Pros & Cons of Swine Mortality Disposal Options

Thomas D. Glanville
Iowa State University, tglanvil@iastate.edu

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Pros & Cons of Swine Mortality Disposal Options

Disciplines
Agriculture | Bioresource and Agricultural Engineering

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Pros & Cons of Swine Mortality Disposal Options
What’s New?

- For Stabilization & Extended Storage (prior to rendering)
  - Fermentation (requires grinding & fermentable carbohydrate)
  - Acid preservation (requires grinding, sulfuric or phosphoric acid [safety concerns])
  - Refrigeration – used by slaughterhouses in Netherlands during FMD outbreak in 2001

- For Disposal
  - Alkaline hydrolysis (biological material dissolved in alkaline hydroxides under heat and pressure) – currently used by NADC and university veterinary research labs
  - Anaerobic digestion – biological decomposition in heated anaerobic vessel
  - Gasification – bio materials heated to produce synthetic gas that is burned

- In general, these new methods not currently widely used
  - Higher capital & operating costs
  - Some are quite complex
  - Some suited for large or highly specialized operations
What’s New?

Commercial Developments & University Research

- **Biovator rotating mechanical composter**
  - Automated processing of routine mortalities
  - Frequent turning promotes rapid decomposition

- **ISU Research on Emergency Composting**
  - Windrow composting for emergency disposal
  - Studied effects of seasonal weather conditions & type of cover material on performance
  - Sponsored by Iowa DNR and USDA

- **ISU Research on Bio-secure swine mortality composting**
  - Use of plastic envelope to reduce risks of pathogen escape
  - Sponsored by Canadian Food Inspection Agency and Canadian Research & Technology Initiative
Traditional Methods

Rendering, Burial, Incineration, Composting

- Not perfect solutions, but are widely used because:
  - Work reasonably well, historically accepted
  - Relatively simple (not necessarily easy)
  - Timely – most can be done on the farm
  - Reasonably affordable
Iowa Swine Mortality Management Survey

% of Iowa **Swine** Operations Using Each Method

From 2001 IPPA / ISU survey of Iowa swine producers
Pros & Cons of Disposal Methods

Key Factors / NEW Info

- Time/Delays
- Bio-security Risks
- Environmental Risks
  - Air pollution - odor
  - Soil/water pollution
- Costs
  - Fixed - facilities & equipment
  - Variable - fuel, services, maintenance
Time Delays

- Rendering
  - Number of rendering plants decreasing in U.S.
    - Iowa lucky to have several
    - Only one plant serves all of the New England states!
  - Fewer plants mean greater haul distances (potential for delays)
  - Most frequent Iowa producer complaint about rendering
    - NOT lack of availability
    - Lack of Timeliness
      - (2001 IPPA / ISU survey of swine disposal practices in Iowa)

- Management Practice
  - Consider refrigerated storage if delays are a frequent problem
Time Delays

- Burial
  - Primary Cause
    - Weather-related delays
      - Frozen soil
      - Muddy conditions
  - Management Practices
    - Schedule excavation during warm/dry weather
    - Locate burial sites in well drained soils
Time Delays

**Incineration**

- Delays Primary Due To
  - Fixed capacity ..... inadequate at times of peak loss
  - Difficult to expand capacity
  - Note: A natural tendency to overload incinerators during periods of high losses ..... can lead to **serious** odor emissions

**Management Practices**

- Use composting or rendering when incinerator capacity is exceeded
Time Delays

- Bin Composting
  - Primary Cause
    - Some delays if bin capacity is exceeded
  - Management Practices
    - Use windrow composting methods to provide extra capacity
      (more about methods later)
Bio-security

- Rendering
  - Process itself
    - Good bio-security
    - High rendering temperatures destroys pathogens
  - BUT, movement of rendering trucks from farm-to-farm is often mentioned by producers as a bio-security concern
    - Not much scientific work on this topic, but one recent study supports this concern
      - Published in JAVMA, McQuiston et.al. 2004 claimed strong evidence of farm-to-farm transmission of avian influenza by rendering trucks during 2002 outbreak in state of Virginia.

