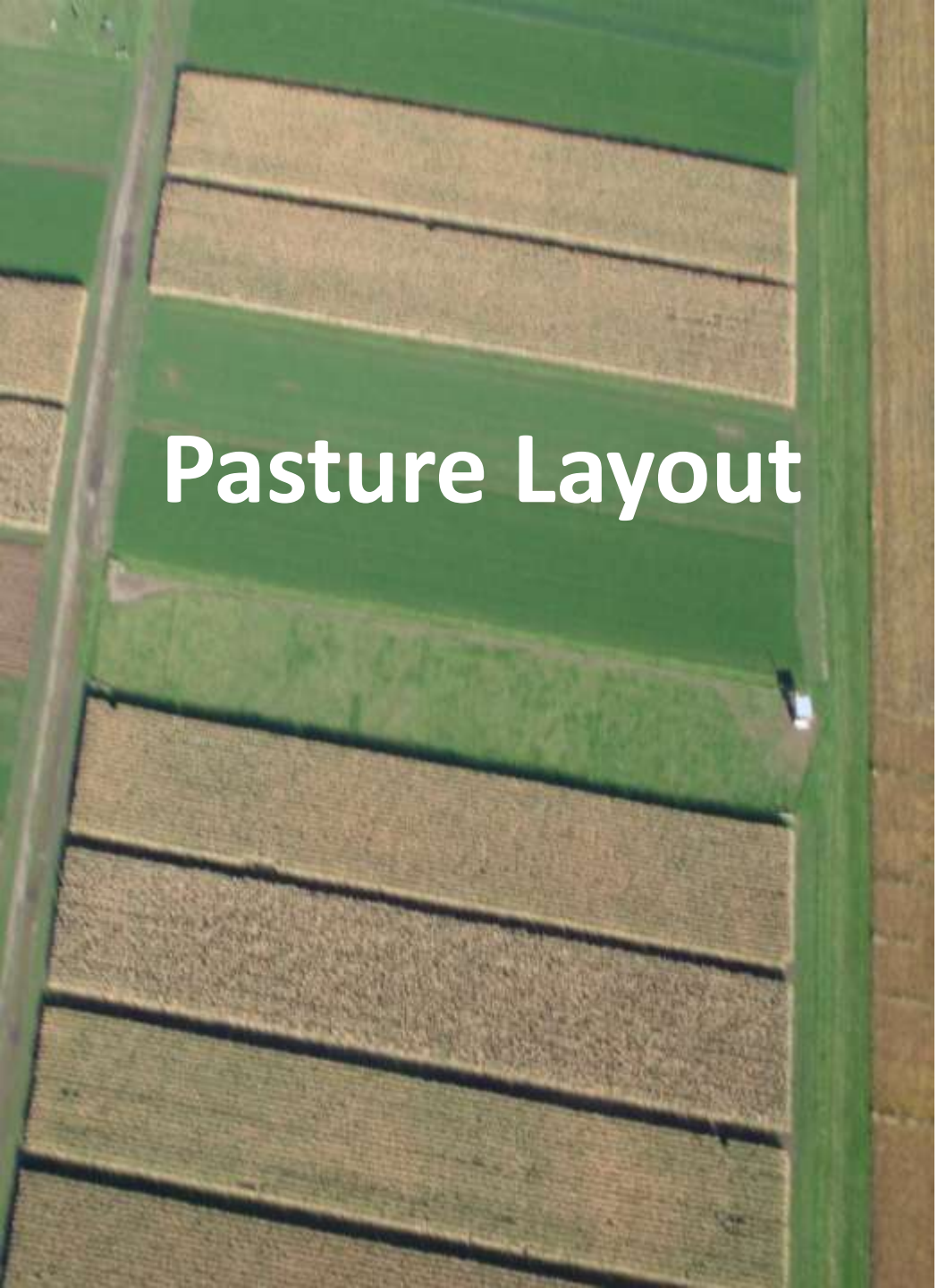
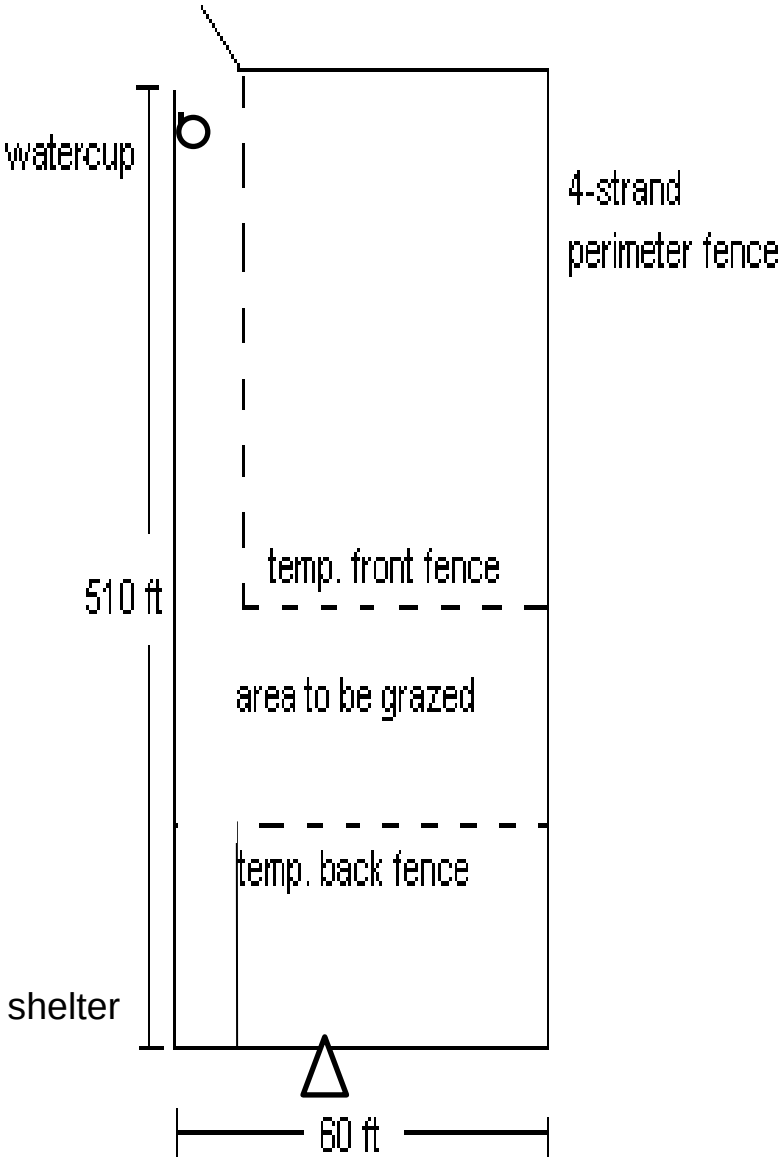
GRAZING'S IMPACT ON SOIL HEALTH

