

Value of Manure Calculator

What is the fertilizer replacement value of manure? What does it cost to apply? How much can I apply given labor and time constraints in the spring?

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Cornell University Nutrient Management Spear Program
<http://nmsp.cals.cornell.edu>

Manure as Nutrient Source

Primary macronutrients:

Nitrogen (N), phosphorus (P), potassium (K)

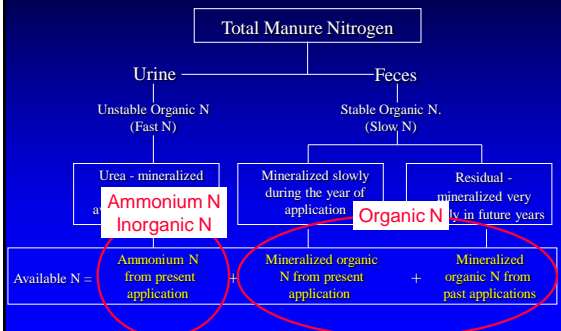
Secondary macronutrients:

Calcium (Ca), magnesium (Mg), sulfur (S)

Micronutrients:

Iron (Fe), boron (B), copper (Cu), chlorine (Cl), Manganese (Mn), molybdenum (Mo), zinc (Zn), cobalt (Co), and nickel (Ni)

Manure as Nitrogen Source



Manure as Nitrogen Source

An example of a manure analysis:

	%	lbs/ton	lbs/1000 gallons
Total Nitrogen (N)	0.41	8	34
Ammonium Nitrogen	0.19	4	16
Organic Nitrogen	0.22	4	18
Phosphorus (P)	0.08	2	7
Phosphate Equivalent (P ₂ O ₅)	0.18	4	15
Potassium (K)	0.26	5	22
Potash Equivalent (K ₂ O)	0.32	6	27

Ammonium N in Manure

- If incorporated in the fall, assume 100% loss.
- If applied as sidedress injection for row crops, assume 100% fertilizer equivalent.
- For spring application:

Incorporation within:

1	2	3	4	5	>5 d after spreading
65	53	41	29	17	0% available

Organic N in Manure

	Current year	Last year	2 years ago
Cow manure <18% DM	0.35	0.12	0.05
Cow manure ≥18% DM	0.25	0.12	0.05
Poultry manure <18% DM	0.55	0.12	0.05
Poultry manure ≥18% DM	0.55	0.12	0.05
Swine manure <18% DM	0.35	0.12	0.05
Swine manure ≥18% DM	0.25	0.12	0.05
Horse manure <18% DM	0.30	0.12	0.05
Horse manure ≥18% DM	0.25	0.12	0.05

Manure as Nitrogen Source

Practice Question:

- How much manure do we need to apply to meet corn N requirements given the following scenario?
 - ✓ N requirement: 50 lbs N/acre.
 - ✓ Manure is applied in this year only (i.e. no past manure applications).
 - ✓ *Manure was surface applied, no incorporation.*
 - ✓ Manure contains 5 lbs organic N and 4 lbs ammonium N per ton.
 - ✓ Dry matter content of the manure is 8%.

Manure as Nitrogen Source

Answer:

- Manure is surface spread without incorporation so all ammonium N is lost as ammonia.
- Per ton of manure, there are 5 lbs of organic N.
- In the first year 35% of the organic N will be available for manure with less than 18% dry matter.
- Thus, per ton of manure there is $0.35 * 5 = 1.75$ lbs N.
- To obtain 50 lbs of N, we need to apply $50 / 1.75 = 29$ tons/acre of this manure.

Manure as Nitrogen Source

Additional question:

- How much P_2O_5 and K_2O are supplied with the 29 tons of manure?

Given: 5 lbs of P_2O_5 per ton of manure.
6 lbs of K_2O per ton of manure.

Answer:

$$5 * 29 = 145 \text{ lbs } P_2O_5 / \text{acre!!!}$$

$$6 * 29 = 174 \text{ lbs of } K_2O / \text{acre}$$

Manure as Nitrogen Source

Another scenario:

- How much manure do we need to apply to meet corn N requirements given the following scenario?
 - ✓ N requirement: 50 lbs N/acre.
 - ✓ *Manure is surface applied in the spring and incorporated within one day.*
 - ✓ Manure contains 5 lbs organic N and 4 lbs ammonium N per ton.
 - ✓ Dry matter content of the manure is 8%.
 - ✓ Manure is applied in this year only.

