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Incorporating Compost in Specialty Crop Production

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Presentation Overview

- Integrating compost in soil N fertility
  - Plant N requirement
  - Other N sources (e.g. cover crops)
  - Soil organic matter contribution
  - Current season compost N availability
  - Compost application rate
  - Soil testing and monitoring
- Compost Research Trials
- Compost Demonstrations
- General Recommendations
- Application Methods

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Fertilizer planning begins with plant nitrogen requirements

Nitrogen needed = Crop demand (lbs N /acre) - [

FIELD FERTILIZATION

NITROGEN (N)

A total application of 150-200 lb N/A is suggested for broccoli. See other files for recommendations specific to other cole crops. Broccoli growers in the Willamette Valley often use rates of 250-300 lb/A particularly with varieties where several harvests of side shoots would be desired for maximum yields. When high rates of N are used, stem splitting could become a problem and bacterial soft rot may be encouraged by rank growth. Research data indicates that stem splitting might be reduced if the extra N is applied in several sidedressings rather than in one large application.

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Fertilizer planning begins with plant nitrogen requirements

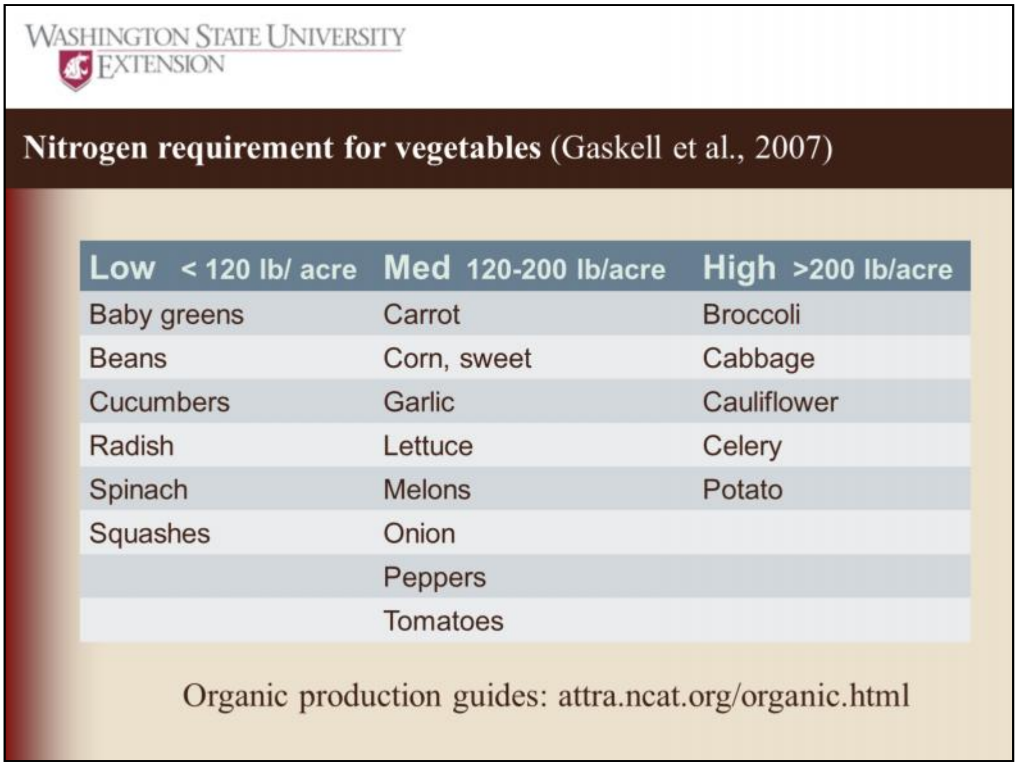
NUTRIENT MANAGEMENT guide

EM 9010-E
October 2010

Sweet Corn

(Western Oregon)

Rainfall, of course, is unpredictable. Furthermore, estimation of N rate at planting is difficult, since an unknown amount of plant-available N will be released via decomposition of soil organic matter during the growing season. Thus, our recommendation is to apply a minimal amount of N at planting (30 lb N/a) and to apply additional N at sidedress time based on the PSNT.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Nitrogen requirement for vegetables (Gaskell et al., 2007)

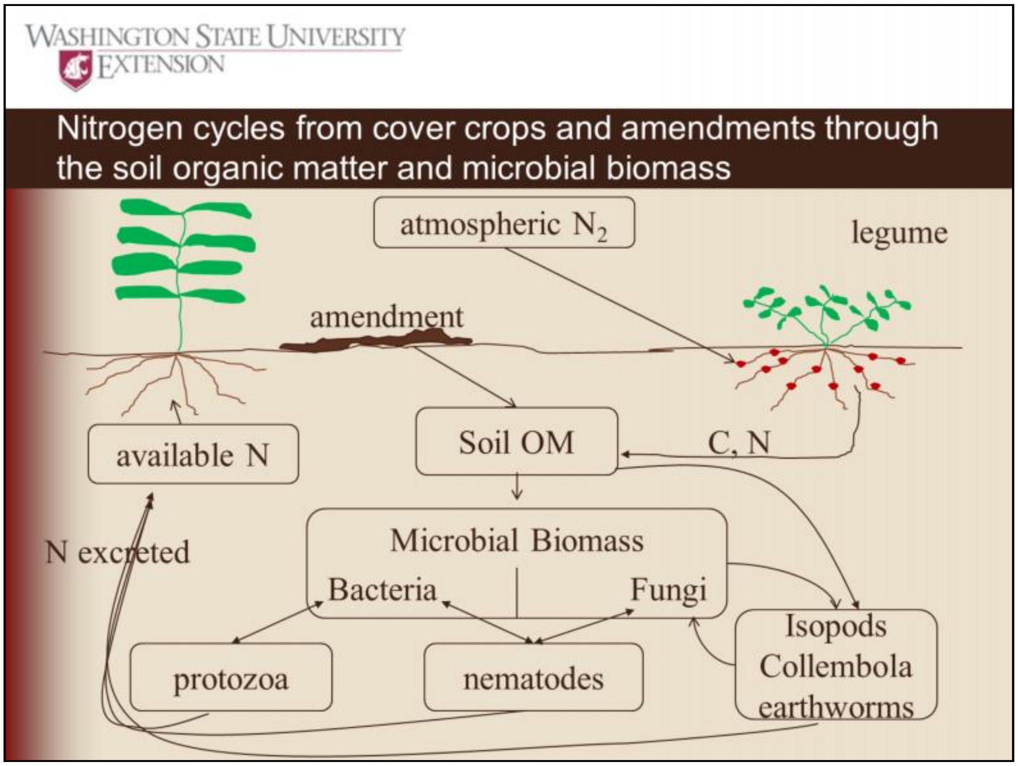
Low < 120 lb/ acre	Med 120-200 lb/acre	High >200 lb/acre
Baby greens	Carrot	Broccoli
Beans	Corn, sweet	Cabbage
Cucumbers	Garlic	Cauliflower
Radish	Lettuce	Celery
Spinach	Melons	Potato
Squashes	Onion	
	Peppers	
	Tomatoes	

Organic production guides: attra.ncat.org/organic.html

As you can see, within the range of some common field crops, there is a wide difference in nitrogen requirements. Developing an organic fertilizer recommendation involves reading soil test results with a focus on your next crop's nutritional requirements, especially nitrogen.

Most soil testing labs can provide crop-specific recommendations for amendment types and quantities. Check with your local Conservation District to find out how to have a soil test done.

In addition, crop production guides like those available from the National Sustainable Agriculture Information Service, or ATTRA, can be used to help you create a crop-specific amendment plan.



Nitrogen is a primary driver of plant growth. When it is in short supply, crops suffer dramatically. While 79% of the earth's atmosphere is nitrogen, it does most plants no good in this form. Legumes are the exception. They can form a symbiotic relationship with rhizobia bacteria that allows them to pull the nitrogen they need directly from the atmosphere. (click)

The microbial biomass – primary and secondary consumers – play an important role in nutrient cycling.

One way to take advantage of that nitrogen is to plant a leguminous cover crop like vetch or clover, then turn the crop into the soil when it starts flowering. When cover crops or amendments, such as manure or compost, are turned into the soil, both nitrogen and carbon are being added. (click)

However the nitrogen is not yet in a form the crop can use. Soil microorganisms use the fresh organic matter to grow. (click)

These soil bacteria and fungi are known as primary decomposers because they are uniquely capable of breaking down raw, organic matter. Larger organisms such as Isopods and earthworms will feed directly on these materials. (click). Earthworms have bacteria in their guts that help break the residues down. Isopods break larger pieces of organic matter down and digest it. They then produce fecal pellets that are more easily colonized by bacteria and fungi than the original fresh material. These fecal pellets act as an external rumen, since, as in a cow's rumen, microorganisms are integral in breaking down the organic material into forms that are usable by animals. Isopods reingest the fecal pellets and derive more energy from the material the second time it is ingested.

Secondary decomposers, such as nematodes and protozoa then feed on the microbial biomass. Their waste products include available nitrogen. (click) Also, as bacteria and fungi die, more available nitrogen is added to the pool. As discussed previously, plants primarily take up nitrogen as the ions nitrate and ammonia. We call these forms of nitrogen "mineral" nitrogen since they are no longer part of plant material or bound to carbon. We call that form "organic nitrogen." This process just described, where organic nitrogen is converted to mineral nitrogen is called "mineralization."

Bacteria and fungi need nitrogen, to be able to utilize carbon in the added organic matter. If too much carbon is added they seek out what nitrogen is available and use it to help them utilize carbon. If available nitrogen is temporarily tied up by the microbial biomass, we call this process "immobilization." The nitrogen has not disappeared, but it is temporarily unavailable to crops. Adding amendments rich in carbon or turning in grain cover crops that have become woody can lead to immobilization of nitrogen.

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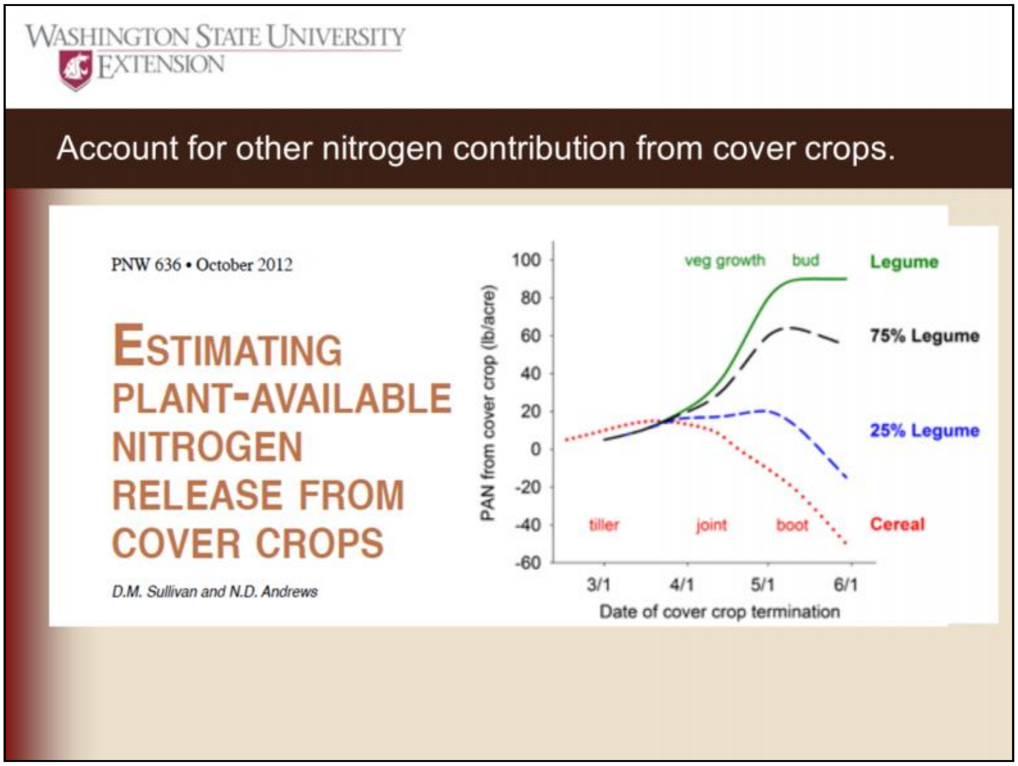
Account for other nitrogen contribution from cover crops.