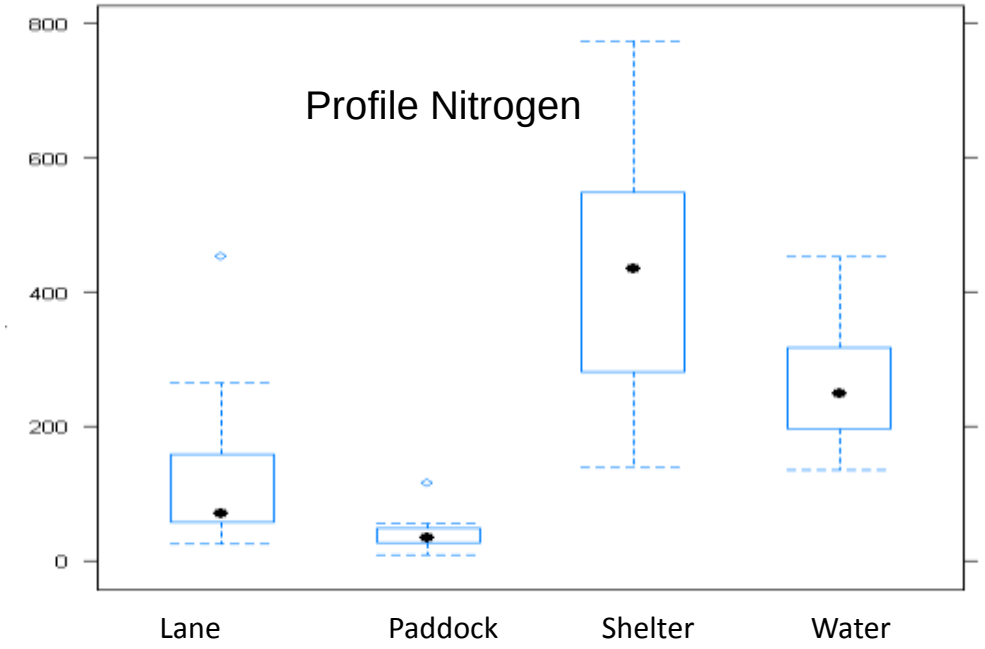
NC WI Grazing Network Winter Meeting - March 2013

