cottonworks™

Closing the Loop

Cotton Composting for a Circular Textile Economy

Today's Speakers

Steven Pires
Associate Director of Sustainability
Cotton Incorporated

Jean Bonhatal
Director of the Cornell Waste Management Institute
Cornell University

Steve Richardson
Research & Development Consultant
Unless Collective

2021 Consumer *Lifestyle Monitor*™ Results

TOP ENVIRONMENTAL CONCERNS

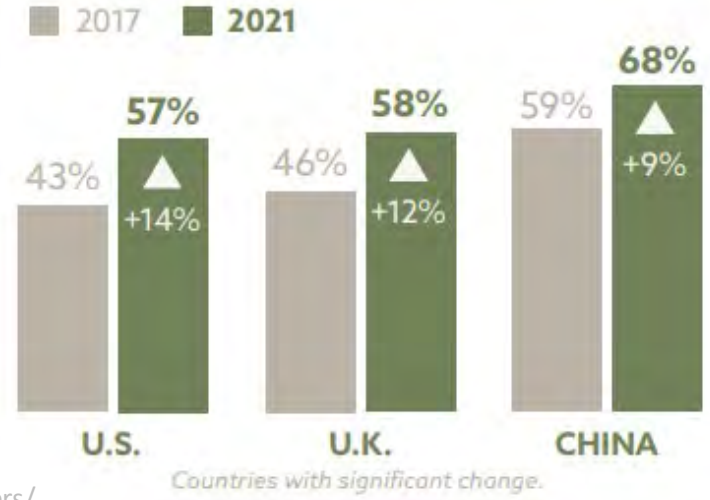
Percent rank issues as #1 or #2 environmental concern.

44%	43%	40%	27%	26%	21%
Climate Change	Water Scarcity or Pollution	Air Pollution	Ocean Waste & Overfishing	Land & Waste Mgmt	Population Growth

84% are motivated to take sustainable actions

SUSTAINABILITY IN CLOTHING PURCHASES

Percent saying sustainability has a moderate to great influence on their clothing purchases.



Countries with significant change.

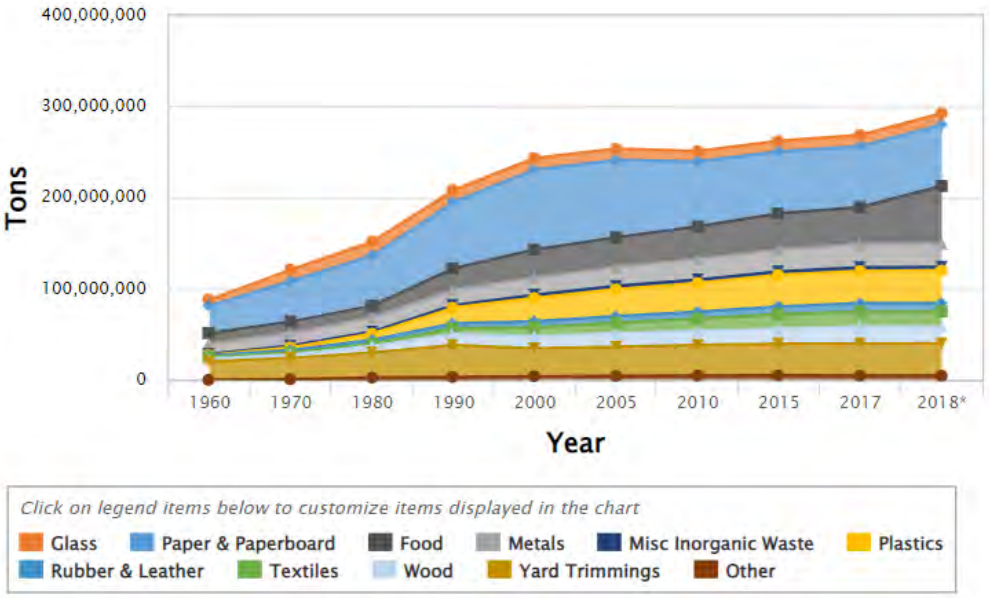
	2017	2021
GERMANY	64%	**62%**
ITALY	62%	**64%**
MEXICO	69%	**71%**
INDIA	81%	**81%**

cotton lifestyle monitor

Source: https://lifestylemonitor.cottoninc.com/sustainability-concerned-consumers/

Municipal Solid Waste Production in the U.S.

- In 2018, a total of 292.4 million tons of municipal solid waste (MSW) were generated in the U.S.
- ~4.9 lbs/person/day
- Textile waste was ~17 million tons
- Organic waste in landfills decomposes anaerobically creating significant methane emissions
- CH_4 is 28x more potent of a GHG than CO_2
- Landfills are the primary MSW pathway in the U.S.
- Landfills are the third-most contributor to CH_4 emissions



Sources:
Text: https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/national-overview-facts-and-figures-materials, IPCC (2013). AR5: Anthropogenic and Natural Radiative Forcing: Supplementary Material.; M. K. Jaunich, J. W. Levis, J. F. Decarolis, M. A. Barlaz, and S. R. Ranjithan, "Solid Waste Management Policy Implications on Waste Process Choices and Systemwide Cost and Greenhouse Gas Performance," Environ. Sci. Technol., vol. 53, no. 4, pp. 1766–1775, 2019; US EPA, "Data Highlights: Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2021," 2021
Photo: Getty Images
Graph: https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/national-overview-facts-and-figures-materials

U.S. Cotton's 10-Year Sustainability Goals

Increasing Soil Carbon by

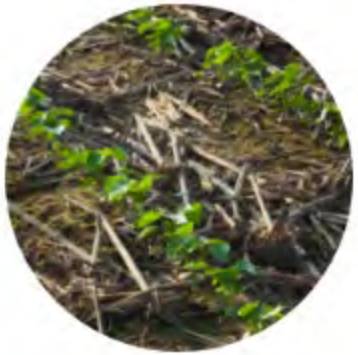
↑30%

Increasing Land Use Efficiency by

↑13%

Decreasing Greenhouse Gas Emissions by

↓39%



Decreasing Soil Loss per Acre by

↓50%

Decreasing Water Use by

↓18%

Decreasing Energy Use by

↓15%

Sources:
Photos: Getty Images
Goals: https://cottontoday.cottoninc.com/wp-content/uploads/2018/09/Cotton_Sustainability_2018.pdf

The Problem

Take

Make

Waste

Linear systems

Image: Courtesy Dr. Jesse Daystar

What is the circular economy?

