Impacts of Agricultural Practices on Soil Carbon

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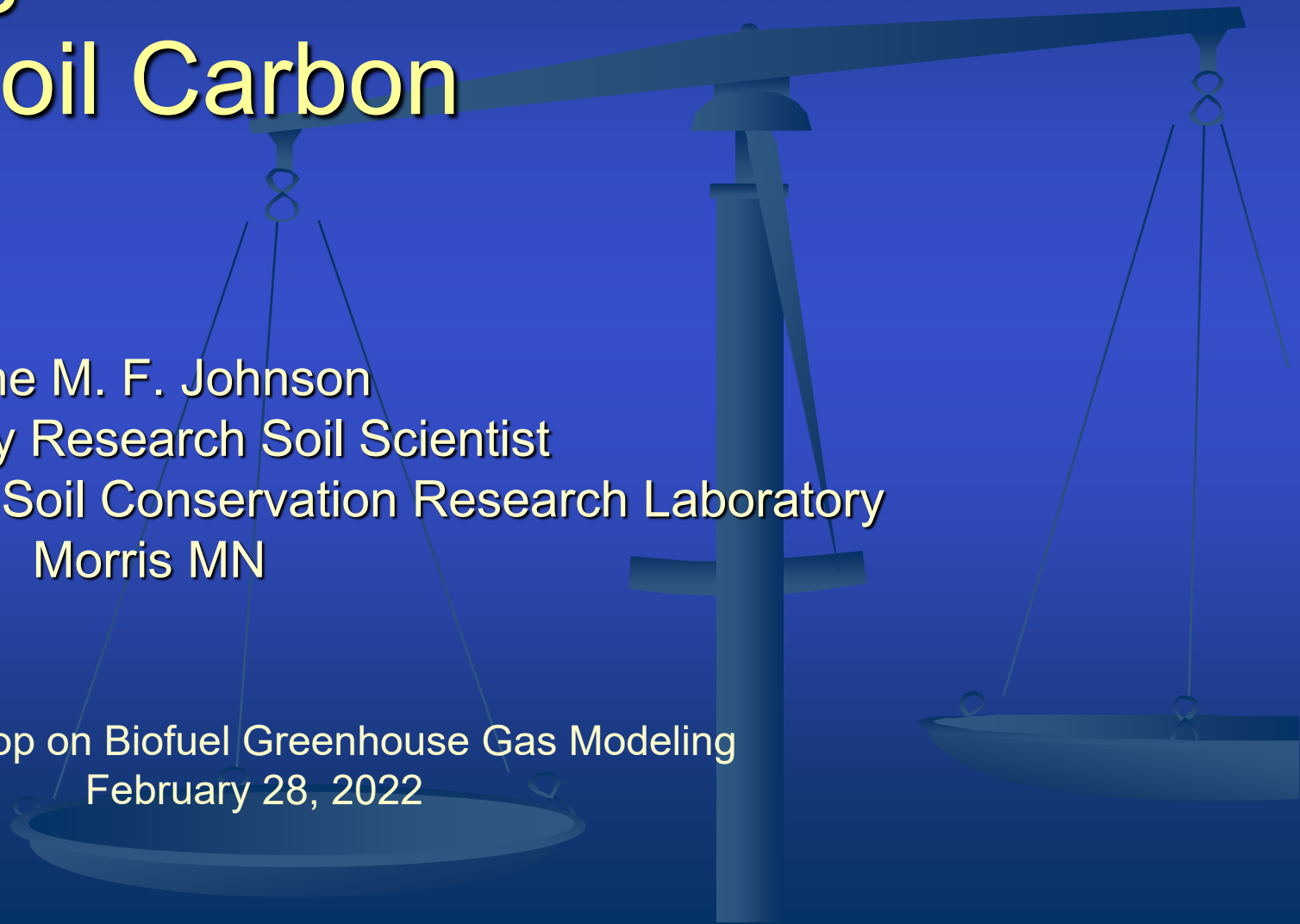
