Environmental protection during animal disease eradication programmes

H.A. McDaniel *

Summary: This paper identifies animal disease eradication (ADE) programme activities which may have a negative impact on the environment. It suggests ways to lessen the impact of such activities without compromising the programme objectives. Reducing losses from livestock and poultry diseases with prevention, control and eradication programmes produces a net positive impact on the environment. An Environmental Impact Statement (EIS) should be integrated into the planning of any ADE programme. Decision-makers should give due consideration to the environmental effects of ADE programme activities, together with cost, personnel needs and other, more traditional, management concerns. A better environment will be a supplemental benefit from ADE programmes.


INTRODUCTION

This paper identifies ways of protecting the environment in the course of animal disease eradication (ADE) programmes. Three basic types of ADE programmes are discussed. The activities with the highest risk to the environment are carcass disposal and application of disinfectants and pesticides. Methods to minimize these risks are presented. This information also may be useful for preparing an Environmental Impact Statement (EIS) on an ADE programme, especially on plans for an emergency response to an exotic disease epizootic. Animal disease prevention, control and eradication programmes are compatible with and complementary to environmental protection.

When diagnosed and eradicated without delay, epizootics cause significantly less environmental contamination than when they are allowed to linger and spread. It is therefore in the best interest of the environment, the food animal industries and the consumer to take fast and decisive measures to stop epizootics as soon as possible.

Fewer animals could sustain the same or higher levels of herd productivity if the disease toll were lowered (6). This could reduce environmental problems in areas where overgrazing is the cause of desertification.

In the United States there are many national, state and local laws and regulations to protect the environment. The National Environmental Policy Act requires an EIS

* Veterinary Services (VS), Animal and Plant Health Inspection Service (APHIS), United States Department of Agriculture (USDA), Hyattsville, MD 20782, United States of America.
for any major federal action which significantly affects the quality of the human environment (5). Many other countries and international agencies have similar laws which also require an EIS (10).

By formulating an EIS in advance, it is possible to avoid court-ordered programme delays while a statement is being prepared. At any given time in the United States, there are approximately 300 active litigations (lawsuits) involving environmental issues in the Land and Natural Resources Division of the Department of Justice. About half of these suits are filed because the accountable agency did not prepare an EIS (5).

Certain animal diseases, especially those which spread rapidly and are not endemic in an area, can be devastating when an epizootic occurs. Such diseases are often called “exotic diseases”, and the response is referred to as an “emergency programme” (12). Since the losses from some of these animal disease outbreaks are comparable to the damage caused by natural disasters, such as floods or tornadoes, “emergency” seems an appropriate term, indicating that this activity has the highest priority.

Plans for an emergency programme against an exotic disease should be developed in advance so that the campaign can begin in a matter of hours, or at least within a day or two after the diagnosis is confirmed. An EIS should also be prepared in advance to cover the plans for responding to epizootics. The EIS would be of benefit to officials responsible for implementing ADE programmes, and the fact that the EIS had been considered during the deliberations would become part of the record. Careful planning and execution will reduce the probability of any adverse environmental impact resulting from ADE activities. If proper precautions are taken any adverse impacts which do occur will be short-term and temporary. These should not be a reason to abandon sound ADE programmes. The benefits to the environment of ADE programmes will outweigh the cost. Healthy, productive domestic animals and wildlife are a long-term environmental asset.

STRATEGIES FOR CONTROLLING ANIMAL DISEASES

Most diseases of food animals are effectively managed by the owner, frequently with professional help from veterinarians. However, for certain diseases which spread rapidly or present other problems, control by owners is not feasible. Intervention by governmental agencies responsible for animal health matters is required to plan and execute ADE programmes designed to manage these diseases. Management strategies to control diseases without having a negative impact on the environment are of primary importance for such programmes.

There are four basic types of ADE programmes to stop epizootics:
1. Therapy
2. Vaccination
3. Destruction of the pathogen before damage is done to the host
4. Depopulation of infected and exposed animals.
These may be applied separately, simultaneously, or in phases. For example, phase one might consist of vaccination and vector control. After the incidence decreases, depopulation could be instituted. In some cases, vector control may be all that is needed to control certain diseases of domestic animals and wildlife. Support systems, such as quarantines and inspections, are usually necessary for ADE programmes.

In the first category, treatment is applied to combat the pathogen. In a typical veterinary/client relationship, treatment is administered only to the clinically affected animals, but may also be applied to control a disease or pest within the entire production unit. For example, antibiotics may be administered into the udder of dairy cows as they are dried to prevent mastitis. Or, to take another example, bee hives may be treated for varroasis.

In the second type of programme, vaccines are given to stimulate production of protective antibodies (11). If the life cycle of the pathogen includes arthropod vectors, they must be controlled until protective immunity develops. Vaccination and vector control programmes are the preferred method against diseases such as Venezuelan equine encephalitis or African horse sickness, in which a biological vector (mosquito or gnat) is the usual source of the causative agent and the primary means of spread. Vaccination should be repeated, usually annually. If arthropods carrying the pathogen feed on susceptible hosts, they will become infected and produce more pathogens; this, in turn, will cause more arthropods to become carriers and the epizootic will begin all over again. After the first epizootic is controlled, however, animal owners, with help from veterinarians, may be able to continue the programme without regulatory intervention.

