Welcome to the webinar! Please note that participants on the phone line are automatically muted. You may not hear anything until the presenters start the webinar at 1:00PM.

Recommendations from the BMP Expert Panel for Manure Treatment Technologies

Thursday, April 14, 2016, 1:00-3:00PM EST

Doug Hamilton, Oklahoma State, Panel Chair

Jeremy Hanson, Virginia Tech, Panel Coordinator

David Wood, Chesapeake Research Consortium

VirginiaTech Invent the Future

Chesapeake Bay Program Science. Restoration. Partnership.

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  - If having difficulty hearing on the phone line: please adjust your volume as needed; check your reception and use a land line if possible
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  - Code: 267 5715#
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Some notes before we get started

- **Please DO NOT put the conference line on hold at any time, for any reason.** If you need to take another call, please hang up and dial back in.
- Remember that any references to the report (figures, tables, page numbers, etc.) are to the March 31st, 2016 version (draft for CBP review). These labels/numbers may change as revisions are made.
- The report is still considered DRAFT until approved by the Water Quality Goal Implementation Team (WQGIT). More info on this process will be provided later in the presentation.
- We will respond to questions after completion of the slides, but please type your questions into the chat box as we go. You're encouraged to use the slide numbers to help us better respond to specific questions about a statement/slide.
- **We are recording this webinar.**

Today’s speakers

- Doug Hamilton, Oklahoma State

- Jeremy Hanson, Virginia Tech, CBPO

- David Wood, Chesapeake Research Consortium, CBPO

Overview

- Background
  - The BMP Protocol
  - The MTT panel and its charge
  - Manure in the model 101
- The panel's recommendations
  - Manure treatment as part of a larger system
  - Walkthrough of the reviewed technologies: Thermochemical, Composting, etc.
  - Future research and management needs
  - Level 3 transfer efficiencies
- BMP verification
- Reporting and crediting the BMPs in Phase 6
- Timeline for review/approval of the report
- Q&A

The BMP Protocol

- All expert panels follow the Water Quality Goal Implementation Team's *Protocol for the Development, Review, and Approval of Loading and Effectiveness Estimates for Nutrient and Sediment Controls in the Chesapeake Bay Watershed Model*, AKA the "BMP Protocol"
  - http://www.chesapeakebay.net/publications/title/bmp_review_protocol
- BMPs are often revisited as new science becomes available

Background: The panel and its charge

Table B.1 – Membership of the Manure Treatment Technologies BMP Expert Panel	
Panelist	**Affiliation**
Keri Cantrell	KBC Consulting (formerly with USDA-ARS)
John Chastain	Clemson University
Doug Hamilton (Chair)	Oklahoma State University
Andrea Ludwig	University of Tennessee
Robert Meinen	Penn State University
Jactone Ogejo	Virginia Tech
Jeff Porter	USDA-NRCS, Eastern National Technology Support Center
Panel support:	
Jeremy Hanson (Coord.)	Virginia Tech/CBPO
Brian Benham	Virginia Tech (Cooperative Agreement Project Director)
Chris Brosch	Delaware Dept. of Agriculture (WTWG rep)
Mark Dubin	University of Maryland/CBP (AgWG Coord.)
Ashley Toy	EPA Region 3 (Regulatory Support)
David Wood	CRC/CBP (CBP modeling team rep)

Background: The panel and its charge (cont’d)

AgWG convened a subgroup in 2014

- Ad hoc subgroup for manure treatment technologies suggested six categories (see Appendix C) for panel review:
    - Thermochemical (combustion, gasification, pyrolysis, torrefaction)
    - Composting
    - Anaerobic digestion
    - Solid-Liquid Separation
    - Chemical-Wet
    - Chemical-Dry

Expert panel convened later that year

- As it progressed, the expert panel further refined the categories based on available data and applicability in the region:
    - Thermochemical (combustion, gasification, pyrolysis)
    - Composting
    - Anaerobic digestion
    - Mechanical solid-liquid separation
    - Settling
    - Wet chemical treatment
- **Recommendations for Phase 6 Watershed Model only**

The CBP partnership modeling tools in one slide…

Planning tools: CAST, MAST, VAST, BayFAST

BMP reporting platform: NEIEN

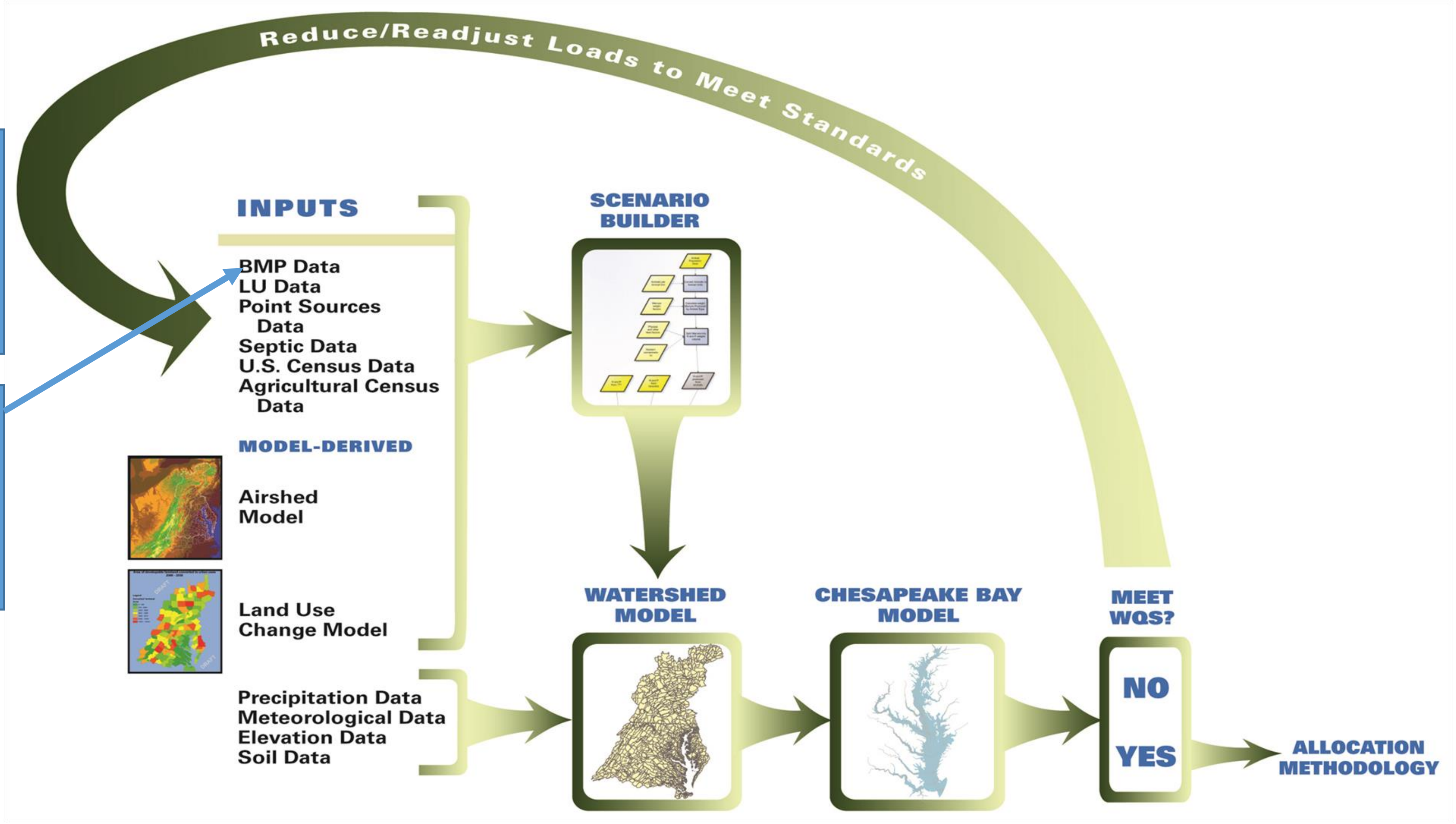


Figure B.1 - Chesapeake Bay Program partnership modeling suite (Phase 5.3.2)

Manure in the modeling tools 101

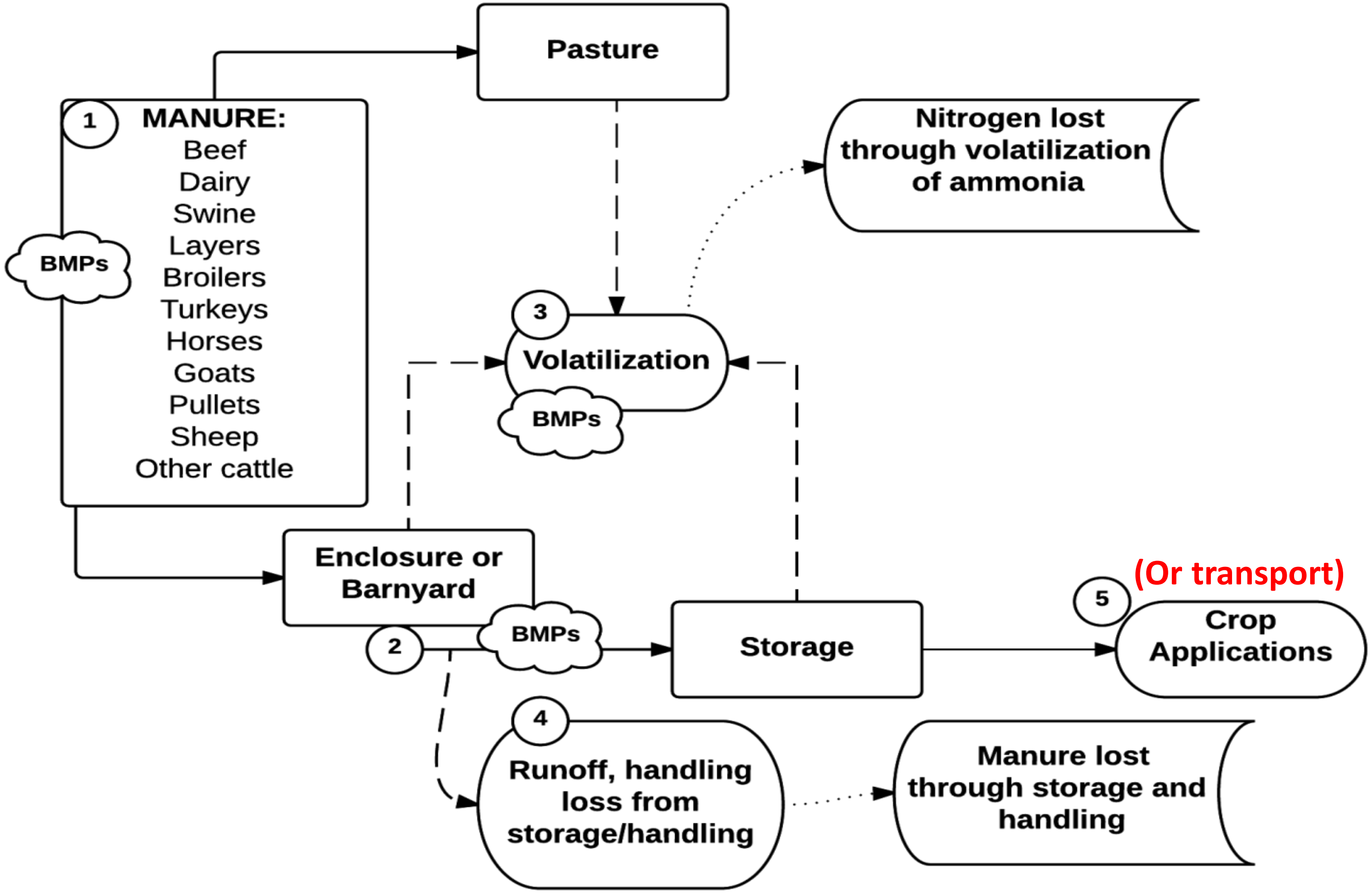


Figure B.2 – Conceptual diagram of manure nutrients in the Phase 5.3.2 Watershed Model

The panel’s recommendations

Some key ideas to understand before we dive into their findings…

Three Levels of Recommendations

- Default
- Defined
- Data-driven

The Effect of Treatment Technologies

- Only "Removal" of nutrients from manure stream is by Nitrogen Volatilization.
- Nitrogen and Phosphorus Separation facilitate the Transport BMP.