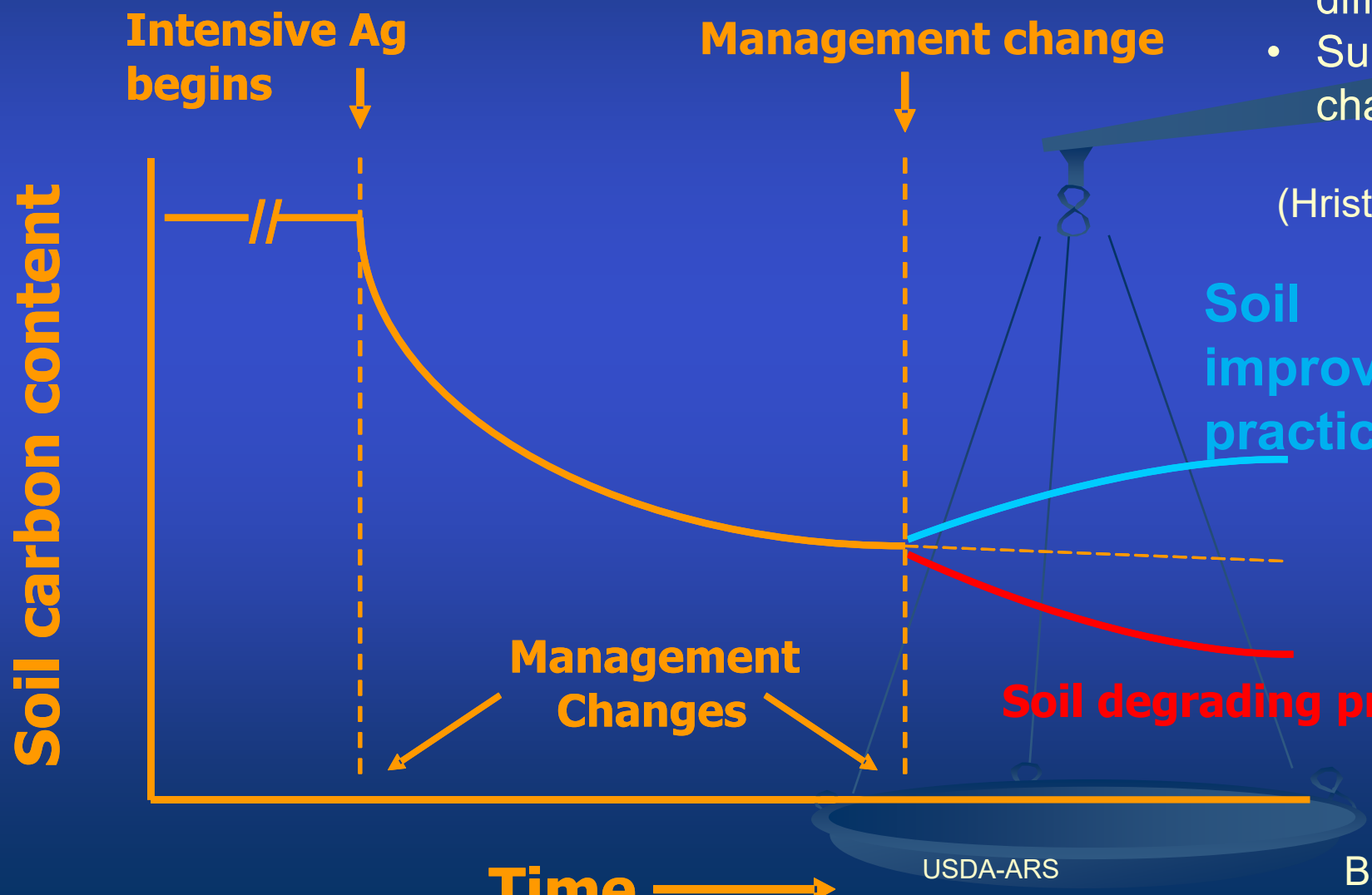
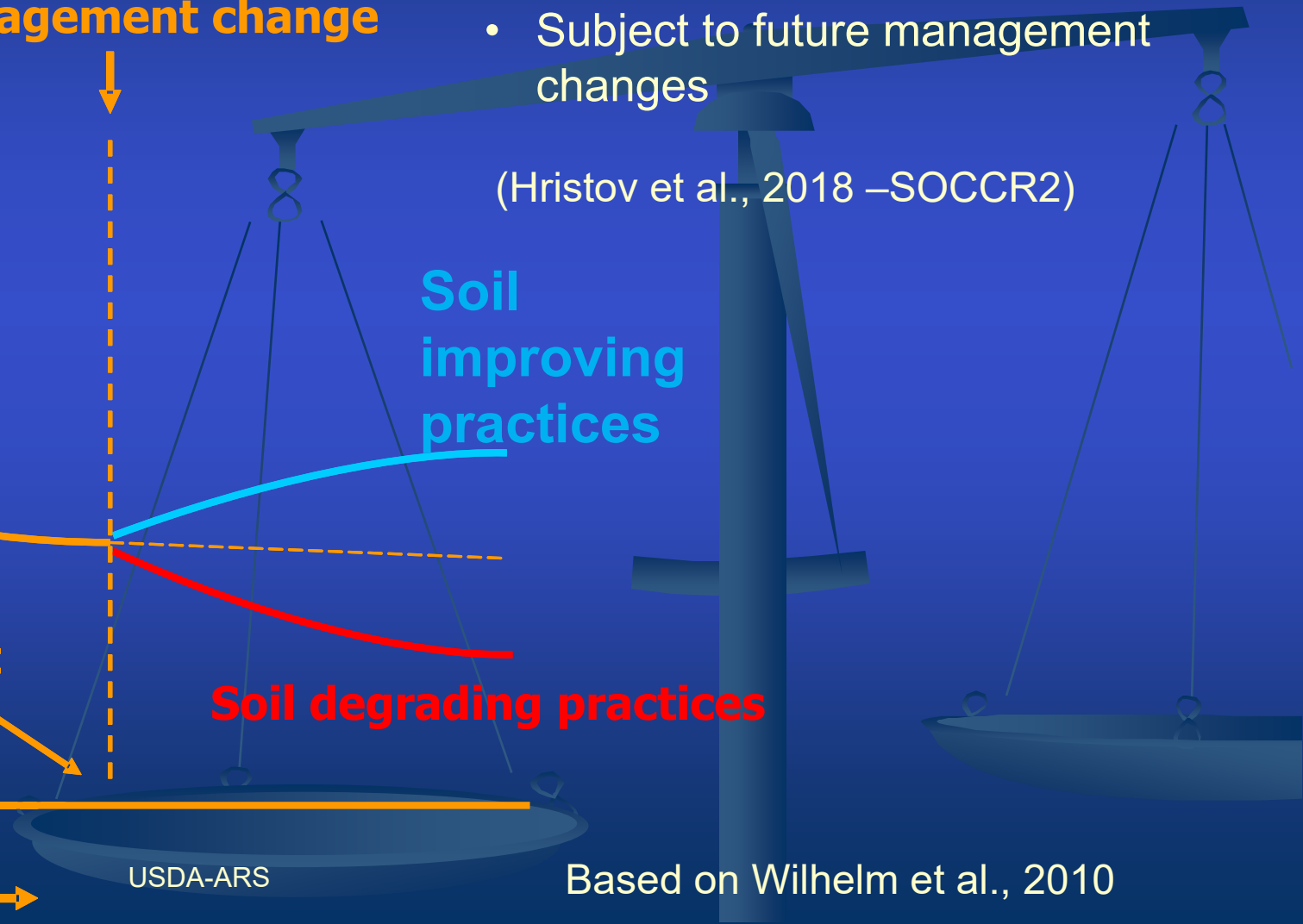


