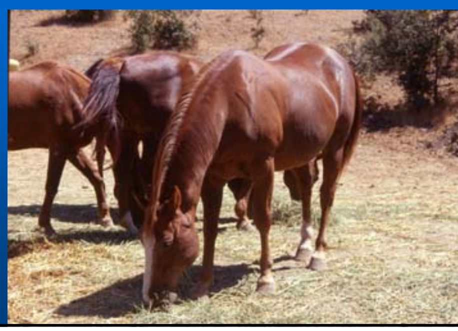
Composting Horse Stable Manure



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With Acknowledgments to "A Horse Keeper's Guide to Manure Management", USDA-NRCS

Compost

"The product of a managed process through which microorganisms break down plant and animal materials into more available forms suitable for (beneficial) application to the soil."

-USDA NOP

"Compost is not a fertilizer, but a soil amendment with soil fertility and soil quality enhancing characteristics."

A 1,000 lb. Horse Can Generate:

30-lbs of manure plus 20-lbs of urine/day

or

8-10 tons or 12-15 cubic yards

annually

Bedding…

At an average 0.75 cubic feet per day, bedding can add an additional 10 cubic yards of waste materials, per horse, to the waste stream annually.

Typical macro-nutrient content of horse manure (dry weight)

Nutrient	Manure		W/ Bedding
	%	lbs./ton of material	
Nitrogen (N)	0.95	19.0	11.0
Phosphorus (P)	0.30	6.0	2.20
Potassium (K)	1.50	30	1.30

Guidelines for Handling Manure

- Regular removal of manure
- Keep stalls and paddocks clean and dry
- Leave behind usable bedding

Average storage volume

No. of Horses	Manure		Manure w/Bedding	
	250 days	Year	250 days	Year
	cubic yards			
1	7	10	12-14	17-20
5	35	50	60-70	85-100
15	105	150	180-210	255-300
25	175	250	300-350	425-500
40	280	400	480-560	680-800

*Assumes 0.75 cu. ft. manure/day and 0.50 to 0.75 cu. ft. bedding/day. A cubic yard is 27 cu. ft. and occupies a cube 3ft x 3ft x 3ft.

Land Application Guidelines

Average manure application and land base area requirements for pasture crops.*

Forage Crop	Annual Manure Application	Land Area Required
	tons/acre	acres/horse/yr
Red Clover	10	0.8
Ryegrass	11	0.8
Tall Fescue	13	0.6
Wheat Grass	2	3.8

*Adapted form Davis and Swinker, 1996 (assumes 8 tons manure/yr).

Why Compost?

RESOURCE CONSERVATION AND

SOIL AND WATER QUALITY!

Land Application

- Is an acceptable disposal method, but may not address pathogens or water quality
- Composting destroys pathogens and weeds and helps protect water quality.

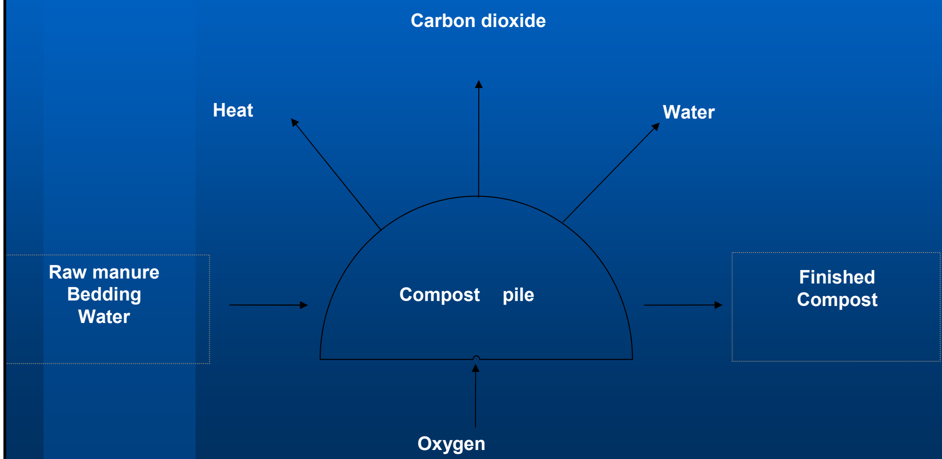
Advantages of Aerobic Thermophilic Composting :

- Pathogens exposed to thermophilic temperatures (>131^{o}F) for a sufficient period of time are destroyed (E.coli, SOD, etc.)
- Most weed seeds are killed
- Decomposition is rapid; volume reduction occurs quickly

Composting can Reduce Risks To Water Quality posed by Manure :