Manure treatment is part of a larger system

Peterpaulrubens.org

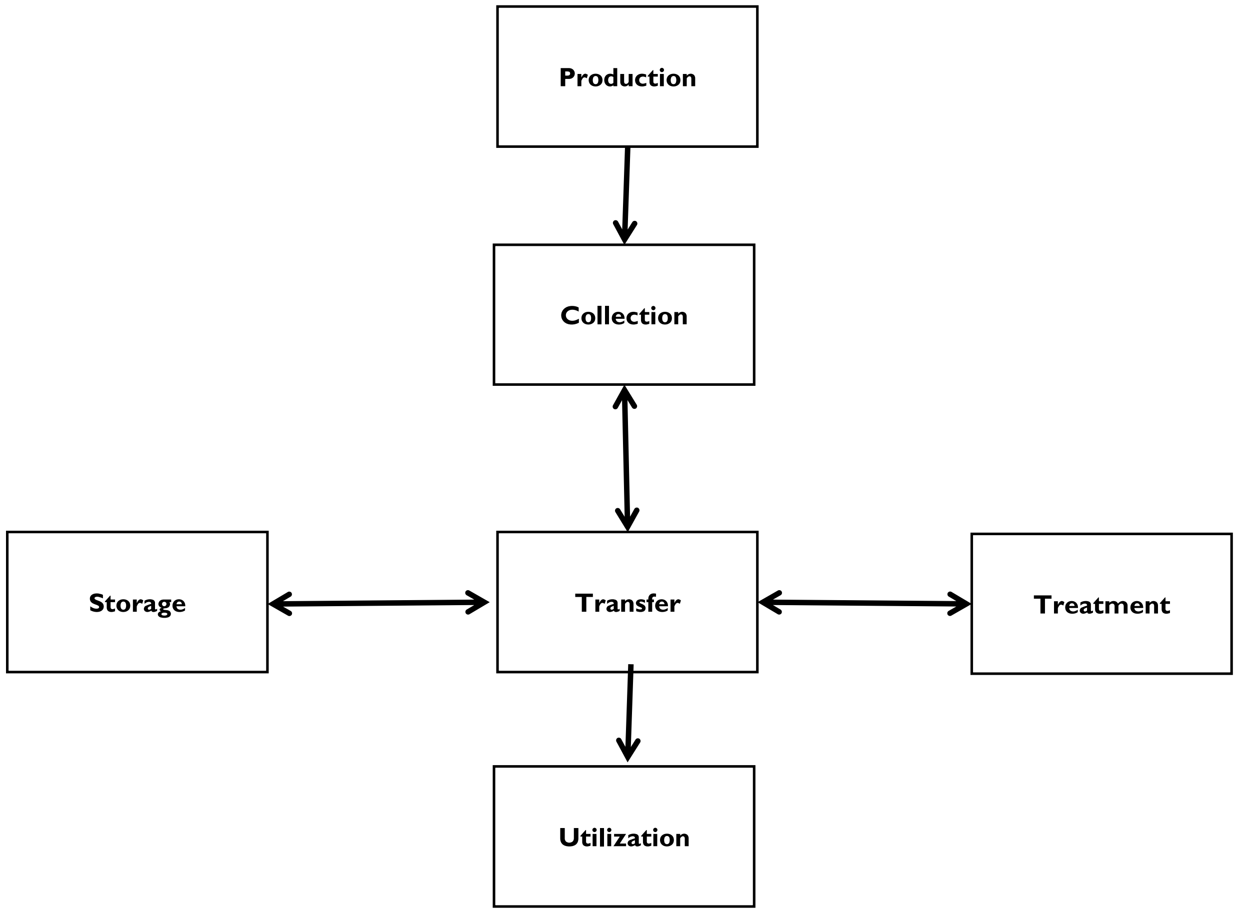


Figure TT.1. Schematic Representation of Manure Handling Systems (from Figure 9-2 in USDA NRCS, 1992).

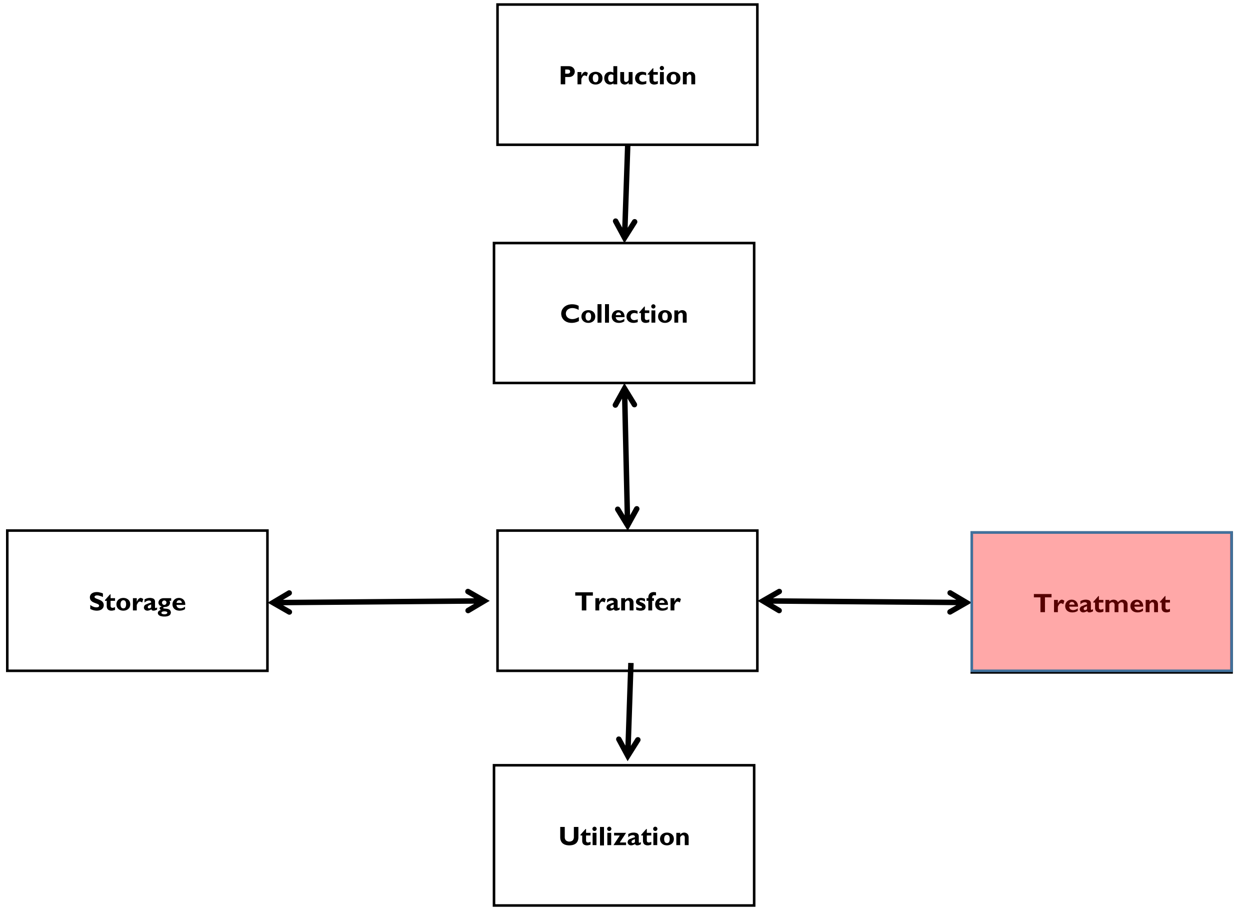
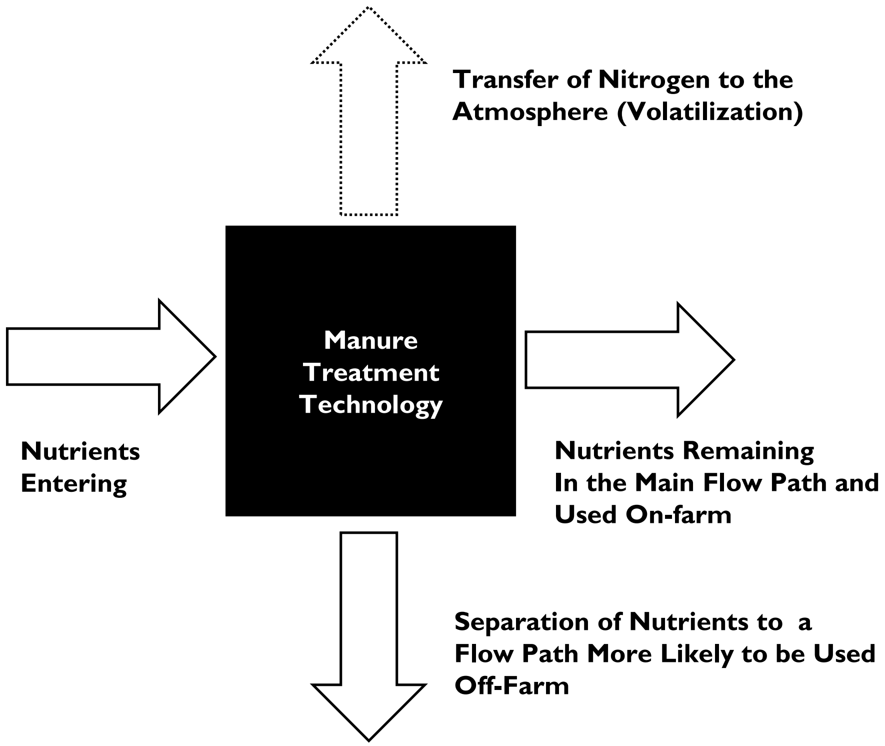
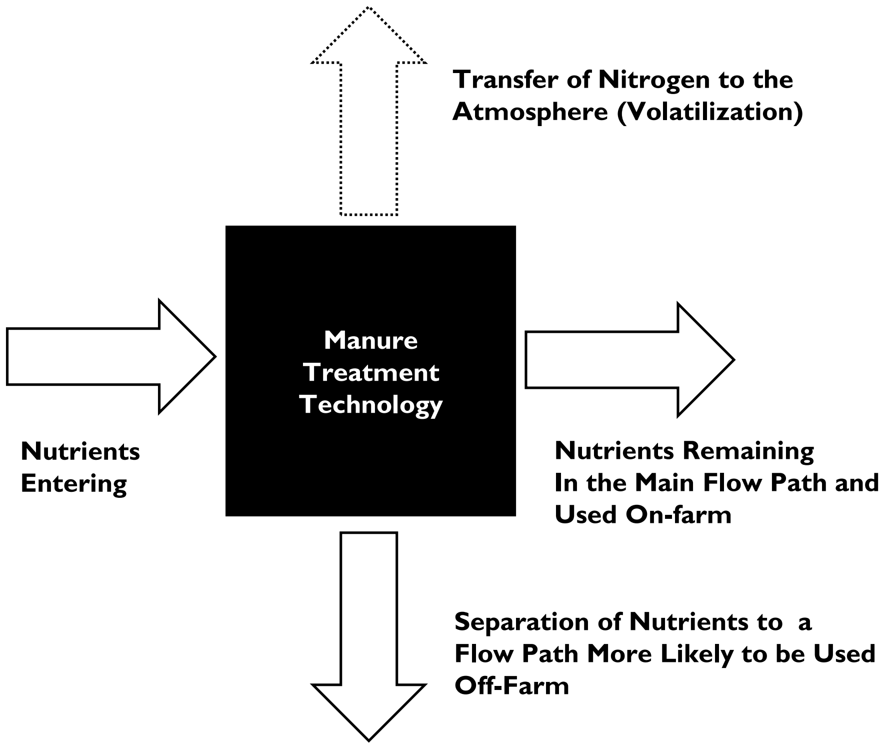


