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Guidance for Manure and Litter Stacking

Eric Simon
Program Associate -
Crop, Soil & Environmental Science

Mike Daniels
Professor -
Crop, Soil & Environmental Science

Livestock manure and chicken litter (mixture of bedding material, manure, and urine) are valuable fertilizer and soil amendments for row crop producers in eastern Arkansas. Manure can be a cheap source of nutrients and can help to build soil health and soil structure in fields. However, the availability of cheap manure may not coincide with growers' application needs, especially timing. Best management practices for stacking and storing manure and understanding the importance of these practices is pertinent to farmers. This factsheet is only focused on the storage of solid manure.

There are many factors to take into consideration when planning manure and litter storage. They include farm specific influences, environmental concerns, safety, and odor. Each of these factors must be considered in conjunction with a storage needs approach. The foundation of a storage needs approach is the duration the manure will be stored and the quantity/quality of manure that will be delivered and stored. Utilizing a needs-based storage approach while considering the planning factors will help farmers choose the optimal method for manure and litter storage.

Short Term Storage

Short term storage indicates that on-farm manure will be fully utilized within a couple of days. Since the manure will only be stored for a very short time, many of the environmental, safety, and odor risk factors are of less importance. Storage location can be selected based on what is most convenient and accessible for the upcoming use. Piles should be constructed with some degree of compaction to reduce the likelihood of errant materials. It is acceptable for the piles to be in direct contact with the ground and to be left uncovered, however, upcoming weather events should still be taken into consideration. Additionally, the piles should still be constructed in a way that promotes water shedding and inhibits water from pooling on top and infiltrating into the manure or litter. If properly constructed, "stockpiled biosolids form an air-dried crust that sheds precipitation and prevents significant percolation of water through the pile" (EPA, 2000). Additionally, manure will have a higher nutrient content when stored short term, as it tends to lose nutrients over time when exposed to air and water.

Intermediate Term Storage

If a farm's specific timing and quantity needs dictate that manure will require storage for more than a couple of days, then additional factors, listed in Table 1, must be taken into consideration. There are multiple options available when a farm needs to store manure on the intermediate term. Covered stockpiles and deep stacking can be a great way to store litter and manure without having to construct expensive structures. When utilizing a stockpile for storage without a structure or pad, location is the most important initial consideration.

The selected location can have a significant effect on the potential environmental impact and off-farm pervasive odors. The preferred location for the placement of a stockpile is on top of a well vegetated hill or slope. This will prevent water from running downhill through the pile and reduce the risk of significant nutrients in surface runoff. The **Natural Resources Conservation Service's (NRCS) Code 318 recommends keeping piles at least 150 feet away from sensitive areas** such as such as streams, wetlands, and groundwater wells. Additionally, stockpiles should not have direct ground contact with soils that have high infiltration rates or are easily saturated. If all soils for a given site fall into this category, then it may be necessary to utilize an on-ground liner beneath the stockpile. Height of the local water table and floodplain must also be considered during stockpile placement because minimizing water contact with stored manure is critical to reducing nutrient loss in runoff.

Once optimal placement has been selected, consideration of how to reduce runoff caused by precipitation falling directly on the pile should occur. **Although it is possible for an "air-dried crust" to reduce the impact of precipitation on a pile, it is often recommended that stockpiles are covered with a poly tarp. The poly cover should be a minimum of 6 mil thick, which should be able to adequately protect a stockpile from precipitation for at least one year.** Regardless of the thickness, the cover must be properly anchored according to engineering specifications and should not be clear (as this can induce excessive solar heating). Prevailing wind direction, if present, should be considered when constructing a covered windrow pile. The length of the windrow should be parallel to the predominate wind direction, as a large updraft area can make it extremely difficult to keep a poly cover securely anchored.

Other intermediate storage options include bunker and covered pad designs. Utilizing these methods allows more freedom in selecting an appropriate location but requires a larger construction input, especially cost. Bunker manure storage design is similar to a silage bunker. They are typically constructed using three concrete barrier walls that are at least five feet high and will sometimes be partially trenched into the ground for increased depth in storage capacity. **The ground of a bunker storage unit should be covered with an appropriate poly liner (NRCS 521), a concrete foundation, or a properly compacted clay soil liner (NRCS 520)**. When constructing a bunker, the ease of access for necessary equipment should be taken into consideration. A well-made bunker will allow firm compaction and deep stacking of biosolids, which will reduce the total storage area required. When litter stacking is completed, a bunker must be protected from precipitation by a properly anchored and appropriately spec'd poly cover.

A concrete covered pad storage unit will be similar to the stockpiles discussed above. The covered pad design will allow more freedom in choosing a stockpile location and can reduce the risk of runoff and infiltration. However, just like a typical stockpile, upstream water should not be allowed to flow through. On-ground water flow can be prevented from interacting with the pile in one of two ways. The first option is to choose an uphill sloped location (as previous discussed); the second option is to lay the concrete foundation on top of a constructed elevated earthen pad. Arkansas NRCS recommends creating at least a 1-ft compacted earthen base beneath the concrete with a sloping perimeter that will "maintain positive drainage away from pad." It is also recommended that the pad be constructed using at least 5 inches of reinforced entrained concrete. The poly cover and anchoring method will be similar to what is used on an on-ground stockpile.