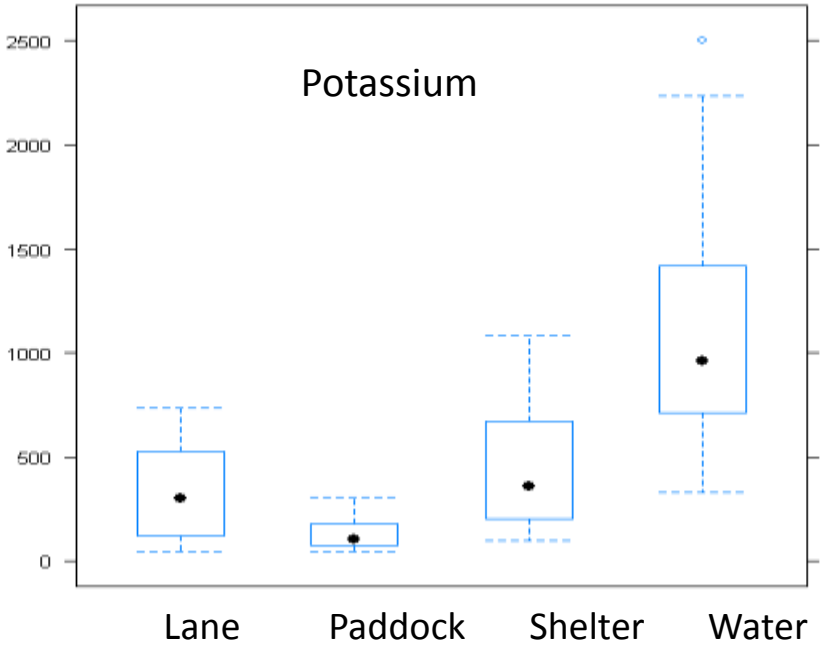
Pasture Layout

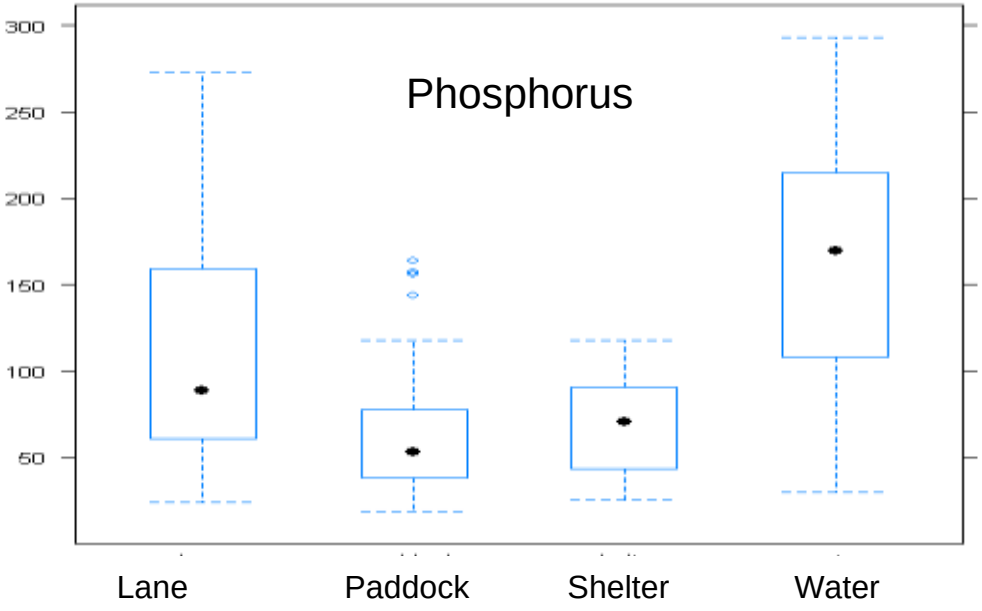




Nutrients (ppm) by Landscape Unit



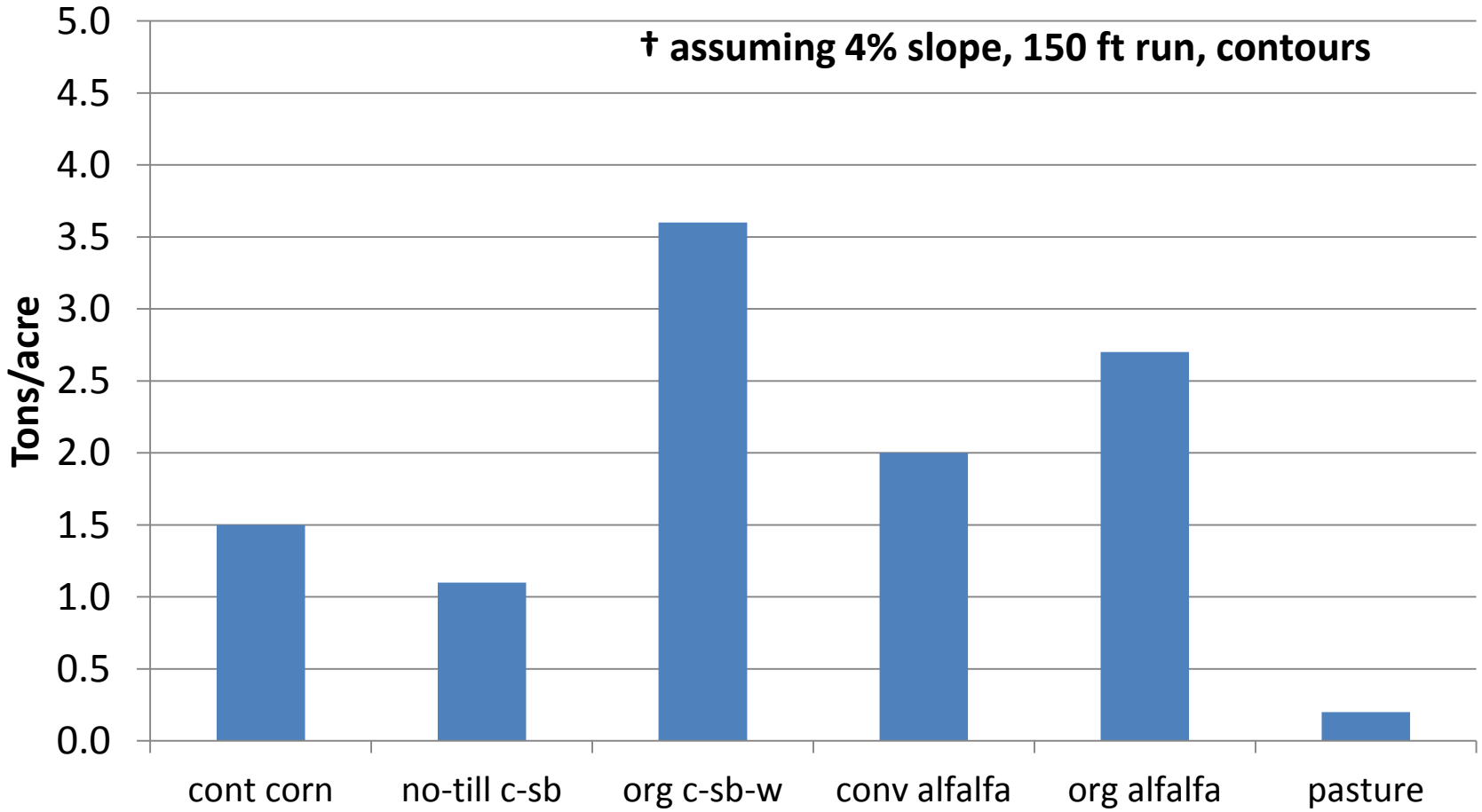




RUSLE2 (NRCS tool)

- Revised Universal Soil Loss Equation
- Predicts soil loss, soil conditioning index (SCI; infers gaining or losing OM), and soil tillage intensity rating (STIR; impact on soil structure)
- Uses county rainfall and specific soil type
- Actual yields and manure inputs from WICST
- All field operations recorded

RUSLE2 Soil loss estimates (18-yr avg)†



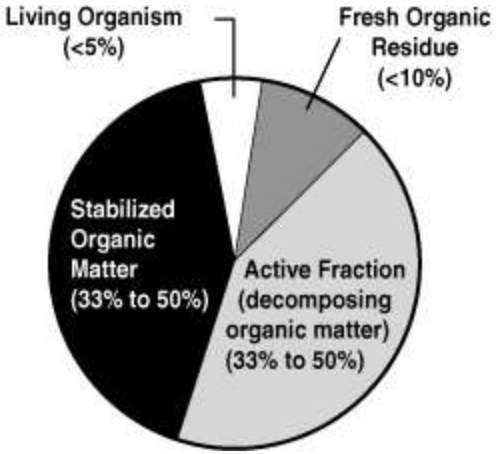
RUSLE2 output (18-yr avg)

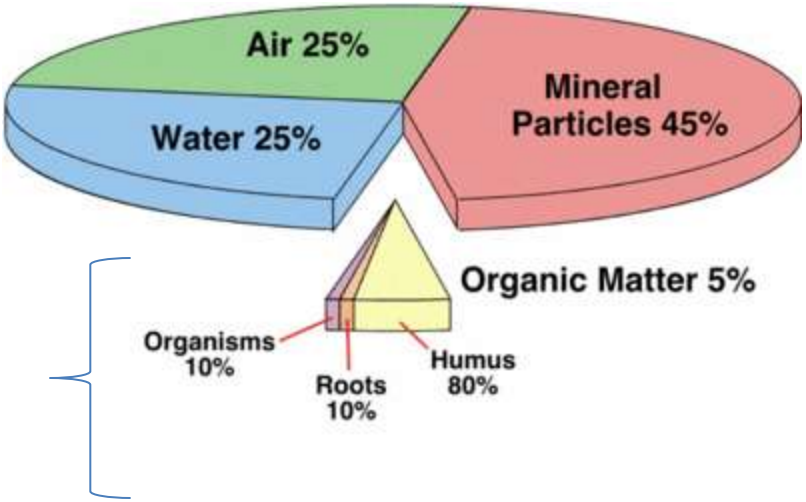
	SCI (-2 to+2; higher better)	STIR (<30 ideal)
Cont. corn (c-c-c)	0.27	165
Min-till corn-sb	0.63	22
Organic grain (c-sb-w/cover crop)	-0.36	185
Conv. Forage (c-a-a-a)	0.44	71
Organic forage (c-o/a-a)	0.17	120
Pasture, MG (cool-season mix)	1.46	15

Soil Organic Matter (SOM)