Figure TT.1. Schematic Representation of Manure Handling Systems (from Figure 9-2 in USDA NRCS, 1992).

Manure treatment schematic

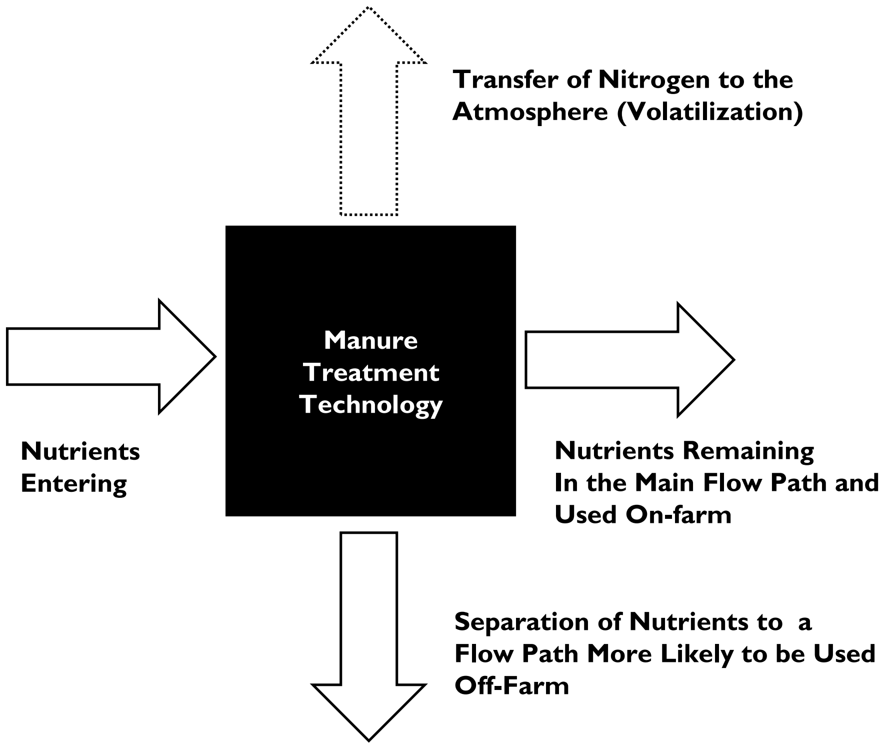


Transfer Efficiency



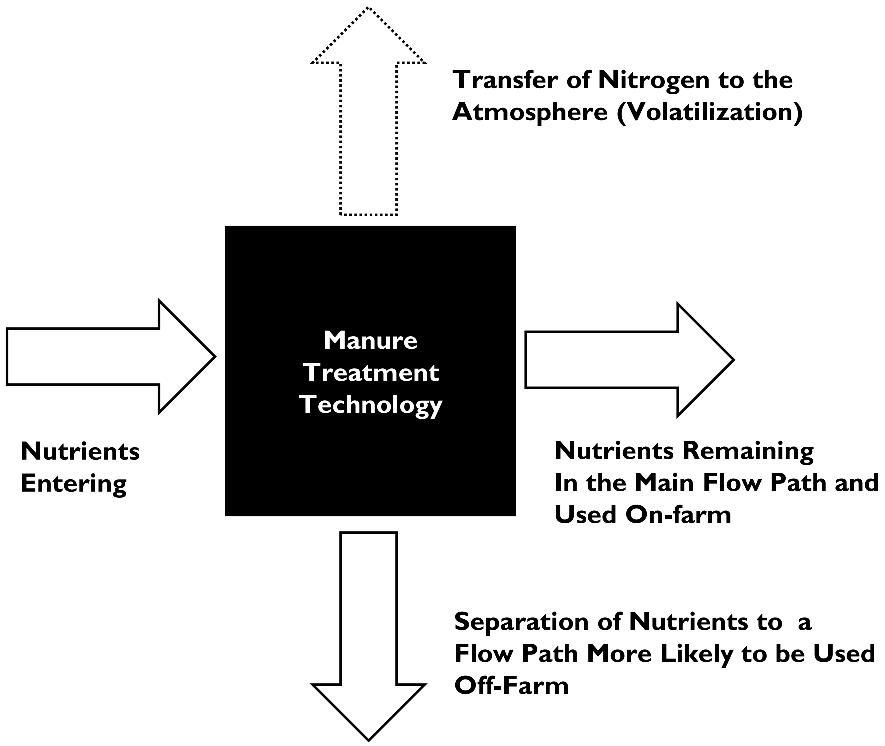
$$\frac{\text{Mass of Nutrient Leaving in Any Flow Path}}{\text{Mass of Nutrient Entering}} \text{ X } 100$$

Nitrogen Volatilization Efficiency (NVE)



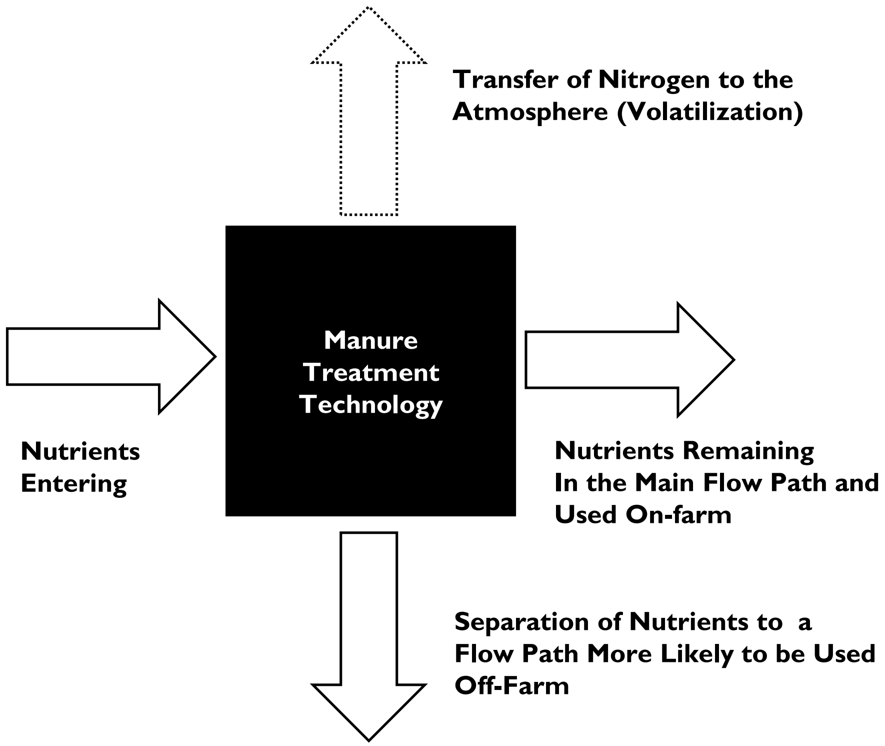
$$\frac{\text{Mass of TN Transferred to Atmosphere}}{\text{Mass of TN Entering}} \times 100$$

Nitrogen Separation Efficiency (NSE)



$$\frac{\textbf{Mass of TN Separated from Main Flow}}{\textbf{Mass of TN Entering}} \quad \textbf{X 100}$$

Phosphorus Separation Efficiency (PSE)



$$\frac{\text{Mass of TP Separated from Main Flow}}{\text{Mass of TP Entering}} \quad \text{X 100}$$

