Disaster Medicine

Disaster planning for agricultural research programs

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ABSTRACT

Institutions that conduct agricultural research must plan for emergencies and disasters that have the potential to compromise the health and safety of research animals and personnel. Agricultural research facilities have unique challenges owing to the overall size and scope of operations, wide range of species housed, and various types of facilities maintained. Identification of hazards and development of strategies to minimize anticipated risks are important to creating a successful mitigation and recovery plan that will minimize both short- and long-term adverse effects on program operations and resources. (*J Am Vet Med Assoc* 2020;257:1249–1258)

Individuals involved in research programs have a regulatory and ethical responsibility to develop effective plans that protect personnel and animals from harm during potential emergency or disaster situations. The special requirements of farm animals and the size, scale, and complexity of facilities used to house and care for these species introduce new and unique considerations when planning for disasters.[1] Many of the same guiding principles of emergency planning relevant to traditional laboratory animal programs can be applied, but must be tailored to address the special needs of programs that are oriented toward agricultural animals and research.

The purpose of this report is to provide an overview of emergency-response concepts and prevailing best practices compiled by the author during a review of plans developed for predominantly agricultural research programs at 30 land-grant, state, and private universities and federal agencies. The programs included in the review varied in size and location, but all concerned research involving livestock, poultry, and fish raised for food or fiber under husbandry and management conditions intended to simulate a commercial agricultural production environment. All institutions complied with applicable federal regulations and policies relevant to the care and use of animals in research, including establishment of a properly constituted IACUC for review, approval, and oversight of research activities involving live animals.

ABBREVIATIONS

AWA	Animal Welfare Act
IACUC	Institutional animal care and use committee
NRC	National Research Council
PHS	Public Health Service

Regulatory and Policy Considerations

The regulation of research involving traditional farm animals, such as livestock and poultry, in the United States depends on the purpose of the research. Agriculture-based research directed at "food or fiber, breeding, management, or production efficiency, or for improving the quality of food or fiber" involving these species is excluded from the US AWA and associated regulations.[2] However, their use in research funded by the US PHS or in human medical and veterinary student education must comply with the AWA and associated regulations in addition to PHS policy. Public Health Service policy also applies to other vertebrate species, such as poultry and fish.[3]

Unexpected emergencies have the potential to severely compromise the health and welfare of animals used in research, so preventing, managing, and implementing effective actions to minimize the associated risks has become a sound quality-management tool for individuals overseeing these programs. The regulations loosely refer to these oversight responsibilities, although there were no formal provisions or requirements for emergency preparations or disaster planning in the AWA and its associated regulations until December 31, 2012, when the USDA published the AWA contingency plan final rule. The new standard added expectations for "contingency planning and training of personnel" by research facilities, dealers, exhibitors, intermediate handlers, carriers, and other regulated entities and required personnel at animal facilities subject to the AWA to develop plans for responding to, and recovering from, emergencies that were likely to affect their facility or program; train employees on the plans; and review plans at least annually. However, following various unanticipated challenges, regulated facilities are not currently absolutely obligated to comply with contingency plan requirements because of an indefinite stay issued by USDA on July 31, 2013.[4]

The NRC Guide for the Care and Use of Laboratory Animals[5] includes similar provisions to prepare for potential disasters and emergencies. It states that disaster plans should specify actions necessary to minimize animal pain, distress, and death due to service or resource disruptions caused by the disaster; describe how animals that are irreplaceable or essential to critical research activities will be preserved; ensure animals that cannot be relocated or adequately protected will be euthanized; and identify staff members who should be trained to assist in implementation of the plan.[5] The PHS requires research institutions that have PHS Animal Welfare Assurances to use this NRC guide as a basis for developing and implementing a program for activities involving animals.[6] The NRC guide is widely recognized throughout the international scientific community and is one of the primary standards that the AAALAC's Council on Accreditation uses to evaluate animal care and use programs.[7]

The Federation of Animal Science Societies has published the *Guide for the Care and Use of Agricultural Animals in Research and Teaching*[8] (referred to as the Ag Guide), which applies to facilities that conduct agricultural research. The Ag Guide is another primary source of standards used by the AAALAC's Council on Accreditation and directs programs to develop disaster plans for observing and caring for animals during emergency situations. With recognition that disaster situations have the potential to substantially disrupt normal operations in agricultural programs, this guide establishes separate criteria and expectations for specific animal populations during and after disasters. For example, some disasters may impede regular observations and feeding of animals, and the Ag Guide allows temporary interruptions of routine checks for up to 24 hours for young animals and 48 hours for healthy adults when conditions interfere with these procedures.[8]

Relevant Terminology

Emergency management discussions often include the use of similar terms, definitions, and acronyms that have distinct and very specific meanings. Therefore, clear and accurate communication is highly dependent on the consistent use of precise terminology to describe key concepts and principles.