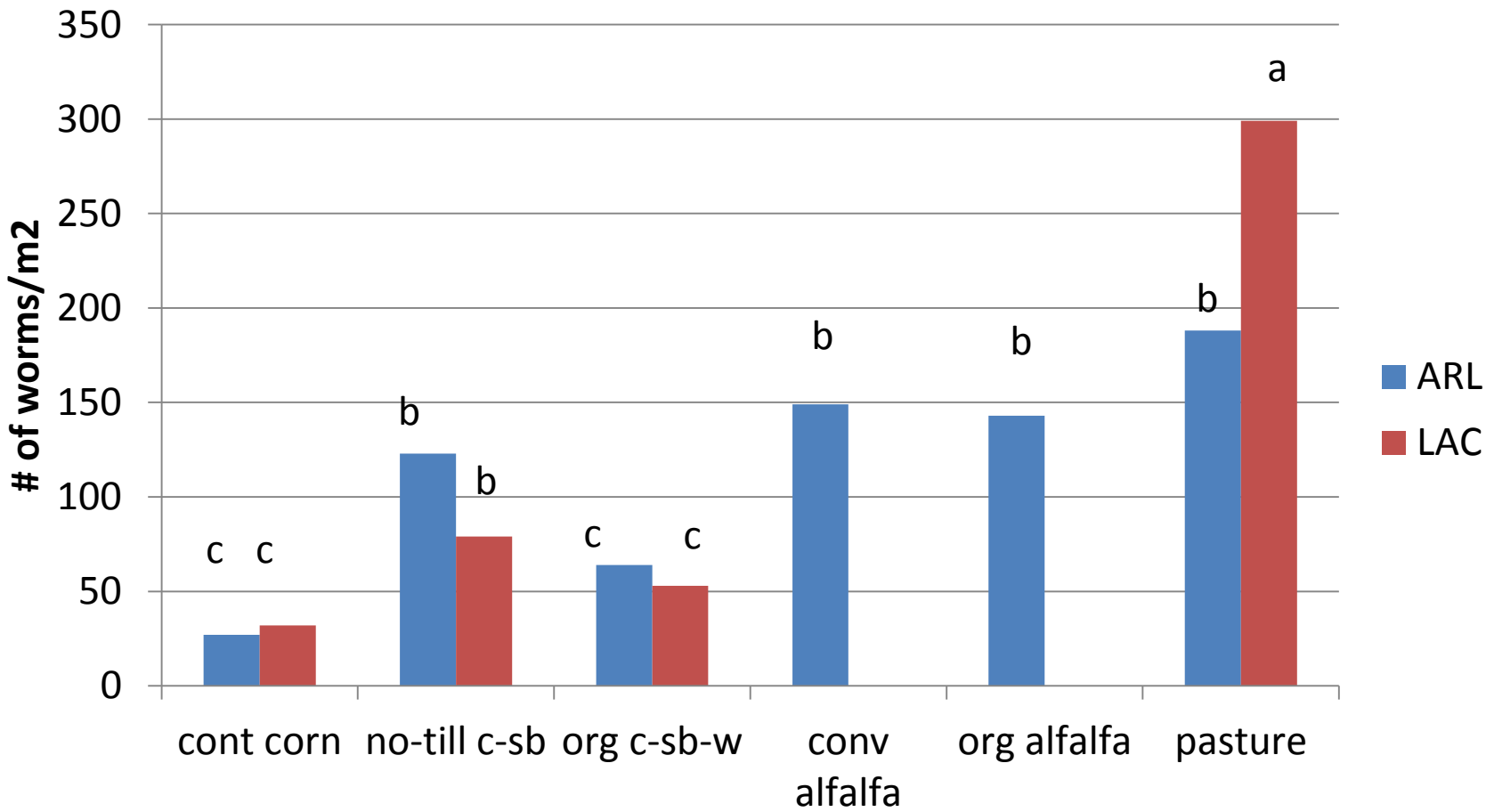
- SOM contains approximately 58% C
- 3 main pools of soil organic carbon (SOC)
  - Quick turnover (< 5 yrs)
  - Intermediate (< 100 yrs)
  - Recalcitrant (half life of several 100 yrs)

Review of Soil Components





Topsoil-dwelling Earthworms



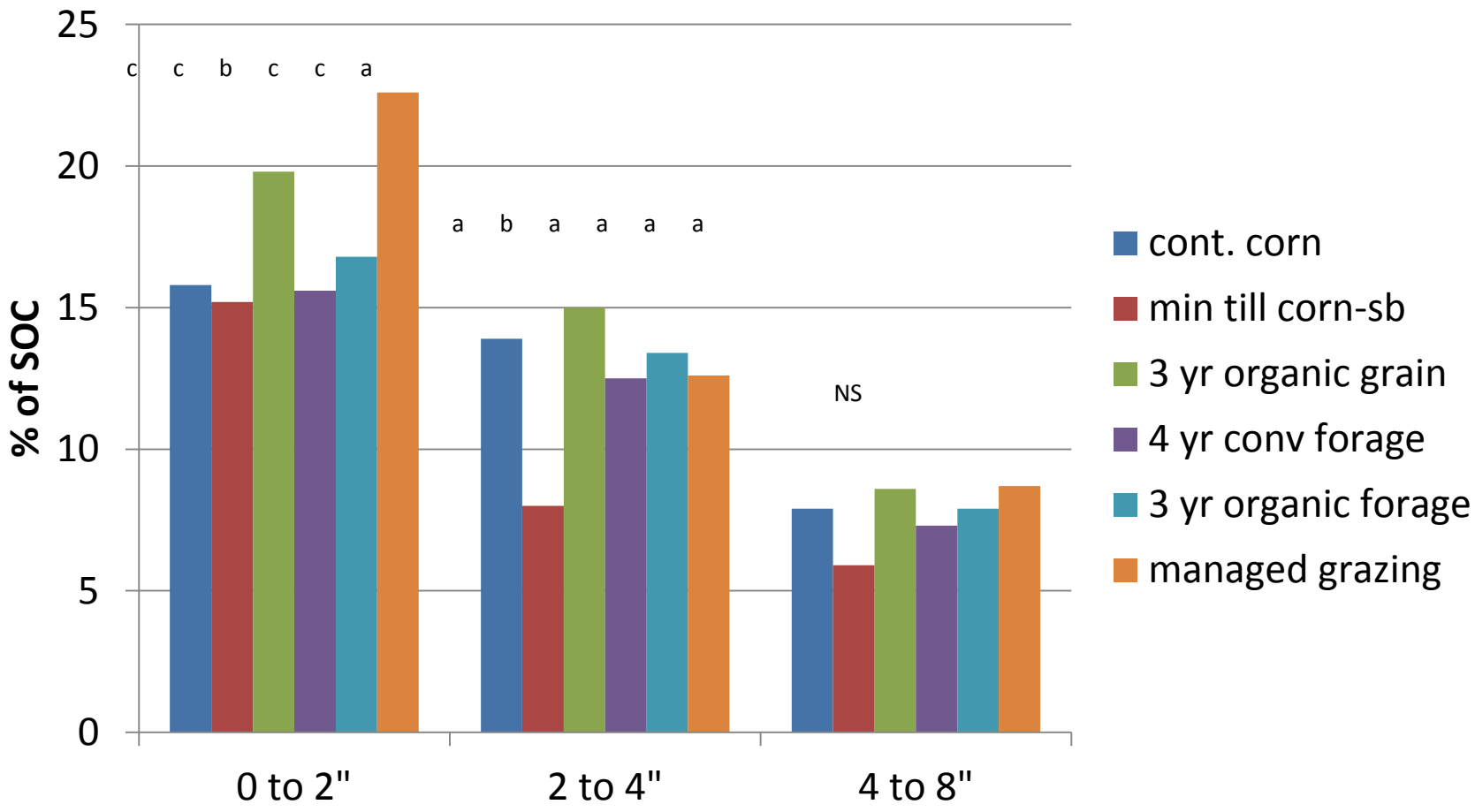
Total Microbial Biomass (nmol/kg soil)

	0-2” depth	2-8” depth
Pasture	523	193
All other systems	194	131
P-value	0.01	0.01