- **Circular economy** – an **economic system** that uses a systemic approach to maintain **a circular flow of resources**, by recovering, retaining or adding to their **value**, while contributing to **sustainable development**

- **Circularity** – degree of alignment with the principles for a **circular economy**

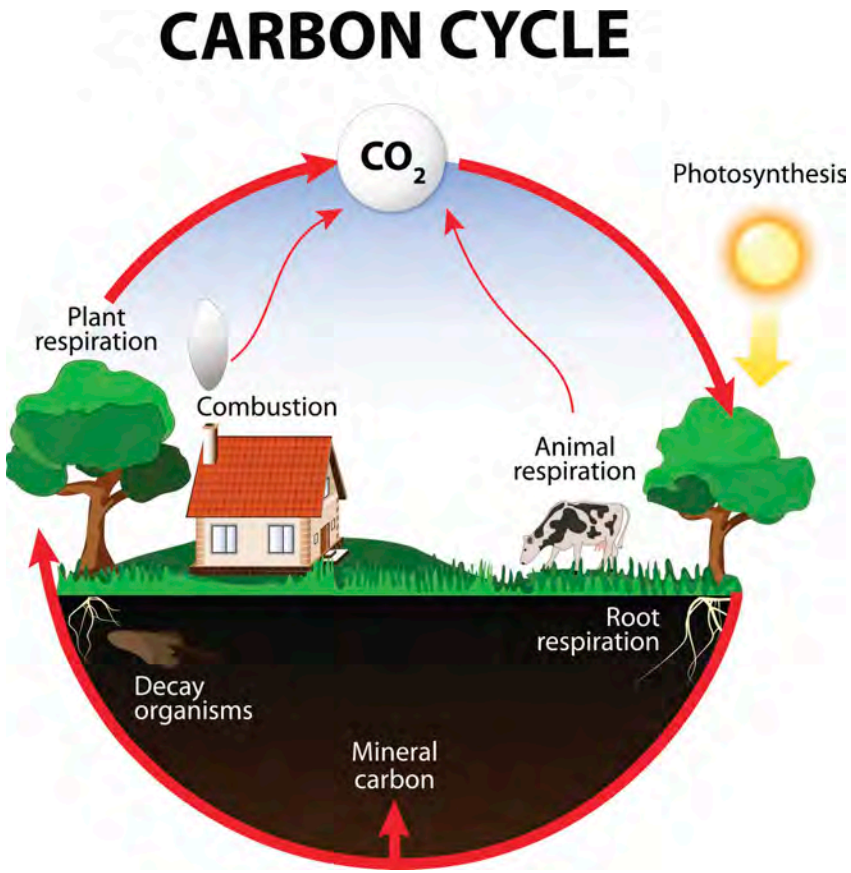


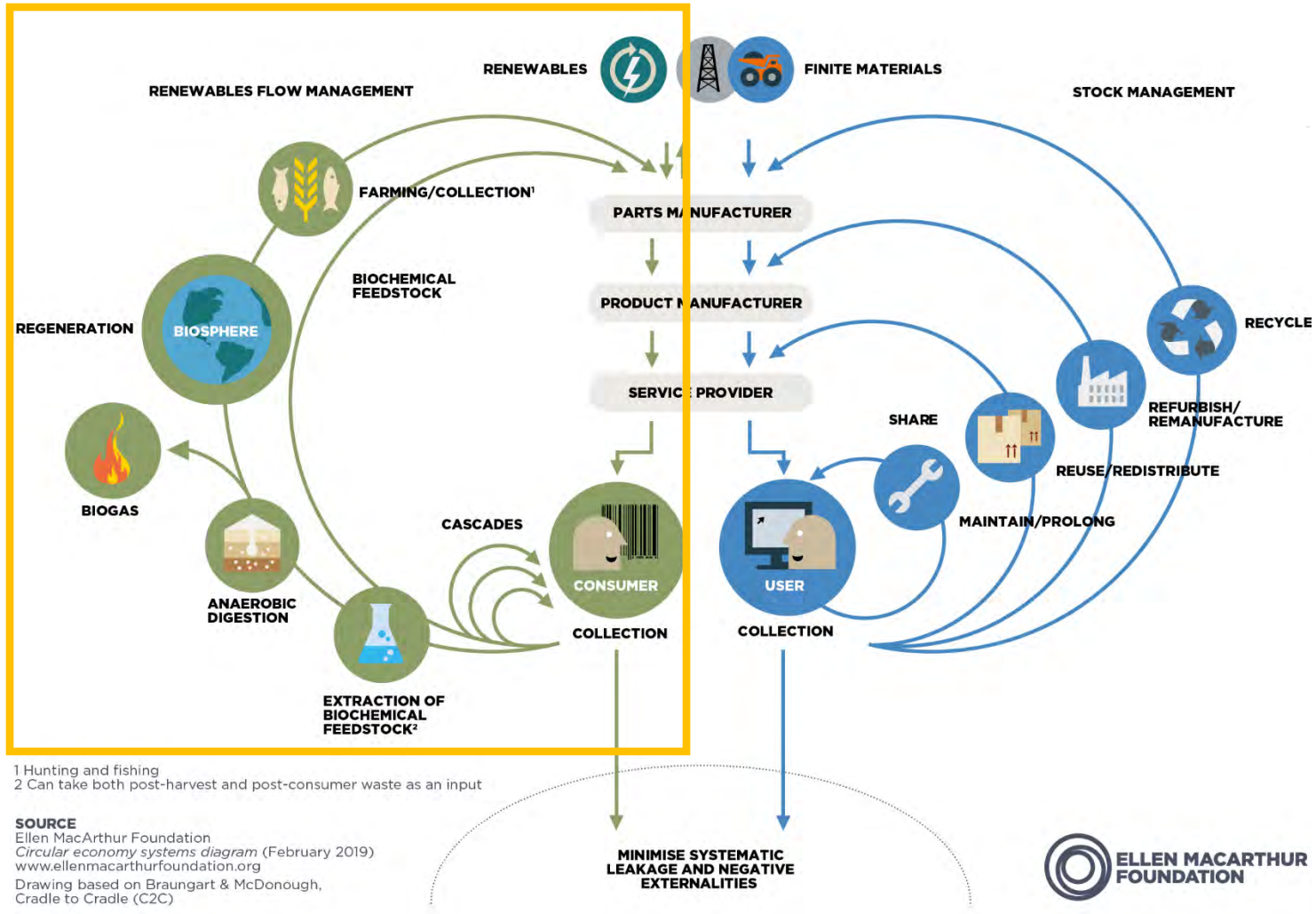
Image: Getty

Source: ISO/DIS 59020 Circular economy – Measuring and addressing circularity (under development)

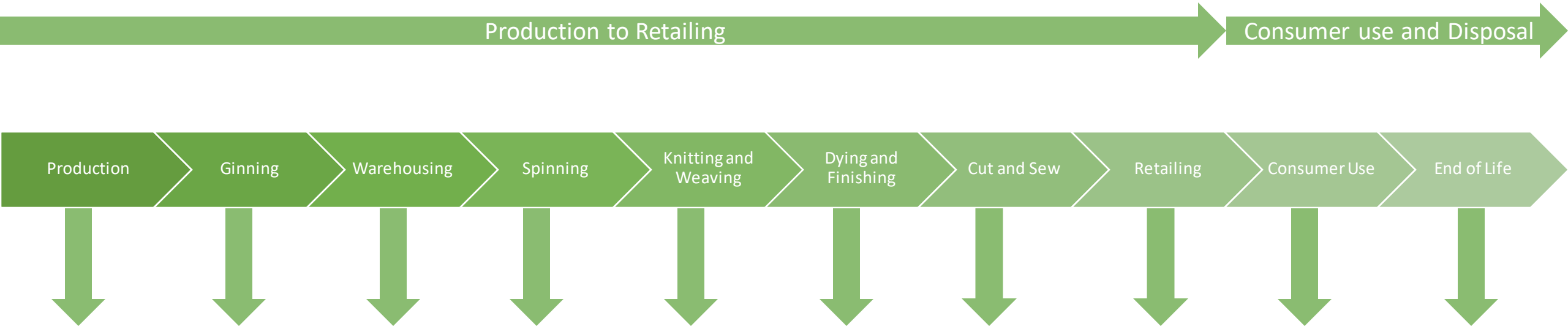
How does cotton fit into the circular economy?

