Developing a farmer friendly soil organic matter calculator

Rafiq Islam, Vinayak Shedekar, and Randall Reeder

Ohio State University

Jerry Grigar

USDA-NRCS Michigan, State Agronomist

March 22, 2012

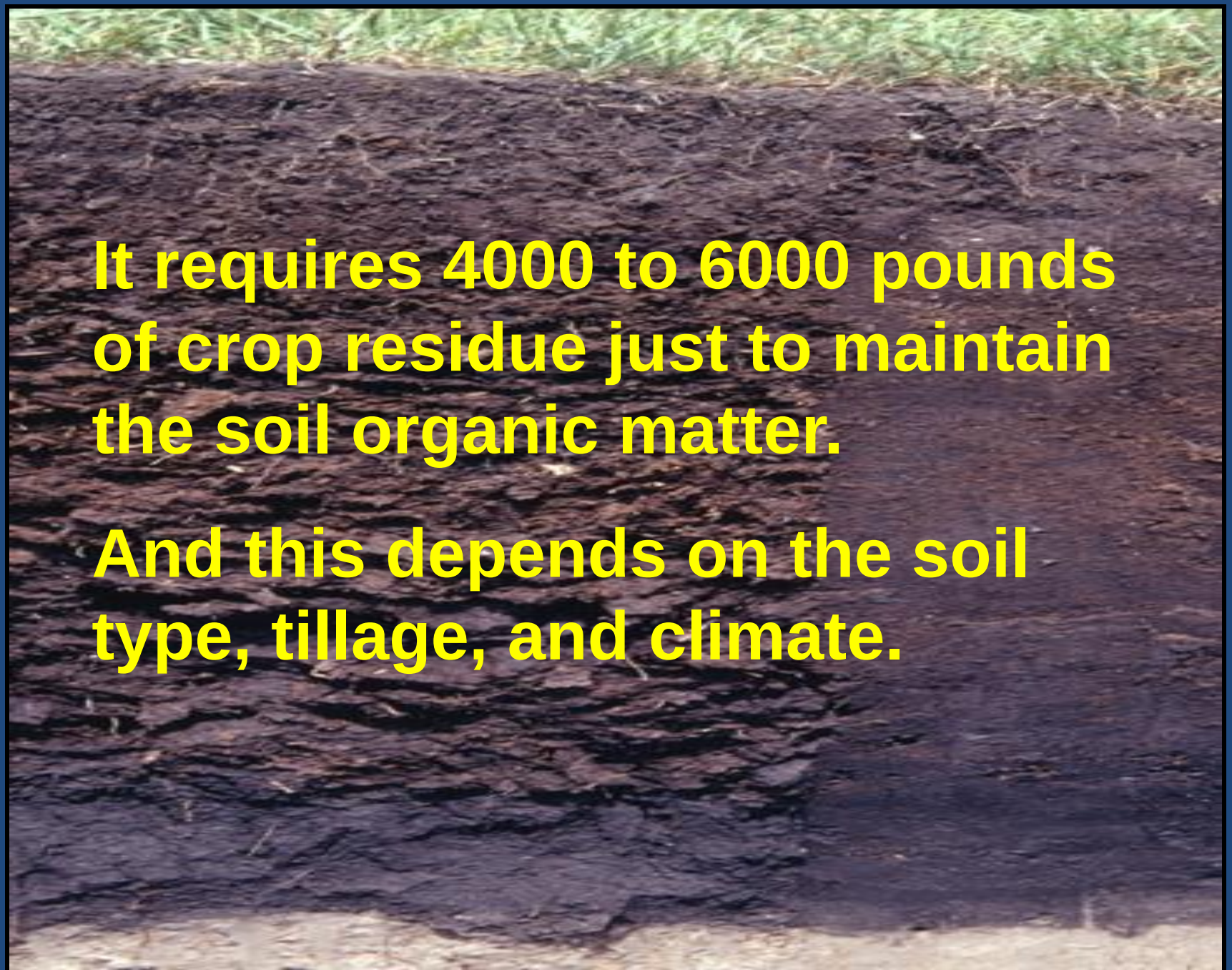
J. Grigar

Soil Organic Matter

- *Goal: maintain Soil Organic Matter*
- There are few tools available to quantify SOM changes when crop residue is removed

“Soil organic matter is the nation’s most precious resource.”

Daniel Albright, 1938, “Soils and Men”



It requires 4000 to 6000 pounds of crop residue just to maintain the soil organic matter.

And this depends on the soil type, tillage, and climate.

Go beyond "T" and manage for "C" !

Substitute "C" for "T" in erosion and soil quality control!

- Source: Don Reicosky USDA ARS

2011 American Society of Agronomy San Antonio TX

CCA's asked: "What's the Bottom Line? How does selling residue for Bio-fuel affect my cash flow and SOM/soil health?"

What is Corn Residue Worth?

Harvest Efficiency?

Residue- Nutrient Value

Residue Type	N	P_20_5	K_2O	$/ton
	----------lbs./ton----------			
Barley Straw	13	3.2	52	$38.80
Corn Stover	22	8.2	32	$36.90
Oat Straw	13	2.8	57	$41.34
Rye Straw	8.6	3.7	21	$19.44
Wheat Straw	13	3.3	23	$22.99

Source: MSUE Bulletin E-550 Table 1: Nutrient removal ... MI field crops :& local Fertilizer prices : N- 28% $385/ton; P_20_5 _ MAP-640/ton ; K_2O - $ 570/ton

Residue for Bio-Energy Goal

GOAL=SOM GAINS = or < SOM LOSSES

Quantify SOM (Lbs./ac)?

