

Evaluation of Manure Treatment Systems



ENTSC Webinar Series
July 30, 2014
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Manure Management Team

Thank you Bill and thank you Holli. Welcome everyone to this month's East Regional Technology Webinar. As it has already been mentioned today we will be talking about a way to "Evaluate various types of Manure Treatment Systems" for both proposed and existing operations. This process will look at the performance and effectiveness of the various manure management technologies. Since every livestock operation is unique, no one technology or group of technologies will solve every resource concern. That is why it is so important for us to understand these systems and be able to effectively evaluate them.

As we know, there has been an increased number of concentrated animal feeding operations across the country. Many of these have centered in specific locations such as the DelMarVa Peninsula, Northwest Arkansas, Central California and the Upper Midwest to name a few. In these and other parts of the country, high nutrient levels and available land application areas are of concern. State and national regulations have also impacted how livestock operations function.

Therefore it is critical that we be able to evaluate these systems to ensure that they are performing as designed and desired to address the necessary resource concerns. (Next slide)

What Will Be Covered

- Part 1 – Overview of technologies
- Part 2 – Manure Treatment System Evaluation Process
- Part 3 – Example Farm Project

Let me give you a brief overview of the topics that we will be discussing today:

This webinar has been divided into three parts. First, I will give you a brief overview of some of the various manure management technologies. We need to understand these processes so that whatever system is selected, it will fit within the farm operation.

Second, I will provide information on the manure treatment system evaluation process. By following the steps that are outlined, you will be able to help landowners decide on the technologies that should work most effectively and can help de-bug some of these systems that are not performing as desired.

Finally, we will look at an example farm operation and apply the evaluation process. New Slide.

Poll Question

Who is participating on the webinar?

- a. NRCS**
- b. University/Extension**
- c. Private Consultants/TSP**
- d. Farmer**
- e. Other**

Before we get into the presentation, I would like get an idea of the make up of our audience. This will provide me with guidance on how to present the material. Take just a moment and click on the most appropriate selection. (10-15 seconds).
New Slide.

How To Choose The Right Technology

- Landowner goals and objectives
- Addressing appropriate resource concern(s)
- Dealing with excess nutrients
 - Nitrogen
 - Phosphorus
- Nutrient imbalance – manure verses crop
- Available and required land application area
- Waste streams

As we work with landowners and producers across the country, there are so many things to consider when looking at selecting various manure management technologies to make sure that it will fit and function properly within their operation.

First and foremost, we must know their goals and objectives. Most of the time this will be for implementing new systems on a farm. If what is planned does not fall in line with the goals and objectives of the landowner/operator, then the system designed is not their plan and may not be implemented properly or even implemented at all.

As we work with landowners and look at resource concerns we need to be asking the right questions. Will the resource concerns be addressed with these applications? Are the correct resource concerns being addresses?

Many times the reason we get involved in working with a particular landowner is because of the amount of nutrients that are produced in the manure. Are they being addressed properly and in a form that can be used by the landowner?

And closely tied in with that is looking at the nutrient imbalance between the amount found in the manure and the crop requirements. As farmers have moved to more monoculture cropping systems, this imbalance has become a greater issue.

It is also important to determine the amount of land that is required to apply the manure. Additional land may be needed. Also how far away is that land? Can it be done efficiently and cost effectively?

How does the landowner want to deal with the manure: as a solid, liquid, slurry? Are they willing to work with multiple waste streams? Knowing this can help a landowner find a technology that best fits their operation. New Slide.

How To Chose The Right Technology

- Regulatory Issues and Requirements
- Know what technologies are available
- Technology requirements
- Operational Type and Size
- Possible added value products (income potential)
- \$\$

We all know that regulations are not going away. The technologies used must help the landowner stay within the federal, state and local regulatory requirements. Farmers want to be environmentally safe.

As I mentioned earlier, not all technologies will work for every operation. It is also important to know what is available in a particular area, and can be adequately maintained if it is not found locally.

Some technologies may require outside assistance for operation or may be handled with existing workforce. Understanding the livestock operation labor force could impact the technologies chosen.

The type of animals and size of operations will also impact what technologies to choose from.

Some operations may look at other uses for the manure as an added value. This could include such things as selling compost or generating electricity. This may require considerable time on the landowners part in developing a market for the product.

Probably the biggest factor a landowner must consider is the financial obligation. And this may not be limited to only the cost of implementing a practice or technology, but may also need to include the cost of not doing something.

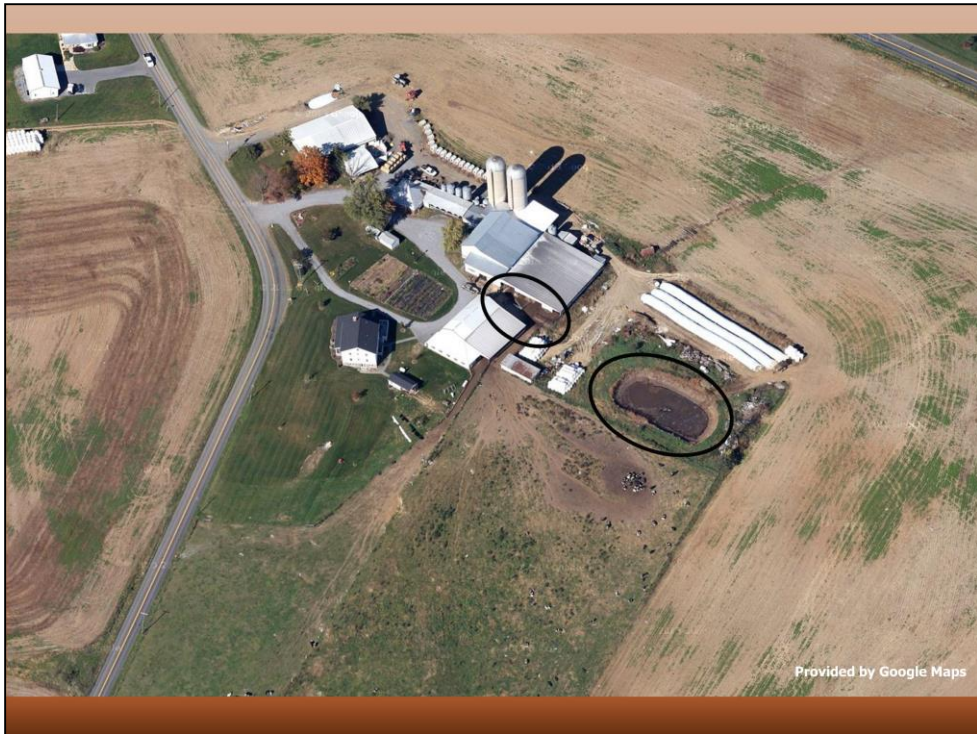
Determining what will work best for a particular livestock operation is not an easy task, and it will likely be different for every livestock operation. New Slide.



