams in the United States each year, the equivalent of 4 million acres of topsoil. Stall [25] estimates that sediment yields average 15 tons per hectare per year in Mississippi, 10 in western Illinois and western Iowa and less than 2 for the forest-covered East and the arid West. Regional differences are associated with variations in rainfall and runoff, proportions of land area in food and fiber production, kinds of cover and soil erodibility. Soil erosion is the dominant conservation problem on 36 percent of cropland.

The national concern for sediment control is not limited to food and fiber production. McIntire [22] points out that today Federal agencies administer some 762 million acres of land or about one-third of the 2.3 billion acres in the United States, including Alaska and Hawaii. Residential, transportation, and other urban uses require 3 percent, grazing 25 percent, and crop production 20 percent. Nearly 6 percent is used for recreation and about 33 percent is forest land. The remaining 10 percent is wasteland.

Sediment control is directly related to the problem of erosion control that is a priority item in conservation. However, concern for sediment control for environmental purposes emphasizes the downstream effects on people and resource uses with less emphasis on maintaining soil productivity for food and fiber production. A decision criterion in soil conservation has been to maintain permissible rates of soil loss whereby soil losses are offset by the formation of new soil. The decision criterion in sediment control will be the maximum amount of sediment which will be allowable and yet maintain desired levels of stream quality. If farm income reductions occur in order to achieve off-farm benefits from sediment reduction, public policy development should take account of the incidence of benefits and costs.

The changes in social goals call for an examination of what constitutes adequate soil conservation. It is desirable to carry out those activities which are profitable to the individual as well as those activities which provide additional value that accrues to others. Considerable research is needed to determine if a gap exists between these two levels of activity. The chances of achieving a proper balance of public and private costs are improved when trade-offs exist and are properly identified.

Tillage systems can be used to adequately control wind and water erosion on many soils. Tillage practices should leave crop residues on the land surface and maintain as rough and cloddy a soil surface as is compatible with good seed germination and crop production. Crop rotations, plow and plant and

no-tillage systems can be used to reduce soil erosion losses by reducing tillage operations.

Semi-permanent conservation practices on cropland such as cover crops, contour farming and strip-cropping have to be repeated every year to be effective. A combination of reduced tillage and conservation practices greatly improves soil erosion control. Comparative cost data for erosion control methods that take into account yield differences are not conclusive because of variations in yield responses. However, operating costs for reduced tillage systems are generally less than operating costs for conventional tillage. Swanson and MacCallum [26] concluded that it is not profitable for farmers in Central Illinois to adopt soil conservation measures which would reduce soil losses to the general rate of 6 to 10 tons/hectares per year which is considered tolerable for typical soils in the study area.

Comparatively unfavorable price and income relationships have limited the ability of farmers to invest in soil conserving measures. High land costs encourage intensive land uses and may limit cropping changes such as grassland and forage production. High production costs encourage short-run gains from soil depleting production practices.

Conservation of the Nation's soil and water resources has been a basic concern of agriculture; and farmers and scientists alike have long been aware of the problems of environmental quality. The current concept of conservation, which goes far beyond mere awareness of wise land use, has led to the consolidation of soil and water environmental issues under the broad umbrella of conservation.

The people of the Department of Agriculture are protecting the environment on many fronts. Our efforts include economic and technical assistance to farmers, ranchers and others for erosion control, long-term small watershed programs that help to hold water and soil in place and economic and technical research on new and improved sediment and plant nutrient control measures.

Many programs designed to control soil erosion, reduce sediment and prevent flooding also provide for increased water supplies, recreation opportunities, improved fish and wildlife habitats and other positive community benefits. The Department's Soil Conservation Service, for example, assisted 100,000 farmers and ranchers in 1972 in developing new conservation plans and updating existing plans. These plans included better conservation cropping systems on 20 million acres, tree windbreaks for 43,000 acres and 50,000 small ponds. Technical assistance was provided by the Department in such areas of sediment control as strip-mine revegetation, fire protection, roadside erosion control, beautification and streambank improvement.