Where does cotton fit in?

- Textile recycling (up and downcycling)
- Cotton clothing composting: regeneration step



The Cotton Supply Chain & Circular Perspective



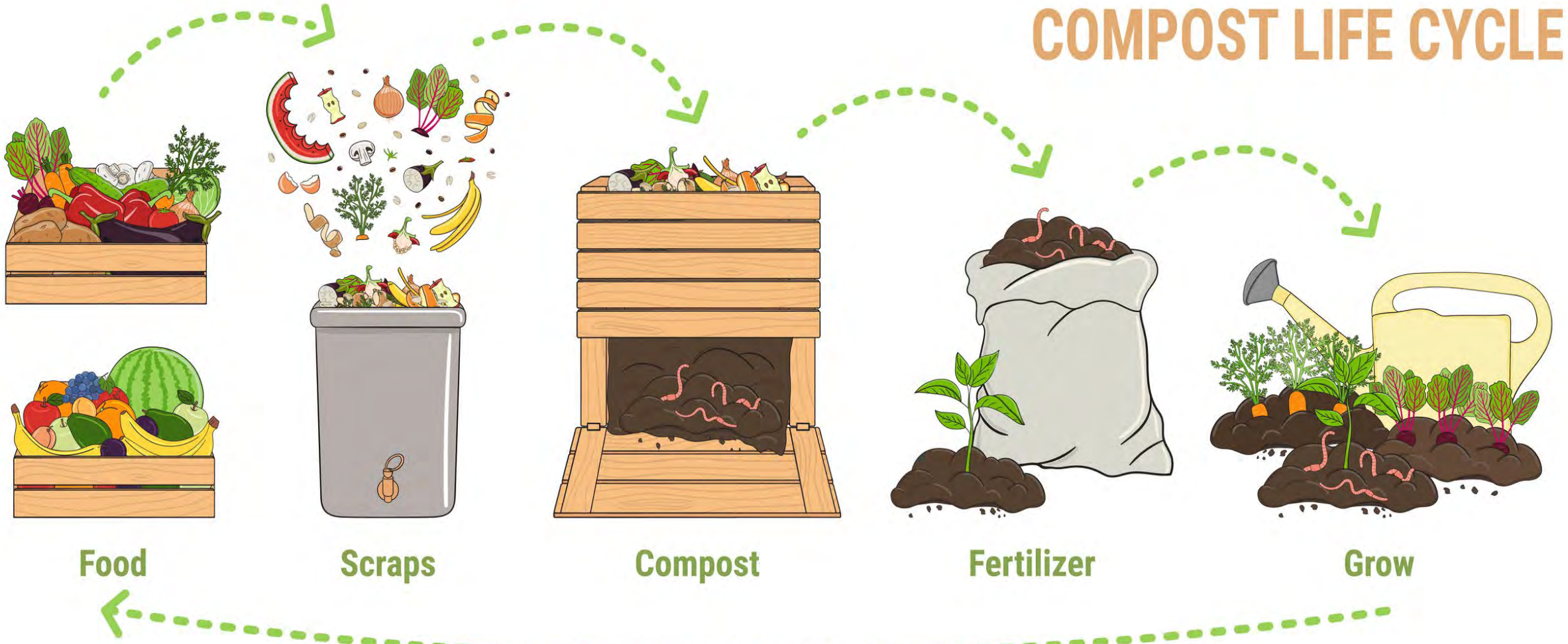
- Circular perspective
  - Limit losses at each supply chain step & optimize the use of co-products and by-products

Source: Adapted from, Cotton Incorporated (2017). LCA Update of cotton fiber and fabric life cycle. https://cottontoday.cottoninc.com/wp-content/uploads/2019/11/2016-LCA-Full-Report-Update.pdf

Does cotton clothing decompose in composting environments?