Nitrogen needed = Crop demand (lbs N /acre) - [N from soil organic matter (lbs N / acre) + N from cover crop (lbs N / acre) + N from amendment (lbs N / acre)]

A good stand of common vetch can provide 70 -100 lbs. of plant available nitrogen (PAN).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Account for other nitrogen contribution from cover crops.
PNW 636 • October 2012
ESTIMATING PLANT-AVAILABLE NITROGEN RELEASE FROM COVER CROPS
D.M. Sullivan and N.D. Andrews
PAN from cover crop (lb/acre)
100
80
60
40
20
0
-20
-40
-60
veg growth
bud
Legume
75% Legume
25% Legume
Cereal
tiller
joint
boot
3/1
4/1
5/1
6/1
Date of cover crop termination

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Soil organic matter can contribute large amounts of plant available nitrogen

Nitrogen needed	=	Crop demand (lbs N /acre)	-	[N from soil organic matter (lbs N / acre)	+	N from cover crop (lbs N / acre)	+	N from amendment (lbs N / acre)	]

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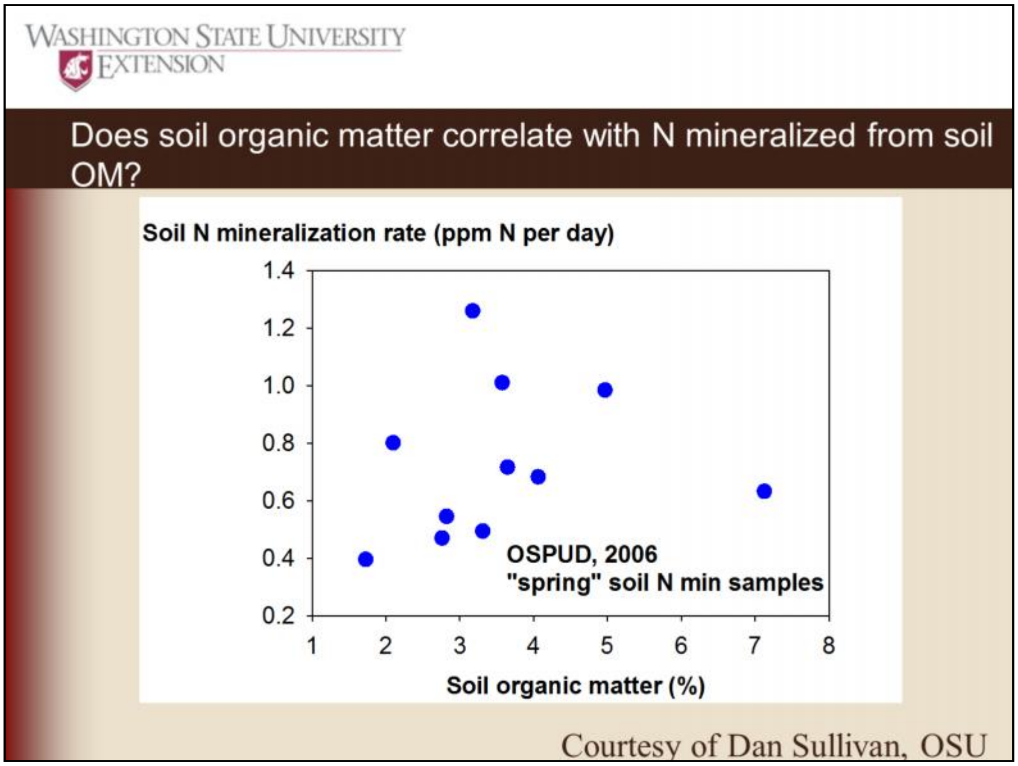
The potential for N mineralization from soils was studied at 8 organic farm sites in western Washington.



It was found that soil OM does not correlate with N mineralization instead an assumption can be made: "Organically managed soils will typically yield between 50 and 200 lb N/A" (PNW 646). This presentation uses a high-mid range of soil OM mineralization (110lbs N/acre). We assume the soil has been amended over previous years with compost and manure.

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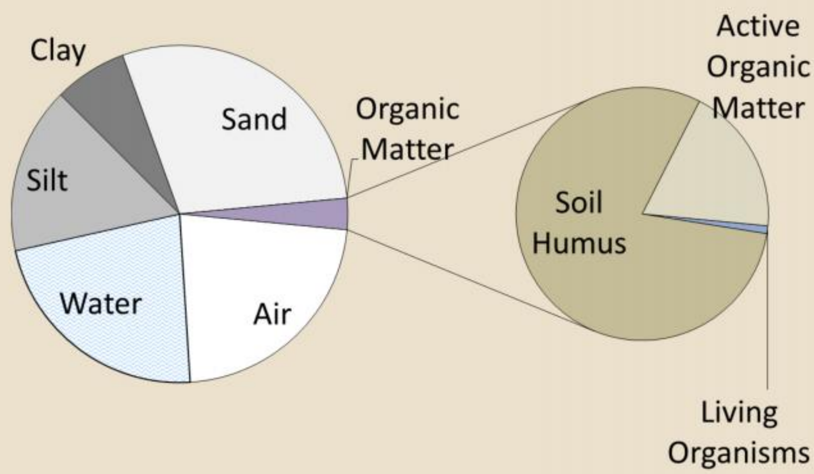
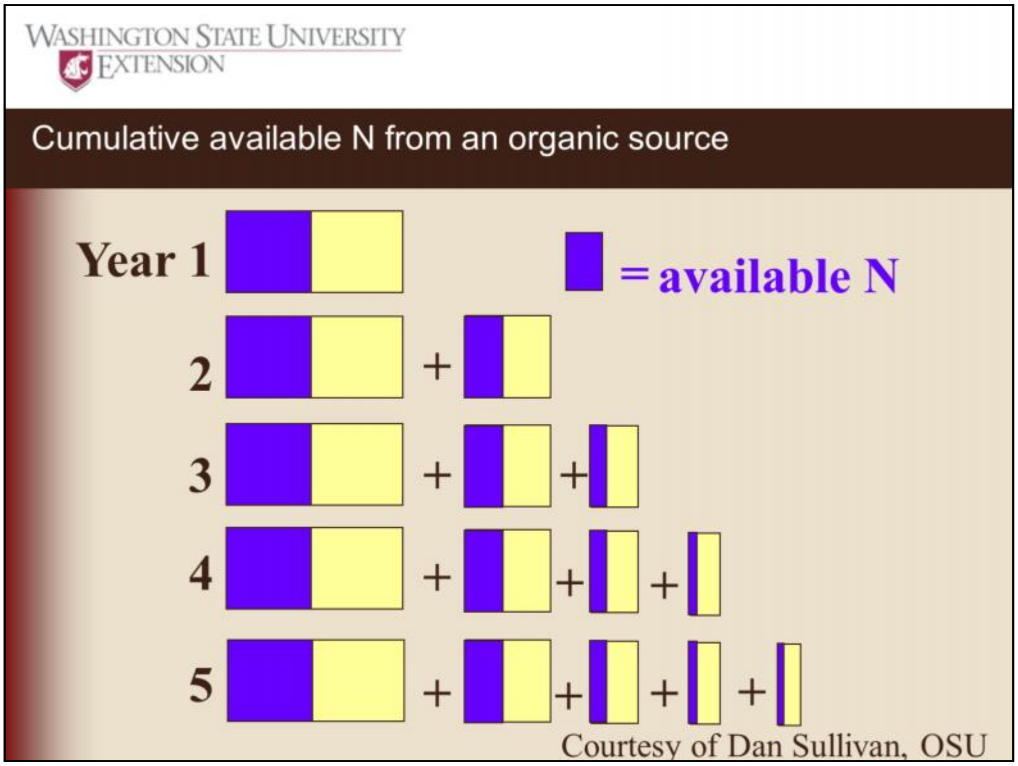
Soil organic matter is split between active organic matter and humus.

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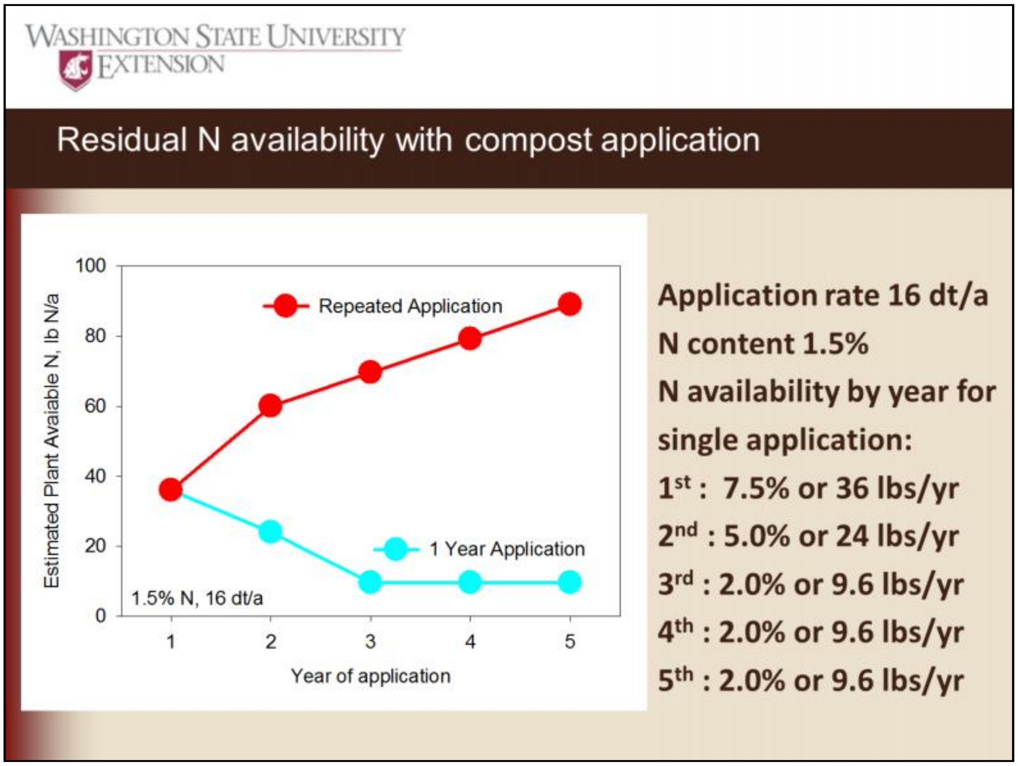
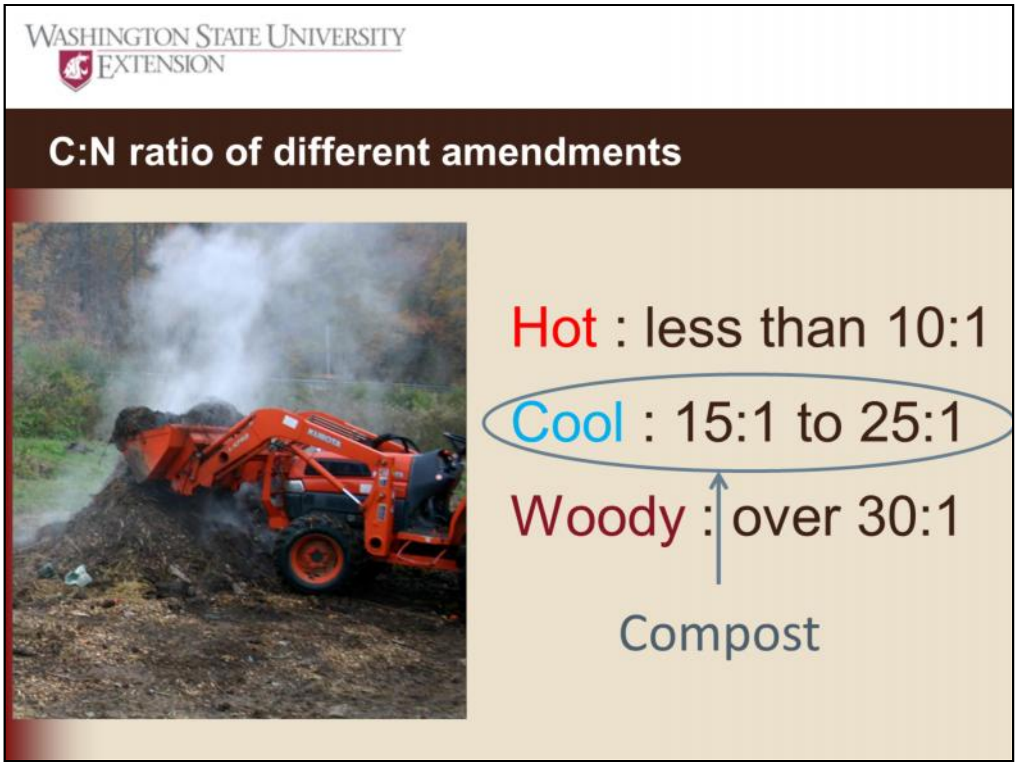
Cumulative available N from an organic source
Year 1
2
3
4
5
= available N
Courtesy of Dan Sullivan, OSU



