Modelling for the Soil Thematic Strategy: Assessing Erosion Control Measures

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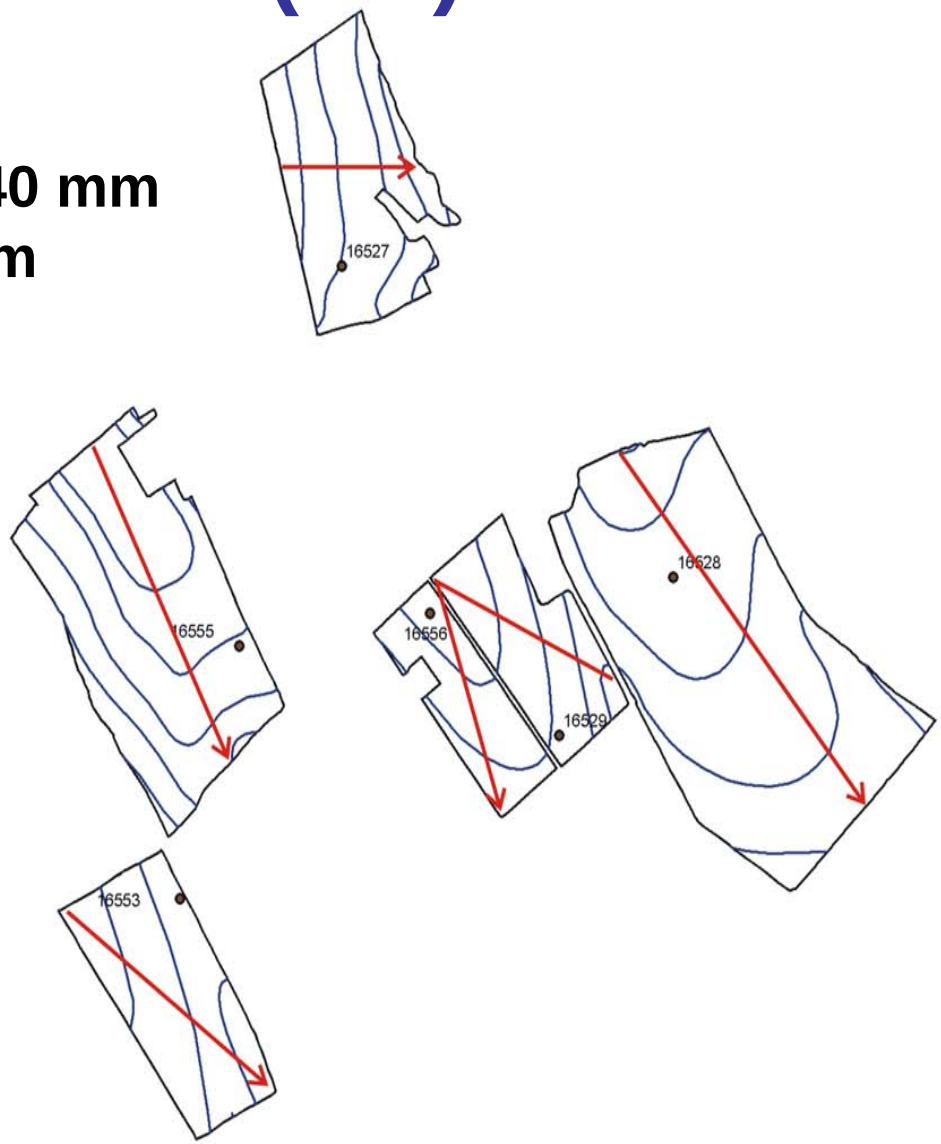
Outline:

- 6 Fields from the Kocin Farm (SK)
- Soil and Crop Management Information
- APEX model
- List of Alternative Management Practices to Control Water Erosion
- Preliminary Model Results
- Discussion

6 Fields from the Kocin Farm (SK)

Ø rainfall/yr: 540 mm
elevation: 251 m



Field 16527:
size: 50.4 ha
Ø slope: 6.35 %

Field 16528:
size: 121.7 ha
Ø slope: 2.78 %

Field 16529:
size: 30.2 ha
Ø slope: 4.48 %

Field 16553:
size: 41.1 ha
Ø slope: 2.11 %

Field 16555:
size: 78.5 ha
Ø slope: 3.54 %

Field 16556:
size: 22.9 ha
Ø slope: 2.57 %

Soil Properties from Field 16527

	Top	Sub1	Sub2
soil layer in m	0.3	0.8	1.2
sand in %	8.0	10.4	23.8
silt in %	59.0	57.3	58.4
clay in %	33.0	32.3	17.8
bulk density in t/m³	1.27	1.28	1.39
Field capacity in m/m	0.443	0.433	0.337
Wilting Point in m/m	0.337	0.331	0.202
orgC in %	0.81	0.24	0.23
pH	6.70	6.24	7.30
Saturated Conductivity in mm/h	1.155	1.432	6.147
Volume of Stones in %	2.0	2.0	2.0
Sum of bases in cmol/kg	19.10	20.02	16.16
Cation exchange capacitiy in cmol/kg	19.20	20.39	15.93

Dominant Crop Rotations

	CR1	CR2	CR3
	CSIL	CORN	CSIL
	ALFA	SBAR	SBAR
	ALFA	WWHT	WWHT
	ALFA	SGBT	WRAP
	WWHT	WWHT	WWHT
	SBAR		
Fields	16555	16528	16527
	16553	16529	
		16556	

Crop Management

	Crop Yields in t/ha		Commercial Fertilizer in kg/ha			Manure in t/ha
	mean	std	N	P2O5	K2O	5% TS
WWHT	5.2	1.0	107	35	30	
CSIL	33.7	6.8	145	9	17	30
ALFA	6.2	1.4	38	10	5	
SBAR	4.8	1.0	32	18	19	
CORN	5.0	0.9	152	43	63	
SGBT	52.1	8.3	96	0	0	40
WRAP	2.6	0.8	160	84	50	

