Western Dairy News
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Strategies for radioactive decontamination of livestock

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Nuclear reactor accidents are very rare, but they can cause a devastating effect on human and animal environments in their vicinity, and even have an impact on agricultural processes around the world. Three such accidents have occurred in the past 35 years, and the most recent one in Japan has raised several questions about the safety of food supplies in the affected area that include livestock.

It is important to remember that a reactor accident is not the only event that can spread radioactive contaminants into the atmosphere. The detonation of a small yield nuclear weapon (called an Improvised Nuclear Device), or a "dirty bomb" containing radioactive substances (called a Residual Dispersion Device) are also types of "nuclear events" that may spread radioactive contaminants. Although the probability of a reactor accident or terrorist event is incredibly small, the aftereffects can be difficult to handle without a plan of action.

The primary concern to those outside of the immediate area of a nuclear event is radioactive contamination from fallout. After an explosion, radioactive particles from the reactor can escape into the environment. Winds transport the particles and spread them globally until they eventually "fall out" from the sky. The radioactive contaminants will then remain in the environment until they decay. The timeline of that decay depends on the length of their radioactive half life.

Isotopes with short half lives can decay in seconds to minutes, whereas long-lived isotopes can take years. Hence, short-lived isotopes are desirable. Radioactive fallout consists of hundreds of isotopes, but only a few dozen are long-lived (i.e. cesium and strontium). Radiation hazards are not characterized by the half life but by the type and energy of the radiation emitted.

Transport of fallout contaminants is accomplished primarily by rain water or snowmelt, which can either dilute or concentrate the material. Expect to find higher radioactive concentrations near building gutter drains, ditches, ponds, and other similar drainage points, although these concentration points will dilute over time with more rains and high winds.

So what do dairy cows have to do with nuclear and radiological events? Dairy cows become contaminated directly by fallout (particles) landing on them, and indirectly by ingesting food and water which has been contaminated. When cows ingest the material a small portion will enter the milk supply that is distributed to the public.

Children are large consumers of milk and are more sensitive to radiation than adults. This was evident following the reactor accident in Chernobyl, Ukraine, in which many children received significant radiation doses from the local milk supply. Therefore, monitoring the milk of potentially affected cows is very important. In addition, radioactive fallout can settle on cows that are not sheltered. These cows have the possibility of spreading contamination to uncontaminated cows and potentially internalizing the contaminants.

In order to prepare for action following a nuclear event, several terms must first be discussed.

Background radiation.

We live in a world filled that is with radiation. You can find it naturally in the ground, air, water, food, and coming from outer space. Man has also created several types of radiation sources, such as those for medical imaging, nuclear reactors, household items, monitoring equipment, etc. So when using radiation detectors, almost all of them will show values slightly above zero because of background radiation.

Background radiation levels vary by location,

Western Dairy News

2x2 sodium iodide radiation detector.

Geiger Muller pancake probe radiation detector.

primarily depending on soil composition, mountainous areas, and altitude. Training is recommended when determining background levels with radiation detectors.

Contamination and radiation.

These two words are widely discussed during nuclear events, and their meanings are very important in order to know how to respond to each.

Contamination is the physical presence of radioactive particles in an unwanted location. The particles are so small in number and size that they are typically not visible. The only way to know contamination is present is by use of contamination detectors such as the very common Geiger-Muller detector that is accompanied by audible clicks. These detectors have meter units of counts per minute.

Contamination is typically external, but can also be internalized by ingestion or inhalation. Trained nuclear contamination workers emphasize the prevention of internal contamination in their work ethic by not eating or drinking, and by wearing respirators when required.

Radiation is the emission of several different types of particles. The most common types of radiation are gamma rays, x-rays, alphas, and betas. As these particles travel through material, they deposit small amounts of energy that cannot be detected by any human senses. So again, detectors must be used to determine the presence of radiation. Typical detector units measure Roentgen per hour, rad/Gray per hour, and rem/Sievert per hour.