Local government officials and land developers often seek help from the Department's local offices on land use and natural resource problems.

Assistance provided to local agencies include natural resource inventories and evaluations, soil surveys, water impoundment surveys and wildlife management. States own 20 million acres of forest land, excluding Alaska, and control nearly as much land dedicated to fish and wildlife as the Federal Government.

A changing technology and improved management of inputs are primarily responsible for the rising productivity in agriculture. Fortunately, these same factors provide a base for environmental improvement through pollution abatement in crop and livestock production. Because of the nature of non-point sources of pollution, pollution control must be achieved through the modification and improvement of production processes. Improved tillage methods, conservation practices, cropping patterns and management practices can be adopted by producers to achieve desired levels of pollution control.

Much of the discussion on the need for sediment control in the past has focused upon the nature and extent of the problem. The new issue, and one which may be more objectively examined, is the range of alternatives that are available to us. Science and technology can provide useful answers to the technical problems. The problems of implementation may be more difficult for obvious political and economic reasons. The development of guidelines and land use programs will be a major activity in 1973. These developments may well set the long-term pattern for carrying out sediment and plant nutrient control solutions.

We would like to try, in a general way, to indicate the direction of activities related to sediment and plant nutrient control. State sediment control programs are expected to allow control activities to remain at the local level with Federal and State Government in a back-up role of providing guidelines and general program direction. Educational, training and research activities of the several levels of government will be more closely integrated.

There is an urgent need to fill existing data gaps. Land use and natural resource inventories will be used extensively. There will be greater reliance on information sources, such as remote sensors, aerial photographs, soil surveys and other techniques developed in response to the need for new techniques for obtaining and processing data. Data systems for processing, storage and retrieval will employ computer techniques to reduce cost and time lags. Sediment and plant nutrient data will be handled as important sub-systems in broad environmental system approaches.

The importance of research has never been greater. There will be increasing emphasis on communicating research results to potential users. Numerous studies have identified restraints on the use of conservation research. Restraints on land managers include the need for immediate income, information gaps, patterns of ownership and rights in land, short-planning horizons, practices which are not adapted to operating conditions and

changing production technology. Research results should be designed to be more broadly applicable to potential users' needs.

Economic data will continue to grow in importance. Cost effectiveness of alternative sediment and plant nutrient control measures will be more broadly studied. Benefits and costs information will be needed to evaluate trade-offs between environmental impacts, providing food and fiber needs, farm income objectives and economic growth. Key economic questions involve economical means of attaining desired levels of environmental quality and the distribution of costs associated with improvements in environmental quality. The Economic Research Service has work underway which focuses on some of the above economic problems concerning sediment control. We expect to increase our effort in this area to meet the demand for cost-benefit information.

Animal Wastes

Feedlots are specifically identified as a point source of pollution in the 1972 Federal Water Pollution Control Act. In carrying out its responsibilities under the Act, EPA is currently developing criteria for a permit system for feedlots and effluent guidelines for the abatement of water pollution. EPA expects to delegate the responsibility for enforcement of pollution abatement guidelines and issuance of permits to the States. Compliance will require many feedlot operators to invest in new facilities and equipment. To minimize their costs, feedlot operators will move to geographic areas of sparse populations and lower rainfall and into a structure that favors the larger more commercial types of operation. Preliminary estimates of pollution abatement costs suggest that the major impact will be on dairy followed by swine, beef and poultry production. In preparation for the announcement of pollution abatement guidelines by EPA, ERS has a study underway to more accurately estimate the economic impact on major livestock production industries.

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The provisions of the new Federal Water Pollution Control Act are a major concern for livestock producers. Livestock feedlots are specifically identified in connection with point source pollution problems. The problems of nutrient run-off and odor from livestock operations tend to be localized and thus, local State government agencies have been the most active in developing pollution abatement standards and procedures. States will continue to be active but under the provisions of the new Act, the Environmental Protection Agency is required to establish Federal guidelines for abatement of water pollution from feedlots.

