Mortality Compost Nutrients and Use On Farm, Ways to Enhance Nutrient Content

American Institute for Goat Research, Langston University, Langston, Oklahoma, April 25, 2014

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Objectives

- If using Composting, how to produce an end product with the greatest nutrient or other value
- Maximizing nutrient conservation
- Discuss how to influence the nutrient value through process management.

Composting

The controlled biological decomposition of organic material under (aerobic and anaerobic) conditions

Not just “above ground burial”

Nutrient Profile

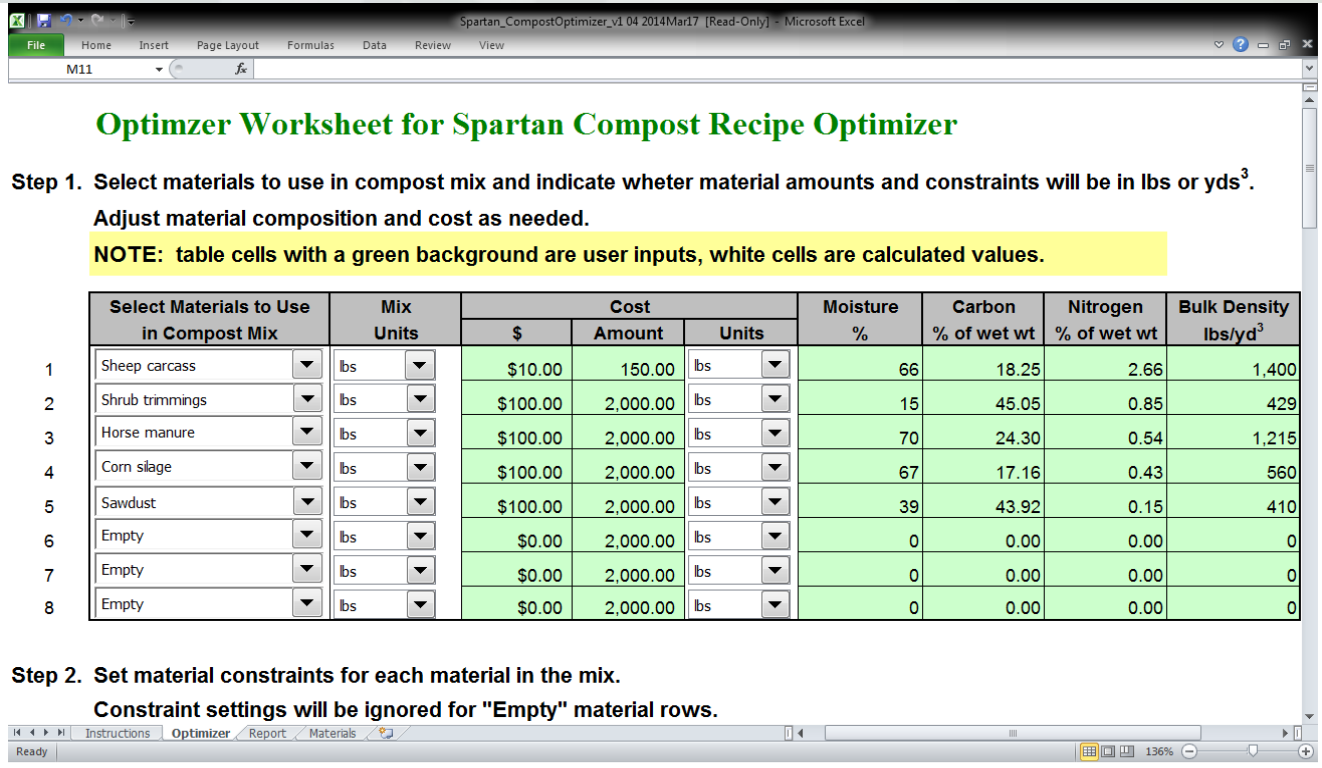
Parameter	Unit	103113	100409	50605	51107	111709i	111709s
Moisture	%	10	42.2	50.9	30.4	48.2	41.8
Organic Matter	%	63.4	83.2	70.4	66.2	45.7	51.8
Carbon	%	36.8	38.9	40.8	34.2	23.1	26.1
Total Nitrogen	%	1.65	1.44	1.95	1.41	1.19	1.2
C:N Ratio	-	22.3	27	20.9	24.4	19.5	21.8
Phosphorus	%	0.63	0.42	2.25	0.13	0.28	0.2
Potassium	%	0.9	0.31	0.63	0.38	0.58	0.59

Best Conditions for Active Composting

- Moisture content range of 40 to 60%
- Carbon-to-nitrogen ratio range of 15:1 to 35:1
- Amendment particle size range of 0.1 to 2 inches
- Temperature range of 100 to 150ºF
- pH range of 5.5 to 9.0

Spartan Compost Recipe Optimizer

- Microsoft® Excel
- Uses Solver Add-In
- Least cost recipe
- User defined constraints
- User defined amendments



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Optimzer Worksheet for Spartan Compost Recipe Optimizer

Step 1. Select materials to use in compost mix and indicate wheter material amounts and constraints will be in lbs or yds^3.

Adjust material composition and cost as needed.

NOTE: table cells with a green background are user inputs, white cells are calculated values.

	Select Materials to Use in Compost Mix	Mix Units	Cost $	Cost Amount	Cost Units	Moisture %	Carbon % of wet wt	Nitrogen % of wet wt	Bulk Density lbs/yd^3
1	Sheep carcass	lbs	$10.00	150.00	lbs	66	18.25	2.66	1,400
2	Shrub trimmings	lbs	$100.00	2,000.00	lbs	15	45.05	0.85	429
3	Horse manure	lbs	$100.00	2,000.00	lbs	70	24.30	0.54	1,215
4	Corn silage	lbs	$100.00	2,000.00	lbs	67	17.16	0.43	560
5	Sawdust	lbs	$100.00	2,000.00	lbs	39	43.92	0.15	410
6	Empty	lbs	$0.00	2,000.00	lbs	0	0.00	0.00	0
7	Empty	lbs	$0.00	2,000.00	lbs	0	0.00	0.00	0
8	Empty	lbs	$0.00	2,000.00	lbs	0	0.00	0.00	0