- Cropland C-Stock in soil
- Management can + /- C stocks
- Magnitude and longevity of C-stock changes are environment and difference sensitive
- Subject to future management changes

(Hristov et al., 2018 –SOCCR2)



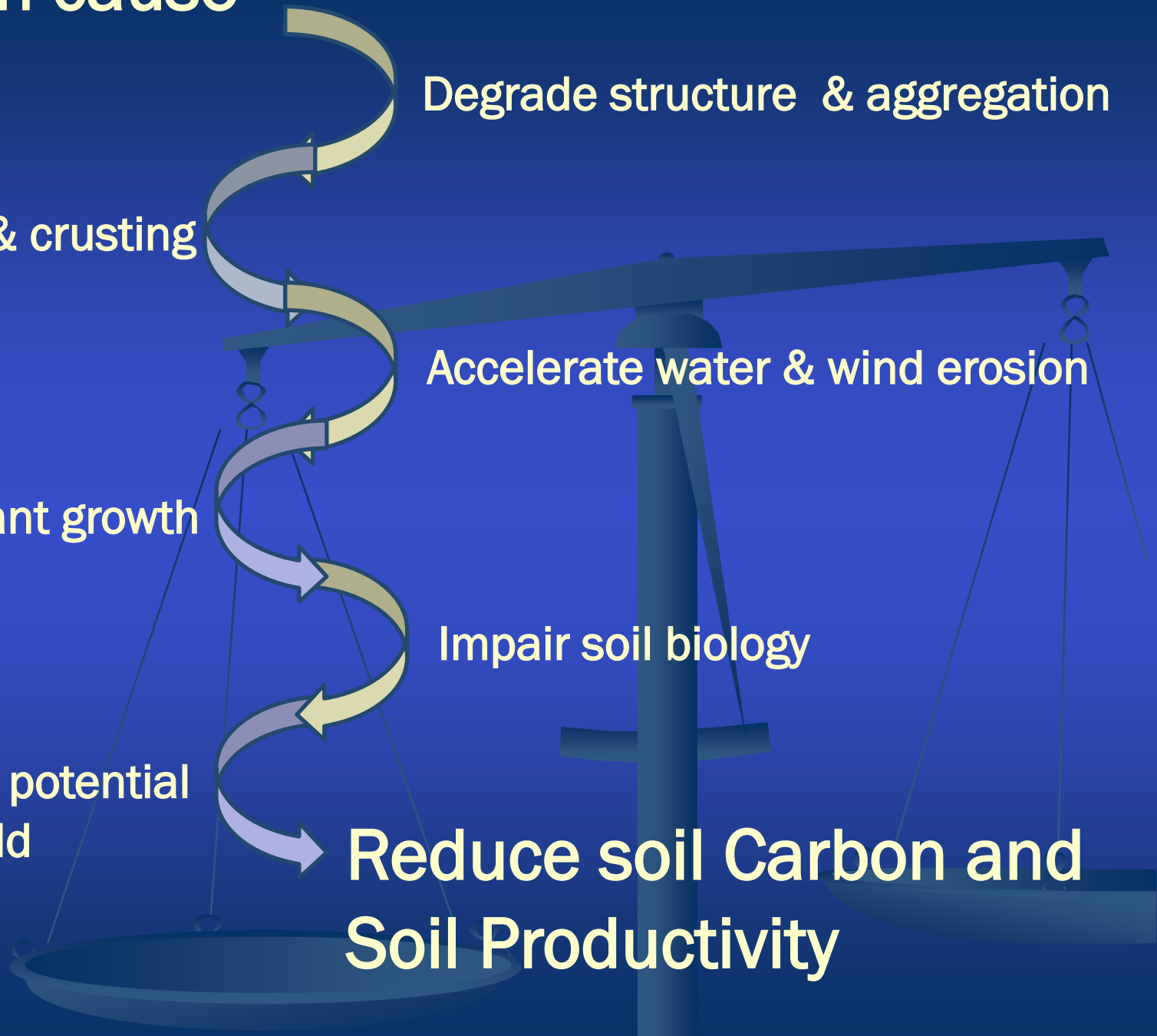


USDA-ARS

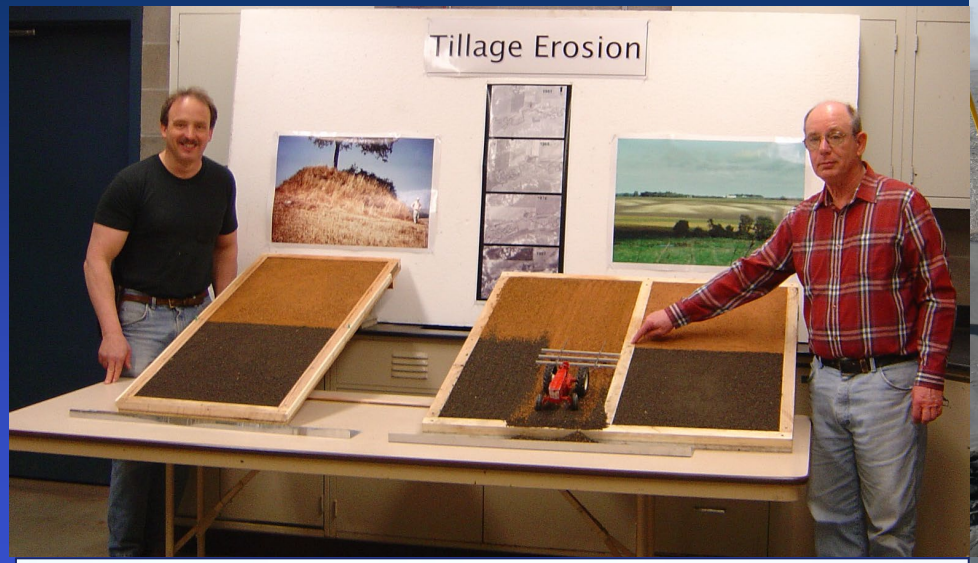
Based on Wilhelm et al., 2010

