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Managing the 4-Cs
Crops - Cows - Cash - Conservation

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NORTHEAST SARE
Sustainable Agriculture Research & Education

USDA
Risk Management Agency (RMA)

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Crops to Cow Project:
Whole Farm vs. Dairy Enterprise

Profit level Number of farms	High 23	Med 22	Low 22
Average Milk Lbs. Sold	11,769,076	3,826,985	9,648,732
Average Total Cows	469	164	391
Net Return over Labor & Mgt/cow:			
Dairy Enterprise, Loss or Profit /cow	$16	($443)	($950)
Whole Farm, Loss or Profit/cow	$447 [1]	($203)	($609)
Crop sales	$57,950	$17,828	$23,505
Other cash income	$207,424	$59,571	$172,297

Combined data for 2016, 2017, and 2018. Analyzed with RankEm software – (Minnesota, 2018)

[1]Benchmark - $800-$1000/cow

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Crops to Cow Project:
Herd performance based on profitability[1]

	High – 7 herds		Med – 8 herds		Low – 7 herds	
Year	2016	2017	2016	2017	2016	2017
At sampling:						
Pregnancy rate, %	27.3	25.4	21.6	22.3	21.6	24.4
Stdev $\pm$	5.4	5.8	8.9	6.5	5.5	3.7
Days in milk	176.1	170.7	177.6	170.8	171.1	170.7
Stdev $\pm$	16.2	8.8	17.4	7.2	8.0	6.7
First lactation, % of herd	35.5	40.9	35.6	40.1	37.6	37.8
Stdev $\pm$	7.1	4.7	5.3	8.7	6.7	2.5
Age at first calving, mos.	23.9	23.7	23.8	23.4	24.3	24.0
Stdev $\pm$	1.7	2.0	1.2	1.1	1.3	1.0

[1]High profit herds had positive net returns for 2016 and 2017; medium profit herds had one year of positive returns; low profit herds did not have positive returns in either year. The comparison is on an annual basis for 2016 and 2017. One herd was not on DHIA (low profit) and was not included.

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Production and intake based on profitability[1]

	High – 7 herds		Med – 8 herds		Low – 9 herds	
Year	2016	2017	2016	2017	2016	2017
At sampling:						
Milk production, lbs.	82.0	82.5	75.9	78.6	74.0	75.8
(St dev ±)	(9.1)	(8.4)	(7.5)	(5.7)	(6.2)	(3.4)
Milk fat, %	3.80	3.67	3.95	3.83	4.00	3.70
Milk protein, %	3.13	3.01	3.12	3.06	3.15	3.06
ECM, lbs.	84.5	83.1	79.5	81.0	78.0	77.0
DMI, lbs.	54.6	51.7	51.8	53.6	50.9	51.5
DMIE	1.56	1.62	1.55	1.53	1.54	1.51

[1]High profit herds had positive net returns for 2016 and 2017; medium profit herds had one year Of positive returns; low profit herds did not have positive returns in either year. The comparison is Fall 2016 and Spring 2017.

ECM = energy corrected milk; DMI=dry matter intake; DMIE= dry matter intake efficiency.

2016 was a drought year

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Production and intake based on profitability[1]

	High – 7 herds		Med – 8 herds		Low – 8 herds	
Year	2017	2018	2017	2018	2017	2018
At sampling:						
Milk production, lbs.	81.8	82.7	76.3	77.0	73.8	73.9
(St dev ±)	(6.7)	(9.6)	(3.9)	(4.4)	(7.3)	(2.2)
Milk fat, %	3.77	3.56	3.96	3.71	3.82	3.58
Milk protein, %	3.10	2.92	3.12	2.96	3.15	2.92
ECM, lbs.	84.0	82.9	80.2	78.2	76.4	74.5
DMI, lbs.	56.9	54.2	52.7	50.7	51.7	48.7
DMIE	1.50	1.54	1.50	1.55	1.48	1.53

[1]High profit herds had positive net returns for 2016 and 2017; medium profit herds had one year of positive returns; low profit herds did not have positive returns in either year. The comparison is Fall 2017 and Spring 2018.

ECM = energy corrected milk; DMI=dry matter intake; DMIE= dry matter intake efficiency.

2017 was a wet year

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Milk cow forage rations based on profitability[1]

	High – 7 herds		Med – 8 herds		Low – 9 herds	
Year	2016	2017	2016	2017	2016	2017
At sampling:						
Corn silage, DM lbs.	20.0	19.0	22.2	21.0	19.0	18.0
Range	15-25	14-27	12-34	15-27	13-26	9-27
Number of herds	7	7	8	8	9	9
Hay-crop forage, DM lbs.	8.0	7.6	5.2	7.7	8.4	7.2
Range	1.6-13	3-11.5	.40-12.3	.4-14	.46-15	.46-15
Number of herds	6	4	5	7	8	8
Small grain silage, DM lbs.	3.9	6.6	7.5	5.2	4.3	3.8
Range	2.4-6	2.7-12	3-11	3-7.5	1.6-6	1.9-7.5
Number of herds	5	6	5	7	5	3

[1]High profit herds had positive net returns for 2016 and 2017; medium profit herds had one year of positive returns; low profit herds did not have positive returns in either year. The comparison is Fall 2016 and Spring 2017.