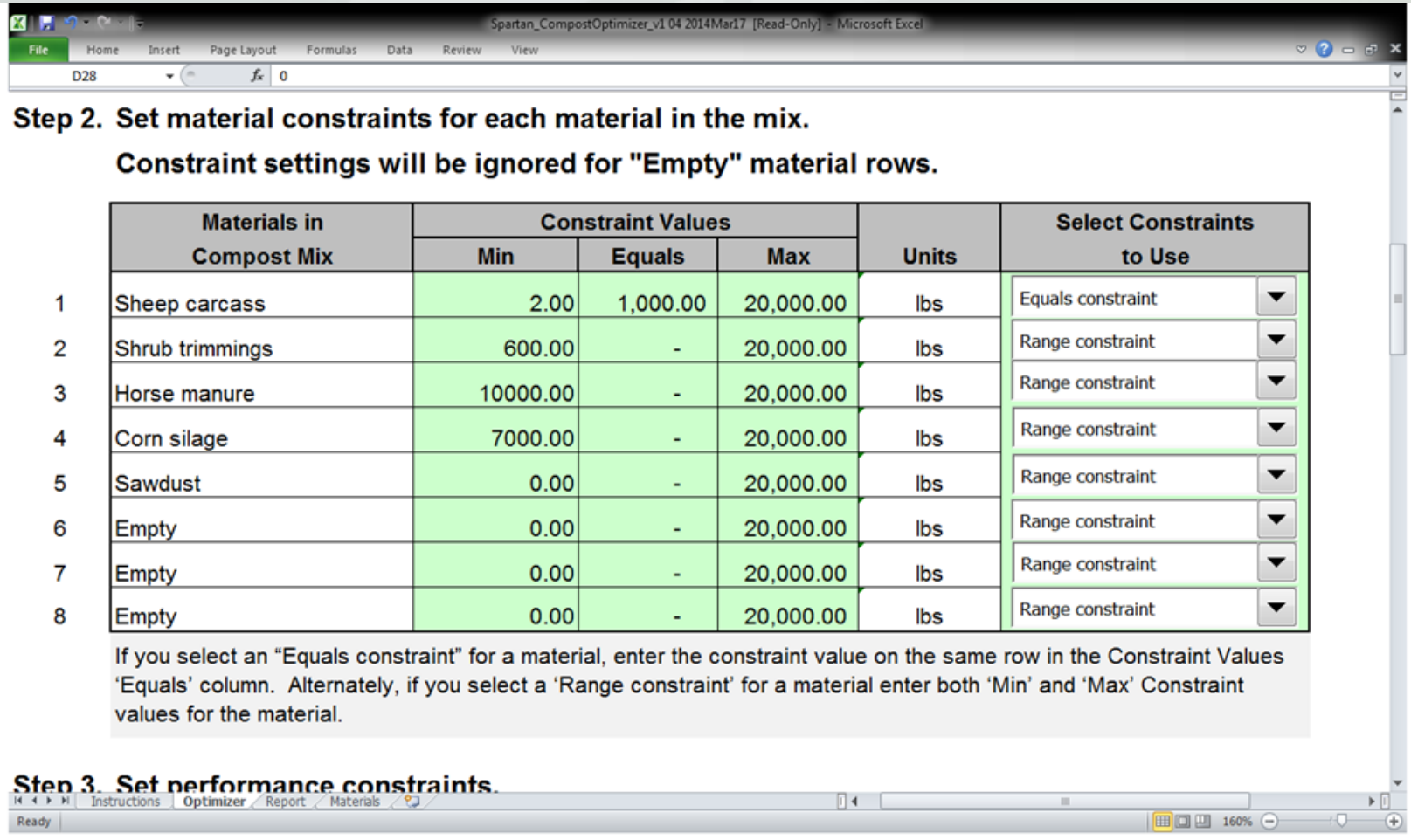
Step 2. Set material constraints for each material in the mix.

Constraint settings will be ignored for "Empty" material rows.

Instructions Optimizer Report Materials

Ready 136%

Materials Constraints



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Step 2. Set material constraints for each material in the mix.

Constraint settings will be ignored for "Empty" material rows.

	Materials in Compost Mix	Constraint Values Min	Equals	Max	Units	Select Constraints to Use
1	Sheep carcass	2.00	1,000.00	20,000.00	lbs	Equals constraint
2	Shrub trimmings	600.00	-	20,000.00	lbs	Range constraint
3	Horse manure	10000.00	-	20,000.00	lbs	Range constraint
4	Corn silage	7000.00	-	20,000.00	lbs	Range constraint
5	Sawdust	0.00	-	20,000.00	lbs	Range constraint
6	Empty	0.00	-	20,000.00	lbs	Range constraint
7	Empty	0.00	-	20,000.00	lbs	Range constraint
8	Empty	0.00	-	20,000.00	lbs	Range constraint

If you select an "Equals constraint" for a material, enter the constraint value on the same row in the Constraint Values 'Equals' column. Alternately, if you select a 'Range constraint' for a material enter both 'Min' and 'Max' Constraint values for the material.

Step 3. Set performance constraints.