For repeated applications the top curve gets laid over the previous year's availability and added together

In-season N availability from amendments (compost)

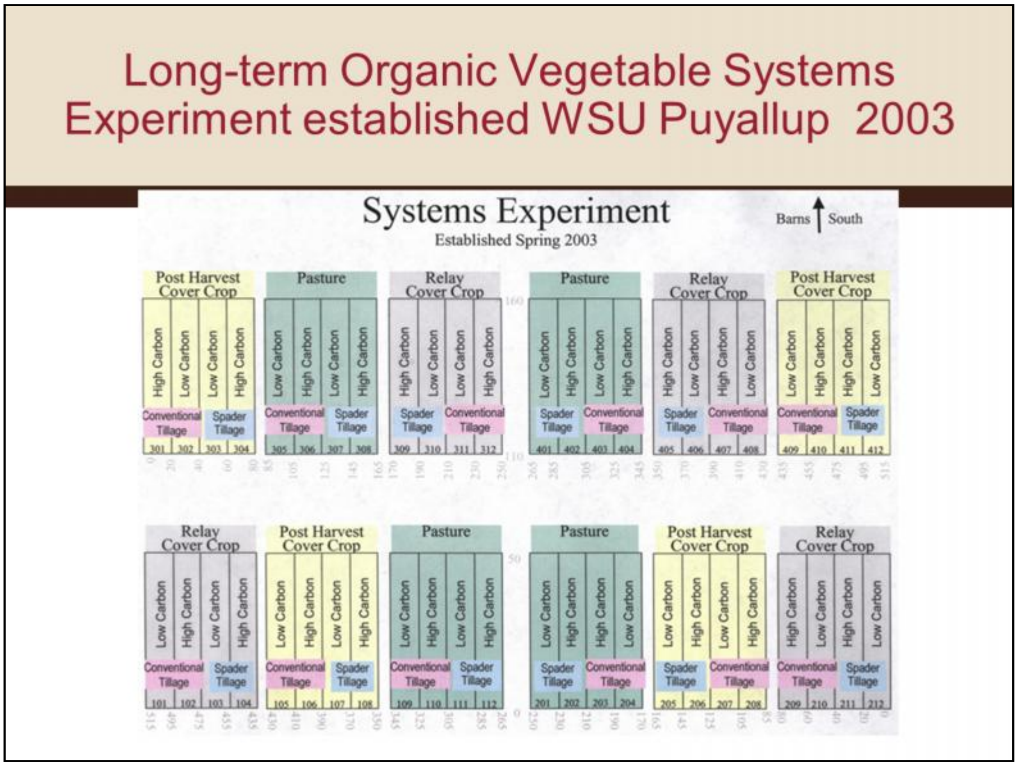
Nitrogen needed = Crop demand (lbs N /acre) - [N from soil organic matter (lbs N / acre) + N from cover crop (lbs N / acre) + N from amendment (lbs N / acre)



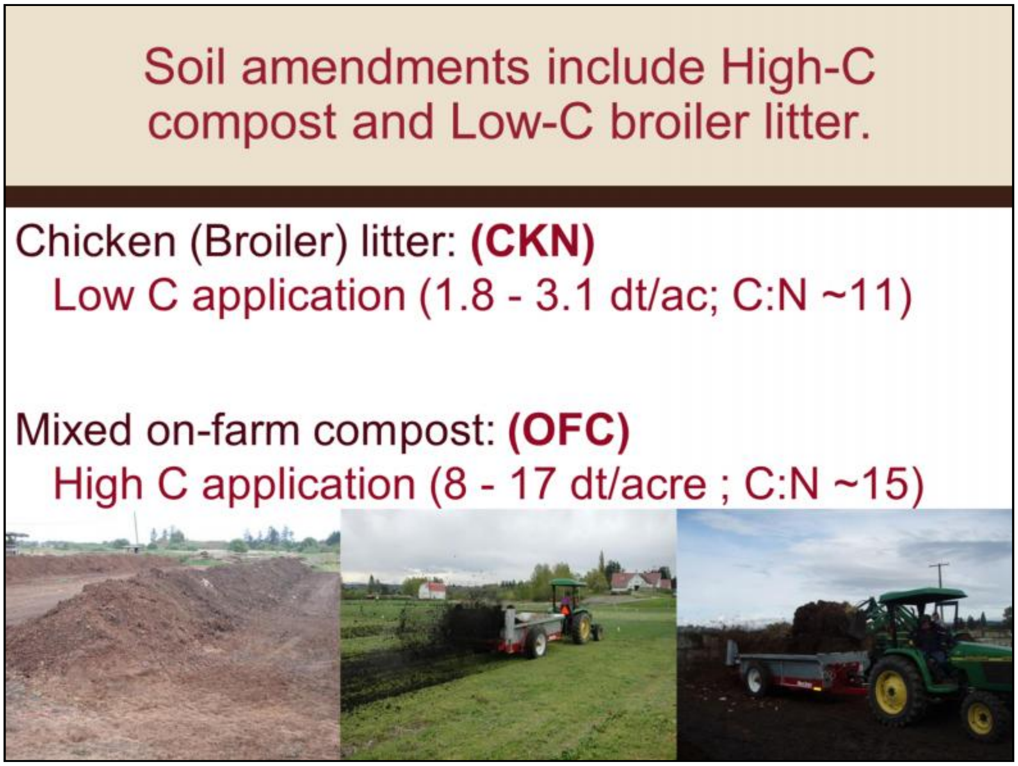
Materials with a low C:N ratio less than 10:1 can be called ‘hot’ because of their ability to supply nitrogen quickly.

Most composts are in the ‘cool’ category between 15:1 and 25:1. They provide a more even, slow-release nutrient source over a longer period.

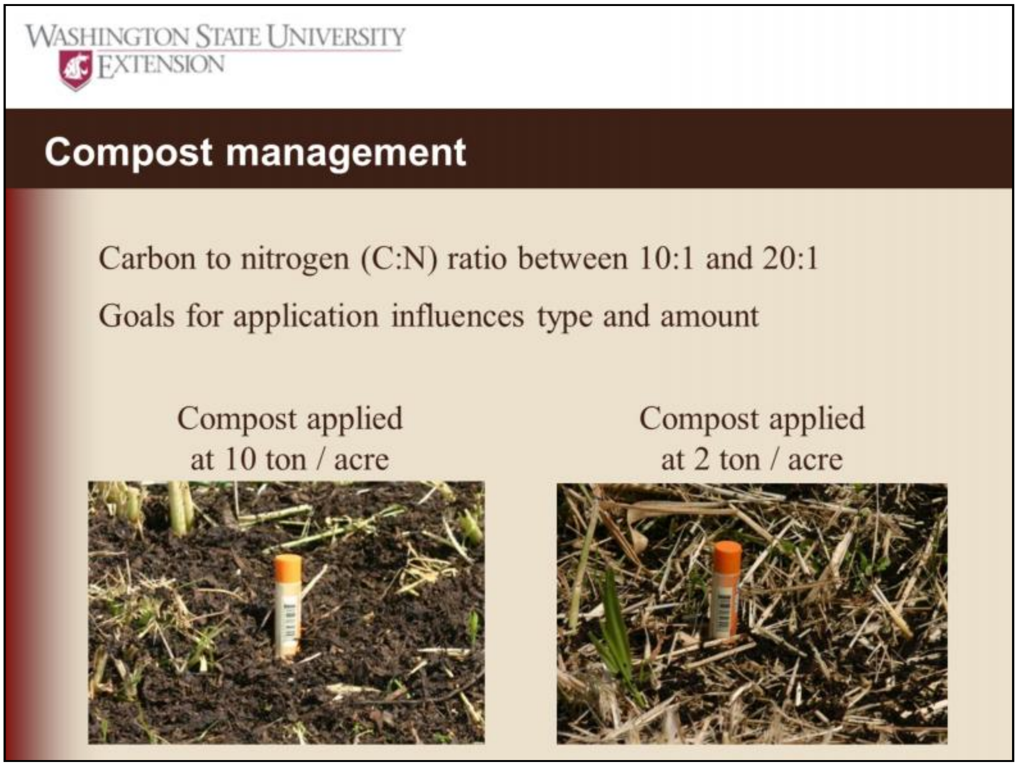
Materials with a very high ratio can be called ‘woody’, and while good as mulching materials, the will immobilize N if incorporated in the soil.



Our organic systems experiment was established at WSU Puyallup in 2003 to evaluate the short and long term effects of different management systems on soil carbon, ecosystem structure and function, and physical properties; nutrient management; weed pressure; and the costs, returns and risks of production.



During one of the early years of the experiment (2006) there was an increase in yield with CKN. There were no differences in yield b/w 2007-2010. In 2011, when wheat was grown, there was higher yield with OFC.



Composted farm waste and manure are excellent sources of organic matter. Using them also helps close the recycling loop by turning waste materials into valuable soil amendments. Compost can be made on the farm or purchased commercially.

Whether home-made or purchased, any material applied should not have a Carbon to Nitrogen ratio exceeding 20:1. This is critical to ensure your crops won't be robbed of nitrogen when they need it most.

Organic materials with a low C:N ratio, such as 10:1 will provide nitrogen quickly. More carbon-rich materials higher than 20:1 can actually decrease nitrogen availability in the weeks following application.

This temporary reduction is called immobilization and occurs as soil organisms decompose the high-carbon compost, using all the available nitrogen and other minerals for survival. Until they complete the process, plant available nitrogen is at a minimum.

The amount to be applied is influenced by your goals. Replenishing a depleted piece of ground may require amounts up to 10 ton to the acre where as fields needing no more than a yearly application can thrive on as little as 2 tons.