The US Federal Emergency Management Agency website is an excellent reference and recognized authority for terms, definitions, acronyms, programs, and legislation relevant to emergency management.[9] The specific terminology used to describe a disaster event changes as the magnitude, intensity, and scale increases. The lower end of this scale typically includes hazards or failures that can contribute or lead to dangerous conditions and negative consequences. Adverse circumstances that continue to escalate without mitigation can progress into a full-scale emergency that warrants prompt and decisive action to protect life, property, the environment, public health, and safety of personnel.

Most emergency management professionals agree the term disaster is generally applied to the aftermath of events that are relatively substantial in terms of impact. Disasters can range from minor to major and may intensify into a full crisis that produces an increasingly substantial and lasting negative impact on an organization, its resources, and its personnel. A catastrophe or catastrophic disaster results when circumstances become so severe that the local emergency response system becomes overwhelmed and cannot fully meet the needs of the affected organization or community. For example, fatalities and damage due to the wind, rain, and flooding associated with Hurricane Rita could be classified as a major disaster, whereas the more extensive destruction and loss of life associated with Hurricane Katrina would be regarded as a catastrophe.

Emergency Management Cycle

The emergency management cycle has been described as ongoing preparations to cope with an emergency, responding safely while an emergency is in progress, recovering to normal operations after the event has ended, and preventing future emergencies or minimizing their effects. A key aspect of preparing for emergencies starts with developing plans to minimize the likelihood of harm or damage. The end results are often dependent on the specific hazard or event that sets the process in motion. However, other factors also influence the end results, including the size and vulnerability of the population at risk, the ability of the affected organization to respond effectively, and the competency of decision-making before and during various stages of the event. The initial step in developing an effective response plan is to identify the range of potential risks and quantify their likelihood and importance. Depending on the situation, opportunities may exist to take actions that will prevent or minimize the severity of an emergency.

Hazard Identification

The terms hazard and risk are often used interchangeably, and this can be a source of confusion. Many definitions exist for hazard, but the most common is "the potential for harm or an adverse effect (for example, to people as health effects, to organisations as property or equipment losses, or to the environment)."[10] Many types of hazards can affect agricultural research programs, and for this reason, no single universal approach to hazard management exists. Hazard response and management must be tailored to the type of incident that is in progress or has occurred. An essential first step in developing an emergency plan is to identify the potential hazards associated with a specific event and then prioritize the actions needed for an effective response.

Depending on their origin, most hazards can be assigned to 1 of 2 general categories: naturally occurring or those instigated by humans (ie, technological). Natural hazards are found universally and include meteorologic (ie, weather) events, geologic events, disease outbreaks and pestilence in animals, and brush or forest fires **(Table 1)**. Technological hazards are the result of human error, accidents, and critical services or infrastructure failures. Major hazards that are classified as man-made or technological include large-scale chemical hazard or effluent releases, confinement or transport dangers, critical service disruptions, pandemics, major equipment failures, security breaches, accidental or intentional releases of radiologic materials, and other substantial infrastructure failures **(Table 2)**.

Table 1—Types and examples of natural hazards.

Type of natural hazard	Examples
Meteorologic	Hurricanes Floods Tornadoes Ice storms Blizzards Droughts
Geologic	Earthquakes Tsunamis Avalanches Sinkholes Mudslides Erosion Volcanic eruptions
Disease and pestilence	Animal disease outbreaks Insect damage Wildfire damage
Brush and forest fires	—

— = No example needed.

Risk Assessment

By contrast, risk is the chance, probability, or likelihood that a person, place, or thing will be harmed or experience an adverse health effect resulting from a hazard. Factors to consider when predicting this likelihood include the probability that an event or exposure will occur, how often an event or exposure may occur, how readily the event or exposure can be predicted, and whether any steps can be taken to avoid or minimize any of these issues. Values assigned to each of these parameters when modeling risk often vary, depending on the geographic location and specific time of year. Other aspects that should be considered for agricultural research programs include (but are not limited to) types and numbers of animals to be included for planning purposes, scope of research activities in progress, other hazards present, facility design and construction, and research staff training and skill level.

A regional hurricane that produces substantial rain and wind lasting 24 hours or longer is generally much more disruptive than a localized thunderstorm lasting less than an hour. By contrast, a more intense local storm could result in torrential downpours that generate severe flash flooding in affected areas. The

Table 2—Types and examples of technological hazards.