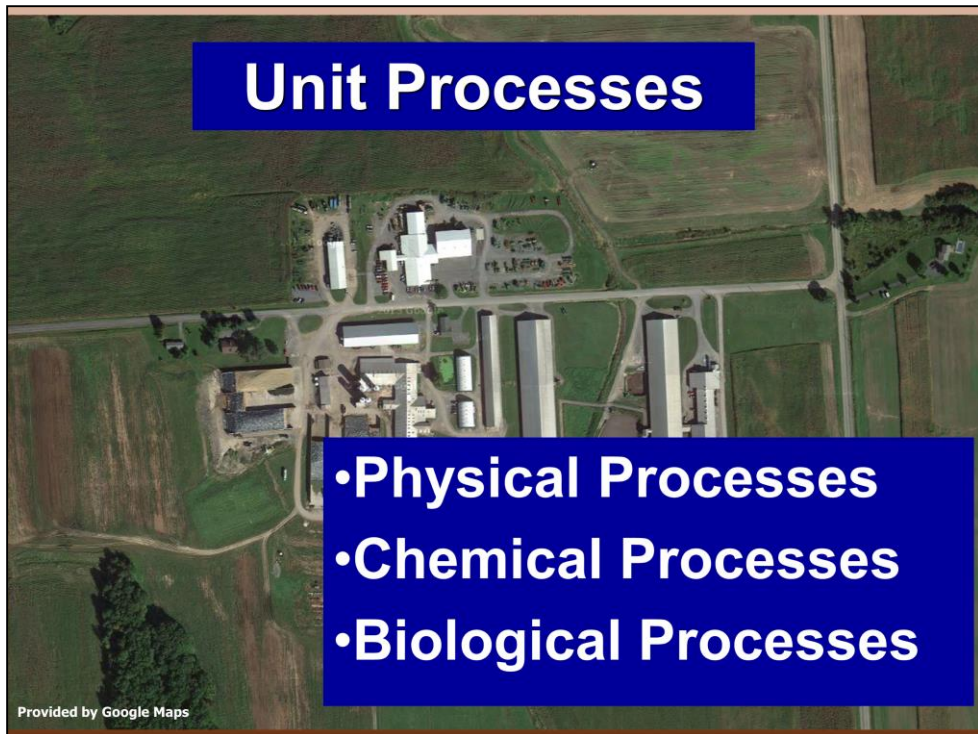
When one looks at a livestock operation, there are so many variables and factors to take into account. Especially when dealing with new technologies, this can be quite daunting. So, where does one begin. New Slide.



The easiest way to look at this is to determine what comes into the system or operation and then what goes out, looking at the big picture. Unfortunately, this is not the most effective way of evaluating manure management technologies. One does not know what goes on inside the operation to get to these final values. New Slide.



Even though there is an overall system or grouping of technologies, each technology in and of itself should be evaluated separately to determine how it is affecting the operation of the system. It is important to break the manure management system into its individual unit processes. In this overhead view we see manure transfer and storage which does not provide adequate information on evaluating the system. New Slide.



This is where it is important to understand the difference between systems and individual processes. These processes make up the overall system.

As one looks at the treatment of animal manure, the individual operations can be divided into one of three main groups of processes:

Physical,

Chemical, and

Biological

Time does not allow me the ability to cover any of these in great detail. But, I would like to give you a quick overview of each of these processes. Additional information on various unit processes can be found in the handout entitled “Selection Guidance for Manure Management Technologies.” [New Slide](#).

Physical Processes

- Usually treats suspended pollutants
- Settle out/float to top
- Filtration
- Mechanical

Sand Lane



Screw Press

Let's begin with physical processes. This is one that the audience is probably most familiar, and for the most part the easiest to deal with. These are the operations that deal with the chucks, as I like to call them.

Physical processes usually treat solids that are in suspension, rather than dissolved solids. (Just to mention, there are other technologies, such as chemical amendments, that can help with this as well.)

Heavier particles settle out while lighter particles may actually float to the top

Filtration methods may be used to remove some of the solids

Mechanical methods can also be used to separate solids from the waste stream

In the first picture we see a sand settling lane. Sand is used in many dairies for bedding. Velocities in the settling lane are high enough to separate manure and other lighter particles from the waste stream while allowing the sand to settle in the lane. This allows the sand to be reused for bedding.

The second photo shows a screw press that removes a significant portion of the water from the waste stream. The solids can be used for bedding or composted.

New Slide.

Chemical Processes

- Change the property of the waste stream
- Convert dissolved solids to suspended solid
- Modify the chemical make up of the waste stream for other uses
- Destroy organic chemicals through processes such as oxidation



Chemical Enhancement



Gasification

The next set of operations I would like to talk about are Chemical Processes.

The purpose for chemical processes is to bring about a change to the properties of the waste stream. Some of these changes include:

1. Converting dissolved solids into suspended solids so that it may be removed by a physical process.
2. Chemicals can be used to change the chemical make up of a product so it can be used for other purposes.
3. Another use of chemical processes is to destroy organic compounds through actions such as oxidation.

Here we see dairy manure in which chemicals such metal salts and polymers are added to coagulate much of the dissolved solids so they can removed by solid/liquid separation processes. We also see the thermo-chemical process of gasification which through heat the complex manure molecular chains are broken down into syngas and other products. Due to the drastic volume reduction and potential energy uses, unit processes such as this, there is an increased interest in these applications. New Slide.

Biological Processes

- Basically same processes that would occur naturally
- Organisms turn organics into different by-products
- In controlled environment can accelerate the process



Composting



Anaerobic Digestion

The last of the three processes that I would like to discuss is biological. They occur around us all the time. These are processes that would occur naturally through biological activity.

Basically these are organisms (bugs) that take organic material and then convert it into some other by-product.

If these organisms are kept under certain controlled conditions, these natural processes can be accelerated and be useful in dealing with waste issues.

One of the common processes that many of you are familiar with is that of composting. Now this could include composting of both animal mortality and manure. In both cases the volume is dramatically reduced and can be land applied or used for other purposes.

Another biological process includes anaerobic digestion. Anaerobic micro-organisms consume volatile compounds and the by-product is biogas which can be used for heat or electricity generation.

The technologies that we deal with while addressing manure management issues will fall under one of these three categories: physical, chemical and biological. To properly evaluate the processes either chosen or currently being used by a livestock operation, one should have a basic understanding of the impacts and limitations of these processes. New Slide.

Where Do We Go From Here?

- Choose the right operations for the right resource concern
- Break down a system into its individual unit operations and processes

So where do we go from here?

We need to realize that there are a number of physical, chemical and biological processes available to address manure management issues.

1. We need to keep our minds open to the various types of processes and operations. I am always looking for new things to add to my tool box to help landowners. We need to know what a landowner wants and what a landowner needs to accomplish the desired goals and objectives. By following the approach that follows should help you help a landowner choose the right operation or operations to adequately address the right resource concern.
2. Also, if you are asked to evaluate an animal manure storage/treatment system, you should be able to look at the individual components and determine the type of process that is taking place whether it is physical, chemical or biological. And with that information, you can determine the effectiveness of those operations in the overall performance of the treatment system. New Slide.

Planning Process

1. Identify the Problem
2. Determine the Objectives
3. Inventory the Resources
4. Analyze the Resource Data
5. Formulate Alternative Solutions
6. Evaluate Alternative Solutions
7. Determine a Course of Action
8. Implement the Plan
9. Evaluate the Results

Just remember we are still going to be using the 9 step planning process as we work with landowners.