Getty Images

What is composting?



Getty Images

Cotton Circularity and Composting

- Cotton is a natural fiber that is inherently circular – grown from sunlight, water and earth – that will biodegrade back into soil
- Composting studies from 2010 show cotton fabrics are compostable in industrial compost facilities [1]
- Continuation of this research is ongoing, focused on denim with Cornell University
  - Evaluated 8 different denim fabrics with varying dye processes
  - Industrial compost and lab conditions evaluated

Earthworms, soil microbes, enzymes

2022 project photos courtesy of Cornell University

1: Li, Lili, M. F., & Browning, K. J. (2010). Biodegradability Study on Cotton and Polyester Fabrics, *5*(4). Retrieved from https://journals.sagepub.com/doi/abs/10.1177/155892501000500406

Composting at Cornell

Images: courtesy of Cotton Incorporated research at Cornell

100% cotton

1 month in hot compost

3 months

4 months

Images: courtesy of Cotton Incorporated research at Cornell

Images: courtesy of Cotton Incorporated research at Cornell

UNLESS

Steve Richardson

R&D Consultant, Unless Collective

Compost Trials @ Agromin

Post Industrial Cotton Textile Waste

Summer 2022

Unless cotton/cellulose materials for compost trials. Hoodie cut waste including paper pattern pieces, canvas upper materials, and Clarus materials from NFW. These should all compost easily. We need to provide SDSs for any dyes and finishes.

WALLACE LABORATORIES, LLC
365 Coral Circle
El Segundo, CA 90245
phone (310) 615-0116 fax (310) 640-6863

June 10, 2022

Dave Green, dave@agromin.com
Ray Richards, ray@agromin.com
Agromin
201 Kinetic Drive
Oxnard, CA 93030

RE: Unless Compost Feedstock, Our ID No. 22-160-20
Received June 8, 2022

Dear Dave and Ray,

The pH is modestly acidic at 6.62.

Salinity is 7.24 millimho/cm. Chloride is 1,062 parts per million in the saturation extract.

Nitrogen and sulfur are moderate. Phosphorus, potassium, iron, manganese, zinc, copper, boron and magnesium are high.

Sodium is moderately high. SAR (sodium adsorption ratio) is 4.0.

The organic matter content is 43.8%. The carbon:nitrogen ratio is 17.5.

The as-received bulk density is 41.2 pounds per cubic foot.

Sincerely,

Garn A. Wallace, Ph. D.
GAW:n

WALLACE LABS	MEDIA REPORT	Print Date	Jun. 9, 2022	Receive Date	6/8/22
365 Coral Circle	Location	Agromin			
El Segundo, CA 90245	Requester	Dave Green & Ray Richards			
(310) 615-0116	graphic interpretation: * very low, ** low, *** moderate				
ammonium bicarbonate/DTPA		**** high, ***** very high			
extractable - mg/kg soil	Sample ID Number	22-160-20			
Interpretation of data	Sample Description	Unless Compost Feedstock			
low medium high	elements		graphic		
0 - 12 16 - 28 32 - 44	phosphorus	414.91	*****		
0-240 240-500 500-700	potassium	5,377.57	*****		
0- 12 12- 20 over 20	iron	75.65	*****		
0 - 2 3 - 4 over 5	manganese	72.92	*****		
0 - 4 4 - 6 over 6	zinc	55.43	*****		
0- 0.5 0.6 - 1 over 1	copper	7.14	*****		
0 - 1 1 - 2 over 2	boron	4.88	*****		
	calcium	1,807.83	****		
	magnesium	781.58	*****		
	sodium	1,059.90	****		
	sulfur	887.26	***		
	molybdenum	0.50	****		
	nickel	1.15	*		
The following trace	aluminum	n d	*		
elements may be toxic	arsenic	0.94	*		
The degree of toxicity	barium	1.37	*		
depends upon the pH of	cadmium	0.35	*		
the soil, soil texture,	chromium	n d	*		
organic matter, and the	cobalt	0.56	*		
concentrations of the	lead	8.67	**		
individual elements as well	lithium	1.25	*		
as to their interactions	mercury	n d	*		
	selenium	n d	*		
The pH optimum depends	silver	n d	*		
upon soil organic	strontium	7.70	*		
matter and soil content-	tin	n d	*		
	vanadium	1.19	*		
under 5 may be too acidic					
6 to 7 may be good	Saturation Extract				
over 8.0 is too alkaline	pH value	6.62	***		
The ECe is a measure of	ECe (milli-	7.24	*****		
the media salinity:	mho/cm)		millieq/l		
good at 200 ppm	calcium	365.8	18.3		
good at 25 ppm	magnesium	180.0	14.9		
	sodium	373.1	16.2		
good at 25 ppm	ammonium as N	24.9	1.8		
good at 150 ppm	potassium	1343.3	34.4		
	cation sum		85.5		
problems over 150 ppm	chloride	1,062	29.9		
good at 100 ppm	nitrate as N	33.1	2.4		
good at 40 ppm	phosphorus as P	27.7	0.9		
toxic over 800	sulfate as S	374.2	23.4		
	anion sum		56.6		
toxic over 1 for many plants	boron as B	2.01	*****		
increasing problems start at 3	SAR	4.0	***		
est. gypsum requirement-lbs./cubic yard		18			
	Total Nitrogen, dry weight basis	1.26%			
	Total Carbon, dry weight basis	21.94%			
	Carbon:Nitrogen Ratio	17.5			
	bulk density pounds/cubic ft as received	41.2			
	lime (calcium carbonate)	no			
	organic matter, dry weight basis	43.89%			
	moisture content of media	13.8%			
	half saturation percentage	104.6%			

Elements are expressed as mg/kg dry soil or mg/l for saturation extract.
pH and ECe are measured in a saturation paste extract. nd means not detected.