Type of technological hazard	Examples
Contamination or hazard releases	Leaks and spills associated with bulk storage systems (eg, farm chemicals or animal waste) Overturned transport vehicles or tanks Effluent or pollution
Confinement or transport dangers	Structure fires Structure collapses Transport accidents or errors Escaped animals
Critical service disruptions	Utility (eg, electricity, gas, or water) outages Labor shortages (eg, labor strikes or human disease outbreaks) Pandemics Funding interruptions
Major equipment failures	Heating, ventilation, or air-conditioning disruptions Water delivery system malfunctions Automated feeding equipment malfunctions
Security breaches	Vandalism Theft Compromised biosecurity Human violence Cyber attacks
Major infrastructure failure	Information technology outage Dam or levee failure Blocked evacuation routes

contrasting outcomes are influenced by variations in the magnitude and scope of these events and will likely lead to different paths when designing tailored strategies to mitigate potential damages that are expected to result. Estimation of anticipated loss due to a naturally occurring or technological event requires consideration of a wide range of factors unique to a specific situation, including the duration, scope, speed, and intensity of impact; effectiveness of response and control strategies (ie, controllability); and other complicating factors such as overlapping incidents or involvement of several sites at the same time (ie, complexity; **Figure 1**).

Likelihood vs	Consequences
	Duration of impact
Probability	Scope of impact
Anticipated frequency	Intensity of impact
Predictability	Speed of onset
Effective mitigation strategies	Controllability
	Complexity

Figure 1—Factors to be considered when estimating risk. Risk estimation involves comparison of the likelihood of an event to its consequences.

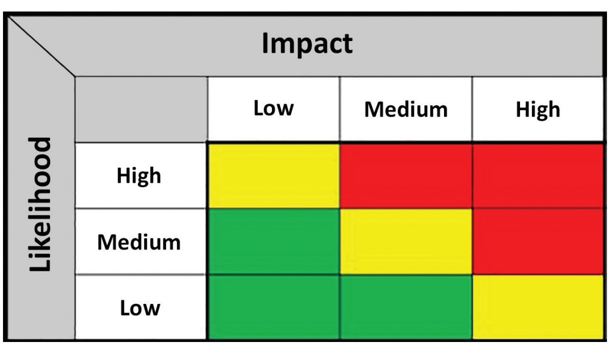

Figure 2—Risk assessment matrix showing the relationship between likelihood and impact in risk assessment. The probability that an event will occur can range from unlikely (low or green) to likely (high or red) and the anticipated impact of the event's consequences from slight (low or green) to extreme harm (high or red). As the likelihood and magnitude of consequences increase from green to yellow to red, the level of risk also increases.

A risk estimate can be generated for various types of events by use of a simple chart that helps to visualize the cumulative effects of likelihood and impact **(Figure 2)**. In this approach, the probability that an event will occur can range from unlikely (low) to likely (high) and the anticipated impact of the event's consequences from slight harm (low) to extreme harm (high). As the risk level increases, so do the likelihood and magnitude of the consequences. This process can be qualitative or quantitative, depending on whether descriptive or numeric values are used to estimate the likelihood and impact of potential hazards **(Figure 3)**. With flooding as an example, likelihood increases in valleys and floodplains that are near natural bodies of water (eg, rivers, lakes, streams, and coastlines) and during seasons when there is more precipitation. The impact varies depending on the type of agricultural facility affected and the amount of advance warning received. During a flash flood, animals confined to low-lying areas may be at more risk if they cannot be easily relocated or allowed to migrate to higher ground. Response efforts are further complicated when large animals (eg, cattle, horses, and pigs) or high numbers of animals that quickly exhaust resources are involved. Institutions engaged in agricultural research programs should routinely compile a list of various hazards that could impact their facility or program and assess the specific level of risk associated with each one. This would allow hazards to be ranked in order of frequency and severity and provide a solid foundation for developing a sound mitigation and emergency response plan.