How NVE, NSE and PSE fit in

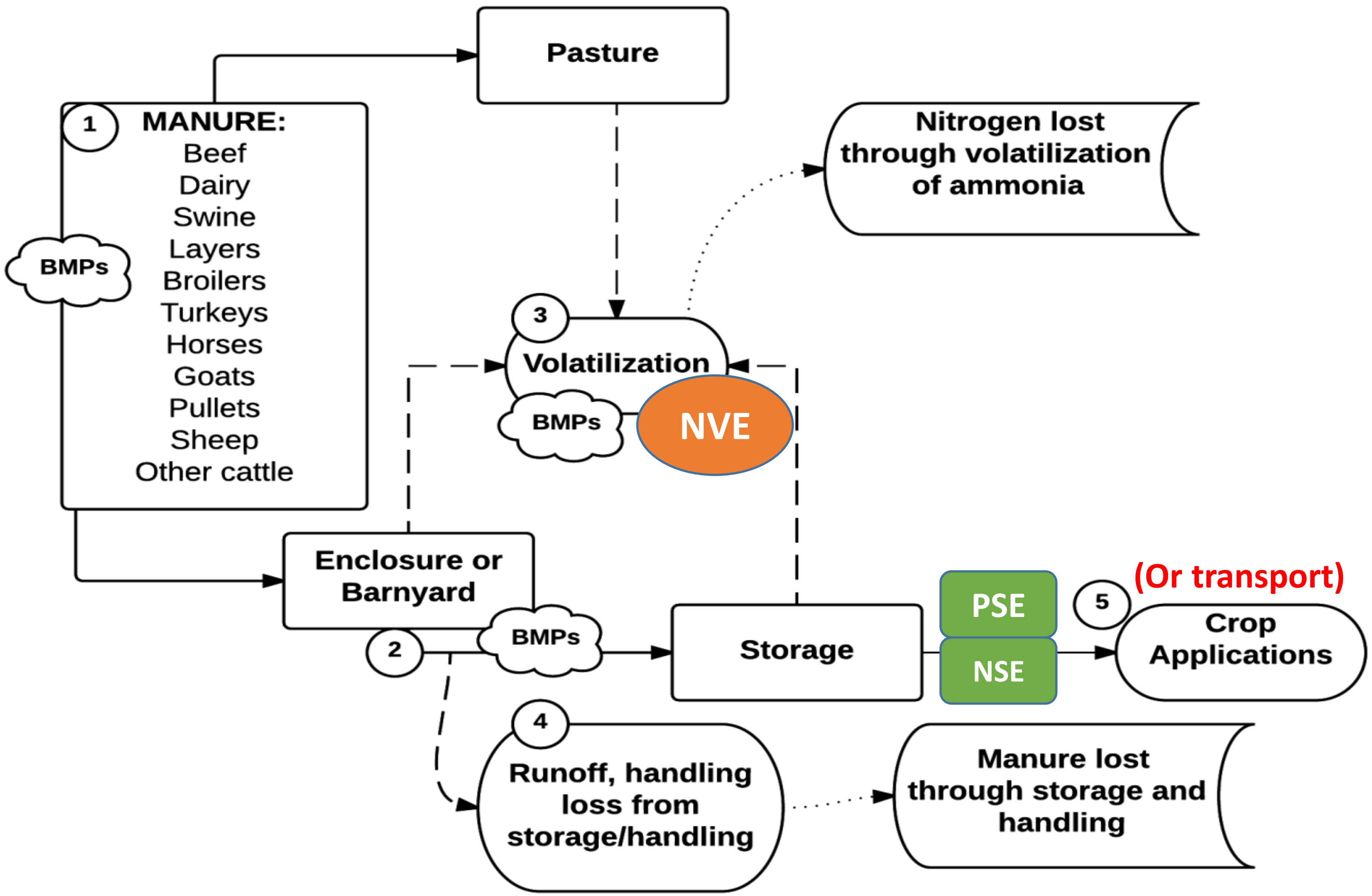


Figure B.2 (modified) – Conceptual diagram of manure nutrients in the Phase 5.3.2 Watershed Model

Three levels of Recommendations

1. **Default (Level 1)** is used when only technology and manure type is known.
2. **Defined (Level 2)** is used when the manure type and pertinent operating conditions of the technology are known.
3. **Data-driven (Level 3)** is used when monitoring data for a given farm is available.

Six Broad Definitions of Technologies

1. **Thermochemical Processing**
2. **Composting**
3. **Anaerobic Digestion**
4. **Settling**
5. **Mechanical Solid-Liquid Separation**
6. **Wet Chemical Treatment**

Thermochemical Conversion

USDA-NRCS

Gasification

1,400 – 2,700 °F

Limited O_2

Syngas

Ash or Char

USDA-NRCS

Combustion

1,500 – 3,000 °F

Excess O_2

Direct Heat

Ash

USDA-NRCS

Pyrolysis

575 – 1,475 °F

No O_2

Thermochemical Conversion

USDA-NRCS

Gasification

1,400 – 2,700 °F
Limited O_2
Syngas
Ash or Char

USDA-NRCS

Combustion

1,500 – 3,000 °F
Excess O_2
Direct Heat
Ash

USDA-NRCS

Fast Pyrolysis

750 – 1,100 °F
No O_2
Residence Time: seconds
Syngas
Bio-Oil
Bio-Char

Thermochemical Conversion

USDA-NRCS

Gasification

1,400 – 2,700 °F
Limited O_2
Syngas
Ash or Char

USDA-NRCS

Combustion

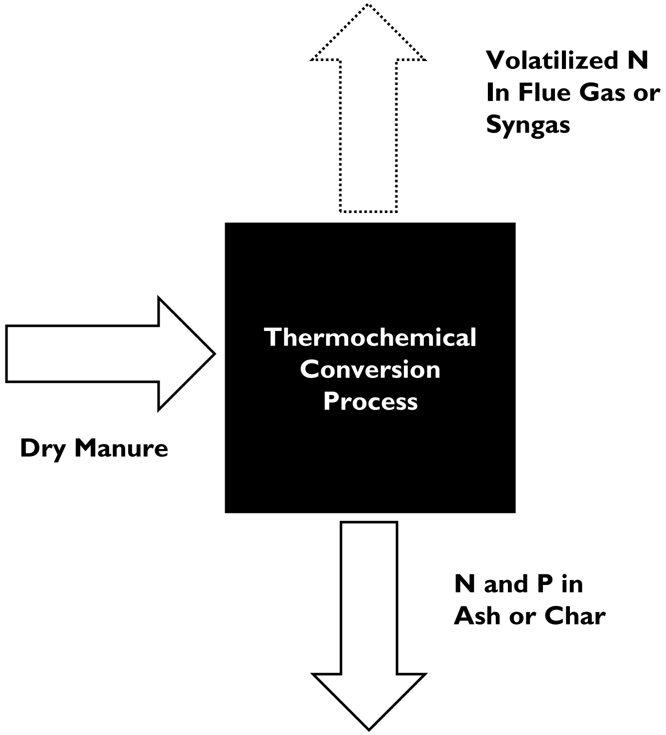
1,500 – 3,000 °F
Excess O_2
Direct Heat
Ash

USDA-NRCS

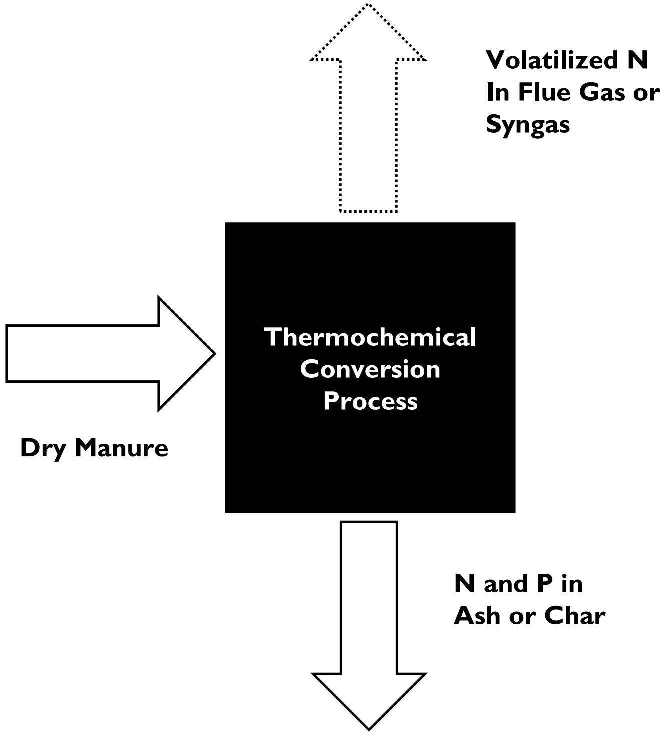
Slow Pyrolysis

575 – 1,475 °F
No O_2
Residence Time: hours or days
Syngas
Bio-Char

Thermochemical Conversion

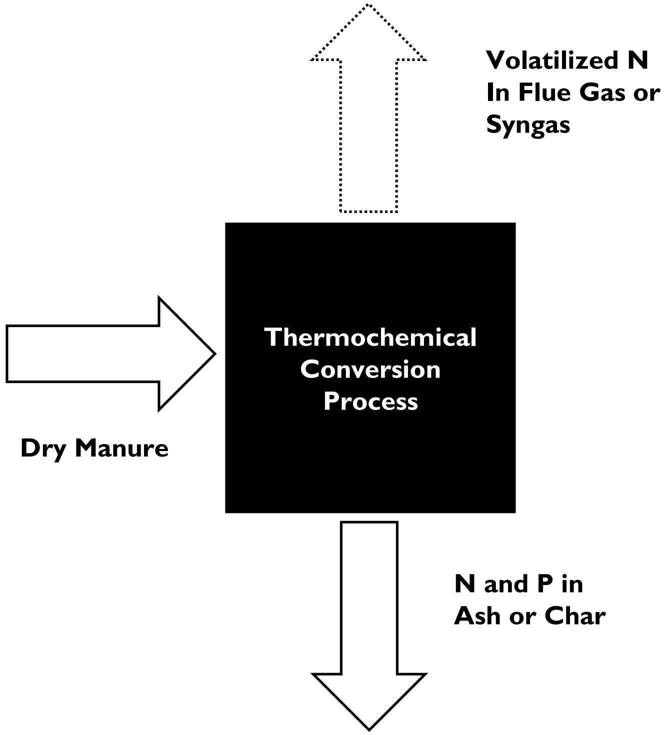


Nitrogen Volatilization Efficiency (NVE)



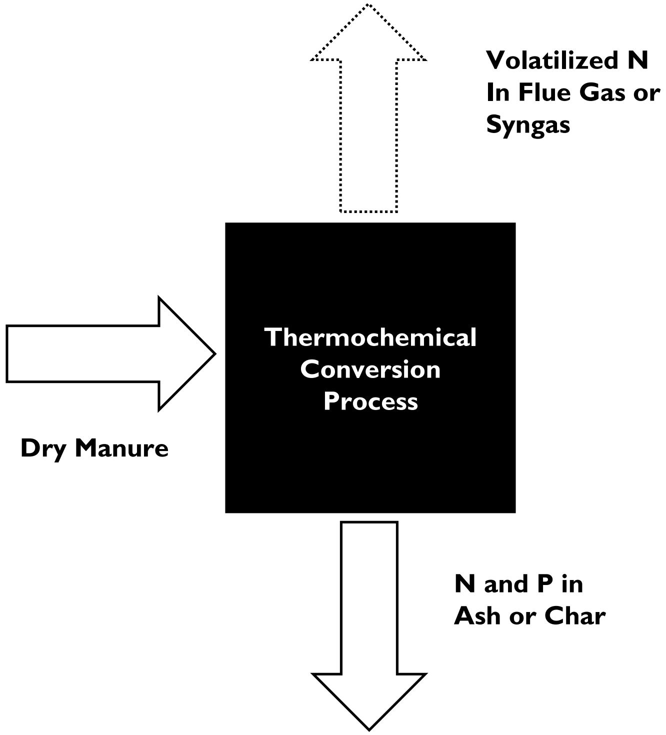
$$\frac{\text{Mass of TN Volatilized as Gas}}{\text{Mass of TN Entering}} \times 100$$