- Change rotation
- Adopt No tillage
- Add manure or cover crops
- Add Irrigation
- Sell crop residue

J. Grigar

Alternative C Sources to maintain SOM if selling residue for bio-energy?

- Manure
- Cover Crops
- Crop Rotation
- Tillage/No-tillage
- Water management

J. Grigar

The “Founding Fathers”!

Dr. Robert Lucas

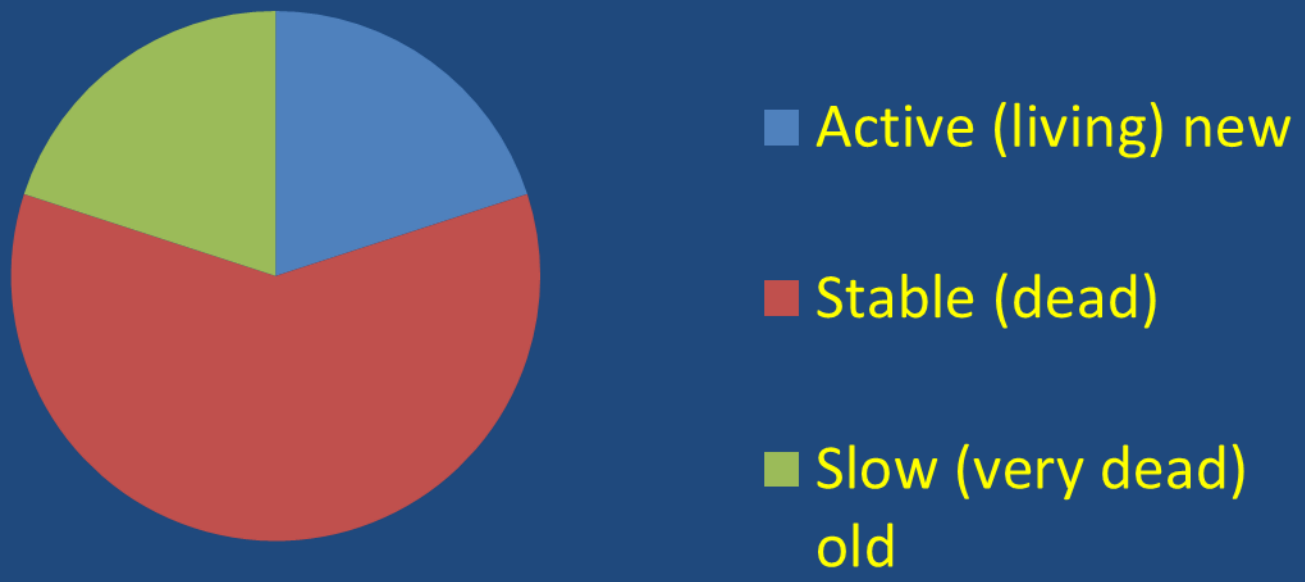
Dr. David Jenkinson

J. Grigar

Lucas Model to predict SOM

- Developed by Dr. Robert Lucas at MSU .
- A two-pool exponential decay model that uses decomposition constants based on Plant Residue Equivalent (PRE)
- Tested by Dr. Lucas and myself using data from several long-term Michigan State University SOM research studies.

Soil Organic Matter Pools



J. Grigar

Farmer-friendly Soil Organic Matter Calculator

Project funded by

Corn Marketing Program of Michigan

- User-friendly software for predicting soil organic matter, nutrients and overall soil quality.
- Management guidelines which farmers can use to ensure the long term viability and sustainability of Michigan agriculture.

How Much Is Your Residue Worth? Lucas Model for Predicting Soil organic matter Changes

Jerry Grigar, State Agronomist **USDA**-NRCS

Rafiq Islam, Vinayak Shedekar, Randall Reeder

Ohio State University

August 15, 2012

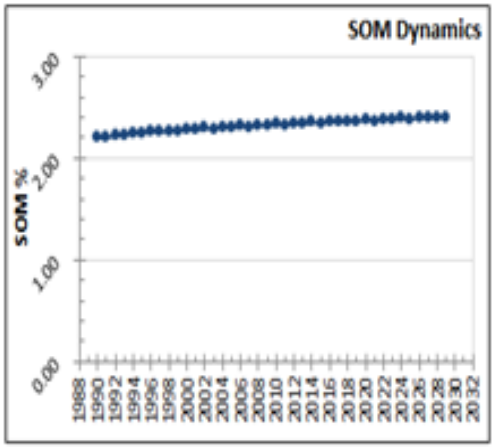
Lucas OM Model Ver1.5x 1.20.2013 - Microsoft Excel

File | Home | Insert | Page Layout | Formulas | Data | Review | View | Developer | Add-Ins | Team