Instructions Optimizer Report Materials

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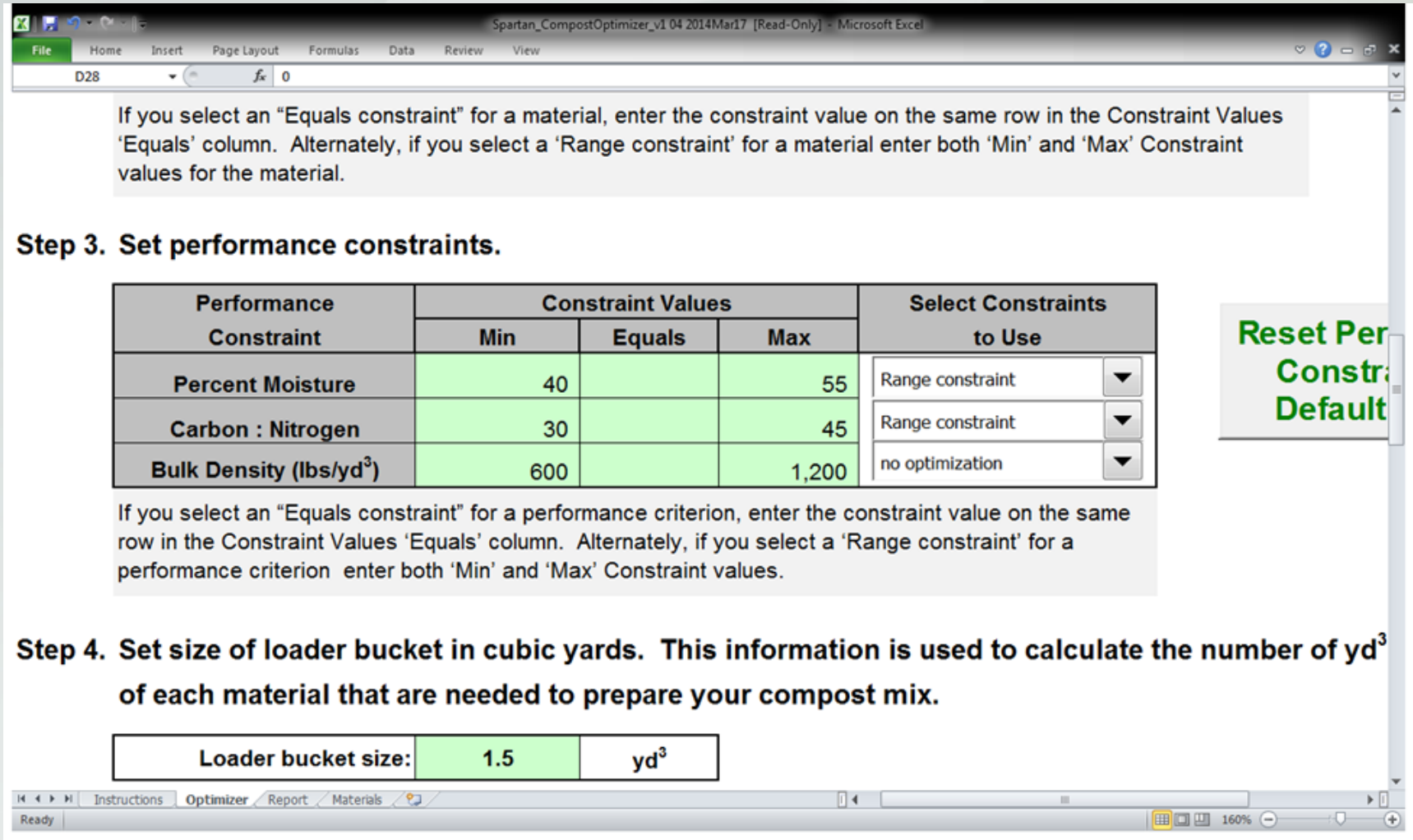
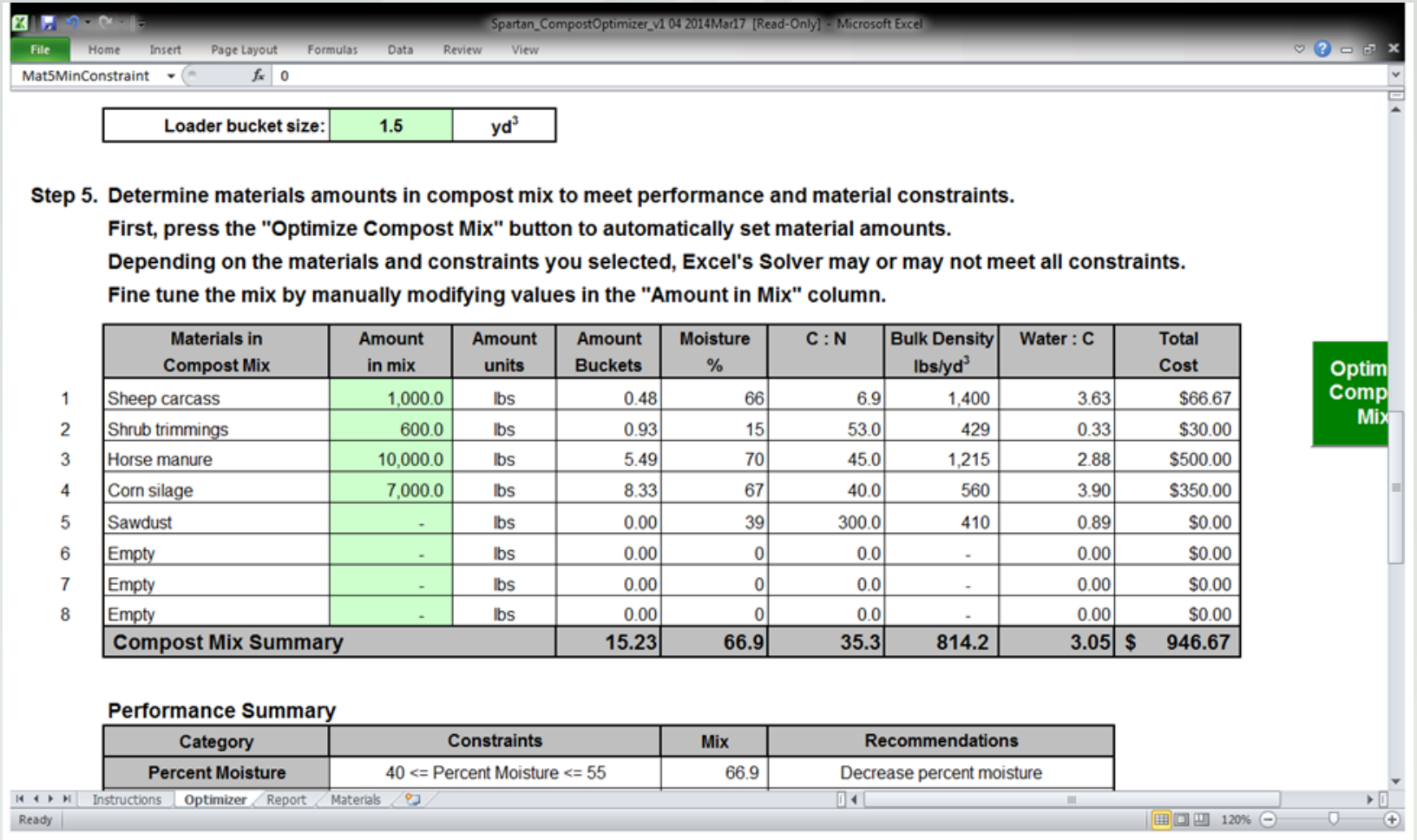
Performance Constraints



