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ANIMAL CARCASS DISPOSAL

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Summary: *The stamping-out approach, which is traditionally the most common and successful method of disease eradication, requires technology for animal carcass disposal as an integral component. Some general principles for choosing a disposal option are enunciated as factors for consideration, however primary consideration must be given to disease control and eradication.*

A summary of currently available technologies for animal carcass disposal is presented as a hierarchy based on their reliability for pathogen inactivation. The technologies listed include: rendering, incineration, pyre-burning, composting, mass burial or open-pit burial, licensed commercial landfill, mounding, fermentation, and examples of technologies under development. As well a special consideration for the disposal of prion disease infected carcasses is discussed, where rendering, incineration, and alkaline hydrolysis are the preferred technologies.

However, there is a growing trend in society to reject the excessive waste of valuable animal products, the negative environmental and animal welfare outcomes, and the devastating economic impacts on agricultural industries as well as on national economies. This is creating pressure for alternatives to mass animal slaughter and carcass disposal, and ultimately for a philosophical change in the approach to animal disease control, depopulation, and animal carcass disposal.

A questionnaire sent to Member Countries of the region yielded 15 responses. The survey sought to create a broad picture of the factors involved in animal carcass disposal in the region.

Considering the numbers of various species of animals raised in the Member Countries as well as the degree of intensive husbandry for each, it was concluded that there are foci of intensive numbers that warrant special attention for risk management.

Complexity of jurisdiction and regulations does exist in some countries. This should be rationalized in advance of a disease outbreak to insure a direct line of authority is clearly understood by all.

In consideration of pre-outbreak activities, a significant number of Member Countries offer an opportunity to enhance technical and financial preparedness. Additionally, some attention could be focused on strengthening partnerships while still in the pre-outbreak phase. The degree of preparedness of staff and policies can be assessed and improved during simulation exercises.

From a different perspective the social factors related to disposal are discussed, especially the negative public reaction to mass slaughter and highly visible methods of carcass disposal.

Finally, the technologies available and chosen by Member Countries were evaluated. This led to the suggestion that further attention on environmentally responsible technology would be desirable and especially so if this was mobile technology.

1. INTRODUCTION

When faced with a major animal disease outbreak, along with the need for immediate disease containment, comes a very significant question that requires an urgent decision. This question relates to the method for handling potentially large numbers of carcasses. If stamping out, the most common and successful approach to disease eradication is chosen, then the method of animal carcass disposal for slaughtered animals must also be decided.

Decision-making requires an evaluation of a number of operative parameters within a broad range of disciplines. Examples of these parameters include:

- Impact on the environment,
- The intensity of livestock production and the potential number of animals involved,
- The impact on trade and the economic implications,
- Animal welfare considerations,
- The characteristics of the pathogenic organism,
- Disease control implications,
- The impact on individual producers,
- Financial and logistical considerations,
- The reaction of the public.

Speed of decision-making is critical at the time of such a crisis. To allow for the most appropriate decision, Veterinary Administrations are advised to carefully think through the options, in advance of the event to establish essential linkages, to pre-determine which options are possible for their particular areas, and to evaluate what this implementation would require. In this way, at the time of need, the best balanced choice can be made and implemented in the shortest possible time.

As well, this approach permits planning and scheduled investment in equipment in preparation for a disaster which inevitably will come.

There are, apart from disease outbreaks, many situations which also demand the same preparation. These situations can take advantage of the same planning strategy. These situations include natural disasters such as flooding or hurricanes which could produce a large number of carcasses, as well as animal contamination by toxic chemical spills, ingestion of contaminated feed, large fires, slaughter for animal welfare reasons such as starvation or humane culling, or deliberate bioterrorism.

If you consider for a moment the massive destruction and waste of such large scale slaughter, you come to the inevitable conclusion that there must be an alternative which will permit avoidance of this destruction while affecting the required disease control. Therefore the very best method of dealing with disposal of animal carcasses is to avoid the need to slaughter the animals.