2016 was a drought year

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Milk cow forage rations based on profitability[1]

	High – 7 herds		Med – 8 herds		Low – 8 herds	
Year	2017	2018	2017	2018	2017	2018
At sampling:						
Corn silage, DM lbs.	20.9	22.3	21.5	22.4	19.6	17.5
Range	14-29	12.5-29	12-27	19-30	14-26	9.5-23
Number of herds	7	7	8	8	8	8
Hay-crop forage, DM lbs.	8.4	5.1	4.3	4.2	5.6	7.5
Range	2.2-11.5	1.6-11	.40-11	.4-11	.46-15	.23-13.6
Number of herds	5	7	7	7	6	7
Small grain silage, DM lbs.	5.7	4.3	5.4	6.5	6.3	7.1
Range	4-8	.95-5.7	2.6-6.6	3-11	1.0-10.4	6.5-7.7
Number of herds	4	5	5	5	6	4

[1]High profit herds had positive net returns for 2016 and 2017; medium profit herds had one year of positive returns; low profit herds did not have positive returns in either year. The comparison is Fall 2017 and Spring 2018.

2017 was a wet year

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Milk cow grain rations based on profitability

	High – 7 herds		Med – 8 herds		Low – 9 herds	
Year	2016	2017	2016	2017	2016	2017
At sampling (as-fed lbs.)						
High moisture corn	15.7	14.8	13.9	13.0	12.5	13.6
Number of herds	3	3	5	5	5	5
Dry corn or barley	10.8	13.1	9.1	9.0	10.0	7.9
Number of herds	5	4	4	4	5	4
Protein ingredient	6.2	4.2	4.0	3.5	4.5	3.3
Number of herds	4	4	4	4	4	3
Wet brewer's grain	13.0	16.0	11.0	9.5	12.8	13.5
Number of herds	1	1	2	2	1	1
Bypass protein ingredient	3.1	8.0	7.0	5.1	3.5	3.7
Number of herds	2	2	2	3	2	3
Sugar	4.0	3.2	2.4	3.9	0	3.4
Number of herds	1	2	3	2	0	1
Fat	0.50	0.60	0.38	0.40	0.32	0.38
Number of herds	3	3	3	4	3	3
Byproduct feed	8.9	9.2	3.0	0	9.0	8.2
Number of herds	4	3	1	0	2	2
Complete feed	0	0	11.6	18.5	0	28.7
Number of herds	0	0	2	1	0	1
Supplement	8.1	9.3	7.8	8.5	12	10.0
Number of herds	7	7	6	7	9	8

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Corn silage quality based on profitability[1]

	High – 7 herds		Med – 8 herds		Low – 9 herds	
Year	2016	2017	2016	2017	2016	2017
At sampling:						
NDF, % DM	37.8	39.5	36.6	36.4	39.1	38.4
Stdev $\pm$	4.9	4.5	3.7	2.8	5.5	6.3
NDFD 30 hr., % NDF	58.2	60.5	58.5	61.0	58.9	59.3
Stdev $\pm$	6.4	3.7	4.9	3.4	4.6	4.2
Starch, % DM	34.4	33.3	34.4	37.0	31.0	34.8
Stdev $\pm$	4.0	3.4	8.4	3.5	7.6	7.6
Starch dig. 7-hr, % starch	72.1	67.7	66.3	62.7	67.0	66.9
Stdev $\pm$	7.8	8.8	10.7	14.4	13.1	12.2

[1]High profit herds had positive net returns for 2016 and 2017; medium profit herds had one year of positive returns; low profit herds did not have positive returns in either year. The comparison is Fall 2016 and Spring 2017.

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Corn silage quality based on profitability[1]

	High – 7 herds		Med – 8 herds		Low – 8 herds	
Year	2017	2018	2017	2018	2017	2018
At sampling:						
NDF, % DM	34.9	36.8	37.2	35.4	36.7	36.6
Stdev +	3.5	4.9	2.6	2.0	6.9	3.8
NDFD 30 hr., % NDF	55.3	55.8	56.6	56.0	53.9	56.3
Stdev +	5.4	4.9	7.1	6.8	8.8	5.5
Starch, % DM	38.7	38.0	35.9	38.7	35.1	37.9
Stdev +	4.7	5.8	4.6	2.5	9.9	5.7
Starch dig. 7-hr, % starch	78.4	71.5	78.0	77.5	71.5	77.9
Stdev +	3.4	12.2	2.5	4.0	9.2	7.3

[1]High profit herds had positive net returns for 2016 and 2017; medium profit herds had one year of positive returns; low profit herds did not have positive returns in either year. The comparison is Fall 2017 and Spring 2018.

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Next – The Cropping Enterprise

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Project Farm Demographics

Metric	2016	2017
Number of Farms	24	26
Total # Cows	7,974	8,385
Total Milk Sold (lbs.)	195,801,178	206,722,139
# acres farmed	12,879	14,323
# acres double cropped	5,781	5,995
# acres corn silage	5,675	5,553
# acres small grain silage	4,731	4,736

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Corn Silage Enterprise Analysis

Corn silage enterprise analysis combined for years 2016 and 2017 and sorted by return over labor and management.