- Management practices
  - Keep rendering vehicles away from production barns
Bio-security

- **Burial**
  - Long considered to pose “low risk”
    - One study (Davies & Wray, 1996) reported that cattle burial caused extensive pathogen contamination in the soil and a nearby drainage ditch
    - Anthrax spores - have long-term survival in soil, and may reach soil surface (Turnbull, 2001)

- **Management Practices**
  - Bury promptly after death
  - Use care when transporting carcasses
  - Observe recommended burial depths and separation distances to wells, streams, & embankments.
Bio-security

- **Incineration**
  - Very low risk, extreme heat kills pathogens

- **Management practices**
  - Incinerate promptly following death
  - Use care when transporting or storing carcasses
Bio-security

- **Composting**
  - Moderately low risk
    - Heat and other stressors (pH, drying, antimicrobial chemicals) reduce pathogen populations
    - But lack of temperature uniformity (cool zones near edges) can allow pathogens to survive

- **Management Practices**
  - Avoid use of small bins or piles (< 1 m$^3$)
    - Cannot retain heat
  - Keep carcasses away from edge of bin or pile (cool zone)
    - Temperatures much higher 2 ft or more from edge of pile
Environmental Risks

- Rendering
  - Very little air or water pollution risk on the farm
  - Occasional odor complaints near rendering plants
Environmental Risks

- **Burial**
  - High risk - nitrogen pollution of soil & groundwater
    - Every 1000 lb of carcasses contains 22 lb of nitrogen
      - High density burial of carcasses (carcasses touching each other) can lead to N loadings of 25,000 lb/acre or greater!
      - Carcasses buried in wet soils can take 10 years or more to decompose

- **Management Practices**
  - Avoid high density burial – especially if groundwater is shallow
  - Locate all burial sites at least 1000 ft meters from wells, and streams
Environmental Risks

- Incineration
  - Risk of serious air pollution
    - If incinerator is loaded too heavily
      - Low operating temperatures

- Management Practices
  - Do NOT overload incinerators
    - Better to use composting or rendering when incinerator capacity is exceeded
Environmental Risks

- Composting
  - Soil pollution
    - If done on unprotected soil
    - If bin or windrow not protected from rain

- Management Practices
  - Place composting facilities on concrete platform
  - Place roof or plastic cover over bins or windrows
Cost

• 2001 Iowa State University Swine Mortality Management Survey

![Total Disposal Cost (Capital+Operating)]

- Rendering: $48.31
- Incineration: $85.90
- Burial: $110.96
- Composting: $74.35
Swine Mortality Composting
Setup & Operation

Equipment

- Tractor/loader or skid loader
  - Haul carcasses & cover materials
  - Build, turn, unload bins
  - Manure spreader – haul / land apply compost

- Long-stem dial-type composting thermometer
  - Check internal compost temperatures ..... useful for troubleshooting
  - Recommend 36 - 48-inch stem length
  - Approximate cost $100-$150
Swine Mortality Composting

Setup & Operation

- Recommended facilities
  - Options
    - Configuration: bins vs. windrows or piles
    - Roofed vs. unprotected
  - Roofed bins recommended for swine disposal in Iowa
    - Why bins?
      - Reduce the amount of cover material needed
      - Help retain heat in cold weather
      - Reduce problems with rodents/scavengers
    - Why roof?
      - Iowa receives 32 inches/yr of precipitation.
      - Causes pile saturation resulting in:
        - Leachate & odors
        - Low internal temperatures
        - Slow carcass decomposition
Bin Example

Back-to-back bins, concrete walls, includes cover material storage

This facility sized for average daily losses of 300 sow farrow-finish operation
Bin Example
Single-row configuration, treated lumber walls

This facility sized for average daily losses of a 450 sow farrow-to-nursery operation
Facility Example
Low-cost bins, constructed in unused shed

Composting need NOT be complicated or expensive!