Manure as Nitrogen Source

- Manure is incorporated within one day in the spring so 65% of the ammonium N is conserved and available is $0.65 * 4 = 2.6$ lbs/ton.
- Per ton of manure, there are 5 lbs of organic N.
- In the first year 35% of the organic N will be available for manure with less than 18% dry matter.
- Thus, per ton of manure there is $0.35 * 5 = 1.75$ lbs N from the organic fraction.
- Total N supply by the manure is $2.6 + 1.75 = 4.35$ lbs/ton.
- To obtain 50 lbs of N, we need to apply $50 / 4.35 = 11$ tons/acre.

Manure as Nitrogen Source

Additional question:

- How much P_2O_5 and K_2O are supplied with the 11 tons of manure?

Given: 5 lbs of P_2O_5 per ton of manure.
6 lbs of K_2O per ton of manure.

Answer:

- $5 * 11 = 55$ lbs P_2O_5 /acre
(compare to 145 lbs when NH_4^+ is not conserved!!!)
- $6 * 11 = 66$ lbs of K_2O /acre
(compare to 174 lbs when NH_4^+ is not conserved!!!)

Manure as Nitrogen Source

Another scenario:

- How much manure do we need to apply to meet corn N requirements given the following scenario?
 - ✓ N requirement: 50 lbs N/acre.
 - ✓ Manure is injected in the spring.
 - ✓ Manure contains 5 lbs organic N and 4 lbs ammonia N per ton.
 - ✓ Dry matter content of the manure is 8%.
 - ✓ 32 tons of the same manure were applied in each of the two previous years.

Manure as Nitrogen Source

Answer:

- From organic N in the 32 tons of manure applied two years earlier, 5% will be mineralized this year: $32 \times 5 \times 0.05 = 8$ lbs of N
- From the organic N in the 32 tons of manure applied last year, 12% will be mineralized this year: $32 \times 5 \times 0.12 = 19$ lbs N.
- Total requirement for this year is: $50 - 8 - 19 = 23$ lbs N/acre.
- Manure is injected in the spring so 65% of the ammonia N is conserved and available is $0.65 \times 4 = 2.6$ lbs/ton.
- Per ton of manure, there are 5 lbs of organic N.
- In the first year 35% of the organic N will be available: $0.35 \times 5 = 1.75$ lbs N per ton of manure.
- Total N supply by the manure is $2.6 + 1.75 = 4.35$ lbs/ton.
- To obtain 23 lbs of N, we need to apply $23 / 4.35 = 5$ tons/acre.

Manure as Phosphorus Source

Manure applications:

1. No adjustments are made for residual P from sod or manure (soil test reflects past applications).
2. Recommendations should be adjusted for present year manure application!!!!



Manure as Phosphorus Source

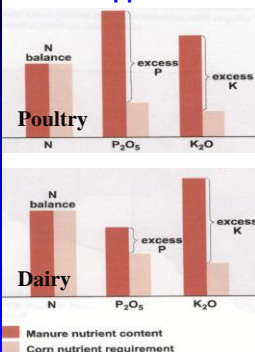
- ✓ P in manure is usually expressed as P and P_2O_5 .
- ✓ Expressed "as received".
- ✓ Expressed in %, lbs per ton, and lbs/1000 gallons.
- ✓ Conversion factors are:

$$1\% = 1 \text{ lb}/100 \text{ lbs} = 10 \text{ lb}/1000 \text{ lbs} = 20 \text{ lbs}/\text{ton}$$

- So % * 20 gives lbs per ton

$$1 \text{ lb}/\text{ton} = 4.17 \text{ lbs per } 1000 \text{ gallons}$$

N based application can result in excess P and K:



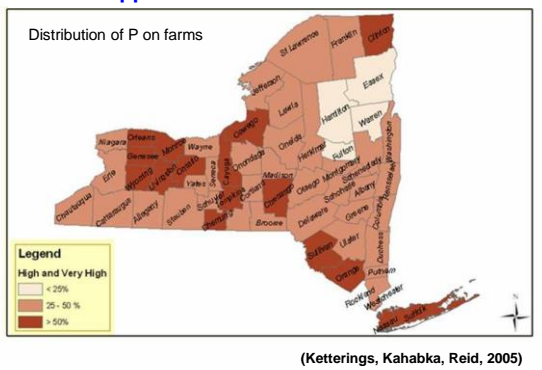
Layer manure lbs/ton:
37 N, 55 P_2O_5 , 31 K_2O
Needed to meet N: ~4 tons
Needed to meet P: <1 ton