The strategy for the third type of programme is to destroy the pathogen or vector outside the host before any damage occurs (13, 14). Pesticide is usually applied as a spray or dip to eliminate mites, ticks, gnats, mosquitoes and other pests which inflict direct damage when they feed on animals or which transmit the pathogens they are carrying. When the arthropod pest has multiple hosts, the pesticide may be dispersed over large areas from aircraft or with surface sprayers to supplement host spraying and dipping. All pesticides used should be registered with the Environmental Protection Agency (EPA) and directions supplied by the manufacturer should be followed.

A novel method of destroying pathogens before they reach host animals has been used to eliminate screwworm (*Cochliomyia hominivorax*) from large areas. Pupae reared in a laboratory were irradiated and released from aircraft. Female screwworm flies mate only once; if they mate with a sterile male, their eggs never hatch.

The strategy of the fourth type of programme is to destroy the pathogen by taking measures against the infected host. With the current level of technology, it is impossible to distinguish all infected from noninfected animals, and the entire herd or flock must be depopulated if the pathogen is to be completely destroyed (1, 15). However, biotechnology and other advances in science are providing much better diagnostic procedures and reagents. Soon it may become possible to separate all infected from noninfected animals, and entire herds or flocks will no longer have to be depopulated. If all animals are not destroyed, some of the infected ones may recover and remain long-term inapparent carriers. If vaccines are available and used, it is unlikely that immunized animals will develop clinical signs of disease; however, they may still become infected and remain carriers indefinitely. Whole herd depopulation, or stamping-out, programmes are most often used against epizootics of African swine fever, hog cholera, velogenic viscerotropic Newcastle disease and foot and mouth disease. It is often necessary to dispose of the carcasses in a manner that will prevent further spread.
Restricting the movement of potentially hazardous animals and animal products by issuing quarantines and mandating inspections is an essential part of almost all ADE programmes. These measures are also essential for protecting the environment; domestic and wild animals are indeed important elements in the environment and deserve protection.

In general, one of the first epizootic response activities is to place a quarantine both on the area where the disease occurs and on an additional buffer zone. The quarantined zone should include such facilities for marketing animals and products as abattoirs, milk pasteurization plants and egg processing plants. After herds or flocks have been inspected and found safe for marketing, a temporary permit is issued to allow direct movement to the designated marketing facility where routine inspection and testing are supplemented. When the marketing facility is located in the quarantined zone, "permitted" marketing is easier to manage.

For diseases which generally spread by direct contact, the outer boundaries of the quarantined zone should extend approximately five miles beyond all herds or flocks which are known to be infected, unless epidemiological data indicates that the area should be smaller or larger. It is likely that the disease will already have spread to areas where signs have been unobserved or unreported; wild animals which may spread the disease can range several miles. When the disease is arthropod-borne, the distance between the infected animals and the quarantine boundary depends on how far the arthropod can travel in the area at the time in question. Such a distance is usually much greater than five miles and is sometimes hundreds of miles. However, one or two miles is usually adequate to stop outbreaks of hog cholera. Swine are the primary host for this virus and biological vectors are not usually involved. It is preferable to encompass the disease early by imposing a quarantine on a large area at the beginning of an epizootic rather than repeatedly expanding the quarantined area.

Area quarantines are usually released six to twelve months after the last evidence of disease (8). Active disease surveillance and inspection are conducted as long as an area is under quarantine. A well-trained veterinarian can often identify diseased animals even before the owner suspects that there is a problem.

The economic burden caused by disease and quarantines can be alleviated by providing an adequate number of well-trained veterinarians and technicians to conduct inspections and issue movement permits for marketing purposes. Otherwise, an undue hardship will be imposed on producers with animals or products ready for market. The value of animals and products decreases rapidly if they are not marketed as soon as they are ready.

To reduce spread within the quarantined areas, quarantines on premises are also imposed on individual herds or flocks as soon as the disease is suspected. Such quarantines are usually released 30 days after all animals have been depopulated and the cleaning and disinfection of premises have been completed. Guards stationed at the farm entrance enhance the effectiveness of quarantines by ensuring that everything which leaves the farm is properly disinfected. The guards are removed as soon as all infected and exposed animals have been killed. If vaccines have been applied, quarantines on premises are usually released 30 to 90 days after vaccination.

If a disease is chronic, such as brucellosis, tuberculosis or scrapie, area quarantines are generally not applied. However, premises usually remain quarantined for more than one year after the last indication of disease or positive test. The incubation period
for this class of disease may be several years. The duration of herd quarantines is
determined by the disease; premature release should be avoided.

Keeping herds under quarantine for long periods and repeatedly testing the animals
are expensive for both the owner and the veterinary administration. Owners will often
accept an incentive payment comparable to the cost of continued testing and agree
to slaughter the entire herd.