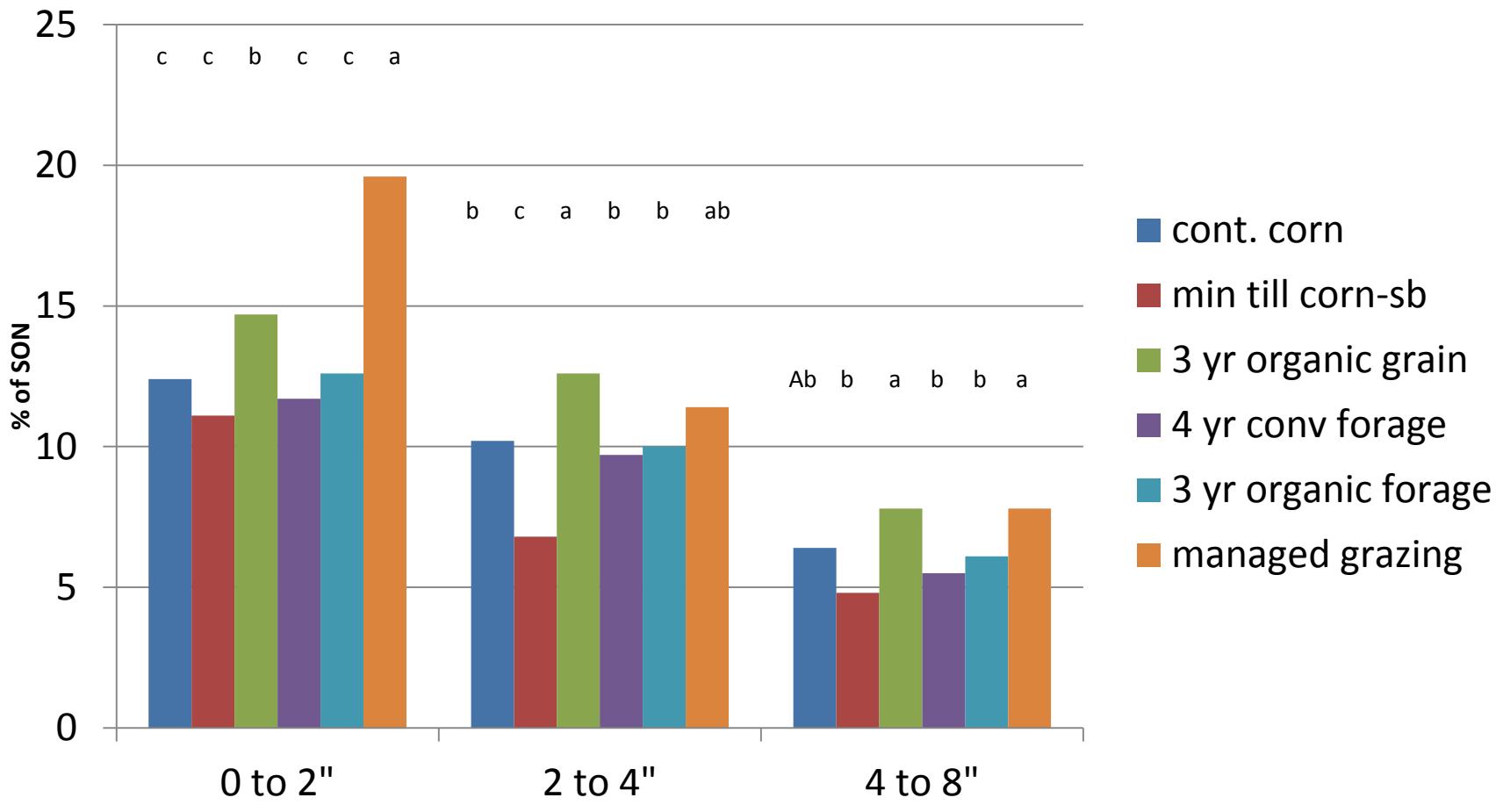
Particulate Organic Matter (POM)

- Biologically and chemically active and is part of the easily decomposable pool (<5 yrs) of soil OM
- It is a source of food/energy for microorganisms and soil animals as well as nutrients for plant growth.
- POM enhances aggregate stability, water infiltration and soil aeration
- POM increases cation exchange capacity and buffering pH.
- It also binds environmental pollutants such as heavy metals and pesticides.

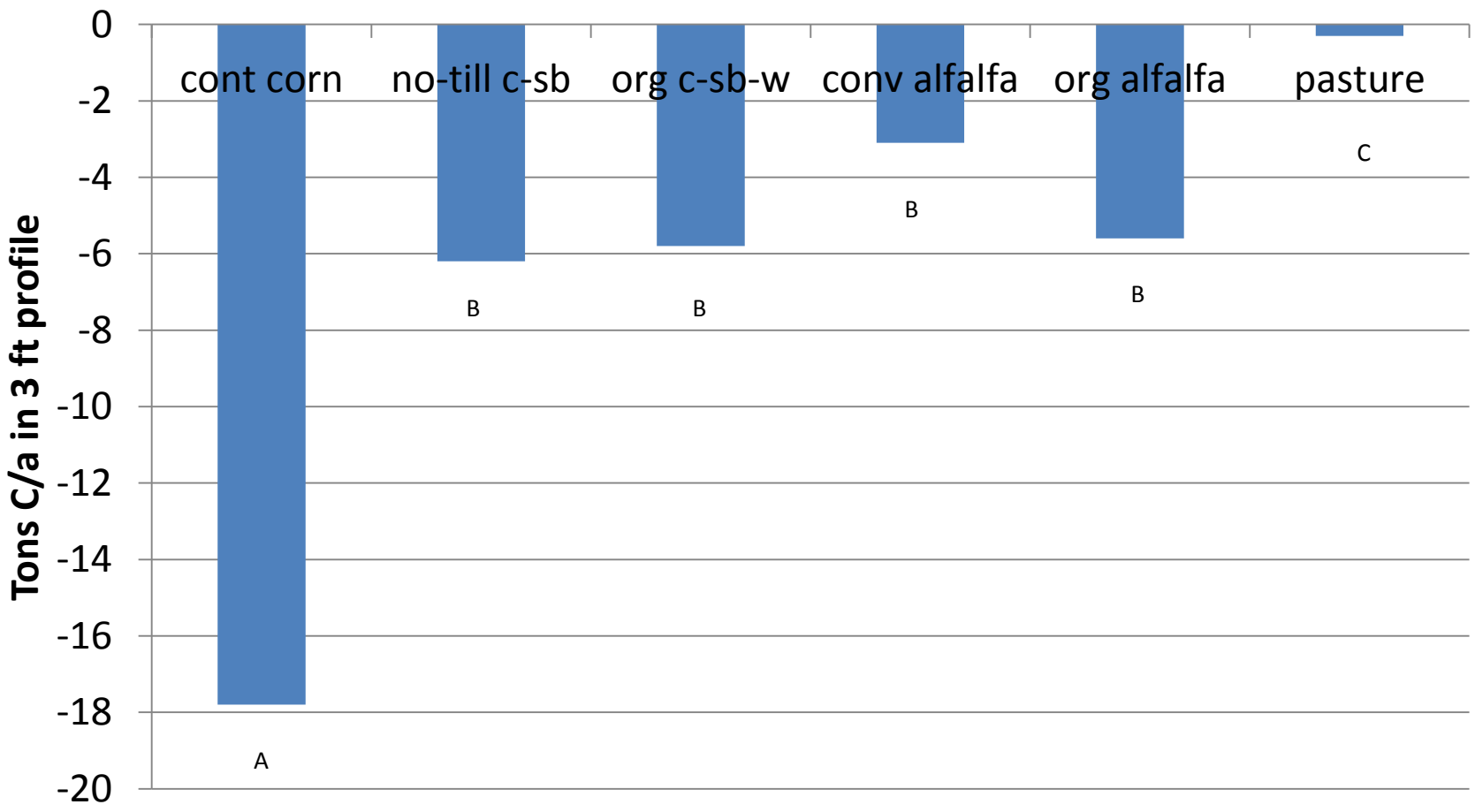
%POM-C on WICST (Arl 2004)