Example:
Corn guidelines (lbs):
120 N, 40 P_2O_5 , 40 K_2O

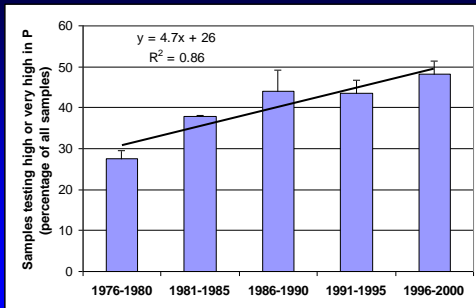
Dairy manure lbs/ton:
10 N, 4 P_2O_5 , 8 K_2O
Needed to meet N: ~17 tons
Needed to meet P: ~10 tons

Sharpley and Beegle (1999).

N based application can result in excess P and K:

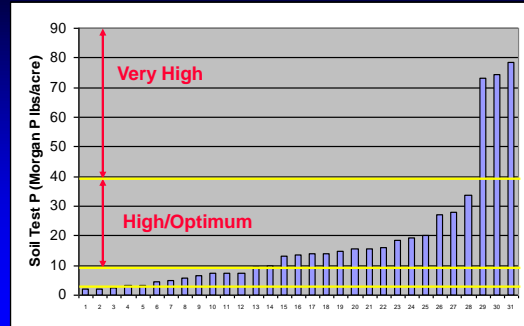


N based application can result in excess P and K:



(Ketterings, Kahabka, Reid, 2005)

Manure as Phosphorus Source



Manure as Potassium Source

Manure applications:

1. No adjustments are made for residual K from sod or manure (soil test reflects past applications).
2. Recommendations should be adjusted for present year manure application to save on fertilizer application costs!!!!



Manure as Potassium Source

- K is not an environmental issue
- K can be luxury consumed by plants
- High K levels in forage (>2.5% K in forage or >1.5% in total diet) can lead to metabolic problems post-calving (i.e. early lactation)
 - Milk Fever (Hypocalcemia)
 - Ketosis, mastitis, displaced abomasums
- Dry cows need low K forage (<2.5% K), especially during the last 4 wk

Manure as Potassium Source

- Fertilizer composition is expressed as K_2O
- Forage composition as elemental K
- Manure often listed as K and K_2O
 - Assume equal availability as fertilizer K
- Conversions...
 - 1 pound of K equals 1.2 lbs of K_2O
 - 1 pound of K_2O equals 0.83 lb of K

Value of Manure Calculator

- To aid with assessment of economic and agronomic implications of manure application options.
- To answer the following questions:
 - What is the value of a load of manure?
 - What is the break-even hauling distance?
 - What are the operating and ownership costs for my manure machinery?
 - What are the fertilizer replacement value and cost of exporting manure?
 - How much time (machinery and labor) will it take to spread manure?

Value of Manure Calculator

Disclaimer:

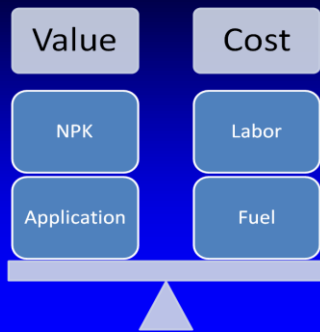
This calculator cannot take the place of careful consideration and collaboration with farm managers, crop advisors, and nutrient management planners. The quality of the output depends on the quality of data entered.

Value of Manure Calculator

The process:

- Gather the data
 - Accurate farm-specific information is required!
 - Tutorial is available to understand data needs.
 - Complete the data collection worksheet (<http://nmsp.cals.cornell.edu/software/index.html>)
- Enter the data
 - All data should be entered in the order of the sheets.
 - Information on later sheets relies on data entered earlier, so make sure all cells are completed.
- Evaluate the outputs
 - Does everything look "right"?
 - Save and/or print results. Consider alternatives.
 - The calculator does not substitute for budgeting or farm planning; changing values like spreading rates, hauling times, etc. is a way to consider new management alternatives.