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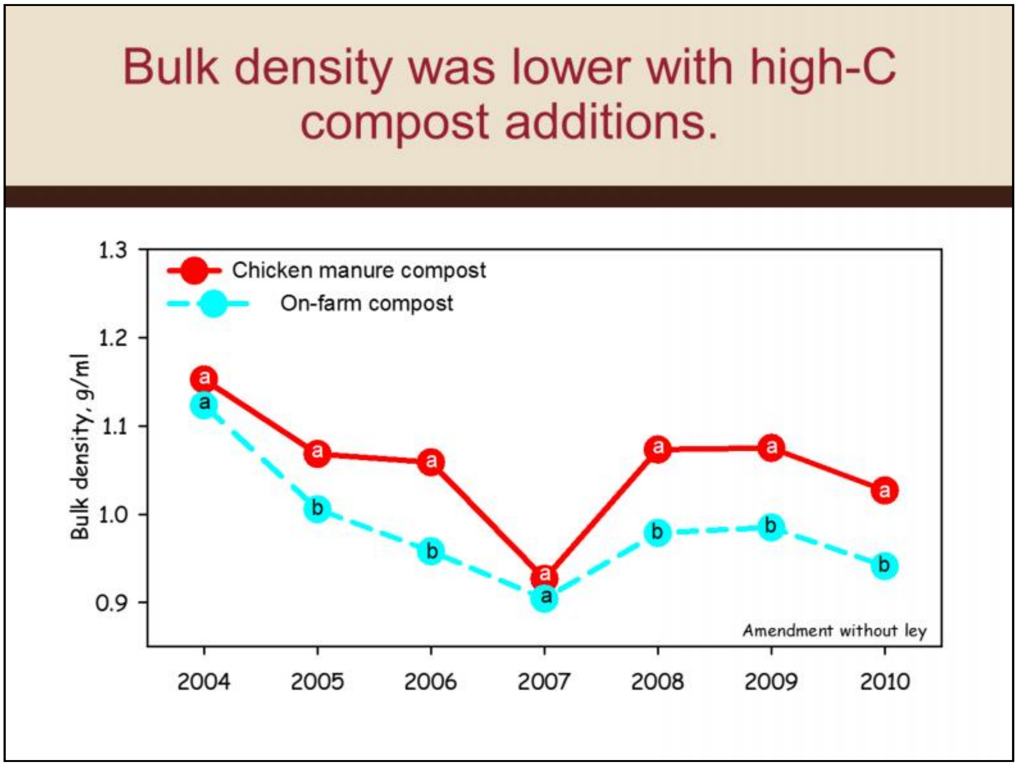
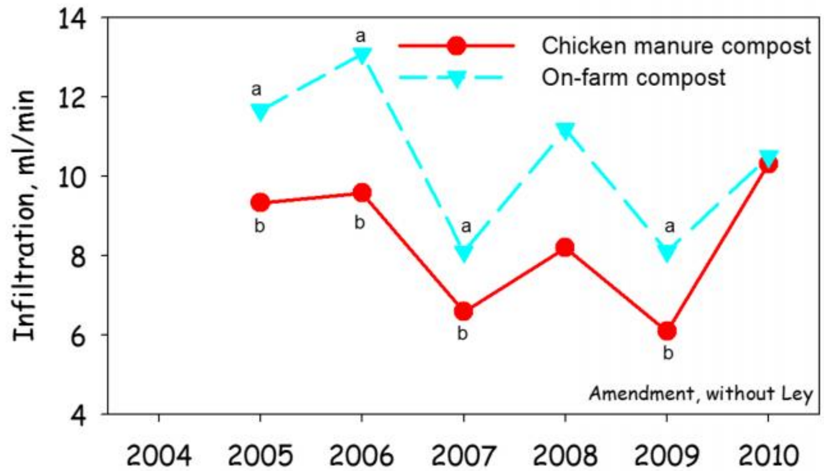
Over time, the higher-C amendment increased active organic matter and N-mineralization potential.

- During one of the early years of the experiment (2006) there was an increase in broccoli yield with CKN.
- There were no differences in yield b/w 2007-2010.
- In 2011, when wheat was grown, there was higher yield with OFC.



Soil structure was improved in the high carbon compost applications

Infiltration was usually faster in plots treated with high-C compost.



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Fertilizing with Compost (C:N=20), 1.5% total N

Compost to apply (lbs)	=	[	Rate of N needed (lbs/ acre)	÷	% N in product /100	÷	% available in one season /100	]
Compost to apply (lbs)	=	[	20	÷	1.5/100	÷	7.5/100	]
Compost to apply (lbs)	=	[	20	÷	0.015	÷	0.075	]
Compost to apply (lbs)	=	[			17778			]
Compost to apply (lbs)	= ~18,000lbs compost/acre or 18 cu yds/acre							

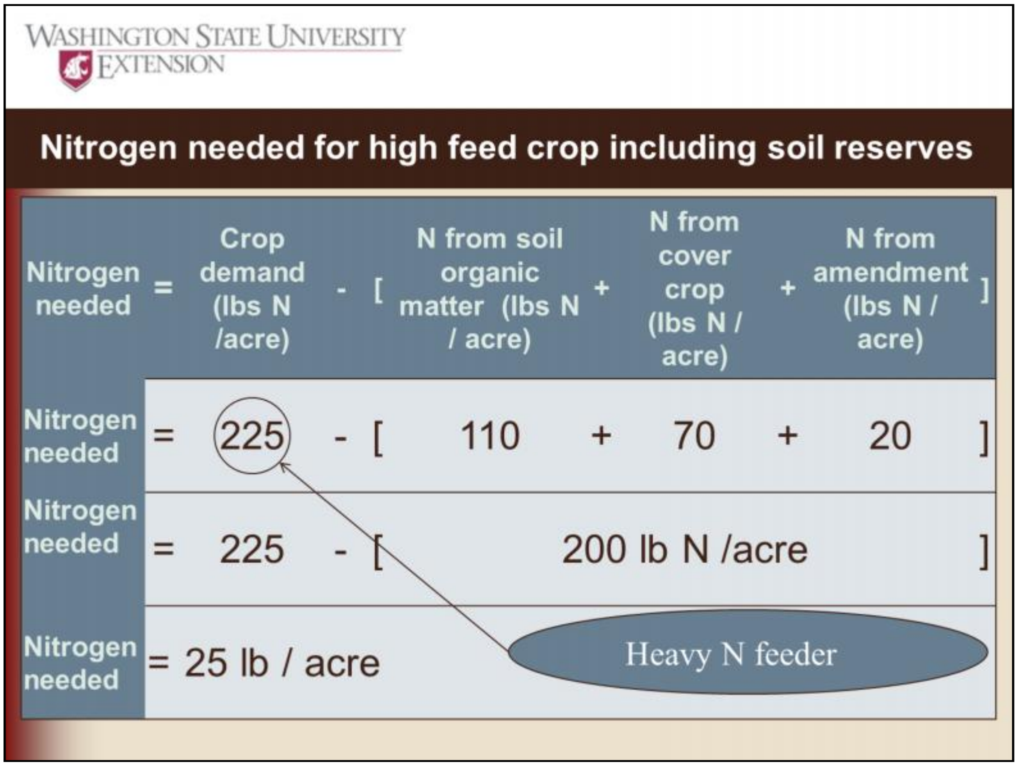
Compost= 1000lbs per cu yd

For organic fertilizers (including compost), both the percentage of total N in the product and the percent available the first season should be considered

For Phosphorus and Potassium, nearly 100% will be plant available in the first season

Assumptions: Compost = C:N=20, Total N= 1.5% (as is), 7.5% available in first season

Use 1000lbs/cu yd as a conversion between tons and yards



Estimating how much organic fertilizer to use can be a challenge. Crop needs should guide fertilizer applications, so different application rates are often needed for different crops.

Here an example demonstrates how to calculate a nitrogen recommendation in pounds of nitrogen per acre for a heavy feeding crop such as broccoli.

Because plants require more nitrogen than any other nutrient, nitrogen management often drives fertility plans and expenditures.

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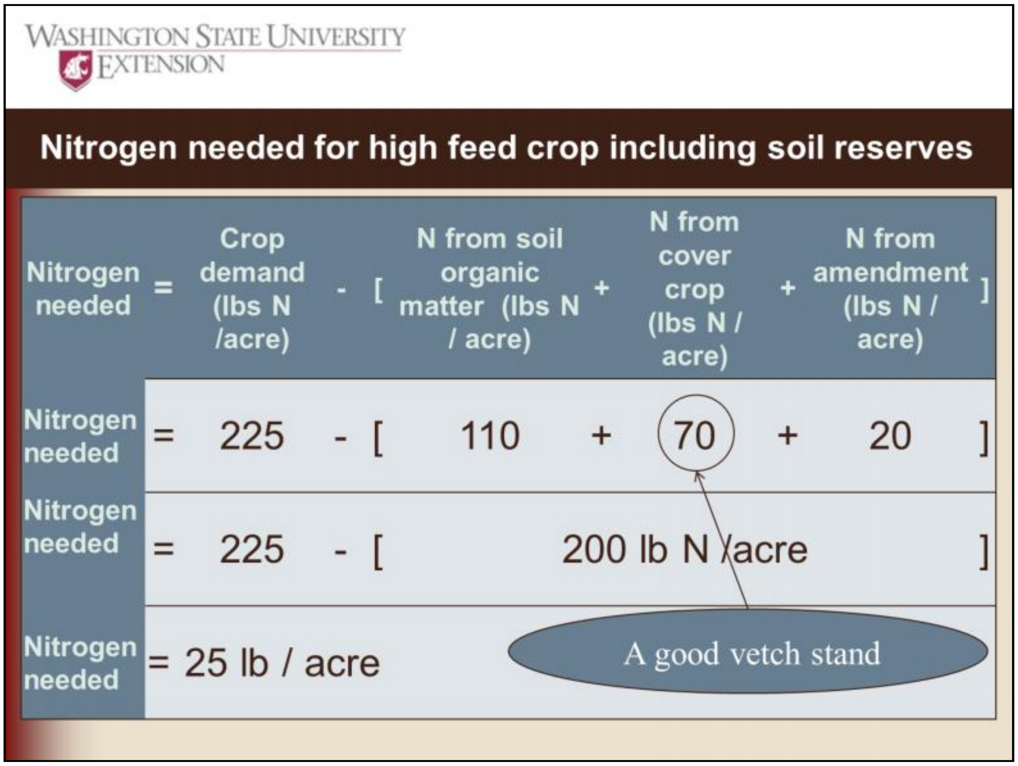
Nitrogen needed for high feed crop including soil reserves

Nitrogen needed	=	Crop demand (lbs N /acre)	- [	N from soil organic matter (lbs N / acre)	+	N from cover crop (lbs N / acre)	+	N from amendment (lbs N / acre)	]
Nitrogen needed	=	225	- [	110	+	70	+	20	]
Nitrogen needed	=	225	- [	200 lb N /acre					]
Nitrogen needed	= 25 lb / acre								

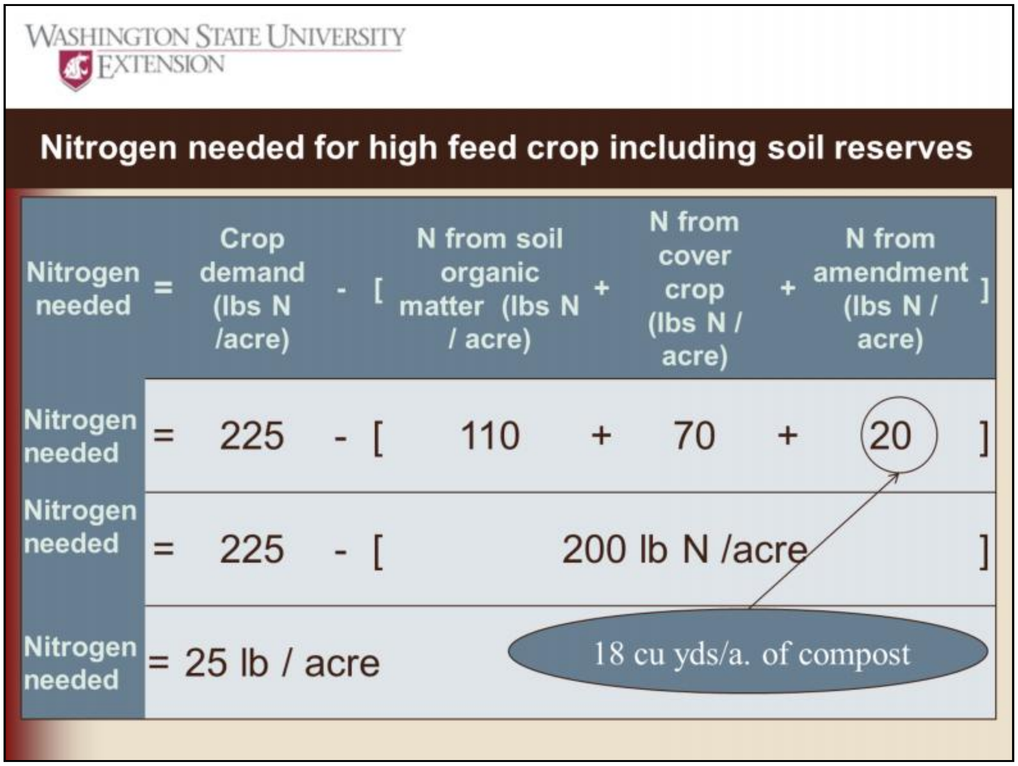
High-mid range of N min

Depending on past soil-building practices, a portion of this nitrogen can be supplied from existing organic matter. Coming from organic matter accumulated over years of cover cropping, manure application, and compost addition, the remaining nitrogen needed must come from additional materials applied during the current growing season. We assume the soil has been amended over previous years with compost and manure.