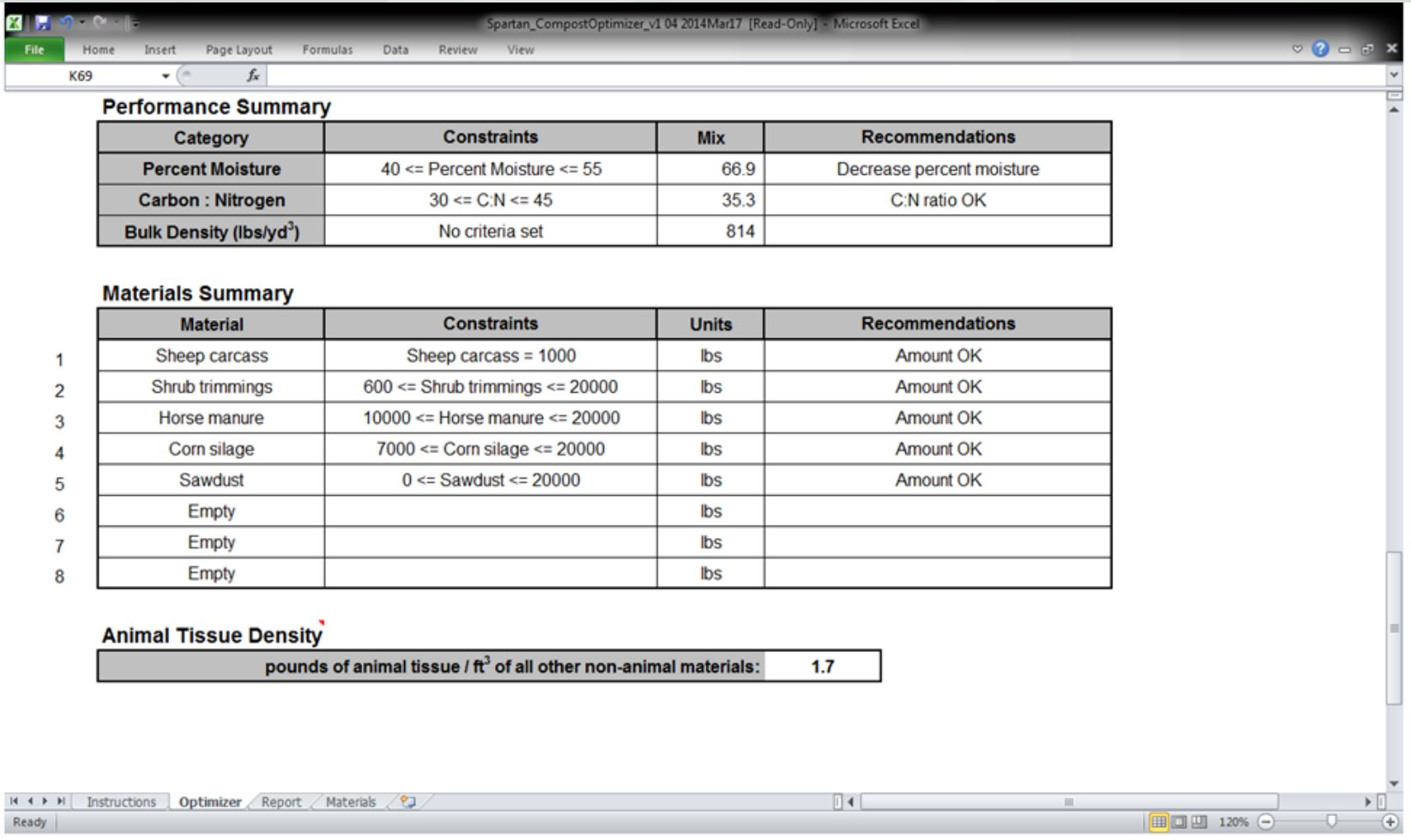
Recipe Creation/Optimization



	Materials in Compost Mix	Amount in mix	Amount units	Amount Buckets	Moisture %	C : N	Bulk Density lbs/yd^3	Water : C	Total Cost
1	Sheep carcass	1,000.0	lbs	0.48	66	6.9	1,400	3.63	$66.67
2	Shrub trimmings	600.0	lbs	0.93	15	53.0	429	0.33	$30.00
3	Horse manure	10,000.0	lbs	5.49	70	45.0	1,215	2.88	$500.00
4	Corn silage	7,000.0	lbs	8.33	67	40.0	560	3.90	$350.00
5	Sawdust	-	lbs	0.00	39	300.0	410	0.89	$0.00
6	Empty	-	lbs	0.00	0	0.0	-	0.00	$0.00
7	Empty	-	lbs	0.00	0	0.0	-	0.00	$0.00
8	Empty	-	lbs	0.00	0	0.0	-	0.00	$0.00
	Compost Mix Summary			**15.23**	**66.9**	**35.3**	**814.2**	**3.05**	**$ 946.67**

Category	Constraints	Mix	Recommendations
Percent Moisture	40 <= Percent Moisture <= 55	66.9	Decrease percent moisture

Performance Summary



Performance Summary

Category	Constraints	Mix	Recommendations
Percent Moisture	40 <= Percent Moisture <= 55	66.9	Decrease percent moisture
Carbon : Nitrogen	30 <= C:N <= 45	35.3	C:N ratio OK
Bulk Density (lbs/yd^3)	No criteria set	814	

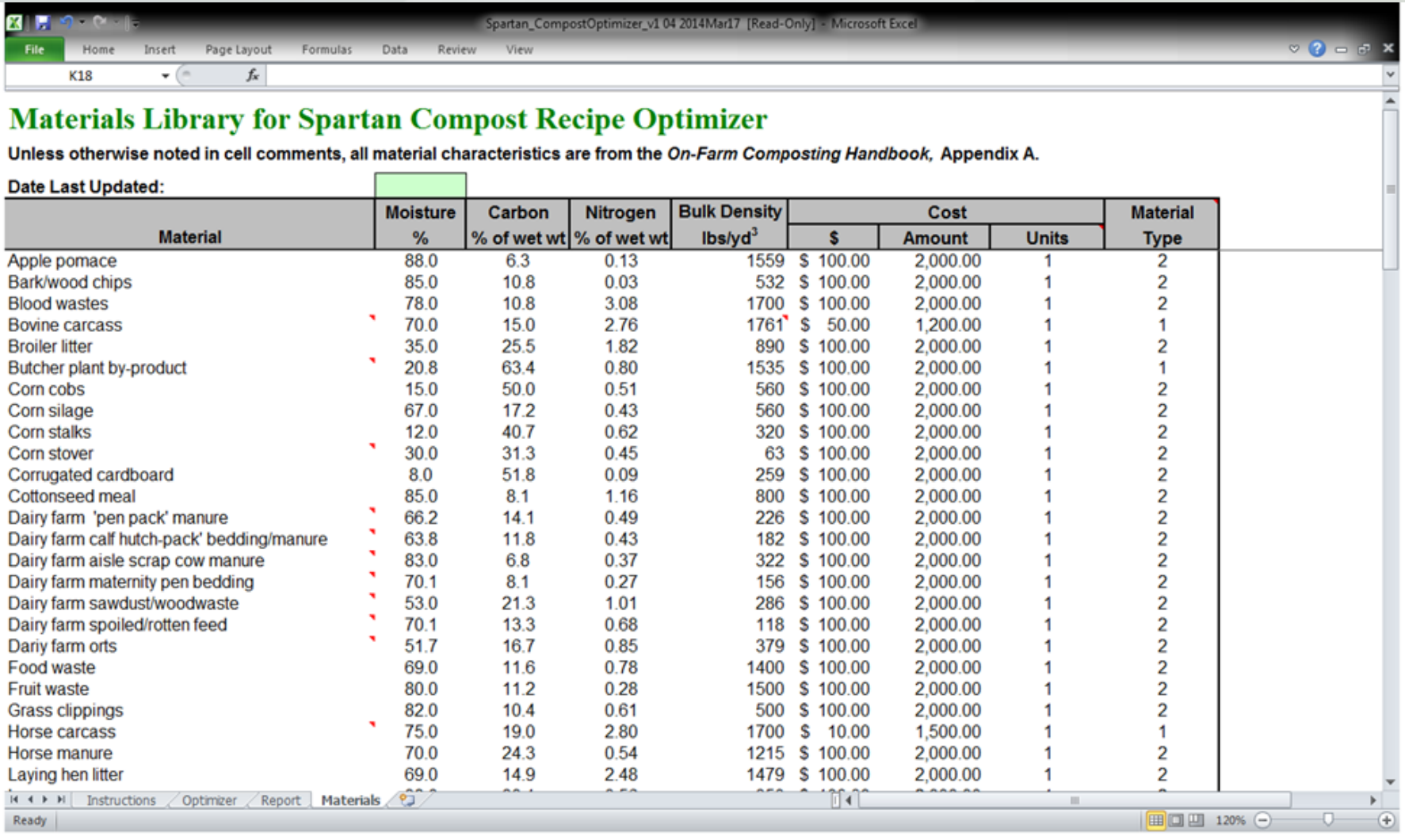
Materials Summary

	Material	Constraints	Units	Recommendations
1	Sheep carcass	Sheep carcass = 1000	lbs	Amount OK
2	Shrub trimmings	600 <= Shrub trimmings <= 20000	lbs	Amount OK
3	Horse manure	10000 <= Horse manure <= 20000	lbs	Amount OK
4	Corn silage	7000 <= Corn silage <= 20000	lbs	Amount OK
5	Sawdust	0 <= Sawdust <= 20000	lbs	Amount OK
6	Empty		lbs	
7	Empty		lbs	
8	Empty		lbs	