June 8-9, 2022

Unless cotton cutting waste from garment production was tested as compost feedstock to determine the mix of organic matter needed for safe composting and use in healthy soil products.

June 22, 2022

Unless Materials were mixed with organic matter and then shredded into a test pile.

July 22, 2022

The test pile was “opened” and we found partly composted textile scraps near the surface and decided to let the pile continue to “cook” for a longer time period.

July 28, 2022

The test pile was “opened” again, and the compost had progressed further, but we still wanted to see a finer consistency so decided to leave it for the full 45 days.

August 9, 2022

Although the temperature in the pile was still high indicating that it was still actively composting, we decided to separate the pile into finished compost and “overs” which are parts of the pile over 2” square which have not composted. Overs are put back into shredding for future compost batches.

Finished Compost

Overs

August 9, 2022

In the Overs pile, we were able to pull out textiles that had not composted, textiles where the color had changed from Navy to Yellow during composting, and trims that had not composted.

August 9, 2022

Samples of the finished compost were taken for testing to ensure the compost is safe for use in healthy soil products.

September 1, 2022

Test results verified that the compost made from Unless cotton textile waste was safe for use in healthy soil products.

US COMPOSTING COUNCIL
Seal of Testing Assurance

Agromin (Oxnard)
Dave Green
201 Kinetic Drive
Oxnard
CA 93030

Date Sampled/Received: 01 Sep. 22 / 02 Sep. 22

Product Identification
Compost 100

COMPOST TECHNICAL DATA SHEET

LABORATORY: Soil Control Lab; 42 Hangar Way; Watsonville, CA 95076 tel: 831.724.5422 fax: 831.724.3188

Compost Parameters	*Reported as (units of measure)*	*Test Results*	*Test Results*
Plant Nutrients:	%, weight basis	Not reported	Not reported
Moisture Content	%, wet weight basis	38.3	
Organic Matter Content	%, dry weight basis	41.3	
pH	units	8.44	
Soluble Salts *(electrical conductivity EC $_{1:5}$)*	dS/m (mmhos/cm)	3.6	
Particle Size or Sieve Size	maximum aggregate size, inches	0.64	
Stability Indicator *(respirometry)*			*Stability Rating:*
CO_2 Evolution	mg CO_2-C/g OM/day	4.2	Moderately Un-Stable
	mg CO_2-C/g TS/day	1.7	
Maturity Indicator (bioassay)			
Percent Emergence	average % of control	100.0	
Relative Seedling Vigor	average % of control	100.0	
Select Pathogens	PASS/FAIL: per US EPA Class A standard, 40 CFR § 503.32(a)	Pass	*Fecal coliform*
		Pass	*Salmonella*
Trace Metals	PASS/FAIL: per US EPA Class A standard, 40 CFR § 503.13, Tables 1 and 3	Pass	*As,Cd,Cr,Cu,Pb,Hg*
			Mo,Ni,Se,Zn

Participants in the US Composting Council's Seal of Testing Assurance Program have shown the commitment to test their compost products on a prescribed basis and provide this data, along with compost end use instructions, as a means to better serve the needs of their compost customers.

Laboratory Group: Sep22A Laboratory Number: 2090046-1/1

Analyst: Assaf Sadeh www.controllabs.com

US COMPOSTING COUNCIL
Seal of Testing Assurance

Agromin (Oxnard)
Dave Green
201 Kinetic Drive
Oxnard
CA 93030

Date Sampled/Received: 01 Sep. 22 / 02 Sep. 22

Product Identification
Compost 100

COMPOST TECHNICAL DATA SHEET

LABORATORY: Soil Control Lab; 42 Hangar Way; Watsonville, CA 95076 tel: 831.724.5422 fax: 831.724.3188

Compost Parameters	*Reported as (units of measure)*	*Test Results*	*Test Results*
Plant Nutrients:	%, weight basis	%, wet weight basis	%, dry weight basis
Nitrogen	Total N	0.78	1.3
Phosphorus	P_2O_5	0.43	0.70
Potassium	K_2O	0.69	1.1
Calcium	Ca	1.3	2.1
Magnesium	Mg	0.35	0.56
Moisture Content	%, wet weight basis	38.3	
Organic Matter Content	%, dry weight basis	41.3	
pH	units	8.44	
Soluble Salts *(electrical conductivity EC $_{1:5}$)*	dS/m (mmhos/cm)	3.6	
Particle Size or Sieve Size	% under 9.5 mm, dry basis	99.3	
Stability Indicator *(respirometry)*			*Stability Rating:*
CO_2 Evolution	mg CO_2-C/g OM/day	4.2	Moderately Un-Stable
	mg CO_2-C/g TS/day	1.7	
Maturity Indicator (bioassay)			
Percent Emergence	average % of control	100.0	
Relative Seedling Vigor	average % of control	100.0	
Select Pathogens	PASS/FAIL: per US EPA Class A standard, 40 CFR § 503.32(a)	Pass	*Fecal coliform*
		Pass	*Salmonella*
Trace Metals	PASS/FAIL: per US EPA Class A standard, 40 CFR § 503.13, Tables 1 and 3	Pass	*As,Cd,Cr,Cu,Pb,Hg*
			Mo,Ni,Se,Zn

Participants in the US Composting Council's Seal of Testing Assurance Program have shown the commitment to test their compost products on a prescribed basis and provide this data, along with compost end use instructions, as a means to better serve the needs of their compost customers.