A vetch cover crop grown the previous year was incorporated along with dairy compost.

The soil organic matter, vetch cover crop, and recent compost amendment will all supply significant nitrogen through mineralization so these contributions are estimated and subtracted from the total necessary to arrive at a current application need of 25 pounds nitrogen per acre.



Compost applied at 18 cu yds/acre will provide approx. 20 lbs of N/acre in the first season.

** Assumptions, compost applied at a rate of 7.5 dt/acre or approx. 15 cu yds/acre (compost at 1000lbs/ cu yd). Compost as 1.5% total N or 30 lbs total N/ton. Approx. 7.5% of the total N becomes available in the first season. (PNW 646)

The soil organic matter, vetch cover crop, and recent compost amendment will all supply significant nitrogen through mineralization so these contributions are estimated and subtracted from the total necessary to arrive at a current application need of 25 pounds nitrogen per acre.

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In the maritime northwest, nitrogen sampling is done in fall for “report card” nitrate test

NO_3^--N in surface foot (ppm)	
Low	<10
Medium	10-20
High	20-30
Excessive	>30

Levels of 10 to 20 are good. If a fall nitrate test reveals levels less than 10, it is possible that evidence of nitrogen stress would have already been observed. Nitrogen stress in plants if visualized by yellowing lower leaves. Nitrogen is mobile within plants, so as the nutrient becomes limiting, it is translocated from older leaves to the newer growing leaves.

Fall nitrate levels of 30, 40, or higher are all to common. These high levels of nitrate indicate that fertilizer was applied in excess of what was needed for crops. 40 ppm nitrate in the top 1 foot of soil would be equivalent to about 140 lbs N/ acre. In addition to the environmental hazard, this represents a lot of money wasted, especially if organic fertilizers are used.

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A fertilizer X compost trial was repeated at 2 Snohomish County Farms in 2015 with sweet corn as a crop.

- Rear discharge spreaders applied compost at a rate of 7.8 dry tons per acre at Farm A and 8.6 dry tons per acre at Farm B
- N fertilizer was spread at 4 different rates (0X,0.5X,0.75X,1X):
  - FarmA: 1X=196
  - FarmB: 1X=100

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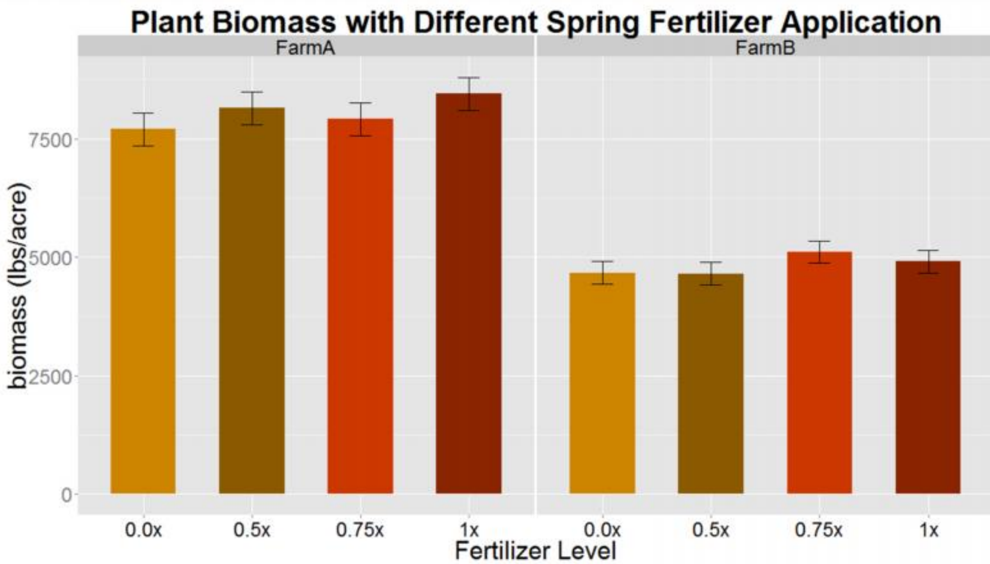
Sweet corn biomass was not affected by compost or fertilizer in 2015 trial



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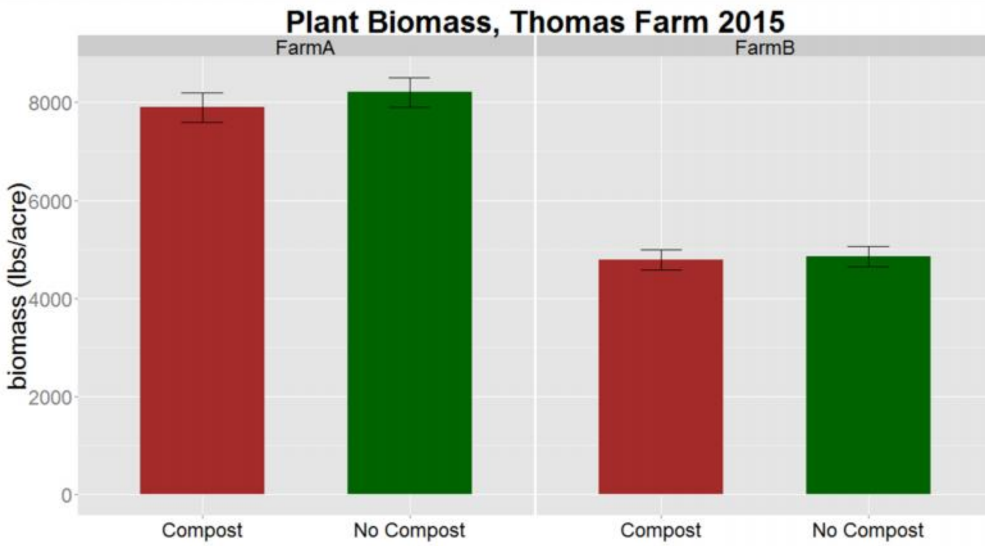

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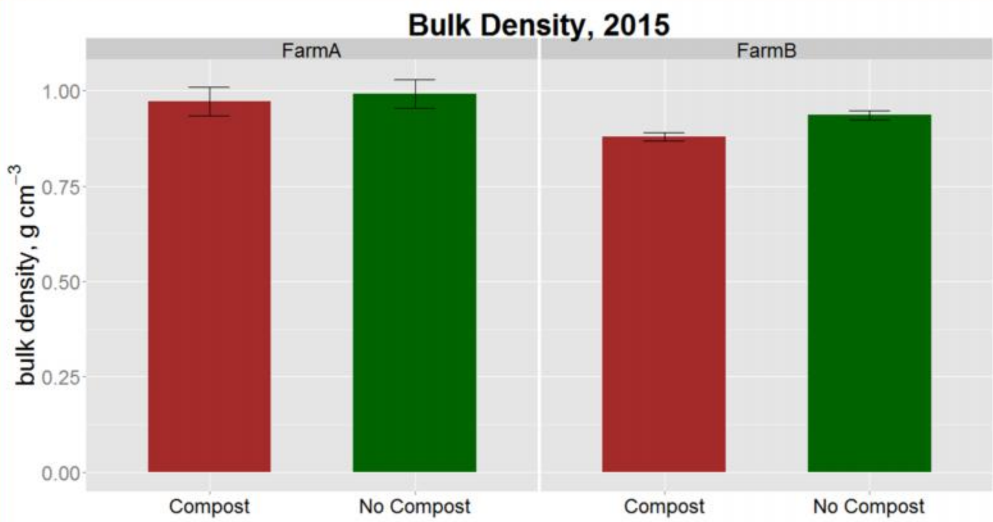
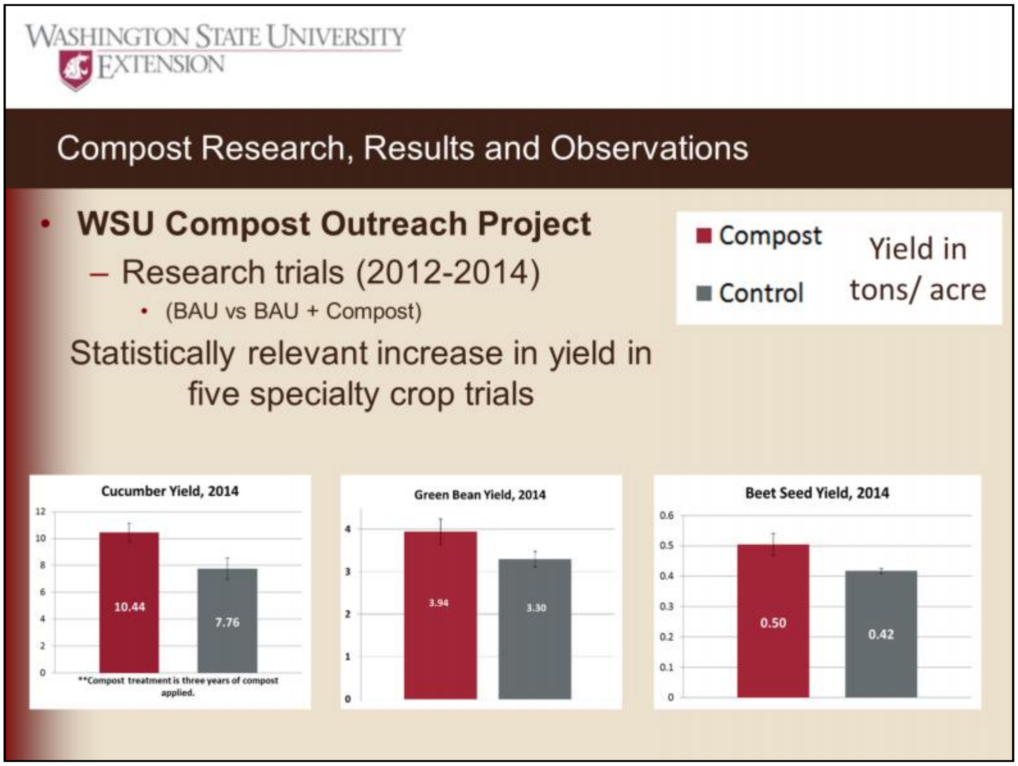
Soil bulk density was decreased at both farms with the addition of compost.