	High profit	Medium profit	Low profit
Number of Farms	17	17	16
Acres, average	152	306	212
Yield per acre (as-fed tons)	21.60	19.83	15.25
Cost per ton, $	22.58	31.43	40.51
Cost per acre, $	487.65	623.31	617.78

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Corn Silage Cost Breakdown

High Net Return Group

Total Overhead, 36%
Direct, 64%

Fertilizer & Chemical, 19%
Custom Hire, 15%
Seed, 19%
Land Rent, 11%

Middle Net Return Group

Total Overhead, 38%
Direct, 61%

Fertilizer & Chemical, 17%
Custom Hire, 19%
Seed, 17%
Land Rent, 8%

Low Net Return Group

Total Overhead, 30%
Direct, 70%

Fertilizer & Chemical, 22%
Custom Hire, 26%
Seed, 17%
Land Rent, 6%

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Corn Silage take away

Icon made by Freepik from www.flaticon.com

⅓ − ½ crop acres

Average: 223 acres

⅔ of cost is direct

Direct costs included:
Seed
Fertilizer
Chemical
Custom hire*
Land rent

*No adjustment for custom hire made.

39% of TMR

Based on DM lbs
low of 20%, high of 58%

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Small Grain Silage Enterprise Analysis

Small grain silage enterprise analysis combined for years 2016 and 2017 and sorted by return over labor and management.

	High profit	Medium profit	Low profit
Number of Farms	14	13	13
Acres, average	270	184	176
Yield per acre (as-fed tons)	8.20	5.67	5.52
Cost per ton, $	33.85	40.12	61.60
Cost per acre, $	277.56	227.45	340.3

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Small Grain Silage Cost Breakdown
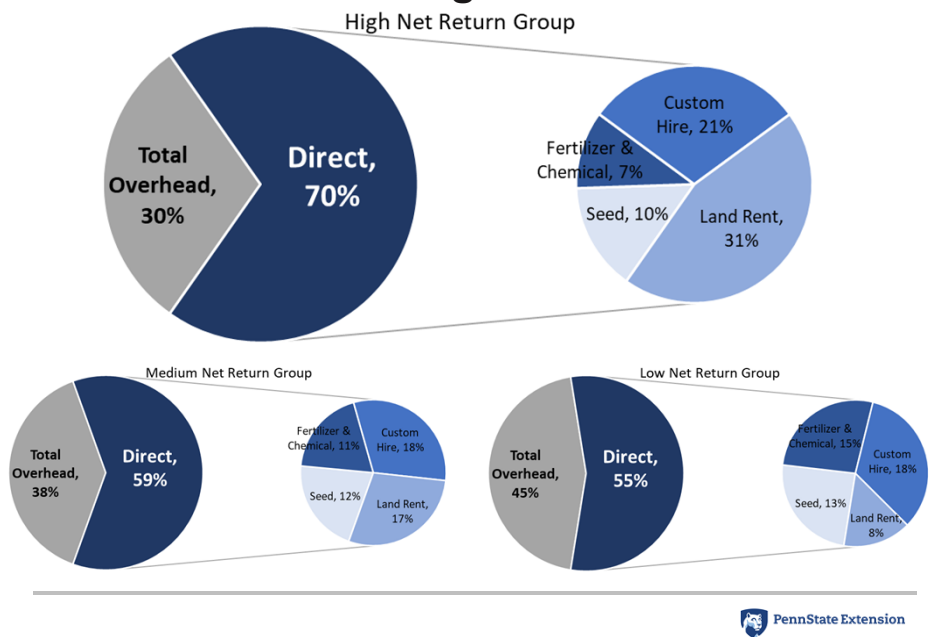
18

Small Grain Silage take away

85% of corn silage acres

76% of actual acres were double cropped

61% of cost is direct

Direct costs included:
Seed
Fertilizer
Chemical
Custom hire*
Land rent

*No adjustment for custom hire made.

11% of TMR

Based on DM lbs
low of 0%, high of 22%

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2016-2017 Monthly IOFC-Cost vs DMI Efficiency by Net Return Group

Monthly IOFC-Cost ($/milk cow/day) vs *Dry Matter Intake Efficiency (lb ECM per lb DM)*

Net return over Labor and Management Group
3-High   2-Med   1-Low
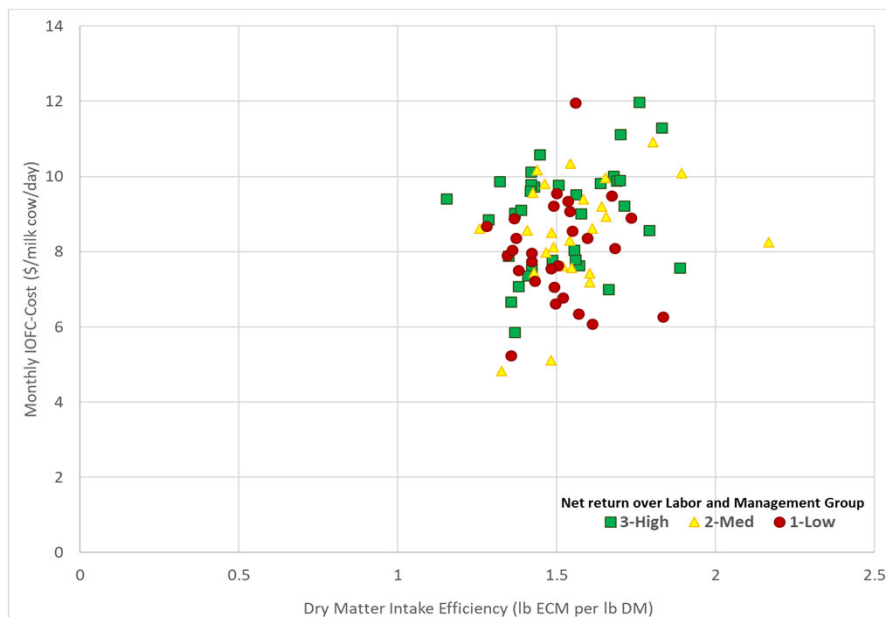
20