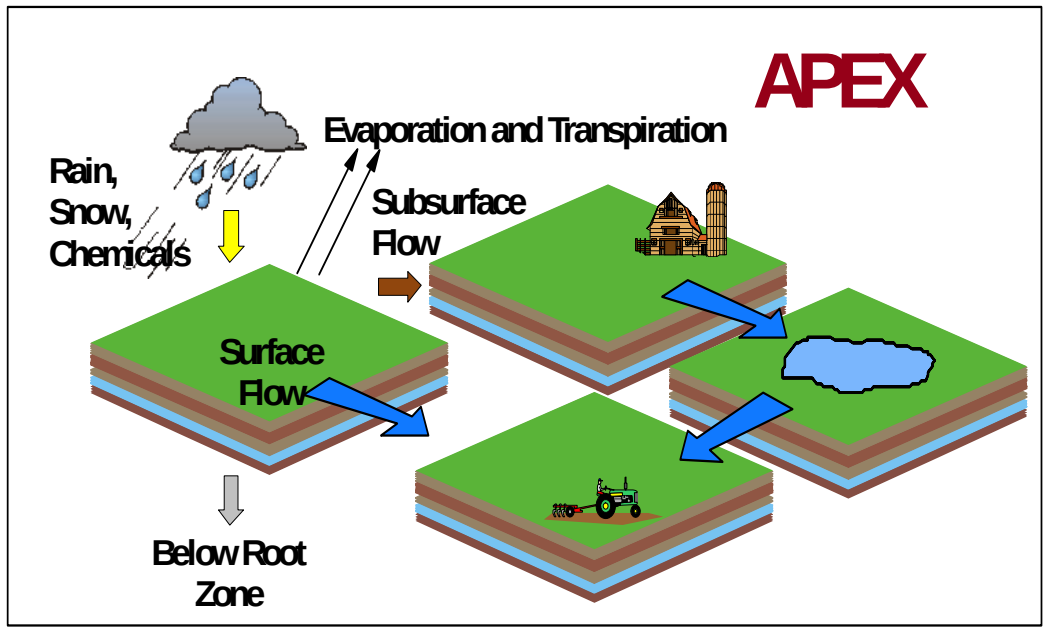
Legend:

WWHT	Winter Wheat	CORN	Corn Grain
CSIL	Corn Silage	SGBT	Sugarbeet
ALFA	Alfalfa	WRAP	Winter Rape
SBAR	Spring Braley		

Agricultural Policy Environmental eXtender model

optional 7 Water Erosion equations

1. MUST theoretical
2. AOF Onstad-Foster
3. USLE Universial Soil Loss Equation
4. MUSS Small Watershed MUSLE
5. MUSL Modified USLE
6. MUSI MUSLE with input parameters
7. RUSLE USLE for steep slopes >20% i.e.



on a daily time step

Management i.e.:

- Buffer Strips
- Grassed Waterways
- Terraces

OUTLET

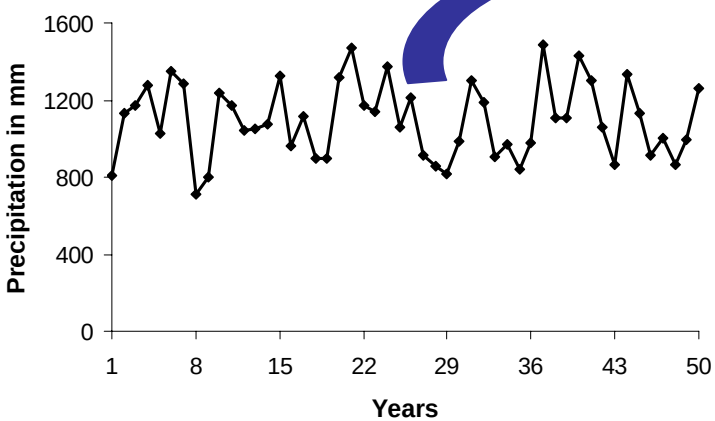
SOILS

LAND USE

DEM

SUB-BASINS

APEX Model



WEATHER

MANAGEMENT

List of Alternative Management Practices to Control Water Erosion

1. conventional tillage (i.e. moldboard plough)
   - reference situation
2. contouring
3. reduced tillage (i.e. shallow disk plough)
4. minimum tillage (except for root crops, e.g. sugar beets)
5. winter cover crops

List of Alternative Management Practices to Control Water Erosion

6 grassed waterways (10% of field; 50m width)

7 buffer strips (2% of field; 10m width)

8 terraces (i.e. permanent crops, e.g., vineyards)

9 comb. of management measures (1);
e.g., contouring, disk plough & grassed waterway

10 comb. of management measures (2)