- *Reduction and elimination* of microbial pathogens
- *Reduction* of ammonia N-levels
- *Reduction* in water-soluble phosphorus
- *Reduction* of Biological Oxygen Demand (BOD)
- *Reduction* in total soluble salts

Aerobic Composting Process



Aerobic Composting Requirements

- Carbon and Nitrogen Ratio: 30/1 – 50/1
- Air: optimize oxygen
- Water: 50-60% moisture
- Temperature: 131° F minimum

Carbon to Nitrogen Ratio

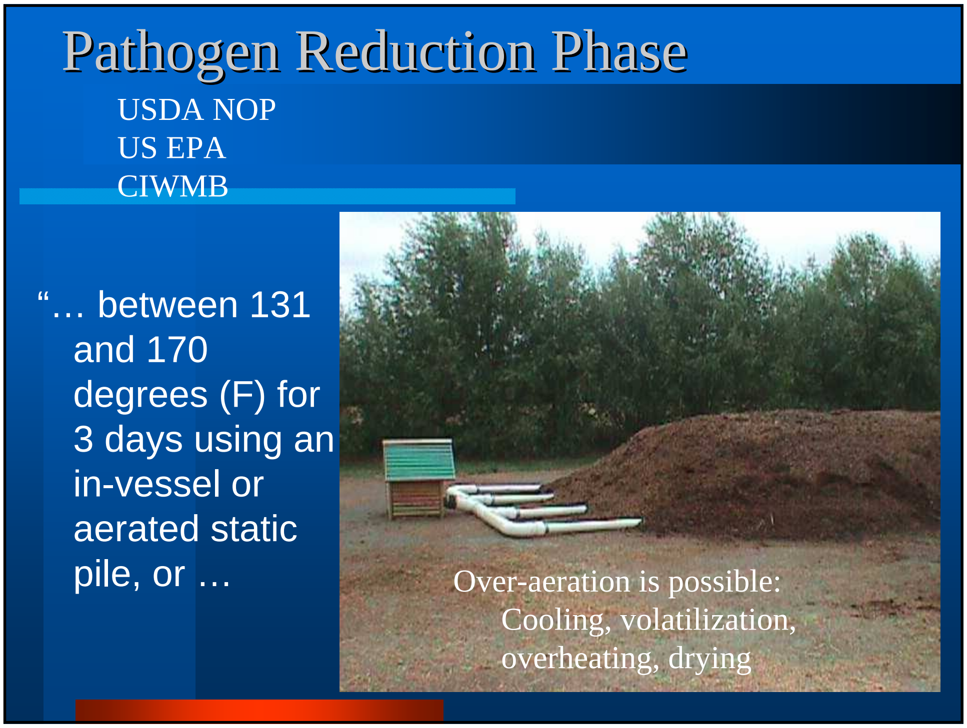
- Relative amount of carbon and nitrogen
- Horse manure alone has C/N ratio of 25-35/1; optimum for composting
- Carbonaceous bedding has a C/N ratio of 50-100/1, unfavorably increasing the C/N ratio of stable manure compared with manure alone.

Aeration

- Turned windrow
- Forced aeration
- Static pile

Aeration Methods

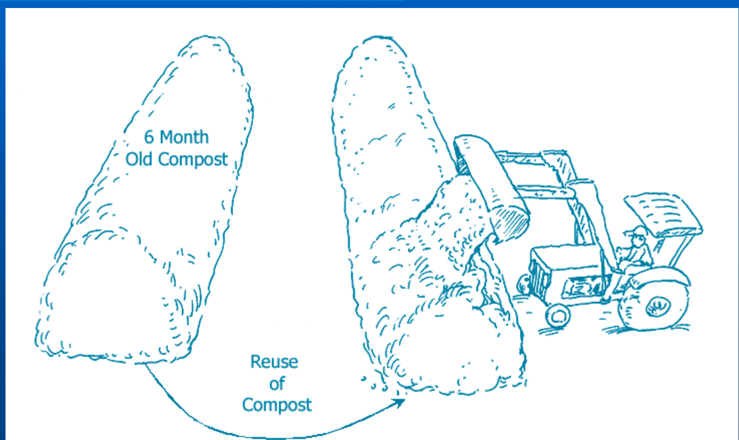
- **Turned windrow:** base turning frequency on temperature profile and pathogen reduction phase requirements (5 turnings, 15 days).
- **Static pile, forced aeration:** excessive aeration is possible; cooling, N volatilization, overheating, drying.
- **Static pile, passive aeration:** aeration is typically inadequate to achieve complete breakdown in the short term.
- **Daily temperature readings** required during Pathogen Reduction Phase (EPA, CIWMB).