%POM-N on WICST (Arl 2004)



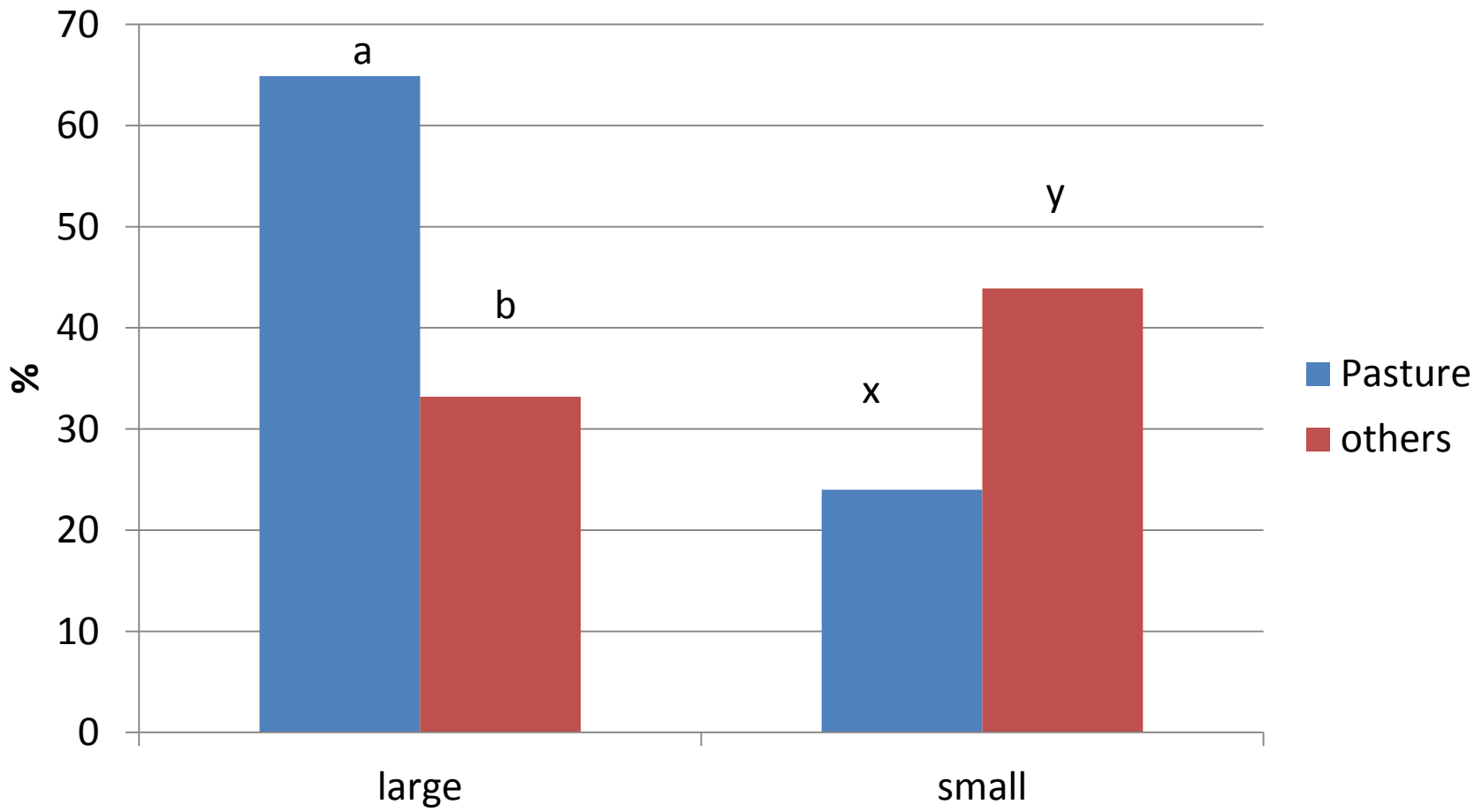
Soil Organic C changes over 20 yrs



Soil C inputs on WICST

	ARL ('92-'09)	LAC ('92-'02)
System	lbs C/acre^{-1}	
Cont. corn	5390	3301
Min-till corn-sb	4081	3324
Org grain (c-sb-w)	3038	2297
Conv. Forage	6075	6353
Organic Forage	6377	7145
Pasture with managed grazing	5380	5548

Water stable aggregates, 0-2” (and 2-8”)



Soil Quality Index (SQI)

- Integrated measure using physical, chemical and biological properties
  - water stable aggregrates, bulk density, total organic carbon, microbial biomass, fertility, etc.
- Measured at surface (0-2”) and plow layer (2-8”)
- Ranges from 0 to 1, where 1 is ideal

SQI in 2008

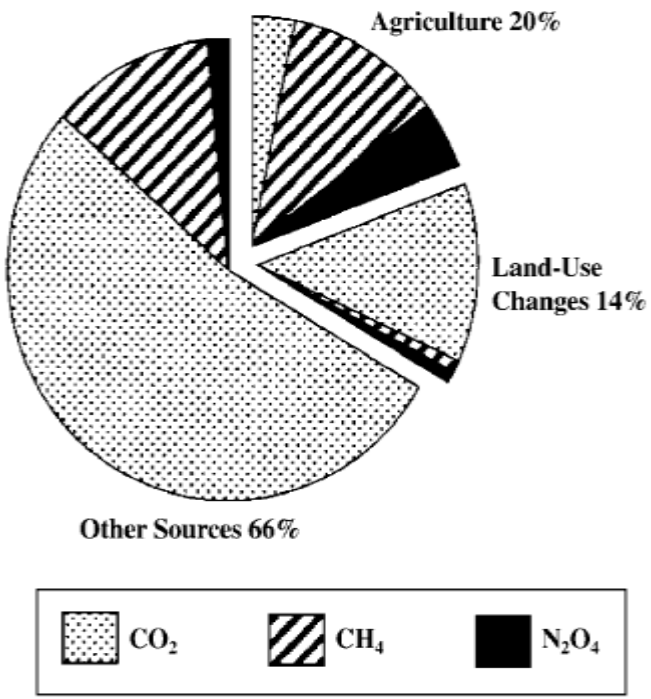
	0-2” depth	2-8” depth
Pasture	96	84
All other systems	87	78
P-value	0.01	ns

