Agriculture and Agri-Food Canada | Agriculture et Agroalimentaire Canada

Composting and Compost Use – A Realist's Approach

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Agri-Trend Agrology Ltd. Farm Forum Event

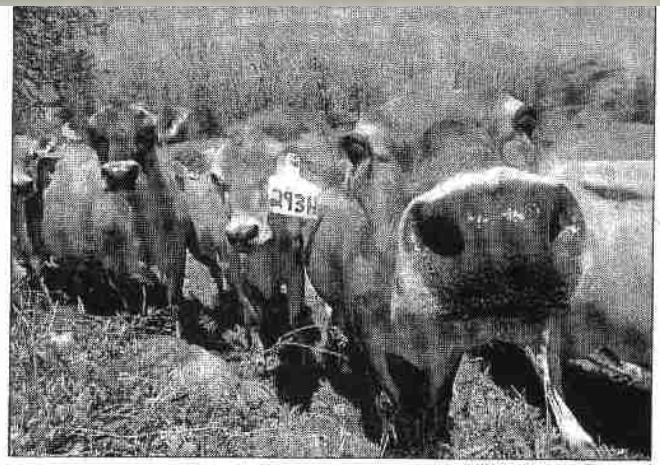
November 25-27, 2008

Saskatoon, SK

Canada

Media view of manure management

Laying the blame



MICHAEL MOORE / ASSOCIATED PRESS ARCHIVES

Over-fertilizing of fields is common in livestock-abundant areas.

Over-fertilizing polluting province's water bodies

By Helen Fallding

FARMERS in livestock-intensive areas of Manitoba are over-fertilizing their land, potentially contributing to water pollution as far away as Lake Winnipeg.

In an $81,000 study for the Manitoba Livestock Manure Management Initiative, DGH Engineering found the nutrients nitrogen and phosphorus building up in soils in the rural municipalities of Hanover and La Broquerie near Steinbach.

In two other municipalities where there is less livestock production — Roland, south of Carman, and Sifton in western Manitoba — there was less buildup.

Excess nutrients not taken up by crops wash off fields into streams and rivers, with Red River nutrients said farmers applying manure to their fields from livestock barns are also applying some chemical fertilizer.

In Roland, fertilizer inputs average 85 kilograms per hectare of nitrogen and 14 kilograms per hectare of phosphorus, but the numbers in Hanover are 98 for nitrogen and 32 for phosphorus.

"We're not saying it's an immediate serious crisis," Small said. "There's an issue here that needs to be addressed for long-term sustainability."

Only about five per cent of Manitoba farmland receives animal manure.

Small said the obvious solution is for farmers using manure to cut back more on expensive chemical fertilizers — something that would save them money and conserve the natural gas used to make fertilizer.

WINNIPEG FREE PRESS, TUESDAY, DECEMBER 10, 2002 LOCAL A11

Lake Winnipeg pollution blamed on farm runoff

By Helen Fallding

FARM runoff may be the biggest source of pollution in Lake Winnipeg and the province's southern rivers, according to a new study by Manitoba Conservation.

About three-quarters of the phosphorus added to the Assiniboine and Red rivers as they passed through Manitoba from 1994 to 2001 had washed off the land. The figures are almost as bad for nitrogen, which combines with phosphorus to promote the growth of algae blooms.

The blooms are bad for fish and wildlife and can produce dangerous toxins.

University of Winnipeg biologist Eva Pip, who has read the report, said many people assumed municipal sewage was the biggest culprit behind the deteriorating health of Lake Winnipeg.

"There's always been finger-pointing... but now that we have some actual numbers, this gives us a starting point which we can use to start addressing the problem."

In a previous study completed last year, Manitoba Conservation staff concluded that nitrogen and phosphorus loads in Lake Winnipeg increased 13 and 10 per cent respectively over the last three decades as a result of changes in the Red River basin.

"Those are very significant values in a short time," Pip said.

A Lake Winnipeg snail recently declared endangered is an early warning sign that the lake is in trouble, she said.

Lake Winnipeg has had very bad algae blooms for the last five years, including some this summer at Victoria Beach and on the western shore as far north as the Jackhead reserve, Pip said.

She is calling for more regulation of the nutrients farmers apply to their land.

The latest Manitoba Conservation study, led by Alex Bourne, did not separate the effects of chemicals from manure or natural sources.

Manitoba's livestock farmers are required to monitor the amount of nitrogen they apply in manure, but phosphorus is regulated only in Quebec.

Livestock farmers have long complained they are subject to much greater scrutiny than the majority of their neighbours who use chemical fertilizer — soon to be regulated in Ontario after the Walkerton contaminated water scandal.

Keystone Agricultural Producers vice-president David Rolfe said quality assurance programs that require farmers to better manage their fertilizer if they want to be certified might be a better approach than more regulation.

Manitoba's water quality manager Dwight Williamson said a discussion paper should be out within six months on setting water quality objectives in the Assiniboine, Souris and Qu'Appelle rivers.

Manitoba Agriculture staff already have extension programs encouraging farmers to invest in soil testing so they don't waste fertilizer and to use low-till agriculture to keep water on the land. "We do this all the time," John Heard said.

When fertilizer prices are high, farmers have more incentive to keep their fertilizer use to a minimum, he said.

Pip said the move to drain more farmland — supported by increased government dollars — is also contributing to runoff problems.

Manitoba has no control over pollutants in the rivers before they cross the U.S. and Saskatchewan borders.

Winnipeg's wastewater treatment plants and sewers added more than 4,000 tonnes of nitrogen to the Red River a year, according to the Manitoba Conservation study — 11 per cent of the total load in the river at Selkirk.

Pip said the nutrient load will be worse now that the city has added orthophosphate to drinking water to deal with elevated lead levels from old pipes.