Pathogen Reduction Phase
USDA NOP
US EPA
CIWMB
"… between 131 and 170 degrees (F) for 3 days using an in-vessel or aerated static pile, or …
Over-aeration is possible:
Cooling, volatilization, overheating, drying


…for 15 days using a (turned) windrow system, during which …it…must be turned a minimum of 5 times."
-NOP/CIWMB
Animal materials (NOP vs CIWMB)
Organic Preharvest Interval

Passive Aeration/Static Pile

Static Pile: Requires an insulating layer of finished compost



Aerobic Composting Parameters

- Optimum Carbon/Nitrogen Ratio:
  25/1 – 40/1
- Air: optimize oxygen (bulk density < 40 lbs/ft^3)
  - Wet dairy manure bd = 65 lbs/ft^3
  - Horse bedding bd = 20 lbs/ft^3
- Water: 50-60% moisture- "wrung-out sponge"
- Temperature: 131° F minimum (pathogen reduction phase)


Raw materials:
manure, bedding, spoiled feed….


Mixed Green Material,
Kitchen Waste, etc.
1 6 '00

Carbon Compound Characteristics

C Compound	Decomposition rate	End Product
Sugars, starches	Fast	CO_2, H_2O
Proteins	Fast, Moderate	** N, P, S, CO_2**
Hemicelluloses	Moderate, Slow	Humus
Cellulose	Slow, Very slow	Humus
Fats, Waxes, Oils **	Slow, Very slow	Humus
Lignins, Polyphenols**	Slow, Extremely slow	Humus