If sound ADE programmes are not implemented when epizootics occur, the
environmental consequences may be disastrous. Markets would be likely to embargo
the animals and products from infected farms, and possibly those from the entire
area. No market can afford the reputation that it spreads disease. The level of
environmental pollution (EP) would quickly become disastrous if all milk from large
dairies, or eggs from large flocks of layers, were dumped on the premises. The
problems would soon be compounded by animals starving and dying because there
is no money for feed. The soil, water and air pollution levels might become so high
that ‘quality living’ in the area would not be possible. The lack of ‘humane care of
animals’ might even provoke demonstrations and riots. If animal-producing and
marketing industries, or responsible regulatory agencies, disregarded diseases, they
would become as guilty of EP as those responsible for causing acid rain, depleting
the ozone layer or fouling streams, rivers and oceans.

ACTIVITIES MOST LIKELY
TO HAVE A NEGATIVE ENVIRONMENTAL IMPACT

On infected premises, the ADE activities most likely to pollute the enviroment
are: carcass disposal; cleaning; application of disinfectants and pesticides; elimination
of flies, rodents, birds, predators and other carriers with poisoned bait. Throughout
the quarantined area, pesticides may be used to dip or spray animals, or they may
be dispersed over the entire area by aircraft or with surface sprayers.

CARCASS DISPOSAL

Without proper disposal, by-products of carcass decomposition can become a
temporary problem. Carcasses still containing viable pathogens can be a source of
further spread if the meat is eaten by susceptible carnivorous species such as pigs,
or carried to other farms by scavengers.

The British Veterinary Services have provided the best information available on
carcass disposal (1, 3). Their recommendations for preparing fire beds, estimating
fuel needed to burn carcasses and preparing burial pits on the farm have been used
by animal health agencies throughout the world.

When animals must be killed on the farm, the methods generally recommended
for carcass disposal include burial, burning and rendering. The carcass disposal
methods which are discussed below are not precise. Procedures must be adapted to
solve the unique problems found on each premises and ensure that any unavoidable
EP is minimal and temporary.
Burial

If satisfactory sites are available, burial is usually the safest, least expensive, fastest and most convenient method for disposing of large numbers of livestock or poultry carcasses on the farm. Soil type, water table, available digging equipment and many other factors may alter the recommended dimensions for burial pits. However, pits which are seven feet wide and nine feet deep are usually satisfactory. In a pit nine feet deep, the bottom three feet contain the carcasses and the top six feet the soil removed earlier. The length depends on the number of carcasses to be buried. Fourteen square feet are required at the bottom of the pit for each adult bovine carcass. To estimate the size of the burial pit needed, five mature hog or sheep carcasses are considered the equivalent of one adult bovine carcass. For each additional three feet in depth, the number of carcasses may be doubled. All carcasses should be covered with at least six feet of fill soil.

Owing to their bulky feathers, poultry require more burial space per unit of weight than cattle, hogs or sheep. The size of the required burial pit can be estimated for each class of poultry by counting the number of carcasses needed to fill a space of known dimensions, such as a truck bed. For example, if 4,000 adult Leghorn layer carcasses filled a truck bed twelve feet long, six feet wide and four feet deep, about one cubic foot of space in the burial pit would be needed for every fourteen carcasses.

Carcass decomposition releases by-products which may have a temporarily negative impact on the environment. The exact time required for buried carcasses to decompose is not predictable; temperature, moisture and other factors affect the rate of decomposition. However, the risk is highest from two to ten weeks after burial. Selecting a proper burial site is extremely important. Groundwater contamination is always a concern, especially when one or two inches of rain fall a few days after carcasses have been buried, causing the water table to rise above the level of the carcasses. Groundwater levels should always be determined before a site is selected. It is a good idea to dig the burial pit the day before the depopulation is scheduled. If groundwater seeps into the pit overnight, the site should not be used.

Fine dry soil will absorb fats, gases and other decomposition products better than coarse wet soil. Good drainage is important; low flat areas should not be used. If questions concerning burial sites cannot be resolved, a hydraulics engineer or other professional with expertise in soil and water properties should be consulted. Permits may be required in some locations.

Underground structures, such as gas, water and utility lines, should always be precisely located before digging begins. Structural damage such as the rupture of a line can be caused by the excavating equipment, and the shock waves or vibrations caused by heavy earth-moving equipment may also cause small breaks which may not be readily detected.

All burial sites should be inspected at least weekly for approximately ten weeks or until the fill soil has settled and the pit has been refilled at least once. Contracts for preparing burial sites should include clauses requiring operators to refill the burial sites after the soil settles. Two, or even three, return trips may be required.

Large burial pits may reduce the value of the land for future construction sites. In some locations, excavation for foundations must extend beneath undisturbed soil. However, the fact that a burial pit was located on the site years ago would not be regarded as EP in most EIS's.
**Burying carcasses in sanitary landfills:** most large, well-managed landfills receive massive amounts of waste daily from private homes, businesses and other sources. All the dumped waste is buried before the end of each day. Flies, rodents, predators and scavengers are controlled. Loads of carcasses can be strategically placed amid the other waste; this helps absorb the decomposition products from the carcasses. Traditional burial problems seldom occur as long as the total carcass volume remains relatively small.

**Carcass decomposition after burial**

Having a general understanding of the decomposition process which carcasses undergo after burial will help in devising the best procedures for use on each farm and reduce any temporary adverse impact on the environment.

The components of buried carcasses can be roughly divided into four categories according to the rate of decomposition after burial. What follows is a review, by category, of this process.