Value of Manure Calculator



Value of Manure

Necessary Information

(1) Manure Nutrient Content

Animal Species	Cows
Units	lbs/ton
Ammonium-N	4
Organic-N	6 lbs/ton
Total N	10 lbs/ton
P ₂ O ₅	5 lbs/ton
K ₂ O	7 lbs/ton
Total Solids	8 %
Density	8.3 lbs/gallon

(2) Fertilizer Costs

N	\$ 0.50 /lb
P ₂ O ₅	\$ 0.60 /lb
K ₂ O	\$ 0.70 /lb
Application	\$ 6.00 /acre

(3) Crop Nutrient Needs

N	50 lbs/acre
P ₂ O ₅	25 lbs/acre
K ₂ O	20 lbs/acre

Field Size: 100 acres

(4) Manure Application

Units	tons
Application Rate	25 lbs/acre
Method and Timing	Explored or incorporated after 5 days
Spreader Capacity	10 tons

Nutrient Balance Check (pounds/acre)

	N	P2O5	K2O
Required	50	25	20
Supplied	90	120	168
Balance	40	95	148

Quantity to Meet Requirements: 240 loads, 2,400 tons

Value of Manure

Value "as applied" versus "currently needed"

(5) Manure Nutrient Credits and Values

Total Ammonium-N	96	lbs/acre
Ammonium-N Lost	96	lbs/acre
Ammonium-N Credit	0	lbs/acre
Current Year Organic-N Credit	50	lbs/acre
O-N Available in Future From Current Application	24	lbs/acre
N Available From Current Application	50	lbs/acre
P ₂ O ₅ From Current Application	120	lbs/acre
K ₂ O From Current Application	168	lbs/acre
Total N Value	\$ 10.50 /load	\$ 25.20 /acre
Total P ₂ O ₅ Value	\$ 30.00 /load	\$ 72.00 /acre
Total K ₂ O Value	\$ 49.00 /load	\$ 117.60 /acre
Fertilizer Application		\$ 6.00 /acre
As-Applied Value	\$ 92.00 /load	\$ 220.80 /acre
Currently Needed Value	\$ 25.00 /load	\$ 60.00 /acre

Value of Manure Calculator

Operating costs and fuel efficiencies

(6) Operating Costs and Fuel Efficiencies

Activity	Fuel cost	Labor cost	Loading time	Fuel efficiency	Speed
Loading	\$ - /gal	\$ - /hour	0 minutes/load	0 gal/hour	
Hauling	\$ 3.00 /gal	\$ 12.00 /gal	10.0 miles/hour	10 gal/hour	
Application	\$ 3.00 /gal	\$ 12.00 /gal	5.0 acres/hour	7 gal/hour	
Incorporation	\$ - /gal	\$ - /hour	0.0 acres/hour	0 gal/hour	

Value of Manure Calculator

(7) Break-even distance On 100 acre field, requiring 50-25-20 NPK, break-even distance (miles one way) is

Hauling Distance (miles)	10.6	2.6
Manure Value less Loading, Application and Incorporation Costs	\$ 21,420	\$ 5,340
Time Required (hours to spread manure)	530	147

Manure Value as applied value (\$/field) as needed value (\$/field)

N	\$ 2,520	\$ 2,500
P ₂ O ₅	\$ 7,200	\$ 1,500
K ₂ O	\$ 11,760	\$ 1,400
Application	\$ 600	\$ 600
Total	\$ 22,080	\$ 6,000

Manure Cost \$/hour \$/acre \$/field

Loading: Fuel	\$ -	\$ -	\$ -
Labor	\$ -	\$ -	\$ -
Loading Total	\$ -	\$ -	\$ -
Hauling: Fuel	\$ 30.00		
Labor	\$ 12.00		
Hauling Total	\$ 42.00		
Application: Fuel	\$ 21.00	\$ 4.20	\$ 420.00
Labor	\$ 12.00	\$ 2.40	\$ 240.00
Application Total	\$ 33.00	\$ 6.60	\$ 660.00
Incorporation: Fuel	\$ -	\$ -	\$ -
Labor	\$ -	\$ -	\$ -
Incorporation Total	\$ -	\$ -	\$ -

Total Operations \$ 75.00

Value of Manure Calculator

Whole Farm Cost Associated with Manure Application
 The Problem: My farm has 2.6 million gallons of stored manure that is spread twice a year on 250 acres of land. What is the cost of investing in manure incorporation equipment?