To provide you with an example of the factors for consideration, we circulated the questionnaire with the intent of being able to evaluate and discuss the status of the region as a whole and to suggest possible areas for emphasis which could hopefully reduce any possible vulnerabilities.

To begin we can consider these factors as general principles, recognizing that primary consideration must be given to disease control and eradication as the most important aspect.

General Principles

- Speed is of the essence - the earlier the official intervention, the fewer the number of animals that will require disposal,
- Complete inactivation of the pathogenic agent must be insured,
- An emergency management plan must be defined in advance and regularly communicated to all levels of the agricultural system,
- All required legal authorities and links to involved industries must be established in advance,
- The Veterinary Administrations must assume primary leadership of an animal disease outbreak,
- Veterinary Administration action must precede uncontrolled animal movement based on unofficial rumours,
- All potential consequences of an outbreak, especially financial consequence, should be assessed in advance to minimize the negative impact on involved industry sectors,
- Producers should be assisted to develop an economic understanding and compliance with the principles of disease control,
- General broad zoning areas can be predetermined and defined in advance for immediate implementation to limit animal movement based on knowledge of normal trade routes of animal movement,
- A system of traceability is required to allow immediate trace back of disease,
- Establish a list of pathogens with methods of transmission, zoonotic potential, environmental resistance, and susceptibility to disinfectants as well as disinfectant availability,
- Determine the availability of effective vaccines,
- Technical capabilities should be established at every step for animal slaughter, storage, and disposal including licensing for emergency situations,
- Environmental assessments should be conducted in advance for suitable burial sites,
- An information policy should be established in advance to promote an understanding by the public of the approach taken and the rationale for it.

2. AVAILABLE TECHNOLOGY

These technologies are presented as a hierarchy based on their reliability for pathogen inactivation.

2.1. Rendering

This is a closed system for mechanical and thermal treatment of animal tissues leading to stable, sterilized products, e.g animal fat and dried animal protein. It grinds the tissue and sterilizes it by heat under pressure. The technology exists in fixed facilities and is in normal usage. It produces an effective inactivation of all pathogens with the exception of prions where infectivity is reduced. A medium sized rendering plant could process 12 tonnes per hour of operation. The availability of the capacity should be determined in advance. Such plants can operate within environmental standards.

2.2. Incineration

This technology can be applied as:

- fixed, whole-carcass incineration,
- mobile air curtain whole carcass incineration,
- municipal incinerators,
- co-incineration.

Fixed whole carcass incineration occurs in an established facility in which whole carcasses or carcass portions can be completely burned and reduced to ash. This process is normally fuelled by natural gas. Effective inactivation of pathogens is produced. Without additional technology, the exhaust emissions are not subjected to environmental control. However these emissions can be subjected to air scrubbing procedures to meet environmental standards.

Mobile air curtain whole carcass incineration is a mobile system which can be taken on-site. Whole carcasses can be burned and reduced to ash using wood as a fuel. Because it can be used on site, there is no requirement for transportation of the animal material. It also produces effective inactivation of pathogens and may actually achieve higher temperatures (1000^{o}C).

Municipal incinerators are pre-established facilities which are normally used for the burning of household or industrial waste. Although they may not be currently licensed to burn carcasses, use of these facilities allows an expanded capacity for effective inactivation of pathogens.

Co-incineration is a process in which meat and bone meal, carcasses or parts of carcasses are burned in conjunction with other substances, e.g.:

a) hazardous waste incineration,
b) clinical waste incineration,
c) other industrial incinerations such as:
    - power plants,
    - cement kilns,
    - blast furnaces,
    - coke ovens.

In practice meat and bone meal has been used as a secondary fuel on a large scale in cement kilns and power plants.