**Category 1:** Body fluids and soft tissue other than fat comprise the first group. They are the first to decompose. Autolytic and microbial decomposition occurs rapidly. Muscle and viscera first undergo slight swelling; this is soon followed by necrosis, cytolysis and liquefaction. The decomposition process mainly produces aqueous liquids and gases. Large amounts of gases accumulate in the decomposing tissue and soon escape from the burial pit through cracks and crevices in the fill. If the fill is packed too tightly, the escaping gases will be more disruptive to the cover and make it easier for insects and predators to reach the carcasses.

Unpleasant odors will be detectable for miles, especially downwind, if the burial sites are too shallow. Scavengers, attracted by such odors, will attempt to dig up the carcasses and carnivorous insects will deposit eggs in any accessible part of the exposed carcass. Slashing carcasses to open body cavities and hollow organs may help only minimally to prevent gases from becoming trapped in these spaces. Carcasses, or parts of carcasses, may still rise to the surface, especially in very wet soil. The decomposition gases trapped in decaying tissue reduce the specific gravity of the tissues so that they become lighter than soil or water. Much as the bodies of drowning victims rise to the surface of the water, if the fill dirt does not provide sufficient resistance, the carcass or parts will 'float up'.

Although burying carcasses immediately after depopulation is a difficult task, it is less frustrating than reburial after decomposition and float-up have begun. As saturated ground seldom supports the weight of heavy earth-moving equipment, it may be advisable to haul in and dump soil on the carcasses.

**Category 2:** Fats comprise the second category of carcass decomposition components. If carcasses are improperly buried, fats cause the most severe impact on the environment. Lighter than either water or soil, when released from carcasses fats will rise to the surface unless they are first absorbed by the soil. Rancid, dark colored fat, bubbling like small geysers from new burial sites and forming small streams which run fifty yards or more from the site, is unsightly and malodorous. If such fat reaches streams or lakes, the EP may be quite serious. While small dams will impede the flow, dikes surrounding the burial site with a height of one to two feet are better suited to contain the liquids temporarily. More soil than that needed to cover the carcasses will always be excavated. This soil can first be used for dams or dikes; as soon as the fill settles, it can be used to refill the burial pit.
Unless they run off or are absorbed by the soil, fats and other decomposition fluids remain in the burial pits. They rise to the surface when the soil settles to the bottom to occupy the space previously taken by the carcass fats, fluids and soft tissues. Burial sites may become pools covered with rancid fat if they are not refilled properly and punctually.

**Category 3:** Skin, cartilage and hair or feathers are the principal tissues in the third category. They decompose slowly but are usually not problematic.

**Category 4:** Bones, horns and hooves comprise the last category. They require the most time to decompose; fragments may remain for years, but seldom cause particular difficulties.

**Burning**

Biological incinerators provide an environmentally and biologically safe carcass disposal system. Such incinerators are often designed to reach a pre-heating level of nearly 2,000°C; they generally have an additional burner near the base of the smoke-stack to assure that the gases and smoke are also burned. Virtually no odors or smoke can be detected from properly designed and operated biological incinerators. These incinerators, however, are very expensive to purchase and operate, and they seldom have a capacity sufficient to incinerate all of the carcasses which result from depopulating a large herd or flock. Opportunities to use biological incinerators are therefore limited, although they are very good for burning small numbers of poultry carcasses. When post-mortem examination of large animals is conducted on farms, carcasses can be quartered or even cut into smaller pieces and placed in plastic bags. Once the bag has been disinfected externally, it can be taken to biological incinerators for disposal.

**Carcass burning on the farm** usually requires long fire lines or large pyres which produce heat, smoke, vapor and odor in amounts unacceptable for many locations. Fuel and labor costs are also high. Carcasses should be burned only in remote and sparsely populated areas. The odor of burning hair and flesh is not pleasant, and that of burning feathers is even more of a nuisance. Consideration should be given to utility lines and other structures which may be damaged by heat. Heat may cause paint on nearby buildings to blister and metal fences to rust and corrode prematurely. Heat readily damages plants, particularly trees situated downwind from the fire.

The two most important instructions to follow when burning carcasses are:

1. Use enough highly combustible material to ensure that the carcasses are quickly heated and sufficiently hot to ignite the fat as soon as it begins dripping from the carcasses (the combustible material must also keep the fire hot enough to burn all the fat until the carcasses are reduced to bone fragments and ashes).

2. Provide enough air space beneath the fire to guarantee adequate air circulation for a hot fire even after ashes and bone fragments from the carcasses have accumulated beneath the fire-bed.

The direction of the prevailing wind is a primary consideration when designing a fire-bed. The fire line should be placed at a 90-degree angle to the wind for maximum ventilation. Air space can be provided by digging trenches parallel to the wind; these trenches should be approximately 5 feet long and 9" X 9" and placed at two-foot intervals on the fire-bed site. Another method of ventilation is to elevate the fire-bed
so that air can enter from beneath. A combination of trenches and elevation will also provide adequate ventilation. Bales of straw and timbers laid parallel to the prevailing wind at two-foot intervals, with an additional layer crossing the bottom layer, also provide space so that air can enter from beneath and rise to the fire-bed level. Tiles, bricks, rails, scrap angle iron or other forms of metal may also be used to support the raised fire-bed and provide ventilation space.