Those within NRCS should be very familiar each of these steps. I want you to notice the color code. The first four are the “Learning” steps - gathering the information.

Steps 5 through 7 is what I call the “Thinking” stage. One takes and evaluates the information that has been gathered to determine the direction or alternative selection.

The final two steps are “Doing.” The developed plan is implemented.

Evaluating manure management technologies uses the same basic process, but is applied at the unit process level. New Slide.

Planning Philosophy

- Go to listen, not to tell.
- Instead of saying, "You can't do that," ask, "How are you going to do that?"
- These are issues that the landowner must address.
- It must be the landowner's plan.**
- Plan first, then consider programs.



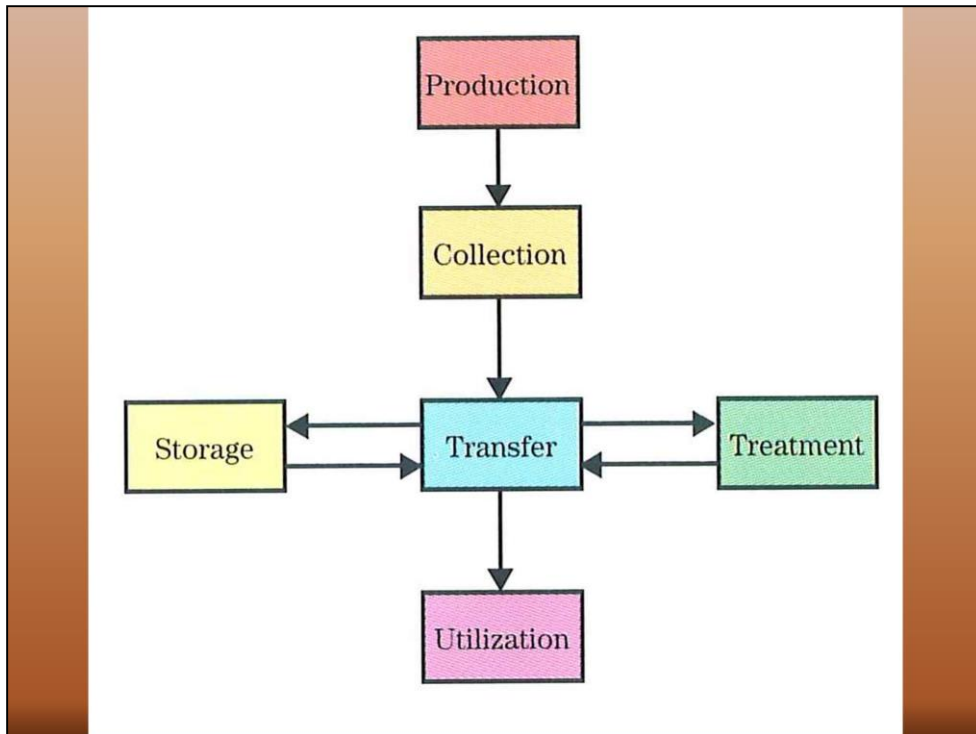
When developing a plan or evaluating an existing waste management system, you must know where you are going in the process. Let the landowner tell you what is desired.

We need to listen to the landowner, and not tell the landowner.

Ask probing questions, put it back on the landowner, help them think through the process.

Remember, we are not the ones addressing the resource concerns, it is the land owners.

And it must be the landowner's plan. If not it may not be implemented properly or implemented at all. New Slide.



Now as we begin to evaluate manure management technologies, we need to realize that we not only have three types of unit processes, but that each of these processes fall under one of the six categories shown in this slide. For those just beginning in the are of manure management, I would suggest reviewing the NRCS Agricultural Waste Management Field Handbook for guidance. Recommended chapters related to manure management technologies and evaluation of those technologies can be found in chapter 9, Agricultural Waste Management Systems and chapter 10, Agricultural Waste Management System Component Design. New Slide.

Questions



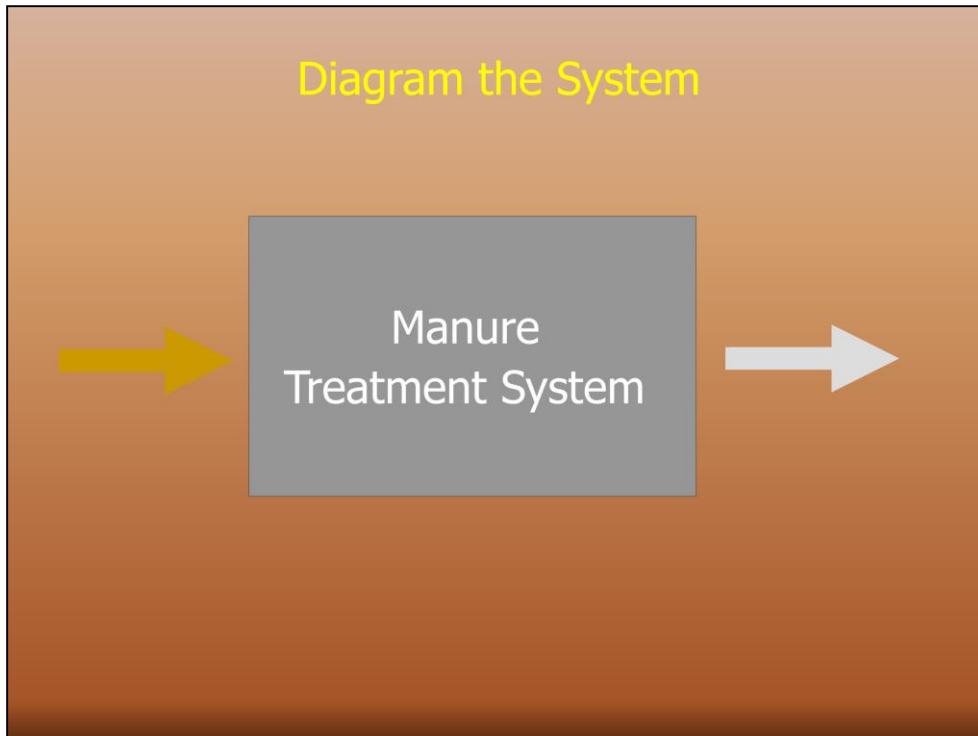
With that we are going to take our first break for questions. Do we have any questions at this time?

Let's continue. New Slide.