Animal Tissue Density

pounds of animal tissue / ft^3 of all other non-animal materials:	**1.7**

Materials Library



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Materials Library for Spartan Compost Recipe Optimizer

Unless otherwise noted in cell comments, all material characteristics are from the *On-Farm Composting Handbook*, Appendix A.

Date Last Updated:

Material	Moisture %	Carbon % of wet wt	Nitrogen % of wet wt	Bulk Density lbs/yd^3	Cost $	Cost Amount	Cost Units	Material Type
Apple pomace	88.0	6.3	0.13	1559	$ 100.00	2,000.00	1	2
Bark/wood chips	85.0	10.8	0.03	532	$ 100.00	2,000.00	1	2
Blood wastes	78.0	10.8	3.08	1700	$ 100.00	2,000.00	1	2
Bovine carcass	70.0	15.0	2.76	1761	$ 50.00	1,200.00	1	1
Broiler litter	35.0	25.5	1.82	890	$ 100.00	2,000.00	1	2
Butcher plant by-product	20.8	63.4	0.80	1535	$ 100.00	2,000.00	1	1
Corn cobs	15.0	50.0	0.51	560	$ 100.00	2,000.00	1	2
Corn silage	67.0	17.2	0.43	560	$ 100.00	2,000.00	1	2
Corn stalks	12.0	40.7	0.62	320	$ 100.00	2,000.00	1	2
Corn stover	30.0	31.3	0.45	63	$ 100.00	2,000.00	1	2
Corrugated cardboard	8.0	51.8	0.09	259	$ 100.00	2,000.00	1	2
Cottonseed meal	85.0	8.1	1.16	800	$ 100.00	2,000.00	1	2
Dairy farm 'pen pack' manure	66.2	14.1	0.49	226	$ 100.00	2,000.00	1	2
Dairy farm calf hutch-pack' bedding/manure	63.8	11.8	0.43	182	$ 100.00	2,000.00	1	2
Dairy farm aisle scrap cow manure	83.0	6.8	0.37	322	$ 100.00	2,000.00	1	2
Dairy farm maternity pen bedding	70.1	8.1	0.27	156	$ 100.00	2,000.00	1	2
Dairy farm sawdust/woodwaste	53.0	21.3	1.01	286	$ 100.00	2,000.00	1	2
Dairy farm spoiled/rotten feed	70.1	13.3	0.68	118	$ 100.00	2,000.00	1	2
Dariy farm orts	51.7	16.7	0.85	379	$ 100.00	2,000.00	1	2
Food waste	69.0	11.6	0.78	1400	$ 100.00	2,000.00	1	2
Fruit waste	80.0	11.2	0.28	1500	$ 100.00	2,000.00	1	2
Grass clippings	82.0	10.4	0.61	500	$ 100.00	2,000.00	1	2
Horse carcass	75.0	19.0	2.80	1700	$ 10.00	1,500.00	1	1
Horse manure	70.0	24.3	0.54	1215	$ 100.00	2,000.00	1	2
Laying hen litter	69.0	14.9	2.48	1479	$ 100.00	2,000.00	1	2

Instructions Optimizer Report Materials

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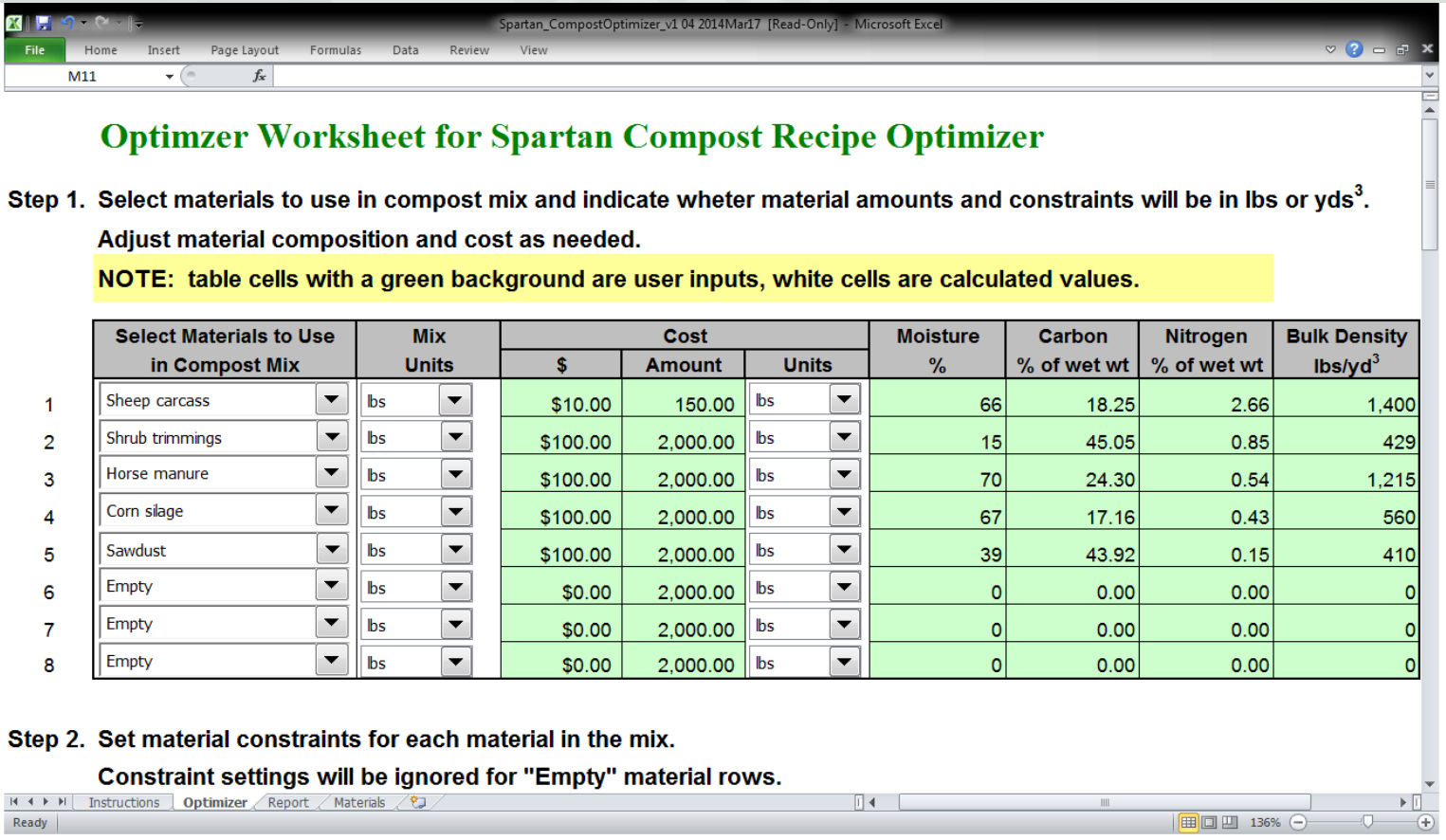
Spartan Compost Recipe Optimizer