In estimating the fuel needed to burn carcasses (Table I), as with burial pit capacity, one adult bovine is considered equivalent to five adult sheep or hogs. One yard of fire line is needed for each adult bovine or the equivalent. However, two pigs, two goats or two sheep can be placed on top of each bovine carcass without expanding the fire-bed.

TABLE I

Estimated fuel needs for burning of carcasses

Amounts needed to burn one adult bovine or equivalent

<table>
<thead>
<tr>
<th>Material</th>
<th>Fuel needs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Straw</td>
<td>3 bales</td>
</tr>
<tr>
<td>Heavy timbers (1' x 1' x 8')</td>
<td>3</td>
</tr>
<tr>
<td>Kindling wood</td>
<td>50 lbs</td>
</tr>
<tr>
<td>Tires *</td>
<td>4</td>
</tr>
<tr>
<td>Coal, large lumps</td>
<td>500 lbs</td>
</tr>
<tr>
<td>Liquid fuel **</td>
<td>1 gal</td>
</tr>
</tbody>
</table>

* Burning tires produce a great deal of heat; unfortunately, they also produce a considerable amount of black smoke and small particles of soot may be deposited over the surrounding area.

** Waste motor oil, furnace fuel, kerosene or diesel fuel is satisfactory; however, gasoline must not be used.

Tires, lump coal, wood, loose straw or similar material is placed on the fire-bed and some is allowed to fall loosely into the spaces beneath the fire-bed. After carcasses are placed on the fire-bed, the flexor and extensor tendons should be cut to prevent legs from being extended during burning; long-handled pruning shears are good for cutting tendons. Next, the fire-bed should be soaked with the liquid fuel and ignited immediately.

This type of fire should quickly become hot enough to burn fats and to inactivate most of the pathogenic micro-organisms. However, a certain amount of vapor containing viable viruses may still rise from the carcasses and thereby constitute the first step in aerosol spread of the pathogens. Foot and mouth disease spread has been attributed to aerosol dissemination of the virus (2).

In areas where the burning of household trash and leaves is prohibited, burning carcasses in open fires would no doubt be illegal without a special permit. Burning carcasses does not pollute the air as much as certain fuels, such as old tires, but the risk of some air pollution does exist. Local fire departments are good sources of information on the legal aspects of open-fire burning. Local public officials responsible
for environmental protection should always be consulted before carcasses are burned in open fires.

Rendering

Rendering is a process in which inedible carcasses are ground and then heated under pressure to extract valuable products, such as fats, protein concentrate and minerals.

If logistically possible, the safest and fastest as well as the most efficient and inexpensive way to dispose of carcasses is to move them from depopulated farms to rendering plants. Rendering plants must be designed and operated in a manner which ensures that raw products are biologically secure until all pathogens have been inactivated. Finished products which may be used for animal feed must not become contaminated by raw products. Insects, rodents and scavengers must be strictly controlled. Vehicles used to haul raw products to rendering plants must be thoroughly cleaned and disinfected before they leave the plant. Rendering plants are not always within a feasible distance; even when one is available, its capacity may not be sufficient for large herds or flocks.

The only animal pathogens reportedly able to survive the heat of rendering are the causative agents of spongiform encephalopathies, such as scrapie and bovine spongiform encephalopathy. A modified rendering process and changes in the procedures used to extract fat may explain how these agents survived the rendering process. More data are needed.

Blood, excrement and fluids often escape from carcasses when animals are killed on the farm and the carcasses are transported to rendering plants. Trucks hauling carcasses should be covered and leak-proof. As an additional safety precaution, two to four inches of relatively dry soil, manure, straw or hay should be placed on the truck bed before the carcasses are loaded in order to absorb the fluids which escape on the way to the rendering plant. Empty vehicles will be easier to clean and disinfect.

CLEANING

Facilities where livestock or poultry are maintained become contaminated very soon after the animals become infected. Faeces, urine, saliva and air expired from infected animals often contain massive numbers of infectious organisms. To prevent the infection of healthy animals, measures must be taken to ensure the removal or inactivation of all such pathogens before the depopulated premises are restocked.

The removal of manure is usually the first stage of cleaning. Traditionally, manure is spread on fields to improve productivity and enhance the environment. This procedure may be satisfactory during ADE programmes if the soil is turned so that the manure is covered within 24 hours. If manure is allowed to remain uncovered too long, however, feed, insect larvae and worms in the manure will attract birds and scavengers which may become contaminated and spread the pathogens to nearby farms.

If the spreading of manure on fields presents too high a risk, manure may be left in a pile with the most hazardous portion in the middle. Owing primarily to internally generated heat which is sufficient to inactivate almost any pathogen, manure
will undergo a decomposing process. If the manure pile is also covered with sheets of polyethylene or similar material, and held in place with used tires or other anchors, even the pathogens on the surface of the pile will be contained until inactivated. After 40 to 60 days, these manure piles should be sufficiently safe to spread on fields.

Once most of the manure, feed and debris have been removed from the area where animals had been kept, an industrial vacuum cleaner should be used to remove most of the remaining particles. For items that are particularly difficult to clean, such as rusty bird cages covered with dried, caked manure, a steam cleaner may be needed. Steam and vacuum cleaning are generally faster, less expensive and less likely to pollute the environment than are soaps, detergents and other cleaning chemicals which may have already reached alarmingly high levels. Cleaning enhances the action of disinfectants, but excessive amounts of cleaning compounds should not be used.