Laboratory Group: Sep22A Laboratory Number: 2090046-1/1

Analyst: Assaf Sadeh www.controllabs.com

US COMPOSTING COUNCIL
Seal of Testing Assurance

Caltrans

Agromin (Oxnard)
Dave Green
201 Kinetic Drive
Oxnard CA 93030

Product Identification:
Compost 100

Date Sampled/Received: 01 Sep. 22 / 02 Sep. 22

COMPOST TECHNICAL DATA SHEET for Caltrans

LABORATORY: Soil Control Lab, 42 Hangar Way, Watsonville, CA 95076 tel (831) 724-5422 fax (831) 724-3188 www.controllabs.com

Compost Parameters	*Test Results*	*Reported as (units of measure)*	*TMECC Test Method*
pH	8.44	Unitless	04.11-A 1:5 Slurry pH
Soluble Salts (electrical conductivity)	3.6	dS/m (mmhos/cm)	04.10-A 1:5 Slurry Method Mass Basis
Moisture content	38.3	%, wet weight basis	03.09-A - Total Solids and Moisture
Organic Matter Content	41.3	%, dry weight basis	05.07-A Loss-on-Ignition Organic Matter Method (LOI)
Maturity Indicator (bioassay)			
Percent Emergence	100.0	average % of control	05.05-A Germination and vigor
Relative Seedling Vigor	100.0	average % of control	
Stability Indicator	4.2	mg CO2-C/g OM/day	05.08-B Carbon Dioxide Evolution Rate
Particle Size	99.3	%, dry weight passing through 9.5 mm	02.02-B Simple Sieving for Aggregate Size Classification
Pathogens	Pass	PASS/FAIL: Per US EPA Class A standard, 40 CFR 503.32(a)	07.01-B Fecal coliforms
Pathogens	Pass	PASS/FAIL: Per US EPA Class A standard, 40 CFR 503.32(a)	07.02 Salmonella
Physical Contaminants	None Detected	%, dry weight basis	02.02-C - Man-Made Inerts Total content
Physical Contaminants	None Detected	%, dry weight basis	02.02-C - Man-Made Inerts Sharps content
Heavy Metals Content	Pass	PASS/FAIL: Per US EPA Class A 40 CFR 503.13, tables 1 and 3	04.06-Heavy Metals standard and Hazardous Elements

Participants in the US Composting Council's Seal of Testing Assurance Program have shown the commitment to test their compost products on a prescribed basis and provide this data, along with compost end use instructions, as a means to better serve the needs of their compost customers.

For additional information pertaining to compost use, the specific compost parameters tested for within the Seal of Testing assurance Program, or the program in general, log on to the US Composting Council's TMECC web-site at http://www.tmecc.org.

This compost product has been sampled and tested as required by the Seal of Testing Assurance Program on the United States Composting Council (USCC), using certain methods from the "Test Methods for the Examination of Compost and Composting" manual. Test results are available upon request by contacting the compost producer (address at top of page). The USCC makes no warranties regarding this product or its consent, quality, or suitability for any particular use.

Laboratory Group: Sep22A Laboratory Number: 2090046-1/1

Analyst: Assaf Sadeh www.controllabs.com

ANALYTICAL CHEMISTS and BACTERIOLOGISTS

SOIL CONTROL LAB

TEL: 831-724-5422
FAX: 831-724-3188
www.controllabs.com

Account #: 2090046-1/1-4899
Group: Sep22A #25
Reporting Date: September 12, 2022

Agromin (Oxnard)
201 Kinetic Drive
Oxnard, CA 93030
Attn: Dave Green

Date Received: 02 Sep. 22
Sample Identification: 22-SP-A-08 Compost 100
Sample ID #: 2090046 - 1/1

Nutrients	Dry wt.	As Rcvd.	units
Total Nitrogen:	1.3	0.78	%
Ammonia (NH_4-N):	260	160	mg/kg
Nitrate (NO_3-N):	< 1.0	< 0.6	mg/kg
Org. Nitrogen (Org.-N):	1.3	0.76	%
Phosphorus (as P_2O_5):	0.70	0.43	%
Phosphorus (P):	3100	1900	mg/kg
Potassium (as K_2O):	1.1	0.69	%
Potassium (K):	9300	5700	mg/kg
Calcium (Ca):	2.1	1.3	%
Magnesium (Mg):	0.56	0.35	%
Sulfate (SO_4-S):	190	120	mg/kg
Boron (Total B):	43	26	mg/kg
Moisture:	0	38.3	%
Sodium (Na):	0.18	0.11	%
Chloride (Cl):	0.36	0.22	%
pH Value:	NA	8.44	unit
Bulk Density:	21	35	lb/cu ft
Carbonates ($CaCO_3$):	28	17	lb/ton
Conductivity (EC5):	3.6	NA	mmhos/cm
Organic Matter:	41.3	25.5	%
Organic Carbon:	19.0	12.0	%
Ash:	58.7	36.3	%
C/N Ratio	15	15	ratio
AgIndex	6	6	ratio

Stability Indicator:

CO2 Evolution	Respirometery
mg CO_2-C/g OM/day	4.2
mg CO_2-C/g TS/day	1.7
Stability Rating	moderately unstable

Maturity Indicator: Cucumber Bioassay

Compost:Vermiculite (v:v)	1:2
Emergence (%)	100
Seedling Vigor (%)	100
Description of Plants	*healthy*

Pathogens	Results	Units	Rating
Fecal Coliform	< 7.5	MPN/g	*pass*
Salmonella	< 3	MPN/4g	*pass*

Date Tested: 02 Sep. 22

Physical Contaminants**	% by dry wt
Total Plastic	< 0.1
Film Plastic	< 0.1
Glass	< 0.1
Metal	< 0.1
Sharps	ND
Total	< 0.5