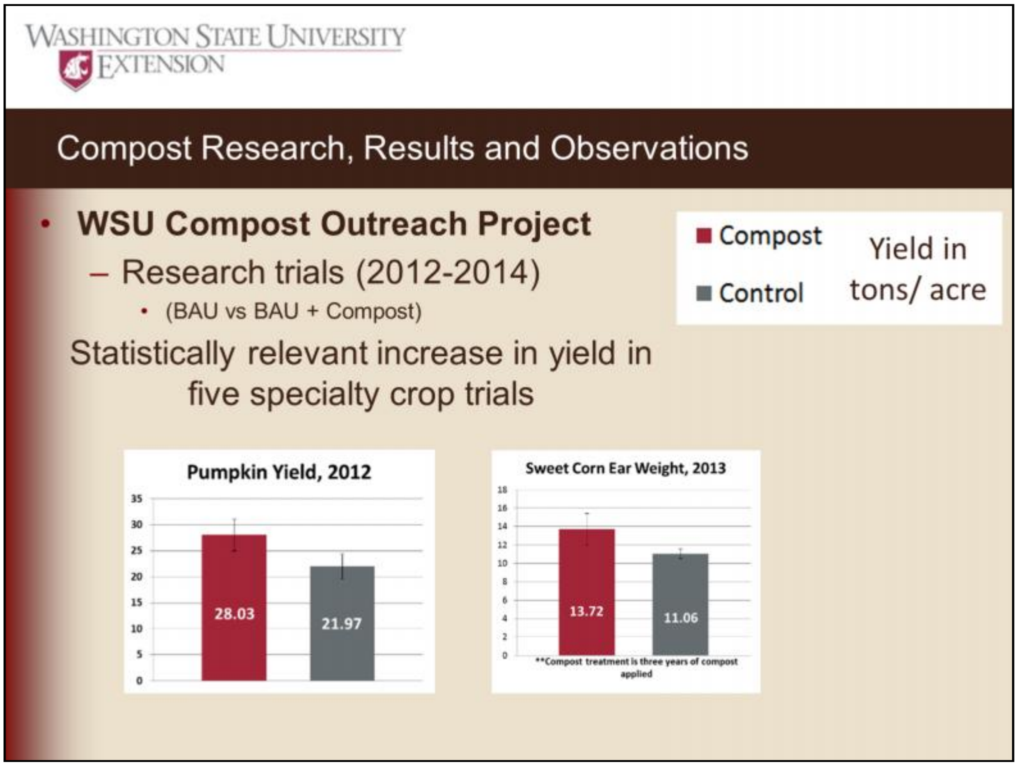
2012 pumpkin trial: Carleton Farm, compost applied years 2011-2012, ~20 dt/a, 28% increase in yield

2013 sweet corn trial: Carleton Farm, compost applied 2011-2013, ~15 dt/a (2013), 24% increase in yield

2014 cucumbers trials: Carleton Farm, 3yrs Compost vs Contral, no new compost applied, 35% increase in yield

2014: green beans: Darrell Hagerty Farms, 6.5 dt/a, 19% increase in yield

2014: beet seed: Williams Farm, 20 dt/a, 21% increase in yield



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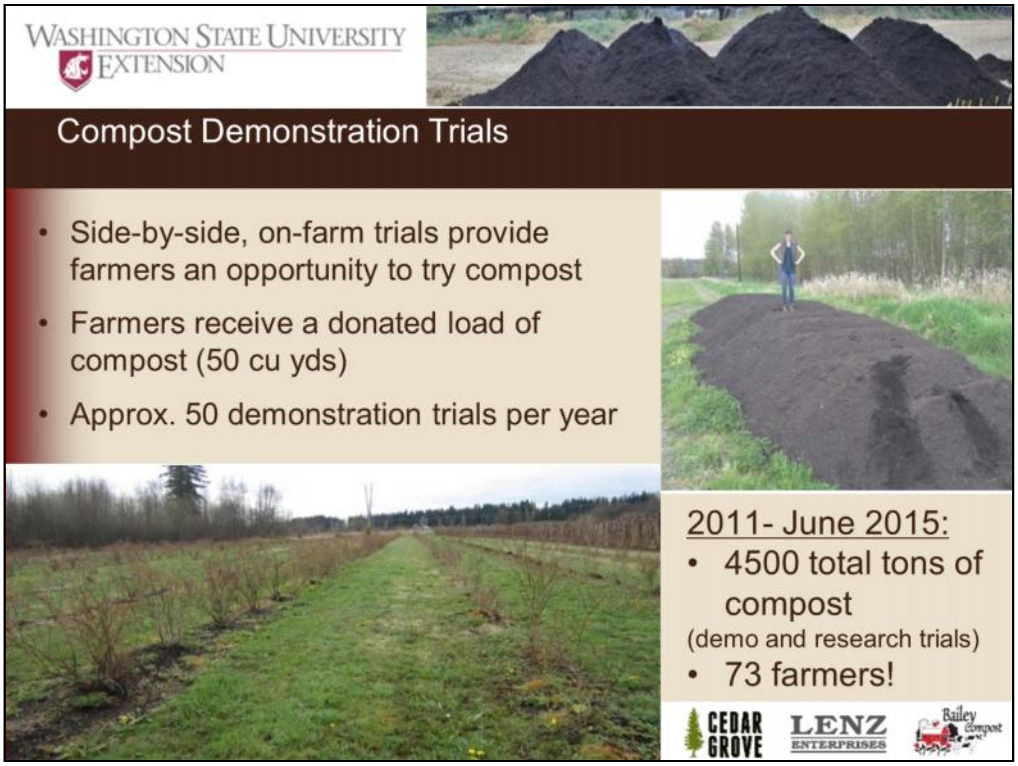
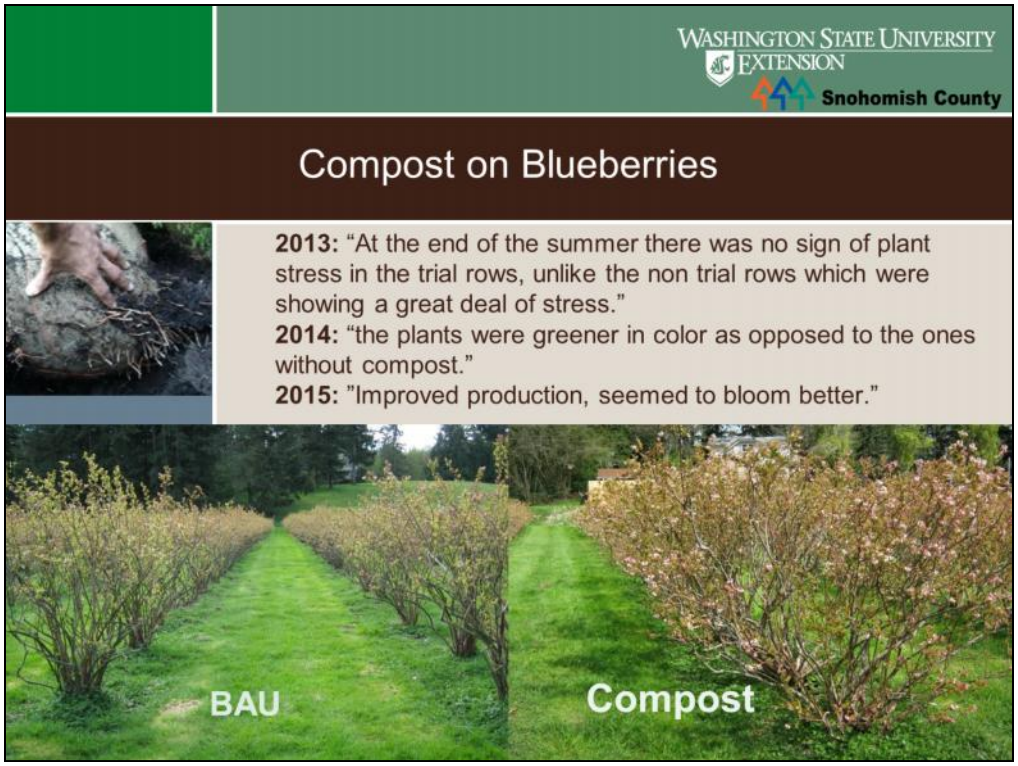


- Purpose of this section is to explain the purpose of the demonstration trials "giving farmers a first hand opportunity to use compost" & "~70% consistently report not having used compost before the program"
- Compost donated by Cedar Grove, Lenz Enterprises, and Bailey Compost



Explain BAU= (Business as Usual)

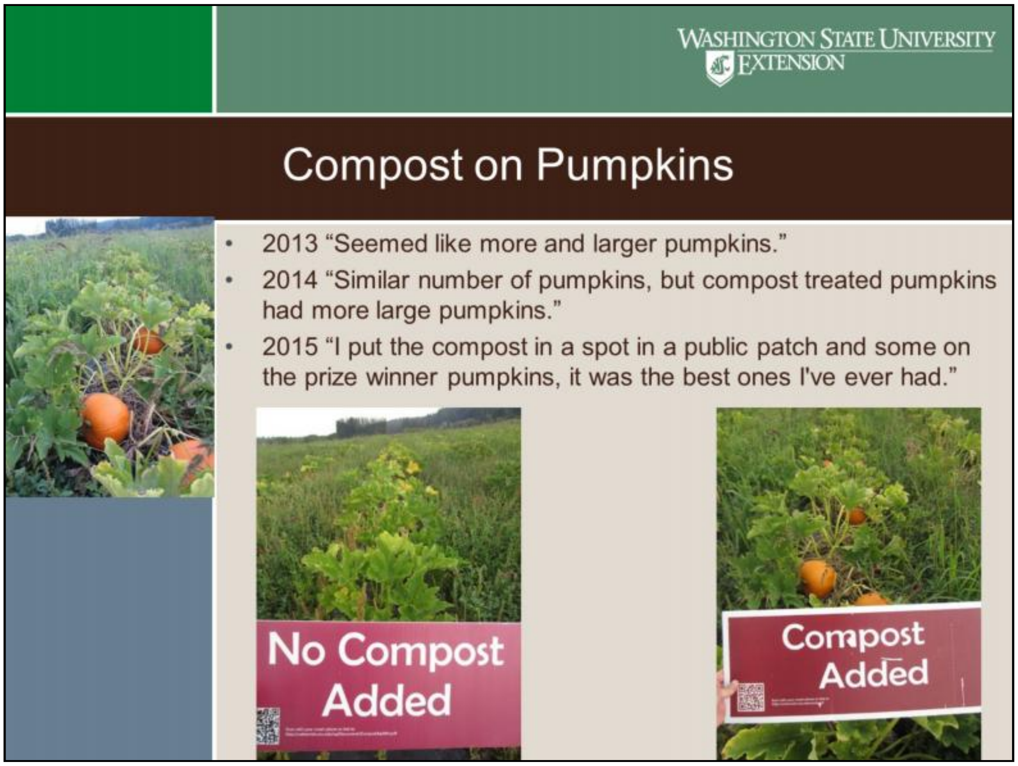
Suggestion: "While there are a diverse array of crops and farm types in the demonstration trials, these next few slides highlight some of the results we have observed"

- We do not collect scientific data on the trials, we monitor the trials with photos and collect farmer feedback through surveys

Blueberries app rate: 2-3" mulch on top

Top-dress/mulch application most effective

Optional info: In 2014, frasier firs at Lochsloy Acres saw ~10% in length of leaders in the compost treatment. ~100 trees sampled, ½ compost ½ no compost . *Not statistically relevant.



Compost has consistently shown positive results with pumpkin crops, through research and demonstration trials.