Cleanliness is relative. Surfaces need not be as clean as a surgical area for the disinfectants to inactivate the pathogens. The better formulations of disinfectants include compounds which increase the penetration of the active ingredients and enhance the residual effectiveness.

Some items, such as feed or water troughs made of wood or rusty metal, may cost more to clean and disinfect than to replace. Owners will usually accept payment for these items comparable to the cost of cleaning and disinfection, and the items may then be burned, buried or safely disposed of by other means.

APPLYING DISINFECTANTS AND PESTICIDES

Officials responsible for approving disinfectants should ensure that criteria for approval include effectiveness against target organisms and potential for EP.

*Always follow directions supplied by the manufacturer when applying disinfectants.* When such products are approved, the directions for use are approved as well, usually by the same agencies and officials. It is a widespread misconception that solutions which are more concentrated than indicated by the directions will do a better job. In fact, stronger solutions may not be better disinfectants and they are usually more dangerous for personnel, more corrosive, and increase the risk of pollution.

*Use only enough disinfectant to wet all contaminated surfaces.* Generally, disinfectant should be applied with a sponge or mop, or as a fine mist or fog (small droplets) under low pressure. Normal water pressure, such as 40 pounds per square inch, may be excessive. Disinfectant that runs off is wasted and may contribute to EP. When disinfectants are incriminated as the cause of fish die-off, there is a strong possibility that either the manufacturer’s directions were not followed or that too much product was used. Instructions regarding protective clothing should be carefully followed. Boots, gloves, helmets, face masks and other items should fit properly and not cause the operator to be too hot or cold. If personnel are uncomfortable, they may take undue risks in order to get the job done faster.

Eliminating flies, rodents, predators and other carriers on infected premises

Before infected and exposed animals are depopulated, free-flying and free-ranging birds and animals which may be carriers of the pathogenic micro-organisms should be controlled. Otherwise, as soon as the domestic animals and feed are gone, these
carriers will leave the infected premises and go to other farms where animals and feed are still plentiful. Often, there is enough time to destroy these vectors between the time when the diagnosis is made and when all indemnity issues have been resolved.

Biting and blood-sucking arthropods can be killed by spraying the host animals 24 to 48 hours before depopulation. Poisoned bait is most effective for scavenger birds and mammals. To protect the environment, locations of bait must be carefully recorded. After about 48 hours, all remaining bait should be collected and safely destroyed or stored. Dead birds, rodents and other animals should be collected for disposal along with the carcasses of depopulated animals. Traps are a safer method but usually are not as efficient. Special authority to eliminate carriers may be required, and a game biologist or an entomologist with appropriate expertise should be consulted.

Dipping and spraying animals in quarantined areas

To prevent arthropods from spreading disease to healthy animals or damaging them in other ways, animals are often dipped or sprayed with pesticide. Pesticide concentrations may reach hazardous levels in the location where the animals stand immediately after being sprayed or dipped. Considerable amounts of pesticide drain from the hair during the first several minutes. Since aquatic animals may die if the pesticide reaches water, sites selected for spraying and dipping should be as far away as possible from streams and ponds. A means for collecting and reusing pesticide may be implemented, or the location can be moved periodically to prevent excessive build-up in one place. Solution remaining in dipping vats for several days or weeks presents a variety of problems. The active ingredients may become too concentrated by water evaporating from the vats or too diluted by rain. Dipping solution must be frequently tested to ensure the proper concentration.

Treating quarantined areas with pesticide

In most locations, and during most of the year, spraying or dipping will be adequate to protect animals from arthropods. However, during some prolonged hot, rainy periods, populations of blood-sucking flies, gnats and mosquitoes may become so large that aerial or surface application of pesticide is required. Aircraft or surface sprayers may also be used when the areas to be treated are particularly large.

Some ADE programmes are designed to eliminate a given arthropod from an area. For example, *Boophilus* ticks have been eradicated from the southern part of the United States. Other programmes are designed only to control arthropods until animals can be vaccinated and a protective level of antibodies develops. Considerably more pesticide is required to eliminate an arthropod pest from an area than to control its presence until vaccines stimulate immunity. Therefore, the same procedures which may be satisfactory from an environmental perspective for short-term control, may be unsatisfactory for long-term eradication programmes.

In general, approved pesticides which are used according to label instructions will not harm the environment unless the level of build-up reaches a critical mass. ADE programmes in which pesticides are used should include monitors to measure frequently the amounts accumulating in soil, water and life forms exposed.
If arthropods are repeatedly exposed to sublethal doses of the pesticide, they are likely to become resistant. Larger and larger doses will then be required to achieve comparable levels of effectiveness. The larger doses increase the risk of EP and of killing beneficial insects and animals. Quality control is very important, and the margin of safety is narrow. Too concentrated or diluted a pesticide solution is hazardous. Entomology expertise is essential for obtaining maximum benefits from pesticides without damaging the environment.

