PANEL: AGRICULTURAL WASTE DISPOSAL

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Abstract. Management of livestock manures, crop residues, and other wastes are receiving increasing attention by the agriculture community. The problems are due in part to changes in production practices and in part to the continuing congestion of former open space by people. Agriculture is continuing to take positive steps to maintain and enhance the quality of the environment.

INTRODUCTION

California agriculture has a gigantic waste disposal problem. Annually it involves 5 million tons of animal manure, 28,000 tons of dead animals, 14 million tons of crop residue, some 4 million pesticide containers, and a like number of fertilizer bags. There also are related industrial wastes amounting to some 8 million tons of logging debris and forest product processing wastes and about 2 million tons generated in the course of food processing. In addition, there are in an average year about 11 million tons of fuel consumed in wildfires and some 400,000 tons from control burns.

On-farm crop and livestock wastes alone amount to about 1 ton per person per year. The problem of waste disposal is not unique to agriculture. It plagues town and industry as well and results largely from the affluence of our society.

Any attempt to discuss this subject completely in 20 minutes is an impossibility. I shall merely point out some of the major areas of concern; review the progress in alleviation of agriculturally caused pollution; and attempt to relate the effect of such efforts upon the fish and wildlife resources.

Today's agricultural waste disposal problems are accentuated, in part at least, because of changes in production practices; the continuing congestion of former open space by people; and the community's--including agriculture's--rightful concern for the quality of our environment.

American agriculture has undergone spectacular changes during the last 30 years. Today, one farm worker supplies 45 people compared to 11 in 1940. Never in history has a nation had such an abundant food supply. The consumer, while paying more dollars for food, is paying a decreasing share of his income for food. This amounts to less than 17%, down from 20% in 1960.

Agriculture takes seriously its responsibility to provide a continuing and adequate supply of food and fiber. Another dimension, however, has been added to the effort. This added emphasis is on the effects of modern-day food production practices upon the environment. This concern is shared alike by the producer, the researcher, and those of us in agricultural education.

Animal Wastes

About two-thirds of the 5 million tons of animal manure in California comes from dairies, the remainder from feedlots and poultry operations. Livestock under high-density confinement has management and marketing advantages, but this same high-density confinement of farm animals creates serious waste disposal problems. Examples of such management are 30 acres with 1,000 dairy cows; 50 acres with 10,000 beef cattle; or 5 acres with 100,000 chickens. Even under high-density confinement manure becomes a crucial problem only if there is lack of nearby farmland where manure can be spread. In California, a great many dairy cattle and poultry operations, and even some feedlots, are on the fringes of metropolitan areas.

Too much manure, or manure in the wrong places, may cause various environmental problems. Dust, odor, and flies can result from the difficulty in managing such quantities. Bacteria and other organisms can become a public health problem. Of concern, too, are the plant nutrients, nitrogen and phosphorus, which may get into surface or sub-surface water supplies. In some cases, these may boost nitrate levels in underground water or increase fertility of surface streams. This is not necessarily all bad. Water fertility is essential to food chain development. Other compounds in manure may degrade water by adding to its load of salt.

Recent University of California research has yielded important information about effects of manure on underground water. A project in the Chino Basin investigated the movement of nitrates in soil solutions beneath corrals, pastures and cropland that had received large amounts of manure. This research showed that nitrates carried by water into deep open soils, move downward very slowly--a matter of years--until they reach and remain in the upper levels of the underground water supply. Another U.C. project studied sources of underground nitrates in the Santa Ana Basin, including chemical fertilizer, manure, sewage treatment plants and natural sources. Manure was one of the significant contributors of nitrates. The study also showed a decrease in the amount of fertilizer nitrogen applied to citrus with the development of leaf analysis as a guide to fertilization.

Recycling animal manure back through the soil-plant system is today the only generally accepted means of manure disposal. The uniqueness of soil as an animal waste disposal medium is illustrated by its abilities to fix and immobilize phosphorus and hold nitrogen for use by crops. When applied to a soil, phosphorus is tied up in the surface soils within a matter of hours. The nitrogen is slowly released from manure and is either used by crops; or moves down to the underground with water; or under certain conditions may be denitrified and lost to the atmosphere as gaseous nitrogen.

The nitrogen of manure starts out as mostly urea, ammonia, or organic nitrogen. About half the nitrogen is soon lost by volatilization as ammonia. Nitrification of most of the remainder forms nitrites and nitrates. These can be leached with water under aerobic conditions or denitrified to gaseous nitrogen if conditions become anaerobic. Usually some nitrates are lost by leaching to the deep underground and some by denitrification to the atmosphere.

What happens to the soil itself is a matter of some controversy. Manure adds some organic matter to the soil. But, despite a good deal of research it has never been shown that soil structure is consistently improved. Sometimes there is evidence of improvement, such as better water penetration. Other kinds of organic residues such as rice hulls or straw may do a better job.