(1) Farm Manure Use

Units	gallons	
Total Manure to Spread	2,600,000	gallons
Average Application Rate	5,200	gallons/acre

(2) Manure Spreading

Total Manured Acres	500	acres	Fuel	\$ 21.00	/hr
Total Hours to Spread	167	hours	Labor	\$ 12.00	/hr
Average Rate	3.0	acres/hour	Total Costs	\$ 33.00	/hr
Fuel Efficiency	7	gal/hour	Average per acre spread cost	\$ 11.92	/acre

(3) Manure Incorporation (if operated separately from manure spreading)

Total Incorporated Acres	500	acres	Fuel	\$ 15.00	/hr
Total Machinery Hours	83	hours	Labor	\$ 12.00	/hr
Fuel Efficiency	6.0	gal/hour	Total Costs	\$ 27.00	/hr
Average Rate	6	acres/hour	Average per Acre Incorporated Cost	\$ 4.50	/acre

(4) Manure Hauling

Total Hauling Machinery Hours	200	hours	Fuel	\$ 30.00	/hr
Fuel Efficiency	10	gal/hour	Labor	\$ 12.00	/hr
			Total	\$ 42.00	/hr
			Average per mile costs	\$ 4.20	/mile

Value of Manure Calculator

Whole Farm Cost Associated with Manure Application
 The Problem: My farm has 2.6 million gallons of stored manure that is spread twice a year on 250 acres of land. What is the cost of investing in manure incorporation equipment?

(5) Capital Costs

Equipment Name	Percent of Time Used for Manure Handling	Purchase Cost	Salvage Value	Equipment Lifespan (yrs)	Age of Equipment (yrs)	Repairs & Maintenance Per Year
Tank/Spreader	100%	\$ 75,000	\$ 5,000	10	4	\$ 2,500
Tractor	50%	\$ 95,000	\$ 10,000	12	2	\$ 1,000
Agitator Pump/Hardware	100%	\$ 13,000	\$ 1,500	6	2	\$ 1,200
Agitator Power	100%	\$ 82,000	\$ 5,000	15	14	\$ 500
Tractor (incorporation)	50%	\$ 85,000	\$ 14,000	15	1	\$ 1,000
Chisel Plow	100%	\$ 8,000	\$ 1,000	20	1	\$ 100

Cost of Capital (%) 6.00%

Equipment Insurance Cost per \$1000 \$ 6.00

Manure Equipment Amount Insured (\$) \$ 200,000

Add more equipment Print Sheet Return to Main Menu

Value of Manure Calculator

Whole Farm Cost Associated with Manure Application

Farm Manure Application Costs for 500 acres at average farm application rate

	Whole Farm	Farm application average \$/a spread	Cost per gallon
Loading (59 machinery hours)			
Fuel	\$ 1,247	\$ 2.49	\$ 0.000
Labor	\$ 712	\$ 1.42	\$ 0.000
Hauling (200 machinery hours)			
Fuel	\$ 6,000	\$ 12.00	\$ 0.002
Labor	\$ 2,400	\$ 4.80	\$ 0.001
Spreading (500 acres)			
Fuel	\$ 3,507	\$ 7.01	\$ 0.001
Labor	\$ 2,004	\$ 4.01	\$ 0.001
Incorporation (500 acres incorporated)			
Fuel	\$ 1,250	\$ 2.50	\$ 0.000
Labor	\$ 1,000	\$ 2.00	\$ 0.000
Manure Equipment Repairs and Maintenance	\$ 5,300	\$ 10.60	\$ 0.002
Total Operating Costs	\$ 23,420	\$ 46.84	\$ 0.009
Ownership Costs			
Depreciation	\$ 18,975	\$ 37.95	\$ 0.007
Interest on Equity	\$ 7,720	\$ 15.44	\$ 0.003
Insurance	\$ 1,200	\$ 2.40	\$ 0.000
Total Ownership Costs	\$ 27,895	\$ 55.79	\$ 0.011
Total Operating and Ownership Costs	\$ 51,315	\$ 102.63	\$ 0.020

Value of Manure Calculator

Fertilizer replacement value and cost of exporting manure
 The Problem: I have the opportunity to export manure to a neighbor - how much should I charge for it?