Mitigation, Risk Reduction, and Prevention

Whenever possible, managers of agricultural research programs should be proactive and identify opportunities to mitigate or minimize risk. Risk assessments often highlight critical program requirements and resources that must be protected or preserved as

A — Qualitative model

Likelihood \ Impact	Very low	Low	Medium	High	Very high
Very high	Medium risk	High risk	High risk	Extreme risk	Extreme risk
High	Low risk	Medium risk	High risk	Extreme risk	Extreme risk
Medium	Low risk	Medium risk	Medium risk	High risk	High risk
Low	Insignificant risk	Low risk	Medium risk	Medium risk	High risk
Very low	Insignificant risk	Insignificant risk	Low risk	Low risk	Medium risk

B — Quantitative model

Likelihood \ Impact	Very low	Low	Medium	High	Very high
Very high	5	7	10	13	15
High	3	4	9	12	13
Medium	2	3	4	9	10
Low	1	2	3	4	7
Very low	1	1	2	3	5

Figure 3—Risk assessment matrix for 2 approaches: qualitative (A; descriptive scale) or quantitative (B; numeric scale). A—Risk categories range from insignificant (green) to extreme (red). B—Risk is quantified on a scale of 1 to 15.

well as program vulnerabilities that are most likely to sustain harm or damage during an emergency event. This information can serve as the starting point for planning more specific actions that are needed to offset the results of potential emergency situations a program is likely to face.

All livestock should be identified with tags, collars, brands, or microchips; this will facilitate tracking and sorting of escaped animals or those that need to be temporarily moved to a common holding area during a disaster event. An animal census and animal health records should also be readily available and accessible remotely whenever possible. An animal census is necessary for determining the quantity of supplies that need to be stockpiled in advance of emergencies and for monitoring the status of animal populations during and after critical events. The capacity of storage systems for animal waste and essential supplies, such as animal feed and drinking water, should be sufficient to meet the program's needs.

Another essential tool for emergency responders and managers is a facility map showing the location of buildings, shelters, and other major structures; access roads; natural refuges; barriers (eg, fences or gates); waste storage systems; hazardous material storage; surface waters, such as ponds, streams, irrigation ditches, and raceways; utility (eg, water, gas, or electricity) lines and shutoff locations; evacuation routes; topography or elevation information; and animal locations. The facility map can be used to identify favorable locations for holding or relocating animals during emergency situations, such as moving animals to higher elevations when flooding occurs or to shelters or open fields away from flying debris during a tornado. It can also identify the location of safe quarters for workers who need to take refuge during a crisis and where emergency provisions can be stored when it is necessary to shelter in place for an extended period.

This information is also useful when planning renovations and new construction. Strategic analysis of the current location and orientation of buildings, utility lines, bulk fuel storage tanks, and other major equipment (eg, ventilation systems, well pumps, tanks, recirculating water system pumps, and filtration systems) can help to determine the optimal location of new construction and the selection of building materials to minimize future risks. Opting to locate a building on higher ground rather than in a floodplain, using construction supplies that are not likely to become airborne and dangerous (eg, woven wire instead of board fencing or solid roofing instead of shingles), and installing underground utility lines in place of overhead lines are all options that minimize future damage and loss.

Multidisciplinary teams should routinely conduct vulnerability assessments of facilities and grounds to identify measures that can be implemented to mitigate risks before an event occurs. Ideally, team members should include IACUC representatives, veterinarians, researchers, and individuals with expertise in animal husbandry, facility management, emergency response, and safety and security. Each member brings a unique background and perspective to the partnership, and their collective actions help to increase the likelihood of a successful outcome when an emergency or disaster occurs. Evaluations should be conducted in a strategic and thoughtful manner, identifying potential hazards and developing preemptive corrective actions as a collaborative effort.

Facility and property features that are common to most agricultural research programs should be included as part of this review, emphasizing recommended abatement practices and procedures that can be implemented to offset potential liabilities. Such practices and procedures include the following:

- Fences should be maintained in good repair and provide secure holding areas for livestock and other animals.
- Vegetation and other debris that interfere with maintenance and obscures structural defects should be cleared.
- Dry brush and excess vegetation around buildings and property perimeters should also be eliminated to provide clear visibility and a break against wildfires.
- Dead, diseased, and non-native trees that are easily damaged by high winds and other loose articles or panels that can become easily airborne should be removed.
- Emergency generators should be available, fueled, and properly maintained to provide the critical power needs of major equipment that must be continuously supplied throughout service disruptions and failures and has been inventoried and prioritized in advance.
- Lightning suppression systems should be installed on buildings and tall or metal structures to protect valuable assets and sensitive technology from damage due to power strikes and surges.
- Hazardous materials such as pesticides, fertilizers, fuels, bulk pharmaceuticals, and other chemicals should be stored safely and away from animal housing areas.
- An accurate inventory of all hazardous materials, indicating location and quantity, should be kept to advise first responders of the location of flammables and explosives during emergency operations.
- The integrity of bulk storage systems should be inspected frequently to prevent leaks and spills that could contaminate adjacent supplies and space if damaged.
- Properly inspected and maintained fire extinguishers should be kept in all buildings and vehicles.
- Emergency warning systems (eg, sirens and intercom systems) should be installed to alert workers to emergency situations and maintain effective lines of communication.