Management choices can cause

Ag. practices that leave the land exposed, providing inadequate carbon inputs



Tillage: erosion and carbon-loss



USDA-ARS

Build Climate Resilient Healthy Soil

Increase yield potential

Increase soil carbon

Improve infiltration

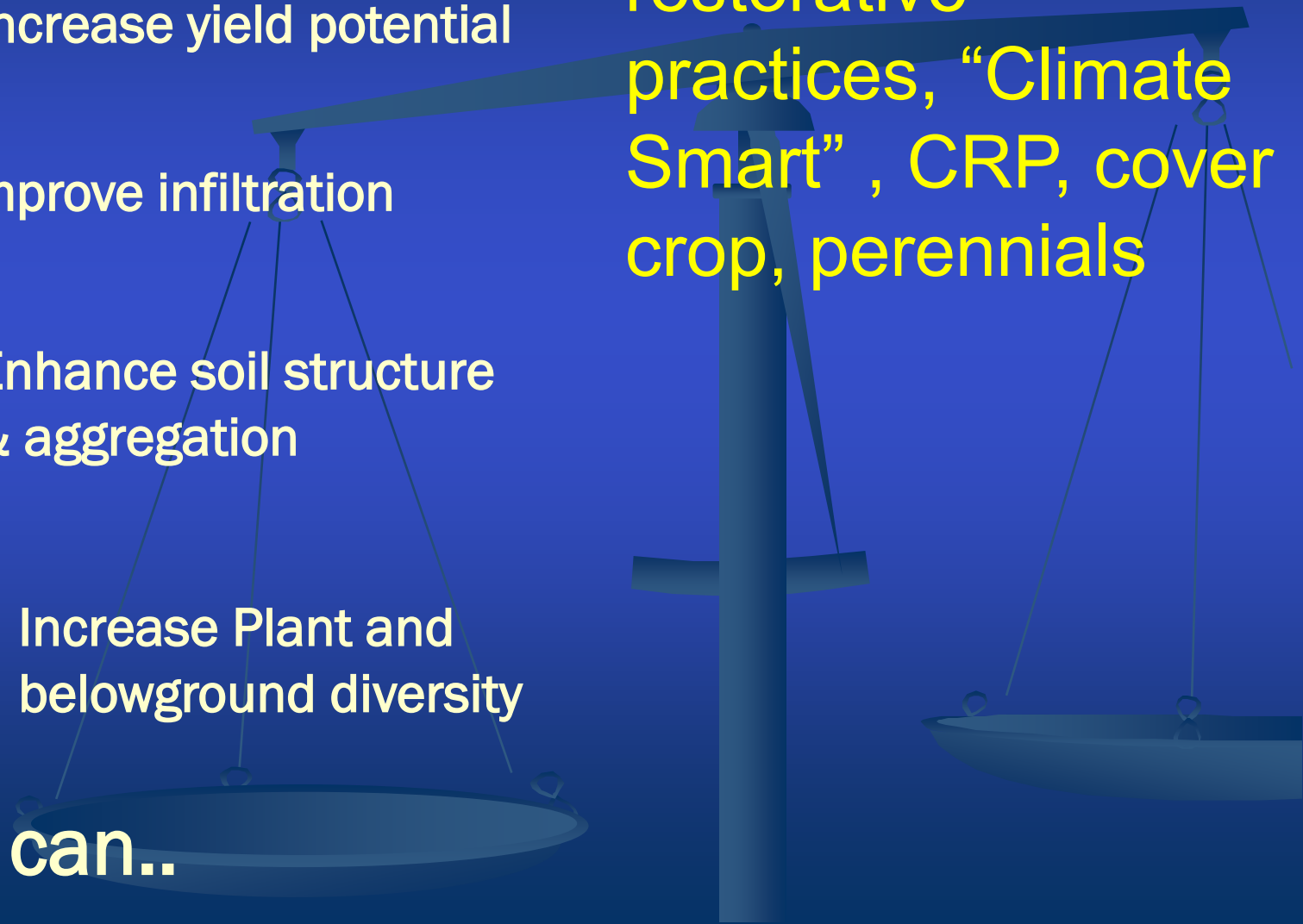
Improve resilience to Water & wind erosion