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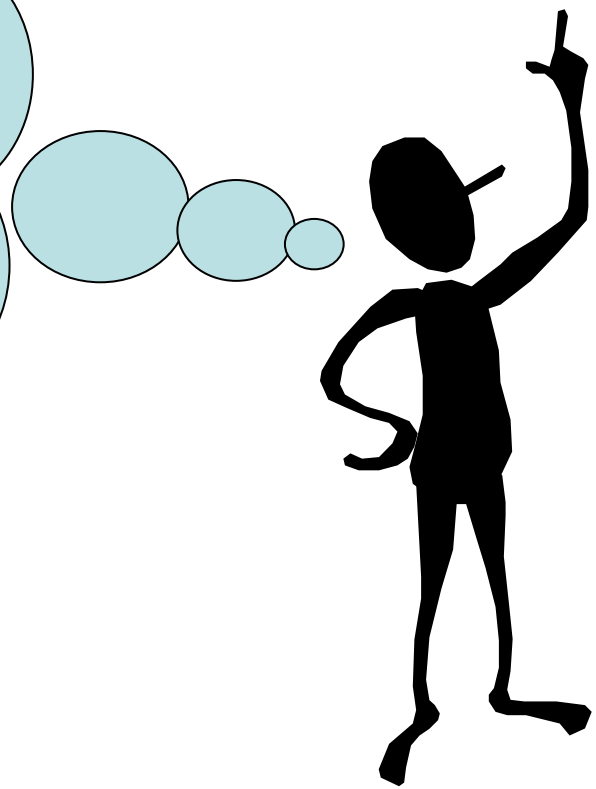
Certain Truth

If the true value of residues of the livestock industry is not demonstrated, then the image of manure as a pollutant and a health hazard will persist.



Organic fertilizers as the only source of nutrients – the truth

Alberta (439,000 tonne nitrogen required)

- 1 T of manure has 12 kg N
- 439,000 T nitrogen/0.012 T N / T manure = 36.5 x 10^6 T of manure
- Average manure production of 500 kg steers in a confined feedlot will produce 3.212 T of manure per year.
- 36.5 x 10^6 T manure x 1.0 animals/3.212 T per year =

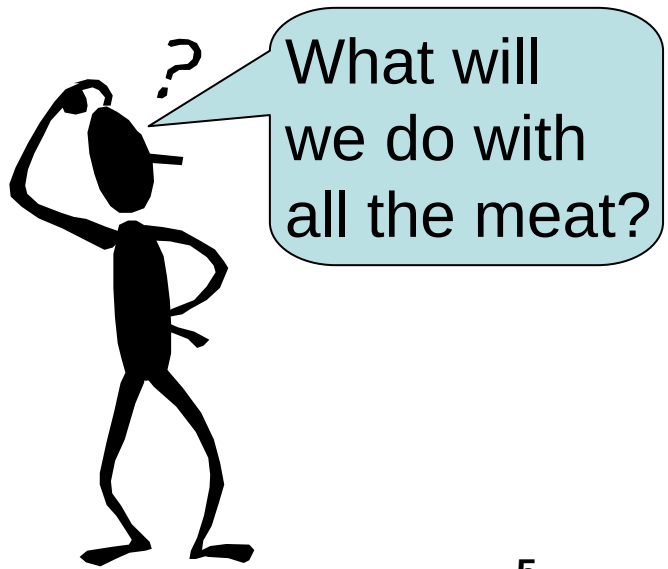
  11,363,636 steers

Saskatchewan (601,000 T nitrogen required)

15,557,050 steers

Manitoba (326,000 T N required)

8,438,599 steers



Nutrient management - inconvenient truths

- Increasing number of people settling in urban areas.
- Economic model adopted is confinement production of livestock.
- Result --- concentration of human biosolids and animal nutrient residues at fewer locations on the landscape.
- As residues become more concentrated, society becomes more sensitive to its existence – hence calls for decreased livestock production.
- Excreted nutrients from livestock are not in balance with crop demands, raw human biosolids are not a desirable fertilizer for food crops.
- Applications of nutrients and organic matter can be made to cropland at rates that restore native fertility --- the tools are available to do this.

But no one said it was easy !

Science and the truth about compost

- Scientists need to examine the effects of good quality compost with specific characteristics and made according to acceptable practices.

The Problem: most research is short term and poorly funded – few researchers make the compost that is used in research trials.

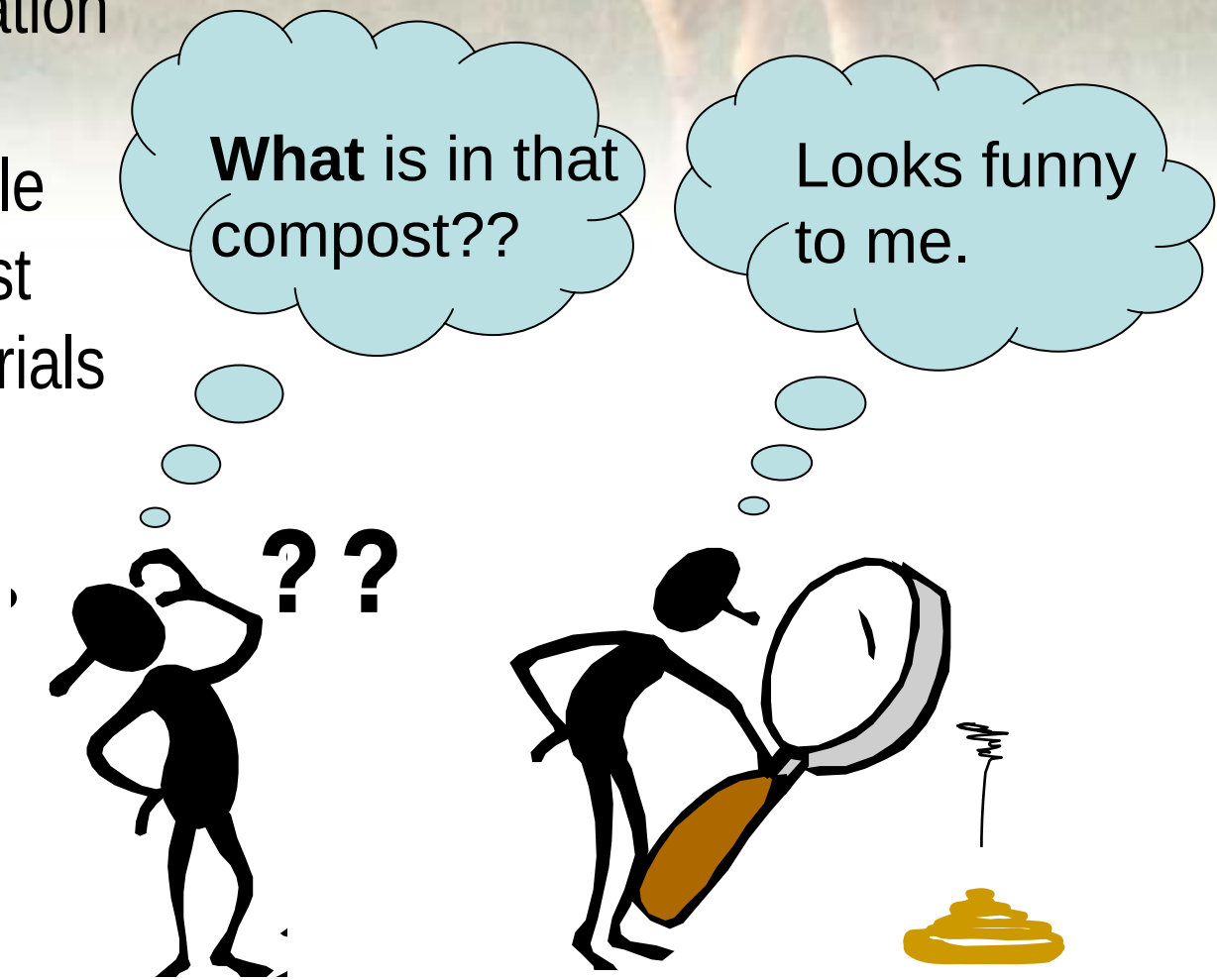
- Producers need to be equipped with the knowledge required to compost organic residues commonly found on the farm and the knowledge to use the compost to derive the greatest economic benefit.