P44

Lucas OM Model Version 1.5x

1	Start Year	1990	SAVE File	PRINT File														
2	End Year	2029					PRE Calculator											
3	Data Entry Form		Rotation #	1	2													
4			Years	1	1	1												
5			Crop	Corn	Soybeans	0-NONE	0-NONE	0-NONE	0-NONE	0-NONE								
6			Yield (bu/ac)	120	55													
7	Test Scenarios		PRE	9240	7331	0	0	0	0	0								
8			Tillage Depth	0	7													
9	CLEAR Sheet		Tillage Type	No-till	Conventional													
10			Ave PRE (Crop)	5524	Residue Removal Rate:		%	0	after every	1								
11			Avg PRE 5 yrs before1990	8285	Residue Removal (lbs/acre-year)			0		years								
12			Manure Type	NONE	NONE	NONE	NONE	NONE	NONE	NONE								
13			Manure PRE (lbs/ton)	0	0	0	0	0	0	0								
14			Manure Rate (tons/ac)	5							Freq. (Yrs)	Adj.PRE	Harvested	Yield	Av. PRE	Cover Crop Name		
15			Average Manure PRE (lb/ac)	0							1		0	1	0	0-NONE		
16			Overwrite Crop PRE (lbs/ac)								Final Cover Crop PRE		0	lbs/ac	lbs/ac			
17			Erosion Rate tons/acre per year	3	Dominant Tillage Type:	No-till		1 % Yield benefit/yr								Drainage Type	Subsurface Drainage	
18			(lbs/acre-year)	6000	Cropping System:	Corn-Soybean Rotation		0.0133	No-till	is most common tillage			#N/A			Fertilizers	Adequate (Recommended)	
19			Initial SOM (%)	2.2	Old OM Decay rate(%)>>	1.1	0.011	2,410,320		<<Overwrite Weight of Furrowslice (lbs/ac)							NTPoints 1	
20			SamplingDepth (in)	0-8	8 in. of profile		Tillage depth (in)>	3.5		<<SoilBulkDensity(lbs/cu.ft.)	Manure Recommendations		Beef Cow calf, pasture patties				402	
21	Crop		Yield	Estimated	Total	Avg Crop	Active	Old	Total									
22	Rotation	Year		PRE	PRE	PRE	OM Pool	OM Pool	OM Pool	OM Pool	PRE (lbs/acre)		MANURE (tons/acre)					
23			bu/ac	lbs/bu	lb/ac	lb/ac	lb/ac	lb/ac	lb/ac	%	Cumulative	Per Year	Per Year	Cumulative		Crop Yield		
24	PreviousCrops	1989				8285	5468			100						Unit		
25	Corn	1990	120	92	8846	8846	5468	47559	53027	2.200	-	-	-	-		bu/ac		
26	Soybeans	1991	55	160	8948	8948	5621	47566	53187	2.207	0	0	0.0	0.0		bu/ac		
27	Corn	1992	120	92	9509	9509	5933	47574	53507	2.220	0	0	0.0	0.0		bu/ac		
28	Soybeans	1993	55	160	9611	9611	6118	47580	53698	2.228	0	0	0.0	0.0		bu/ac		



1 Use Separate PRE/year

UserGuide | OMCalculator | Report

Ready

100%

Cont. Corn Erosion Study- 20 yr. 2 ton mulch added

Marlette Loam Erosion	Ave bu/ac	Mulch Rate**	Soil Test SOM 1985	2004	SOC Predicted	Model error 20 yr.
			----------SOM%----------			
Slight	126	2 ton	1.1	1.4	1.57*	.17
Moderate	108	2 ton	0.9	1.3	1.35	.05
Severe	83	2 ton	0.7	1.3	1.25	(.05)

*8- inch furrow slice. Annual SOM decay 1.3%.

**Used SOC Manure source for straw- Beef Finishing, straw solid @ 2tons/acre Added each year beginning in 1993

Source: Dr. Del Mokma-MSUE Soil Scientist unpublished data Assumed 8 inch furrow slice

Cont. Corn Erosion Study- 20 yr.

