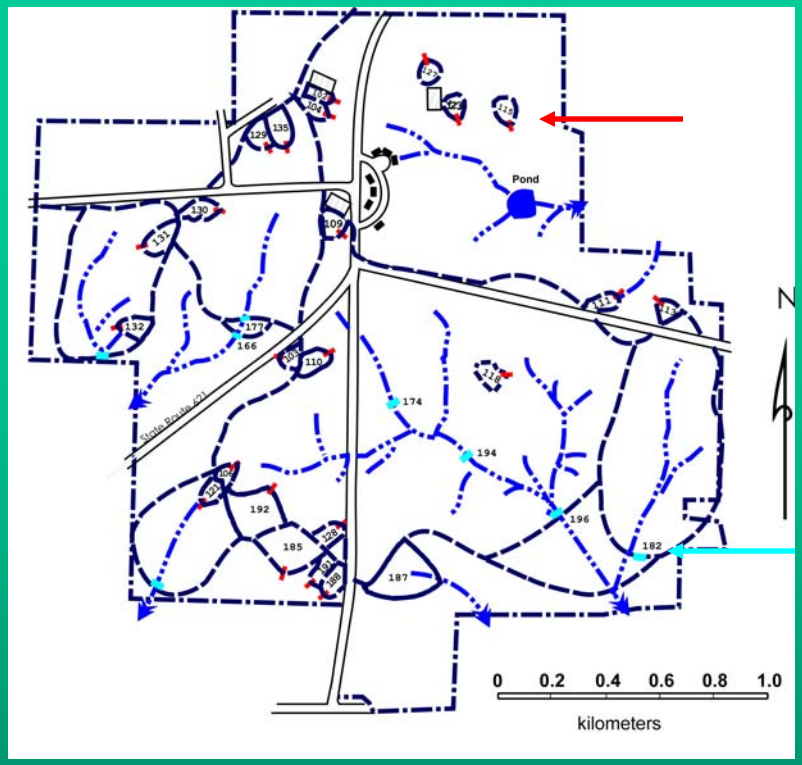
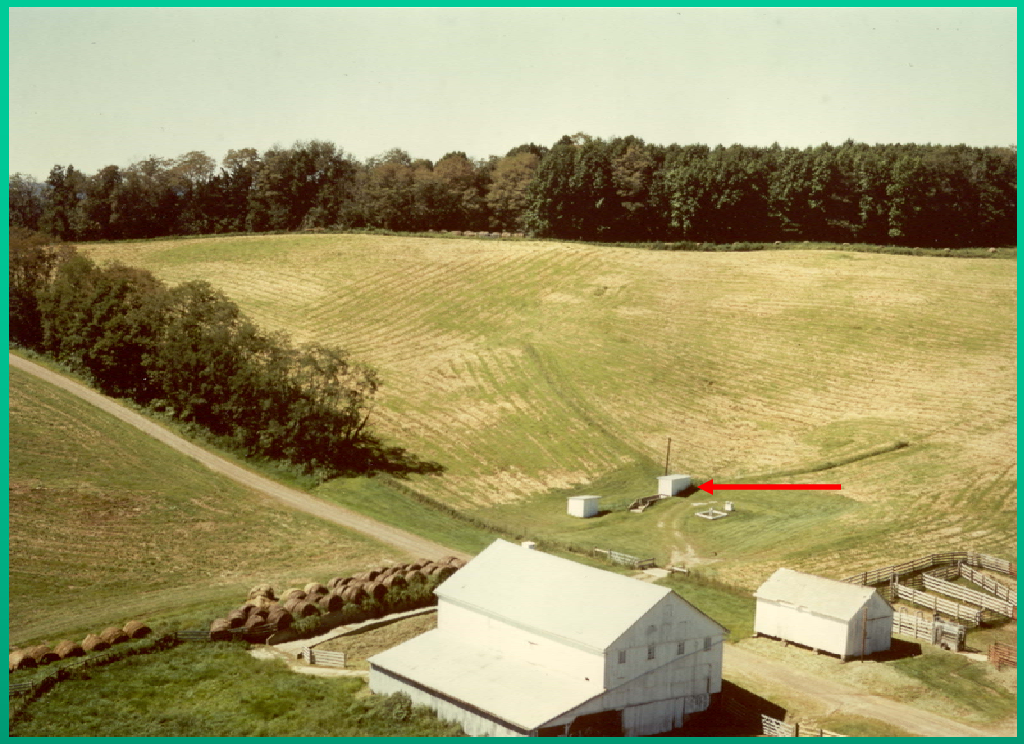
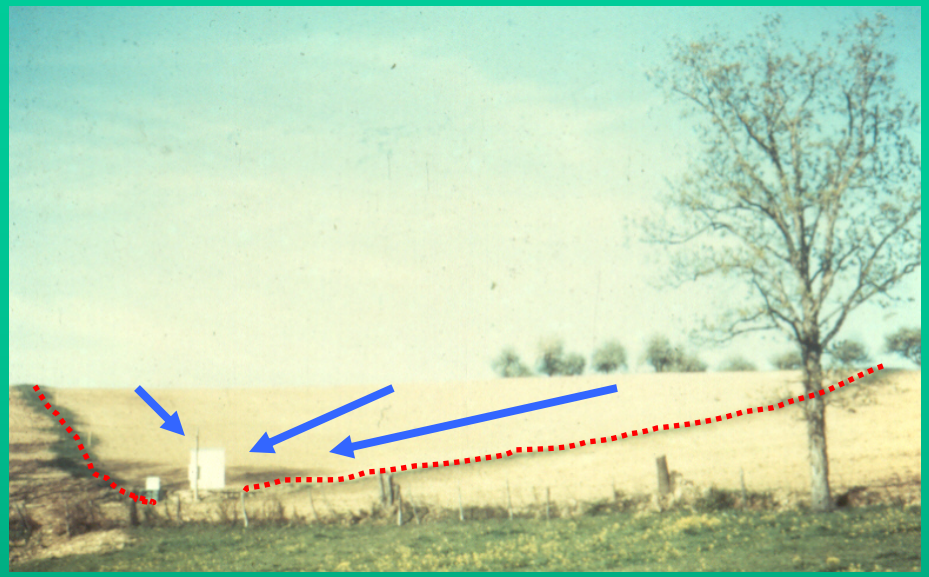
The ***North Appalachian Experimental Watershed*** (NAEW) was established in the 1930's and is operated by the USDA - Agricultural Research Service