2016-2017 Monthly IOFC-Cost vs CS Dig. Starch Intake by Net Return Group
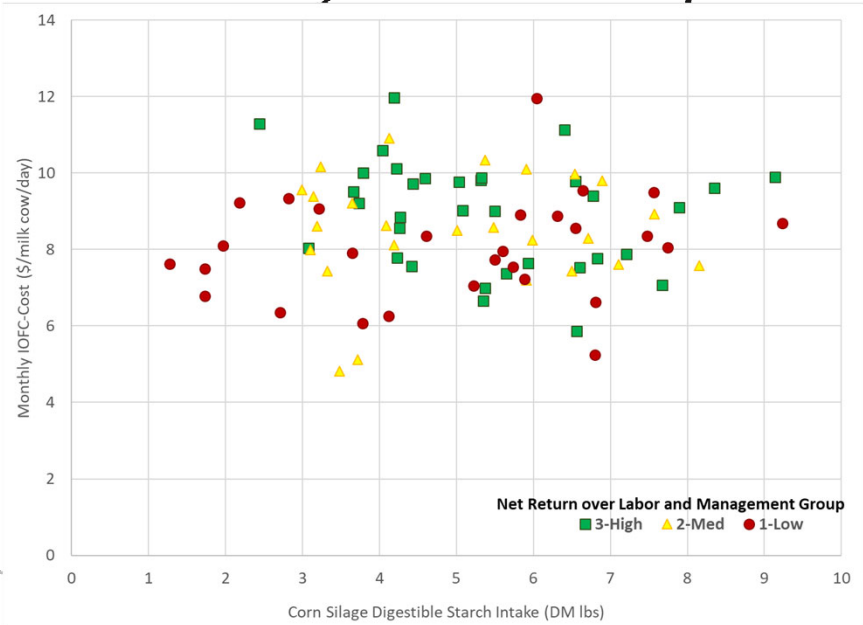
21

2016-2017 Monthly ECM vs CS Dig. NDF Intake by Net Return Group
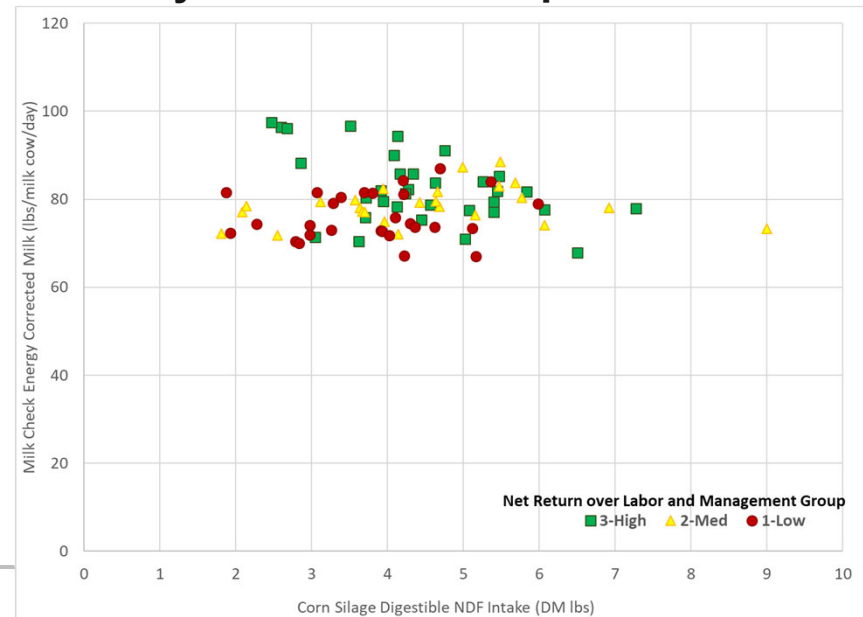
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Getting the Most out of Your Manure

Image Credit: Matthias Schrader, AP

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Have a plan . . .

- Required by state law
  - CAFO
    - Large numbers of animals
    - NPDES Permit with an approved Nutrient Management Plan
  - CAO
    - High animal density (> 2AEU/A)
    - Approved nutrient management plan
  - All others who generate or use manure
    - Written Manure Management Plan required
    - Manure Management Manual
    - Can be prepared by the farmer
    - No Approval required

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Have a Plan . . .