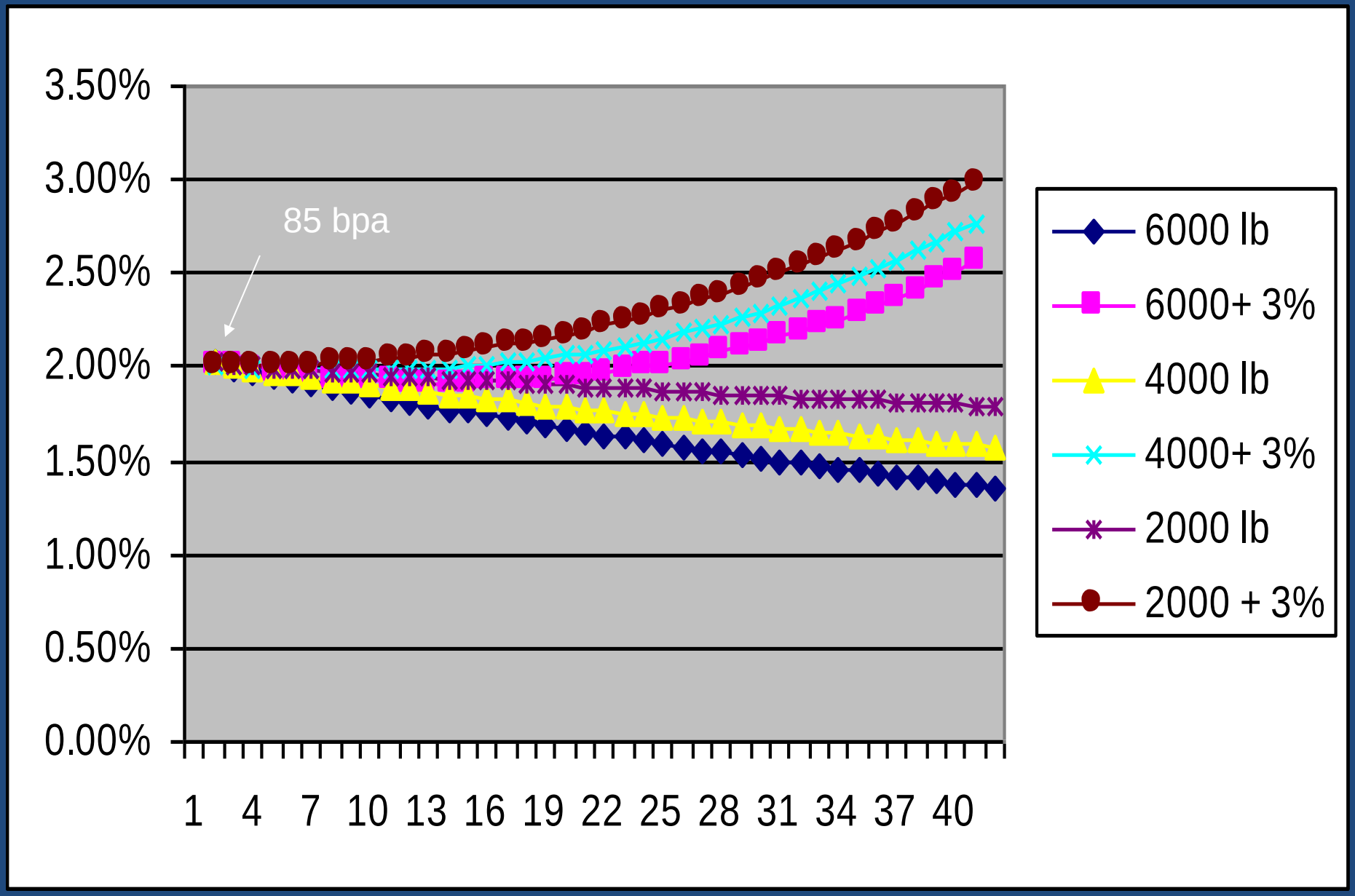
Marlette Loam Erosion	Ave bu/ac	NO MULCH	Soil Test 1985	SOM 2005	SOC Predicted	Model error
			----------SOM%----------			
Slight	129	no	1.1	1.4	1.49*	.09
Moderate	120	no	0.9	1.3	1.29	.01
Severe	96	no	0.7	1.2	1.28**	.08

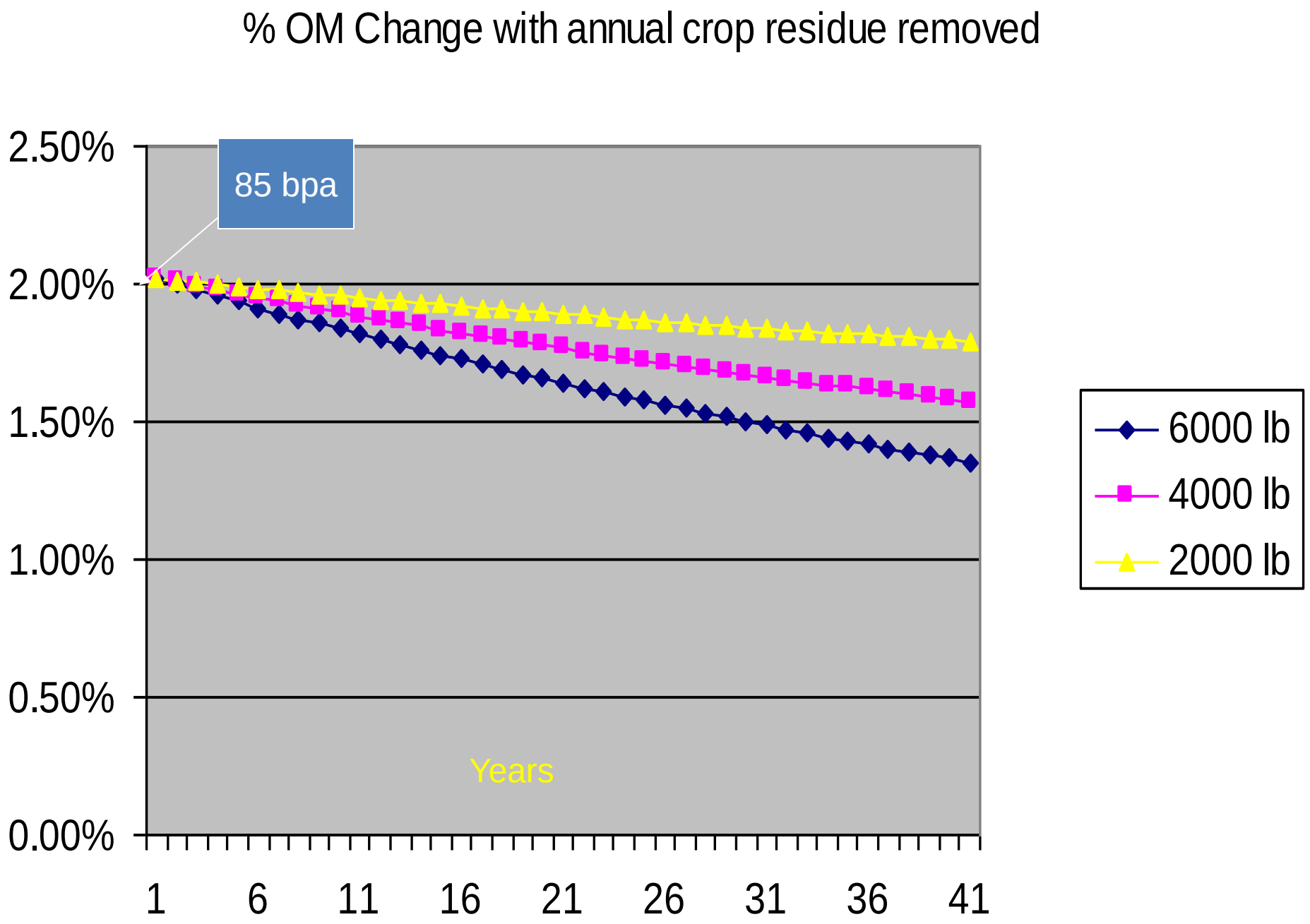
*8- inch furrow slice. Annual SOM decay 1.3%. Added straw @ 2 ton/ac beginning 1993