App rate~ 50 cu yds/acre

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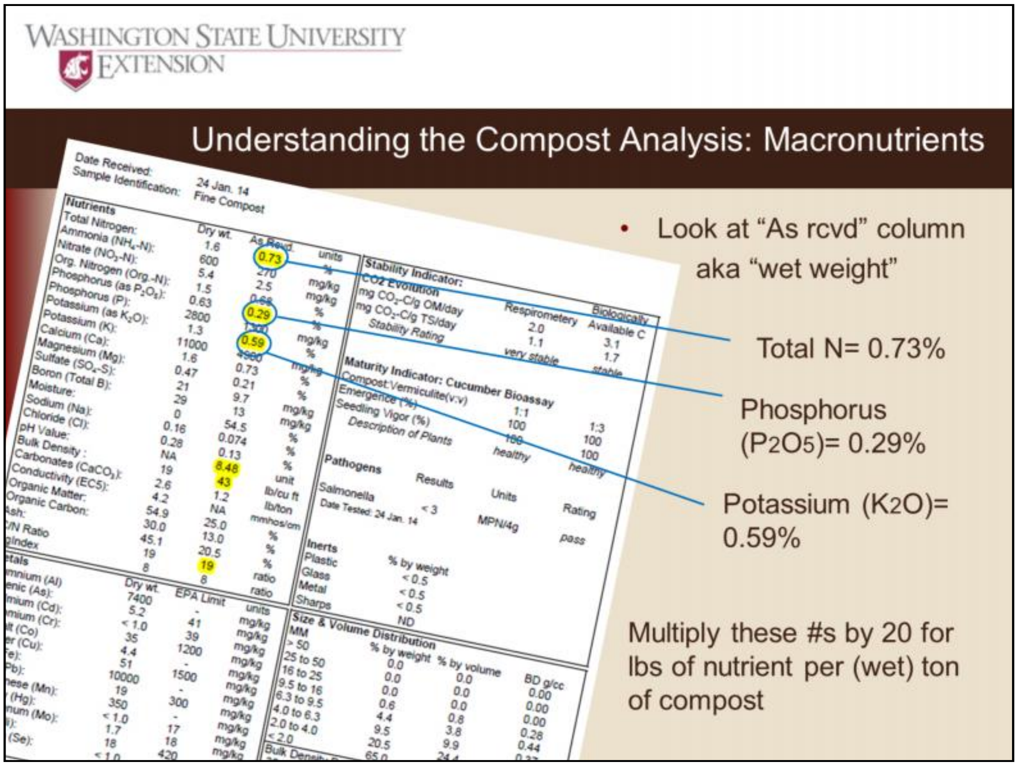
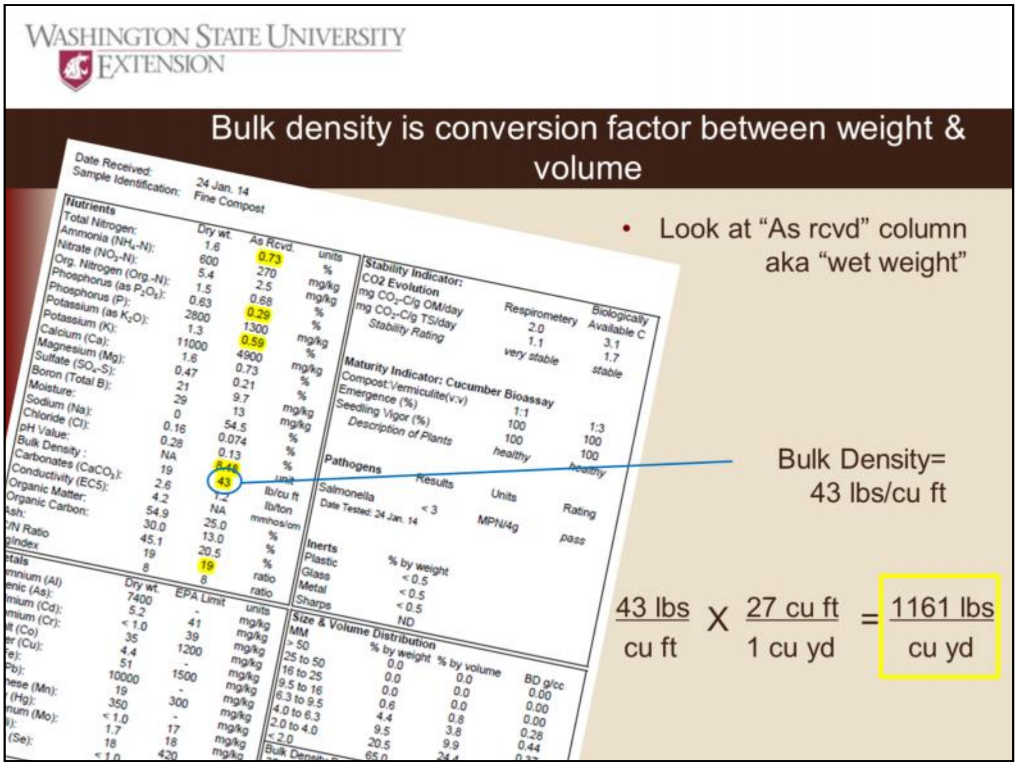
Breaking Down Barriers to Using Compost

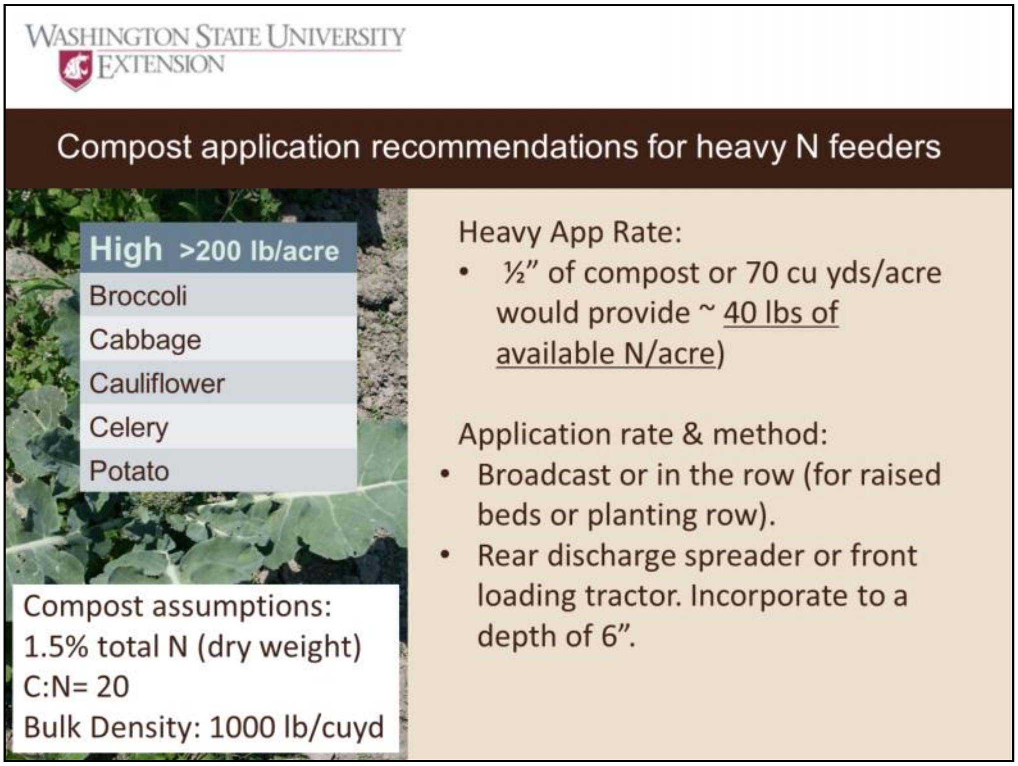
- Off-season compost delivery
- Spreading services, rental equipment
- Tiered pricing system for bulk purchases
- Partnership with composters and farmers for marketing possibilities



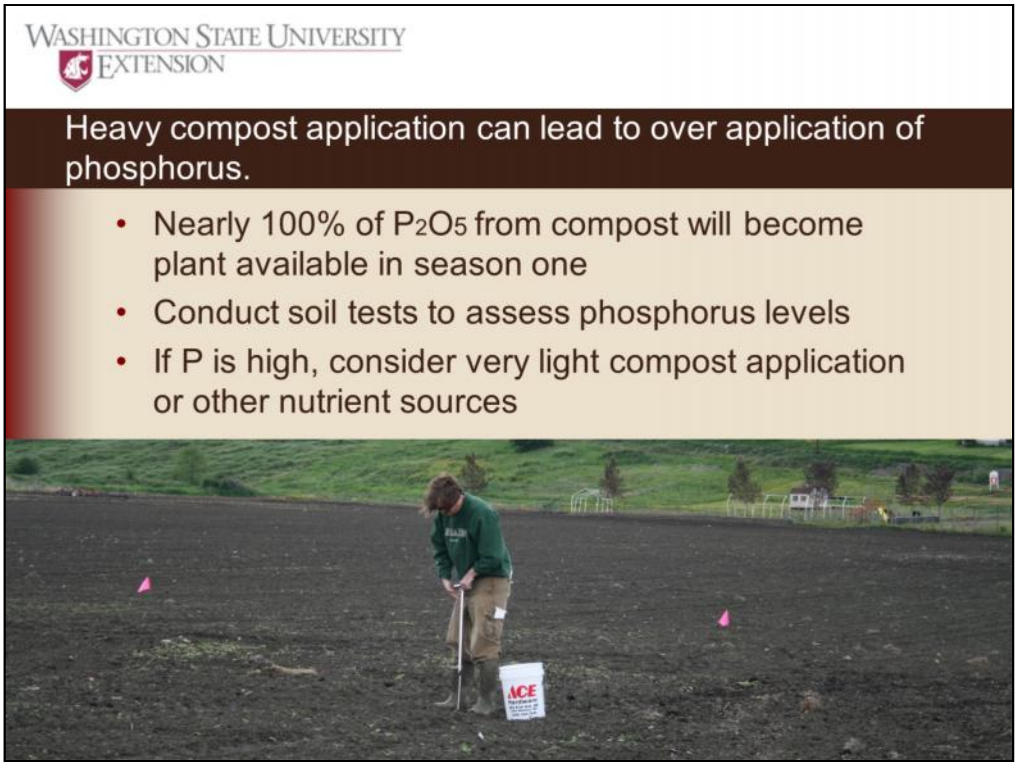
- When purchasing compost, customer should ask for (and receive) an analysis of the compost from the compost producer, although with a delivery ticket with the weight and volume of the load that was received.
- The next couple slides gives some quick advice for understanding and using the compost analysis or "testing data".
- We will recommend looking at the values in the "As Rcvd" column or "wet weight" because that is the product as you will be working with it.
- Often application rates are given in "dry tons/acre" , it can be assumed that the compost is 50% moisture (so the dry tons/acre is approx. the wet tons per acre divided by two)



- Bulk density can help farmers convert between cubic yards and tons.
- Bulk density is the weight of a certain volume of compost, in this case there are 1161 lbs of compost per one cubic yard
- Other pieces of importance on the analysis include the pH and C:N ratio
- The total N is from dry weight calculations



Note the assumptions on this slide. These assumptions will guide the general estimates of plant available N that are given in the next couple slides. 1.5% N is for the dry weight of the compost (and is typical of most local commercial composts). A C:N of 20 indicates that a small portion of Nitrogen will be available in the first season.



- Phosphorus warning: Compost can contain relatively large amount of phosphorus and application of compost to meet all crop N needs may lead to an over-application of phosphorus.
- If a soil test reveals that high levels of phosphorus are present in the soil, the fertility plan should eliminate high phosphorus fertilizers or amendments.
- Phosphorus is a nutrient that can leach into surface or ground water, causing excess nutrients, algae blooms, and other challenges.

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Compost application recommendations for low N feeders

Low	< 120 lb/ acre
Baby greens	
Beans	
Cucumbers	
Radish	
Spinach	
Squashes	

- Manure spreader/broadcast application, single pass= ~10 dry ton/acre or 40 cu yd/acre
- ~23 lbs of N/acre in year 1

- Research has shown ~20 % increase in pumpkin yield
- Demonstration trial farmers have reported less disease and larger pumpkins in compost area

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Upgrading marginal soils with compost

- Multi-year broadcast application:
  - Apply annually for 2-3 years
  - Rear discharge manure spreader
  - (10-20 dta/ 20-40 wet tons per acre or 40 – 80 cu yds/acre)
- Heavy application rate (most economically feasible for small planting beds):
  - One-time application provides benefits for several years
  - 1-3 inch layer, applied by loading tractor, tilled in to 6 inches

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Nursery trees, berries, Christmas Trees, & mulch applications

- 1-2" layer of compost, remove from base of woody stems/trunks
- Mature, compost with <1/2" particle size will likely not provide desired weed suppression
- Compost application may not provide all needed nutrients
- Prior to planting, soil can be prepared by incorporating compost