It may be advisable to seek medical assistance in monitoring the health of personnel using pesticides, especially those pesticides which have organic phosphates as the active ingredient. Tolerance varies widely among individuals for some compounds, and the effects may sometimes be cumulative. Tests are available which help identify individuals with low tolerance or who have been exposed to amounts which may cause symptoms or even death. An emergency kit containing atropine, an antidote for the pesticide being used or other drugs for emergency treatment is an additional safeguard.

Pesticides should be stored and used only according to the manufacturer’s directions. Malfunctioning equipment and mistakes in formulating solutions for dispersal can be serious enough to result in EP. Disposal of containers and cleaning material used for servicing the equipment requires special attention, especially when the same location is used repeatedly (14).

ROLE OF THE CHIEF ENVIRONMENTAL PROTECTION OFFICER ON AN ADE TEAM

The environmental protection officer on ADE teams may be as or even more important than traditional specialists, such as diagnosticians and epidemiologists.

Qualifications

Education

A veterinary medical degree, or its equivalent, is necessary to take part in all ADE programme activities. In addition, the environmental officer should have specialized training and/or experience in environmental protection.

Duties

The environmental officer must be able to:

- design and conduct environmental impact assessment studies of activities and operations, as required;
- develop and implement procedures to monitor insecticide levels in soil, water and animals;
- explain in clear and understandable terms the environmental consequences of ADE activities, when particular issues are raised;
- maintain a working knowledge of all environmental laws, rules and policies in force in the jurisdiction where the programme is being executed (this requires working with local, state and national agencies authorized to promulgate rules to protect the environment);
- advise other officials on the ADE team regarding compliance with environmental laws, rules and policies;
- contact and obtain the necessary permits from the relevant authorities, when approval is required for activities such as carcass disposal or application of pesticides.

**Responsibilities**

The environmental officer is the ‘eyes and ears’ of the ADE team on environmental issues and concerns. All activities and procedures utilized will be those which cause the least damage to the environment. He or she must also develop and record all pertinent data on activities and events with any potential for detrimental impact on the environment. These records can prove vital if compliance is legally challenged.

**Preparing Environmental Impact Statements (EIS)**

It is beyond the scope of this paper to suggest any procedure which would ensure compliance with all of the laws and rules designed to protect the environment in the course of ADE programmes. However, the first requirement is likely to be the preparation of an EIS in accordance with rules and policies.

Under the same EIS, it is advisable to include all of the ADE programmes, for both exotic and endemic diseases, that require similar control measures. The primary focus is not the environmental impact of the disease-producing agents but the specific activities required to control them as opposed to alternative strategies or taking no action at all. For example, all ADE programmes which require depopulating of animals and disposal of carcasses on the farm might be covered under the same EIS. The fact that the causative agent is the bacillus that causes bovine tuberculosis or the virus that causes hog cholera does not significantly alter the impact on the environment. The primary concern is disposal of the carcasses in an environmentally and biologically acceptable manner. To take another example, all ADE programmes which require spraying and dipping of animals or dispersal of pesticides would be grouped together.

When similar response plans for exotic and endemic diseases can be considered in the same EIS, the total benefit/cost concept is more likely to receive due consideration. If the EIS covers only activities which will have a negative environmental impact, the programme benefits, including those that enhance the environment, may be overlooked.

The EIS will be enhanced by including information from a cross-section of people who have been, or could be, involved in ADE programmes. Public hearings provide an opportunity for animal producers and representatives of related industries to express their opinion and provide information, e.g. on developments at a burial site weeks, months or years after the carcasses were buried. This type of information is needed in an EIS.

Through the EIS process, veterinary administrators should determine if ADE activities required to stop enzootic or epizootic diseases could have a negative environmental impact. If there is no risk, a finding of “no significance” should be filed, or these findings could be used to request an exemption. If a risk does exist, plans should be modified to protect the environment as much as possible without compromising the animal health objective. If a risk is still present after the plans have been modified, the decision on whether to conduct the ADE programme will
have to be made. Some ADE programmes should be conducted even though a negative impact on the environment may result from certain activities. When an exotic disease outbreak is so disruptive that an emergency situation must be declared, it may be wise to implement a response programme even though all of the negative environmental impact could not be mitigated.

The process of preparing an EIS on ADE programmes may also bring to the surface other opposing views which can be resolved in advance along with the environmental issues. Indemnity, marketing restrictions imposed by quarantines, and environmental protection rules are examples of concerns which need to be resolved in advance. Preparing an EIS prior to an emergency epizootic reduces the likelihood of delays due to the preparation of a statement. A delay can be disastrous when a rapidly spreading disease must be brought under control.

The Food Production and Inspection Branch of Agriculture Canada has developed procedures for an environmental assessment review and produced a draft report entitled \textit{Environmental assessment review process} in compliance with Canadian laws (4). This report is well-written, with an easy-to-follow set of procedures and numerous charts, graphs and tables to help the reviewer decide which of the nine possible categories best fits the programme under review.

Another Canadian document, \textit{Northern Diseased Bison} (7), presents an example of an environmental assessment conducted following the occurrence of an animal disease. A variety of cultural, economic and political issues concerning the depopulation of a very large bison herd are addressed. The herd, which is publically owned and free-ranging, is infected with bovine tuberculosis and bovine brucellosis. There is considerable interest in using animals from another herd to replace the infected herd. The other herd is free of both diseases, but the animals have slightly different genetic characteristics. This report provides an excellent example of how an environmental review procedure works in Canada.