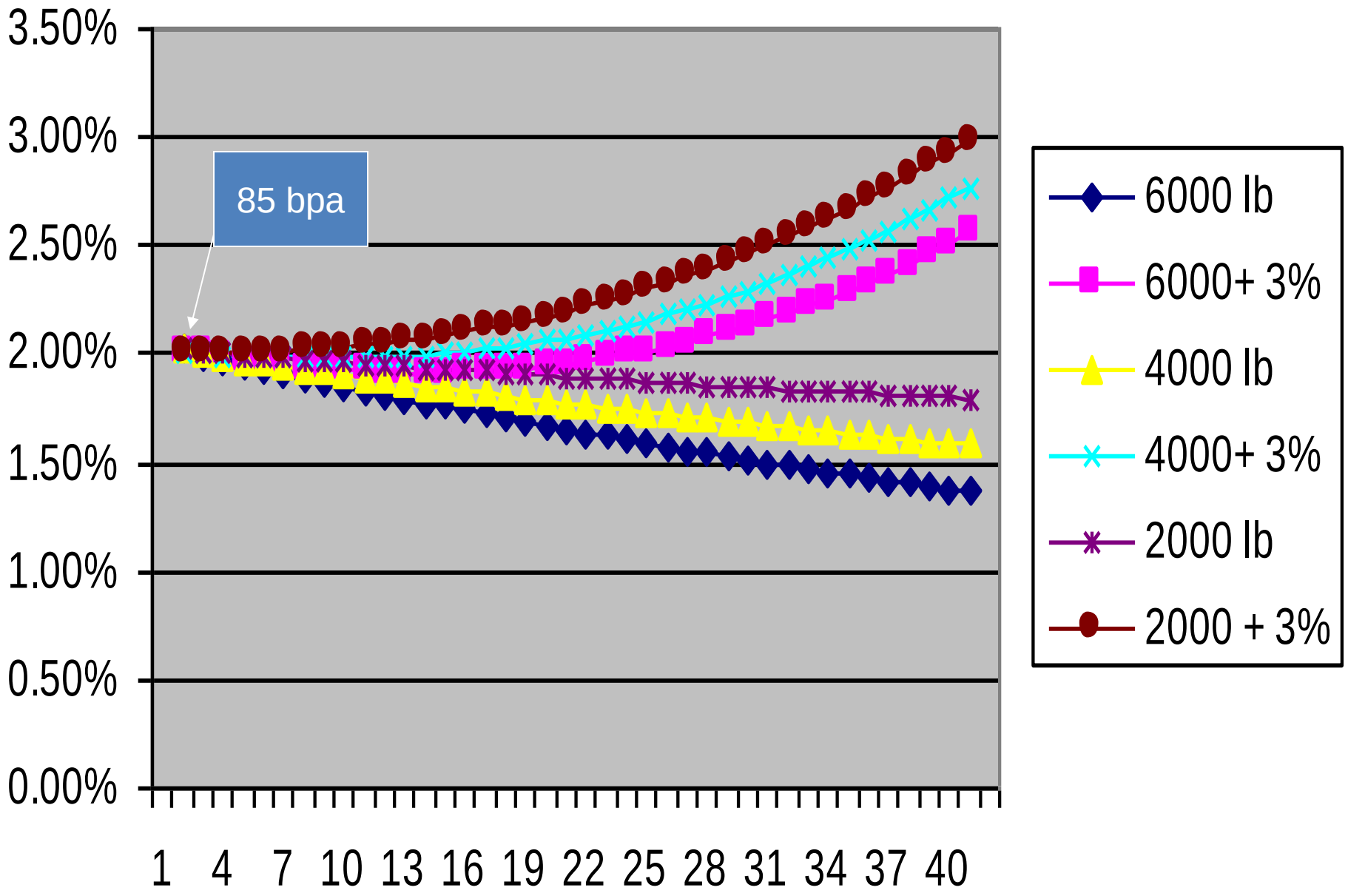
** Bulk density of 1.8 reduced plow depth to 6-inch furrow slice