2.3. Pyre Burning

This is an open system of burning carcasses either on-farm or in collective sites fuelled by additional materials of high energy content. This is a well established procedure that can be conducted on site with no requirement for transportation of the input material. However, this process is contrary to environmental standards for air, water, and soil. It takes an extended period of time and has no verification of pathogen inactivation. In fact, there is a possibility of particulate transmission from incomplete combustion. Further, because the process is open to view, there is a negative reaction and lack of acceptance by the public.

2.4. Composting

This is a process of aerobic microbiological decomposition conducted in either open or closed systems. It preferably requires prior grinding of tissues and as well the addition of organic material for microbial maintenance. Additionally, mixing or aeration is required to assure homogeneous decomposition. This simple process, which can be conducted on site at low cost, can achieve temperatures of up to 70^{o}C. It does, however, require a significantly extended period of time. Further it is necessary to insure a constant

temperature throughout the material for the total time period and it is difficult to verify the effectiveness of pathogen inactivation.

2.5. Mass Burial or Open Farm Burial

This is a system to deposit whole carcasses below ground level and to be covered by soil, with no additional inactivation of pathogens. It is an established procedure which if conducted on site does not require transportation and is used to control the spread of disease. It does however require an environmental assessment because of the potential contamination of groundwater, or of aquifers if leachate is not controlled. Further, it does not inactivate all pathogenic agents.

2.6. Licensed Commercial Landfill

This process involves deposition of carcasses in predetermined and environmentally licensed commercial sites. Because the site has been previously licensed, all environmental impacts such as leachate management, gas management, engineered containment, flooding, and aquifers have already been considered. However, the area is open and uncovered for extended periods, there is a potential emission of aerosols, and there is resistance from the public to such an approach.

2.7. Mounding

This process is one of mass burial above ground and it has similar considerations to those of mass burial.

2.8. Fermentation

This process is a closed system of anaerobic microbiological decomposition which requires prior mechanical and thermal treatment and which results in the production of biogas. This process does not inactivate pathogens, but typically uses non-dried rendered product as the input material.

2.9. Technologies under Development

Alkaline Hydrolysis: Alkaline hydrolysis consists of treating carcasses or tissue in an aqueous alkaline solution at elevated temperatures under pressure. It converts proteins, nucleic acids, and lipids of all cells and tissues into a sterile aqueous solution of small peptides, amino acids, sugars, and soap. What remains are the mineral constituents of the bones and teeth. This process requires specialized equipment and operates at 150^{o} C for three hours. It completely inactivates pathogens with the exception of prions where infectivity is reduced, and is environmentally responsible.

Biosphere Process: The biosphere process is a bio-refining technology which employs a biolytic hydrolyzer, operating under high temperature, steam pressure, and internal agitation in a sealed steel vessel. The process produces hydrolysis of protein and carbohydrate materials, fracturing long chain molecules and yielding sterile, high nutrient fertiliser as an output. It operates at 180^{o} C under 12 atmospheres of pressure for a period of 40 minutes. It inactivates all pathogens and is environmentally sound. Inactivation of prions is still undetermined.

2.10. Special Considerations for Prion Diseases

One of the problems in demonstrating the effectiveness of the inactivation of prions is the lack of a simple, rapid and inexpensive test for the presence of the infective agent, especially at low concentrations. The ultimate test is bioassay in a sensitive detector species by an efficient route, but usually this is only relevant in research. Typically this is done using panels of mice bred to be susceptible to particular types of transmissible spongiform encephalopathies (TSEs). However it must be recognized that the mouse to cattle species barrier has been demonstrated to be 500, therefore affecting sensitivity.

Although rendering at 133^{o} C and three bars of pressure for 20 minutes is a defined standard, reductions of infectivity by this technology are in the order of 1:200 - 1:1000. Commercial incinerators have an inactivation rate of one million fold, while burning on pyres has a reduction rate of 90%. (It should be noted that pyres are not suitable for sheep because of the wool and fat.) Alkaline hydrolysis produces a 3-4 log reduction in infectivity overa three hour period. Landfill and deep burial are suggested to have a reduction in infectivity of 98 - 99.8% over three years. Based on this information, rendering, incineration, and alkaline hydrolysis are the most reliable technologies at this time.