Metals	Dry wt.	EPA Limit	units
Aluminum (Al):	5400	-	mg/kg
Arsenic (As):	3.1	41	mg/kg
Cadmium (Cd):	2.0	39	mg/kg
Chromium (Cr):	19	-	mg/kg
Cobalt (Co)	4.6	-	mg/kg
Copper (Cu):	38	1500	mg/kg
Iron (Fe):	12000	-	mg/kg
Lead (Pb):	11	300	mg/kg
Manganese (Mn):	220	-	mg/kg
Mercury (Hg):	< 1.0	17	mg/kg
Molybdenum (Mo):	3.5	75	mg/kg
Nickel (Ni):	16	420	mg/kg
Selenium (Se):	< 1.0	100	mg/kg
Zinc (Zn):	110	2800	mg/kg

Size Distribution

MM	% by weight
> 50	0.0
25 to 50	0.0
16 to 25	0.0
9.5 to 16	0.7
6.3 to 9.5	4.2
4.0 to 6.3	8.9
2.0 to 4.0	20.6
< 2.0	65.7

**Greater than 4mm in size (Sharps greater than 2mm)

Analyst: Assaf Sadeh

*Sample was received and handled in accordance with TMECC procedures.

Account No.: 2090046 - 1/1 - 4899
Group: Sep22A No. 25

Date Received 02 Sep. 22
Sample i.d. 22-SP-A-08 Compost 100
Sample I.d. No. 1/1 2090046

INTERPRETATION:

Is Your Compost Stable?

Respiration Rate
4.2 mg CO2-C/ g OM/day
< Stable >|<Moderately Unstable>|< Unstable >|< High For Mulch

Is Your Compost Mature?

AmmoniaN/NitrateN ratio
270 Ratio
VeryMature>|< Mature >|< Immature

Ammonia N ppm
260 mg/kg dry wt.
VeryMature>|< Mature >|< Immature

Nitrate N ppm
< 1.0 mg/kg dry wt.
< Immature >|< Mature

Cucumber Emergence
100.0 percent
< Immature >|< Mature

Is Your Compost Safe Regarding Health?

Fecal Coliform
< 1000 MPN/g dry wt.
< Safe >|< High Fecal Coliform

Salmonella
Less than 3 /4g dry wt.
<Safe (none detected) >|< High Salmonella Count(> 3 per 4 grams)

Metals US EPA 503
Pass dry wt.
<All Metals Pass >|< One or more Metals Fail

Does Your Compost Provide Nutrients or Organic Matter?

Nutrients (N+P2O5+K2O)
3.1 Percent dry wt.
<Low >|< Average >|< High Nutrient Content

AgIndex (Nutrients / Sodium and Chloride Salts) ((N+P2O5+K2O) / (Na + Cl))
6 Ratio
Na & Cl >|< Nutrient and Sodium and Chloride Provider >|< Nutrient Provider

Plant Available Nitrogen (PAN) Estimated release for first season
3 lbs/ton wet wt.
Low Nitrogen Provider>|< Average Nitrogen Provider >|<High Nitrogen Provider

C/N Ratio
15 Ratio
< Nitrogen Release >|< N-Neutral >|< N-Demand>|< High Nitrogen Demand

Soluble Available Nutrients & Salts (EC5 w/w dw)
3.6 mmhos/cm dry wt.
SloRelease>|< Average Nutrient Release Rate >|<High Available Nutrients

Lime Content (CaCO3)
28 Lbs/ton dry wt.
< Low >|< Average >|< High Lime Content (as CaCO3)

What are the physical properties of your compost?

Percent Ash
58.7 Percent dry wt.
< High Organic Matter >|< Average >|< High Ash Content

Sieve Size % > 6.3 MM (0.25")
4.9 Percent dry wt.
All Uses >|< Size May Restrict Uses for Potting mix and Golf Courses

Account No.: 2090046 - 1/1 - 4899
Group: Sep22A No. 25

Date Received 02 Sep. 22
Sample I.d. 22-SP-A-08 Compost 100
Sample I.d. No. 1/1 2090046

INTERPRETATION:

Is Your Compost Stable?

Respiration Rate

4.2 Moderate-selected use mg CO2-C/g OM/day

The respiration rate is a measurement of the biodegradation rate of the organic matter in the sample (as received). The respiration rate is determined by measuring the rate at which CO2 is released under optimized moisture and temperature conditions.

Is Your Compost Mature?

AmmoniaN:NitrateN ratio
270 immature

Ammonia N ppm
260 mature

Nitrate N ppm
< 1.0 immature

Composting to stabilize carbon can occur at such a rapid rate that sometimes phytotoxins remain in the compost and must be neutralized before using in high concentrations or in high-end uses. This step is called curing. Typically ammonia is in excess with the break-down of organic materials resulting in an increase in pH. This combination results in a loss of volatile ammonia (it smells). Once this toxic ammonia has been reduced and the pH drops, the microbes convert the ammonia to nitrates. A low ammonia + high nitrate score is indicative of a mature compost, however there are many exceptions. For example, a compost with a low pH (<7) will retain ammonia, while a compost with high lime content can lose ammonia before the organic fraction becomes stable. Composts must first be stable before curing indicators apply.

Cucumber Bioassay

100.0 Percent

Cucumbers are chosen for this test because they are salt tolerant and very sensitive to ammonia and organic acid toxicity. Therefore, we can germinate seeds in high concentrations of compost to measure phytotoxic effects without soluble salts being the limiting factor. Values above 80% for both percent emergence and vigor are indicative of a well-cured compost. Exceptions include very high salts that affect the cucumbers, excessive concentrations of nitrates and other nutrients that will be in range when formulated to make a growing media.

Is Your Compost Safe Regarding Health?

Fecal Coliform

< 1000 / g dry wt.

Fecal coliforms can survive in both aerobic and anaerobic conditions and is common in all initial compost piles. Most human pathogens occur from fecal matter and all fecal matter is loaded in fecal coliforms. Therefore fecal coliforms are used as an indicator to determine if the chosen method for pathogen reduction (heat for compost) has met the requirements of sufficient temperature, time and mixing. If the fecal coliforms are reduced to below 1000 per gram dry wt. it is assumed all others pathogens are eliminated. Potential problems are that fecal coliform can regrow during the curing phase or during shipping. This is because the conditions are now more favorable for growth than during the composting process.