- Current contact information for first responders (eg, police or fire department) and essential personnel should be maintained in a readily retrievable format or notification system.
- An alternate site may be identified where animals can be transported and temporarily held during a disaster, although the logistics of relocating agricultural animals can be challenging because of their size, their temperament, and biosecurity and safety concerns.
- Trucks, vans, and other equipment used for animal transport must be maintained in good repair and have sufficient fuel levels.
- Portable corrals, ramps, and other special equipment may be needed to safely load animals into crates or onto trailers and other vehicles.
- Whenever possible, multiple access and evacuation routes should be identified in advance, including those that are not publicly available.

Response Plans

Emergencies can take many forms and are influenced by a wide range of factors. Agricultural research activities that involve larger animal species are often conducted in open-air facilities, rangelands, and large pastures. Lacking the physical advantages of environmentally controlled biomedical facilities, these less stable conditions can create opportunities for an isolated event to quickly escalate and intensify. Dealing with multiple, overlapping emergencies that are spread out over a large and sometimes rough terrain can be complicated, and a successful outcome often requires implementation of tiered response plans that strategically address competing issues in order of severity and importance. Agricultural animals that are housed intensively can present equally challenging situations. Power or equipment failures that interfere with the performance of ventilation systems in confinement housing systems for swine or poultry or the water distribution in recirculating aquaculture systems will be devastating to the entire animal population if such failures are not detected and resolved quickly. The urgency associated with these emergencies emphasizes the importance of having sensitive detection systems, reliable notification networks, and an agile emergency response network that can be deployed on short notice.

The National Response Framework of the Federal Emergency Management Agency[11] provides guiding principles needed to prepare and present a coordinated response to national or regional disasters and emergencies, building on those found in the standardized national incident management system and incident command system structures in effect at national, state, and local response levels. These basic principles include engaged partnerships; tiered response; scalable, flexible, and adaptable operational capabilities; unity of effort through unified command; and readiness to act.[11] The same principles should be incorporated into facility-level emergency management response plans for agricultural research programs. Plans should be scalable, flexible, and adaptable and should accommodate a variety of different situations and shifting priorities. Depending on the exact circumstances, local emergency coordinators should ideally be able to quickly choose from a range of incident-specific response options and select an action or a series of actions purposely designed to address or manage the full range of consequences resulting from an individual event or series of specific events.

Common features of some emergency response options may provide multiple use opportunities for personnel, procedures, facilities, and equipment, increasing efficiency and simplifying some aspects of the plan by reducing the number of functional components. Compartmentalizing the various elements of an emergency response plan provides an organization with flexibility to deal with unexpected or rapidly changing scenarios.

Combining individual response modules linked to different emergency scenarios provides a framework for the development of a core emergency response plan. Each module should include clear criteria that identify when a plan should be put into action and who has the authority to make or change these orders. The various modules should integrate easily into a master plan that facilitates quick and effective coordination and management for responding to multiple competing incidents. For example, a pending winter event might trigger plans requiring essential personnel to report and prepare to remain on-site while a storm is in progress. Ancillary plans that address other potential events associated with winter storms, such as extended power outages from downed power lines or frozen water lines that disrupt the water supply, can also be readied for use in case they are needed.

Whenever possible, plans should be scalable so a response can be adapted as incidents change in size, scope, and complexity while the event is in progress. For instance, a scalable response would contain a wide range of actions that can be implemented to protect facility personnel and animals during various emergency situations that range from sheltering in place to an emergency evacuation **(Table 3)**. The option selected should be the most appropriate alternative for the type of emergency in progress. For example, the best option may be to relocate animals to a temporary holding area on higher ground before anticipated flash flooding, and equally prudent would be to direct only essential personnel to remain at the facility prior to an expected blizzard.

Response plans can be developed by anyone who is involved with the agricultural research program, including veterinarians, research personnel, facility managers, caretakers, safety professionals, and IACUC members. All plans should be developed in consultation with the IACUC, resident subject-matter experts, and local authorities, including emergency

Table 3—Examples of scalable response plans, ranging from sheltering in place to a full-scale emergency evacuation.