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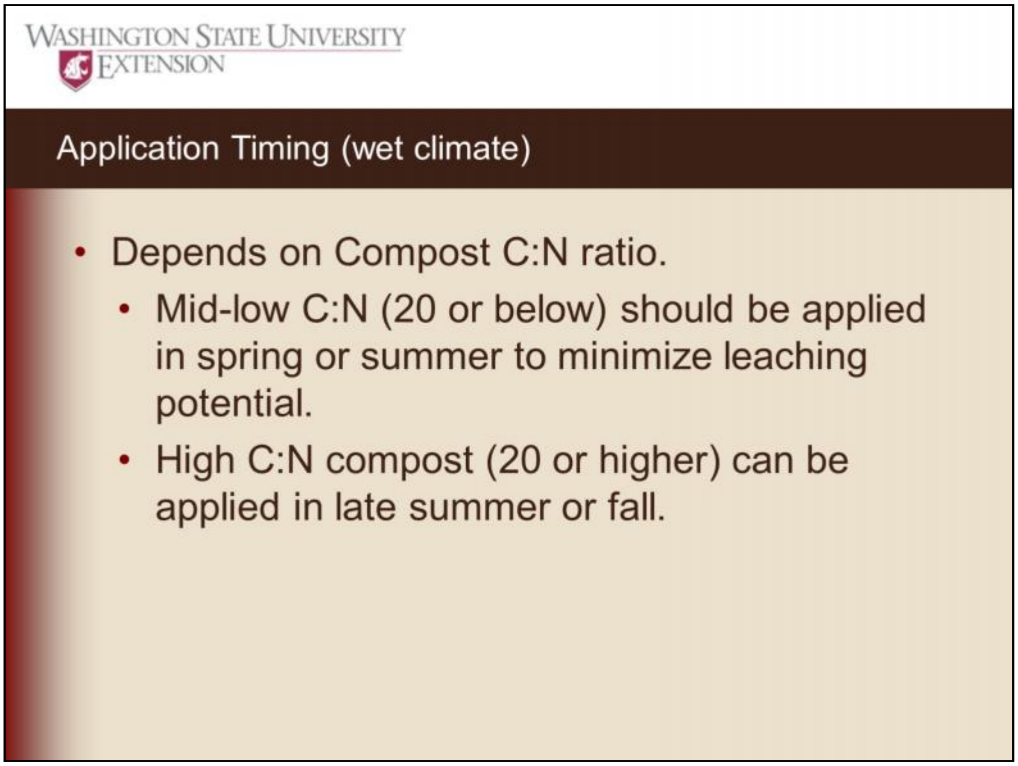
High tunnel or greenhouse

- 1-2" of compost tilled 6" into soil
- Applied using loading tractor to distribute compost, then tilled in.

*Use "topsoil calculator" online to determine quantity of compost needed, (dependent on square footage of greenhouse).

2015 demonstration trial on sweet peppers 7/24/15

Application Restrictions: While application of manures for food crops requires a waiting period between application and harvest, compost that has been tested and meets EPA pathogen reduction standards (131*F + temps.) has no application restrictions [2] (Composters that have met USCC Seal of Testing assurance & EPA testing standards meets this requirement).



Fall compost applications should be applied to cover crops, perennials, or other active-growing crops.

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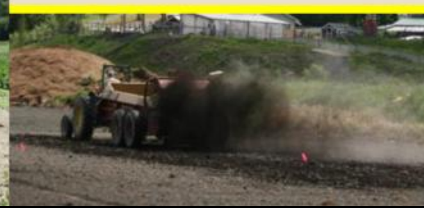
Compost Spreading Methods, Equipment

- Broadcast/rear discharge application using manure spreader, for field crops
- Compost applied using loading tractor, often tilled in for heavy rate of application. (Typical method of application for high tunnels/greenhouse).
- Compost applied as mulch along berry, nursery trees, Christmas trees (by hand or row mulching spreader).


Tarp method, measure sq footage of tarp, use tarp that is no wider than spreader spray pattern, weigh the compost, determine lbs/sq foot. Convert to tons of compost/per acre .

Spreader method, know volume of spreader at capacity (cu yds). Spread compost in rectangle on field, measure the area of the rectangle of the field where compost was applied, divide by area for cu yds/squ foot. Use bulk density & multiply by 46530 to convert to tons/acre of compost.

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Worksheet C

Spreader Calibration Using Manure Bulk Density

This method can be used if you know or estimate the manure bulk density, but is not as accurate as one of the other methods. You will need a tape measure, calculator and a measurement or estimate of the manure bulk density.

1. Determine the length, width, depth, and stacking height of the manure spreader and enter values in Worksheet C. Measure or estimate manure bulk density from Table 1 and enter in the worksheet.
2. Calculate the volume and weight of manure in a spreader load using Worksheet C.
3. Spread a load on the field, using constant, even tractor speed and settings to cover field uniformly. Spread in a rectangular pattern so the area calculation will be simple. Record tractors speed and gear settings used on Worksheet C.
4. Measure the length and width covered by one full load and compute the application rate in tons per acre using Worksheet C.
5. Adjust the application rate by changing tractor speed or gearing, or making an adjustment on the manure spreader. After adjustment, you will need to repeat the calibration procedure until you have arrived at the desired application rate.

Worksheet C

Date ______________ **Field** ______________ **Spreader ID** ______________

Speed ______________ **Gear** ______________ **Operator** ______________

	Replicates			
	Example	A	B	C
1. Manure bulk density from table (lb/yd)	*1,100*			
2. Length of manure spreader (ft)	*7.0*			
3. Width of manure spreader (ft)	*3.0*			
4. Depth of manure to top of spreader side boards (ft)	*1.4*			
5. Stacking height from the top of the side boards to top of pile (ft)	*1.1*			
6. Volume of manure in spreader (ft^3) **(line 2 x line 3 x (line 4 + (line 5 x 0.8))**	*48*			
7. Weight of manure in the spreader (lb) **(line 1 x line 6) / 27**	*1,951*			
8. Length of area spread (ft)	*245*			
9. Width of area spread (ft)	*4*			
10. Area spread (sq ft) **(line 8 x line 9)**	*980*			
11. Manure applied (lb/sq ft) **(line 7 / line 10)**	*1.99*			
12. Convert to tons/acre **(line 11 x 21.78)**	*43*			

12 — Fertilizing with Manure

Worksheet A

Application Calibration Using a Tarp

You will need some tarps and a scale on which to weigh the manure. Hanging scales work well. Then follow these steps:

1. Weigh the tarp and record the weight and size of the tarp on Worksheet A.
2. Place tarps in application area.
3. Spread manure over the application area using the spreading pattern typically used in the field. Make sure the spreader is traveling at the speed it would typically travel. On Worksheet A, record tractor speed and gear, and note spreader settings.
4. Collect and weigh the manure. Record the weight on Worksheet A.
5. Calculate an average application by completing Worksheet A.
6. Repeat steps 1–4 five to nine times. Replication gives you more accurate results.
7. Adjust the application rate by changing tractor speed or gearing, or making an adjustment on the manure spreader. After adjustment, you will need to repeat the calibration procedure until you have arrived at the desired application rate.
8. Keep the calibration records for future use.

Worksheet A

Date ______________ **Field** ______________ **Spreader ID** ______________

Speed ______________ **Gear** ______________ **Operator** ______________

	Tarp ID						
	Example	A	B	C	D	E	F
1. Weight of tarp with manure (lb)	*9.2*						
2. Weight of empty tarp (lb)	*6.5*						
3. Weight of manure **(line 2 minus line 1)**	*2.7*						
4. Tarp area (sq ft)	*9.0*						
5. Manure applied (lb/ sq ft) **(line 3 / line 4)**	*0.3*						
6. Convert to tons/acre **(line 5 x 21.78)**	*6.5*						
7. Average application rate (Ave. over all locations) tons/acre							

10 — Fertilizing with Manure

These worksheets available as handouts - http://cru.cahe.wsu.edu/CEPublications/pnw533/pnw533.pdf

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Conclusions

- Compost can be an important short-term and long-term source of fertility
- Soils with a large N contribution from soil organic matter may not see a fertility boost in the year of application
- Degraded or compacted soils can benefit from changes in soil physical properties

1: US Composting Council, Field Guide to Compost Use © 2001. http://compostingcouncil.org/wp/wp-content/uploads/2010/12/Field_Guide_to_Compost_Use.pdf

2: Soil Fertility in Organic Systems: A Guide for Gardeners and Small Acreage Farmers. 2013. http://cru.cahe.wsu.edu/CEPublications/PNW646/PNW646.pdf

3: Fertilizing with Manure, PNW533. Washington State University Extension: http://cru.cahe.wsu.edu/CEPublications/pnw533/pnw533.pdf

Other partners not explicitly mentioned include the Washington State Dept of Ecology, and Snohomish County Surface Water Management and Snohomish County Office of Energy and Sustainability.

Washington State University
Extension

Compost

Compost is the dark, earthy material produced by decomposing yard debris, animal waste, and food scraps.

Benefits:

- Improves soil structure, porosity, and density
- Increases infiltration and permeability of heavy soils, reducing erosion and runoff
- Improves water holding capacity
- Supplies a variety of macro and micronutrients
- Supplies organic matter
- Improves cation exchange capacity (CEC)
- Supplies beneficial microorganisms
- Improves and stabilized soil pH
- Can bind and degrade specific pollutants [1]

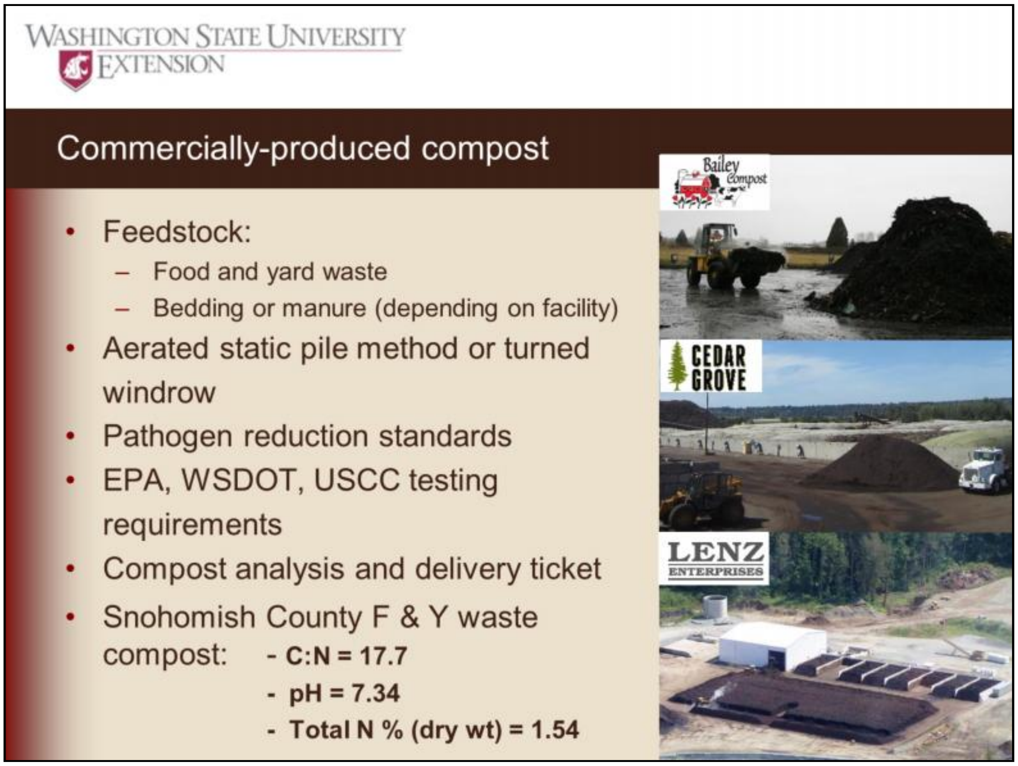
½ "brown", carbon-rich materials (such as dry leaves, sticks, and woody products) and approximately

½ "green", nitrogen-rich materials (fresh grass clippings, manure, vegetable scraps).

Additional resources: Resources

On-Farm Composting Handbook – farmers

Natural Yard Care Composting Handbook – gardeners



- Feedstock:
  - Food and yard waste (collected curbside and self-hauled)
  - Bedding or manure (depending on facility)
- Aerated static pile method or turned windrow (other methods include in-vessel, vermicomposting, or digestion)
- Pathogen reduction standards
- EPA, WSDOT, USCC testing requirements (heavy metals and chemical contaminants, inert (plastics) limits, more.)
- Compost analysis and delivery ticket (Compost analysis provides nutrient breakdown, moisture, bulk density, pH, and more)
- Average values/assumptions for Snohomish County F & Y waste compost (obtained from compost analyses and research trials).

**For listings of additional compost producers in Snohomish county- see the Using Compost brochure.