The Problem: location, location, location

Science and the truth about compost

Recent scientific publication (2008) described a commercially-available dairy manure compost used in crop growth trials as having a labeled fertilizer value of

<u>0.5 - 0 – 0</u>!



Dairy manure compost
0.7 - 0.3 – 0.7

Confusion about compost and compost use

- Compost used in research trials comes from many animal species and often is poorly characterized.
- Much of the scientific and popular literature deals with MSW (municipal solid waste) compost or a combination of manure and MSW compost rather than residues from livestock facilities.
- In scientific studies, the extent of the composting process and compost quality is usually not described.

Why compost? What is in it for the livestock producer

- Volume reduction and improved handling characteristics.
- Pathogen and parasite destruction.
- Reduces flies – eliminates breeding ground.
- Reduces odour – good neighbour relations.
- Improves the appearance of your operation.

Why compost? What is in it for the crop producer

- Improved uniformity of application.
- Reduced crop lodging.
- Reduce irrigation water requirements.
- Reduced use of synthetic fertilizers.
- Reduced soil erosion.
- Decreased effects of high salinity.
- Increased long-term productivity and total soil carbon.
- Improved soil structure and tilth.
- No time restrictions on time of harvest of horticultural crops after application.

What is Composting??

What available resources must be committed?

What are the costs?

Is composting manure an option for you?

Composting is a feasible manure management option for - Beef Feedlots

AAFC, Lethbridge 2004

Composting is a feasible manure management option for – Operations using solid/liquid separation


Composting is a feasible manure management option for –
Straw-based hog rearing systems
AAFC Brandon, 2008

Principles and fundamentals of composting

Composting is the *aerobic*, or oxygen requiring,

decomposition of organic materials by

microorganisms under controlled conditions.

Feedlot manure/straw mixture is deposited in windrows using solid manure spreaders

AAFC Brandon 2008

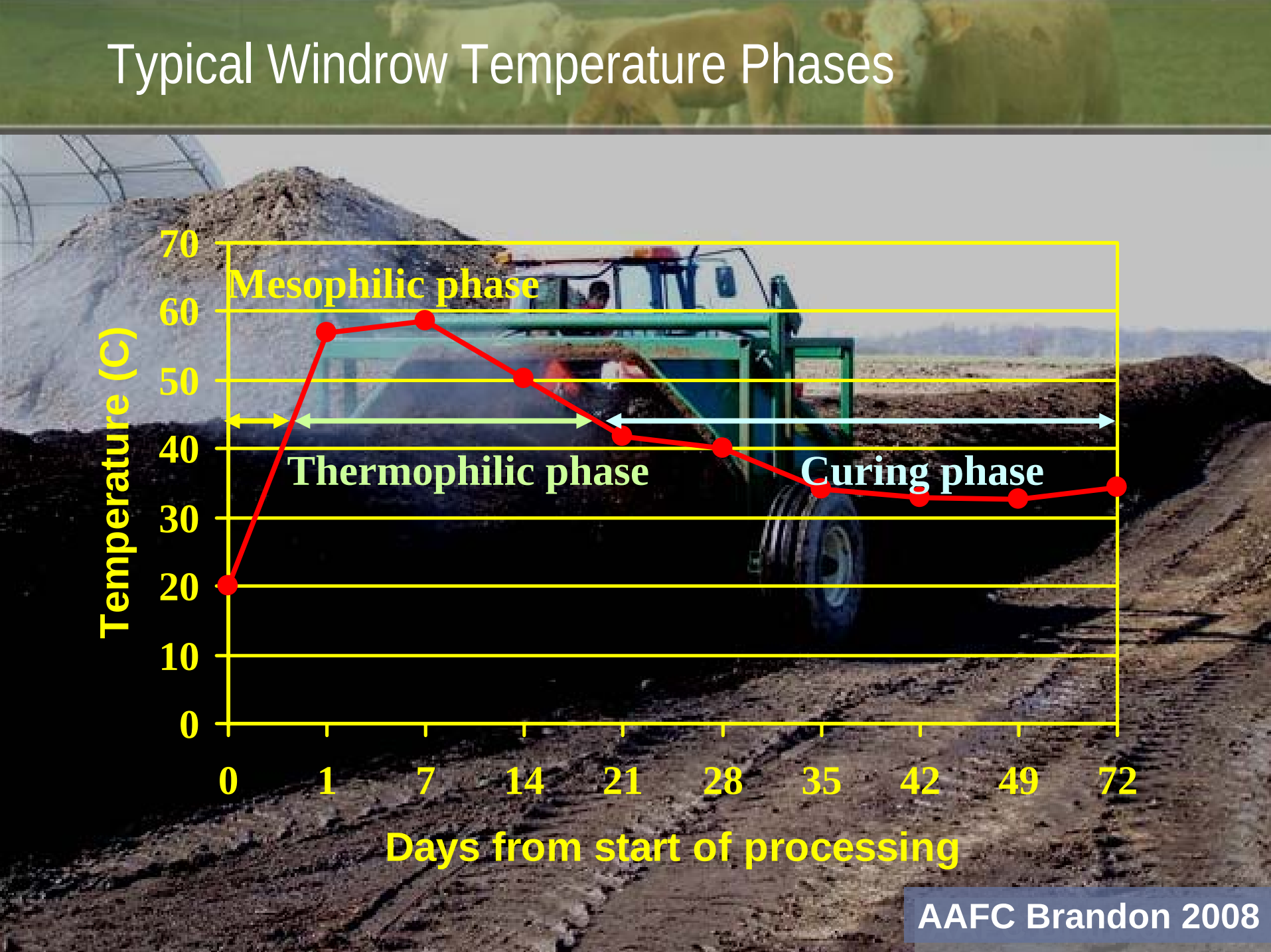
Windrows are shaped then turned

Self-propelled Drum turner

Thermophilic phase of the composting period (*thermophilic bacteria predominate*)