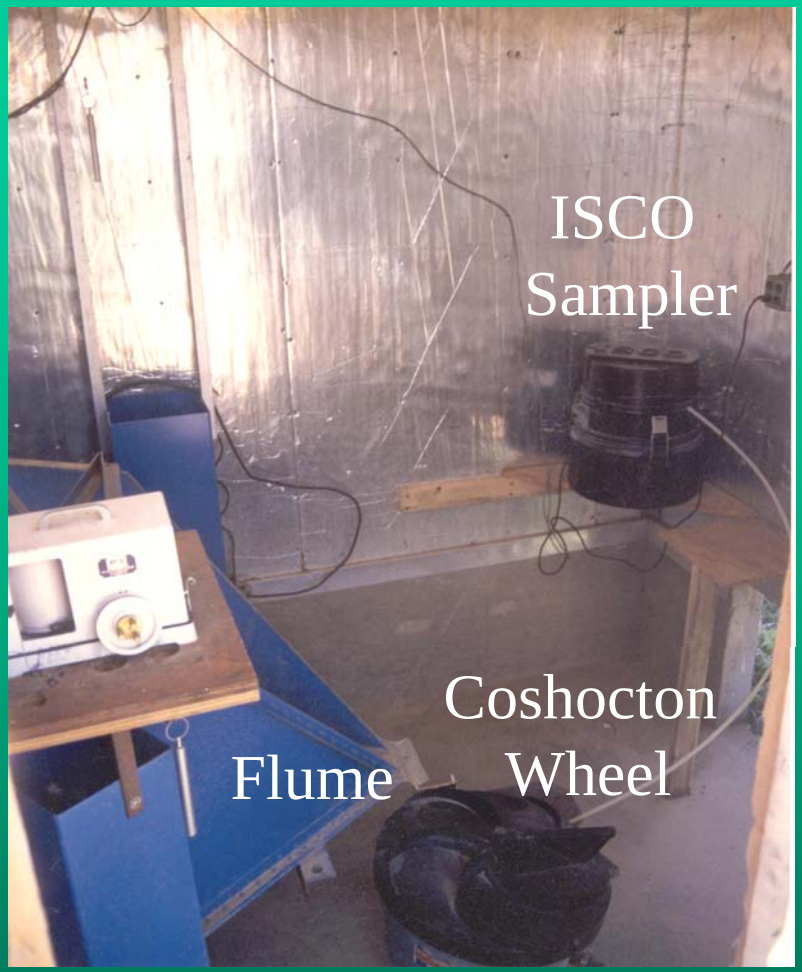


At the 420 hectare NAEW, small (0.5 to 1 ha) and large (up to 120 ha) watersheds are used to assess the field-scale effects of various management practices on surface water quality