In carrying out this responsibility, EPA is also required to establish a permit system for point sources of water pollution. The USDA is working

with EPA in developing criteria for requiring a permit to operate a livestock feedlot. At this time, we expect the Federal requirements for the issuance of permits to be limited to relatively large operations; for example, 1,000-head capacity beef feedlot and comparable sizes of dairy, swine, sheep and poultry operations. EPA expects to eventually delegate the responsibility for enforcement of pollution abatement guidelines as well as the issuance of permits to the States. Based on hearings and preliminary effluent guidelines developed by State Pollution Control Boards, we should expect most States to announce requirements which are more stringent than the Federal standards.

At the present time, we have no good estimates of the cost to the various livestock sectors of complying with possible animal waste abatement standards. One estimate by the Council of Environmental Quality (CEQ) for water pollution abatement for feedlots shows the accumulative requirements for 1971 to 1980 at $1.9 billion capital investment and $1.8 billion operating costs [12]. These are costs only to meet new environmental standards or to provide for pollution abatement on new feedlots constructed during that period.

A preliminary examination of hog production suggests that investments for a pollution abatement could be extremely high for many traditional medium to large size confinement operations [28]. New investment requirements for drainage control and waste storage could be as high as $15,000 to $20,000 for 500-head open-lot operation. Added annual costs range to $6 per head. Continued operation on such farms may be unprofitable, perhaps impossible, if debt exists. Yet, two-thirds of the total hog production comes from enterprises of this general size. In contrast, the thousands of "crop-livestock" farmers who annually produced 50 or more hogs on pasture may be little affected by point source pollution abatement guidelines and standards.

For the past 2 years, the Soil Conservation Service has provided technical services and the Agricultural Stabilization and Conservation Service has shared the cost of livestock facilities, for pollution abatement on livestock farms. The following summary of 73 systems in Illinois provides an indication of the magnitude of costs to individual livestock operators [5]:

	Number completed	Cost per head (Dollars)	One-time capacity (Head)
Holding ponds	13		
Beef		15	300
Swine		10	1,000
Dairy		75	100
Holding tanks	53		
Beef		52	300
Swine		20	600
Dairy		80	100

	Number completed	Cost per head (Dollars)	One-time capacity (Head)
Lagoons	7		
Beef		60	300
Swine		10	200
Dairy		60	100

The livestock operations in Illinois are relatively small compared with those in California and Great Plains. Costs per head will vary consideraly due to types of livestock physical layout of existing facilities, geographic locations and size of operations. In some cases, it is difficult to separate costs of manure handling facilities from other costs such as building modifications.

Although we have some indication of the magnitude of costs to abate pollution on individual livestock farms, our aggregate estimates to date are questionable. Thus, the Economic Research Service has underway studies to estimate the aggregate cost to producers of poultry, hogs, dairy and beef of complying with animal waste abatement standards. We have been handicapped in our attempts to move ahead with these studies because of lack of data on the current manure handling technology as well as considerable uncertainty concerning EPA pollution abatement standards and guidelines. However, we will be prepared to evaluate EPA effluent guidelines on livestock production by midyear.

One alternative for disposal of animal waste is recycling as feed. 4/ The conclusions of a USDA-EPA-FDA task force indicate that it is technically feasible to recycle hog, beef cattle and poultry waste as feed, but for most producers it is not economical [15 & 29]. For the foreseeable future, anaerobic and/or land disposal systems will be the most economical methods of handling livestock and poultry waste. However, for operations of 50,000 to 80,000 layers it appears economical to feed about half of waste produced. The remaining poultry waste would have to be sold as a feed ingredient or organic fertilizer, spread on land that is available or disposed of by an improved treatment process. Also, for hog operators who are using slotted floor confinement units, the refeeding of aerobically digested waste shows promise of becoming an economic system.