Bins constructed with used materials (slat panels) inside unused shed.

Photos by Kris Kohl, ISU Extension Engineering Field Specialist
Estimating Needed Bin Space

- Step 1: Estimate total **annual** pounds of mortalities based on operating records
- Step 2: Divide annual pounds by 365 to get **average daily loss**
- Step 3: Multiply daily loss by **40** to get **total** cubic feet of bin volume needed
Bin Dimension Guidelines

- **Minimum** bin width (feet) = 2X loader bucket width
  - Reduces potential damage to both loader and bin walls

- Front-to-back dimensions = 1 to 2X bin width

- **Maximum** sidewall height - 6 feet
  - load to 5-foot depth
  - greater depth complicates loading/unloading & reduces oxygen penetration into pile

- Loaded bin volume = width (ft) X length (ft) X loaded height (5 ft)
Estimating Number of Bins Needed

- Divide total bin volume by loaded volume of a single bin
- Round UP to nearest whole number
- IF result is an odd number, add 1 more to get an even number
  - Need an equal number of “primary” and “secondary” bins
Additional Storage Needs

- For cover materials
  - Must be sheltered to keep them dry
  - Can incorporate envelope material storage bins into composting system, or store materials in nearby shed

- For additional details see: ISU Extension Publication Pm-1917, *Composting Swine Mortalities in Iowa*
Additional Space/Planning Considerations

- **Location of composting bins**
  - Convenient to production facilities
  - On a well-drained area
    - No runoff onto or off of composting area
    - Recommend construction of an all-weather surface that permits accessibility during inclement weather
      - compacted soil or granular aggregates, asphalt, or concrete

- **Minimum required separation from environmentally sensitive areas**
  - 500 ft from residences
  - 200 ft from public wells, 100 ft from private wells
  - Outside of wetlands, 100 ft from surface water bodies
Keys to Successful Composting

Permeable (coarse textured) cover material

.... lets oxygen into pile,

.... and excess water vapor & decomposition gases out

Moist bio-decomposition zone ... degrades carcasses & odorous byproducts

Absorptive base layer ... controls leachate

During cold weather .... 18 inch “insulating layer” retains heat....kills pathogens ... speeds decay
Composting Procedures

Loading the Bins

- **Use PLENTY of Envelope Material**
- Retains heat, odor, & leachate
  - 12-inch thick absorptive *base layer* (minimum)
  - Space *between* adjacent carcasses (same layer)
    - 4-6 inches - small carcasses
    - 6-12 inches large carcasses
  - Material *between* layers
    - Same as between adjacent carcasses
    - Cap top layer with 6-12 inches ..... more during cold weather
Composting Procedures

Temperature Monitoring

• Monitor Internal Temperatures
  • Low temperatures (< 100 °F)
    • Cover material too wet, too thin, or too porous to retain heat
    • Insufficient pile size to retain heat
  
• High temperatures (> 160 °F)
  • Can kill beneficial composting organisms
  • Turn the pile to cool it down
Composting Procedures

Turning the Piles

- Move compost from one bin to another midway through decomposition
  - Introduces oxygen, redistributes moisture, speeds decay

- Approximate decomposition times (depends on weather [temperature] & size)
  - 1-2 months – swine < 100 lbs
  - 2-4 months – swine > 100 lbs
Composting Procedures

Compost Utilization

• IDNR rules allow mortality compost to be applied to cropland without a permit
  • Application to other types of land requires IDNR approval

• Nutrients (bin compost)
  • N& P usually low – 0.5 to 1% on wet basis (unless manure is used in compost)

• Finished compost WILL contain bones
  • Dry & free of soft tissues – but may attract some scavengers
  • Not recommended to spread near to residences
Troubleshooting Mortality Composting Problems