The significance of small amounts of infectivity become evident when you consider that experimentally it has been shown that exposure of sensitive species to as little as 1.0, 0.1 or even 0.01 grams of infected nervous tissue can induce infection.

Given all of the above, it must be recognized that no process has been demonstrated to be 100% effective in removing TSE infectivity and there will be some residual levels of infectivity remaining after treatment.

3. THOUGHTS ON ALTERNATIVES TO ANIMAL DISPOSAL

While addressing the current practicalities of animal disposal technology, it is perhaps also worth while to look ahead a bit and consider alternatives to the present approach of depopulation and animal carcass disposal.

The best method of animal disposal is to avoid the need to slaughter the animals permitting them to reach their potential in terms of the reasons for which they were bred. However, above all else, animal disease control must be achieved as a primary consideration.

Stamping out is deeply entrenched in the veterinary organizational culture. It is a tried and true approach that is advocated by the OIE for effective disease eradication. It has been used successfully in numerous animal disease outbreaks and is regarded as the standard.

On the other hand, trends are now developing which are introducing factors that are creating pressure for a philosophical change in the approach to animal disease control and ultimately to depopulation and animal carcass disposal.

Such factors include:

- logistical factors - following the developing trend of larger farms with more animals on small geographic areas,
- economic factors - following globalization and international trade considerations in which disease control actions are often market driven,
- societal factors - creating pressures based on public perceptions and ethical issues, e.g. the trend may be for the public to become less tolerant of the potential for the waste of vast amounts of edible protein because of depopulation practices,
- animal welfare consideration - and the public's reaction to mass slaughter and carcass disposal,
- environmental factors - which force higher standards and more extensive environmental assessments to protect the status of the environment.

A summary of the growing trend is that society is rejecting the excessive waste of valuable animal products, the negative environmental and animal welfare outcomes, and the devastating economic impacts on agricultural industries as well as on national economies.

Approaches that can be taken to address this include:

- Prediction - to avoid disease occurrences by preemptive trend identification,
- Prevention - of disease or minimization of any disease that occurs (vortex containment concept where the approach is to direct all movement towards the centre of an outbreak),
- Speed of disease detection or control.

Ultimately what will be required is a complete paradigm shift in thinking to a new concept of disease control which incorporates these driving forces and trends into its essence.

4. SURVEY QUESTIONNAIRE

The survey results and observations are based on the fifteen returned questionnaires. While this may not be a truly accurate representation of the region, it does serve to create a broad picture of the region. It introduces ideas, factors and areas for discussion which can provide some guidance for ways to strengthen the preparedness of the region and to identify some specific areas of focus or vulnerability.

4.1. Background Information

This section seeks to probe areas of potential concern in terms of numbers of animals and intensification of livestock husbandry. These areas may warrant preemptive special consideration or may represent areas of increased vulnerability.

It is assumed that increased numbers equate to increased risk, and if one million is chosen as the unit of volume, the largest numbers of species are: cattle, sheep, swine, and birds.

With cattle, 13/15 countries are in the range of 1 - 97 million animals. Of these, five countries have in excess of 10 million animals.

With sheep, 7/15 countries are in the range of 1 - 91 million animals with three countries having more than 10 million animals.

With swine, 11/15 countries are in the range of 1 - 91 million animals with three countries having more than 10 million animals.

With birds 14/15 countries are in the range of 11 - 621 million birds with eight countries having more than 100 million birds.

In addition, five countries have 2-4 million buffaloes, four countries have 1 - 12 million goats, two countries have 2 - 5 million horses, one country has 2 million cervidae, and one country has 4 million rabbits.

These numbers point out the multiple areas where the destruction of high numbers of animals could result from disease outbreaks. Therefore, preparations to deal with these contingencies should focus particularly in these areas. This does not mean that slaughter and disposal of smaller numbers of animals is not important, but rather that it is a matter of scale for logistical purposes.