4/ Recycling of animal waste as feed is not recommended by the USDA at the present time nor is it approved by FDA. The subject is under consideration by the USDA, EPA, and FDA with the objective of developing policy recommendations.

One of the major questions for the future is the control of odor in livestock and poultry production systems of increasing size. If EPA or State and local governments impose strict standards for the control of odor, the economics could shift in favor of aerobic systems and increase the feasibility of recycling waste as feed.

It is clear that compliance with these standards will require changes in manure storage and handling practices on many farms. Investments in new facilities and equipment will increase producer costs. To minimize costs, livestock production will move in the direction of sparse populations, geographic areas of lower rainfall and into a structure that favors the larger and more commercial types of operations. Although we have limited data on costs for livestock producers to abate pollution, the indications are that the major impact will be on dairy production. Swine production will be a distant second with beef and poultry far behind in third and fourth place.

Feed Additives

In August 1972, FDA banned the use of diethylstilbestrol (DES) in livestock feed effective January 1, 1973. However, DES can still be implanted between the skin and cartilage in the ears of the animals to be fattened. The ban on DES was based on the provision of the Delaney Amendment to the Food, Drug, and Cosmetic Act which specifically prohibits the use of chemicals in food products that are known to cause cancer, either human beings or animals. The uses of subtherapeutic dosages of antibiotics in poultry and livestock feeds are also under review. The antibiotics under review are those which are also used in human clinical medicines. Since there are alternative antibiotics, restrictions on the antibiotics used for humans would not affect livestock production. However, if all antimicrobials were withdrawn from use in poultry and livestock production, annual costs of production could be increased $45 million and $475 million, respectively, for poultry and livestock producers. Consumer prices could increase as much as 2.5 cents per pound for poultry, 7 cents for beef and 12 cents for pork.

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Another area of concern to the livestock sector is feed additives. Here, we are referring primarily to growth stimulants such as diethylstilbestrol (DES) and the subtherapeutic use of antibiotics in animal feeding. Articles and reports on DES have been frequent in the news media. More than 2 years ago, the Economic Research Service was asked by the House of Representatives Intergovernmental Relations

Subcommittee to evaluate economic consequences of banning the use of DES in cattlefeeding. The report, which was published in June 1971, suggested that the annual cost to consumers of banning DES for feeding beef cattle would range between $300 million and $460 million [14]. However, the researchers felt that the most probable adjustment would be about $300 million in increased costs to consumers or about 2.6 cents per pound of beef.

A decision a year ago by the Food and Drug Administration (FDA) to continue the use of DES in feed was based on the assumption that a new rule of withdrawing the feed at least 7 days before marketing would be sufficient to eliminate the possibility of residues. In spite of the new FDA rule, DES residues were found in 2.2 percent of tests of beef and lamb livers.

In early August 1972, the Food and Drug Administration banned the use of DES in livestock feed effective January 1, 1973. The FDA action still will permit DES to be implanted as a pellet between the skin and cartilage in the ear of the animal. Cattlemen say that the implants are inconvenient to use.

In the case of the DES ban, FDA was compling with the Delaney Amendment to the Food, Drug, and Cosmetic Act which specifically prohibits the use of chemicals in food products that are known to cause cancer in either human beings or animals. And DES has caused cancer in test animals.

One alternative to using DES in steer feeding may be the increased feeding of bulls. Several experiments show that bulls could be raised at less cost than steers fed DES and yet produce beef that is quite acceptable to consumers [9]. It may take several months or years for bull beef to gain wide acceptance with consumers. But the current price of beef and the potential reduction in beef production if all DES is banned make bull feeding a feasible alternative.