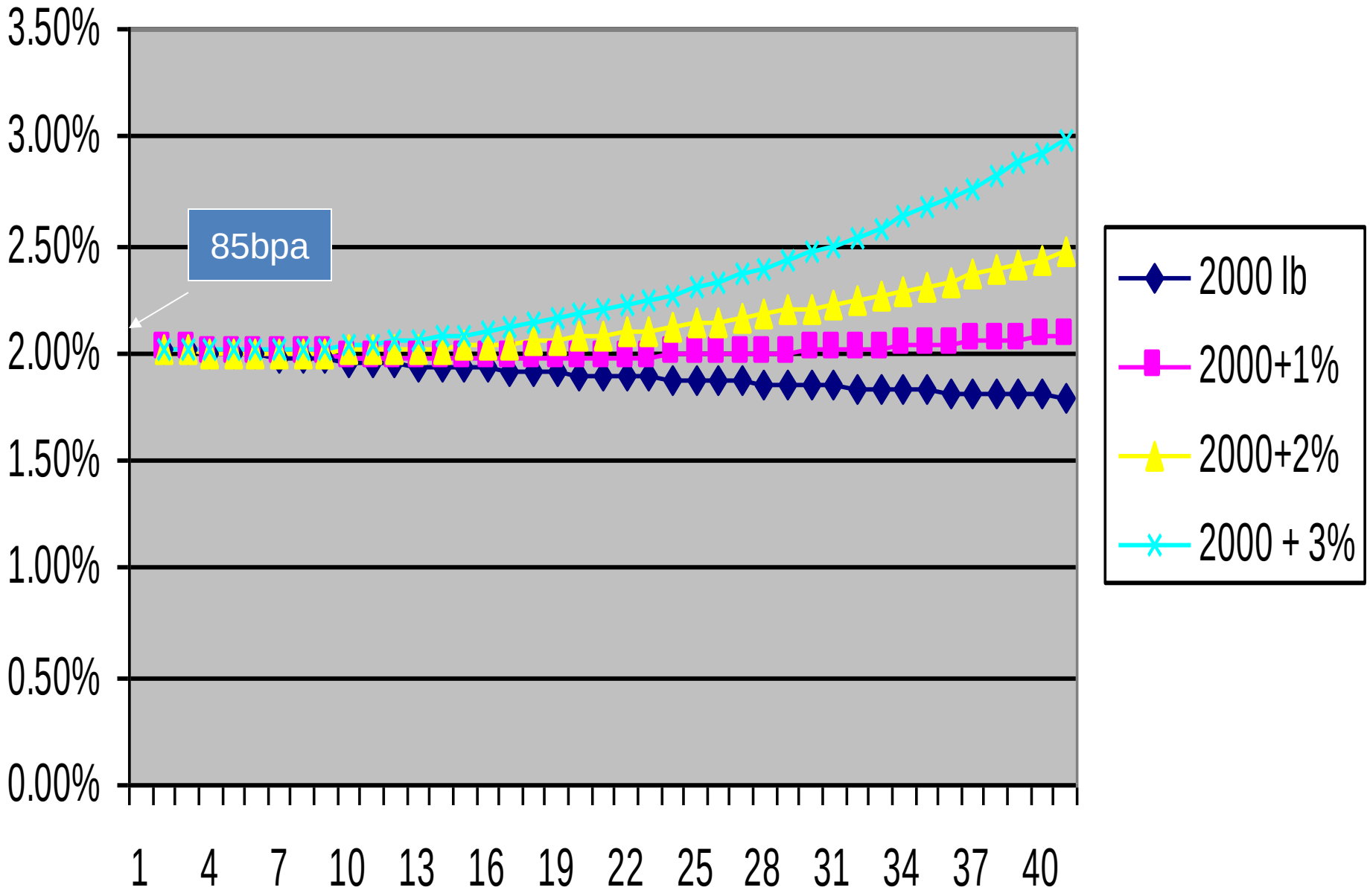
Source: Dr. Del Mokma-MSUE Soil Scientist unpublished data Assumed 8 inch furrow slice

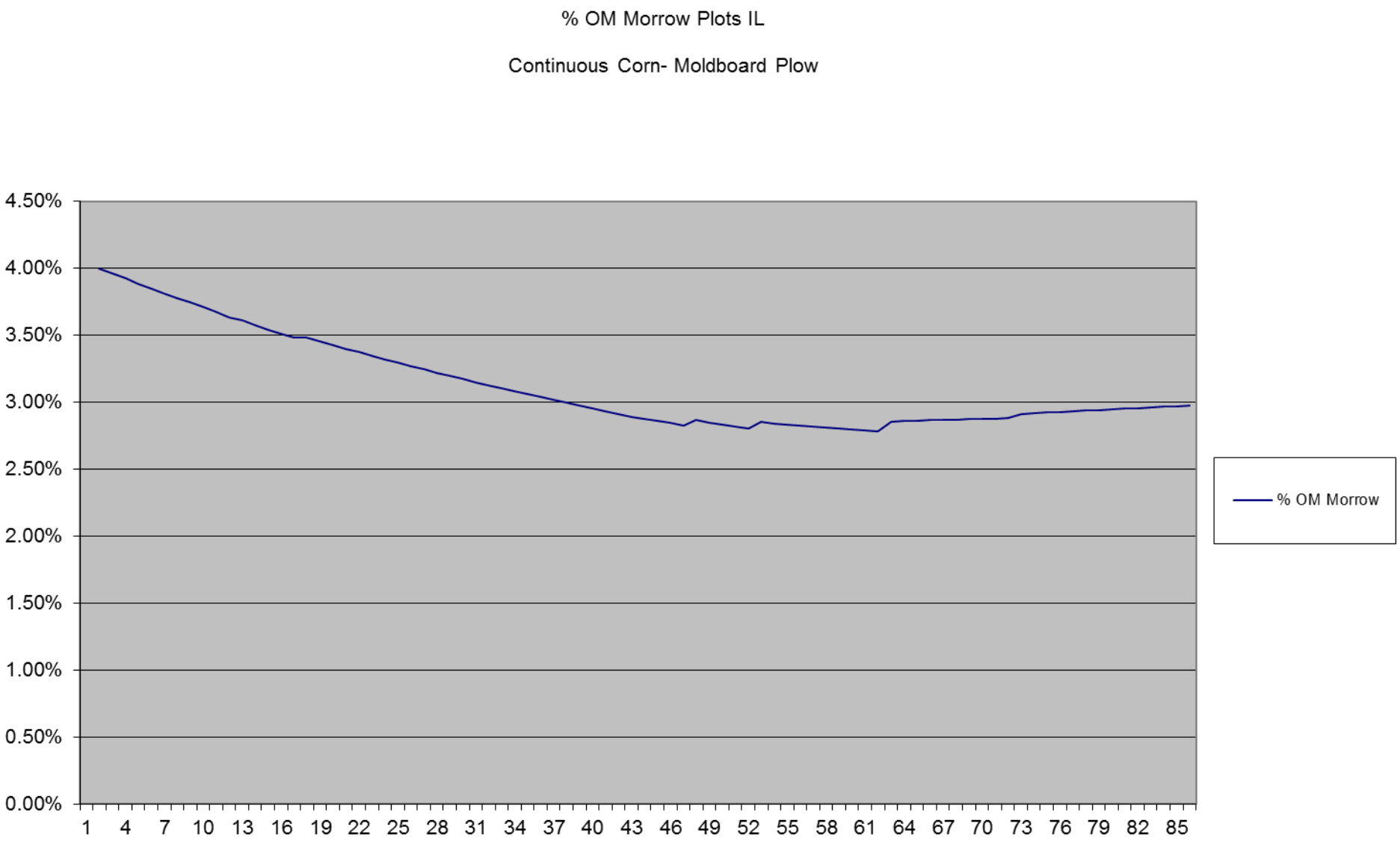
% OM Change With 3% /yr yield gain & Annual Crop Residue Removed