Long Term Storage

The best option to store manure or litter long term is to use a roofed stacking shed. Constructing a roofed stacking structure will have a higher initial expense, however, it will provide the most effective pile protection while significantly reducing the annual management labor time. Many different stacking shed designs are available but are there several logical engineering practices that should be followed for roofed manure storage structures. Support posts should be limited to the exterior walls, as interior posts can impede equipment maneuverability. Also, if a wooded post intersects a litter pile, it poses an increased risk of catching fire and causing significant structural damage. Walls must be engineered to withstand lateral pressure if biosolids will be piled against them. The primary function of this structure is to provide manure piles lasting and effective protection from precipitation and prevent runoff. The roof must be clear span, and if full wall panels are not used, then it should be constructed with an adequate overhang to prevent wind blowing in excessive precipitation. Typically, it is recommended that roofs be at least 12 feet high to allow for equipment maneuverability when managing large piles. Roofs should be

constructed of corrosive resistant materials as ammonia gas can be released from stored litter and corrode roofing material. For this same reason, all steel used in construction should be galvanized. Additionally, it is recommended that the roof have vents to allow potentially dangerous gases and excess moisture to escape. **The Arkansas division of NRCS may have a stacking shed design available upon request with more specific engineering instructions, as part of their cost share program.**

Safety

For all manure and litter stacking endeavors there are important safety practices and considerations that must be followed. Different biosolid materials have variable physical characteristics that dictate their stacking angle of repose. Attempting to force a material to stack at too steep of an angle can create hazardous circumstances where a collapse may occur and cause harm to equipment operators or bystanders. **Manure managers should always follow the recommended safety procedures for equipment being utilized.** When covering a stockpile with a poly tarp, the tarp must be safely and securely anchored. If heavily weighted items are utilized to help hold covers in place, they should not be placed in locations where they may fall on bystanders. If there is an area where objects may fall, the ground should be marked with high visibility flags. Additionally, the tarp itself poses safety risks if blown off during heavy winds, which is why proper anchoring is critical. When constructing a stacking structure, engineering and design guidelines should be followed so that only appropriate materials and methods are used.

Another important safety hazard associated with manure stacking, which must be factored into storage management, is the chance of spontaneous combustion, which is especially true for poultry litter stacking. There are several best management practices that can help mitigate the risk of spontaneous combustion. **The maximum height of stockpiles should be limited to seven feet.** Piles over this height cannot adequately shed heat and are far more prone to igniting. Additionally, if litter is stacked in a structure with wood walls, then the height of the litter to wall contact should be limited to five feet. A great safety practice is to monitor the pile's temperature. **If temperatures exceed or persist within 160°-190°F, management action needs to be taken to dissipate the heat.** The best management action is to spread out the pile and increase its surface area as this allows for faster heat dispersion. Adding moisture to piles has the potential to induce more thermophilic reactions and increase the likelihood of spontaneous combustion.

References

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Table 1: Factors to Consider When Storing Manure		
Factors	**Variables Within Factors**	**Specific Considerations**
Farm Specific Influences	Field specific needs	• Crop nutrient requirements • Soil test levels • Food safety (Food Safety Modernization Act: Biological Soil Amendments of Animal Origin)
	Nutrient Management Application Plan	• Timing – how soon will it be applied and where is current crop cycle? • How much will be applied/how much will be delivered? • Method and equipment used for application
	Location	• Accessibility – is the storage location accessible to necessary equipment with consideration given to weather related changes? Is it optimally located for field use? • Landscape – Hill tops are the best location for open stacking. Flood prone areas must be avoided • Sensitive areas – see environmental consideration • Neighbors
Environmental Considerations	Environmentally sensitive areas	• Streams • Wetlands • Karst topography • Groundwater wells
	Runoff and groundwater infiltrations	• Minimize water contact with stored manure • Avoid direct contact storage on soils with high infiltration rates • Water table and floodplain • Runoff direction – use setbacks and buffers/vegetative filter areas when necessary
	Wind	• Predominate wind direction - if applicable, windrows should be constructed so that their length runs parallel to the wind. This will reduce updraft pressure on poly covers. • Stockpiles should be constructed and packed so that wind cannot readily remove material from the pile.
Safety	Engineering and stability	• Angle of repose • Variability in material physical characteristics • Safe practices based on equipment that will be utilized • Proper poly cover anchoring • Follow construct guidelines for stacking structures – e.g. do not use roofing that is prone to corrosion from ammonia, ensure roof clearance or venting to allow gases to escape, use entrained concrete and galvanized steel.
	Spontaneous combustion	• Maximum height of 7 ft • Maximum temperature of 160°-190°F - when temperature exceeds or persists within this range management action needs to be taken to avoid pile combustion. • Moisture – adding moisture has the potential to increase thermophilic reactions which raises the likelihood of spontaneous combustion • Follow construction guidelines for structures – e.g. Minimum clearance height of celling above pile, no wooden support beams within piles, limit height of pile stacked against walls
Odor	Location	• Proximity to neighbors and adjacent areas • Predominate wind direction
	Timing	• Heat, humidity, and sunlight can increase the release of pervasive odors. To reduce odor, try to avoid manure pile agitate and application during these peak times.

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ERIC SIMON is a program associate - crop, soil and environmental science with the University of Arkansas System Division of Agriculture, Little Rock. **MIKE DANIELS** is a professor - crop, soil and environmental science with the University of Arkansas System Division of Agriculture, Little Rock.

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