The uses of subtherapeutic dosages of antibiotics in poultry and livestock feeds are also under review. In response to a potential human health hazard, the FDA initiated an investigation and proposed that all antimicrobial agents used in both human clinical medicines and animal feeds that fail to meet certain criteria be withdrawn from use in animal feeds before the end of 1973. The antimicrobials being considered for withdrawal include the tetracyclines, streptomycin, dihydrostreptomycin, sulfonamides and penicillins.

In response to the concern over the use of antibiotics in feeds, the ERS estimated the direct economic consequences of restricting use of these

agents in poultry and livestock production [1 & 17]. For the group of antimocrobials currently being considered, it appears there would be little cost associated with their withdrawal. Alternative antibiotics that produce similar results will be available.

If all antimicrobials were withdrawn from use in poultry and livestock production, some significant economic consequences could be expected. The direct cost of production could increase $45 million and $475 million, respectively, for poultry and livestock producers if antibiotics were withdrawn for use in feeds and meat output was maintained. However, if producers responded by reducing meat production, consumer prices could increase as much as 2.5 cents per pound for poultry, 7 cents for beef and 12 cents for pork.

These costs are striking, but even they do not include all the possible effects of such an action. The present trend toward concentrated poultry and livestock production is possible because of the use of antibiotics. Without the use of these agents in feed, livestock and poultry producers may be forced to use more space and additional labor. Such adjustments would affect the structure of the livestock industry and could be made only at an additional cost.

One thing seems clear. Public concern over the use of feed additives will remain for some years to come. How restrictive the policies will be concerning the use of these agents will depend in a large part on how much the consumer is willing to pay for meat produced without feed additives and how successful we are in developing alternative economic production practices.

Crop Residues

Open field burning of rice straw, cereal straw, grass residues and trash for sugarcane stalks is causing air pollution in California, Oregon, Washington, Idaho, Minnesota and Florida. Some producer groups have initiated private burning regulations. Some States are considering controls that will ban open field burning by 1975. Alternatives are expensive--$5 to $10 per acre to use a field sanitizer for grass residues and $21 to $26 for incorporating the residues into soil. ERS is studying the economics of harvesting sugarcane without field burning and is planning an evaluation of utilizing rice straw as livestock feed as well as alternative ways of utilizing rice hulls.

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Another aspect of the environmental concern is air pollution. While one commonly thinks of automobile exhaust in metropolitan areas and black smoke from the furnace stacks of manufacturing firms when air pollution is

mentioned, open field burning of agricultural crop residues is also an environmental problem in some locations.

Open field burning of residue is a widely adopted cultural practice in the production of a number of grass crops. More than 300,000 acres of grass seed and cereal grain straw are burned in the Willamette Valley of Oregon. More than 400,000 acres of rice and other cereal grain straws are burned annually in California. About 6,000 acres of bermuda grass in Arizona, some bluegrass in Minnesota and various types of grasses in eastern Washington and Oregon and northern Idaho are field burned. And in the Southeastern United States, the trash from sugarcane stalks is burned.

This cultural practice has been credited with destroying fungus in infected seeds which wintered in crop residues, stand thinning and physiological plant stimulation, increased fertilizer efficiency, increased effectiveness of soil-active herbicides, extended productive life of stands and reduced pesticide needs in grass production [6]. In sugarcane production, the practice has increased harvest efficiency and quality of sugar.

However, open field burning has come under public scrutiny because of its nuisance effect, soiling damage, contribution to respiratory ailments and driving hazards. It has also been charged with reducing the aesthetically desirable views that attract tourists in some localities. Because of public scrutiny, some producer groups have initiated private burning regulations. But some States are considering controls that will lead to total prohibition of open field burning by 1975. 5/ With some States developing controls that will soon ban field burning and the increasing likelihood that other States will follow, alternative methods of disposing of crop residues will be needed.