LAND APPLICATION OF MANURE
A supplement to Manure Management for Environmental Protection

Manure Management Plan
Guidance
361-0300-002

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION
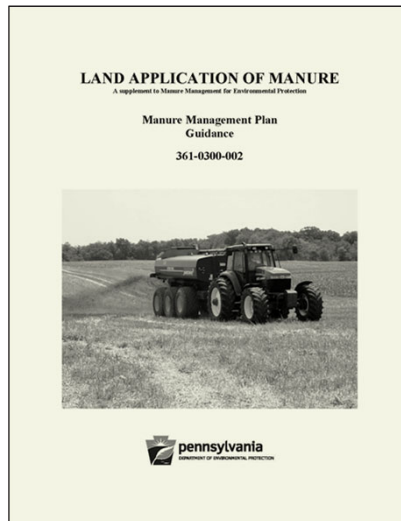
Revised Manure Management Manual

– Must be a written plan

– Can be developed by the farmer or other non-certified individual

– Must use the standard format and worksheets in the MMM
  • Unless an alternative is approved by DEP

– Do not need to be submitted for approval
  • But must be available onsite to DEP or Conservation District staff on request for inspection

– Includes
  • Manure application rates by crop group
  • Mechanical manure application setbacks
  • Winter manure application
  • Manure storage and stacking areas management
  • Pasture management
  • Animal concentration areas management

– Records are required to document implementation
  • Must be kept on the farm

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Soil Testing

If you don't test, it's just a guess!

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Managing Soil Acidity

- Soil acidity is probably the single most important factor affecting the chemistry of the soil
- In Pennsylvania, our soils are constantly acidifying
- Sources
    - Decomposition of residues
    - Excretion of H^+ by plant roots
    - Acid rain
    - Weathering
    - Oxidation of NH_4^+ to NO_3^- by soil microbes

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pH vs Availability of Nutrients

Image Credit: D. Beegle, Penn State

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Solubility of Soil P Minerals vs pH

Credit: D. Beegle, Penn State

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Nitrogen Cycle
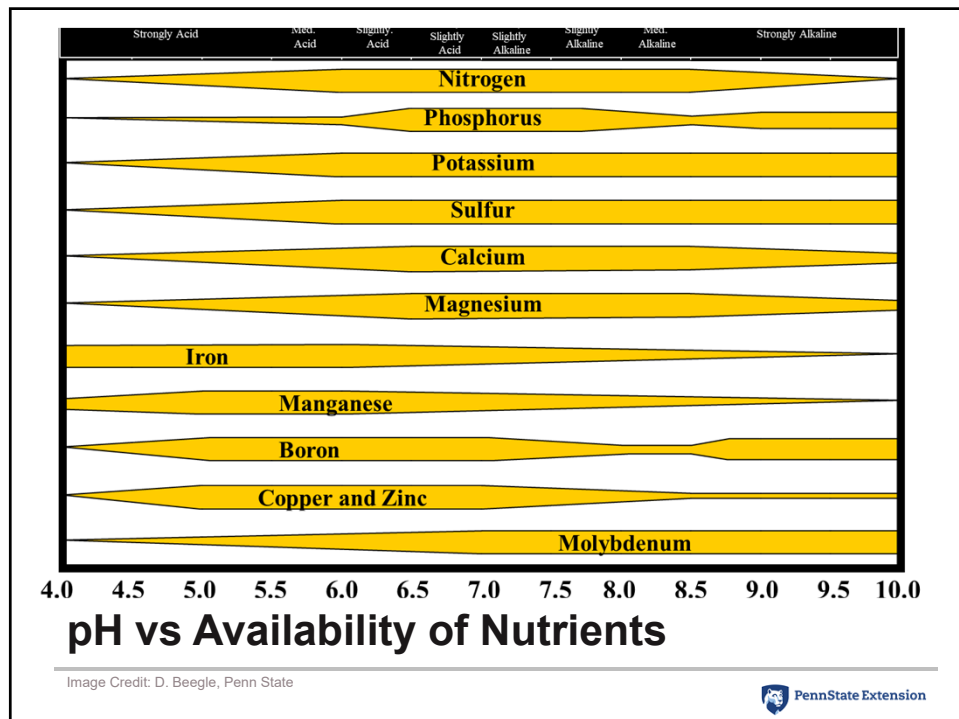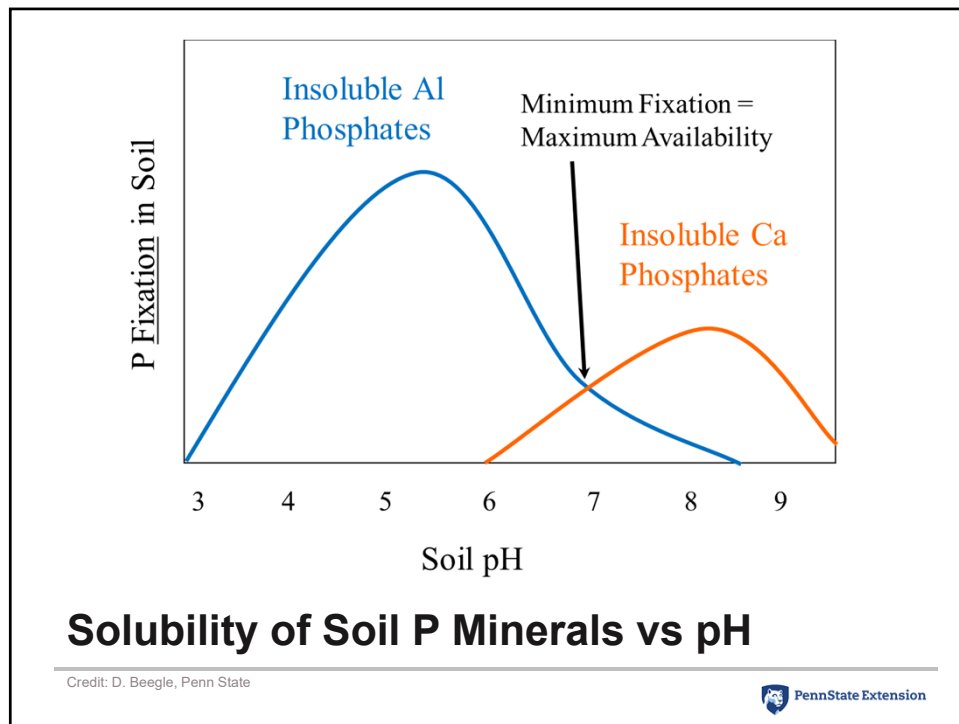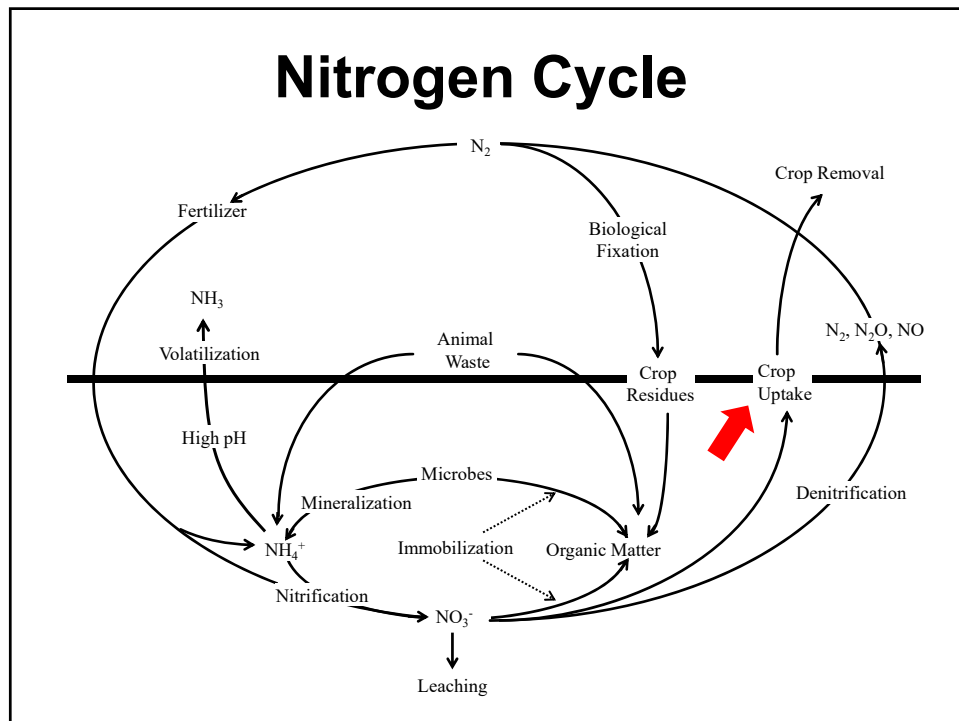
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Know what is in the manure. . .