Contamination does emit radiation, but their meanings and measurement metric are quite different. For example, during a hospital x-ray the patient is being exposed to radiation, but is not contaminated. Fallout from a reactor accident is contamination. Fallout also irradiates those that are nearby. The most effective means to minimize radiation dose is to increase your distance from the source and minimize your time near it.

Plume (evacuation and shelter)

Following a nuclear event, radioactivity is likely to be released into the atmosphere in a non-visible plume. The direction and shape of the plume depend on the wind currents, and both change often due to changes in wind direction and speed. If the plume is moving toward your location you have two options: evacuate, or take shelter in place.

Evacuation of large numbers of animals is a difficult task that is highly undesirable and usually costly. In fact, if radioactive contamination levels are expected to be low, evacuation is not important. The best option is to provide shelter for animals in a barn-type enclosure with secured windows and openings to minimize contamination entering the enclosure. Securing windows can be done by simply shutting them and then placing tape and plastic over the creases.

Not every enclosure is ideal for securing ventilation, though, so this decision should be made with consideration of the number of animals involved and the outside temperature in order to prevent heat exhaustion. If a barn is not available, any type of shelter is better than none. Outdoor food supplies and water troughs should be covered with tarps for later use. Keep animals and provisions under shelter until the plume has passed. Remember, you will normally not be able to see the plume, so you will need to rely on experts or notifications from authorities.

In order to determine if your livestock are contaminated, the correct detector and scanning technique must be used. External contamination is the easiest to detect and decontaminate. Workers must be protected themselves, but the use of industrial personnel protective equipment such as yellow anti-contamination clothing or white Tyvek suits should be used with caution since they may alarm the animals.

Two common types of handheld contamination detectors are the Geiger Muller pancake probe and the 2x2 sodium iodide detector. Before use, training is highly encouraged to understand detector operation and survey techniques.

Western Dairy News is published as a service to people interested in the health and welfare of the Western dairy industry. Archives of this publication may be found at:
http://animalscience-extension.tamu.edu/dairy/wdn.html

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External vs. internal contamination.

The likelihood of animals dying from external contamination is very small. If they were not under a shelter, the best course of action is to leave them where they were when the event occurred. Moving and handling contaminated animals increases the potential spread of contaminants to clean areas and/or to humans. There is limited information on what is effective at removing external contamination from animals, and is a current subject of research at Colorado State University. Water, soap, and vacuuming are the methods of decontamination being studied.

Internal contamination of animals is most likely to occur through the eating and/or drinking of contaminated supplies. The best and easiest method to decontaminate is by feeding them uncontaminated provisions. Depending on the types of radioactive contaminants, internal contamination may take months to remove. Keep in mind that any internally contaminated animal will have contaminated milk and excrements.

A fine balance will have to be established between what is and is not salvageable, taking into account cost and effort. There are several methods to dispose of an animal: euthanization and disposal as radioactive waste for burial, euthanization and incineration of the carcass, decontamination of the animal and subsequent euthanization, or euthanization and decontamination of the carcass. Bio-radiological waste disposal is extremely expensive and is currently estimated to be more than $8,000 per animal.

Public perception.

With a reactor accident, the likelihood of animals or humans receiving immediate injury from fallout is unlikely. Very few people understand radiation and there is a common public fear of it. Therefore, even if animals are successfully decontaminated, it is very likely that the public will not be willing to purchase animal products that were contaminated at one time. Radiation experts are the best asset to effectively communicate that the animal products are indeed safe for consumption.

Although the possibility of a reactor accident is minimal, just one can impose long lasting effects. Planning for such an event can minimize the potential for radioactive contamination and increase the possibility of successful decontamination in order to minimize financial and economic loss.

More information about this subject is available in one hour online webinar that is archived at: http://www.ext.colostate.edu/eden/