Greenhouse Gases (GHGs)

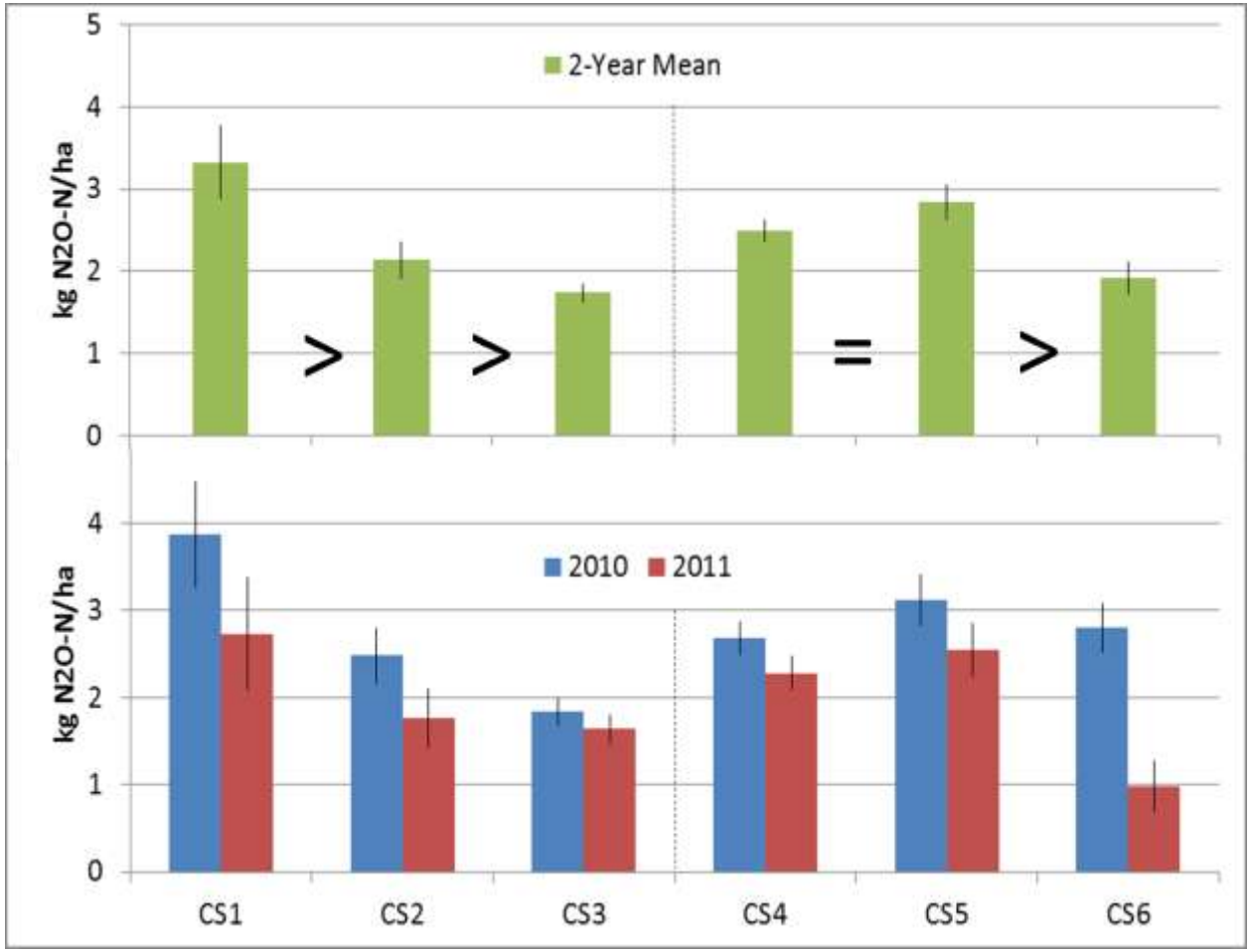
- Medium-term changes
- Absorb solar radiation, heating the atmosphere
- Carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O)
  - Different relative atmospheric warming potency
  - CO_2=1
  - CH_4=23
  - N_2O=300
- Significant increases observed over last 50 years
- Theory supported by 97% of climate science experts

Emission of GHGs from human activities have increased since the 1800s

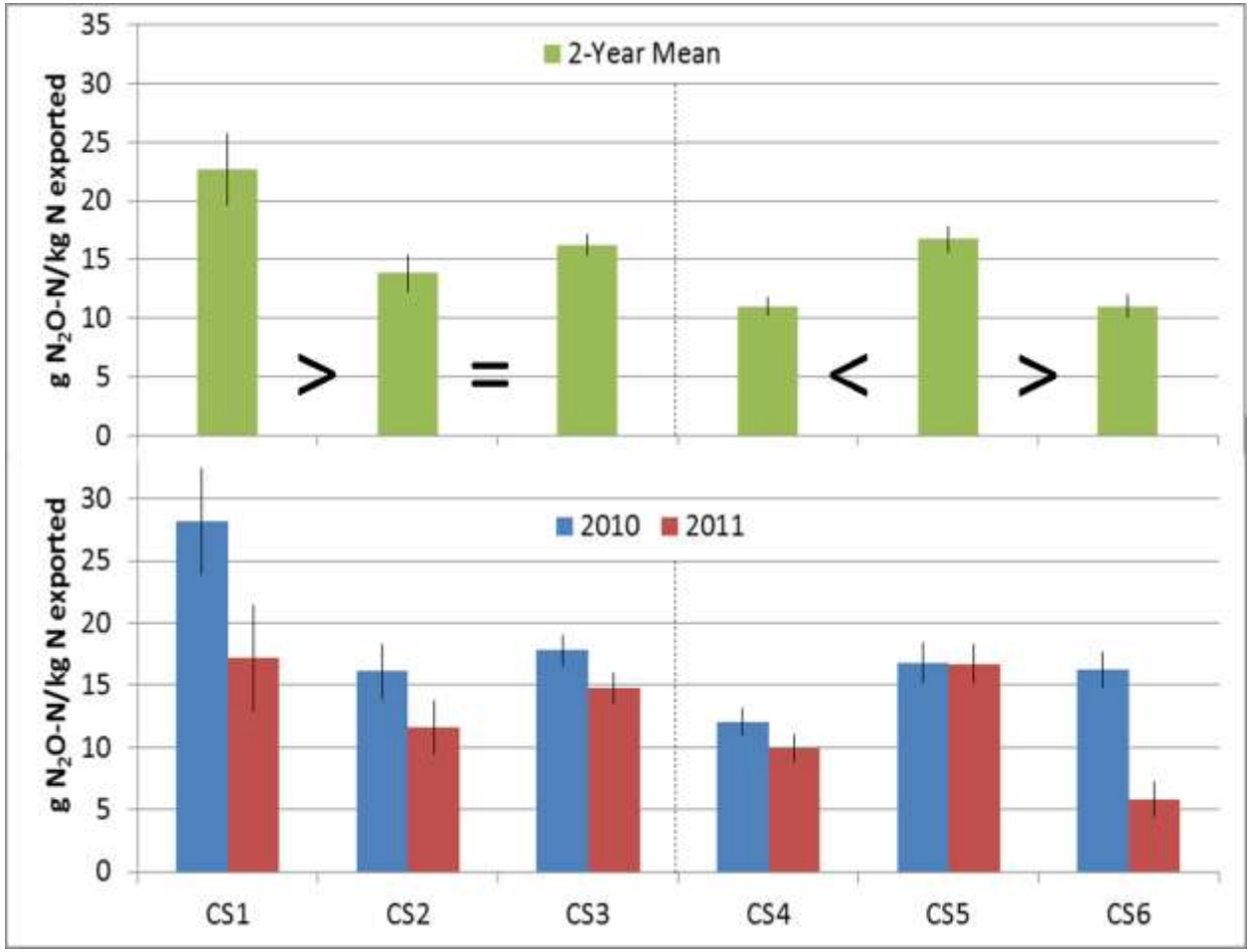
- Burning fossil fuels (coal, petroleum)
  - CO_2 from combustion, transportation
- Expansion and intensification of agriculture
  - CO_2 from input manufacturing, soil carbon release due to soil disturbance
  - CH_4 from soil carbon release under saturated conditions, livestock metabolism
  - N_2O from nitrogen cycling in soil