\section*{DISCUSSION}

Despite the absence of long-term EP from ADE programmes, these programmes need to be re-examined to ensure that the procedures used have the least possible potential for polluting the environment. Some activities, procedures and concepts employed in previous programmes may no longer be satisfactory. Earlier, at a time when there was less concern for the environment, some carcasses were improperly buried and excessive amounts of pesticides and disinfectants were used. The lack of data on negative environmental impact from these ADE programmes seems to indicate that no particular harm was done. Nature's biodegradation processes apparently transformed the potential pollutants into non-polluting products. However, the environment is more fragile now, and activities that were harmless in the past could be damaging in the future.

Since a literature review did not provide much information on EP from ADE programmes or on how to protect the environment in the course of these programmes, the recommendations in this paper are usually based on personal observations coupled with scientific reasoning. More scientific data are needed.
There is an old adage, ‘Dilution is the solution to all pollution’. From an ADE perspective, the adage, ‘An ounce of prevention is worth a pound of cure’ is more apt. Even though future ADE programmes may require destruction of even greater numbers of carcasses and other activities with comparable potential for damaging the environment, better planning and more careful execution will continue to keep these programmes from being incriminated as the cause of EP.

Environmental issues are increasingly important world-wide. Environmental thinking is becoming an integral part of decision-making in the public and private sectors. All animal health agencies should develop policies which preserve and protect the environment during ADE programmes. Most agencies have policies to ensure resource conservation; however, unless environmental conservation policies also receive attention in the decision-making process, they are likely to be mandated by higher authorities.

There is a great need for carcass-disposal methods which have less environmental impact. Producers find it increasingly difficult to dispose of carcasses considered as normal production mortality (9). This problem will be magnified manyfold when an entire herd or flock must be depopulated. From an animal health benefit/cost perspective, no other strategy is as good as eliminating all the susceptible animals and cleaning and disinfecting the premises to stop outbreaks of certain rapidly spreading diseases. Although better vaccines, pesticides and other advances in animal health will no doubt eventually reduce the need for on-farm depopulations, in the immediate future the most pressing need is for alternatives to burning or burying carcasses on the farm.

Biologically safe procedures should be used to move healthy exposed animals to abattoirs. When there is a danger of additional animals acquiring the infection from the meat, it can be cooked or treated to inactivate any pathogens. Another option might be to limit distribution to institutions or inner cities free of susceptible animals. Some might have to be ground into a slurry on the farm and transported to the renderer in sealed tank-trucks. The value of the meat or the rendered product might partially offset the cost of depopulation.

To eliminate future epizootics, even larger amounts of carcass material may have to be destroyed and more pesticides and disinfectants applied unless new technology is developed. Production units continue to increase in size; facilities and support systems are being designed for greater efficiency. Integration increases movements between production units and, thereby, increases potential for exposure to infectious diseases as well. Future outbreaks will be even more disruptive and expensive. Having more effective disease prevention policies seems to be the best answer, at least for now.

* *

PROTECTION DE L'ENVIRONNEMENT LORS DES PROGRAMMES D'ÉRADICATION DES MALADIES ANIMALES. — H.A. McDaniel.

Résumé: L'auteur traite des actions menées lors des programmes d'éradication des maladies animales qui sont susceptibles d'avoir un impact négatif sur l'environnement. Il propose des approches visant à réduire cet impact sans pour autant compromettre les objectifs des programmes. La diminution des pertes
dûes aux maladies animales grâce aux programmes de prophylaxie et d'éradication se solde par un bilan positif pour l'environnement. Tout projet de programme d'éradication doit comporter une présentation de ses répercussions sur l'environnement. La prise de décision doit prendre en compte ces répercussions, au même titre que les coûts, les besoins en personnel et les autres problèmes classiques de gestion des programmes d'éradication des maladies animales. L'amélioration de l'environnement sera un avantage supplémentaire apporté par ces programmes.


PROTECCIÓN DEL MEDIO AMBIENTE EN LOS PROGRAMAS DE ERRADICACIÓN DE ENFERMEDADES ANIMALES. – H.A. McDaniel.

Resumen: El autor analiza las acciones realizadas para la implementación de los programas de erradicación de enfermedades animales, que pueden tener consecuencias negativas para el medio ambiente. Propone soluciones para reducir esas consecuencias de dichas acciones sin afectar los objetivos de los programas. La disminución de las pérdidas ocasionadas por las enfermedades animales gracias a los programas de control y erradicación, produce un resultado positivo para el medio ambiente. Cualquier programa de erradicación debe incluir un análisis de sus repercusiones en el entorno. Las decisiones deben tomar en cuenta estas repercusiones, además del costo, las necesidades de personal y demás problemas corrientes de la gestión de los programas de erradicación de enfermedades animales. La mejora del medio ambiente será así una ventaja adicional proporcionada por dichos programas.

PALABRAS CLAVE: Control - Desinfectantes - Enfermedades animales - Erradicación - Legislación - Pesticidas - Protección del medio ambiente - Tratamiento de cadáveres animales.

REFERENCES