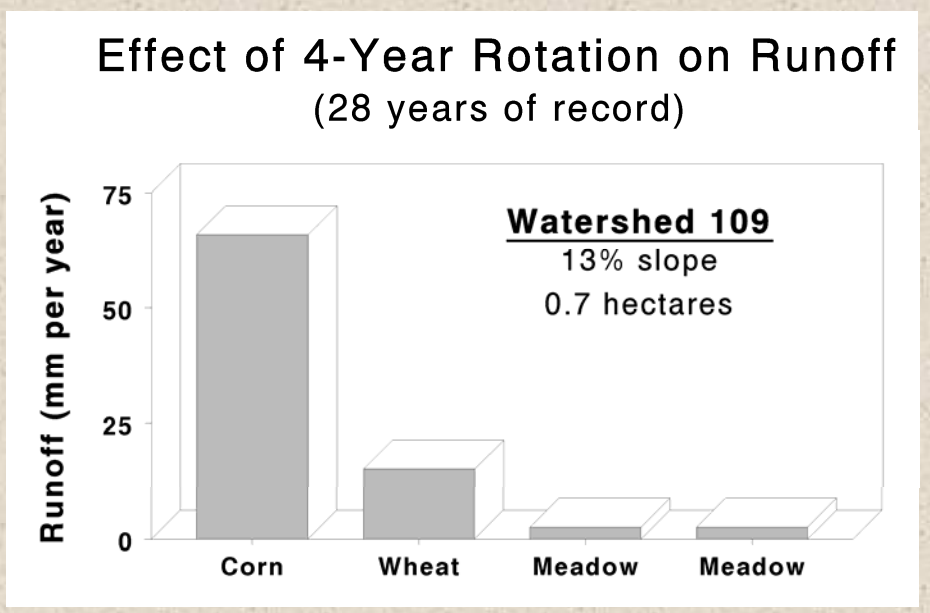
Small Tilled Watershed

Monitoring Building

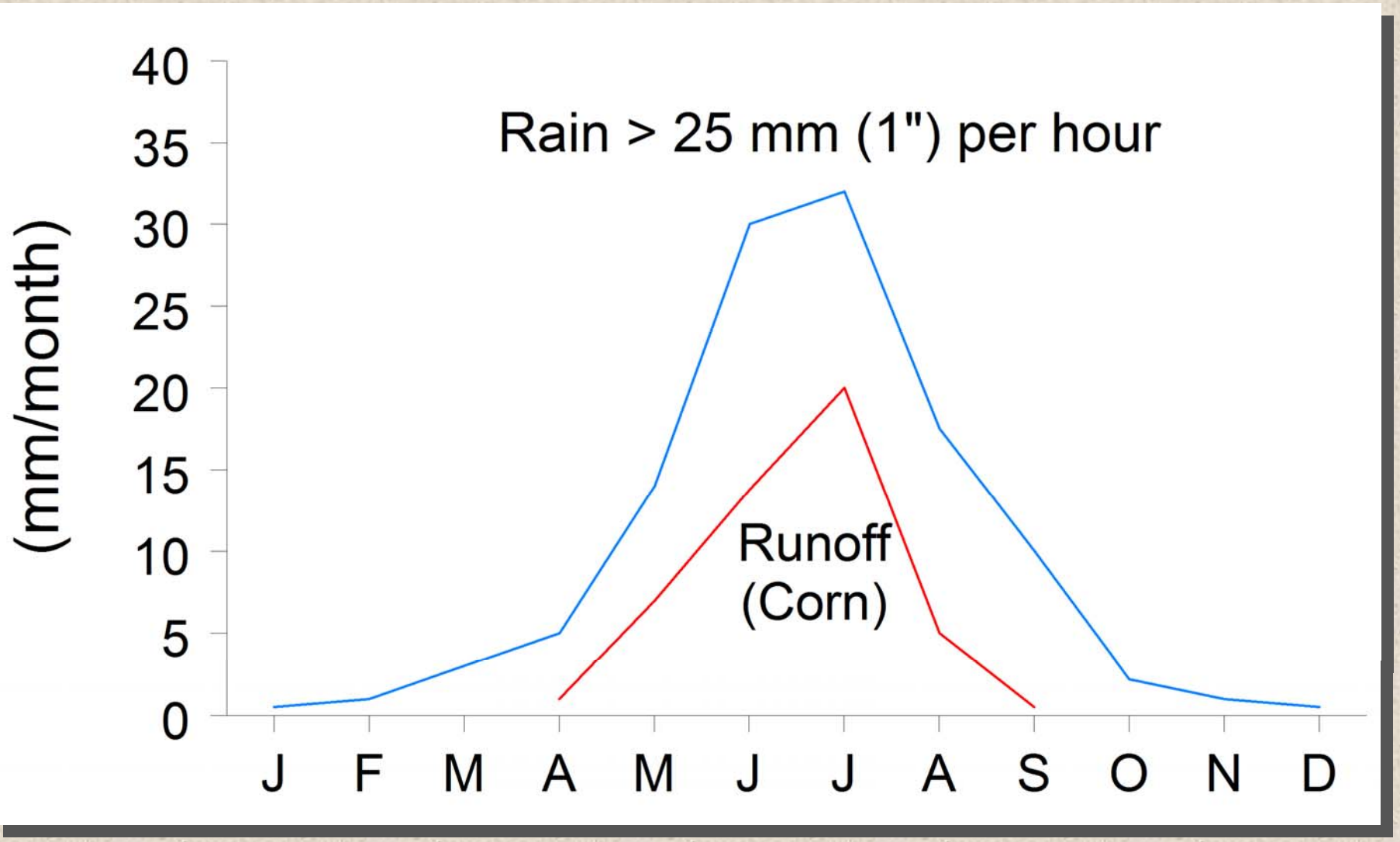


- H Flume
- Coshocton Wheel (Flow – Proportional Sampler
- ISCO Sampler (Discrete Sampler)

Conservation Tillage from 1940's to 1960's



- 92% of the soil erosion occurred in corn years
- Contour tilling and planting reduced erosion from 15.7 to 4.7 Mg/ha/corn yr



Most of the runoff is the result of high-intensity rainfall and these events occur mostly in the months of May-July

Erosion in Big Storms (WS 115)

Storm Rank	Erosion per Storm Mg/ha	Erosion per Storm Tons/Acre	Cumulative Loss (% of Total)
1	55.3	24.7	54
2	15.0	6.7	69
3	11.0	4.9	80
4	2.9	1.3	83
5	2.0	0.9	85

- More than 4000 rainstorms occurred on this prevailing practice watershed in the 28-yr period
- Five storms resulted in 85% of the total soil loss of 102 Mg/ha

Erosion in Big Storms
(Cumulative % of 28-Year Total)

Storm Rank	Improved Watersheds				
	WS 103	WS 121	WS 123	WS 109	WS 113
1	25	16	35	29	16
2	48	31	50	52	28
3	63	44	65	62	39
4	72	52	75	69	47
5	79	61	80	74	54
6	83	67	-	78	61
7	-	71	-	80	67
8	-	74	-	-	73
9	-	77	-	-	78
10	-	80	-	-	83

Runoff and Erosion on Corn Watersheds

(May-September 1964)

Tillage	Number of Events	Runoff (*mm*)	Erosion (*kg/ha*)
Prevailing Conventional	12	35	9946
Improved Conventional	5	15	6384
No-Till with Contour Rows	1	5	134

Severe Storm of 5 July 1969

(*126 mm in 10 hours*)

Tillage	**Slope** (*%*)	**Runoff** (*mm*)	**Erosion** (*kg/ha*)
Prevailing Conventional	7	112	48,500
Improved Conventional	6	58	7,200
No-Till with Contour Rows	21	64	70

Rainfall, Runoff, & Erosion

Continuous No-till Corn since 1964

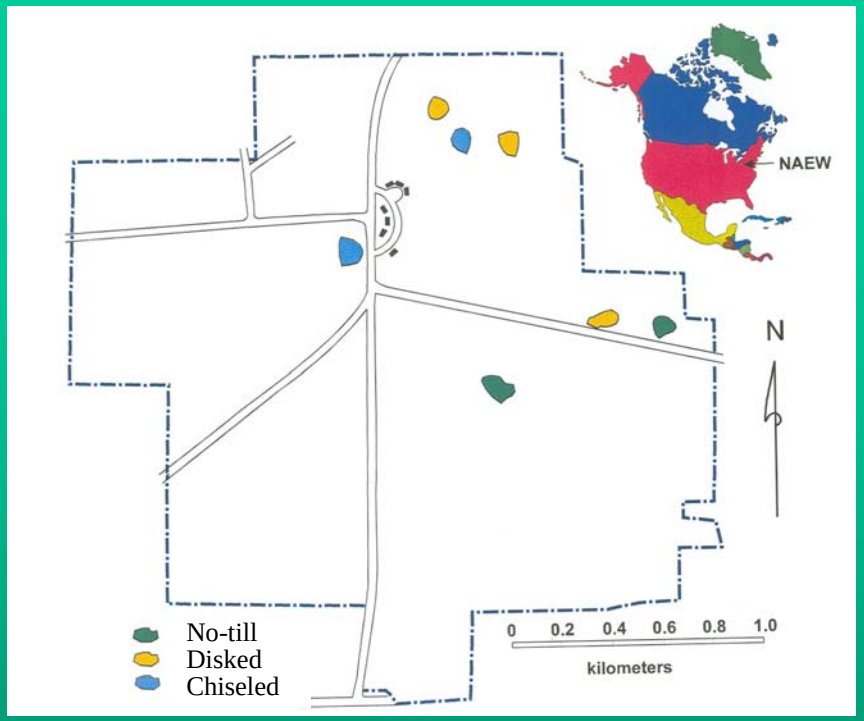
Year	Rainfall	Runoff	Erosion
	---------- mm ----------		--- kg/ha ----
1964	987	9.7	nd
1965	833	0	0
1966	772	0	0
1967	862	0.5	0
1968	871	0	0
1969	895	4.6	12
1970	944	0	0
1971	697	40.4	0
1972	885	0	0
1973-78		Not in Service	
1979	1124	3.8	9
1980	1175	4.9	17
1981	1057	0.2	1
1982	889	0	0
1983	1028	0	0
1984	907	2.3	1
1985	929	0	0
1986	980	9.2	16
1987	841	0.2	0
1988	832	0	0
1989	964	7.4	38
1990	1321	0.3	1
1991	679	0	0
1992	915	0	0
1993	941	1.0	3
1994	888	0	0
1995	911	0	0
1996	1130	0	0
1997	846	9.5	25
1998	989	0.6	0
1999	833	0	0
2000	1035	0.5	0
2001	807	0.2	1
2002	855	0.2	0
2003	1079	20.9	6
2004	1407	45.7	49
2005	1087	0	0
2006	1099	0	0
37 year:			
Total	**35294**	**162.1**	**179**
Average	**954**	**4.4**	**5**

Rainfall, Runoff, & Erosion (Continuous Corn)

		Runoff		Soil Loss	
Year	**Rainfall**	*No-Till*	*Conventional*	*No-Till*	*Conventional*
	mm	---------- mm ---------		---------- kg/ha ----------	
1979	1124	3.8	140.2	9	491
1980	1176	4.9	316.8	17	9500
1981	1057	0.2	142.2	1	8590
1982	889	0	113.2	0	2765
4 - Year Total	4246	8.9	712.4	27	21346
Average	*1062*	*2.2*	*178.1*	*7*	*5337*