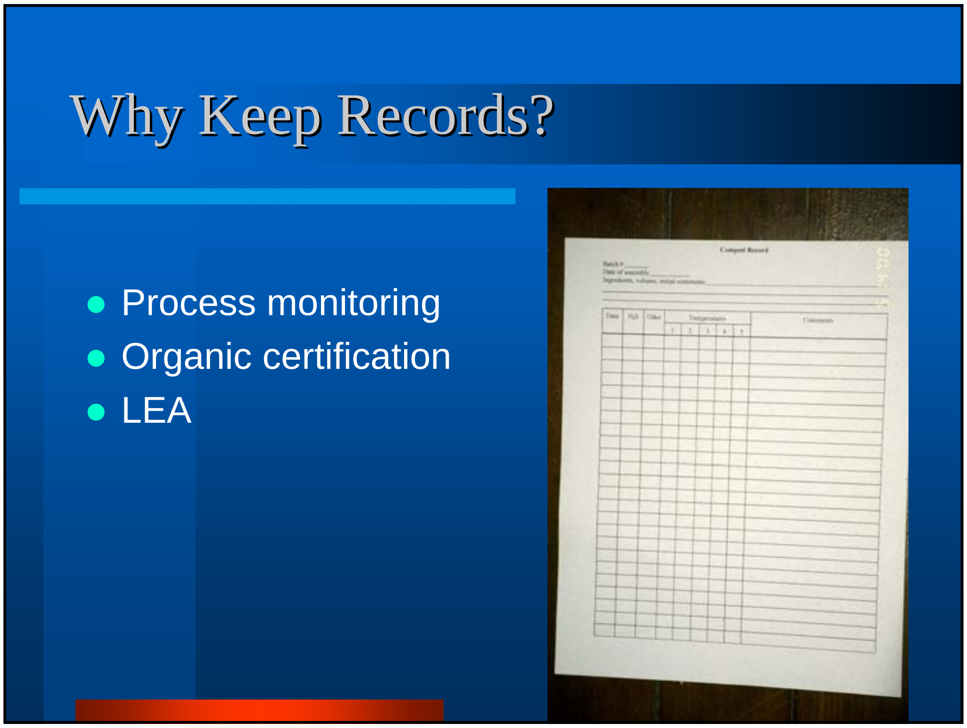
- *McGourty and Reganold, 2005*

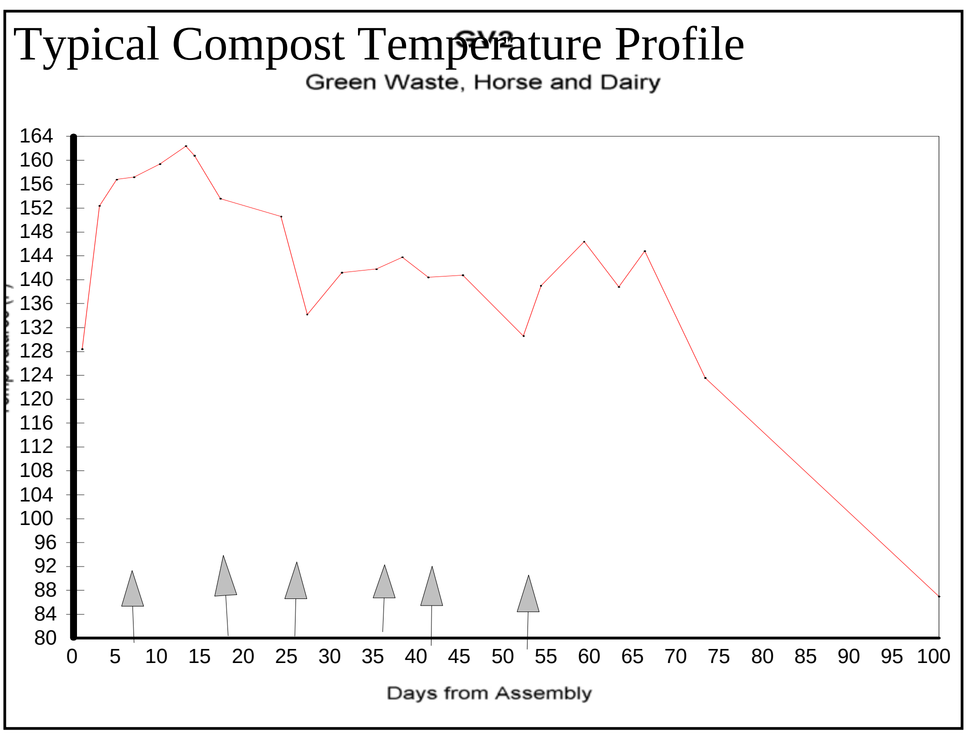
- ***Trouble shooting indicators*

Checking Compost Temperatures

- Temperatures usually will increase within 24 hours of pile assembly, and may reach 155°F or more within 2-3 days
- A compost thermometer (24-48”) and record keeping are essential equipment
- Temperature should be measured at multiple (2+) locations to a depth of 24”

Check temperature at several points at a depth of 24”


Why Keep Records?
Process monitoring
Organic certification
LEA


Typical Compost Temperature Profile
GW2
Green Waste, Horse and Dairy
164
160
156
152
148
144
140
136
132
128
124
120
116
112
108
104
100
96
92
88
84
80
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100
Days from Assembly

Site Selection and Construction

Operation Size Determines Site and Technology Requirements

There must be adequate space to:

- *store the anticipated volume of manure and bedding*
- *provide equipment access and working area*
- *accommodate active composting and temporary storage of final product*

Most importantly:

- ***The site design must protect water quality***

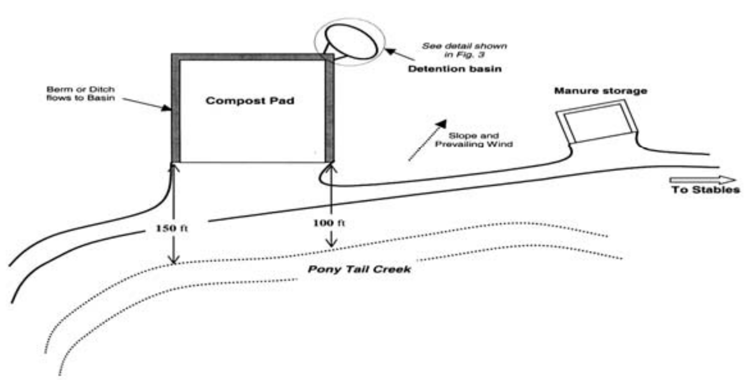
Basic Components of an On-Farm Composting System

- Located away from creeks and drainage;
- Bins or piles large enough to maintain temperatures (> 1 yd^3):
- A mechanism for aerating the bins or piles;
- Temperature monitoring
- Available water

No single design for an on-farm composting system is appropriate for all sizes and types of facilities.

Basic Site Requirements……

Figure 2. Example of idealized compost site details




All Weather Access


All Weather Compost Pad
2% slope
Concrete
Asphalt
Road base
Lime-clay
Quarry fines
D.G.