N_2O emissions/land area



N_2O emissions/unit of N harvested



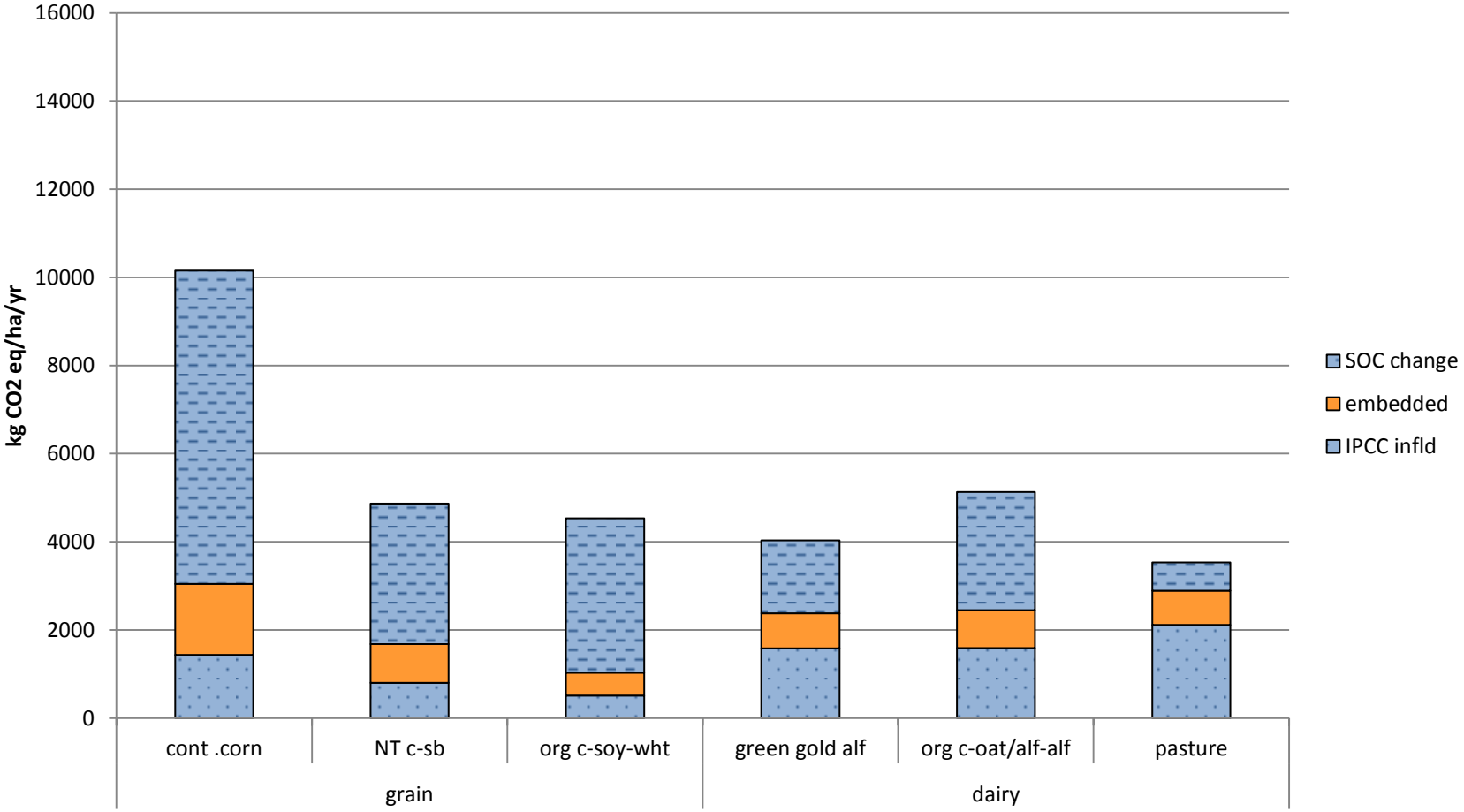
LCA: Embedded Emissions

- Data from the GaBi databases
  - Seed
  - Diesel
  - Fertilizer
  - Pesticides
  - Grain Drying
  - Supplemental heifer feed while on pasture
- N2O, CH4, CO2 computed and converted to CO2 eq in kg/ha/yr

In-field Emissions

- Crop residue and cover crops
- Organic N inputs (i.e. manure, legume)
- Mineral N inputs (i.e. commercial fertilizer)
- N2O Emissions from Urine and Dung in Pasture
- Indirect – leaching & volatilization of N, CO2 from urea, and CO2 from loss in SOC

Partitioning of kg CO2 eq/ha - Arl, 1993-2008



SUMMARY (cont'd)

- Pasture exceeds other systems in soil health
  - SQI
    - Water stable aggregates
    - earthworms,
    - microbial biomass
  - POM, SOC status
  - RUSLE2
    - less soil loss
    - best SCI
    - best STIR

Improving nutrient distribution

- Portable shade
- Put water in each paddock vs. permanent set up
- Use other form on N fertilizer besides urea – i.e. ammonium sulfate (less volative)
- Inject or broadcast slurry for improved nutrient distribution