Note: No-till 9% slope
Conventional 6%

- No-till reduced Runoff 81*x* and Soil Loss 762*x* compared to conventional tillage
- Up to 20*x* year-to-year variability in soil loss with CT
- Conventional tillage has not been used on watersheds since 1982



Conservation Tillage Study

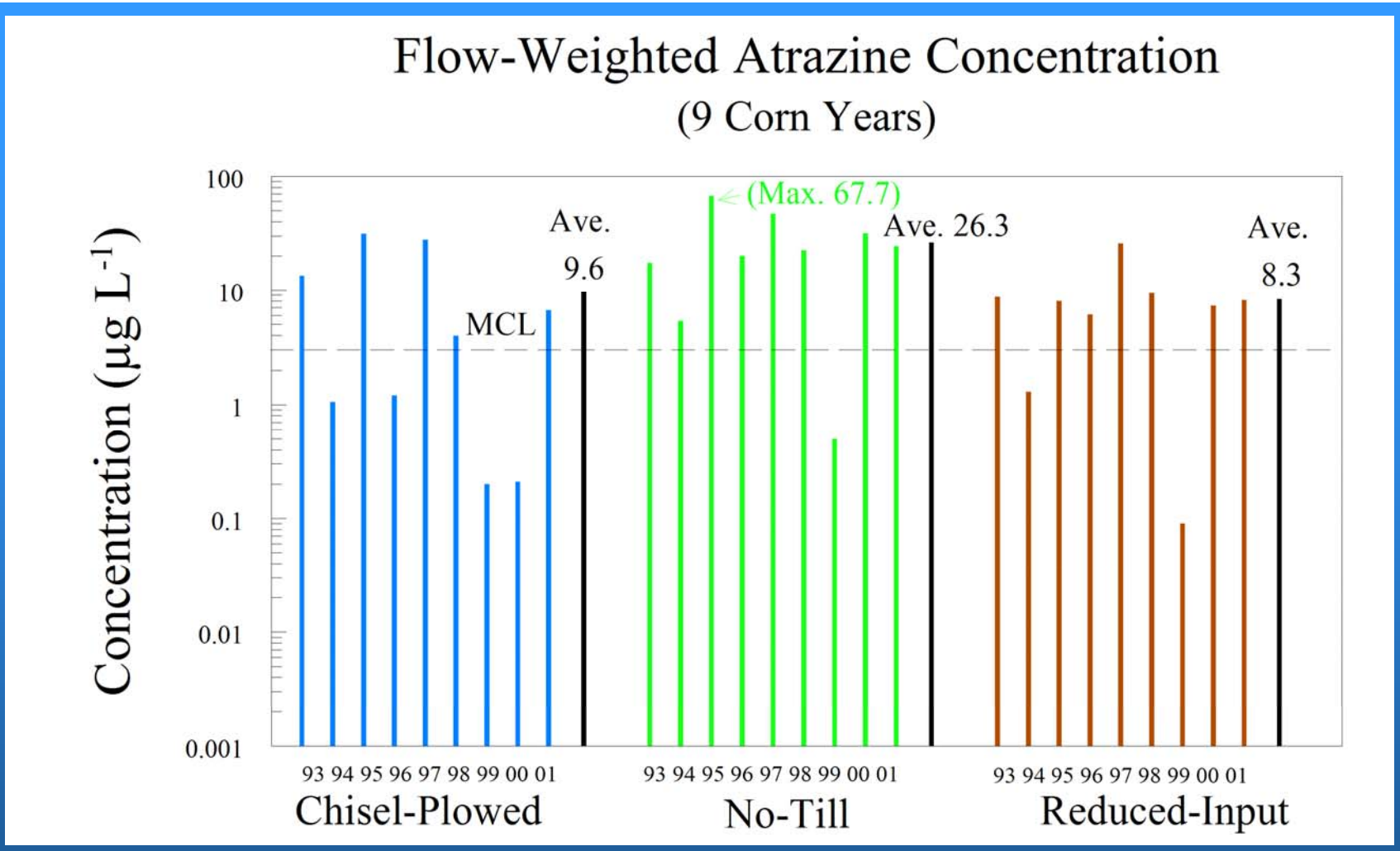
- 7 small (0.45-0.79) ha watersheds
- 2 No-till corn-soybean rotation
- 2 Chisel corn-soybean rotation
- 3 Disked corn-soybean-wheat rotation with half-rate herbicide applications (Reduced-Input)

% Soil Loss in Top 5 Events

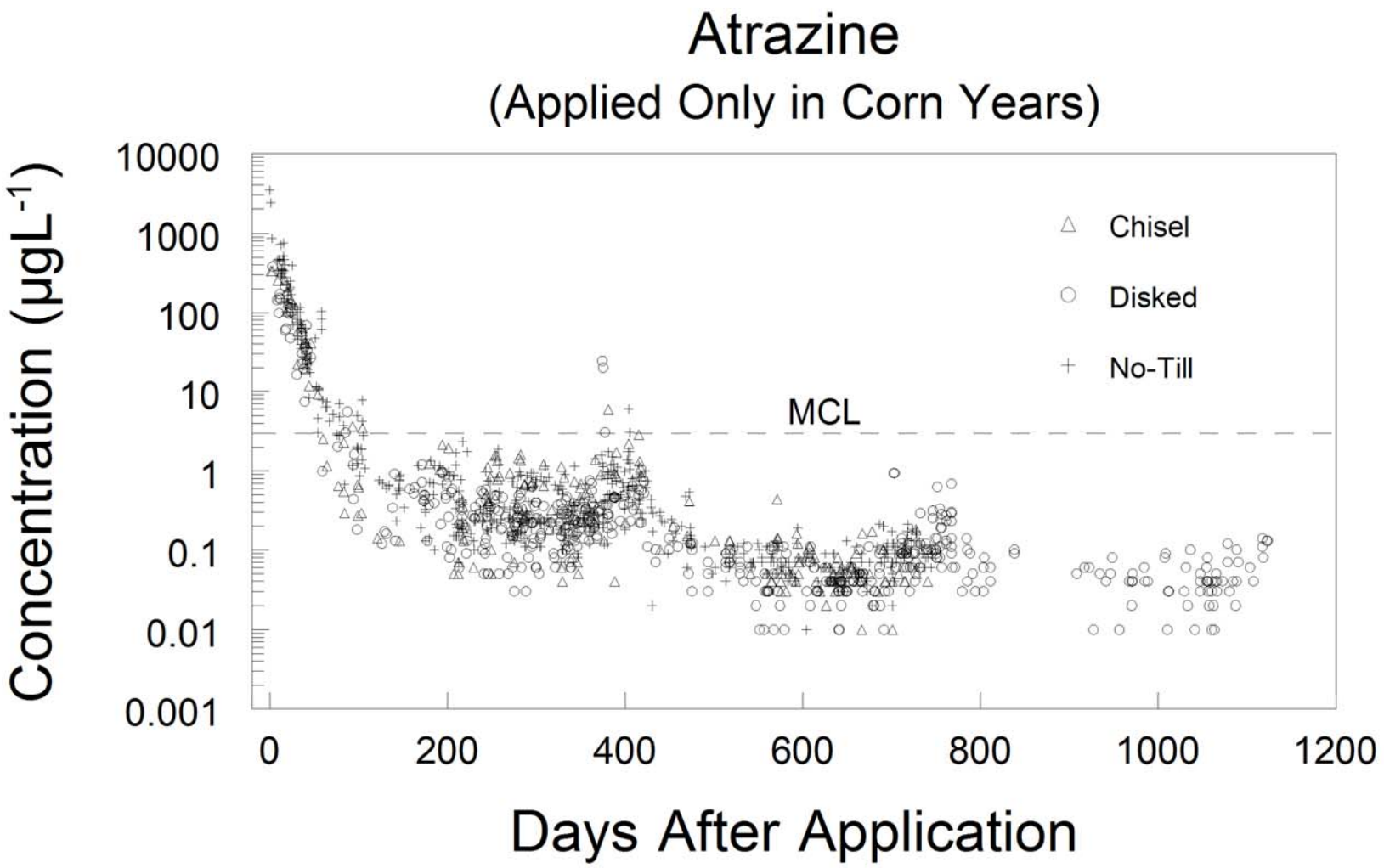
6 Crop Years (1990 – 1996)