Some Preliminary Modelling Results for Field # 16527

Water Balance

conventional tillage

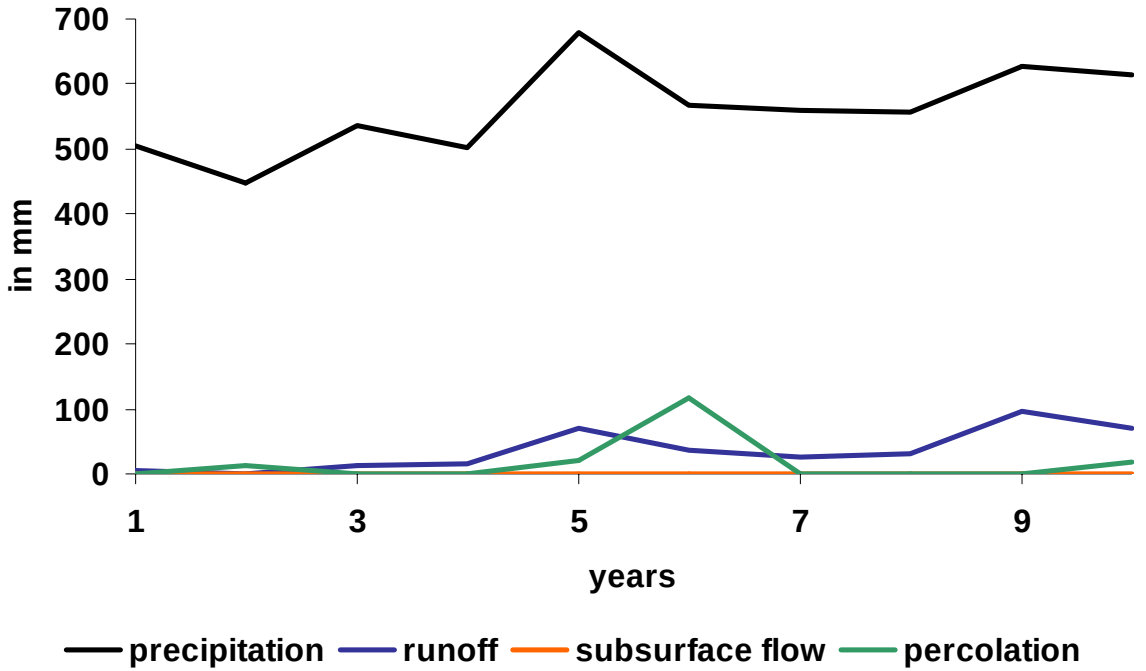
<u>10 year averages:</u>

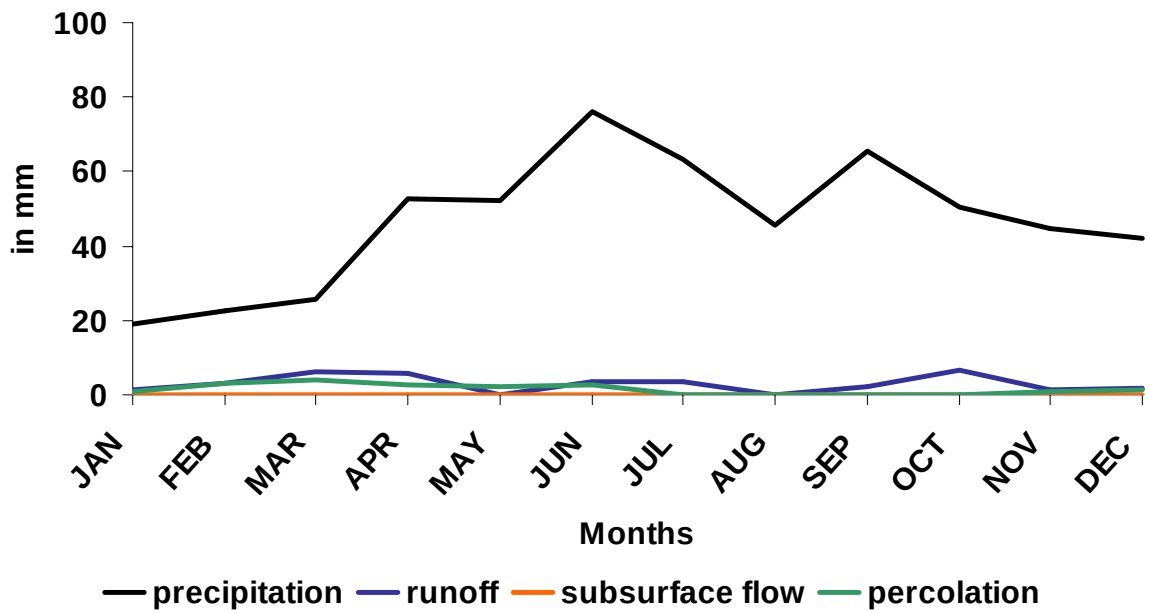
precipitation: 560 mm
(450 - 680 mm)

runoff: 36 mm
(0 - 95 mm)

subsurface flow: <1 mm

percolation: 17 mm
(0 - 118 mm)