- https://www.msu.edu/~rozeboom



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8	Empty	lbs	$0.00	2,000.00	lbs	0	0.00	0.00	0

Step 2. Set material constraints for each material in the mix.

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Instructions Optimizer Report Materials

Ready 136%

Management Approaches

- Intensively managed
  - Active composting
    - Rapid decomposition into CO_2, water, heat, minerals, and compost (humus)
    - Temperature increase to 120 to 150º F
    - Aerate when temperature decreases to <100º F for 7 days
    - Repeated cycles of activity accompanied by heat production
      - With repeated aeration and moisture management
    - Curing – less activity and heat
- Minimal management
  - Initially active, with allowed gradual decrease
    - Not aerated for months
    - Slower process, slowly transitioning to curing

Nutrient Loss to Leaching and Runoff

Effluent

- Any liquid leaving the compost site.
  - Managed through containment of runoff or avoiding run off (pile management or roof)

Nutrient Loss to Leaching and Runoff

- Leachate - The water moving downward through the compost mixture and reaching the compost-pad interface.
  - Results from poor siting and undersized systems for volume of mortality
- Avoided by –
  - not composting on soil
  - maximizing the layer underneath pile
  - managing compost system shape and/or type of system

Nutrient Losses to Emissions

- Aerobic – Active Phase
  - Heat, H_2O & CO_2 main products
  - Also produces varying amounts of CH_4, N_2O, and NH_3.
    - The emission of these is believed to be mediated by the compost system structure and management.

Air Emissions from In-Vessel Rotating Drum and Open Static Pile Composting of Swine Carcasses, Whole and Ground

Rozeboom, D.W., A.C. Fogeil, Z. Liu, W.J. Powers. 2012. Air emissions from in-vessel rotating drum and open static pile composting of swine carcasses, whole and ground. In Proceedings: 4th International Symposium on Managing Animal Mortality, Products, By Products and Associated Health Risk Dearborn, Michigan. May 24.

Appreciation expressed to National Pork Board for support of this research and Jolene Roth for photographs included in this presentation.

Emission measurements

- Emissions and temperature were measured continuously during two phases of composting
  - 20-d primary phase (1º; d 1 to 20)
  - 15-d secondary phase (2º; d 65 to 80 after initial formations of batches)
  - 8 sealed rooms at the Michigan State University Animal Air Quality Research Facility (AAQRF)

Beginning of 1º phase

End of 1º phase (d 20)

Between phases (45 d)

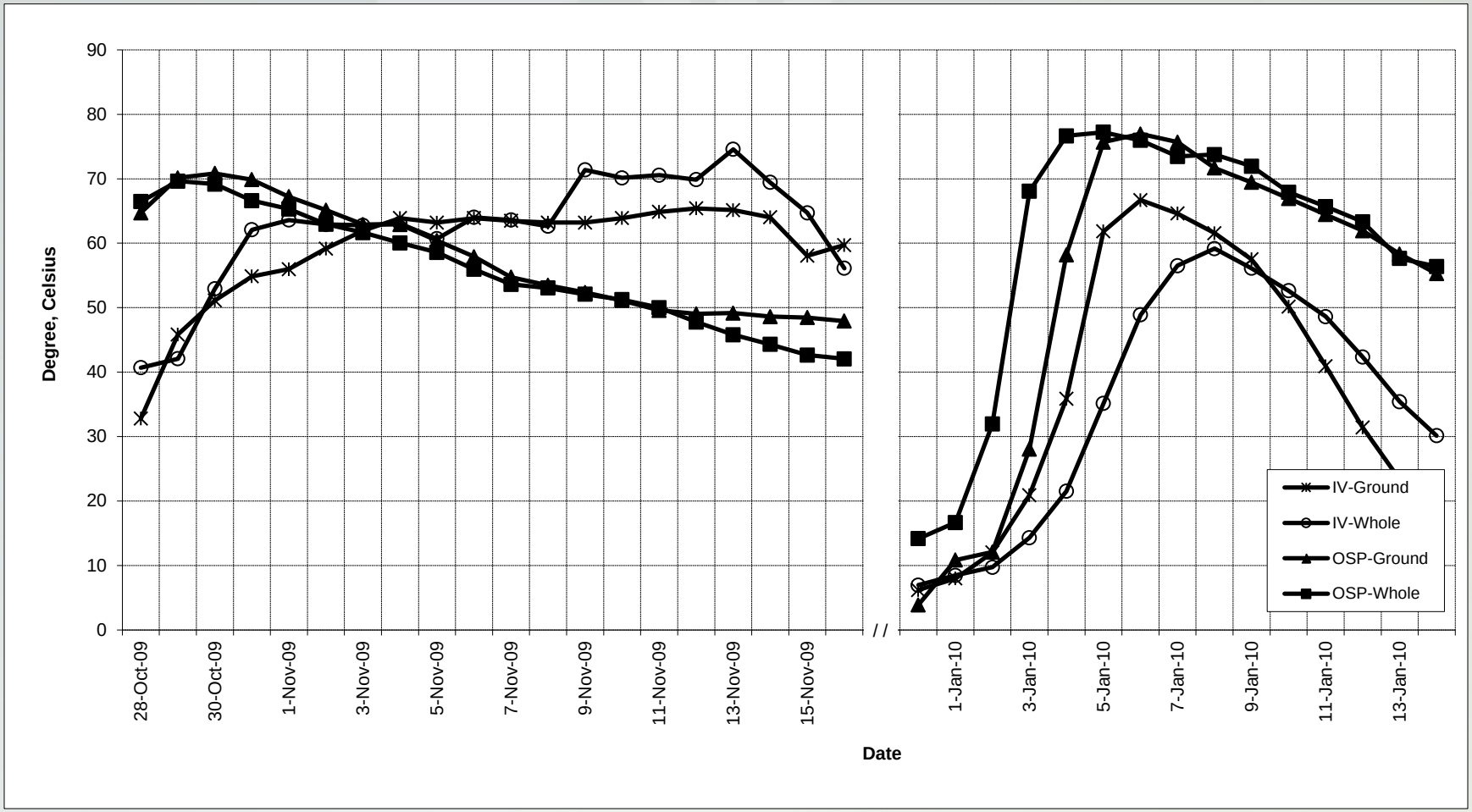
2º phase (d 65-80)