Manure contains plant food-nitrogen, phosphorus and potassium. When any one or more of these nutrients is in short supply, plants respond to manure. Traditionally, in California, manure has been valued for its nitrogen; but recent research has demonstrated that its phosphorus and potassium may be more useful. In spite of this, California farmers use relatively little manure because of its bulk and low percent of nutrients--

usually less than 5%; and its relatively high cost compared to commercial fertilizer. Manure accumulates. There is no ready market.

Manure disposal is just another production cost today. Most dairymen, stockmen and poultrymen already realize this. The best they can hope for is that the value of manure as fertilizer and soil conditioner will, in some cases, pay part of the cost of handling and moving for disposal and re-cycling in crops. This means walking an economic and environmental tight-rope. For example, adding just $2 per ton to the cost of dairy manure disposal today would wipe out the California dairy industry's entire net profit. The only alternative may be to raise prices to the consumer to pay for added costs of waste disposal.

California agriculture is cooperating with researchers and water quality control people to develop guidelines so that water quality will not knowingly be adversely affected by waste disposal practices. Among these very likely will be: (1) The "containment of wastes" guideline. This means that neither manure nor manure-polluted water will be permitted to move off the livestockman's property. (2) The "3-to-5 cows per disposal acre" guideline. An acre of cropland can re-cycle the nutrients in manure from a certain number of cows, or their equivalent in steers or chickens. The exact amount depends on cropping procedures, soil, weather, etc. The "3-to-5 cows" figure derives from U.C. research in southern California, under intensive double-cropping. The numbers may well be fewer elsewhere in the State. Under this guideline, manure in excess of the "re-cyclable" amount of any particular acreage will have to be disposed of on some other land, so significant amounts of wastes do not leave the soil-plant system.

Such manure-disposal guidelines are tied to a larger issue, the use of land. The prospect of tighter regulations for manure disposal points directly to another requirement for environmental protection, namely broader and more effective land-use planning and control. That, in fact, may be the master key to solution of a lot of environmental problems in California.

Crop Residues

California's 8.5 million acres of field and row, and tree and vine crops production result in well over 14 million tons of cellulosic waste annually. These crop residues are disposed of in several ways: incorporation into the soil; feed for livestock; burning; etc.

Soil incorporation of crop residues may influence the physical, chemical and biological properties of soil. While there are recognized benefits, these are not without some hazard. The incidence of diseases and insects always needs to be considered when determining the feasibility of soil incorporation of plant residues.

The economic necessity of double cropping is another limiting factor to soil incorporation. Double cropping involves planting a second crop following early summer harvest of a first crop such as cereal grain. Though there are exceptions, burning of straw and stubble facilitates tillage and seedbed preparation, and in certain instances, reduces insect damage during germination and early seedling growth.

Burning crop residues contributes in a minor way to the gaseous air pollution problem--particulates or smoke are the main points of objection. The State of California has established rules for burning crop wastes and will soon do so for burning for range improvement and forest management. Burning is now permitted only when meteorological conditions favor rapid dilution and transport of smoke away from centers of population.

About three-fourths of the crop residues are already disposed of by means other than burning. Virtually all of the vegetable crop waste is disced back into the soil shortly after harvest. Nearly 70% of all field crop waste is returned to the soil. Over 85% of the citrus waste is mechanically shredded, and much of it left on the soil surface to decompose. Commercial firms or on-farm equipment chip or shred nearly 65% of the deciduous fruit, nut and vine crop waste.

There is more to crop residue disposal than just incorporating the material into the soil. Extensive studies currently underway deal with the effect of incorporation of these wastes upon certain plant disease and insect pests. Other studies deal with methods of improving combustion efficiency of field burning, including mobile incinerators and various other ways of disposal of these wastes.

Soil incorporation of plant residues aids in preventing pollution in two ways. The most obvious is by elimination of burning. The other is through the tie-up or utilization of nitrogen for residue decomposition, during which time the nitrogen resists leaching and is later available for recovery by crops.

Brush Management for Range Improvement

Since 1945, California cattlemen and private rangeland operators have control-burned over 2 million acres under permit for range improvement. This removes "less desirable" woody vegetation which is followed by reseeding where necessary with forage species to provide more feed of better quality for domestic cattle. Such burning also has increased the amount and quality of feed as well as improved the habitat for wildlife. Conducted by private landowners under supervision of the California Division of Forestry, control burning also provides additional benefits to adjacent urban communities in the form of increased water yield, reduced fire hazard, and improved access for sportsmen as well as cattlemen.

Control burning has decreased over the past several years. This is due in part to chemical and mechanical control, which have significantly increased. Chemicals frequently are used to control regrowth of undesirable species following control burns.