Control Runoff

- Controlling runoff and drainage from the compost site is essential

Compost Regulations

"When the country is confused and in chaos, loyal ministers appear" - Lao Tzu

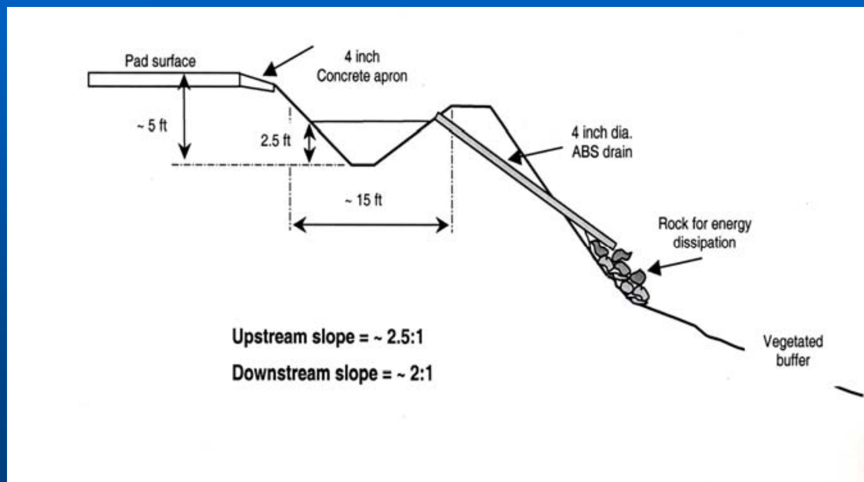
- CIWMB
- LEA (SOP)
- NOP
- RWQCB

"An activity is excluded (from CIWMB regulation) if it handles agricultural material derived from an agricultural site, and returns a similar amount of the material produced to that same agricultural site, or an agricultural site owned or leased by the owner, parent, or subsidiary of the composting activity. No more than an incidental amount of up to 1,000 cubic yards of compost product may be given away or sold annually". - CIWMB

Water Quality Regulations

- CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
- REPORT OF WASTE DISCHARGE
- BMP's
- WAIVER
- http://www.waterboards.ca.gov/

Cross Section of an Example Detention Basin



Detention Basin and Energy Dissipator

A detention basin should be included in the design at the low end of the compost pad to capture and temporarily hold storm water


Grassed waterway
for safe disposition
of runoff


Vegetated filter
between compost pad and surface water


Bins


O2 Compost Micro-bin
Photo: Peter Moon, 02Compost


Windrows


KUBOTA
L4850

Pellet Bedding

- May reduce volumes by 20-25%
- Requires less time to compost
- Results in a final product with a lower C:N ratio

When is Compost Done?

- Temperature: 90-120º F
- Odor pleasant; no ammonia or off odors
- Material is dark in color and uniform in texture
- Bioassays

Germination Index

(Zucconi et al, 1981)

$$\text{G.I.} = \frac{\text{Rootlet's length in OMW}}{\text{Rootlet's length in water}} \times \frac{\text{Germination in OMW}}{\text{Germination in water}} \times 100.$$

From: Tsioulpas, et al, 2002

- **Relevance depends upon use of final product:**
  - **seedbed vs permanent pasture.**
- **Garden Cress**
- **Roquette**
- **Rapini**

Compost Use

- 300 cubic yards of manure will produce 150-200 cubic yards of compost
- Which will cover one acre of land with about 1 inch of compost

2” of compost per acre is about 300 cubic yards or 150 tons

Composting Economics

- *Site Development Costs: materials and labor*
- *Quantity of manure with bedding generated (per day, week, month, and year)*
- *Labor required to collect, store, transport to site, compost and manage*
- *Equipment needed (loader, watering system, transport, thermometer)*
- *Equipment maintenance expenses*
- *Other costs (lab sample, permitting, other)*
- *Compost use (on site, trucked away or sold – could be a cost or a return*
- *Present manure disposal costs*
- *Avoided environmental and regulatory costs*