	Chisel-Tilled		No-Till		Disked		
Event Rank	**WS 109**	**WS 123**	**WS 113**	**WS 118**	**WS 111**	**WS 115**	**WS 127**
1	**22**	**36**	**13**	**8**	**27**	**23**	**14**
2	16	22	10	6	13	14	11
3	13	6	10	6	11	11	9
4	9	3	9	5	9	7	8
5	8	2	8	4	6	7	6
Total	***68***	***69***	***50***	***29***	***66***	***62***	***48***
Ave. (kg/ha/yr)	1287		577		1022*		

Top 5 events (Ave. 221 per watershed) transported 55% of the sediment



- **Average concentrations of atrazine exceeded the drinking water standard, even when a half-rate application was used on the disked watersheds**
- **Atrazine concentrations were highest in the no-till watersheds**



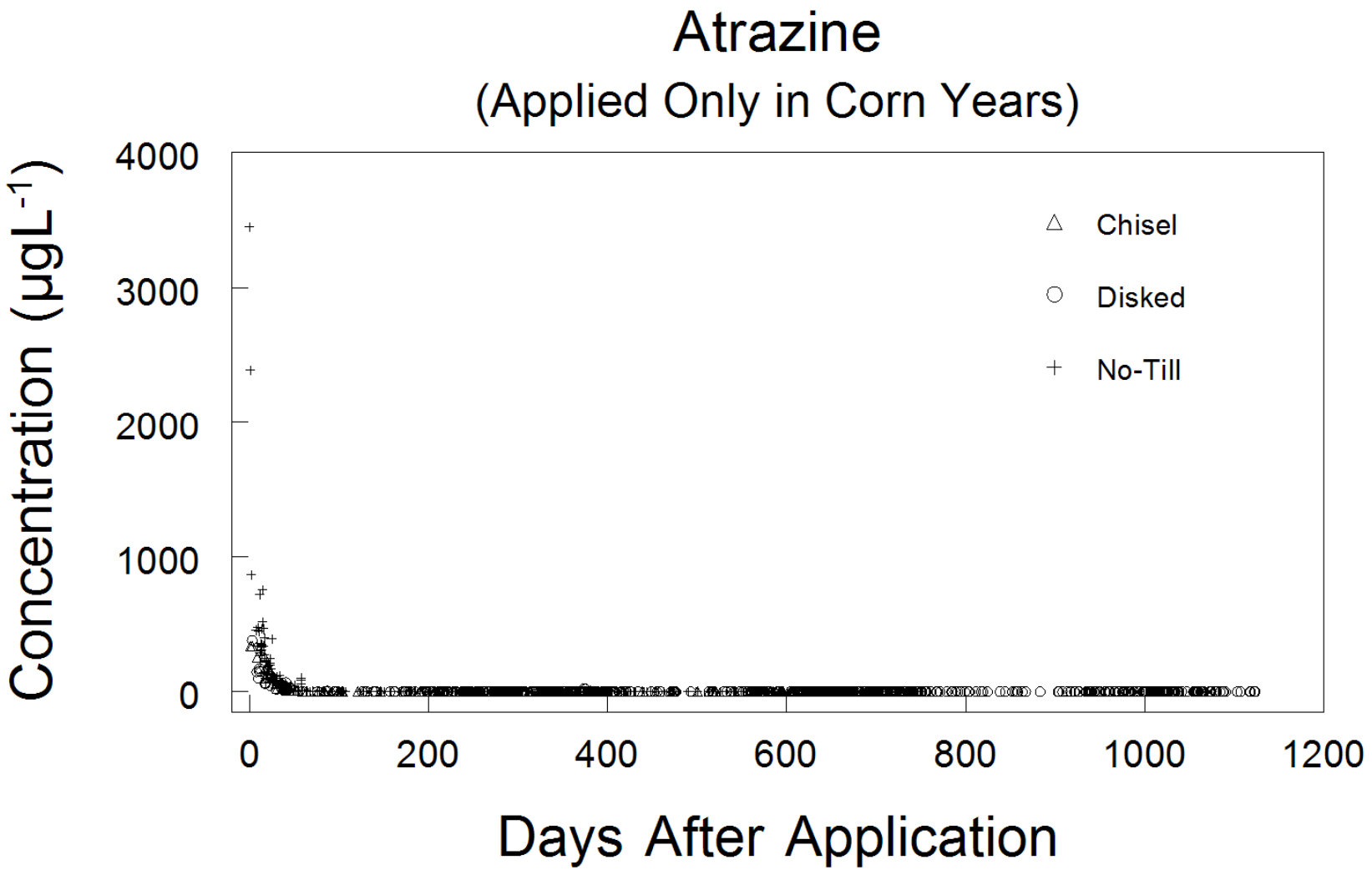
Atrazine concentrations followed a similar pattern for all tillage treatments. Most of the concentrations exceeding the drinking water standard occurred within 100 days after application.