In the cattle species, 4/5 countries with the largest numbers of animals also have a significant proportion of intensively managed production.

There is only one country with large numbers of sheep that has 28% intensive production. With the swine species, although 6/11 countries have a significant percentage of intensive husbandry, only three countries have both large numbers of animals and significant intensive husbandry.

With birds, 9/14 countries have a high percentage of intensive production, and of these six also have large numbers of birds.

For the one country with large numbers of cervidae, there is also a 100% intensive management.

Once again, the intent is to identify areas of greater potential for risk management. However with intensive management there may also be greater opportunities to mitigate the risk through enhanced biosecurity practices.

4.2. Regulation and Jurisdiction

The fundamental questions which must be answered are:

- Does the legal authority to take action exist?
- What is the complexity of the jurisdiction that must be coordinated?
- Is there a need to harmonize regulations or are there possible conflicts in the applications of regulations for animal carcass disposal or for environmental standards to be met? (Differences are less significant if they are transparent, while conflicting regulations must be rationalized in advance.)
- Has the complexity and time requirement for the approval of disposal sites been recognized (e.g. environmental assessments).

Only 4/15 countries have only one level of jurisdiction. Of these, three are federal which should provide clear authority, while one country has only municipal authority which would require being cognizant of differing rules.

Beyond this, four countries have two levels of jurisdiction, four countries have three levels of jurisdiction, and two countries have four levels of jurisdiction.

In this area, it would be necessary to rationalize the different levels of jurisdiction in advance of an outbreak to insure that there would be no time delays because of different perceived authorities. A direct train of authority should be clearly understood by all in advance of the need to implement it.

All but one country had legislation or regulations specifically related to the disposal of large numbers of animal carcasses. Five countries had only federal regulations which would appear to be the simplest procedure, while one country had only municipal regulations. Four countries had two levels of regulations, two countries had three levels of regulations and one country had four levels of regulations.

As with the mixed authorities, it must be recognized that multiple levels of regulations increase the complexity for taking clear, rapid, and decisive action. This therefore suggests that this complexity should be dealt with in advance of a disease outbreak. In this way, the resolution of differences in regulations can be negotiated clearly and fairly without the pressure and urgency of addressing a disease occurrence at the same time. This can also serve to promote solid and productive partnerships.

In considering disposal sites, 9/15 countries have already achieved approval of disposal sites. Other countries may have already decided not to use disposal sites for multiple possible reasons. However, if any of these countries would consider using disposal sites in the future, the complexity and extended time requirement to obtain such an approval should be recognized. It warrants this effort in advance of an outbreak, particularly since in some circumstances, extensive environmental assessments may be required.

4.3. Pre-outbreak activities

This section of the survey seeks to probe the degree of preparedness which the region enjoys prior to a significant disease event occurring, from the aspects of technical and financial preparedness, the pre-establishment of partnerships, and the active practice of simulation exercises.

Technical preparedness includes a predetermined decision process enunciated in a document, training of staff in the technical aspects of applicable technologies, and the development of instructional manuals. In 9/15 of the countries, ratings of 3 or greater were recorded in all three categories indicating acceptable to excellent preparation. However, there are other countries recording minimal preparation in these categories. This therefore presents an opportunity for sharing competence, and for assisting in training and development in these areas. This could perhaps be achieved under the coordination and guidance of the OIE Regional Representative. The benefit would be to reduce the vulnerability of the region as a whole.

Similarly in the area of financial preparedness, the factors of: a compensation mechanism to assist affected producers; access to emergency funding permitting rapid and effective action; and, access to an expanded human resource through agreements with private veterinarians, are considered critical to the success of the program. In 9/15 countries these preparations are considered acceptable to excellent. In other countries, organizational assistance would be beneficial as these factors are considered essential to success. To be effective, these factors must be considered, resolved, and in place prior to a disease occurrence.