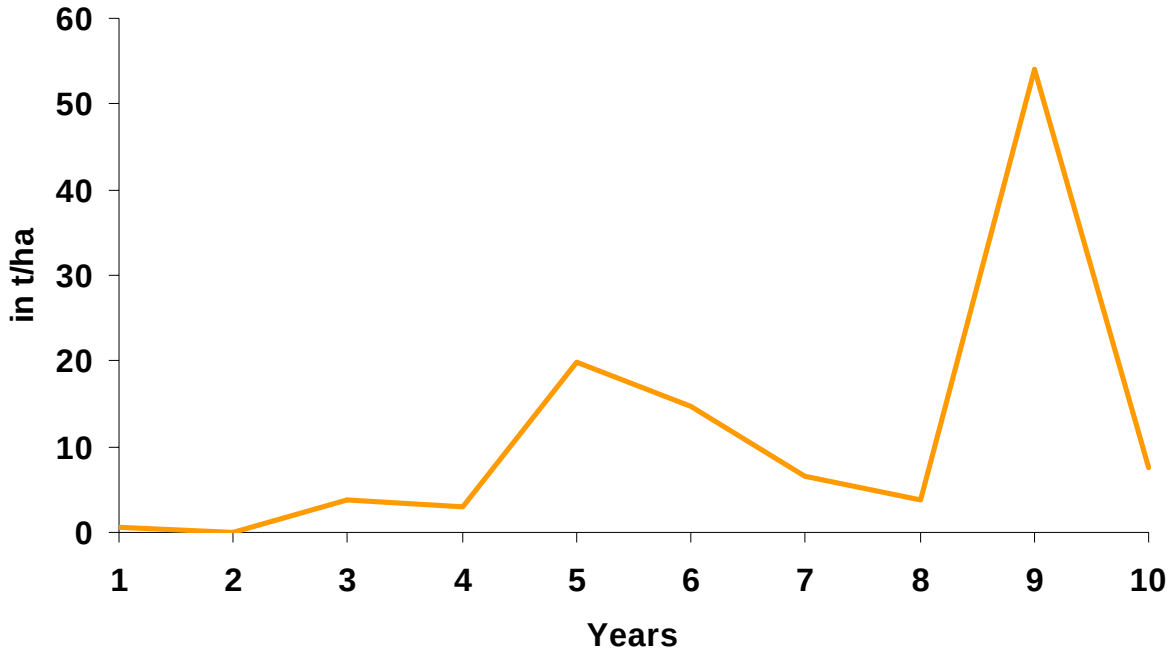


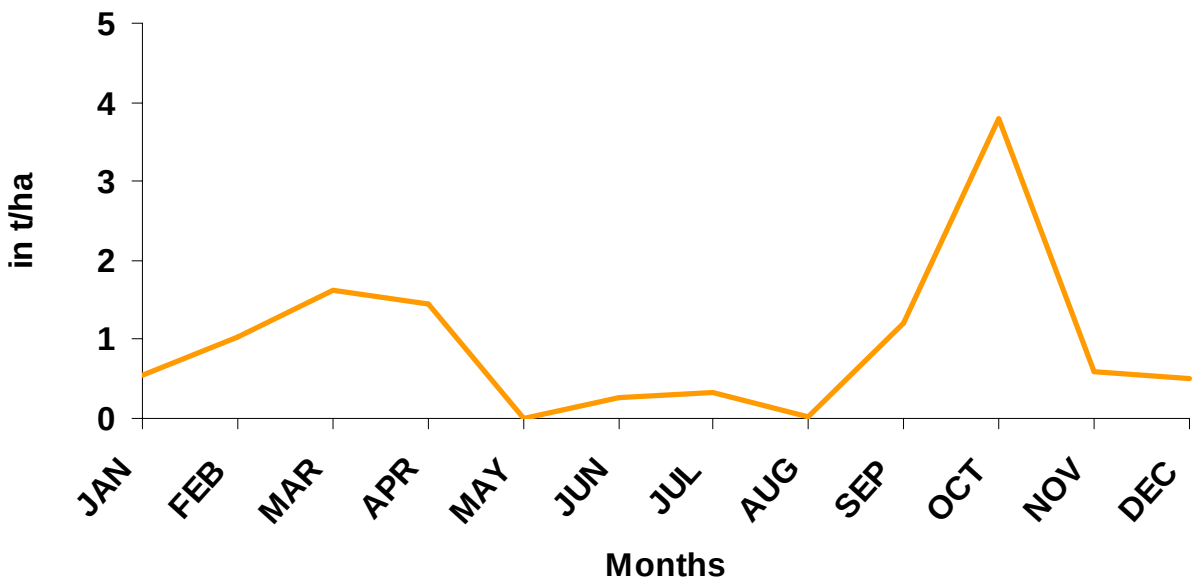
Sediment Transport

conventional tillage

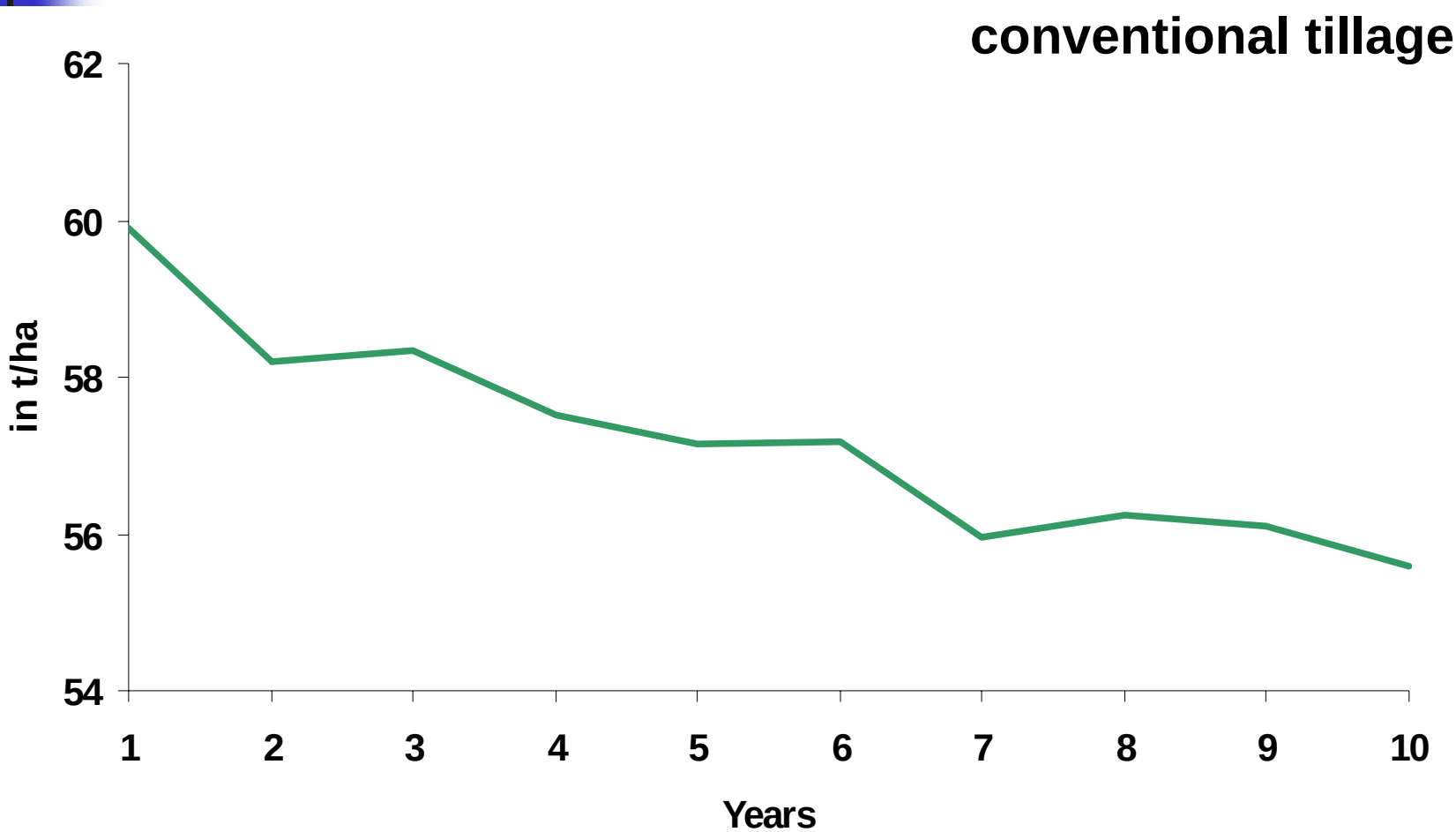
<u>10 year average using MUST:</u>

sediment yield:
11.4 t/ha
(0 - 54 t/ha)