In an attempt to evaluate farmer alternatives to open field burning in the Willamette Valley of Oregon, Conklin and Bradshaw concluded that incorporation of residues into the soil was applicable only in annual ryegrass production [6]. Even then, it was not the most economic alternative. The use of a mobile field sanitizer was the least cost method of disposing of grass straw--an estimated $5 to $10 per acre compared with $21 to $26 per acre for incorporating ryegrass straw into the soil. This method also gave some of the same benefits as open field burning. And smoke emissions were estimated to be reduced by 80 to 90 percent and unburned hydrocarbon emissions by 99 percent when compared with open field burning.

Field sanitizers are not yet commercially available. The one used in the Oregon study was developed in 1970 by agricultural engineers at

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5/ The Oregon Senate and House, in 1971, voted to ban field burning by January 1, 1975.

Oregon State University. However, the demand for such a machine may soon justify commercial production and it does demonstrate the need for interdisciplinary research to develop economic alternatives for open field burning of other crop residues.

The Economic Research Service has underway a study to estimate the economic effects of harvesting sugarcane without field burning. The traditional cultural practice has been to burn sugarcane fields prior to harvest. This has increased harvest efficiency, particularly in Florida where recumbant cane is grown, and it has resulted in a larger quantity and higher quality sugar than without burning. Florida growers are now following private burning regulations, but additional burning restriction may be imposed by the State.

Also, ERS is planning to evaluate the economics of utilizing rice straw as a feed for livestock and alternative ways of utilizing other rice byproducts such as rice hulls. ERS researchers are cooperating with the Agricultural Research Service researchers located at USDA regional research laboratories in Albany, California and New Orleans, Louisiana.

The agriculture of several States will not be affected directly by these concerns over burning of crop residues. However, few States will escape the indirect effects. Grass seeds produced in the west are planted over much of the United States. Thus, the availability and costs of these seeds, if they are affected by burning bans, will be felt throughout much of the U.S.

Agricultural Processing Wastes

Under current legislation, agricultural processing firms will be required to comply with Federal and State standards for pollution control. Farmer returns and consumer prices could be adversely affected since the agricultural processing-marketing complex represents industries with a retail product value of $100 billion in 1972. Economic impact research is underway or recently completed in the cotton, grains, poultry, sugar, fruits and vegetables and dairy processing industries. Findings thus far indicate a great deal of variation among industries as to the impact of pollution abatement on costs. The final answer will depend on (1) the ability of firms to seek least-cost solutions and thereby minimize costs; and (2) the development and adoption of new technology, particularly that relating to byproduct utilization of recovered wastes. If such markets can be developed, the net cost of waste treatment will decline and thus lessen pressure on consumer prices.

* * * *

What is the agricultural processing-marketing complex? It is that part of our economy that transforms, preserves and adds value to the raw material

produced by American agriculture. In 1972, the retail value of products sold by the agricultural processing-marketing complex industry was estimated at $100 billion.

The industries making up this complex now face adjustments in those production, processing and distribution activities which pollute the environment. These industries cause water, air, odor, and aesthetic pollution. The distribution stage generates large packaging and container wasteloads.

ERS has recently completed, or has currently underway, research in the following agricultural processing-marketing industries: cotton, grain, rice, tomato, dairy, cane sugar, and poultry. Most of the work has been in response to requests from other USDA agencies, the EPA, and industry groups. Research highlights from our current program of research on agricultural processing wastes are discussed under three headings--air pollution, water pollution, and special impact studies.

Air Pollution

The air pollution studies in the cotton ginning and grain storage industries are related to our research on marketing costs. The work is limited to two areas: (1) methods and costs of controlling air pollution at cotton gins; and (2) materials and costs of air pollution control for grain elevators. The work on cotton ginning during the current fiscal year consists of developing costs of installing and operating air pollution control equipment in various size gins and developing a report on applicable State regulations, available equipment for pollution control at gins and costs of installation and development of the equipment. The Agricultural Engineering Research Division of ARS is developing new technology applicable to the cotton ginning problem. The data developed from our study will be used to determine the economic feasibility of this new ARS technology along with abatement equipment developed by private industry.