In the category of pre-established partnerships, only two countries were rated as 3 or greater in all nine categories, while five more countries were 3 or greater in all but one or two categories. Established partnerships with industry were lower than expected with 8/15 countries as 3 (acceptable) or greater. A relationship with industry would seem essential to obtain compliance with animal health policies. Again established partnerships with the media or the public were only rated as 3 or greater in 8/15 countries. This relationship is encouraged to enhance the receptivity to future risk communications.

In some countries tourism is a very significant contributor to the national economy. And as well tourism can be adversely affected by animal disposal and emergency operations. Yet only one third of the countries had already worked out acceptable (3) or better relationships with the tourism industry.

It is suggested that partnerships, established in advance, can be a strong contributor to a successful animal disposal program. This region would appear to have opportunities to proactively advance the position of this area.

An excellent method to seek out deficiencies or gaps in the implementation of an emergency program, including animal disposal is the use of simulation exercises to test the degree of preparedness of staff and policies. This is an area where it is suggested that considerable gain could be realized in the region since only 6/15 countries had conducted such an exercise in the last two years. It is also an area where outside assistance and guidance could be very helpful and instructive, potentially reducing vulnerabilities in the region in a significant fashion.

4.4. Social factors related to disposal

A quite different perspective on animal carcass disposal involves the reaction of the public to large disposal programs. In the last few years, in many countries there has been a growing negative reaction to mass slaughters and carcass disposal, especially with some highly visible approaches such as pyre burning. Indeed this reaction in some countries could even extend to the point of legal injunctions to prevent the slaughter and disposal of animals from proceeding.

Once again, since the speed of effective action is absolutely critical to success - legal action to prevent or delay the process could be disastrous. It therefore behooves all Veterinary Administrations to treat this aspect very seriously and to anticipate and if possible address such concerns in advance.

It is fortunate that this is well recognized in this region since there was unanimous concern expressed by all countries in the questionnaire.

The anticipated public reaction to the negative aspects of animal disposal in individual countries varies, but in general, the bulk of the responses rate this fairly high. Overall 9/15 countries anticipate a strong negative reaction from the public. As a modifier to this, six countries feel that this negative reaction will be less if it is well managed. A further complication was identified by three countries in that they anticipate a negative public reaction as a result of fundamental religious philosophies.

The comments of one country provide some guidance in that it was suggested that the public can accept approaches if they are well informed and are helped to understand the rationale and the benefits for the country of the proposed option. Risk communication is an extremely powerful yet delicate tool to achieve acceptance and support from the public.

4.5. Technology

In the region, the technologies that exist and are available for an emergency, are primarily burial, landfill, rendering, fixed incineration, and pyre burning. There are some exceptions to this but on a regional basis, they are more limited.

However, at the time of a disease emergency, the amount of technology that would be available beyond its normal usage is extremely limited. In fact, beyond burial and landfill, there would be very little extra technology available. Further, if you consider the above list of technologies, all with the exception of rendering, have the potential to have significant environmental impacts. This leads to the recognition that the anticipated use of these approaches could carry an impending potential vulnerability if increasingly stringent environmental standards prevented their use.

As countries, in responding to the question of which elements you consider most important in making your choice of a disposal option, the responses were fairly consistent. Disease control was an obvious given since this is the primary requirement of any chosen option. All countries included this element. There was strong recognition (9/14 countries), that environmental impacts must be considered. This is interesting since most of the stated available technologies have the potential for environmental impacts. It does suggest that alternative environmentally responsible disposal options should be investigated. Included with disease control and environmental considerations were the elements of cost, technology availability, and public health in decreasing order of priority.