AAFC Brandon 2008

Typical Windrow Temperature Phases

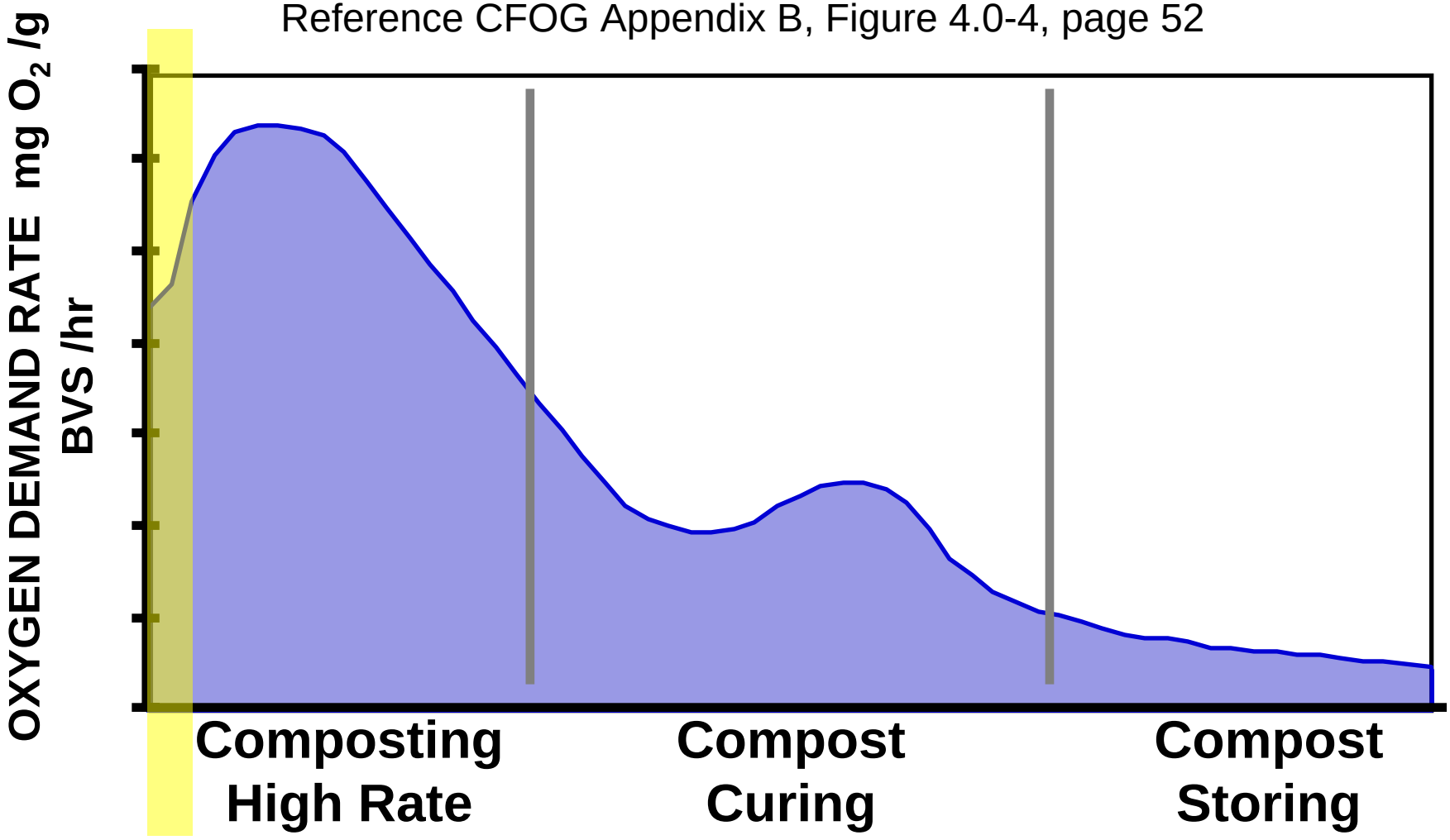


AAFC Brandon 2008

Pile Oxygen Demand

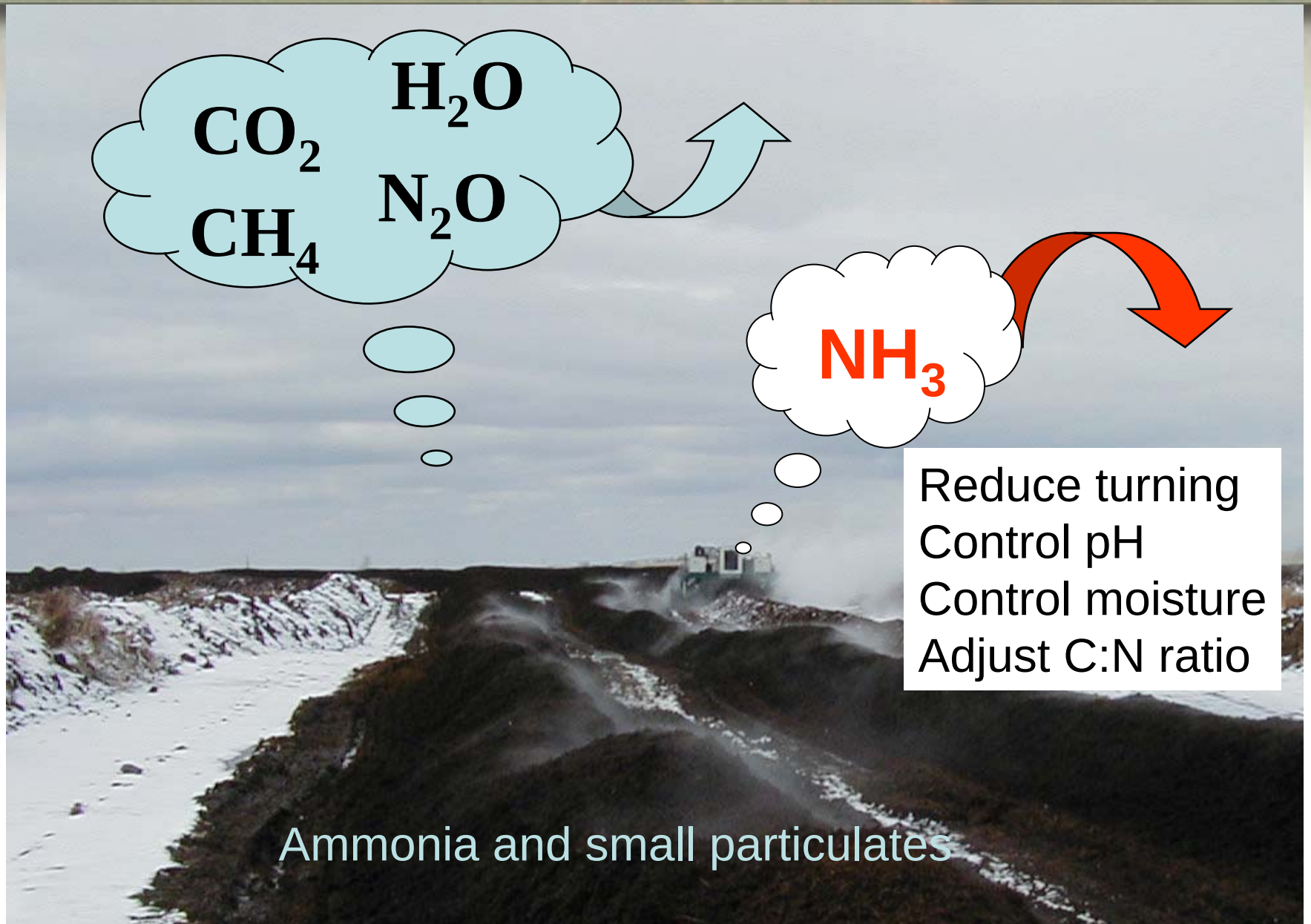
Characteristic Curve - Pile Oxygen Requirements