Manure Treatment System Evaluation Steps

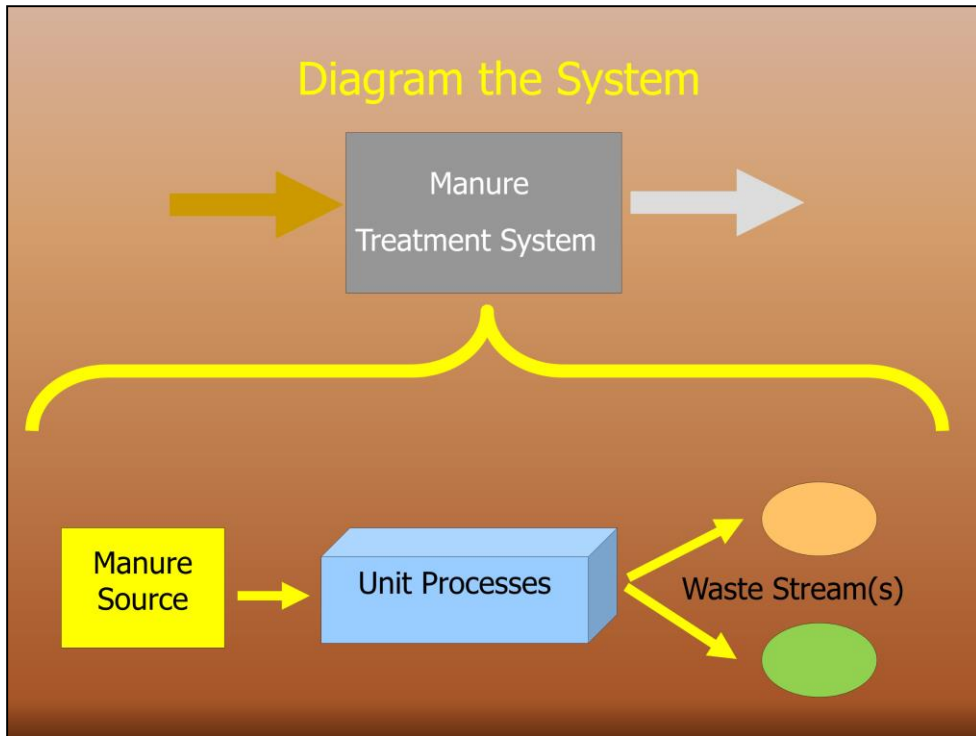
1. Diagram the System
2. Identify System Components (Unit Operations and Processes)
3. Characterize input manure (TS, COD/BOD, N, P, K & Pathogens)
4. Track form and fate of constituents through each process in order
5. Identify System nutrient outputs and forms

The Manure Treatment System evaluation method is a five (5) step process. In the following slides each step will be explained. The process begins by diagramming the system and then it should conclude with an understanding of the fate and final form of the nutrients and other products that output from the system. New Slide.



Speaker Notes:

Step # 1 is to diagram the system. One needs to understand the flow of the manure throughout the entire system. New Slide.



Speaker Notes:

Here we see a very simple block diagram illustrating how to set up and begin the evaluation process. When diagramming the system it is very important to include all components and to place them in the correct order. Be careful to not skip any of the unit processes when developing the diagram. New Slide.

The order of components is critical !

The same unit operations and processes arranged in a different order can provide very different results

Speaker Notes:

Understanding the operational order of the system components is critical. The same components arranged in a different order may have a completely different output in terms of nutrient fate and form. For example, some anaerobic digesters require very low solids content. (Induced Blanket) In this case solid separation likely occurs before the manure enters the digester. Whereas in other situations, solid separation occurs after digestion. New Slide.

What if you do not have enough information to diagram or identify the system components ?

Speaker Notes:

In some cases you may not have enough information to adequately diagram and identify all system components. If that is the case, you will be unable to effectively evaluate the system without obtaining this information. Gather as much information as you can about the individual processes. The more information available, the better the evaluation process. New Slide.

Identify the system manure input and output points

Have the operator “walk” you through the system.

Speaker Notes:

If you are not able to get the information that is needed to diagram the system and identify the components, or if you have some reason to question the information you have been provided, have the operator “walk” you through the system whether on paper or out in the operation. A technology “walk through” would be a good idea to do even if you have all of the necessary information. This helps you better understand the system. New Slide.

Ask questions that follow the material flow through the system

The manure comes in here

Show me where the manure goes next ...

What does this part of the system do ...

Speaker Notes:

When you do the “walk through” with the operator or vendor make sure you do it in the same order in which the manure is processed. Begin where manure enters the manure management operation and follow it throughout the system in the correct sequential order as it is proposed to treat or process the manure. Also ask questions to clarify information. Remember this is their system. New Slide.

Knowing the characteristics of the input manure is important.

The functionality of any given unit operation or process is directly impacted by the characteristics of the input manure.

Speaker Notes:

We are now ready for step 3. Here we need to understand the characteristics of the manure as it enters the system. Having an accurate estimate of the manure input characteristics is very important. The magnitude of an input such as Chemical Oxygen Demand (COD) or ammonia can cause a unit operation or process to succeed or fail. New Slide.

Why does nutrient form and other characteristics matter ?

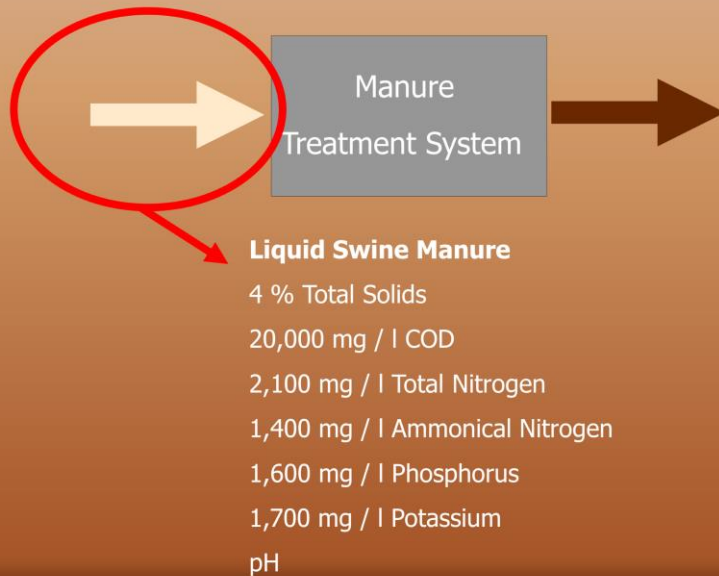
A treatment process may be able to handle a nutrient in one form and not another or one consistency and not another

For instance, while nitrogen in an organic form does not negatively impact an anaerobic digester, too much nitrogen in an ammonical form can be toxic to the anaerobic digestion process

Speaker Notes:

Again, let me stress why this is so important. The form and magnitude of nutrients that are found in the manure or the waste do make a difference in the effectiveness in the performance of many unit operations and processes. Look at the example that is provided here. Nitrogen in the organic form does not have negative impact on the operation of an anaerobic digester, but too much ammonia in the system can be toxic to the digestion process. New Slide.