Nitrogen Separation Efficiency (NSE)



$$\frac{\text{Mass of TN in Char or Ash}}{\text{Mass of TN Entering}} \times 100$$

Phosphorus Separation Efficiency (PSE)



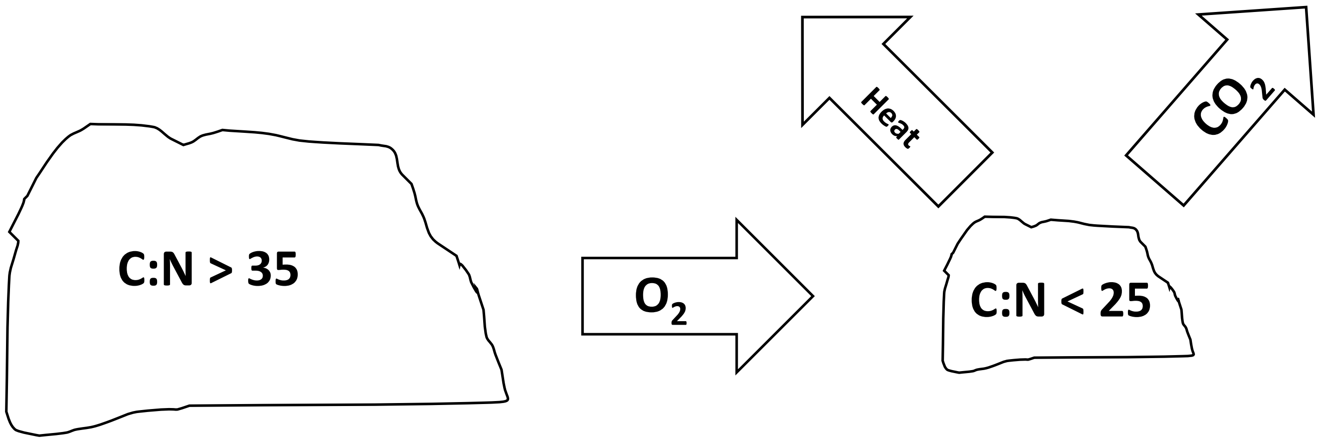
$$\frac{\text{Mass of TP in Char or Ash}}{\text{Mass of TP Entering}} \quad \text{X 100}$$

Table TCC.1. Default Transfer Efficiencies for Thermochemical Conversion Processes

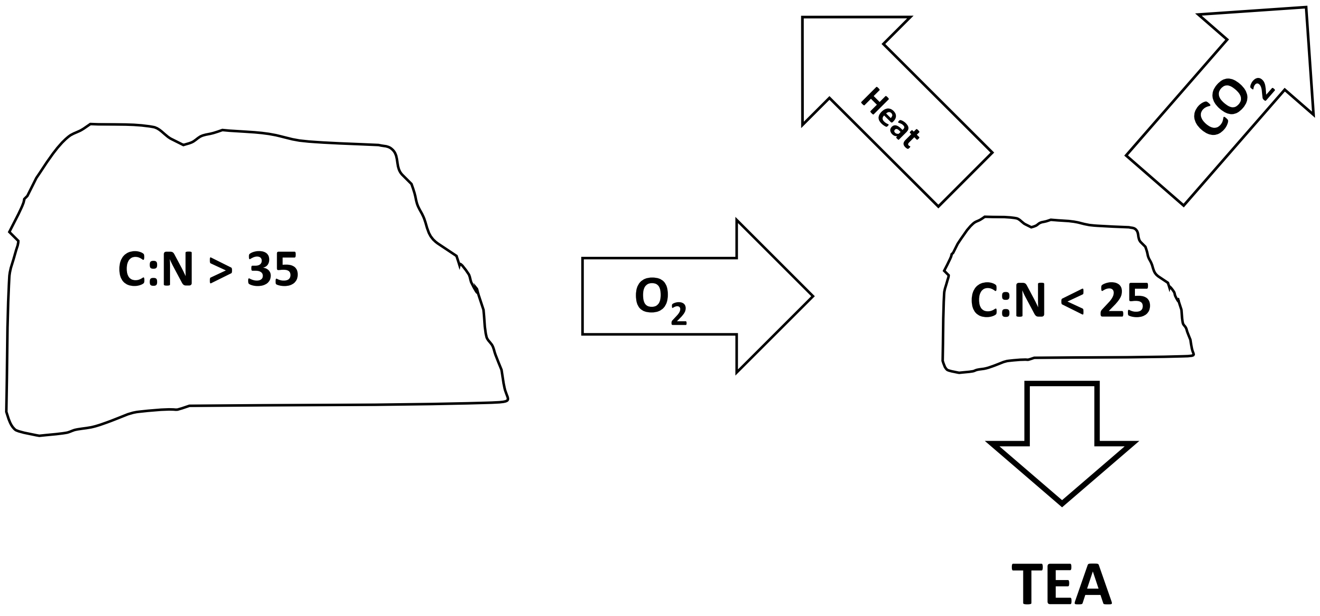
Thermochemical Conversion Process	Transfer Efficiency (%)		
	NVE	NSE	PSE
Combustion	85	15	100
Gasification	85	15	100
Pyrolysis	25	75	100

Table TCC5: Defined Transfer Efficiencies of Thermochemical Conversion Processes based on Process Factors

Thermochemical Conversion Process	Operating Temperature (°F)	Transfer Efficiency (%)		
		NVE	NSE	PSE
Combustion	1,500 – 3,000	95	5	100
Gasification	1,500 – 2,700	85	15	100
Gasification	<1,500	25	75	100
Fast Pyrolysis RT ~ Seconds	750 – 1,100	75	25	100
Slow Pyrolysis RT ~ Hours or Days	575 – 1,475	25	75	100



Composting



Composting

Clatsop County Water Conservation Dist.

Static Pile

Gatheringtogetherfarm.com

Turned Pile

O2Compost.com

Forced Aeration

Composting

OCES.

In-Vessel (Rotating Bin)

Composting

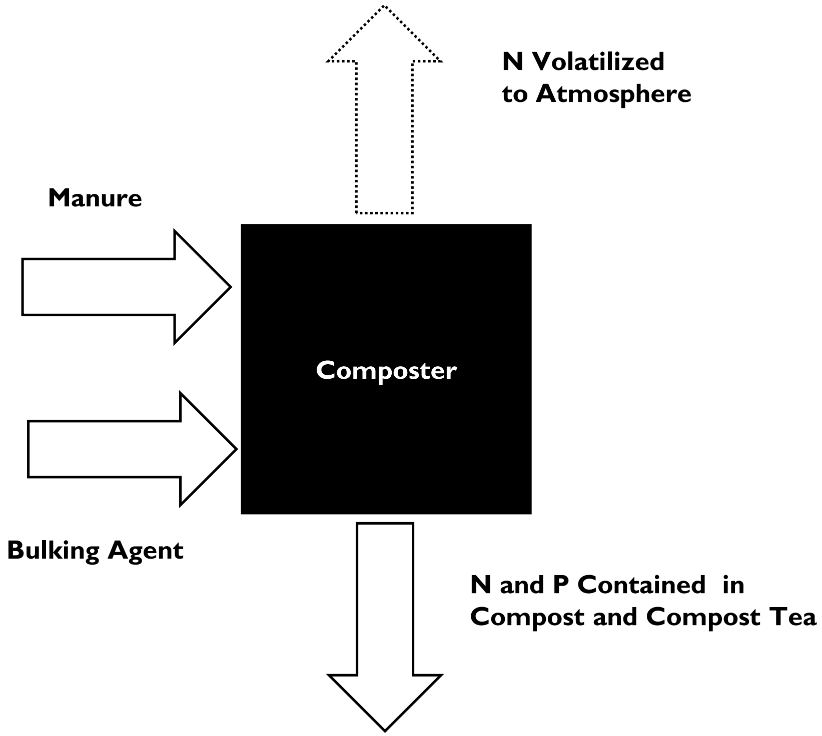
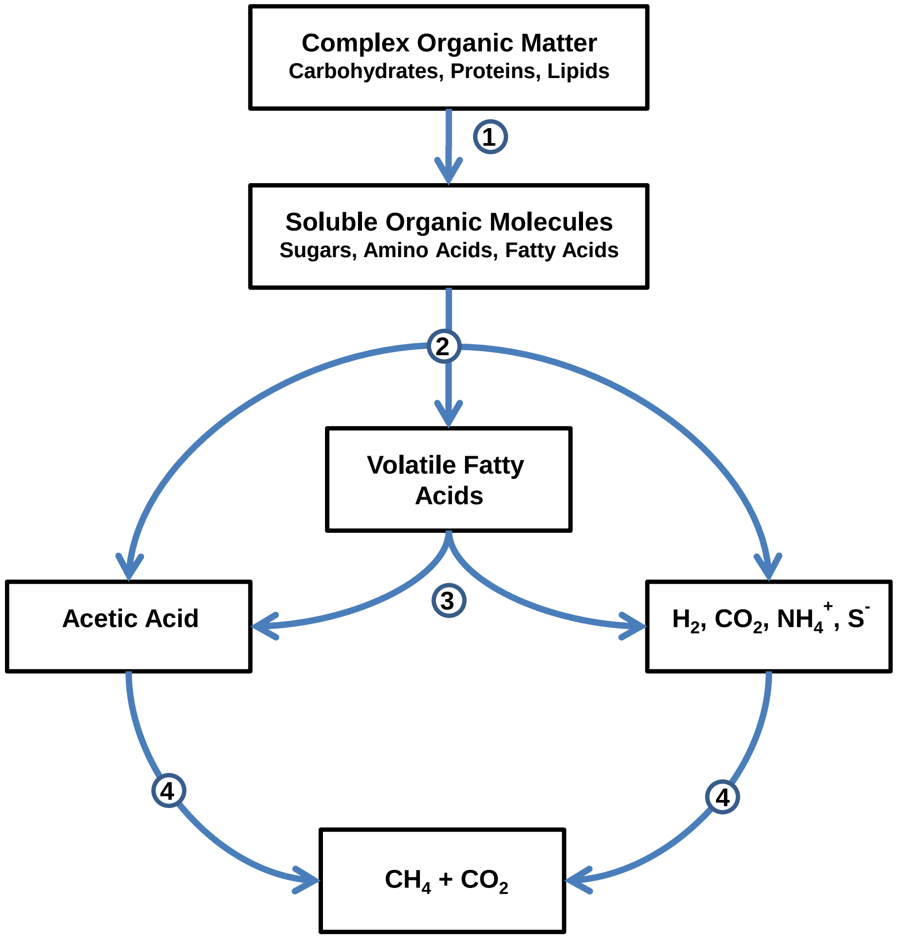

N Volatilized
to Atmosphere
Manure
Composter
Bulking Agent
N and P Contained in
Compost and Compost Tea