Plan	Description
Shelter in place	Animals and facility personnel remain at the farm before, during, and after the emergency. The farm becomes self-contained for a set period, relying on its own food, water, and other supplies.
On-site animal relocation	Animals are relocated to safer areas on the farm grounds or nearby, such as turnout pastures, alternate barns, and other temporary holding areas.
Essential personnel only	The farm is temporarily evacuated by all but essential personnel who will provide basic feed and care for animal populations.
Complete farm evacuation	All personnel and animals are relocated to a designated site. Livestock and other animals that have complicated transport needs are methodically moved and sheltered in an alternate remote location, away from the primary farm.
Personnel evacuation only	All personnel are evacuated. Prior to personnel evacuation, animals are moved to safe locations on the farm with food and water sources available until it is safe for personnel to return. In severe situations, it may be necessary to depopulate prior to staff evacuation.
Emergency evacuation	Personnel are at risk and must take shelter or evacuate immediately.

management officials, firefighters, and law enforcement officers. These officials can provide valuable information regarding the capabilities and limitations of local emergency services and may provide other suggestions that help to ensure a more coordinated response during emergency situations. Transfer of knowledge and critical skills can be facilitated through cross-training and joint participation in inspections and drills, and these types of activities help to promote cohesion and communication in the case of an actual disaster event. In some situations, a formal agreement may be required for an external agency to provide specific resources during a time of crisis, and such an agreement should be negotiated in advance. Programs that have elevated security needs may also decide to acquire additional services through an independent contractor if a facility's physical security is in danger of becoming compromised during an emergency.

Preparedness

The ability of individuals involved in agricultural research programs to organize a centralized, coordinated, and consistent response is highly dependent upon having a well-defined chain of command and clear lines of communication. A breakdown in either component frequently results in delays or confusion that can lead to failure at some point in the process, making both even more important when there is minimal lead time and a quick response is critical.

An emergency or incident command center should be established, with the primary and secondary officials in charge clearly indicated. At least 1 individual should be assigned to oversee each area of responsibility, such as animal care, emergency equipment operation, or communications. Alternates should be designated and provided with the necessary cross-training to take over when the primary individual is unavailable. This is particularly important if key staff members are expected to be absent or unable to perform their duties on-site or remotely for an extended period, such as during human disease outbreaks and pandemic situations. Whenever possible, instructions or checklists should be developed for routine tasks, and these should be made available to emergency workers to ensure duties are completed accurately and consistently.

The minimum number of personnel needed to perform assigned duties must be determined. Individuals should be identified who are readily able to report and perform duties that contribute to the response effort; personnel who are essential and required to be present should be distinguished from those who are optional and report on a voluntary basis. At minimum, all responding staff should receive regular health assessments and vaccines necessary to ensure their safety during emergency situations and be trained in hazard awareness and basic first aid procedures.

Alternate daily operating plans should be developed for unusual situations when excessive absenteeism prevents minimum staffing levels from being met. This may happen with widespread illness during disease outbreaks or as a result of infrastructure failures that interfere with transportation and other basic services and materials necessary for personnel to continue their normal work routine. Supply chain disruptions of critical items, such as personal protective equipment, disinfectants, and pharmaceuticals, can severely compromise the ability to maintain core operations and may necessitate temporarily delaying research activities and reducing animal numbers through sale, transfer, or euthanasia if appropriate standards of care cannot be maintained.

Establishing clear channels for communication and regular intervals for critical information exchange should always be a major priority. Easily activated and reliable systems for contacting individuals on- and off-site should be available. Redundancy is important, and combinations of communication systems that allow both audible and visual forms of notification and that use different types of technology capable of integrating cross-communication between devices to bypass service malfunctions should be considered. Widespread panic and confusion can result when substantial delays or breakdowns in communication occur. A well-known example was the false ballistic missile alert issued via the Emergency Alert System and Wireless Emergency Alert System by the Hawaii Emergency Management Agency on January 13, 2018. More than 38 minutes passed before a second alert was sent to notify the public that the initial warning was released in error. A postincident investigation determined that a combination of insufficient management controls, poor computer software design, and human factors contributed to transmission of the false alert and delayed notification that the initial alert was issued in error.[12]

Commonly used technologies for communication include intercom systems, closed-circuit television monitors, telephones (landline and mobile), electronic messaging (eg, email or text messages), and other mass media (eg, newspapers, magazines, web pages, blogs, podcasts, signs, and placards). Having prepared messages composed in advance helps to improve efficiency and speed when time is limited. If email is available, an electronic mailing list should be used for essential personnel to facilitate real-time communications throughout the course of an event, or regular times and intervals should be established for information to be formally exchanged between workers.