Carbon in Soil Profile



Nitrogen Transport

conventional tillage

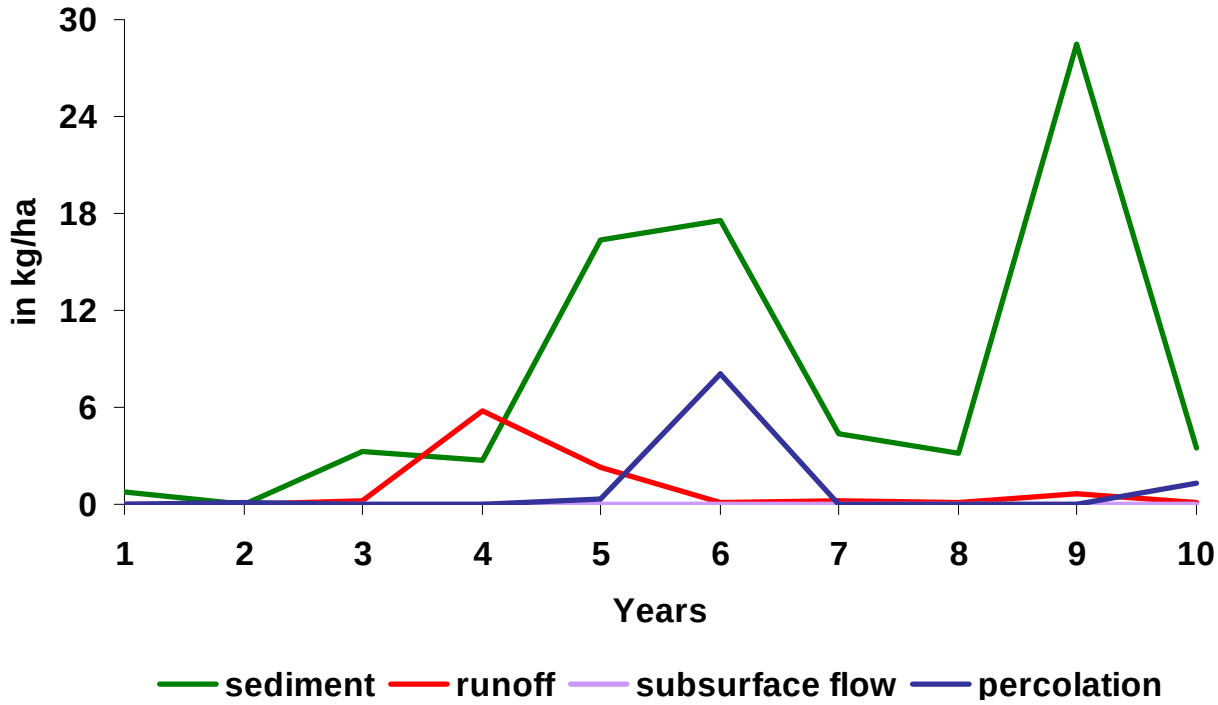
Nitrogen in kg/ha/y

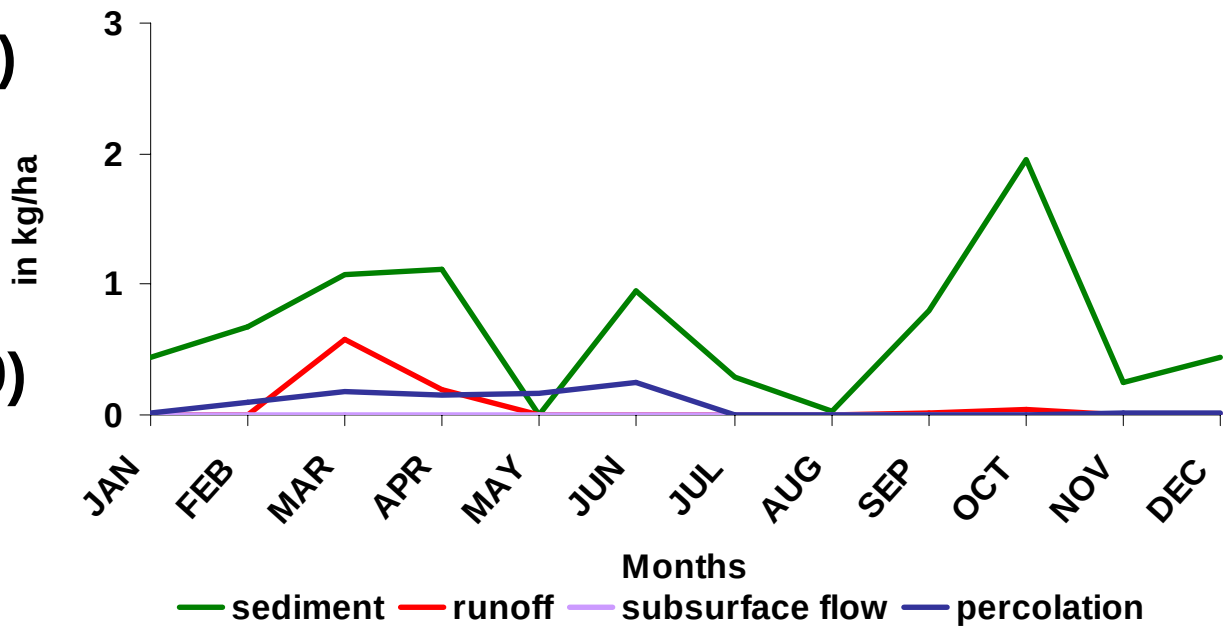
sediment: 8.0 (0 - 28.5)

runoff: 0.9 (0 - 5.8)

subsurface flow: <0.1

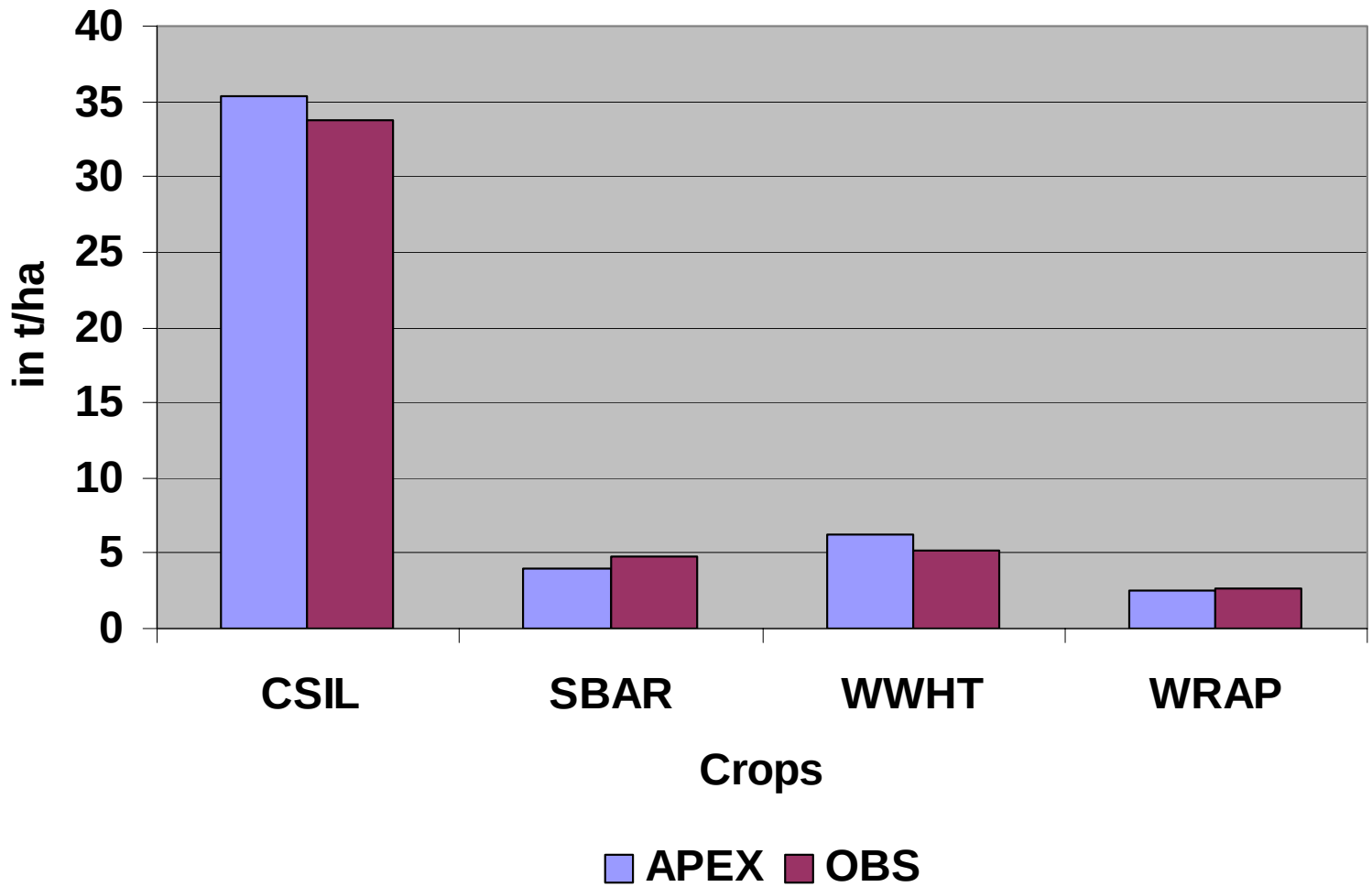
percolation: 1.0 (0 - 8.0)