- Manure analysis is critical
- You can't get the full value from manure if you don't know what is in it
- Book values are good averages but range is ± 100%

Dairy Manure (PSU-AASL)

Manure Analysis (lb/1000gal)

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N P_2O_5 K_2O
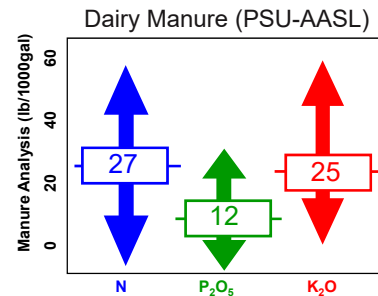
Agronomy Guide Values for Dairy Manure
28 – 13 - 25

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Dairy Farm Nutrient Imbalances

Corn Crop Requirement

Available Nutrients in Dairy Manure

N P_2O_5 K_2O

N P_2O_5 K_2O

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16
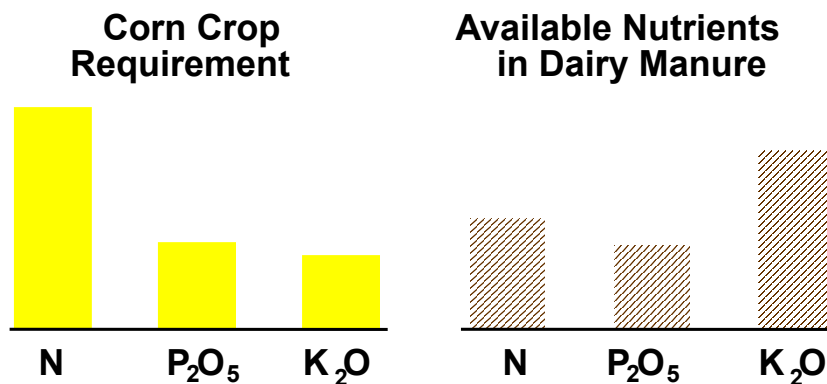
Crop Nutrient Imbalances