Salmonella Bacteria

Less than 3 3 / 4g dry wt.

Salmonella is not only another indicator organism but also a toxic microbe. It has been used in the case of biosolids industry to determine adequate pathogen reduction.

Metals

Pass

The ten heavy metals listed in the EPA 503 regulations are chosen to determine if compost can be applied to ag land and handled without toxic effects. Most high concentrations of heavy metals are derived from woodwaste feedstock such as chrome-arsenic treated or lead painted demolition wood. Biosolids are rarely a problem.

Does Your Compost Provide Nutrients or Organic Matter?

Nutrients (N+P2O5+K2O)

3.1 Average nutrient content

This value is the sum of the primary nutrients Nitrogen, Phosphorus and Potassium. Reported units are consistent with those found on fertilizer formulations. A sum greater than 5 is indicative of a compost with high nutrient content, and best used to supply nutrients to a receiving soil. A sum below 2 indicates low nutrient content, and is best-used to improve soil structure via the addition of organic matter. Most compost falls between 2 and 5.

Account No.: 2090046 - 1/1 - 4899
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INTERPRETATION:

AgIndex (Nutrients/Na+Cl)

6 Average nutrient ratio

Composts with low AgIndex values have high concentrations of sodium and/or chloride compared to nutrients. Repeated use of a compost with a low AgIndex (< 2) may result in sodium and/or chloride acting as the limiting factor compared to nutrients, governing application rates. These composts may be used on well-draining soils and/or with salt-tolerant plants. Additional nutrients form another source may be needed if the application rate is limited by sodium or chloride. If the AgIndex is above 10, nutrients optimal for plant growth will be available without concern of sodium and/or chloride toxicity. Composts with an AgIndex of above 10 are good for increasing nutrient levels for all soils. Most composts score between 2 and 10. Concentrations of nutrients, sodium, and chloride in the receiving soil should be considered when determining compost application rates. The AgIndex is a product of feedstock quality. Feedstock from dairy manure, marine waste, industrial wastes, and halophytic plants are likely to produce a finished compost with a low AgIndex.

Plant Available Nitrogen (lbs/ton)

3 Low N Provider

Plant Available Nitrogen (PAN) is calculated by estimating the release rate of Nitrogen from the organic fraction of the compost. This estimate is based on the respiration rate, ammonia, and nitrate values. Despite the PAN value of the compost, additional sources of Nitrogen may be needed during the growing season to offset the Nitrogen demand of the microbes present in the compost. With ample nutrients these microbes can further breakdown organic matter in the compost and release bound Nitrogen. Nitrogen demand based on a high C/N ratio is not considered in the PAN calculation because additional Nitrogen should always be supplemented to the receiving soil when composts with a high C/N ratio are applied.

C/N Ratio

15 Indicates immaturity

As a guiding principal, a C/N ratio below 14 indicates maturity and above 14 indicates immaturity, however, there are many exceptions. Large woodchips (>6.3mm), bark, and redwood are slow to breakdown and therefore can result in a relatively stable product while the C/N ratio value is high. Additionally, some composts with chicken manure and/or green grass feedstocks can start with a C/N ratio below 15 and are very unstable. A C/N ratio below 10 supplies Nitrogen, while a ratio above 20 can deplete Nitrogen from the soil. The rate at which Nitrogen will be released or used by the microbes is indicated by the respiration rate. If the respiration rate is too high the transfer of Nitrogen will not be controlable.

Soluble Nutrients & Salts (EC5 w/w dw - mmhos/cm)

3.6 Average salts

This value refers to all soluble ions including nutrients, sodium, chloride and some soluble organic compounds. The concentration of salts will change due to the release of salts from the organic matter as it degrades, volatilization of ammonia, decomposition of soluble organics, and conversion of molecular structure. High salts + high AgIndex is indicative of a compost high in readily available nutrients. The application rate of these composts should be limited by the optimum nutrient value based on soil analysis of the receiving soil. High Salts + low AgIndex is indicative of a compost low in nutrients with high concentrations of sodium and/or chloride. Limit the application rate according to the toxicity level of thesodium and/or chloride. Low salts indicates that the compost can be applied without risking salt toxicity, is likely a good source of organic matter, and that nutrients will release slowly over time.

Lime Content (lbs. per ton)

28 High lime content

Compost high in lime or carbonates are often those produced from chicken manure (layers) ash materials, and lime products. These are excellent products to use on a receiving soil where lime has been recommended by soil analysis to raise the pH. Composts with a high lime content should be closely considered for pH requirements when formulating potting mixes.

Physical Properties

Percent Ash

58.7 Average ash content

Ash is the non-organic fraction of a compost. Most composts contain approximately 50% ash (dry weight basis). Compost can be high in ash content for many reasons including: excess mineritzation(old compost), contamination with soil base material during turning, poor quality feedstock, and soil or mineral products added. Finding the source and reducing high ash content is often the fastest means to increasing nutrient quality of a compost.

Particle Size % > 6.3 MM (0.25")

4.9 May restrict use

Large particles may restrict use for potting soils, golf course topdressings, seed-starter mixes, and where a fine size distribution is required. Composts with large particles can still be used as excellent additions to field soils, shrub mixes and mulches.

Appendix:
Plant Available Nitrogen (PAN) calculations:
PAN = (X * (organic N)) + ((NH4-N) + (NO3-N))
X value = If RR < 2 then X = 0.1
If RR =2.1 to 5 then X = 0.2
If RR =5.1 to 10 then X = 0.3
If RR > 10 then X = 0.4
Note: If C/N ratio > 15 additional N should be applied.
RR = Respiration rate

Estimated available nutrients for use when calculating application rates

	lbs/ton (As Rcvd.)
Plant Available Nitrogen (PAN)	3.4
Ammonia (NH4-N)	0.32
Nitrate (NO3-N)	0.00
Available Phosphorus (P2O5*0.64)	5.5
Available Potassium (K2O)	13.7