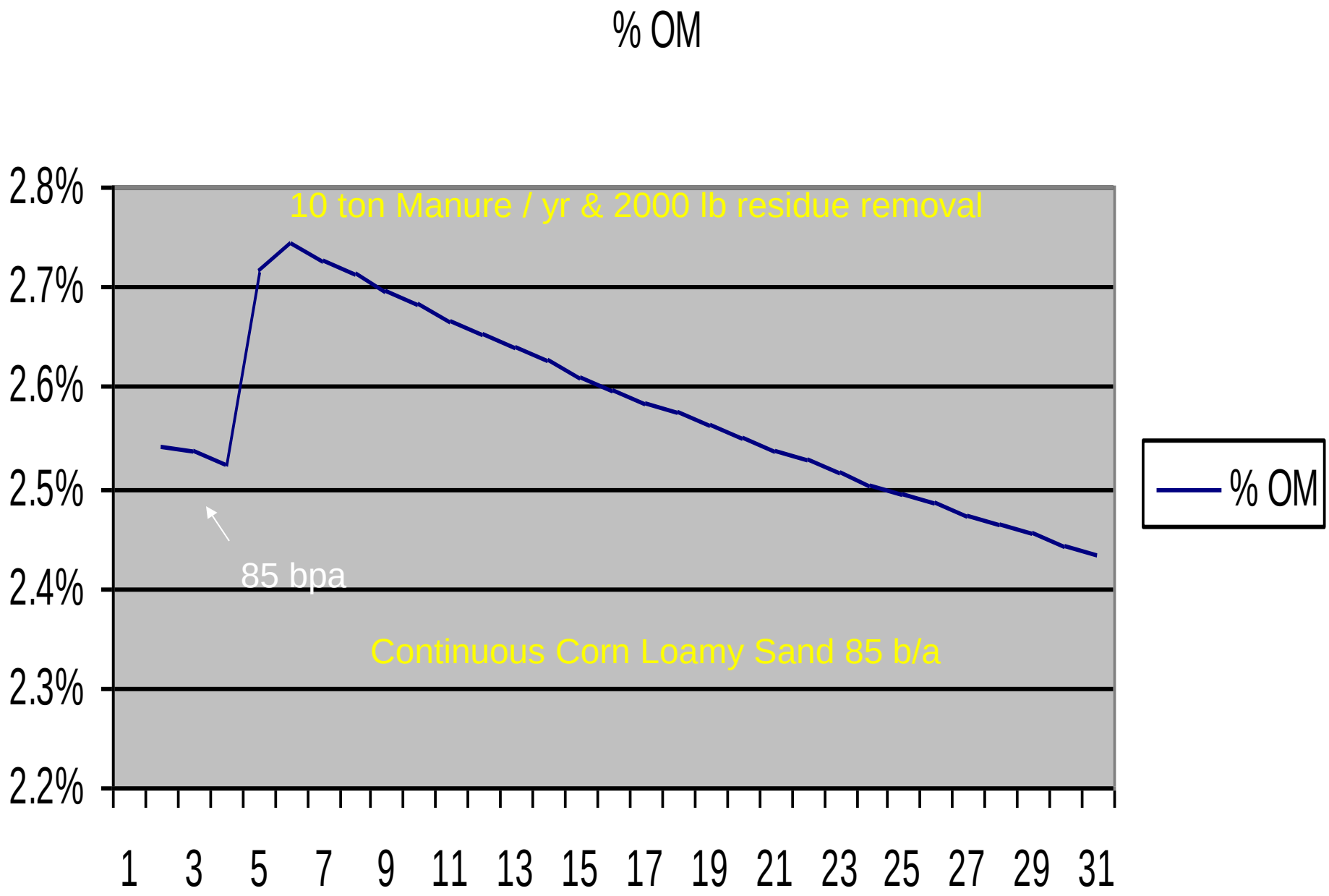


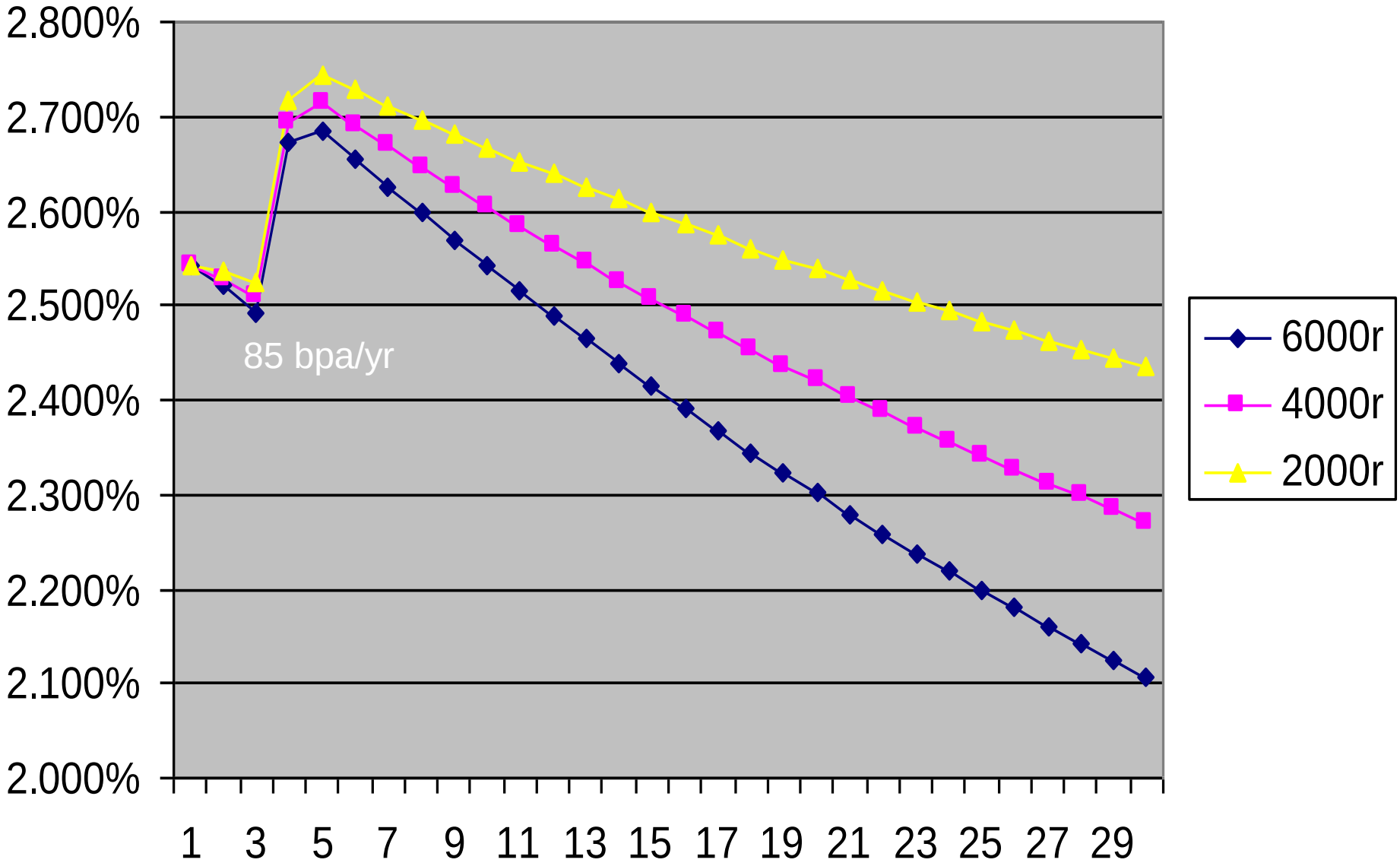

% OM Change with annual crop residue removed
85 bpa
2.50%
2.00%
1.50%
1.00%
0.50%
0.00%
Years
1
6
11
16
21
26
31
36
41
6000 lb
4000 lb
2000 lb


3.50%
3.00%
2.50%
2.00%
1.50%
1.00%
0.50%
0.00%
85 bpa
1 4 7 10 13 16 19 22 25 28 31 34 37 40
6000 lb
6000+ 3%
4000 lb
4000+ 3%
2000 lb
2000 + 3%


3.50%
3.00%
2.50%
2.00%
1.50%
1.00%
0.50%
0.00%
85bpa
1
4
7
10
13
16
19
22
25
28
31
34
37
40
2000 lb
2000+1%
2000+2%
2000 + 3%


% OM Morrow Plots IL
Continuous Corn- Moldboard Plow
4.50%
4.00%
3.50%
3.00%
2.50%
2.00%
1.50%
1.00%
0.50%
0.00%
1 4 7 10 13 16 19 22 25 28 31 34 37 40 43 46 49 52 55 58 61 64 67 70 73 76 79 82 85
% OM Morrow


% OM
2.8%
2.7%
2.6%
2.5%
2.4%
2.3%
2.2%
10 ton Manure / yr & 2000 lb residue removal
85 bpa
Continuous Corn Loamy Sand 85 b/a
1
3
5
7
9
11
13
15
17
19
21
23
25
27
29
31
% OM



Continuous Corn 85 b/a Loamy Sand