• Most Common Problems
  1. Leachate production
  2. Poor odor retention
  3. Slow carcass decay
Troubleshooting - Leachate

• **Cause # 1: Excessive precipitation exposure during wet seasons**
  
  • **Solution:** Reduce exposure
    • Roofed bin system; or
    • Install tarp over piles
Troubleshooting - Leachate

- **Cause # 2: Inadequate liquid absorption capacity**
  - Solution: Use thicker envelope of absorptive material under, between, & over carcasses
  - **REMEMBER!** 1000 lbs of carcasses contains \(650 \text{ lbs } H_2O\)
Troubleshooting - Leachate

- **Cause # 3: Use of envelope material that is too wet**

  - **Solution:**
    - Use “squeeze” test to check moisture
      - Material should feel moist … but yield only a few drops of water when squeezed (not saturated)
      - Store envelope material in dry location to avoid excessive moisture
Troubleshooting – Poor Odor Retention

- Cause # 1: Envelope material placed over carcasses too thin … or too coarse

- Solution:
  - Use at least 12 inches of envelope material over carcasses
  - Avoid use of extremely coarse envelope materials
    - Must grind coarse materials such as cornstalks or straw (use 2-inch screen)
Troubleshooting – Poor Odor Retention

• **Cause # 2: Compost turned prematurely**

  • **Solution:**
    • Don’t turn compost too soon
      • “Too soon” varies with carcass size & seasonal temperatures
        • A few days for small pigs during warm weather
        • 8-12 weeks for large pigs during cold weather
        • Experience the best teacher

    • Stockpile extra envelope material … be prepared to cap pile with more material if needed to suppress odor emissions
Troubleshooting – Poor Odor Retention

- **Cause # 3: Compost too wet**
  - Prevents oxygen penetration … pile goes anaerobic … produces excessive odor
  - Often accompanied by leachate release

- Solutions: Same as for leachate … easier to prevent than to fix after odor starts
  - Reduce exposure to excessive rainfall
  - Avoid overloading pile
  - Mix wet compost with drier cover materials
    - CAUTION … likely to increase odor releases during mixing ….. re-cap with thick layer of material to retain odor
Troubleshooting – Slow Decay

- **Cause # 1**: Inadequate O₂ penetration caused by fine textured cover material
  - Solution: Use coarser cover material
    - Particles with 1/8th inch minimum dimension … obvious pore spaces between particles (below right)
    - Avoid “soil-like” materials comprised of small particles with tiny pore spaces (below left)

![poor texture](image1.png) ![better texture](image2.png)
Troubleshooting – Slow Decay

• **Cause # 2: Inadequate O$_2$**
  • Caused by excessive moisture
  • Often accompanied by leachate
    • Solution: Again ... similar to those for leachate
      • Reduce exposure to excessive rainfall
      • Avoid overloading pile with too many carcasses and too little absorptive material
      • Mix wet compost with coarser and drier cover materials
        • Time consuming, may not work if compost is too sticky to mix
Troubleshooting – Slow Decay

- Causes # 3: Inadequate moisture
  - Typically occurs only during very dry weather

- Solution:
  - Add water sparingly and turn (to mix)
  - May need to repeat several times
  - Proceed slowly … very easy to over wet small sections resulting in odor and leachate
Troubleshooting – Slow Decay

• Causes # 4: Low temperature caused by inadequate heat production or retention

• Solution:
  • IF material near carcasses is moist … increase thickness of envelope material to improve heat retention
  • If material near carcasses is dry… add moisture to improve microbial activity & heat production
  • Note: do not put frozen carcasses into a composting system … takes extremely long time for carcasses to thaw and produce heat
Emergency Livestock Disposal Planning

By failing to prepare, you are preparing to fail.

*Benjamin Franklin (1706-1790)*
Why Plan?