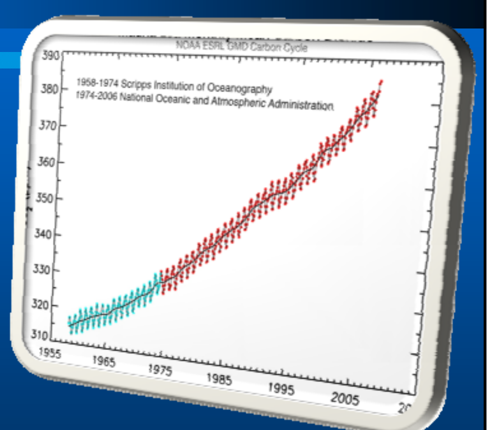
Composting Summary

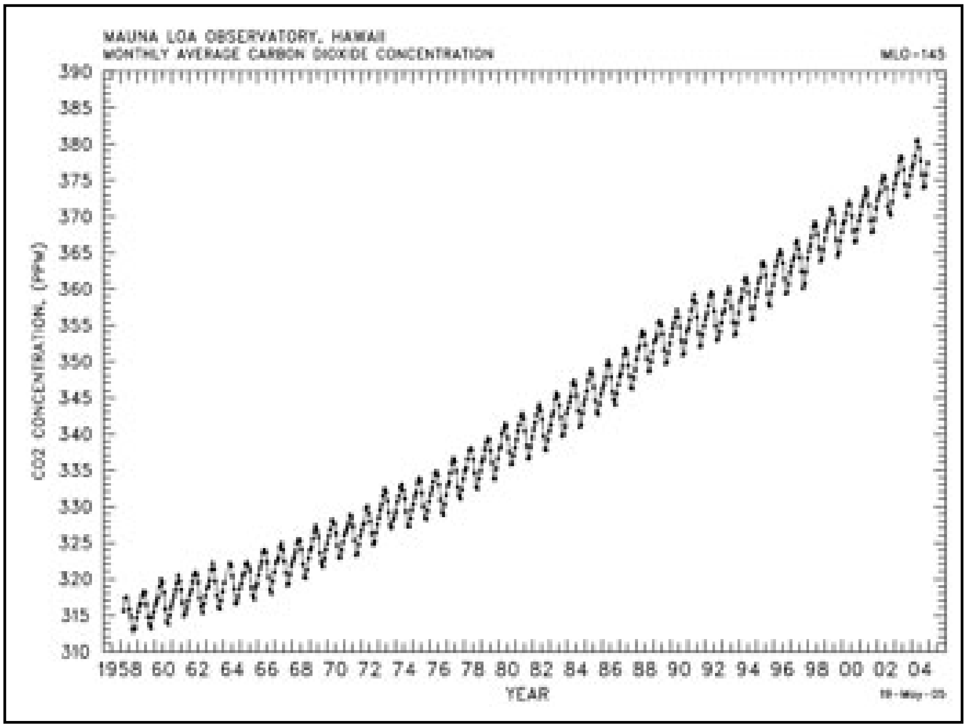
- Prepare your site to ensure the compost area drains well and does not threaten water quality.
- Collect manure from corrals and pens carefully - conserve bedding.
- Monitor temperature and moisture regularly.
- Make provisions for turning and adding supplemental water when needed.