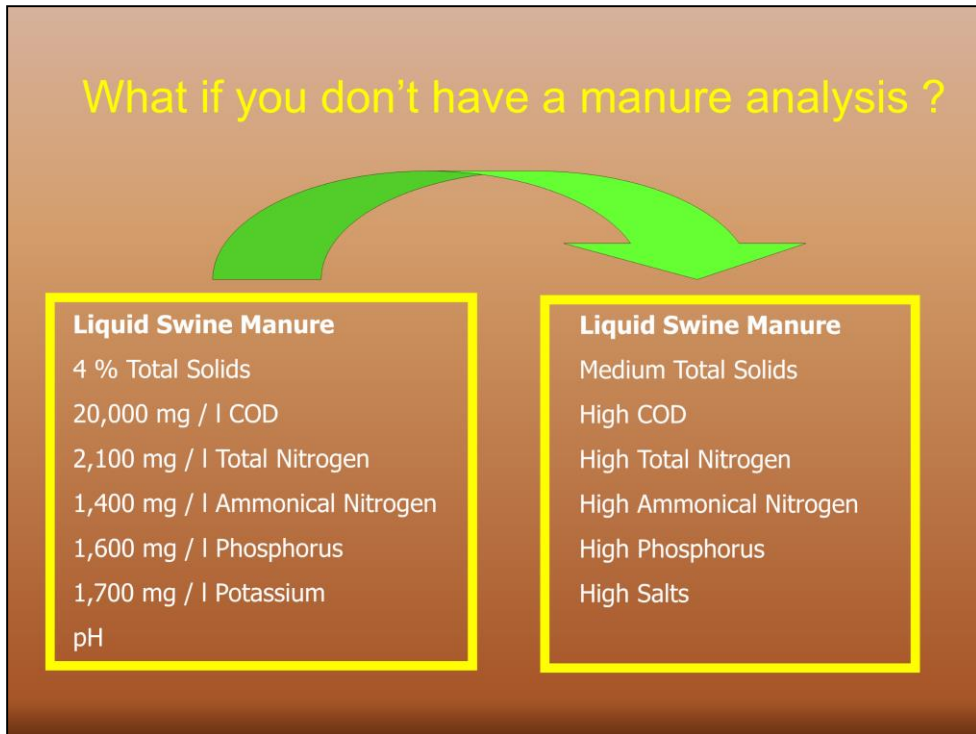
Characterize input manure stream



Speaker Notes:

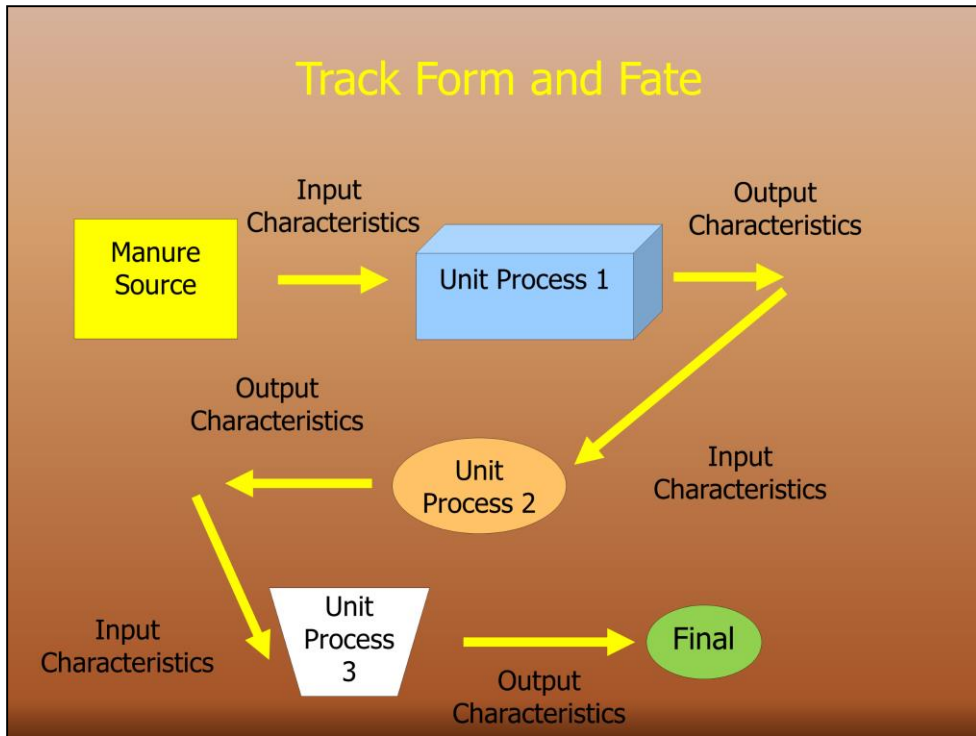
The typical characteristics that one would look for in the manure stream as it travels through the system includes; TS, COD, TKN (or TN), TAN, P and K and pH at a minimum. Here we have an example of the manure characteristics prior to entering the manure management system for a swine operation. (Discuss these number some. These will likely not be as excreted values, because of such things as dilution, bedding and the addition of other waste products.) New Slide.

What if you don't have a manure analysis ?



Speaker Notes:

You will not always have the analysis for a system, especially when doing the initial design. In that case, a general assessment of “high, medium or low” in terms of the input characteristics can be effectively substituted for exact values. This will require at least some knowledge of manure systems and relative analysis levels. And here we see how that is done with the example that is provided. New Slide.



Speaker Notes:

In step 4, one tracks the nutrients and other desired characteristics throughout the system. This is where diagramming is so important in understanding what happens. As seen here, the output characteristics for one unit process become the input characteristics for the next. This pattern is followed until all of the processes have been completed. This can become quite complicated when dealing with multiple waste streams which further emphasizes the importance of diagramming. [New Slide](#).

Identify System "Outputs"

- Value added products
- Residues
- Air pollutants

Speaker Notes:

Finally, the last step is to identify all system outputs in terms of what they represent. Do the unit processes produce a marketable product such as electricity, a residue that must be managed like land application of nutrients or an air pollutant that must be reported or controlled which could include methane or NO_x (nitric oxide or nitrogen dioxide)? Any or all of these could result from the unit processes that are implemented on a livestock operation. By following these five steps one should be able to effectively evaluate the functionality and performance of a waste treatment system. Through this process, one can help a landowner determine whether the system is operating properly. And if not, provide some guidance as to where within the operation changes could be made. New Slide.

Questions



Up to this point does anyone have questions on the Manure Treatment System Evaluation Steps.

Let's move on. New Slide.

Example Farm



Our final section today will be to look at an example farm and see how this evaluation process works. New Slide.

AT System Evaluation Steps

1. Diagram the System
2. Identify System Components
3. Characterize system input manure stream
4. Track constituents through each process in order
5. Identify System nutrient outputs and forms

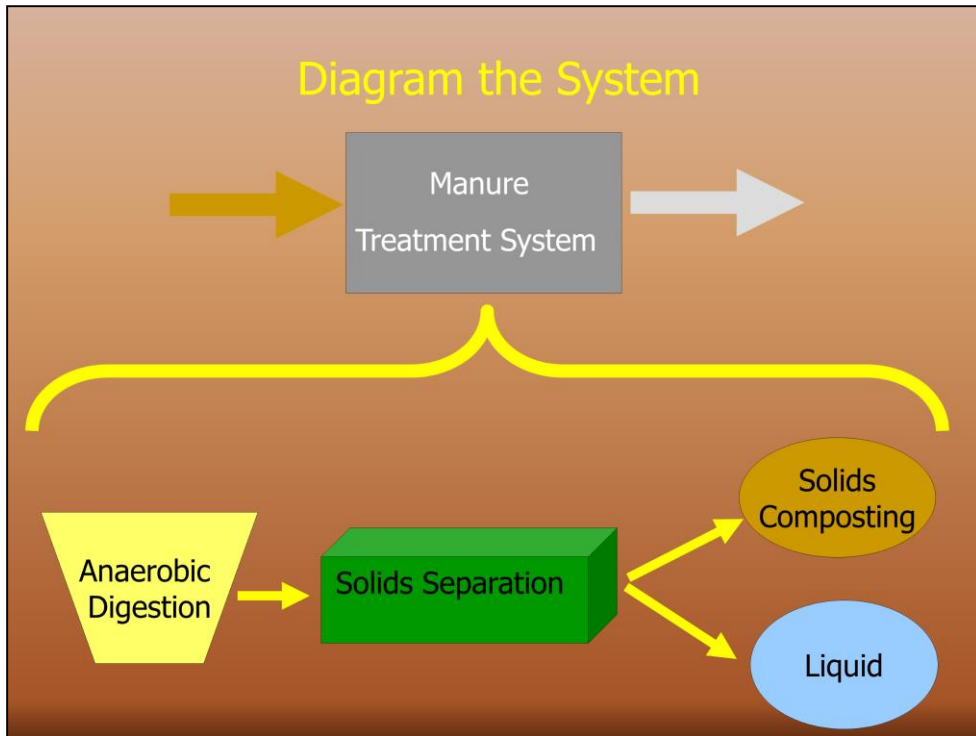
Speaker Notes:

As I go through this example, I will show this slide highlighting the step that will be addressed. This will help those that desire to review the process or refresh your memory at a later date. We begin by diagramming the system. New Slide.

Example Manure Treatment System

- 1,500 Cow Dairy Operation
- An anaerobic digester is located on the farm
- Manure consistency – 8% solids
- Bedding is dried manure solids
- Adequate land is available for land application

Give an overview of the livestock operation. Characteristics are given in the slide.
(Read items.) New Slide.



Speaker Notes:

This initial diagram gives a big picture of the project. Here we see for this treatment system, manure enters an anaerobic digester. The digestate is passed through a solid separator creating two waste streams, solids and liquids. The solids are then composted for other uses. New Slide.

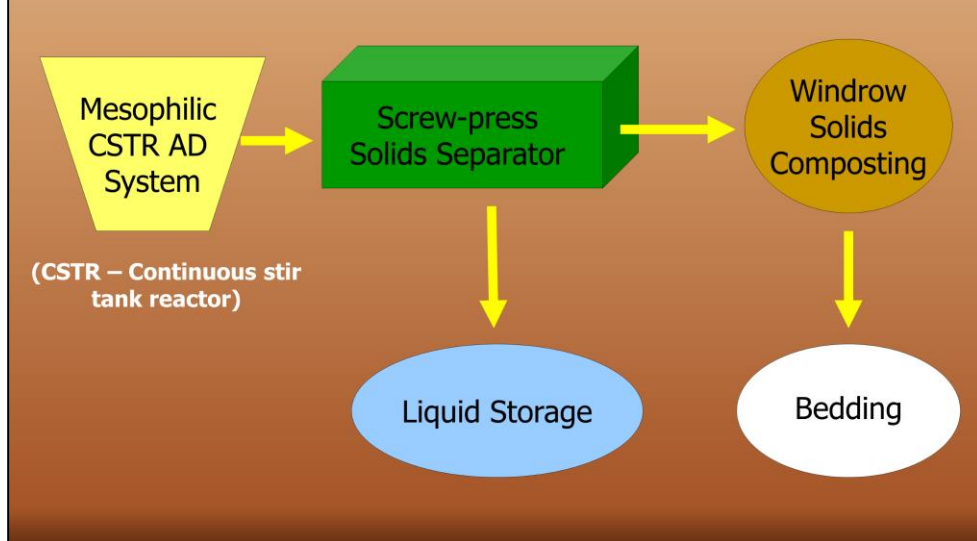
AT System Evaluation Steps

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Speaker Notes:

Many times steps one and two will be combined identifying the individual components in the diagram. New Slide.

Identify System Components (Unit operations and processes)



Speaker Notes:

With **Step # 2** one identifies the type of unit operation or process that each component represents. It is good to know at this point as to whether the unit processes are physical, chemical or biological. For this example farm, a mesophilic continuous stir anaerobic digester will be installed which is a biological unit process. Following the digester is a screw press (physical process) will separate the solids from the liquid portion of the waste. The liquid portion is stored in holding pond until it is land applied. The solids are composted which is also a biological process. Once completed, the compost will be used as bedding for the cows in the free stall buildings. New Slide.

AT System Evaluation Steps

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Speaker Notes:

Now we move to step 3 to characterize the system inputs. [New Slide](#).

Liquid Dairy Manure

(As it enters the digester)

High Total Solids

High COD

High Total Nitrogen

High Ammonical Nitrogen

High Phosphorus

High Salts

Speaker Notes:

For this situation not all of the input characteristics are known. Therefore, the general assessment approach will be used. Here we will get an idea of the expected trends when applying an given unit process and not actual values. New Slide.

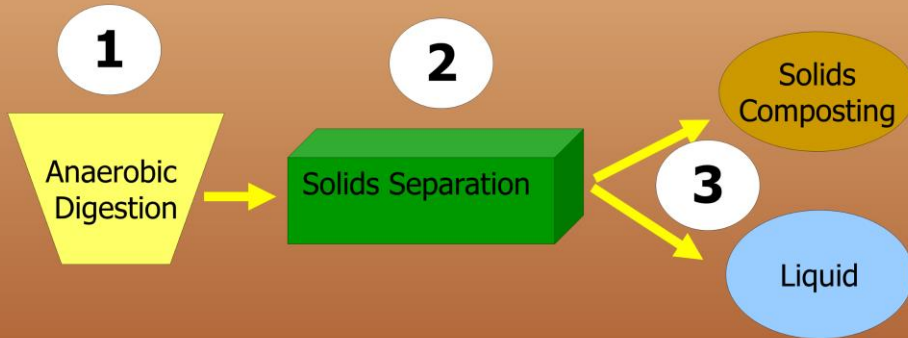
AT System Evaluation Steps

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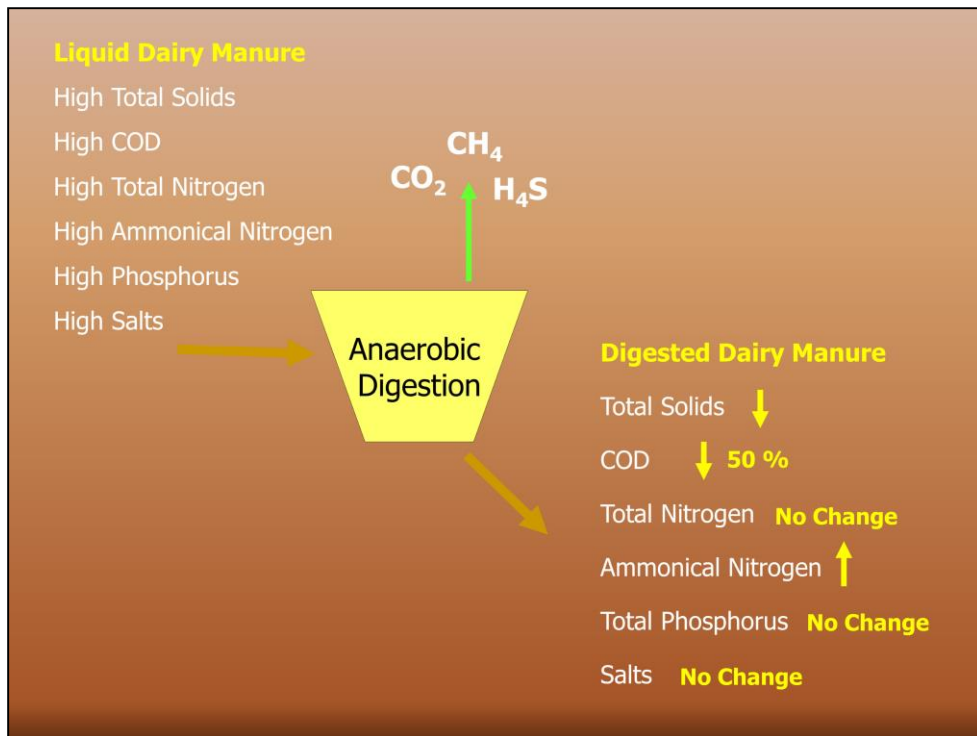
Now one begins to track what happens to the nutrients and other constituents through each unit process. Remember to follow in the order that the manure passes through the system. New Slide.