% Atrazine Loss in Top 5 Events

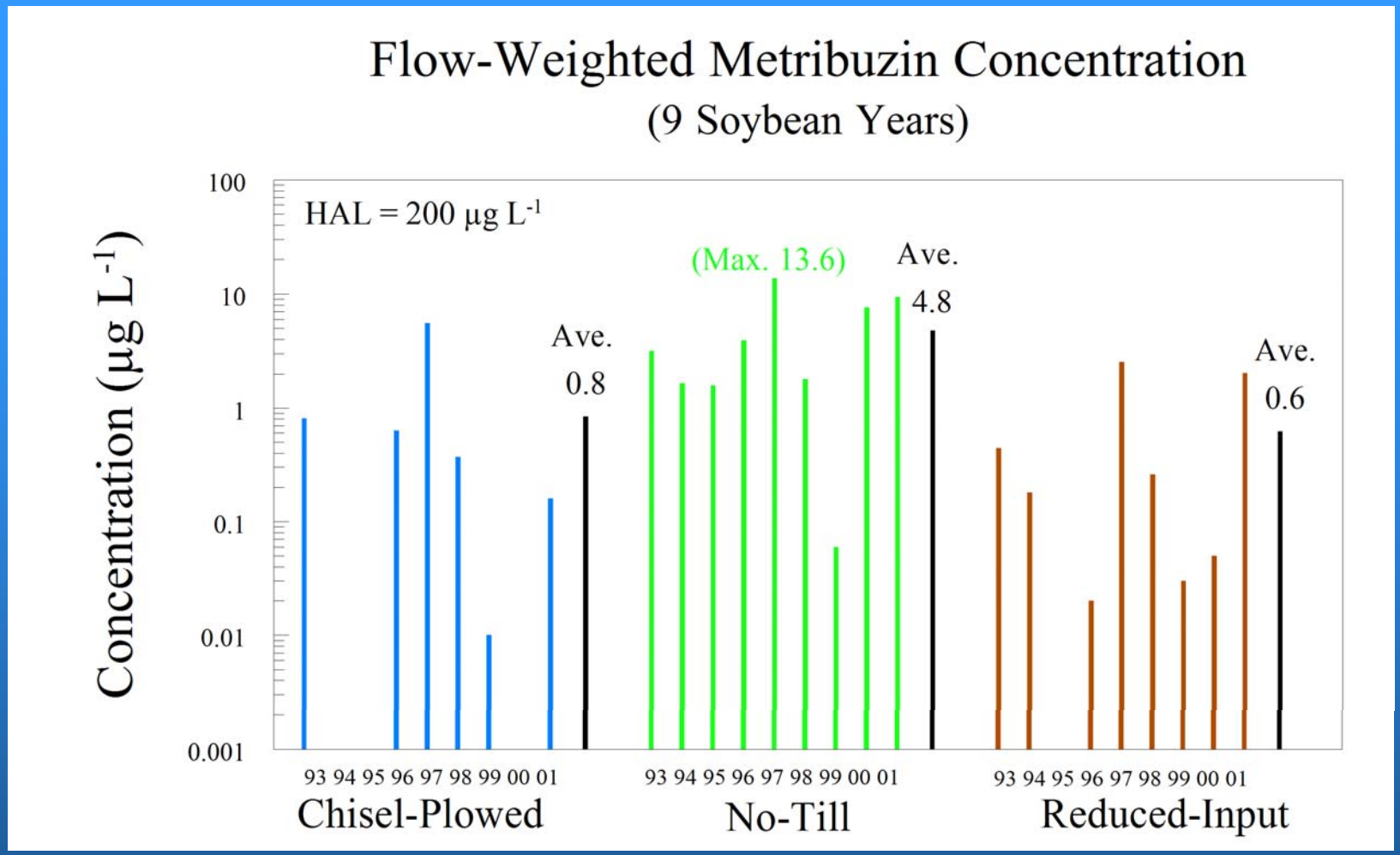
9 Crop Years ~ 1800 Storms

	Chisel-Tilled		**No-Till**			**Disked**	
Event Rank	**WS 109**	**WS 123**	**WS 113**	**WS 118**	**WS 111**	**WS 115**	**WS 127**
1	**34**	**36**	**27**	**38**	**64**	**37**	**56**
2	15	21	17	17	27	22	14
3	14	13	15	9	2	18	10
4	10	6	11	6	2	15	9
5	7	5	6	4	1	3	5
Total	***80***	***81***	***75***	***74***	***95***	***95***	***94***

Single worst event transported an average of 42% of the atrazine and the top 5 transported 85%



A linear plot of atrazine concentration accentuates the importance of the first few runoff events after application.



- **Average concentrations of metribuzin never exceeded the drinking water standard for any of the tillage treatments**
- **Metribuzin concentrations were highest in the no-till watersheds, and were as high as 562 µg L^{-1} for an individual event**

% Metribuzin Loss in Top 5 Events

9 Crop Years ~ 1800 Storms

	Chisel-Tilled		No-Till		Disked		
Event Rank	**WS 109**	**WS 123**	**WS 113**	**WS 118**	**WS 111**	**WS 115**	**WS 127**
1	**50**	**42**	**21**	**24**	**81**	**76**	**85**
2	30	30	16	22	6	8	8
3	17	25	15	12	5	7	3
4	2	2	13	10	4	2	2
5	<1	1	12	5	3	1	1
Total	***99***	***99***	***78***	***73***	***99***	***94***	***99***

Single worst event transported an average of 54% of the metribuzin and the top 5 transported 92%