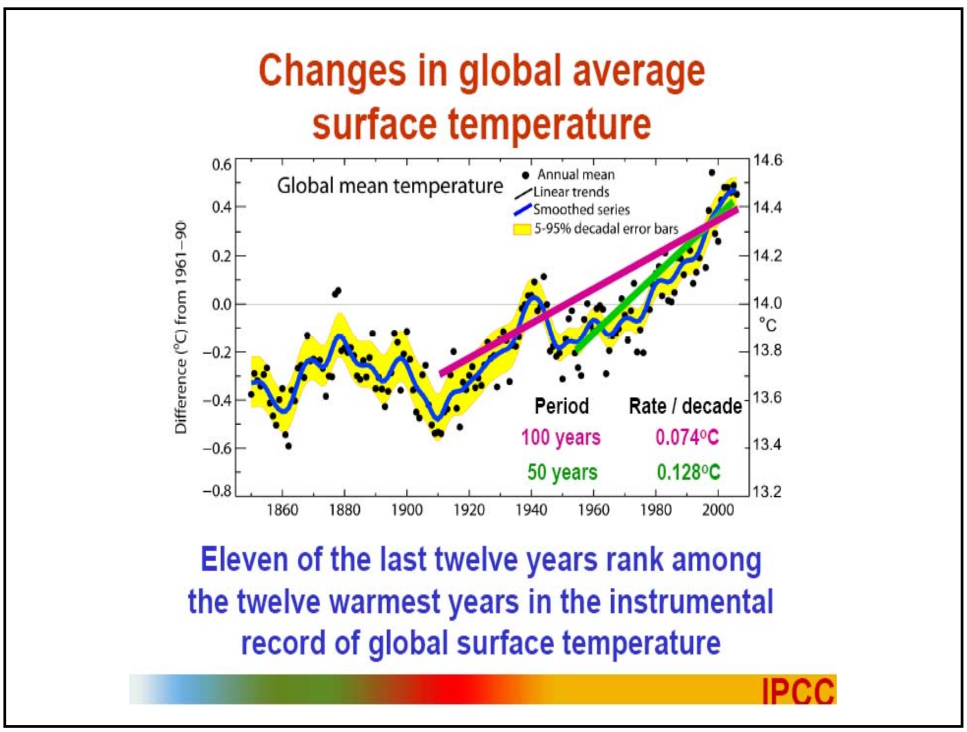
Composting Summary, Cont…

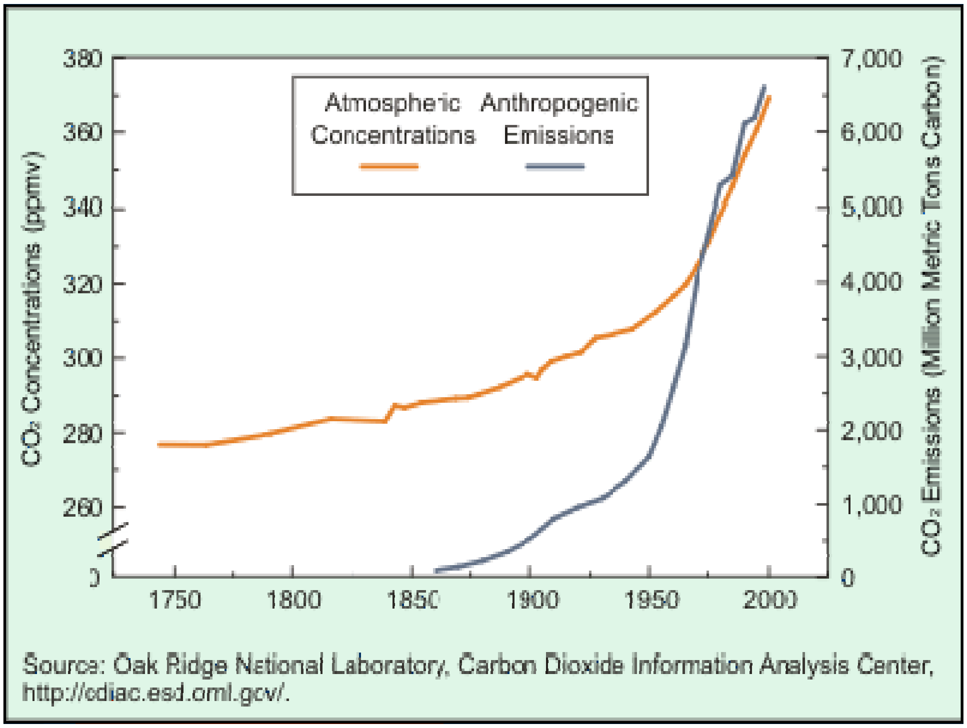
- Keep the composting area clean and well maintained.
- Use the finished product in your landscapes, planters, and gardens.
- Have laboratory analysis performed on compost samples initially and if compost procedures change.

Global Warming and Soil Carbon Sequestration

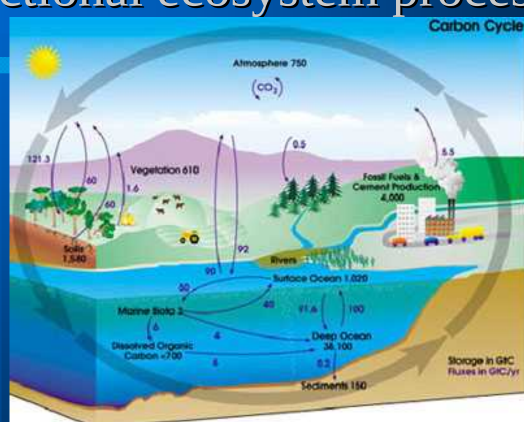



MAUNA LOA OBSERVATORY, HAWAII
MONTHLY AVERAGE CARBON DIOXIDE CONCENTRATION
MLO-145
CO2 CONCENTRATION,
390
385
380
375
370
365
360
355
350
345
340
335
330
325
320
315
310
1958 60 62 64 66 68 70 72 74 76 78 80 82 84 86 88 90 92 94 96 98 00 02 04


Changes in global average surface temperature
Global mean temperature
Annual mean
Linear trends
Smoothed series
5-95% decadal error bars
Difference (°C) from 1961–90
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6
−0.8
14.6
14.4
14.2
14.0
°C
13.8
13.6
13.4
13.2
1860 1880 1900 1920 1940 1960 1980 2000
Period
Rate / decade
100 years
0.074°C
50 years
0.128°C
Eleven of the last twelve years rank among the twelve warmest years in the instrumental record of global surface temperature
IPCC



Climate Change is a symptom of dysfunctional ecosystem processes.