Track form and fate of constituents through each process *in order*



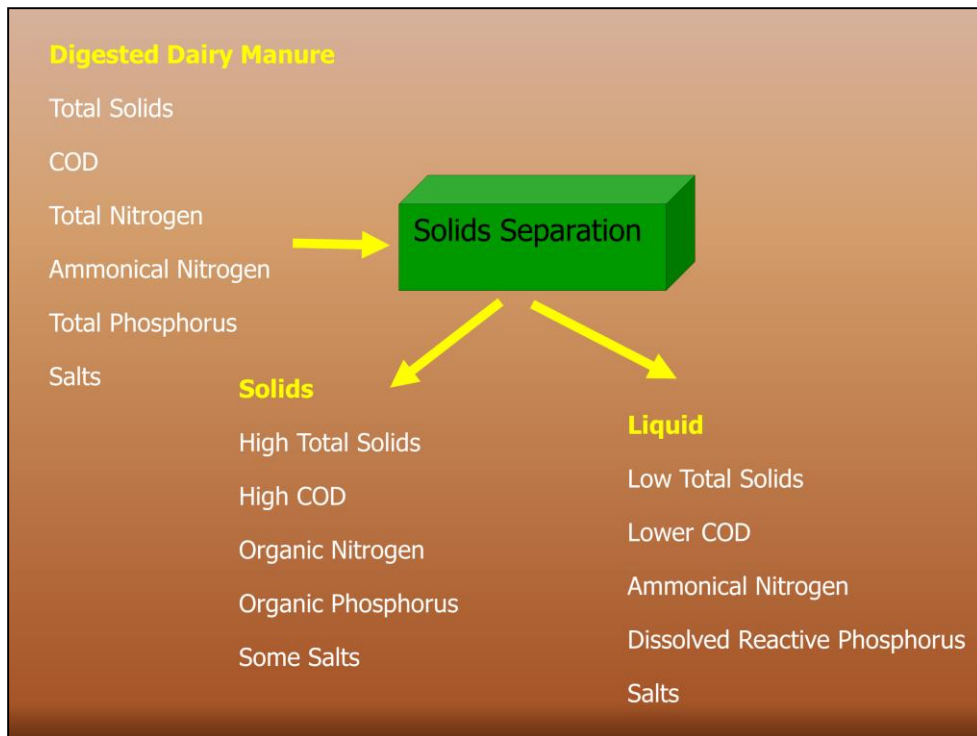
Speaker Notes:

For this example, the system has been broken into three segments, anaerobic digester, solid separation, and composting. New Slide.



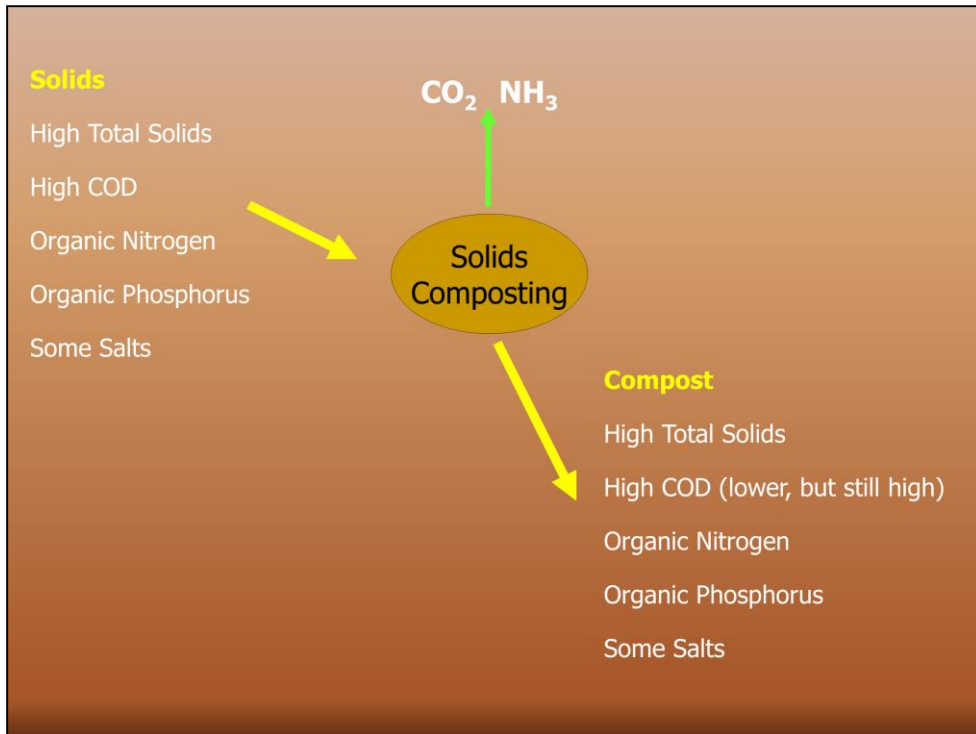
Speaker Notes:

Note that not only the characteristics of the input and output manure have been listed, but also any losses or movement of nutrients out of the system. In this case the movement of carbon dioxide, methane and hydrogen sulfide out of the process in a gaseous form has been shown. Also note that through digestion, there is basically no change in the nutrient content of the manure. What comes in, goes out. The form may change, but the overall amount does not. Even though not shown here, pathogens are reduced through the digestion process. This may be an item of concern that needs to be addressed. New Slide.



Speaker Notes:

Here the screw press creates two output streams – solid and liquid. Notice the difference in the general characteristics between the two waste streams. Even though two waste streams may complicate the handling of the manure, this does provide added flexibility for land application and other uses. New Slide.