21 May 2001 (*10 days after spraying*)

- 16.5 mm of runoff (28th largest event)
- 85% of metribuzin loss in 9-yr period

25 July 2001 (*75 days after spraying*)

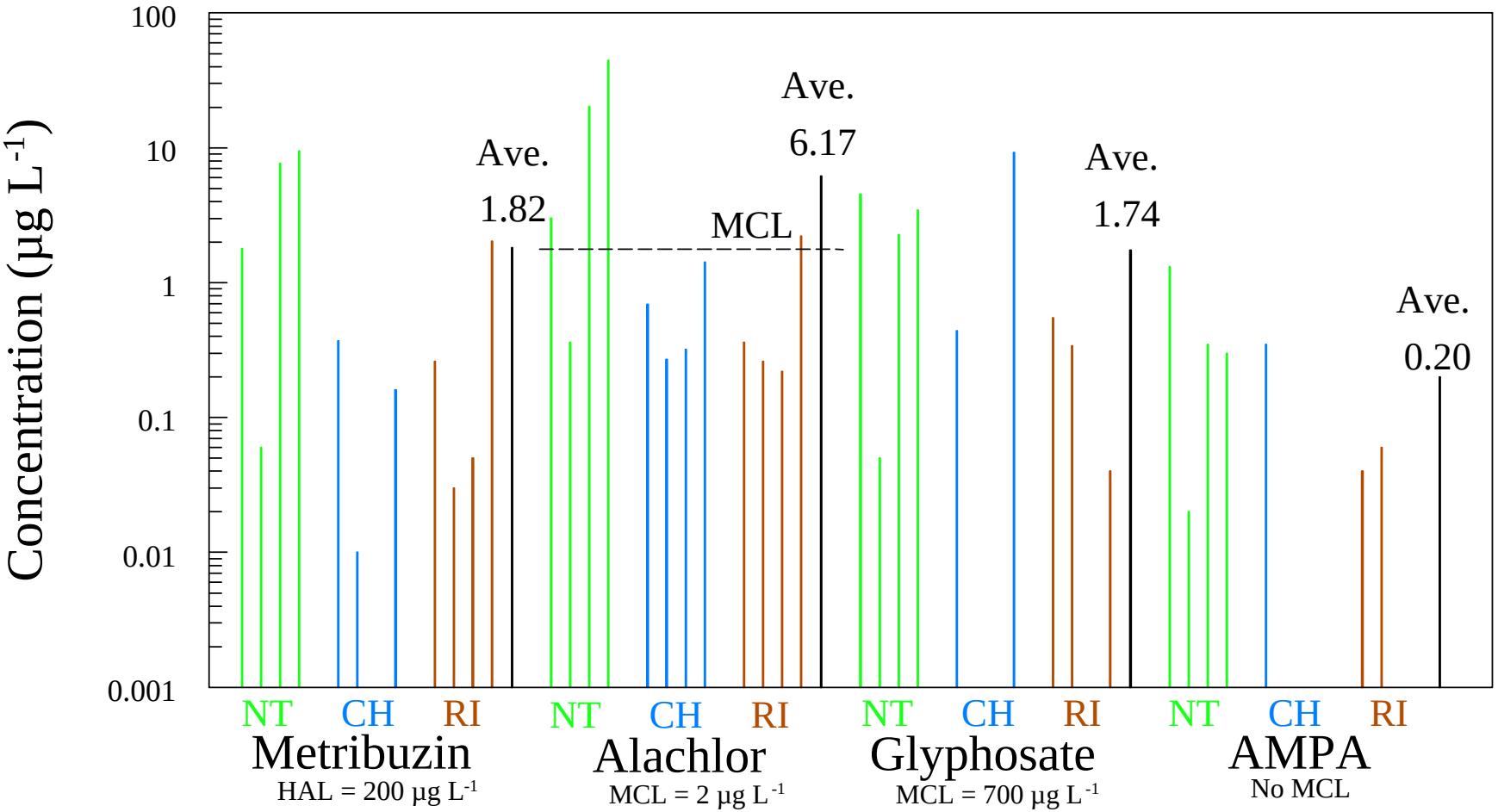
- 45.7 mm of runoff (4th largest event)
- 2% of metribuzin loss in 9-yr period

With genetically modified, herbicide-tolerant crops (GMO's) persistent, residual herbicides can be replaced with readily degradable, contact herbicides

Roundup-Ready ™ soybean and Liberty-Linked ™ corn were planted on the 7 conservation tillage watersheds and both herbicide types were applied

Flow-Weighted Herbicide Concentrations

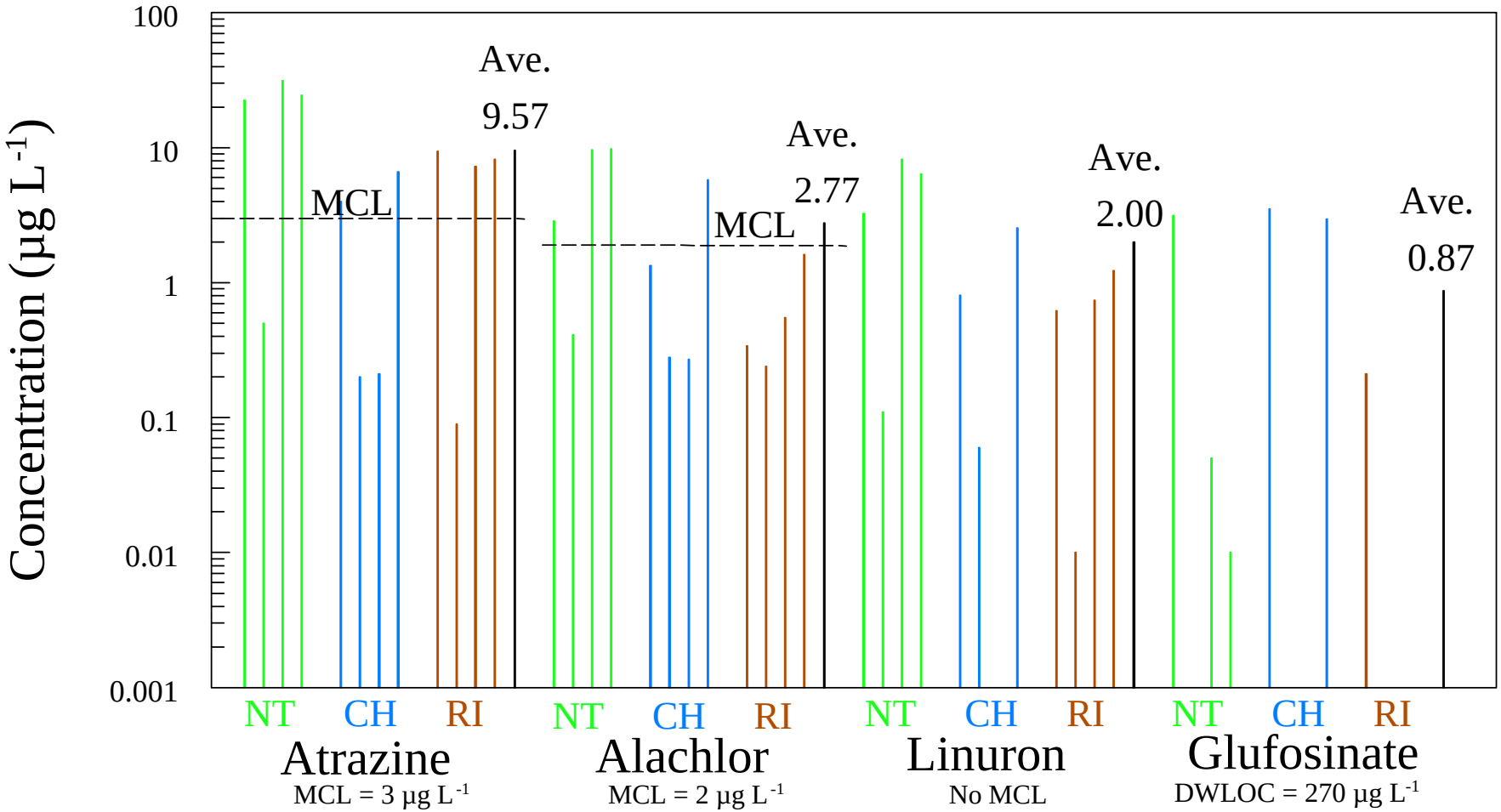
(Soybean 1998-2001)



In soybean years flow-weighted alachlor losses exceeded its MCL while glyphosate was well below its MCL