Mismatch between manure nutrients and crop requirements

Nitrogen Balance Corn/Dairy Manure
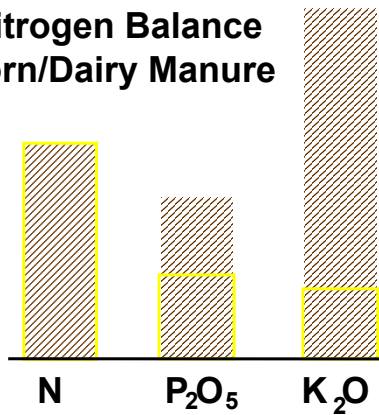
Phosphorus Balance Corn/Dairy Manure

N P_2O_5 K_2O N P_2O_5 K_2O
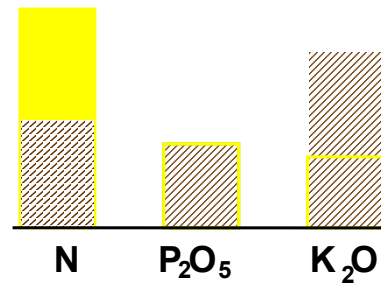
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Put the manure in the right place . . .

- Prioritize fields for manure application

High Priority	Low Priority	Other considerations
High N requirement	Legumes	Distance
Low soil test P and/or K	Environmentally sensitive areas	Neighbors
Far from water	Near water	Public perception
Conservation practices in place	Steep slopes	
Cover crops		

- Other considerations
    – Liquid manure on forages
    – Manure on grass hay between cuttings in the summer
    – Solid manure on bare fields
    – Fall manure on fields with cover crops
    – Avoid manure on new forage legume seedings
    – If necessary apply manure to older legume forage stands
    – Be cautious with manure on small grains – too much can cause lodging
    – Avoid putting manure on the same fields year after year
        • Field behind the barn syndrome

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Apply the right manure rate . . .

- Nutrient availability (Agronomy Guide Table 1.2-14 or 1.2-15)
  - Manure N is not all available like fertilizer N
  - P and K are similar to fertilizer P and K
- Cover crops dramatically increase N availability of fall and winter applied manure

Total N

Soluble Mineral N | Organic N

Mineral N
Readily available similar to urea fertilizer. Susceptable to volatilization

Organic N
Must be mineralized by microbes before it becomes available.

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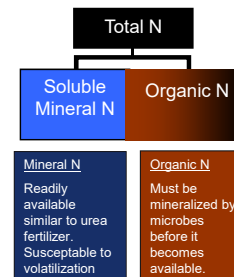
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Manure

- Base crop needs on soil test recommendations
- Account for all sources of nutrients
  - Starter fertilizer
  - Fertilizer applied as herbicide carrier
  - N from previous legumes in the rotation
  - Residual N from past manure applications
- Apply manure to meet but not exceed crop nutrient requirements
  - Excess N should never be applied
  - If possible do not apply excess P and K
  - Manure applied to meet crop N needs will usually apply excess P & K

Net need to be met with Manure

Residual from past Manure

Soil

Fertilizer Equivalence

Total Manure N

Starter Fertilizer

Legume

Total Crop N Requirement

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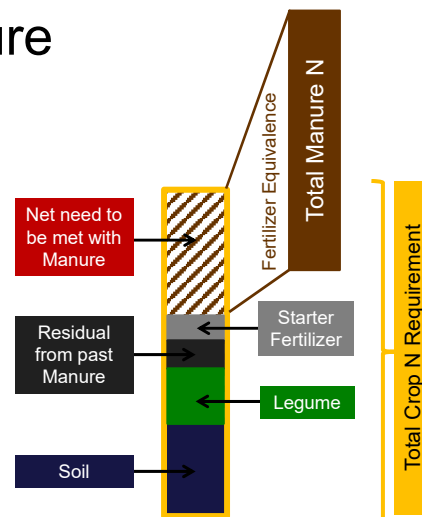
Apply the right manure rate . . .

- Availability of Manure N Depends on:
  - Time of application
  - Timing of crop uptake
  - Method of application
  - Type of manure
  - Example:
    - **Spring applied,**
    - **Corn**
    - Not incorporated
    - **Dairy manure**

Answer = 0.20
20 % availability or 0.20 lb fertilizer equivalent N per lb. of manure N

Table 1.2-14. Manure nitrogen availability factors for use in determining manure application rates based on planning conditions.

A. Current Year

To use this table, find the *planned manure application season* in the left column, then move to the right in that row and select the target crop utilization. Continue to the right in that row to find the *nitrogen availability factor* for the *planned manure application management*.

The manure nitrogen availability factor is the fertilizer equivalence of the manure N or the lb of fertilizer N equivalent per pound of total manure N. For example, if the N Availability Factor = 0.50, effectively there is the equivalent of 0.50 lb of fertilizer N for every pound of total N in the manure.