Table C1. Default Transfer Efficiencies for Composting Systems

Type of Composting System	Transfer Efficiency (%)		
	NVE	NSE	PSE
Turned Pile and Windrow	25	75	100
Static Pile and Windrow	26	74	100
In-Vessel and Rotating Bin	10	80	100
Forced Aeration	25	75	100

Table C8. Defined Transfer Efficiencies based on Composting System and C:N of Bulking Agent

Type of Composting System	C:N of Bulking Agent <100			C:N of Bulking Agent >100		
	Transfer Efficiency (%)			Transfer Efficiency (%)		
	NVE	NSE	PSE	NVE	NSE	PSE
Turned Pile and Windrow	32	68	100	28	72	100
Static Pile and Windrow	33	67	100	29	71	100
In-Vessel and Rotating Bin	13	87	100	11	89	100
Forced Aeration	32	68	100	28	72	100



1 Hydrolysis
2 Acidosis
3 Acetogenesis
4 Methanogenesis

Anaerobic digestion

Anaerobic digestion

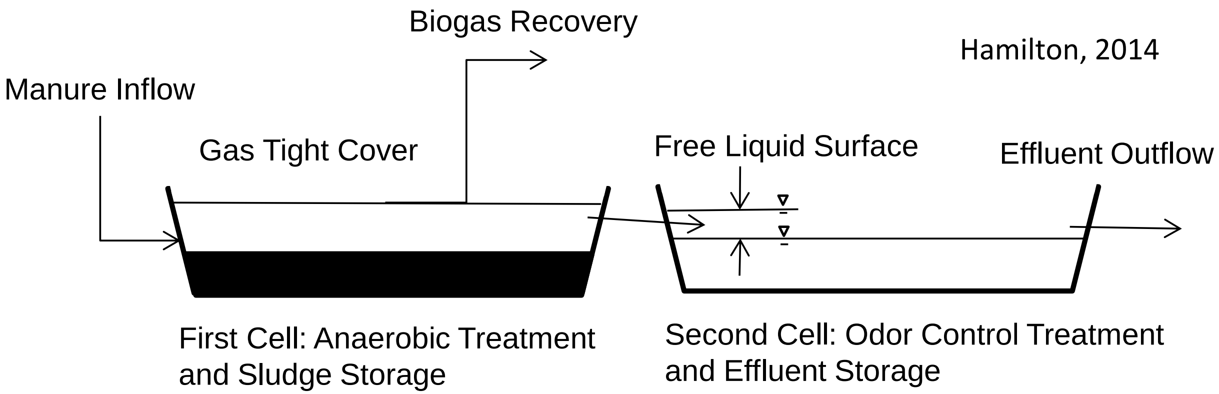
OCES

Complete Mix

Penn State Ext.

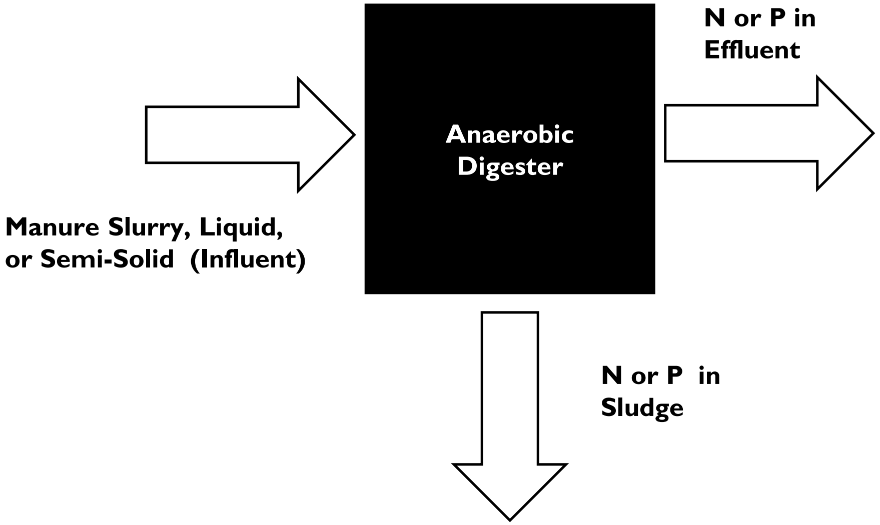
Plug Flow

Hamilton, 2014



Covered Lagoon

Anaerobic Digestion



Default Efficiencies for Anaerobic Digesters

NVE = NSE = PSE = 0

Table AD.3. Defined Transfer Efficiencies for Anaerobic Digestion for All Types of Manure

Type of Digester	Transfer Efficiency (%)		
	NVE	NSE	PSE
Plug Flow and Mixed Plug Flow	0	0	0
Complete Mix	0	0	0
Covered Lagoon with Sludge Storage Exceeding 10 Years	0	30	60

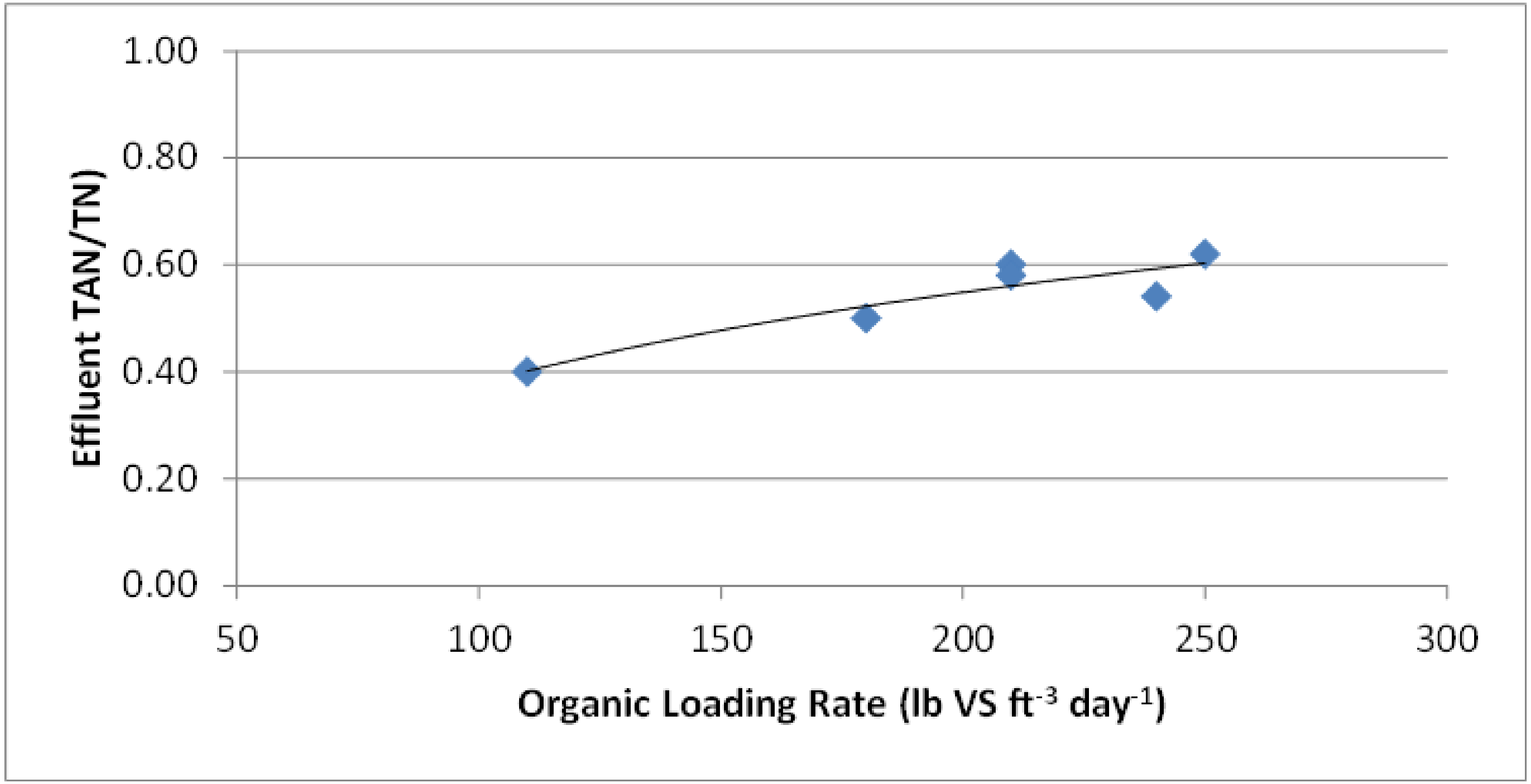


Figure AD.11. Effect of Organic Loading Rate on Concentration of Total Ammonia Nitrogen (TAN) in Effluent of Farm-Scale, Mesophilic, Single Cell, Cattle and Swine Manure Digesters

nrcs.usda.gov

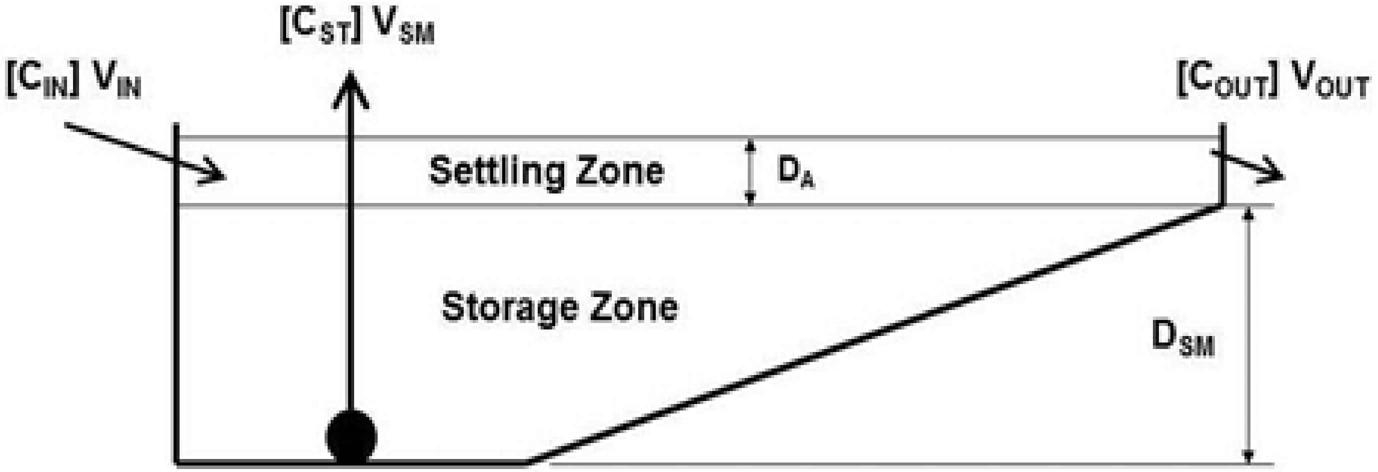
Settling Basin

Umich.edu

Clarifier

Settling

Settling



Pondboss.com

Flashboard Dam

Porous or Picket Dam

Iowa State Ext.