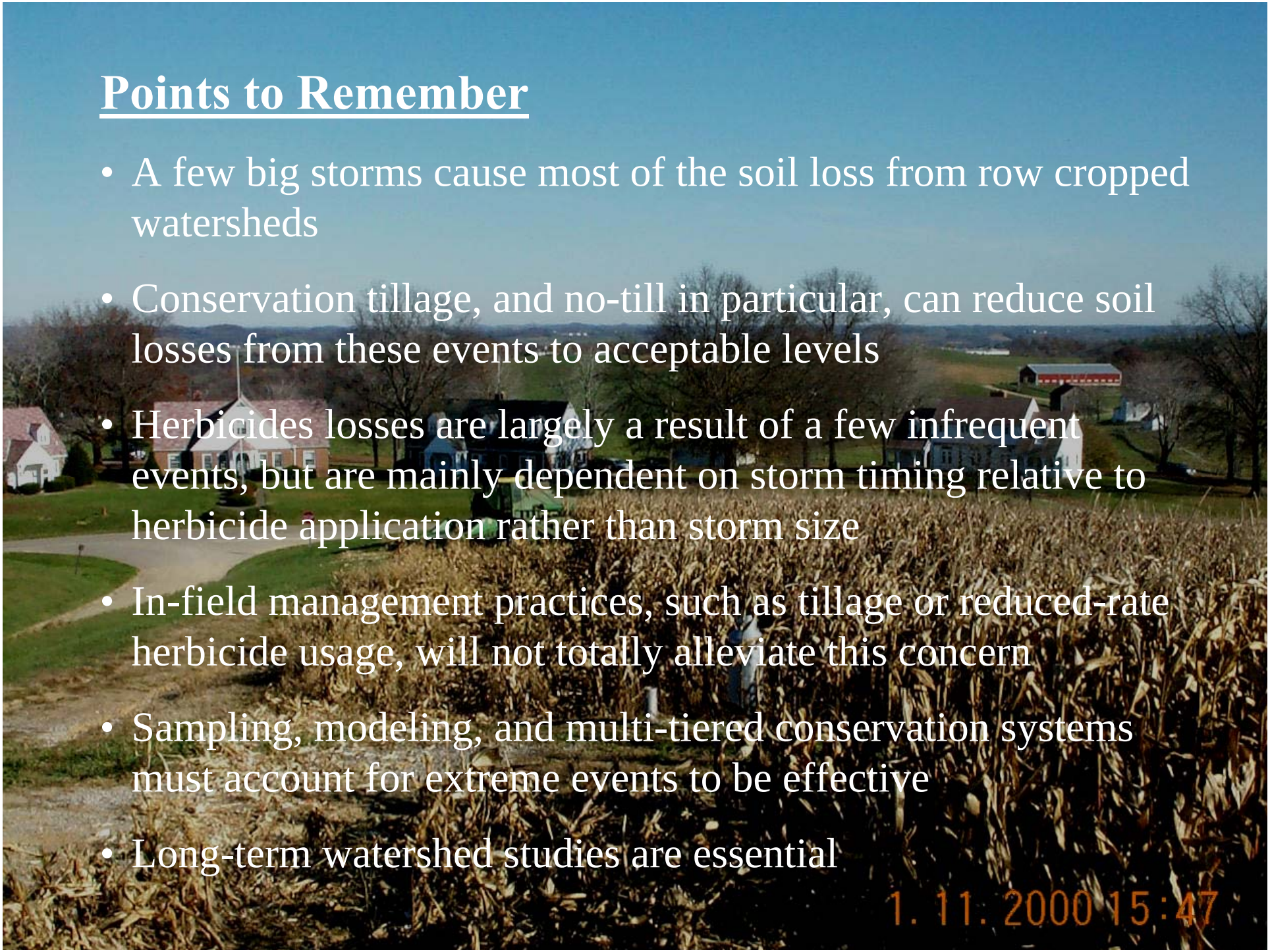
Flow-Weighted Herbicide Concentrations

(Corn 1998-2001)



In corn years flow-weighted atrazine and alachlor losses exceeded their MCLs while glufosinate was well below its acute DWLOC

Extreme Events



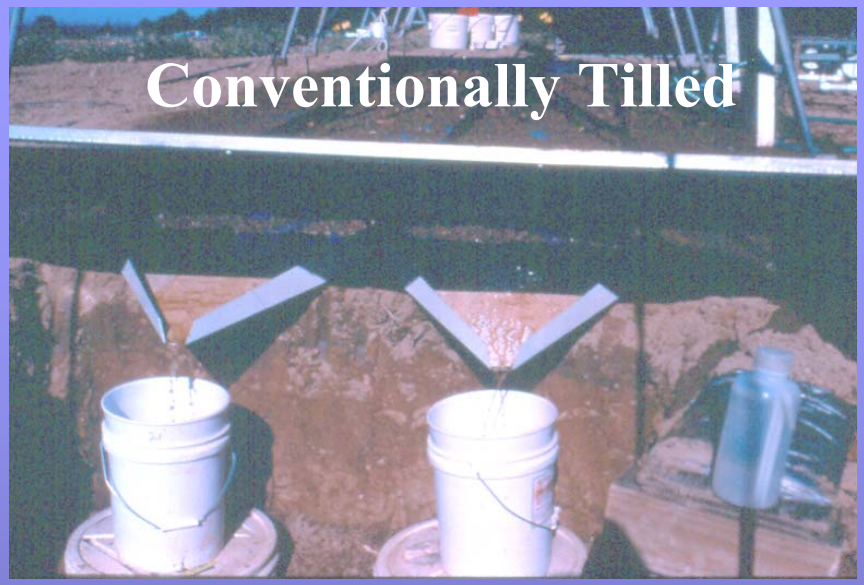
Points to Remember

- A few big storms cause most of the soil loss from row cropped watersheds
- Conservation tillage, and no-till in particular, can reduce soil losses from these events to acceptable levels
- Herbicides losses are largely a result of a few infrequent events, but are mainly dependent on storm timing relative to herbicide application rather than storm size
- In-field management practices, such as tillage or reduced-rate herbicide usage, will not totally alleviate this concern
- Sampling, modeling, and multi-tiered conservation systems must account for extreme events to be effective
- Long-term watershed studies are essential

Grassed Waterway Research

- Most herbicide loss occurs in a few events shortly after application
- Because of concentrated flow, grassed waterways are usually ineffective in reducing herbicide concentrations

- We have installed NRCS-designed, paired grassed waterways downstream from two watersheds
- Filter socks filled with compost have been placed in the waterways



Runoff & Erosion

(Simulated Rainfall)

	Runoff			Soil Loss		
Rep	No-Till	1st yr CT	13th yr CT	No-till	1st yr CT	13th yr CT
	---------- (mm) ----------			---------- (kg/ha) ----------		
1	12.0	22.8	29.1	-	2495	3307
2	1.9	23.7	31.3	-	2198	3867
Average	6.9	23.2	30.2	0	2347	3587

Note: Approx. 64 mm of rain was applied in 1 hr to 4.7 m^2 plots on 19-23 May 1997

Most of the erosion control benefits of no-till can be lost with a single year of tillage