An adequate supply of critical resources and materials must be kept stored and available to sustain operations throughout the immediate crisis period. At a minimum, sufficient feed and water to sustain animals for 72 hours should be stockpiled as well as drugs and supplies needed to provide emergency animal care, including equipment and pharmaceuticals needed to euthanize or depopulate animals in extreme or catastrophic situations.

Other essential emergency supplies, such as personal protective equipment, sandbags, plastic sheeting, duct tape, wire and rope to secure objects, lumber and plywood to protect windows, extra fuel, and hand tools, should be saved in advance. Inventories should be kept, and perishable items should be routinely checked to ensure they have not expired or become compromised. Facilities, equipment, and storage areas should be inspected regularly to ensure they are functional and ready for use in the event of an emergency. Generators used to supply emergency power should be kept serviced, fueled, and tested under load at least quarterly to ensure they are always in working order.

Other basic supplies should be collected in the event workers are required to shelter in place for an extended period. This reserve should include food, water, clothing changes, blankets, cots, and personal hygiene items.

Plans should also include strategies for maintaining research activities in progress and preserving highly unique and rare research resources. Alternate housing options for highly valuable research animals should be identified in case emergency relocation becomes necessary, and the germplasm of unique species should be cryopreserved if possible. Designated rooms used for special research procedures (eg, surgeries, biocontainment studies, or work with hazardous materials) should be equipped with emergency power and utilities to ensure continuity of services to support ongoing studies and prevent inadvertent biosecurity lapses or contamination of nonresearch areas. Critical equipment (eg, freezers, computers, and analytic instruments) should also be maintained on emergency power to ensure that the integrity of archived samples and data is preserved.

Training and Drills

Training sessions and drills provide opportunities to evaluate the knowledge of facility personnel and assess the effectiveness of various response strategies. Several training options are available, including online modules, didactic lectures, webinars, and live or hands-on practical training. Each has advantages and disadvantages, depending on the topics addressed and individual preferences of those being trained. Incorporating variety and flexibility into the training program offers many advantages and helps ensure broader participation.

Drills can take many forms, including tabletop exercises, routine practice sessions, and simulations or mock events. They should be conducted at regular intervals and incorporate exercises focusing on specific aspects of different plans. Exercises may be coordinated in advance or conducted without notice so that accuracy and speed of response under mock emergency conditions can be assessed. While drills are in progress, specific individuals should be designated as observers and recorders to provide feedback to the group on what went well and what needs improvement. Debriefings should be scheduled after every session to critique plans, facilities, equipment, and staff performance.

Preparing for emergencies is not a static process, and local plans should be updated on a regular basis. Every plan should include strategies to capture opportunities for improvement, implement needed changes, and measure the impact of these changes. At a minimum, the content of plans should be critically evaluated and updated at least once every year to reflect changes in personnel, facilities, animal populations, and environmental conditions. However, the results of drills, combined with a careful analysis of near misses and actual incidents, also provide valuable information on the effectiveness of local plans and often help identify specific areas for improvement. It may also be beneficial to compare local plans with those from other organizations to incorporate best practices and the latest technologies.

Emergency Response

The designated emergency or incident response team, as defined in the preceding discussion, should be assembled at the onset of an emergency. This is the executive group responsible for determining the order and sequence of actions taken during an emergency. For larger institutions, this team may represent a dual chain of command, consisting of the institutional leaders (or leadership team) and an ancillary crisis response team. The crisis response team is usually made up of a smaller group of individuals with expertise in emergency response and safety. These individuals function primarily in an advisory role to the leadership team and are often delegated limited decision-making authority to activate response action plans close to the incident site, owing to their familiarity and superior knowledge of local conditions. However, institutional leadership must be closely engaged during decisions involving resource allocation and policy changes, so close and frequent communication is needed at all levels of the organization throughout the entire incident.

The status of the disaster event and affected areas, both on- and off-site, should be monitored closely and at appropriate intervals after an emergency response plan has been activated. Less frequent updates may be suitable for longer and more drawn-out events such as droughts, disease outbreaks, pandemics, or hazardous spills. In contrast, continuous monitoring is typically needed when conditions are expected to change rapidly with minimal warning (eg, hurricanes, fires, or floods). Systems can become overwhelmed when the status changes quickly, particularly in rural regions where local resources are often limited. Response times can be negatively impacted, forcing local plans to be quickly modified or improvised to compensate for shrinking resources and rapidly changing priorities.