Carbon dioxide emissions exceed carbon capture

-Abe Collins, Carbon Farmers of America

Carbon Sequestration

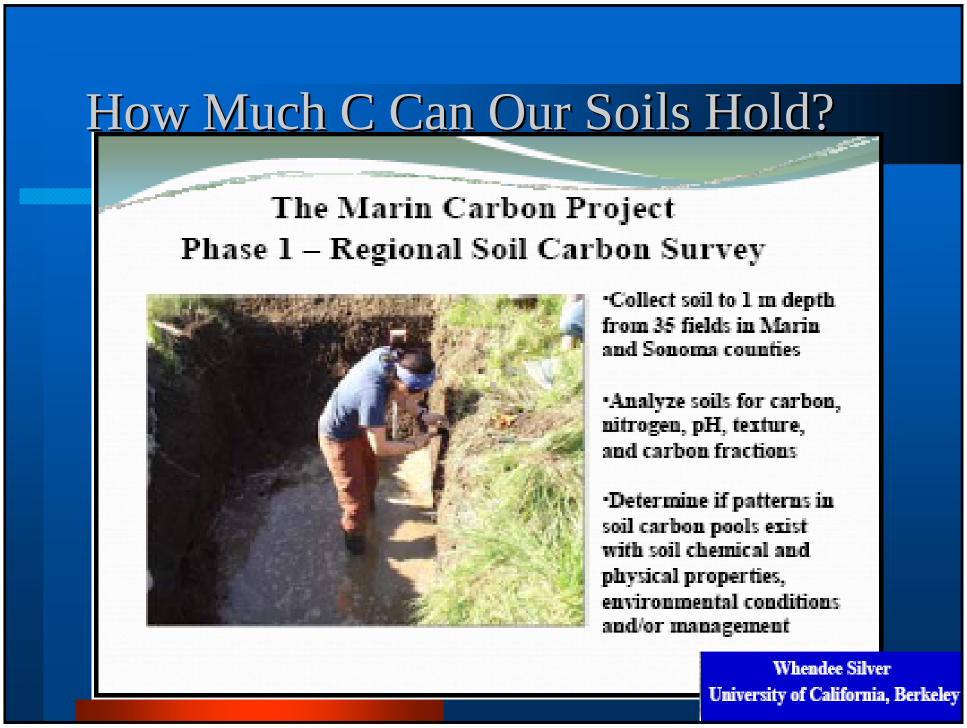
- **If we ended all greenhouse gas (GHG) emissions tomorrow, atmospheric CO2 would take a hundred years to return to 1985 levels. [IPCC, 2007].**
- **Even the most effective GHG emissions reductions program will not be enough to avoid catastrophic changes in global ecosystems.**
- **Such programs *must* be accompanied by *carbon sequestration* on a global scale.**

Good News: Soil C Increases can Reduce Atmospheric CO2

'… every one tonne increase in soil organic carbon represents 3.67 tonnes of CO2 sequestered from the atmosphere and removed from the greenhouse equation.'

'For example, a 1% increase in organic carbon in the top 20 cm of soil (with a bulk density of 1.2 g/cm3) represents a 24 t/ha increase in soil OC which equates to 88 t/ha of CO2 sequestered.'

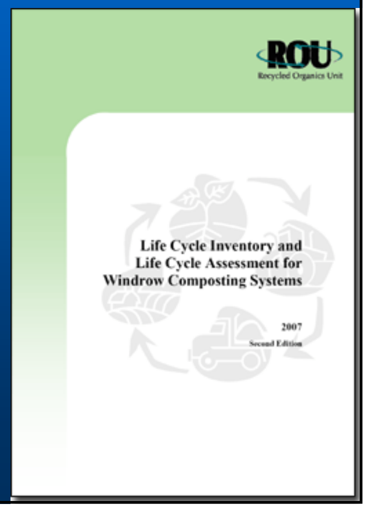
-Dr Christine Jones (2006), Australia


How Much C Can Our Soils Hold?
The Marin Carbon Project
Phase 1 – Regional Soil Carbon Survey
•Collect soil to 1 m depth from 35 fields in Marin and Sonoma counties
•Analyze soils for carbon, nitrogen, pH, texture, and carbon fractions
•Determine if patterns in soil carbon pools exist with soil chemical and physical properties, environmental conditions and/or management
Whendee Silver
University of California, Berkeley


West Marin Co-Composting Project

Carbon Sequestration and Carbon Trading

- **Compost has significant potential to rapidly increase rates of carbon sequestration in crop and rangeland soils**



Excess Carbon Dioxide in the Atmosphere Can Be Transformed Into Soil Organic Matter Through the Processes of Photosynthesis and Decay.

Abe Collins, CarbonFarmersofAmerica.org

The solution to the inextricably linked global crises of

- food security,
- water availability and
- climate stabilization

lies in the soils beneath our feet.

COMPOST!

Acknowledgements

Much of the material for this presentation was generously provided by the NRCS Petaluma Field Office.

Special thanks to McEvoy Ranch, Petaluma, CA, Dr. Whendee Silver, UCB, and the Marin Carbon Project