Reference CFOG Appendix B, Figure 4.0-4, page 52

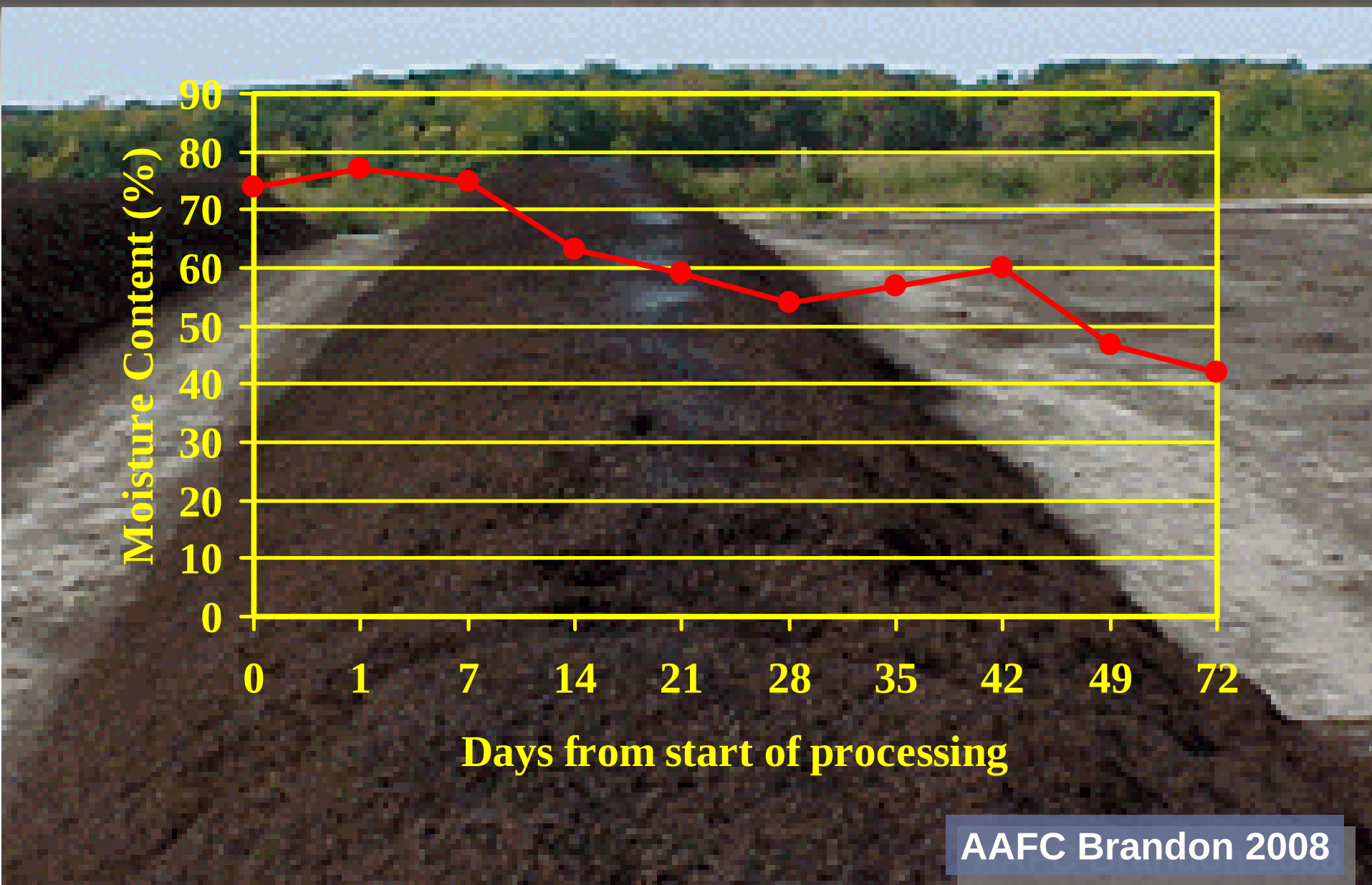


Initiation of the curing phase of the composting period (*fungi and actinomycetes predominate*)

Regulations -- Air Quality



Typical Compost Moisture Content



AAFC Brandon 2008

Moisture addition during composting

Maintaining windrow structure

Compost site preparation

- An all-weather, impermeable surface is required.
- Run-off must be contained.

AAFC Brandon 2008

Turning frequency

- more frequent turning in the first month of composting
- decrease frequency as the temperature and moisture level declines.

Applying compost

Truck mounted load cells and GPS improve accuracy and distribution. Better road worthiness decreases transport time.

Compost use in field production systems

1. Application rates are generally are low to moderate (10 to 50 T/ha).
2. Application timing – spring, fall or after a forage cut.
3. Surface application or incorporated

Chemical changes in compost

What's in 1000 kg of beef manure or beef manure compost?