Planned manure application season	Planned manure target crop utilization	Application management	Nitrogen availability factor — Poultry manure	Swine manure	Other manure
Spring or summer	Spring utilization by grass hay and small grains. Summer utilization by corn, other summer annuals, and grass hay.	Incorporation the same day	0.75	0.70	0.50
		Incorporation within 1 day	0.50	0.60	0.40
		Incorporation within 2–4 days	0.45	0.40	0.35
		Incorporation within 5–7 days	0.30	0.30	0.30
		Incorporation after 7 days or no incorporation	0.15	0.20	0.20
Early fall[2,3]	Early spring utilization by small grains, small grain silage, and grass hay, including the winter crop in a double-crop system	Incorporated less than 2 days	0.50	0.45	0.40
		Incorporated 3–7 days	0.30	0.30	0.30
		Incorporated more than 7 days or no incorporation	0.15	0.20	0.20
Early fall — Additional N available to the summer crop in a double-crop system from manure applied in the fall for the winter crop (above)[2,4]	Summer utilization by the second crop, corn or other summer annuals, in a double-crop system	All methods of incorporation	0.15	0.20	0.20
Early fall with a cover crop not harvested and used as a green manure[2]	Summer utilization by corn, other summer annuals, and grass hay	Incorporated less than 2 days	0.45	0.40	0.35
		Incorporated 3–7 days	0.25	0.25	0.25
		Incorporated more than 7 days or no incorporation	0.15	0.20	0.20
Early fall with no cover crop[2]	Summer utilization by corn, other summer annuals, and grass hay	All methods of incorporation	0.15	0.20	0.20
Late fall or winter[6]	Spring utilization by small grains and grass hay	All situations	0.50	0.45	0.40
	Following summer utilization by corn or other summer annuals	No cover crop	0.15	0.20	0.20
		Cover crop harvested for silage	0.15	0.20	0.20
		Cover crop used as green manure	0.50	0.45	0.40
Grazing	Late spring through early fall grazing	Manure deposited more or less continuously by grazing cattle	—	—	0.20
	Year-round grazing	Manure deposited more or less continuously by grazing cattle	—	—	0.30

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Apply the right manure rate . . .

Liquid Manure Example

Dairy manure analysis:
N: 28.02 lb/1000 gal
NH_4-N: 10.5 lb/1000 gal
Organic N: 17.52 lb/1000 gal
P_2O_5: 11.91 lb/1000 gal
K_2O: 24.24 lb/1000 gal

Spring applied, no incorporation

Available N: (Agronomy Guide Table 1.2-15)
Crop requirement: Corn Silage
N: 160 lb/acre
P_2O_5: 90 lb/acre
K_2O: 180 lb/acre

Following alfalfa, 30% stand, Hazleton soil series
(Agronomy Guide Tables 1.1-1 and 1.2-6)

What would be an N balanced manure rate?

What would be a P balanced manure rate?

What are the nutrient imbalances (inadequacies or excess) for each application rate?

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Apply the right manure rate . . .

N Balanced Rate

N credit from alfalfa: 70 lb (90 lb left)

N available in manure: 7.28 lb/1000 gal

(NH_4-N * .10 and Organic N * .35)

90 lb N/ 7.28 lb N/1000 gal = 12,400 gal

Nutrient Imbalance:

P applied: 11.91 lb/1000 gal * 12.4 1000 gal

     = 148 lb P **(58 lb excess!)**

K applied: 24.24 lb/1000 gal * 12.4 1000gal

   = 300 lb K **(120 lb excess!)**

**P Balanced Rate**

P need: 90 lb

P available in manure: 11.91 lb/1000 gal

90 lb P/ 11.91 lb/1000 gal = 7500 gal

Nutrient Imbalance:

N applied: 7.28 lb/1000 gal * 7.5 1000 gal

     = 55 lb available N **(45 lb short)**

K applied: 24.24 lb/1000 gal * 7.5 1000 gal

     = 181 lb K **(1 lb excess)**

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Animal Density Matters

Category 1- Less than 1.25 AEUs/Acre

- Typically <50% of feed from off-farm
- Nutrient _deficient_- need to import manure or fertilizer to meet crop requirements

Category 2- 1.25-2.25 AEUs/Acre

- Typically 50-80% of feed from off-farm
- Nutrient _balanced_- can usually meet crop fertility needs with available manure
- Some management changes can improve environmental impact

Category 3- More than 2.25 AEUs/Acre

- Typically >80% of feed from off-farm
- Some manure will need to be exported- can result in a significant expense

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Meeting Crop Sulfur Needs

- Historically, requirement was met by atmospheric deposition
- Routine soil test not accurate to predict sulfur requirement
- Fields with history of manure application tend to have higher soil S concentrations.
- Some cases of S deficiency reported in PA in recent years
- Sulfur Sources-
  - Imported Manure
  - Ammonium Sulfate (common nitrogen source)
  - Elemental sulfur (significant impact on soil pH)
  - Gypsum (also a source of calcium)

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Importing Manure

- Get a manure analysis
- Be aware of possible spread of difficult to control weeds

Solid Dairy Manure		Poultry Manure	
Total N	9 lb/ton	Total N	61 lb/ton
P_2O_5	3 lb/ton	P_2O_5	43 lb/ton
K_2O	8 lb/ton	K_2O	47 lb/ton

- Poultry manure has a much higher dry matter content (65% vs 12%)
- Poultry manure, esp. from layers, is high in calcium carbonate, and has lesser impact on soil pH

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