Settling Basin or Clarifier

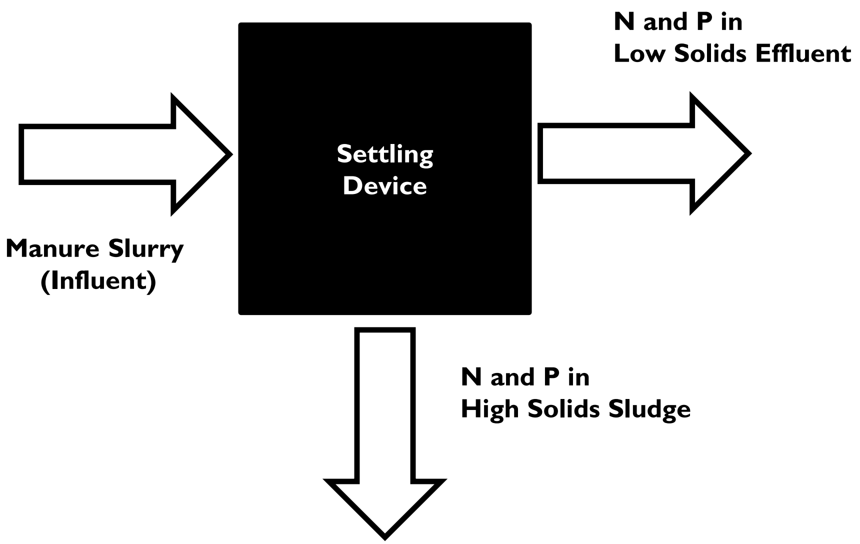


Table STTL1. Default Transfer Efficiencies of Gravity Settling based on Type of Influent

Type of Influent	Transfer Efficiency (%)		
	NVE	NSE	PSE
Milking Center Wash Water	0	20	47
Flushed Dairy Manure	0	25	45
Flushed Swine Manure	0	20	50

Table STTL.5. Defined Transfer Efficiencies of Settling Devices based on Type of Device, Type of Manure, and Manure TS Content

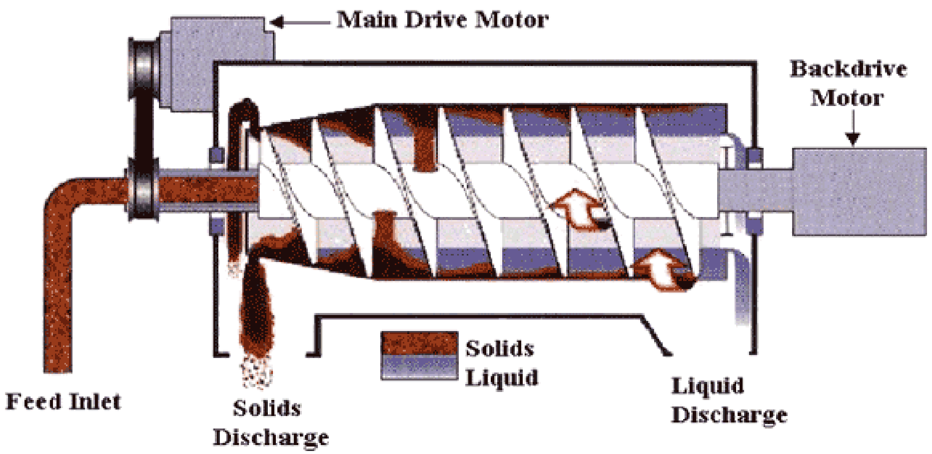
Type of Device	Type of Manure	Manure TS (% wb)	Transfer Efficiency (%)		
			NVE	NSE	PSE
Clarifier	Dairy, Dairy Milking Center Swine	<3%	0	20	50
Basin	Dairy	<5%	0	35	45
Basin	Dairy Milking Center	<2%	0	20	48
Basin	Swine	<3%	0	30	60
Weeping Wall Basin	Dairy	3 to 10%	0	60	55

Mechanical Solid-Liquid Separation

OCES

Devices that use Particle Size

Hutch-hayes.com



Devices that use Centrifugal Force

Mechanical Solid-Liquid Separator

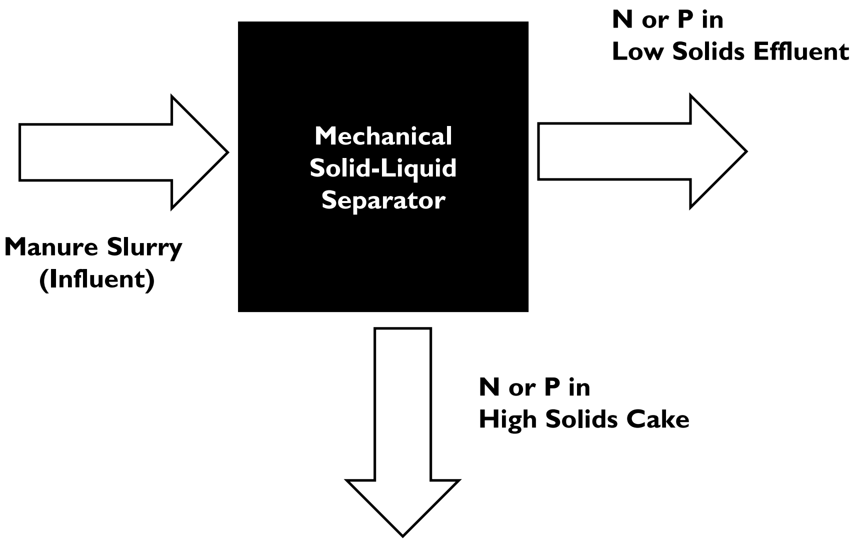


Table MSLS.1. Default Transfer Efficiencies for Mechanical Solid-Liquid Separators given Types of Separator and Manure

Type of Separator	Transfer Efficiency (%)				
	NVE	NSE		PSE	
	All Types of Manure	Dairy Manure	Swine Manure	Dairy Manure	Swine Manure
Stationary Screen	0	13	3	11	2
Rotating Screen	0	0	5	0	3
Screw Press	0	8	5	6	8
Belt Press	0	10	10	15	18
Brushed Screen Roller Press	0	13	6	15	6
Centrifuge	0	20	10	45	50

Table MSLS.8. Defined Separation Efficiencies for Stationary Screen Separators based on Process Factors

Type of Manure	Screen Opening Size (mm)	Influent TS Content (%)	Removal Efficiency (%)	
			NSE	PSE
Dairy	1.5 or less	2-7	15	29
Swine	1.0 or less	1-10	4	7

Table MSLS.11. Defined Separation Efficiencies for Centrifuge Separators Treating Dairy and Swine Manure based on Process Factors

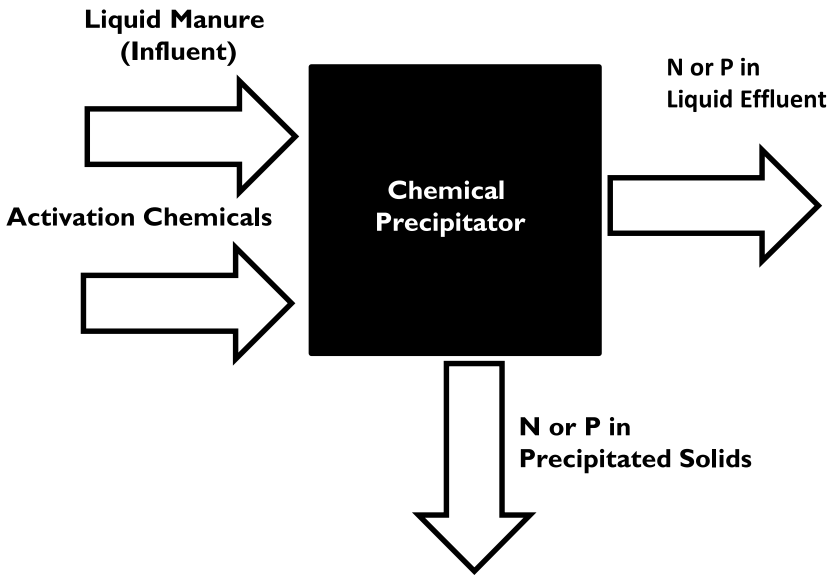
Manure Type	Influent TS (%)	Cylinder Speed (rpm)	Separation Efficiency (%)	
			NSE	PSE
Dairy	< 4.0	4,100	25	50
	4.0 to 6.0	4,100	25	50
	>6.0	2,200	25	50
Swine	< 2.0	5,000	10	50
	2.0 to 4.0	4,100	10	65
	4.0 to 7.0	2,200	15	70
	>6.0	2,050	20	70

Wet Chemical Treatment

Precipitation
Coagulation
Flocculation

Wet Chemical Treatment

Wet Chemical Treatment



Because Wet Chemical Treatment depends on Dosing of Activation Chemicals

1. **Default Level = Default Level for Settling and Mechanical Solid-Liquid Separation.**

2. **Recommend using Data Driven Levels.**

Data Driven (Level 3) Transfer Efficiencies

Data Driven (Level 3) transfer efficiencies

- Applicable to a treatment system that utilizes one or more manure treatment technologies described in the report. Technologies may be proprietary or non-proprietary and may be used in any sequence to produce one or more end products for subsequent transport or land application.
- Unique transfer efficiencies determined using monitoring data; the calculated transfer efficiency will vary annually from system to system.
- Transport or land applications of any end products from these systems should be reported under separate BMPs (e.g. Manure Transport).
- Manure treatment systems that lack adequate annual performance data to support a Data Driven Transfer Efficiency (i.e., Level 3) should be reported using the appropriate Level 1 or Level 2 Transfer Efficiency for that system's primary manure treatment technology.
- See Table DD.1, page 115 of report

Future Research Needs

1. **Liquid Aerobic Systems**
2. **Other Defined Technologies**
3. **Update with Farm-Scale Data**

BMP verification

- MTT BMPs subject to the same expectations set forth in the partnership's BMP Verification Framework
  - http://www.chesapeakebay.net/about/programs/bmpverification
- Follow the AgWG's existing BMP verification guidance
  - http://www.chesapeakebay.net/about/programs/bmp/verification_guidance
- Manure treatment technologies have elements of both "Visual Assessment, Multi-Year" and "Non-Visual Assessment" BMP categories, as defined by the AgWG. Jurisdictions can follow the guidance for either of these categories for Level 1, 2 and 3 MTT BMPs.

BMP verification (continued)

- MTT BMPs are reported/credited annually, and closely related to Manure Transport. Transport is a Non-Visual Assessment BMP, so jurisdictions can utilize protocols/procedures outlined by the AgWG to spot check and verify their records of how much manure is treated, where it is transported, etc.
- The treatment systems themselves have physical components (e.g., a compost facility, a gasifier, etc.) which can be verified using the AgWG's guidance for Visual Assessment-Multi-Year BMPs.
- Systems reported using Level 3 transfer efficiencies will likely be associated with programs that provide more rigorous verification (regulatory, permit, trading). These programs will have detailed and specific requirements for data collection and reporting to provide the mass of volatilized nitrogen.