In the grain area, work was completed on a survey of 251 elevators for their progress in compliance with regulations set forth in the Clean Air Act [23]. It was found that the majority of these firms were waiting for guidelines from State control boards before attempting any renovation for pollution control. An update of this survey has been requested by ASCS and is presently in progress.

Water Pollution

In the fruit and vegetable processing area, several research projects bearing on water pollution are either completed or near completion at this time. One study, just released, concerns the economic feasibility of a new dry caustic peeling process developed at the Western Regional Research Laboratory, ARS [18]. While the initial research was limited to peeling peaches, this technology probably can be applied to other fruits and has

been applied successfully to potatoes. The process could have considerable potential as a pollution abatement technique since much of the waste occurring in the peeling operation is diverted as a solid waste and does not enter into the plant's water effluent.

Our interdisciplinary research shows the possibility of potentially large savings in some areas depending on rates charged for water, sewage treatment and hauling of solid waste. The results should be helpful to the peach canning industry in making decisions regarding applications of this new processing method.

Another research activity in the fruit and vegetable processing area concerns the current status of the tomato processing industry with respect to pollution control. Work is nearing completion on identifying, describing and estimating the cost of waste disposal and treatment practices currently used in the tomato processing industry and determining the changes required to meet the new water control regulations. In 1971, the estimated cost of treating tomato processing wastes was $7.1 million. The major task that remains is to determine the cost of using alternative methods of waste treatment to meet desired pollution control standards. The National Canners Association has agreed to provide us with some data to help answer the above questions. We hope to complete the study by June 1973. Aside from its usefulness on the pollution side, the study will provide an input to our larger subsector systems study of the tomato processing industry.

In our poultry processing research, work has been directed mainly in two areas; one, solid wastes and the other dealing with water pollution. The solid waste environmental research was primarily in cooperation with other ERS divisions.

A contract study was completed for EPA who wanted to know what the effect would be on poultry processing plants if best available technology were applied to reduce wastewater pollution [30]. Findings indicate that poultry plants faced with strict effluent guidelines will need low-cost treatment systems and means to reduce water use and inplant wasteloads. Estimated costs for such installations range from 8 to 23 cents per 100 pounds of lightweight slaughter.

Another study of considerable importance now in the planning stage is an economic analysis of the elimination of giblet processing in poultry plants. This particular operation requires the most water and is the chief source of pollutants in poultry processing. The objective of the study will be to determine the feasibility of, and the effect on, poultry processing costs and revenue from a partial or complete elimination of the giblet operation.

Special Impact Studies

ERS was asked by EPA to conduct short-term impact studies of the dairy and cane sugar industries. Such studies are required of EPA before it can impose standards on a particular industry. These studies are designed to

provide EPA with an analytical framework for determining the economic impact of pollution control requirements upon an industry and an analysis of the expected impact of proposed water effluent standards. Technical data on pollution costs were supplied by EPA.

The work on the dairy industry is the furthest along and so it will serve as an example of the kind of research findings generated by these short-term studies. Pollution control requirements will have an economic impact on the dairy industry. It will not be uniformly felt throughout the industry. Differences will be noted among the subindustries, among plants of different volume grouping and among geographic regions. Variation also will result from plant location regarding concentration of population, access to municipal sewer systems, access to land for private disposal and concentration of milk supplies. The greatest problems will be faced by small plants, cottage cheese plants, cheese plants, butter plants, plants without access to municipal systems, plants in communities with a small population base and northern plants (frozen ground for land disposal). This certainly implies that small cheese plants located in small northern communities without access to municipal systems will be facing the most difficult problems. In fact, few of these plants can be expected to survive if left to their own resources. Increased unit processing costs will not be the major reason for shutdown decisions. For most dairy products, prices could well be raised to reflect the higher unit cost. However, the major factor, especially for small and medium plants, is the high investment requirement for pollution control equipment [21].