The California Air Resources Board will soon adopt agricultural burning regulations for forest management and range improvement. These will create the paradoxical situation wherein strict regulations will be imposed on burning for range improvement but, of course, no regulation can be put on wildfires. It is noteworthy that during the 5-year period 1964-68 there was an average of about 11,300,000 tons of fuel consumed from some 266,000 acres of wildfires while the 58,000 acres control-burned involved about 400,000 tons. Over one-half the control-burned area was reburns accounting for the reduced fuel volume. On this basis it has been calculated that wildfires emitted each year an average of over 96,500 tons of particulate (smoke) as compared with some 3,600 tons from control-burns.

It is difficult to assign an exact value to open areas created within brush fields as a means of wildfire hazard reduction. Candid judgment suggests the result is positive. State Board of Forestry policy recognizes controlled burning as a method appropriate to the development, management, and conservation of natural resources of California.

Agricultural Chemicals

Because residues from agricultural chemicals are classed as wastes, I shall comment briefly on pesticides and fertilizers. These will continue to be significant factors in assuring an abundant and wholesome food supply.

Pesticides

Unfortunately, fish and wildlife losses caused by pesticides have occurred. Usually they result from carelessness or from use of toxic materials in ways that could have been avoided. Research on the possibility of more subtle, long-range effects must continue in order to determine the full extent and seriousness of this aspect of the problem.

Largely as a result of intensified educational programs and strict enforcement of regulations, incidents of fish and wildlife losses have been significantly reduced. There were fewer reported fish and wildlife losses from pesticide poisoning in 1970 in California than in any of the previous 10 years. There was not a single reported fish die-off in 1970 attributable to pesticides. There were three wildlife losses reported in 1971. Statistics on fish were not yet tabulated my last inquiry indicated.

Modern techniques of food production require pesticides. Therefore efforts are being intensified and directed toward: (1) continued effective educational programs in proper use and safe handling; (2) development of new or better methods of pest control, including new and better pesticides as well as biological control; and (3) more effective regulation.

Pesticide monitoring in California admittedly has been somewhat fragmentary and uncoordinated. The California Department of Agriculture has one of the better programs in the United States. Further improvement of data management techniques will result from the recently initiated interagency Monterey Basin pilot monitoring project which includes agricultural chemicals. Objectives of the project are to "Design an efficient and effective monitoring program which will trace the source, movement and fate of environmentally harmful substances and determine the extent to which this can be planned and implemented by a multitude of agencies with separate interests and responsibilities with regard to environmental quality." Hopefully this may be extended to a Statewide, continuing and coordinated effort. New legislation which now requires licensing of pest control advisors should further the proper use of pesticides.

Commercial Fertilizers

Commercial fertilizers contain just a few of the nutrients already present in a productive soil. They are used to supplement the soil's nutrient reservoir when plant nutrients are low or deficiencies occur. The more usual identifiable deficiencies in California soils include nitrogen, phosphorus, zinc, sulfur and potassium.

Nitrogen and phosphorus compounds are the two plant nutrients of major concern when discussing fertilizers as related to pollution.

Nitrogen may be the main offending constituent found in most surface water supplies because its presence in relatively small amounts can stimulate algae growth and have an effect on fish and wildlife. Nitrates are present in underground water supplies in many areas of California. It should be emphasized, however, there have been no reported cases of nitrate poisoning to children (blue baby disease) from water supplies in California.

Agriculture accepts the fact it is a part of the problem. But it is also a part of the solution. Removal of nitrogen by re-cycling through crops is one of the few available ways to reduce nitrogen in water supplies.

There are other sources of nitrogen, besides animal waste and commercial fertilizers. Other sources include nitrogenous wastes from people, nitrogen fixed from the air by legumes, micro-organisms, electrical storms and internal combustion engines (smog); and native or fossil nitrogen and organic matter accumulated under natural conditions. The latter is a prime source. For each 1% of organic matter in an acre-foot of soil there will be over 1 ton of nitrogen.

The possiblity of phosphorus from commercial fertilizer contributing to pollution of groundwater supplies is rather remote. The chemistry of phosphorus fertilizers in soils indicates it does not move through soil to any extent. Phosphorus from agriculture enters surface waters in conjunction with sediments. The amount of water soluble phosphorus from sewage effluent in the United States is over six times as great as the amount assumed coming from sediments.

Soil and plant tissue analyses are in use for some crops and are being perfected for others. Such techniques to guide fertilization practices will help to avoid over-fertilization--a factor with some crops--and aid in timing of applications to match crop needs. Greater attention is being given to irrigation water management to control leaching losses since the concentration of nitrate in soil water can be varied by the volume of water applied as well as by the quantity of nitrogen applied. Farmers should take the nitrogen content of the irrigation water into account and include it as a part of the total fertilization regime.