Compost Amendment

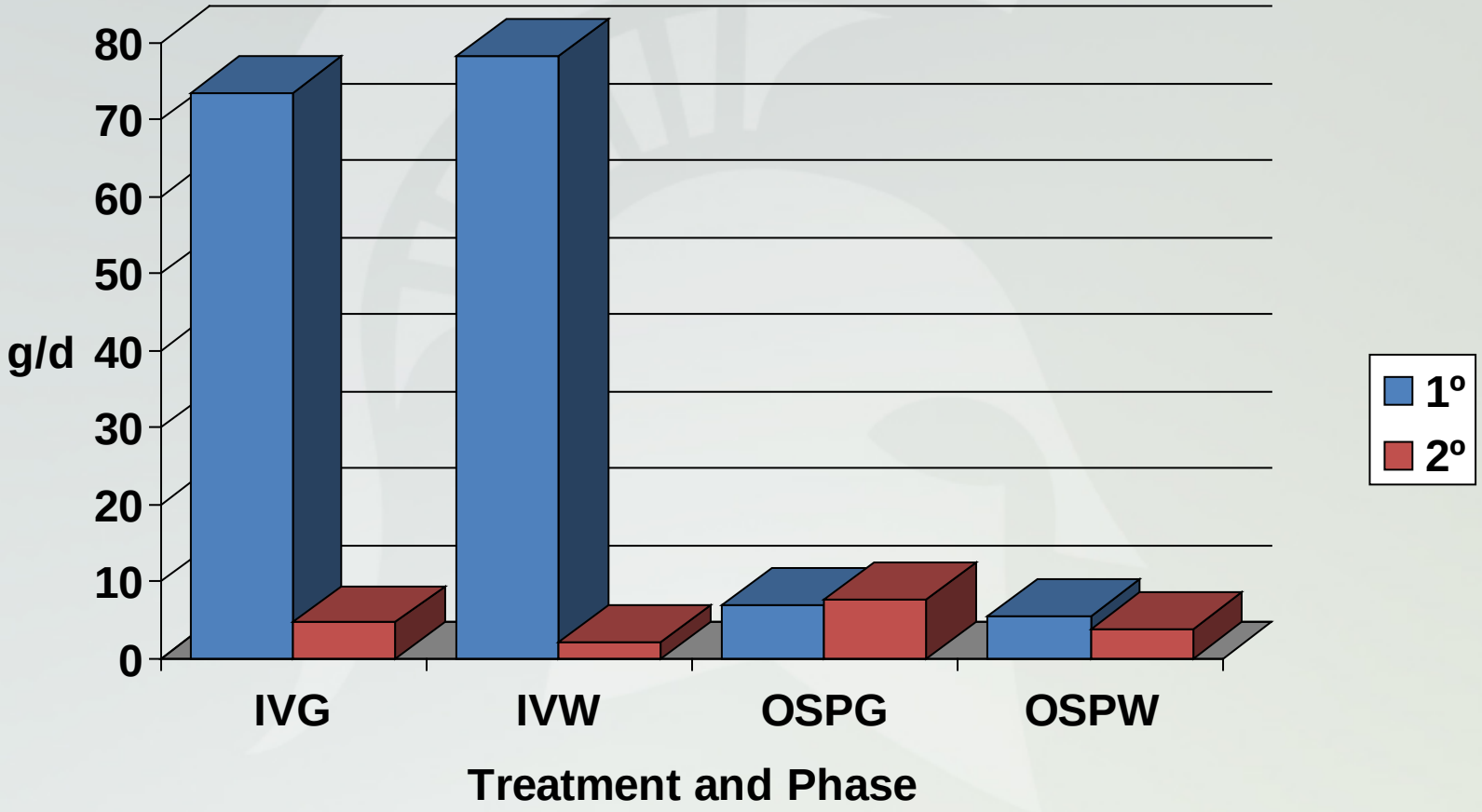
- Blend
  - Dairy manure compost
  - Horse stall bedding
  - Finished swine mortality compost
  - Dry wood shavings

Item	
Moisture, %	48.3
Mineral matter, %	5.91
N, %	0.761
P, %	0.176
P_2O_5, %	0.402
K, %	0.512
K_2O, %	0.617
Ca, %	0.864
Mg, %	0.190
Na, %	0.129
S, %	0.146
C, %	24.113
B, ppm	7.4
Fe, ppm	1308.6
Mn, ppm	86.8
Cu, ppm	16.5
Zn, ppm	46.7
C:N	31.8
pH	8.72