From the aspect of animal carcass disposal, transmissible spongiform encephalopathies (TSEs) present unique challenges. Most countries recognize this and 12/15 have a plan developed for TSE tissue or carcass disposal. Although five countries had incineration on their list of technologies to be used with TSE carcass disposal, the most commonly quoted options were burning and burial. Two countries either selected or included alkaline hydrolysis as a technology to be used. Given a basic principle of insuring pathogen inactivation during carcass disposal, and recognizing the unknown or limited prion inactivation of many technologies, it would suggest that the region should reconsider the choice and availability of disposal technology for prion contaminated tissue and animal carcasses.

Right now, should an outbreak situation occur in this region, it would be useful to recognize which technologies would be chosen. In response to this question the technologies most likely to be used in order of preference were: burial, burning, incineration, and landfill. Only four countries included rendering in their choice, and one country included composting. Once again burial and burning were at the top of the list. Should an environmental challenge be posed against these technologies, thought should be given to alternative technologies or approaches in the event that these technologies were blocked from use.

The method used to euthanise large numbers of animals prior to their disposal also requires due consideration. Factors which influence the choice of methods will include the species of livestock, the age of the animals, the logistics, the required facilities and the practicality, humane aspects, and the influence on the transmission of the pathogen. Particular attention must be paid to the euthanasia of young, unweaned animals.

This is also an area which may attract the attention of the media and the public. This should be expected and should warrant adequate preparation to respond to such challenges.

The OIE Working Group on Animal Welfare has included this topic in their future work plan and it can be anticipated that expert guidance and specific recommendations will be forthcoming.

In order to take advantage of the efficiencies associated with a central slaughter and disposal facility, there is a requirement for the capability of moving large numbers of live animals to a central location. In this regard 10/14 countries do have this capability.

It must also be recognized that to gain this potential for efficiency and access to more suitable technology, the pathogen must be contained and its transmission limited. Movement of live animals magnifies the chance of increased spread unless the infectious animals can be suitably and effectively contained. Even if slaughtered animals are transported, although the risk of transmission is reduced, the carcasses must be transported in leak proof and disinfectable vehicles. It should also be noted that four countries did not have this capacity of moving large numbers of live animals, and so could not avail themselves of central disposal facilities.

Lastly we sought to determine what was the availability of moving disposal technology to the site of the disease outbreak. The capability of pursuing the vortex containment philosophy would appear to be considerably limited in this region due to reduced availability of mobile disposal technologies. Only five countries had the capability to use mobile air curtain technology and two had limited mobile rendering capacity.

The best chance of limiting the number of animals infected or exposed and thus requiring slaughter, is to most strongly contain a disease outbreak in a defined and limited area. The vortex containment concept seeks to achieve this. However it depends on mobile slaughter and disposal technology. Other than the traditional burning and burial, the possibility of this would appear for now to be limited in this region.

5. CONCLUSIONS

After considering animal disposal from a very broad perspective, although there are many variables that cannot be resolved, there are a few conclusions which can be drawn from this examination. These include:

- In the application of animal disease and eradication programs, stamping out with animal carcass disposal has and does perform an essential function.

- Trends are developing which are beginning to challenge this approach and to require the development of alternative ways of achieving animal disease control and alternatives to animal disposal.

All presently available technologies have advantages and disadvantages with there being no one perfect technology.

Capacity is a critical factor since the number of carcasses for disposal may be excessive.

Prion diseases require special consideration for disposal.

This region, because of the numbers of animals in some areas does have foci of vulnerability.

Countries with multiple levels of jurisdiction and of regulations must insure all complexities are resolved prior to a disease outbreak.

There is an opportunity to assist some countries of the region with technical and financial preparedness.

An investment in developing and strengthening partnerships with other supporting organizations in advance of a disease outbreak would be warranted and beneficial.

The use of simulation exercises to test preparedness is encouraged and should be assisted.

The development of appropriate risk communication approaches or how to inform the public and help then to understand the rationale for actions is important to achieve acceptance and support from the public.

Consideration should be given to obtaining mobile, environmentally responsible disposal technology for the region.

Seeking ways to avoid the need to slaughter large numbers of animals is the best, most widely beneficial approach possible.

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