Further techniques to alleviate environmental problems can be expected as research continues. An example of one research effort is the unique interagency Firebaugh study on the occurrence of nitrogen and methods of removal from agricultural waste waters of the San Joaquin Valley. Another is the research program of the University of California's Kearney Foundation of Soil Science 5-year program devoted exclusively to nitrate problems.

Used Pesticide Containers

The magnitude of the container disposal problem is emphasized by the fact that an estimated 3.9 million agricultural pesticide containers required disposal in California in 1969. The estimated number of each type is as follows:

55-gal. metal drums	8,000
30-gal. metal drums	98,000
Small metal containers	346,000
Paper sack	3,239,000
Other paper containers	8,000
Glass containers	91,000
Plastic containers	81,000
	3,871,000

These figures do not include pesticide containers from public health and structural pest control operations.

There are several California State Codes which contain sections applying to safe handling and disposal of used pesticide containers. Even without an organized program and formal procedures, handling and disposal of used containers has not been a serious problem. This does not mean we should not strive to improve. Accordingly, in 1970 a joint inter-governmental and industry effort has led to developing tentative guidelines for the safe handling and disposal of used pesticide containers in California. It includes instructions to persons receiving permits to use injurious materials, and guidelines for safe handling, field rinsing, transportation, storage, decontamination and reclamation or disposal.

A continuing problem is the lack of approved landfill disposal sites suitable for the disposal of the used pesticide containers. Another deterrent to orderly progress has been the unfavorable community reaction to a proposed disposal site.

Sediment

Sediment is a generally recognized major water pollutant. Stream flow is the primary transport vehicle. While certain agricultural operations contribute to the problem, improved practices have greatly reduced sediment damage. Again agriculture is not the sole offender. Urban areas under development, exposed banks from road construction, as well as fully and stream banks not associated with any agricultural operations also add to the sediment load.

Research and field observation have produced much useful information on sediment properties, yield, transport, deposition, and the behavior of stream channel systems. Application of this technology continues to be a principal component of several United States Department of Agriculture agency programs as well as University of California research and education efforts. Complete elimination of erosion is virtually impossible.

Salt Balance

All irrigation water contains salts in varying amounts. These accumulate as water is removed by growing crops or as water evaporates either through the leaves of plants or from the soil surface. This concentration of salts is referred to as evapotranspiration. The resulting saline solution sooner or later must be leached out of the root zone. Unless drainage waters remove appreciable quantities of these salts production and crop adaptability will be adversely affected. The need for a favorable salt balance is a fundamental principle for a continuing irrigated agriculture.

Besides fertilizers, animal manures, and soil amendments, municipal and industrial wastes also add to the general salt load. The establishment and maintenance of a favorable salt balance is one of the most critical and unresolved waste disposal problems facing California agriculture.

Farmers can manage individual on-farm drainage by installation of artificial drainage. But off-farm drainage presents a far more complicated problem. Solution here will require the joint effort of agriculture, industry and the urban sector since it will involve such public policy matters as transport, disposal and financing.

Agriculture has much in common with the fish and wildlife resources. Among these is the fact that each continues to be victimized by certain polluting influences. Damage to crops from air pollution alone was estimated at $44.5 million in 1970.

Let me repeat: Additional emphasis is being given to the effect of modern-day food production practices upon the environment. Agriculture is cognizant that certain of its practices at times can be the source of irritating or potentially harmful pollutants. Agricultural waste disposal like any other ecological problem cannot be solved in an atmosphere of emotionalism or government decree. Often overlooked are such facts as cost and what the effect of the alternatives may be.

It is unfortunate that agriculture is faced with public misunderstanding and even mistrust. Agriculture is not the wanton despoiler of the environment as some have seemingly concluded. Agriculture has far too great a stake in the environmental resources. The nation's very food supply is dependent upon clean air, uncontaminated soil, and quality water.

Solutions to environmental problems are not likely to be easily accomplished in most instances. Agricultural waste management is exceedingly complex. There is no easy solution. Agricultural research is addressing itself to these problems. Even while the research effort is in progress it is proceeding to implement pollution alleviating practices where the scientific information and technical know-how is available.

Alleviation of any agriculturally-caused pollution will enhance fish and wildlife resources, in many instances. Among positive steps by agriculture are: (1) preventing nitrogen escape into surface or subsurface water supplies whether from confined livestock operations or commercial fertilizers; (2) pest management programs such as the strip planting employed for control of lygus bugs in cotton by use of alfalfa as a trap crop, and increased use of biological control; (3) better trained and licensed pesticide advisors and stricter enforcement of regulations in use and handling of necessary pesticides; (4) increased use of mechanical equipment for range improvement; and (5) continued development and application of improved practices on crop, pasture, range and forest lands to further reduce sedimentation.

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