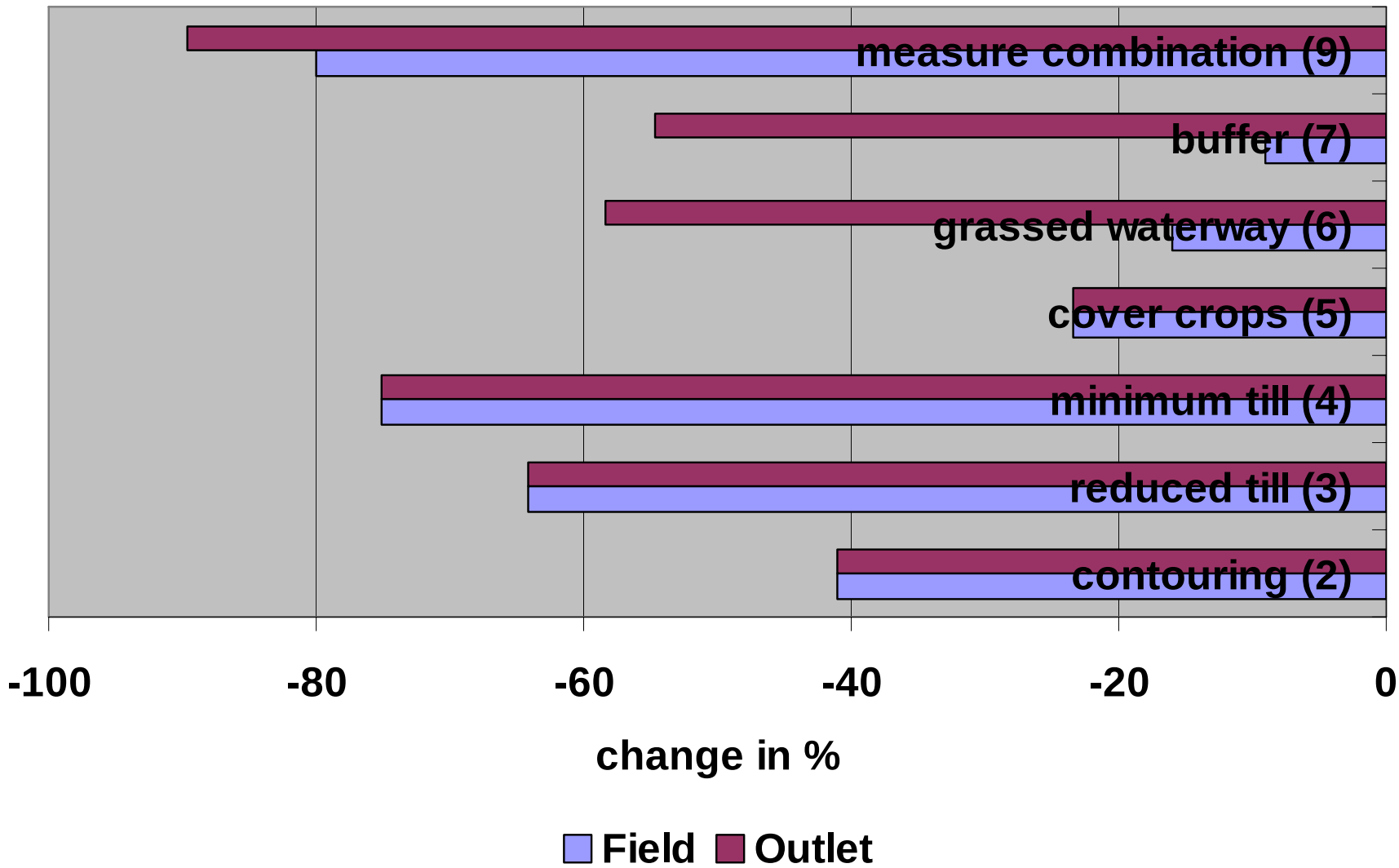
Crop Yields

conventional tillage

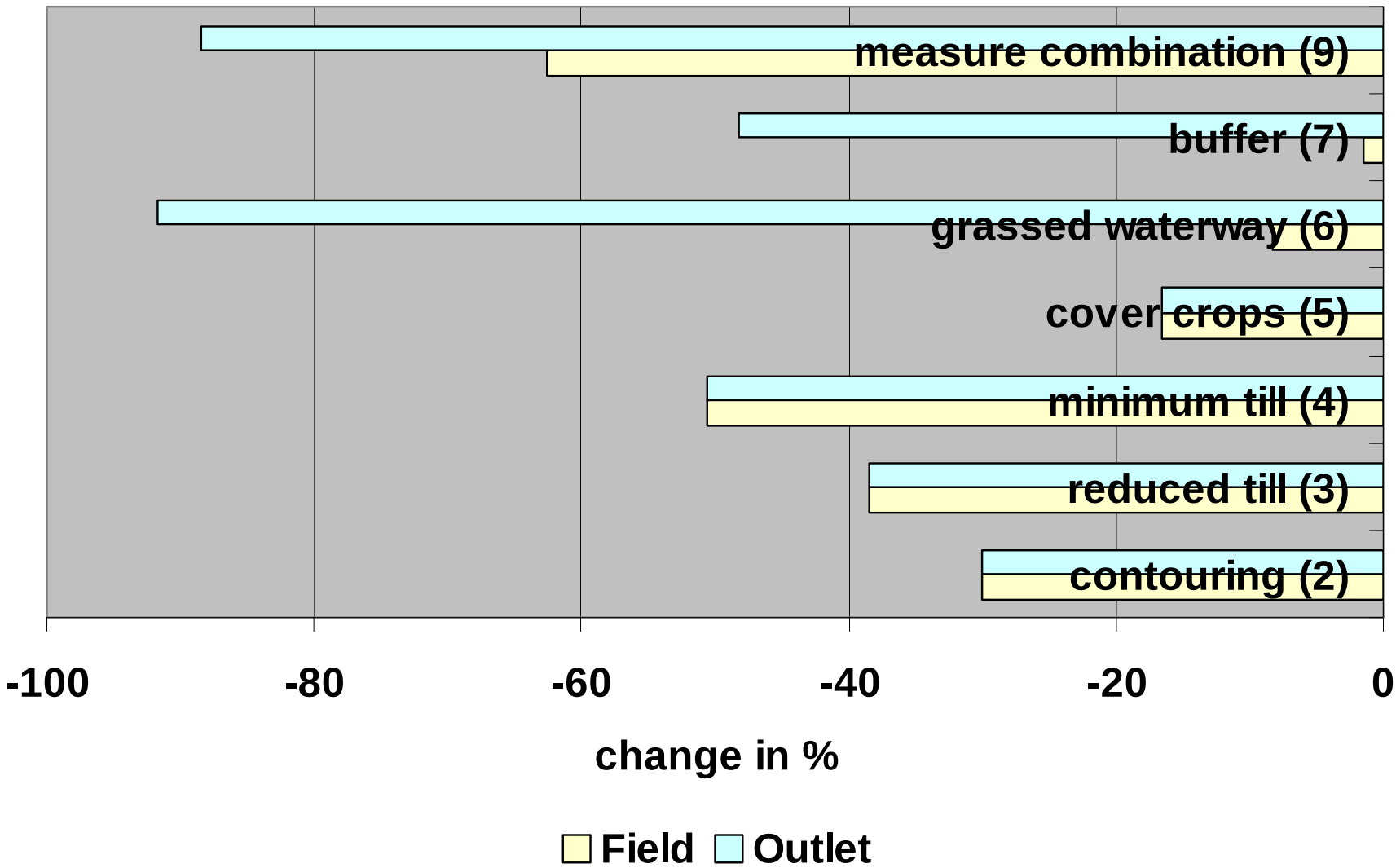


Impact Assessment of