Compost temperature during 1º and 2º phases

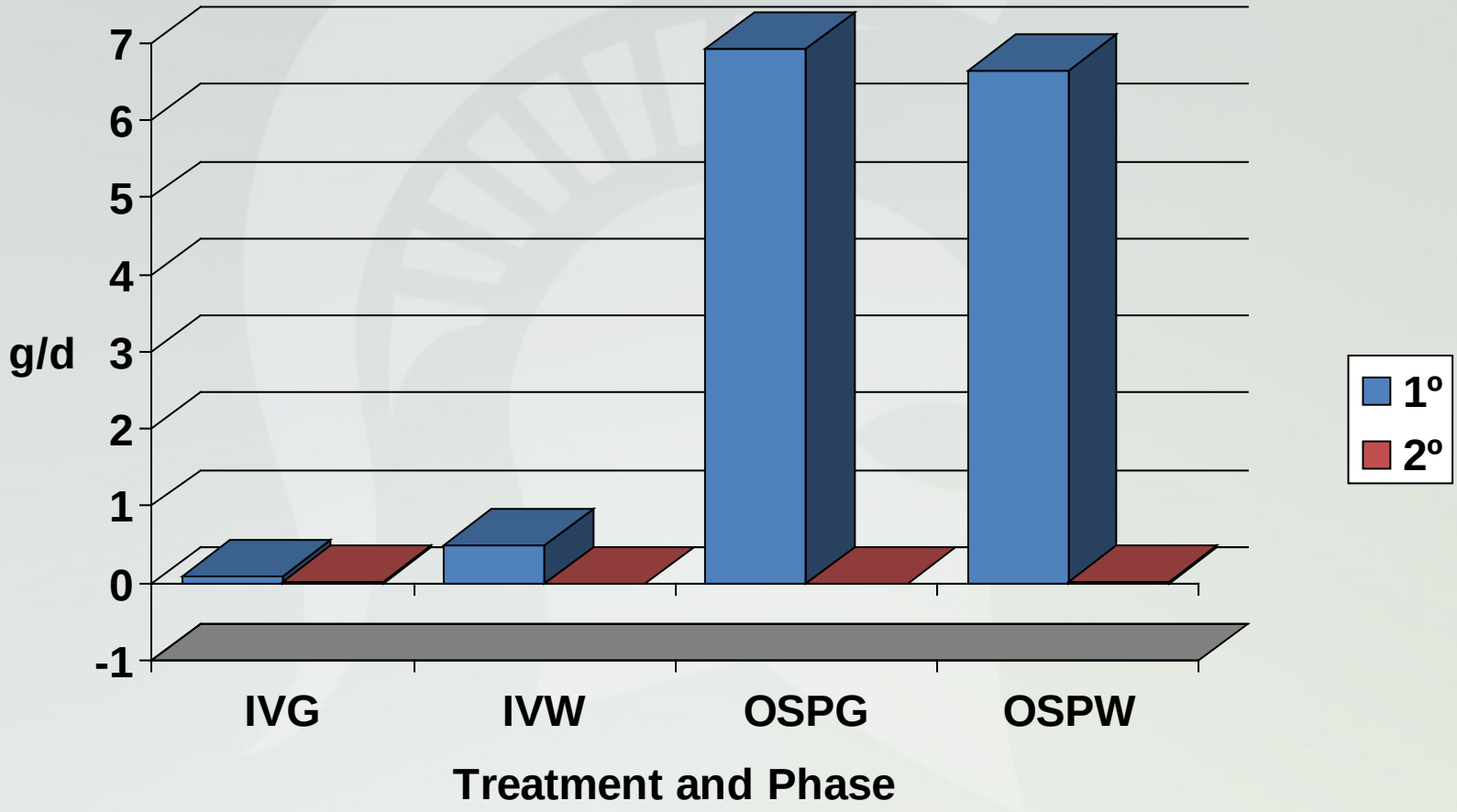


NH_3 mass



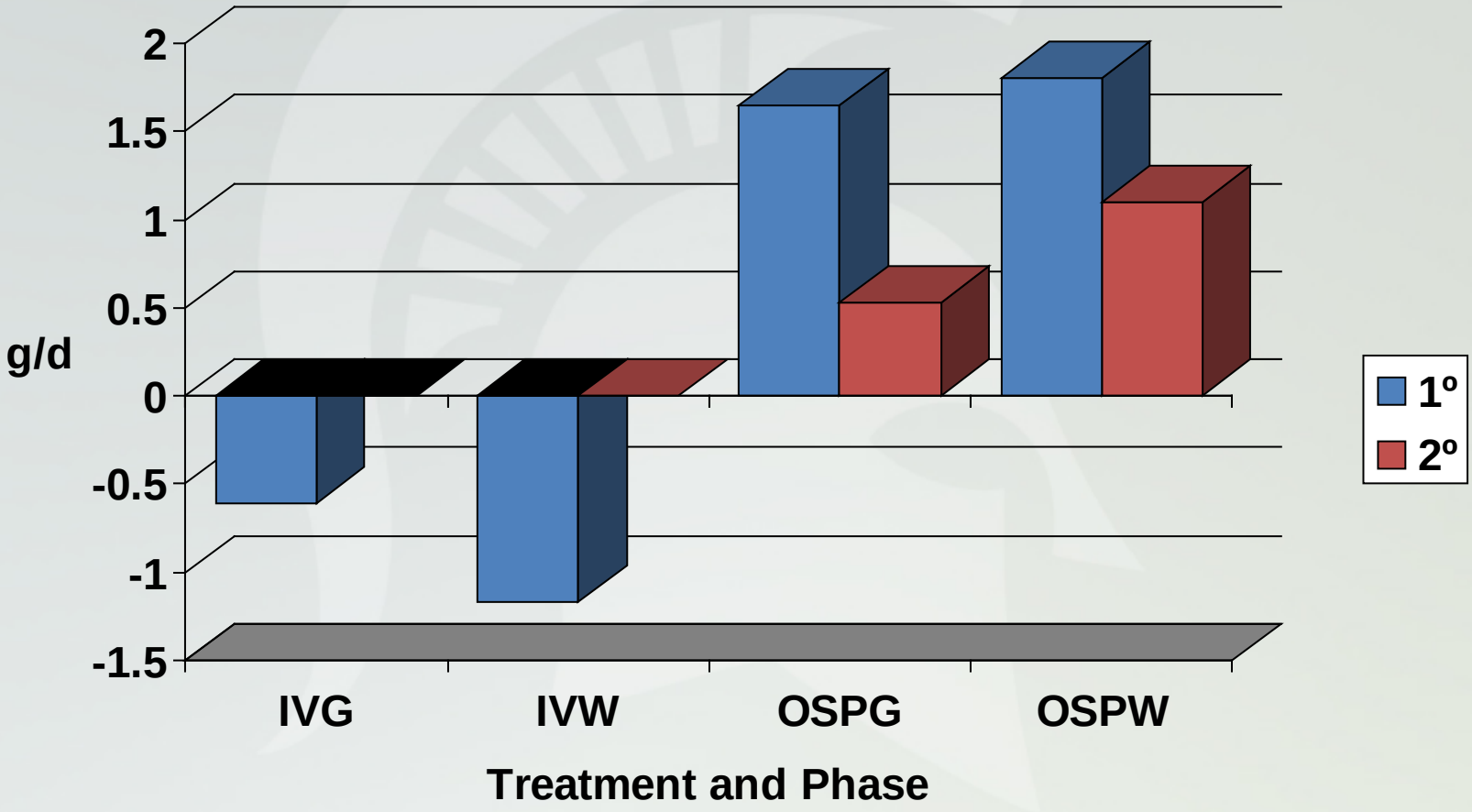
Treatment ($P < 0.001$)
Phase ($P < 0.001$)
IV vs. OSP ($P < 0.001$)

CH_4 mass



Treatment ($P < 0.001$)
Phase ($P < 0.001$)
IV vs. OSP ($P < 0.001$)

N_2O mass



Treatment ($P < 0.001$)
Phase ($P = 0.01$)
IV vs. OSP ($P < 0.001$)

Beginning of 1º phase

Brown and colleagues (2009)

- Using a feedstock mixture with a C:N ratio greater than 30:1
- Covering piles with finished compost
- Moisture content less than 55%

Brown, S., Cotton, M., Messner, S., Berry, F., Norem, D. 2009 Issue Paper, Methane Avoidance from Composting, Climate Action Reserve.

Nutrient loss to air conclusions

- Total emissions during the first weeks of very active composting are greater with the IV composting system.
- Passive vs Active OSP approaches
- No biofilter cover of OSP in this study
- When maturity is reached with an IV or OSP system may differ.
- Emissions during entire composting remains to be determined.

Final Conclusions

- Fertilizer value of animal tissue compost
- Must be managed to retain nutrients
- Formulating the correct feedstock recipe
- Maximizing sustained rate of decomposition
- No leachate
- Minimizing aerosolization of nutrients

Thank you!

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