Reporting treatment BMPs for Phase 6 Watershed Model

Recalling how NVE, NSE and PSE fit in

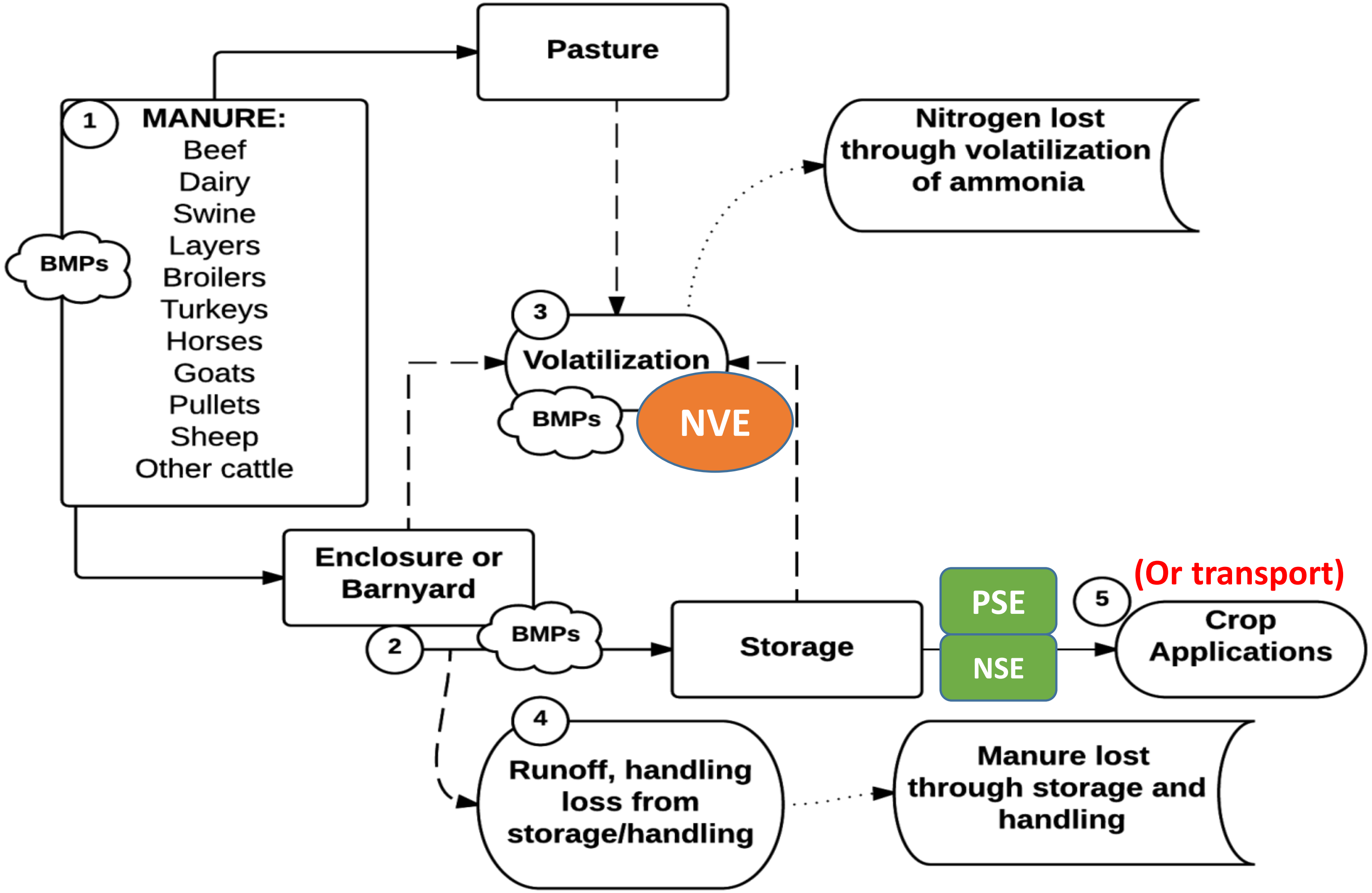


Figure B.2 (modified) – Conceptual diagram of manure nutrients in the Phase 5.3.2 Watershed Model

Table A.1. Manure Treatment BMPs eligible for crediting in the Phase 6.0 Watershed Model

Practice Number	Practice Category	Technology Specifications*
MTT1	Thermochemical	Slow Pyrolysis
MTT2	Thermochemical	Fast Pyrolysis**
MTT3	Thermochemical	Gasification-Low Heat
MTT4	Thermochemical	Gasification-High Heat**
MTT5	Thermochemical	Combustion
MTT6	Thermochemical	Combustion-High Heat**
MTT7	Composting	In-Vessel and Rotating Bin- Standard
MTT8	Composting	In-Vessel and Rotating Bin- C:N>100**
MTT9	Composting	In-Vessel and Rotating Bin- C:N<100**
MTT10	Composting	Forced Aeration- Standard
MTT11	Composting	Forced Aeration- C:N>100**
MTT12	Composting	Forced Aeration- C:N<100**
MTT13	Composting	Turned Pile and Windrow- Standard
MTT14	Composting	Turned Pile and Windrow- C:N>100**
MTT15	Composting	Turned Pile and Windrow- C:N<100**
MTT16	Composting	Static Pile and Windrow- Standard
MTT17	Composting	Static Pile and Windrow- C:N>100**
MTT18	Composting	Static Pile and Windrow- C:N<100**
MTT19	Directly Monitored	

* Definitions for specific thermochemical and composting technologies can be found in the report in Sections 4 and 5, respectively.
**Information about process factors, as described in Section 4, pages 29 - 32, and Section 5, pages 43-47, is needed to report these BMPs

Table A.2. Pollutant Reductions Associated with Manure Treatment Practices			
Practice #	TN Removal (%)	TP Removal (%)	TSS Removal (%)
MTT1*	25	0	0
MTT2	75	0	0
MTT3	25	0	0
MTT4	85	0	0
MTT5	85	0	0
MTT6	95	0	0
MTT7*	10	0	0
MTT8	11	0	0
MTT9	13	0	0
MTT10	25	0	0
MTT11	28	0	0
MTT12	32	0	0
MTT13	25	0	0
MTT14	28	0	0
MTT15	32	0	0
MTT16	26	0	0
MTT17	29	0	0
MTT18	33	0	0
MTT19	Monitored	0	0
*MTT1 represents the default practice Thermochemical treatment systems, and MTT7 represents the default for composting treatment systems.			

What If My MTT isn’t in Table A.1?

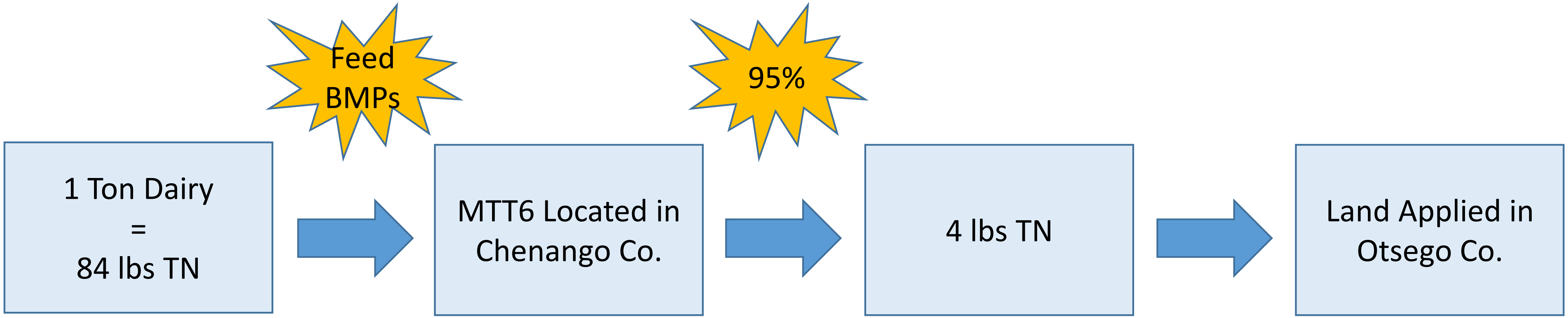
- Credit may be available through the manure transport BMP!

What Do I Need to Report?

- *BMP Name*: Practice name (e.g. MTT1)
- *Measurement Names*:
  - Animal Type - the unit for this will be tons, similar to manure transport, but you will be asked to report the measurement name as an animal type (e.g., “Broilers”)
  - County From – FIPs code associated with the county in which the manure was generated
  - County To – FIPs code associated with the county to which manure was transported after treatment by the technology
- *Geographic Location:* Qualifying NEIEN geographies including: Latitude/Longitude; *or* County; *or* Hydrologic Unit Code (HUC12, HUC10, HUC8, HUC6, HUC4); *or* State in which the facility is located
- *Date of Implementation:* Year the manure treatment was done
- *Land Uses*: Permitted feeding operation, non-permitted feeding operation, feeding operation

Example

- *Practice Name*: MTT6 (Thermochemical, Combustion – High Heat)
- *Animal Type*: 1 ton Dairy
- *County From*: Chenango
- *County To*: Otsego



Timeline for review/approval of report

- **Thurs. March 31:** Report released for review/comment
- **Thurs. April 14**: Webinar
- **Wed. April 20**: Briefing for Trading and Offsets Workgroup
- **Thurs. April 21**: Presentation to AgWG. Abridged version of webinar presentation, no approval or decision will be requested until after comment period closes and response to comments is available.
- **Wed. May 3**: Initial 30-day comment period closes. Comments on the report should be submitted to Jeremy Hanson (jchanson@vt.edu) by close of business.
- **Thurs. May 19**: Present/discuss response to comments to AgWG; earliest potential date to seek AgWG approval of report.
  - Note: Any necessary adjustments to the schedule for workgroup approval as a result of major substantive comments will be made in coordination with leadership of the AgWG and WTWG.
- **Thurs. June 2**: Earliest potential date to seek WTWG approval
- **Mon. June 13** or **Mon. June 27**: Earliest potential dates to seek WQGIT approval

Q&A

- First we’ll review written questions from the chat box. Then we’ll take verbal questions from participants. Please do not un-mute until asked to do so.
  - *6 to un-mute
  - #6 to mute. Please remember to mute when finished with your question. This will limit background noise on our recording. Thank you.

THANK YOU FOR JOINING US

Comments on report are request by close of business on Wednesday, May 3. Comments should be submitted to Jeremy Hanson (jchanson@vt.edu).

Contact Jeremy with questions following today's webinar.

The webinar recording will be placed on the calendar entry soon:

http://www.chesapeakebay.net/calendar/event/23875/