Alternative Management Practices for Field # 16527

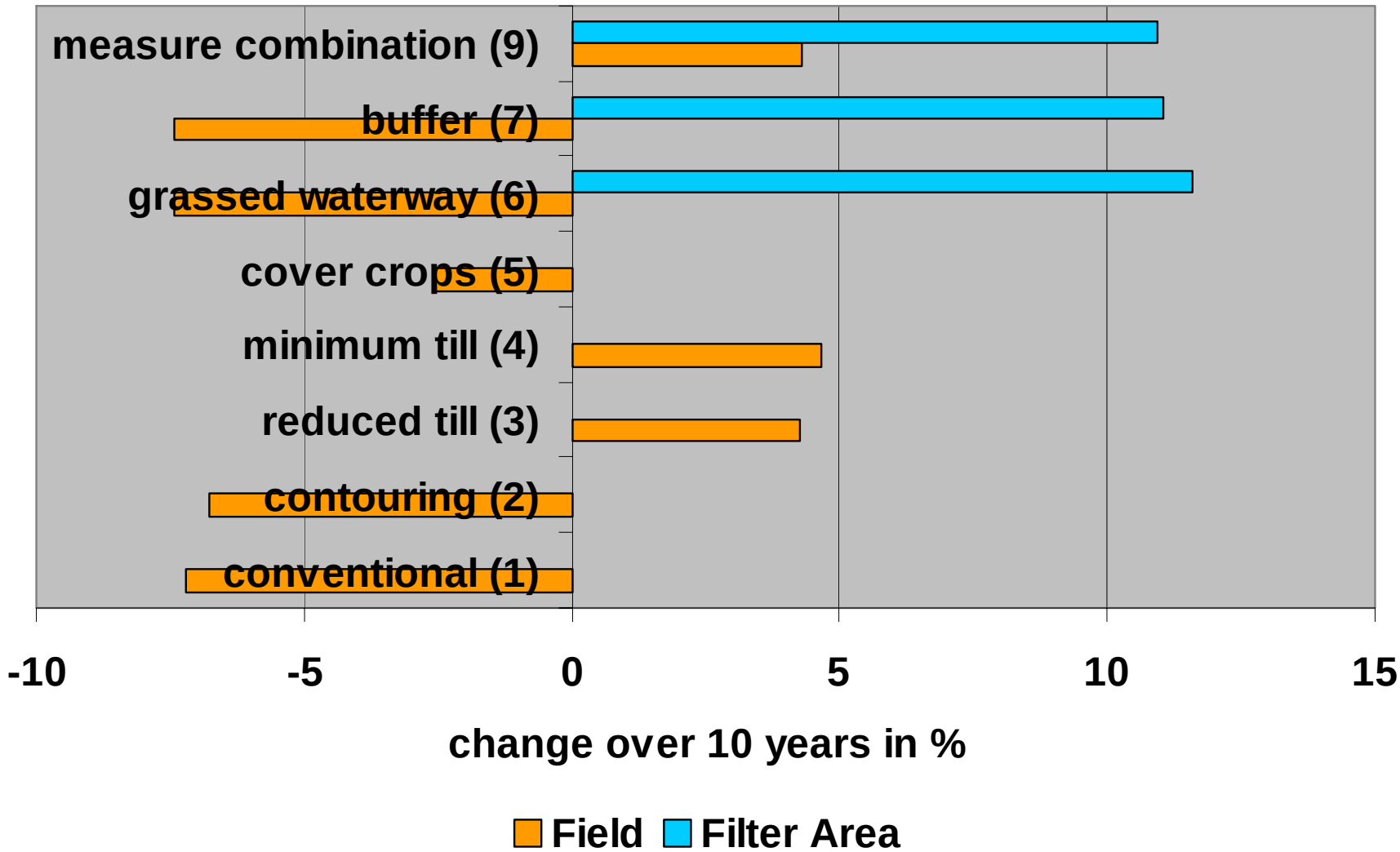
Sediment Transport relative to Conventional Tillage (1)