Fertilizer Replacement Value and Cost of Exporting Manure User's Manual NMSF

v3.0 May 2010 Return

(1) Characterize Exports

Application Rate 12,000 gallons/acre

Distance one way from source 5 miles

(2) Value of manure to the field receiving manure (fertilizer replacement value)

Applied lbs/acre	As Applied Value \$/gallon	\$/acre	Crop Needs lbs/acre	As Needed Value \$/gallon	\$/acre
N 326	0.014	\$ 163.02	N 125	\$ 0.005	\$ 62.50
P ₂ O ₅ 285	0.014	\$ 171.00	P ₂ O ₅ 50	\$ 0.003	\$ 30.00
K ₂ O 399	0.023	\$ 279.30	K ₂ O 50	\$ 0.003	\$ 35.00
Fert. Application 0.001	6.00	Fert. Application \$ 0.001	6.00	\$ 0.001	\$ 6.00
Total	0.052	\$ 619.32	Total	\$ 0.011	\$ 133.50

Value of Manure Calculator

Fertilizer replacement value and cost of exporting manure
 The Problem: I have the opportunity to export manure to a neighbor - how much should I charge for it?

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K ₂ O 399	0.023	\$ 279.30	K ₂ O 50	\$ 0.003	\$ 35.00
Fert. Application 0.001	6.00	Fert. Application \$ 0.001	6.00	\$ 0.001	\$ 6.00
Total	0.052	\$ 619.32	Total	\$ 0.011	\$ 133.50

(3) Cost of transporting and spreading manure to the receiving field (operating and ownership costs)

Operating Costs	Machine hour/load	\$/load	\$/gallon	\$/acre
Loading	0.17	\$ 5.50	\$ 0.001	\$ 0.04
Hauling	1.00	\$ 42.00	\$ 0.01	\$ 69.04
Application	0.20	\$ 6.69	\$ 0.00	\$ 11.00
Incorporation	0.00	\$ -	\$ -	\$ -
Total Operating Costs		\$ 54.19	\$ 0.01	\$ 89.08
Ownership Costs		\$ 137.78	\$ 0.02	\$ 226.45
Operating + Ownership Costs		\$ 191.95	\$ 0.03	\$ 315.54

Value of Manure Calculator

How much time will it take me to spread manure?

The Problem: *I am considering using a drag-hose system – how many trucks will I need to run from the storage to the fields?*

Number of Loads	Hauling Equipment Number	Loading & Hauling round trip time (hours)	Application Equipment Number	Application speed load/hr	Hauling machinery hours	Spreading machinery hours	Hauling clock hours	Application clock hours	Total clock hours	Total Labor hours	
500	3	0.5	1	10	250	50	83	50	83	333	
600	3	1	1	10	600	60	200	60	200	800	
					0	0	0	0	0	0	
					0	0	0	0	0	0	
					0	0	0	0	0	0	
					0	0	0	0	0	0	
					0	0	0	0	0	0	
					0	0	0	0	0	0	
					0	0	0	0	0	0	
					0	0	0	0	0	0	
1100					TOTAL	850	110	283	110	283	1133

If you add an addition hauling truck, total labor hours and total clock hours decrease (as there is less down time for application operator).

Number of Loads	Hauling Equipment Number	Loading & Hauling round trip time (hours)	Application Equipment Number	Application speed load/hr	Hauling machinery hours	Spreading machinery hours	Hauling clock hours	Application clock hours	Total clock hours	Total Labor hours
500	4	0.5	1	10	250	50	63	50	63	313

Value of Manure Calculator

Tool to answer the following questions:

- What is the break-even hauling distance?
- What are the operating and ownership costs for my manure machinery?
- What are the fertilizer replacement value and cost of exporting manure?
- How much time (machinery and labor) will it take to spread manure?

Value of Manure Calculator

- Agronomy Fact Sheet # 4:
 - Nitrogen Credits from Manure
- Agronomy Fact Sheet # 18:
 - Manure Spreader Calibrations
- Agronomy Fact Sheet # 38:
 - Manure Sampling, Handling and Analysis
- Agronomy Fact Sheet # 53:
 - Manure Cost, Value and Time Management Calculator

The screenshot shows the Cornell University Nutrient Management Spear Program website. The header includes the Cornell University logo and the program name. Below the header is a navigation menu with links for Home, About Us, Projects, Publications, Publications, Software, Events, Contacts, and Links. The main content area is divided into several sections: News, Featured Links, and Photo Gallery. The News section contains several articles with dates and titles, such as '12-27-10: New Student Intern Impact Study' and '12-03-10: New value of manure calculator'. The Featured Links section includes 'Cornell Nutrient Guidelines for Field Crops' and 'Agronomy Factbooks'. The Photo Gallery section shows a photograph of a person operating a manure spreader in a field. At the bottom of the page, the URL <http://nmsp.cals.cornell.edu> is displayed.