Speaker Notes:

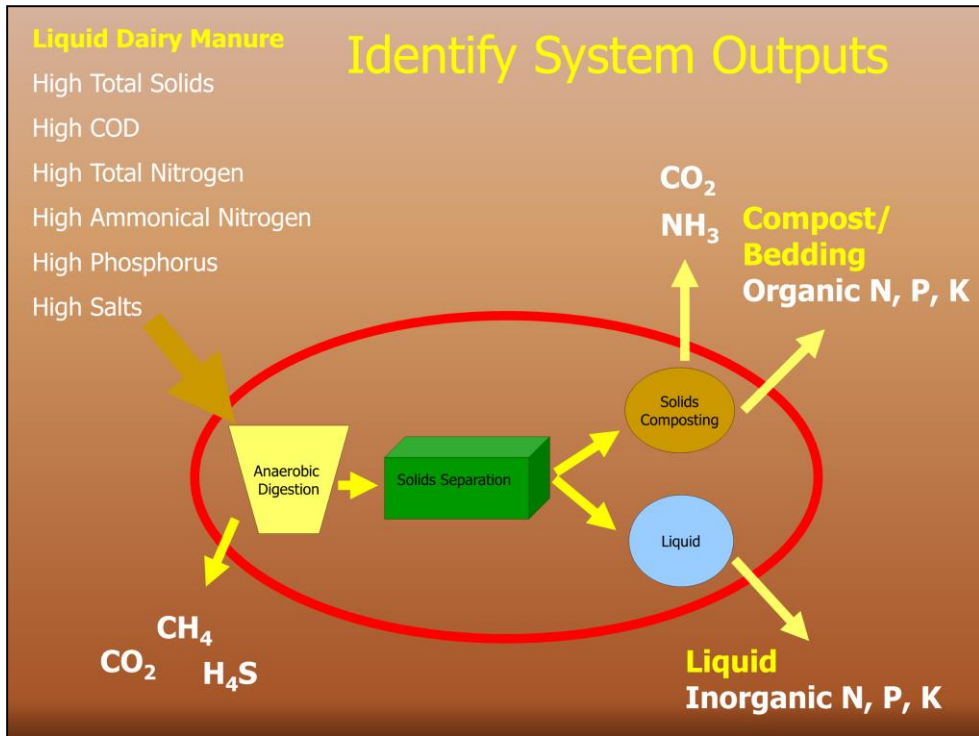
This example composting process includes a gaseous escape pathway for both ammonia and carbon dioxide. Other items that could be listed are pathogen and volume reduction. New Slide.

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Speaker Notes:

The final step is to review the nutrient and other by-product levels and forms once the manure has traveled through the entire system. New Slide.



Speaker Notes:

For this step, one looks at what crosses the system boundary. One should consider the mass balance and make a very good estimate as to the magnitude and distribution of the input nutrient mass in the output streams. If the compost material is used for bedding, it remains in the system. Also note that the gases produced from the anaerobic digester will be addressed in some fashion by other unit processes such as hydrogen sulfide scrubbers and micro-turbines.

New Slide.

Example System Outputs

- Compost
- Bedding
- Nutrient Laden Liquid
- Air Emissions – NH_3 & CO_2

Speaker Notes:

From our example system we can expect to generate outputs that include compost (some or most may be used as bedding), a nutrient rich liquid manure fraction and air emissions of ammonia and carbon dioxide. Note this approach could be expanded to include land application as well, which would also address the fate of nutrients and crop utilization.

Additional Resources

Livestock and Poultry Environmental Stewardship
(LPES) Curriculum Lesson 25

Manure Treatment Options

<http://www.extension.org/pages/14849/lesson-25-manure-treatment-options>

Agricultural Waste Management Field Handbook,
Chapters 9 and 10

<http://directives.sc.egov.usda.gov/>

Speaker Notes:

That is the process. The two references shown may provide useful information as you perform evaluations of manure treatment systems. (Discuss them in some detail – more lessons and more chapters).

Manure Treatment System Evaluation Steps

1. Diagram the System
2. Identify System Components (Unit Operations and Processes)
3. Characterize input manure (TS, COD/BOD, N, P, K & Pathogens)
4. Track form and fate of constituents through each process in order
5. Identify System nutrient outputs and forms

If one follows this evaluation process properly, it should help the landowner in selecting or updating a manure management system that should meet the goals and objectives of the operation.

Special Thanks To:

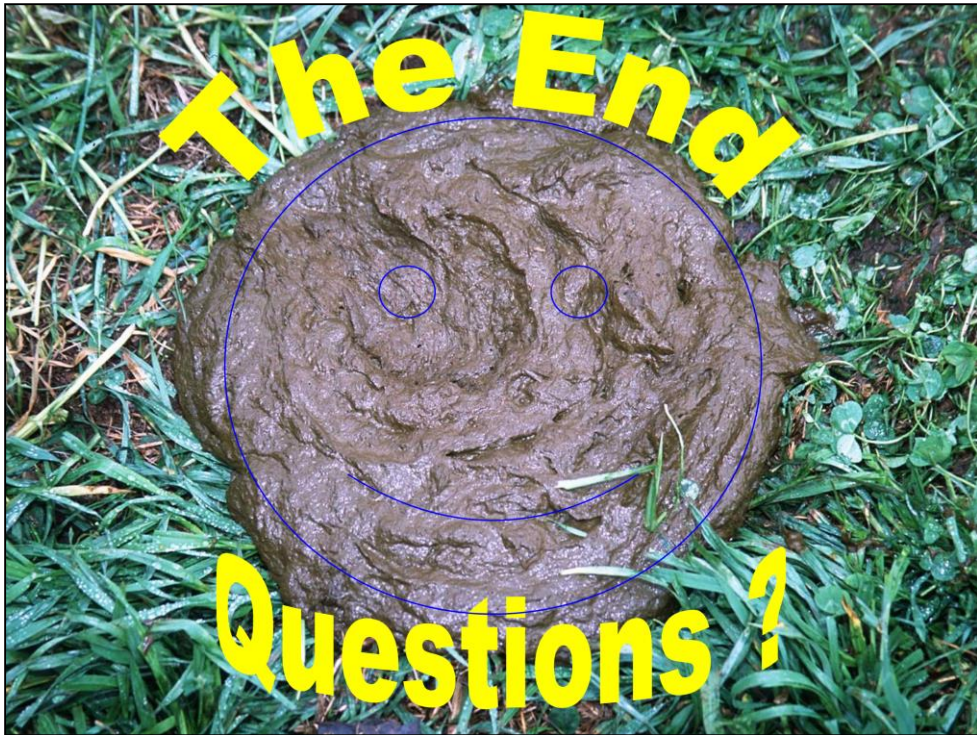
•Farm Pilot Project Coordination (FPPC)

www.fppcinc.org

•Dr. Robert Burns, University of Tennessee
Extension

•For major contributions to the Evaluation of
Alternative Manure Treatment Systems
training course (November 6-9, 2006)

Much of the information for this presentation was derived from material presented at the Alternative Manure Treatment Systems training course which was held in 2006. The information provided today is a summary of a three day training course. Special thanks goes out to Farm Pilot Project Coordination (FPPC) and Dr. Robert Burns for the work that they put into preparing this initial training material. New Slide.



I want to thank you for your time, and hope that you found the information useful when evaluating manure management systems. And with that I would like to open the floor to any questions that you may have. (Once questions begin, move to last slide.) Last Slide.

Contact Information

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(Address Questions.) Thank you to everyone that participated. Have a great day.