Fluid milk plants are in the best position. Most are connected to municipal systems and can make the necessary inplant adjustments. The cheese industry will be most affected by pollution controls--physically and financially.

As presently envisioned, dairy plant pollution control costs should not greatly affect the price of dairy products. This should result in price increases below 2 percent, except for cottage cheese which may have a greater increase. Additional supplies of dried whey, almost doubling last year's marketings, will put pressure on non-fat dry milk prices.

Outlook for Agricultural Processing Industries

Pollution abatement by firms will increase costs substantially and cause certain adjustments in operations. There is no universal solution to pollution control and the impact of added costs will vary from industry to industry and from firm to firm. Firms will seek least-cost solutions to pollution control problems which are affected by firm size, type, location and technology. The extent to which industry adjustments to pollution abatement costs are minimized can have significant impact upon individual firms, consumers and society in general. The development of new technology, particularly that relating to byproduct utilization of recovered waste materials, could be a key item in the survival of many small and medium size

processing and marketing firms in the United States. A major issue in the development and subsequent adoption of new pollution abatement technology is whether byproduct markets can absorb large increases in recycled waste materials from the food processing industries. If byproduct markets can be developed, the net cost of waste treatment will decline and thus lessen pressure on consumer prices.

Conclusions

We discussed some of the concepts concerning pollution control and environmental quality; we reviewed the provisions and implications to agriculture of two new and important environmental Acts concerned with the use of pesticides and the control of water pollution; and we pointed out some of the problems and implications to agriculture of measures to abate pollution from pesticides, plant nutrients, soil sediment, crop residues, animal wastes, feed additives, and agricultural processing wastes. Summaries are presented at the beginning of each of these sections. Therefore, we will limit our concluding remarks to a few conclusions concerning the environment and economics as they relate to agriculture.

Concern for environmental quality is not a passing fad. The Federal and State Governments have enacted new environmental laws and appropriated funds to carry out the intent of these laws. Nevertheless, the present status of environmental quality in the United States could be characterized as having identified the major problems, but only in the beginning stages of developing solutions.

Specifically, in regard to agriculture, the uses of DDT, DES, and compound 1080 (predator control) have been banned. Cotton growers, cattle-feeders and the western sheep ranchers will soon feel the crunch of these restrictions in terms of higher production costs. The "monkey has been on their back" in recent months, but they will not be alone in the future.

Attempts to ban and restrict additional chemicals will surely follow. In addition, compliance with air, water, and noise quality standards will require additional investments as well as increased operating costs for farmers and agricultural processing firms. With increasing costs, we can expect adjustments in the total production of individual commodities as well as changes in the size and distribution of firms in the production and processing sectors. In general, we can expect the additional costs of production to stimulate the trend to increasing size of farms and agricultural processing firms. There are economies of scale to many of the technologies which must be considered to abate pollution.

As we begin to face some of the hard facts in regard to the feasibility and cost of pollution abatement technology, some of the emotionalism

concerning environmental quality should begin to fade. Of course, the environment cannot be improved without additional cost and the public must be willing to pay for it. Also, as we begin to try to solve the environmental pollution problems, we will create second-round problems such as the substitution of the more hazardous organophosphates for DDT.

Agricultural technology is being challenged--technology that was developed, evaluated, and recommended by scientists and proven to be economical by extensive adoption. The scientific community has been aware of some of the hazards involved in the use in many of these technologies, but it has not considered them significant enough to outweigh the benefits. A total social accounting of costs and benefits has not generally been considered.

We need more information, both on the causes of environmental problems and on how our economic system can resolve some of the problems through adequate pricing and incentives. A major thrust of the Economic Research Service in the years ahead will be to assist in more clearly identifying the magnitude of environmental problems and to evaluate alternative strategies and incentives to achieve the level of environmental quality desired by society. At the same time, we recognize that economics is only one factor in the final policy decisions concerning environmental quality.

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