Mass	Fresh, kg	Compost, kg
Total	1000	1000
Water	700	300
Dry matter	300	700
Total N	5.5	12
Available N†	1.2	0.8
Total P	1.2	3.7
Available P‡	0.7	1.9
Total C	90	150
Mineralizable C	42	9

Larney at al. 2004

†Available N (KCl extract): 22% of manure N; 7% of compost N

‡Labile P (Water and $NaHCO_2$-extractable): 61% of manure P; 51% of compost P

Nutrient mineralization rate after application

Nitrogen:

- Green waste composts and livestock manure composts
  - Generally 6 to 20% of the nitrogen is mineralized the first year.
- Poultry manure composts
  - Mineralization rate depends on presence and type of litter – can be as high as 50%.

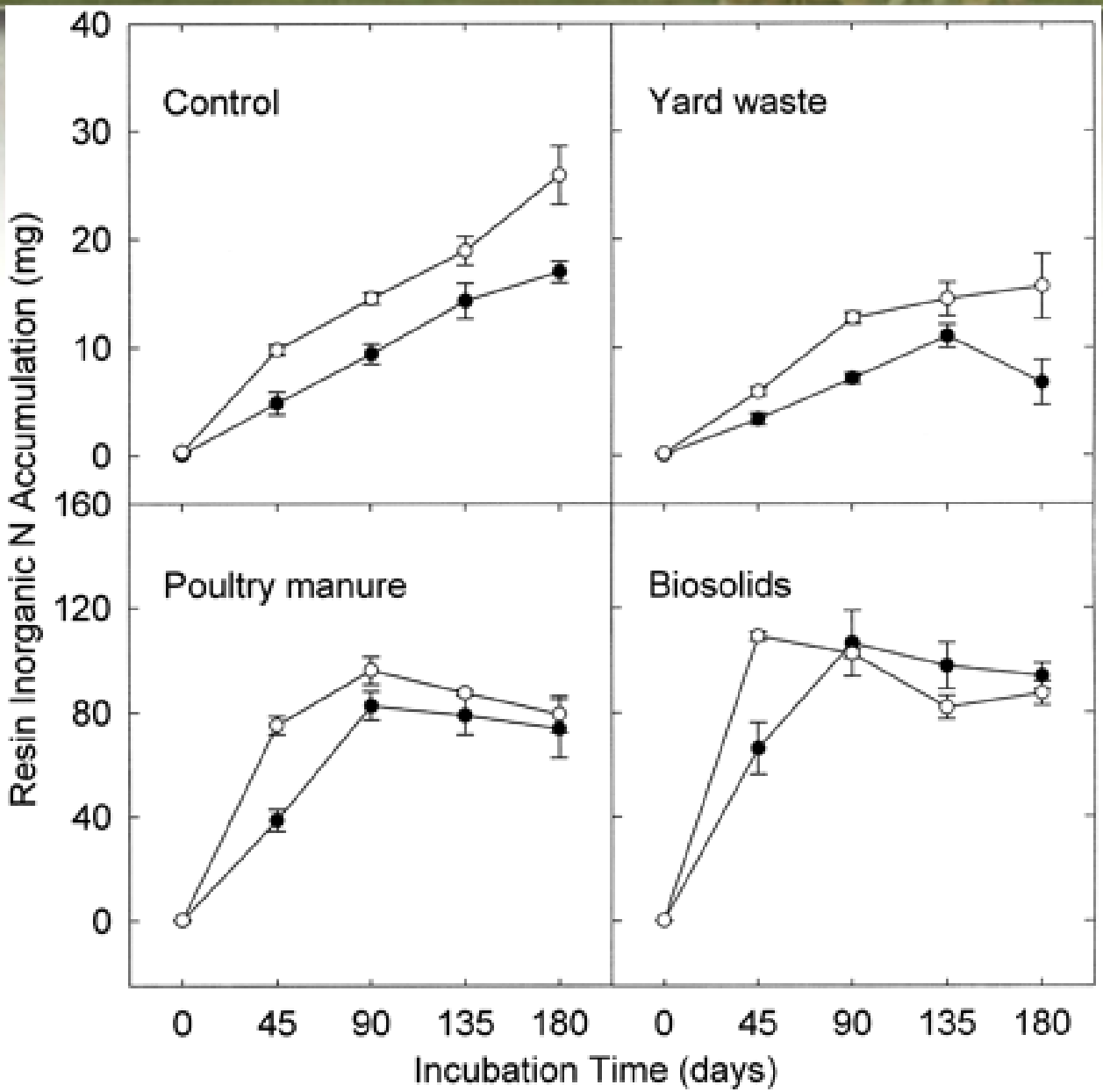
Phosphorus:

- Availability similar to chemical fertilizers in the first year, continued release of phosphorus in second year.

Potassium:

- Availability similar to chemical fertilizers.