- Catastrophic poultry & livestock death losses do happen!
  - Fire, blizzard, ventilation failures, heat stress, contagious disease, accidental or malicious poisoning, flooding

Photo courtesy of Iowa DNR
Why Plan?

- During emergencies **time** is critical!
  - Rapid carcass containment is essential
    - Disease control
    - Odor control
    - Water and soil pollution prevention
Why Plan?

- Making decisions in haste can be frustrating and costly!
  - Options overlooked
  - Consequences not considered

- Incorrect assumptions (what can & cannot be done)
  - Can cost you time and money; and
  - Slow down recovery from catastrophic losses
Assumption

“I can always send them to the landfill”

- Some landfills accept carcasses … and some do not … have you checked with yours?
  - Small landfills often do not!
  - If a human disease risk … service may be denied
    - During *avian influenza* outbreak in British Columbia in 2004 … public landfills closed their gates to poultry producers
Assumption

“I can always bury them on-farm“

- Not always … emergency burial of catastrophic mortalities requires **prior approval** by Iowa DNR
  - About 30% of Iowa is mapped as “**restricted**” for burial of large quantities of poultry and livestock
    - Why? … Shallow bedrock, steep slopes, shallow groundwater, wetlands, streams, public wells
Assumption
“I can always bury them on my farm”

- IF emergency burial is approved … consider this
  - 1,000 lbs of carcasses contains 20 lbs of nitrogen

- High density mass burial practices like this … can be equivalent to applying 25,000 lbs of N per acre !!
  - Threatens shallow groundwater
  - Pollution persists for many years
  - Iowa DNR requires
    - Mass burial sites to be recorded on property deed
    - Installation of groundwater monitoring wells

photo courtesy of Iowa DNR
Assumption
“*I can always burn them on my farm*”


- Iowa DNR prohibits carcass incineration in open fires.

- Air-curtain incinerators (below right) produce much less air pollution, but this specialized equipment is not commonly found in Iowa.

Source: BBC
http://news.bbc.co.uk/hi/english/sci/tech/newsid_1260000/1260776.stm

Source: Air Burners LLC
http://www.airburners.com
Assumption
“The rendering plant will take them”

- Maybe … Iowa is fortunate to have access to 6 major plants
- But haul distances can be long (costly)
- And a plant may not always have sufficient capacity to handle a large surge during an emergency
Assumption
“I can always compost them”

Maybe…

- Emergency composting requires **LARGE** volumes of cover material
  - 8-12 cubic yards of cover materials per 1000 lbs of carcasses
  - Cornstalks or straw need to be ground before use
  - Unless stockpiled … difficult to acquire in a hurry
- State veterinarian may not approve IF death caused by highly contagious disease
Developing an emergency disposal plan ... before the emergency ... allows time to

- Consider all alternatives
- Collect & record important contact information
- Acquire equipment, stockpile materials
- Identify important service providers
  - Transportation
  - Excavation
  - Cover material suppliers
- Document emergency plan & inform employees
If you plan to rely on rendering for emergency disposal ...

- Contact nearest rendering service providers to determine
  - Ability to accept your entire flock/herd
  - Disposal cost
  - Will the rendering firm supply transportation
If you plan to rely on **land filling** for emergency disposal …

- Contact local landfill(s) to determine
  - Will they accept carcasses … under what conditions … at what disposal cost
If you plan to rely on Incineration for emergency disposal …

- Contact emergency service provider that can provide high capacity/high temperature incineration
  - If incineration service is mobile, establish standing contract for emergency service
If you plan to rely on On-farm burial for emergency disposal …

- Determine if there is unrestricted area on your property for emergency burial

- Check Iowa DNR “Livestock Burial Zones” map on WWW
  - [http://csbweb.igsb.uiowa.edu/imsgate/introduction/home.asp](http://csbweb.igsb.uiowa.edu/imsgate/introduction/home.asp)
    - Click on “Livestock Burial Zones”
    - Zoom in on your location
    - Pink colored areas are restricted, mass burial not permitted
If you plan to rely on On-farm burial for emergency disposal …