It is important to monitor the status and general location of emergency responders and other employees who are on duty while response actions are in effect. Workers should be rotated frequently during prolonged or physically demanding events. Staff on duty should check in at the start of their shift, notify supervisors of their status periodically while on duty, and formally check out when completing their work shift. Implementation of standard infection control procedures may be prudent during disease outbreaks and pandemics to minimize disease transmission and protect essential workers. Strategies should rely on a basic understanding of the modes of transmission and options for treatment and prevention of the agents and diseases of concern. Unlike other emergencies, the typical pandemic is a sustained crisis and will have a longer duration of 6 to 8 weeks or more. Plans must be flexible owing to the uncertainty associated with pandemics and must include integrated processes for reviewing rapidly changing recommendations and updating facility plans accordingly.[13]

On some occasions, animals may panic and become difficult to manage while an emergency is in progress. This can impede actions to transport or contain animals within a safe area, particularly when a larger species or high numbers of animals are involved. Livestock with unpredictable behavior can become a danger to individuals who are attempting to work with them. The safety of personnel should always be the top priority, and staff should not be expected to take unnecessary risks if animals become wild and unmanageable in these situations.

Relief and Recovery

Damages and losses should be assessed after conditions have stabilized and it is safe to do so. Veterinary care should be provided for animals that have escaped or are injured, and the carcasses of dead animals should be moved to a suitable area for storage or disposal. The structural integrity of all buildings and facilities should be evaluated and verified safe to reoccupy by local authorities through the incident command center. Buildings that are unsafe should have warning signs posted to prevent entry and be stabilized, barricaded, or cordoned to protect individuals from falling debris and environmental hazards if needed. Repairs or temporary connections to portable utility units such as generators or water storage tanks should be made to restore vital services where necessary. Receptacles used for hazardous material storage should be checked for accidental release attributable to damage, leaks, or spills.

A comprehensive list of resource needs and action items should be prepared that prioritizes immediate and long-term needs. Such a list can provide the foundation to develop a tiered recovery plan to restore basic operations to predisaster conditions as quickly and efficiently as possible. Highest priority should be given to essential functions, and the list should include steps to do the following:

- Contain and secure hazards.
- Contain and secure escaped animals.
- Address emergent animal health and welfare needs, including euthanasia of severely injured animals in response to urgent circumstances.
- Maintain a safe drinking water supply.
- Salvage safe feed sources (eg, grains, prepared rations, hay, and grazing areas).
- Closely monitor animal health status.
- Continue care for sick and injured animals.
- Repair or replace critical equipment and facilities.
- Remove debris and carcasses.

Maintaining effective lines of communication throughout relief and recovery efforts will help maintain momentum and progress.

A thorough and disciplined postdisaster review should always be performed to identify effective actions and strategies to determine where changes are needed. Plans and preparations drive actions taken during emergencies, and studying the results of these efforts yields valuable information that can be used to improve future strategies. The IACUC has a key role in assessing the cumulative impact of these events on the agricultural animal care and use program relevant to animal welfare, facility operations, and the research program. The committee has local oversight authority for the program and advises the institutional leadership on program deficiencies and adverse events that have the potential to adversely affect animal health and well-being. The institution is obligated to submit an official report to the NIH Office of Laboratory Animal Welfare when PHS-funded research is compromised[14] (or to the appropriate agency if another funding source is involved) and should provide notification to the AAALAC if the program is accredited.[15]

With the right leadership, each crisis provides an opportunity for research facility staff to gain experience, learn, and improve. Over time, this model becomes self-sustaining and helps to establish a continuous cycle of quality improvement.

Conclusion

Unfortunately, initial responses to emergency situations may be limited for many agricultural research programs, given the type of operation, management practices, and sheer size and scope of the facilities. On-site sheltering options are frequently limited, open ranges or fields can be challenging to secure, and relocating agricultural species is often difficult. During large-scale disasters, the situation can become overly complex because authorities are often overwhelmed with humanitarian concerns and available resources become quickly depleted.

The environmental impact and public health concerns associated with response and recovery efforts can be substantial because of exposure to pathogens, delays in carcass disposal, and groundwater contamination. Biosecurity may also be difficult to maintain because of substantial increases in the movement of animals, people, and equipment. The personal safety of emergency responders and workers can be put at risk when delays exist in accessing shelter or evacuation efforts.

Individuals involved in agricultural research programs should consider contingency planning as an organizational priority to minimize the substantial and sometimes long-term impact of these consequences. Developing plans that include all elements of emergency response and recovery will help institutions ensure appropriate and humane care for animals over a wide range of emergency scenarios. Investments in advanced planning, personnel training, and regular practice sessions increase the likelihood of a successful outcome and ensure that program leaders consider and provide the adequate supplies, equipment, resources, facilities, and time needed to support these efforts.

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