Mineralization rate of compost



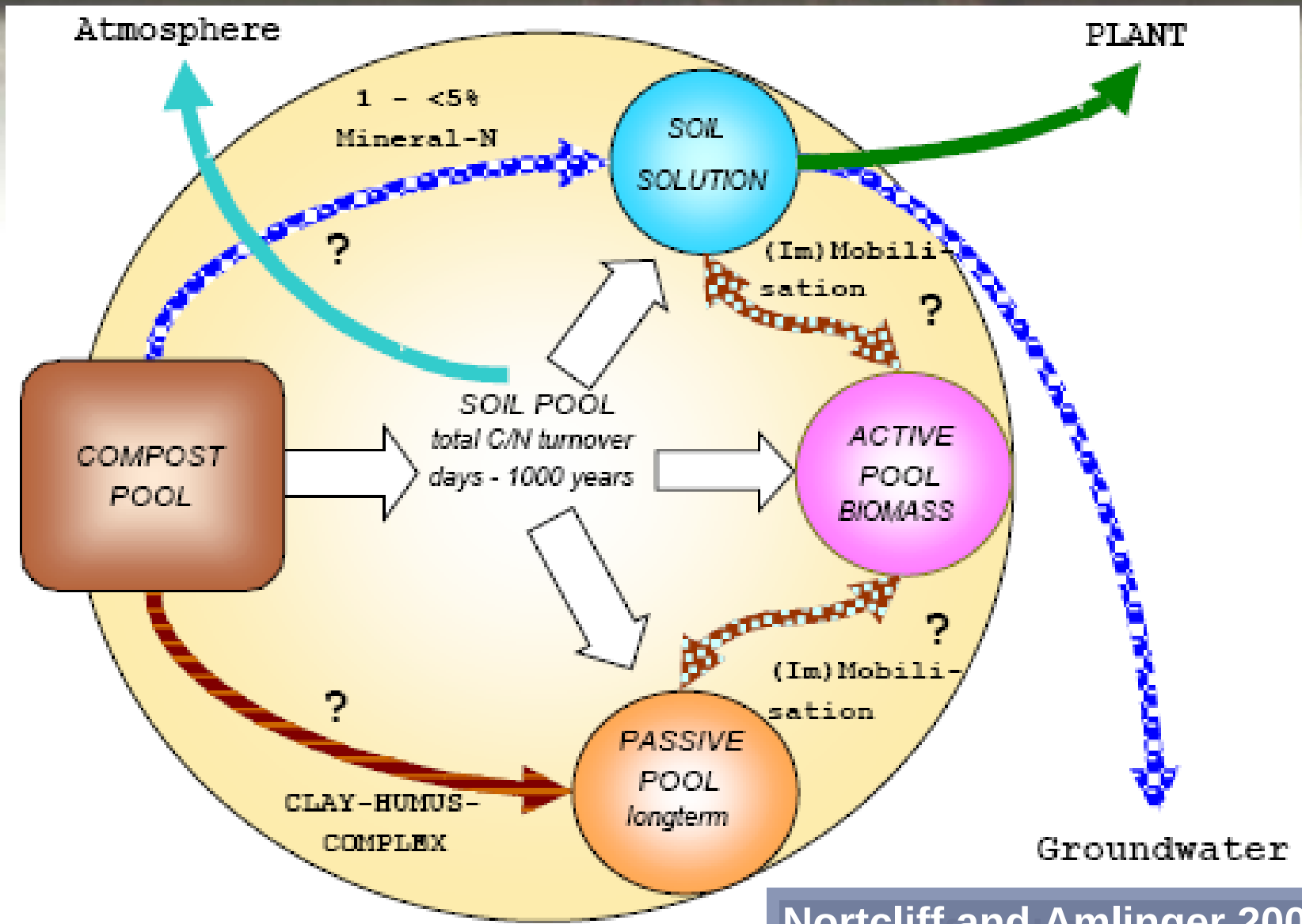
- Std resin trap
- New resin trap

Hanselman et al. 2004

The challenge of balancing manure compost nutrient applications and withdrawals

- N:P ratio of most manures is 3:1 or less
- N:P ratio of most crops is 4:1 or more
- Application of manure to meet the crop's N removal rate results in accumulation of P in soil

Fate of compost nutrients in SOM pools is poorly understood



Nortcliff and Amlinger 2001

Compost nutrients

The decomposition of fresh organic amendments is dependent upon:

- C content, C:N ratio of organic amendment
- Soil temperature – slower at low temperatures
- Soil moisture – slower in dry soils
- The status of the soil including inherent fertility and pH
- Soil texture - faster mineralization rate on sandy soils
- Method of application of the organic residues: soil incorporated or surface applied (difficult to measure)
- Rate of application

Soil organic matter

The objective should be to have a steady supply of organic matter undergoing mineralization for the benefit of the growing crop.

SOM is reduced by:

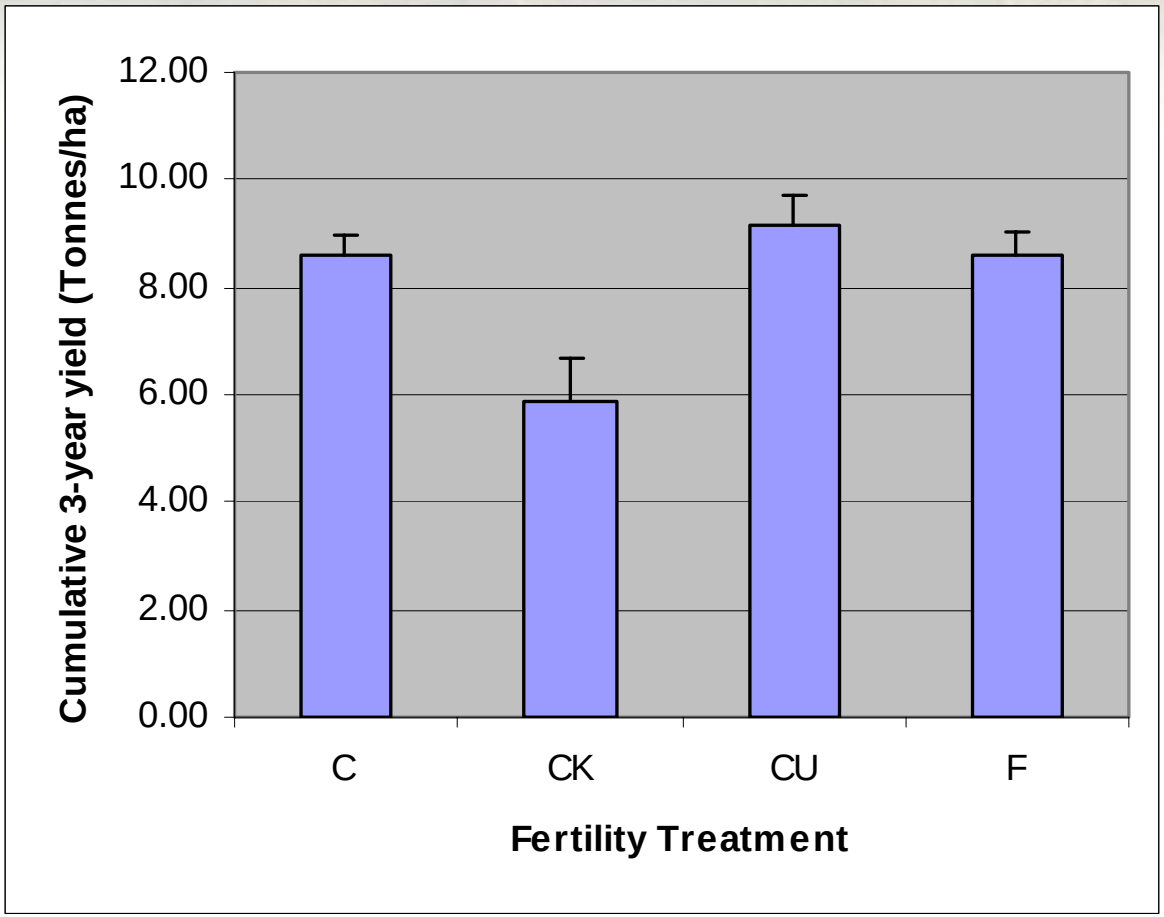
- Excessive cultivation
- Summerfallow
- Limited diversification in a crop rotation
- Fertilizer practices
- Crop residue removal

Compost and food security

- Compost is one of the best tools available to maintaining soil productivity and reducing environmental degradation as a result of intensive agriculture.
- The implications of practices such as composting could be enormous for food security. A one tonne increase of the soil carbon pool in degraded soils may increase crop yield by 20 to 40 kilograms per hectare (kg/ha) for wheat and10 to 20 kg/ha for maize.