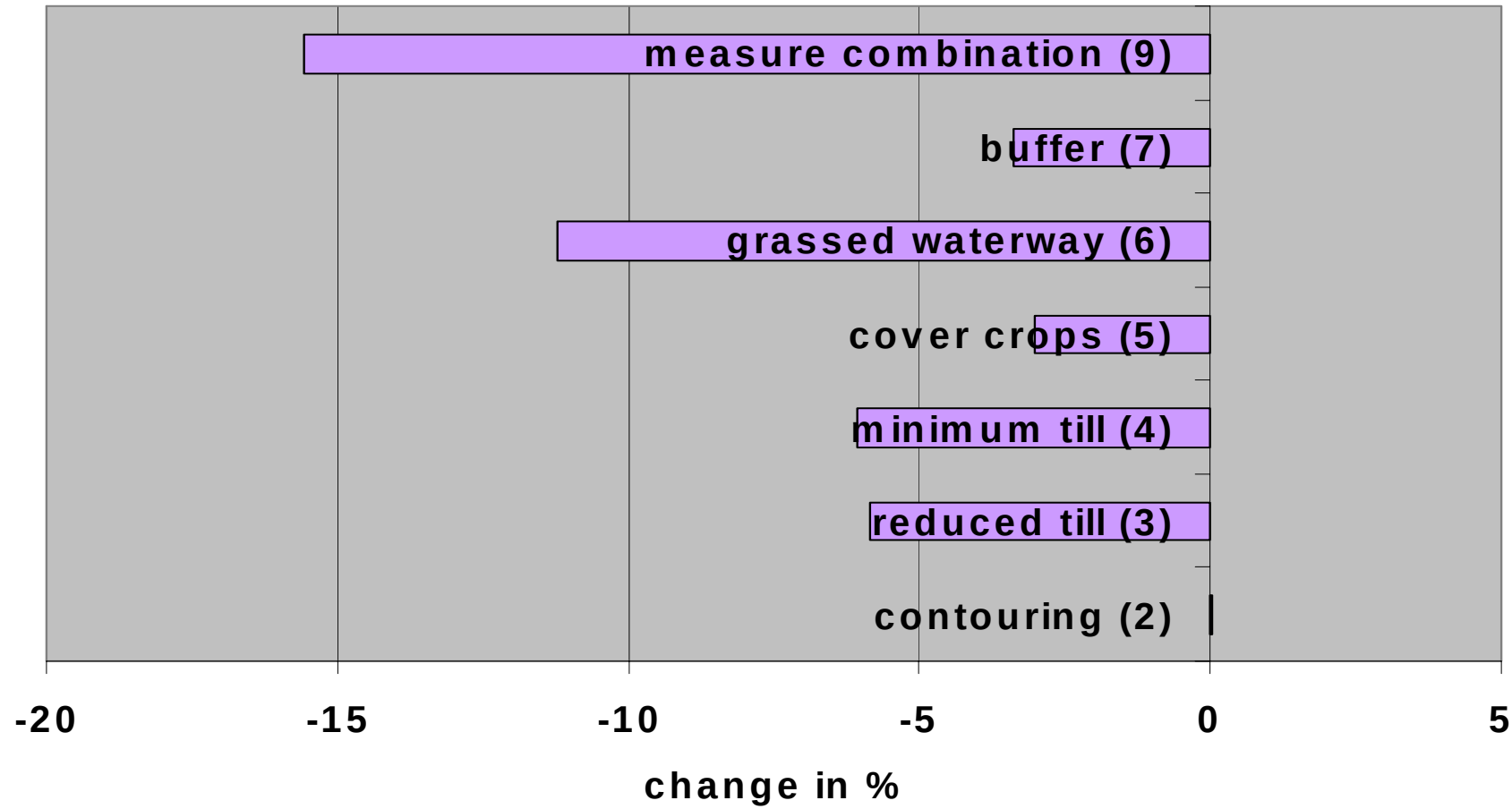
Nitrogen in Runoff relative to Conventional Tillage (1)



Change of org. Carbon in Soil Profile after 10 years of simulation



Total Crop Production relative to Conventional Tillage (1)



Note: Total production is the sum of dry matter yields of all crops in the crop rotation times field area. Reduced field area in (6), (7), and (9) due to waterways (-10%) and buffer strips (-2%).

Impact Assessment of Alternative Management Practices for all 6 Fields

Model Output Presentation with Output Response Functions

Regression Model (OLS) using Dummy Variables

$$Y = \beta + \beta_2 M_2 + ,..., + \beta_{10} M_{10} + \varepsilon$$

where M_2,..., M_{10} are alternative management practices that are represented by dummy variables (0,1)

Average Sediment Yields (t/ha)

Variable	Parameter Estimate	in %	t - probability
β	4.14117	100	< .0001
β_2	-1.75083	-42.3	0.0366
β_3	-2.43033	-58.7	0.0038
β_4	-2.94917	-71.2	0.0005
β_5	-1.31683	-31.8	0.1155
β_6	-1.86117	-44.9	0.0263
β_7	-1.66233	-40.1	0.0471
β_9	-3.46617	-83.7	< .0001

Average org. Carbon in Soil Profile (t/ha)

Variable	Field			Filter Area		
	Parameter Estimate	in %	t - probability	Parameter Estimate	in %	t - probability
β	70.48318	100	< .0001			
β_2	0.05286	+0.1	0.9844			
β_3	3.78598	+5.4	0.2039			
β_4	4.75454	+6.7	0.1108			
β_5	1.54817	+2.2	0.6031			
β_6	-0.03227	-0.1	0.9914	12.84499	+18.2	< .0001
β_7	-0.03156	-0.1	0.9915	12.83685	+18.2	< .0001
β_9	3.95125	+5.6	0.1849	12.82589	+18.2	< .0001

Average Crop Yields (t/ha)

Variable	Parameter Estimate	in %	t - probability
β	6.71183	100	< .0001
β_2	-0.01683	-0.3	0.9745
β_3	-0.23817	-3.5	0.6509
β_4	-0.32600	-4.9	0.5357
β_5	-0.17683	-2.6	0.7369
β_6	-0.73193	-10.9	0.1647
β_7	-0.20039	-3.0	0.7034
β_9	-0.92123	-13.7	0.0805

Note: Average dry matter yields per hectare. Reduced field areas in (6), (7), and (9) due to waterways (-10%) and buffer strips (-2%).

Discussion

- selection of representative plots across EU25 (project by end of July)
- list of alternative management practices
- time length of simulation (short, medium, long-run impacts)
- crucial input information (field size, slopes, crop management i.e., fertilization, irrigation, tillage, etc.)
- grassed waterway and buffer strip design
- environmental and economic impacts
- model output presentation: surface response functions