- Print burial zone map for your property
  - Outline unrestricted areas on the map that you plan to use for burial
- Be sure to check records for underground utilities in proposed burial area
  - Contact Iowa One Call 1-800-292-8989
  - NOTE: Iowa law requires that Iowa One Call be notified 48 hours prior to any excavation within the State
- Burial sites of any size must be at least
  - 50 ft from property line
  - 100 ft from private well or stream
  - 200 ft from public well
  - 500 ft from a residence
If you plan to rely on On-Farm Burial for emergency disposal …

- Identify 2 or more earthmoving contractors having sufficient equipment & capacity to quickly excavate burial pit

**NOTE**
- Emergency burial of catastrophic mortalities requires prior approval by Iowa DNR
- IDNR 24-hour emergency phone number 515/281-8694
If you plan to rely on On-Farm Composting for emergency disposal ...

- Estimate required quantity of cover material needed for your total herd/flock
  - Corn silage @ 3.2 tons/1,000 lbs of carcasses
  - Ground cornstalks @ 1.4 tons/1,000 lbs of carcasses
  - Ground straw @ 1 ton/1,000 lbs of carcasses

- Stockpile the cover material, or establish a contract with suppliers
If you plan to rely on On-Farm Composting for emergency disposal ...

- Cornstalks and straw require grinding prior to use
  - Locate 2 or more portable grinding service providers
For all off-farm disposal methods
land filling, rendering, off-site incineration

- Rapid and reliable transport is essential

- Contract with 2 or more local trucking firms
  - Must be properly equipped to haul carcasses in accordance with Iowa law
    - Watertight box, enclosed, or covered with tarpaulin
Benefits of Emergency Disposal Planning

- Answers important questions before disaster strikes
- Helps avoid costly mistakes due to misinformation & inaccurate assumptions
- Documents important service providers and critical contact info for them
Put your plan in writing

- Give yourself & your employees an emergency response “road map”
  - For each disposal option … record important names & phone numbers
    - Include “after hours” numbers
    - Regulatory Agencies
      - Iowa DNR
      - State Veterinarian, Iowa One Call
    - Available Disposal Services
      - Rendering plant manager
      - Landfill manager
      - Incineration service
    - Transportation - trucking companies
    - On-site disposal
      - Excavation contractors
      - Hay grinding contractors

Prepared by Dr. Tom Glanville, Agricultural & Biosystems Engineering, for Iowa Pork Congress, January 29, 2009
Put your plan in writing

- It documents your **good faith effort** to do things right
  - May help to avoid potential legal problems relating to environmental pollution, disease transmission, worker safety
Don’t forget “Plan B”

- If livestock losses are regional
  - Heat stress, disease, flooding, blizzard

- Transportation and disposal services will likely be in short supply

- Plan 2 (or more) emergency disposal alternatives
  - At least one on-farm, and one off-farm disposal option
For Additional Assistance Information

- Regional Offices – Iowa Department of Natural Resources
  - Emergency burial site approval
  - Assistance locating emergency composting cover materials

- State Veterinarian’s Office - Iowa Department of Agricultural & Land Stewardship
  - Must be consulted on disposal of animals known to have died from disease.
Need Detailed or Updated Information?

- Dr. Tom Glanville
  - Ag & Biosystems Engineering, Iowa State University
  - Phone: 515/294-0463  Email: tglanvil@iastate.edu
  - Research & Demonstration websites:
    - Swine composting demo: [http://www.abe.iastate.edu/pigsgone/](http://www.abe.iastate.edu/pigsgone/)
    - Emergency composting: [http://www.abe.iastate.edu/cattlecomposting/](http://www.abe.iastate.edu/cattlecomposting/)


  - [http://extension.umaine.edu/ByproductsSymposium09/](http://extension.umaine.edu/ByproductsSymposium09/)