Rattan Lal 2004

Composted manure as a substitute for inorganic fertilizer



- Cumulative yield of durum wheat over 3 years.
- Comparison of annual application of beef manure compost (C), compost + 20 kg/ha of seed placed 46-0-0 (CU) and inorganic fertilizer (F).
- Compost applied at an equivalent rate of 70 kg of available N/ha.
- Rotation plan required to include forages to manage P accumulation.

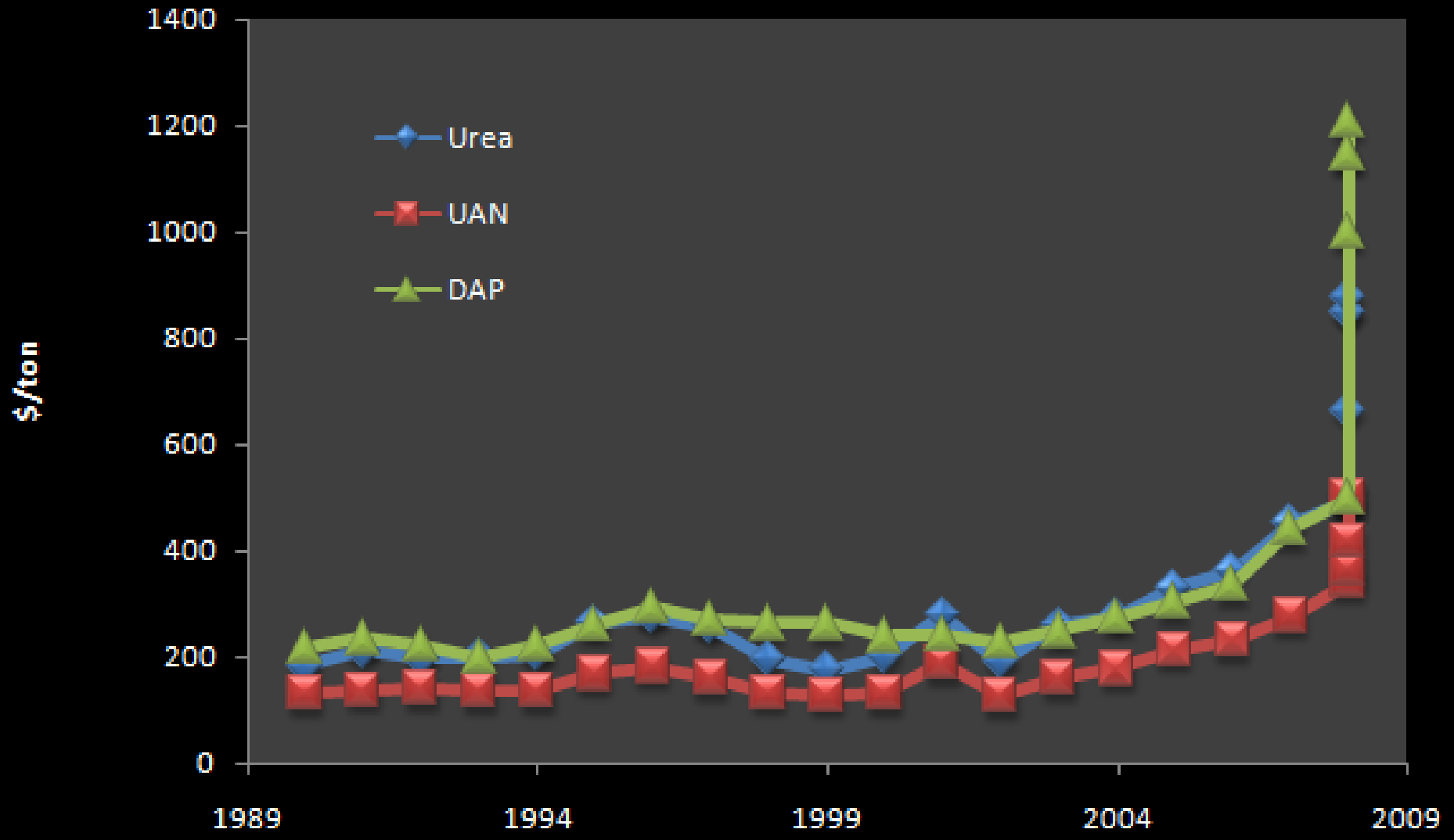
Buckley 2004 (Unpublished data)

Land application of feedlot manure compost: 4 yr studies

	% C conserved near soil surface	
	Fresh manure	Compost
Alberta†	45	65
Nebraska‡	25	36

†Larney et al. 2007
‡Eghball 2002

Fertilizer Prices, 1990-2008



Price comparison (estimate)

Material	Kg N-P-K-S per Tonne	Cost/ Tonne	Other Nutrients	$/kg nutrients
Urea	460-0-0-0	$670		$1.46
MAP	110-520-0-0	$860		$1.37
Ammonium Sulphate	210-0-0-240	$480		$1.07
Potash	0-0-500-0	$375		$0.75
Compost	12-12-13-2	$25 to $40	Ca (23), Mg (5), micros (B, Cl, Cu, Fe, Mo, Zn, Cr, Co), OM	$0.56 to $0.91

Value of contribution of compost to soil quality

- Increase in soil aggregate (crumb) stability → improved water absorbing capacity and permeability during heavy precipitation → erosion protection → higher moisture reserves during drought
- Compaction protection, increase of soil resilience → improved traffic tolerance → decrease in crusting and draft weight
- Enhanced soil biological activity → increased mineralization
- The quantity of N, P, K, Zn, Cu and other trace elements

Value of compost ~ $200/tonne

Adapted from Rattan Lal 2004
Carbon Management and Sequestration Centre
Ohio State University

It is not all about increasing yield in a test plot

- It is about stabilizing yields over time
- It is about reducing impact of drought and saturated soils.
- It is about increasing returns by controlling and eliminating….

... this...

...and this...

Crop damage due to herbicide residues in soil

...and this...

Effect of soil compaction on root growth resulting in manganese deficiency

....this....

....and this....

Cranfield University, 2000

Canada