Enhance soil structure & aggregation

Increase soil biology and function

Increase Plant and belowground diversity

Conservation-restorative practices, “Climate Smart” , CRP, cover crop, perennials



Or Agricultural Practices can..

Example: empirical study

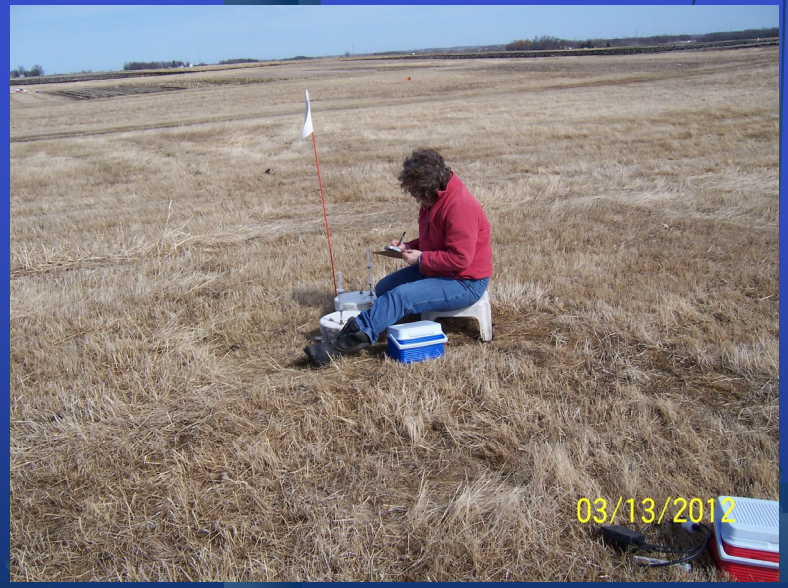
Rotation history and sampling, all no tillage

	2000	2001	2002	2003	2004	2005	2006	2007	2008	**2009**	**2010**	**2011**
	Soil Sampling						Soil Sampling					Soil Sampling
Perennial Grass	SW	SW	SW	SW	SW	SW	SW	SW	SW	**SW**	**SW**	**SW**
	A	A	A	A	A	A	A	C	S	**W/A**	**A**	**A**
	C	S	C	S	C	S	C	S	C	**S**	**C**	**S**
Perennial Grass	BBS	BBS	BBS	BBS	BBS	BBS	BBS	BBS	BBS	**BBS**	**BBS**	**BBS**
	W	A	A	C	S	W	A	A	A	**C**	**S**	**W/A**

A=Alfalfa, BBS = Big Bluestem, C=corn, SW=Switchgrass,

S-Soybean, W=spring wheat

Nitrous oxide measured

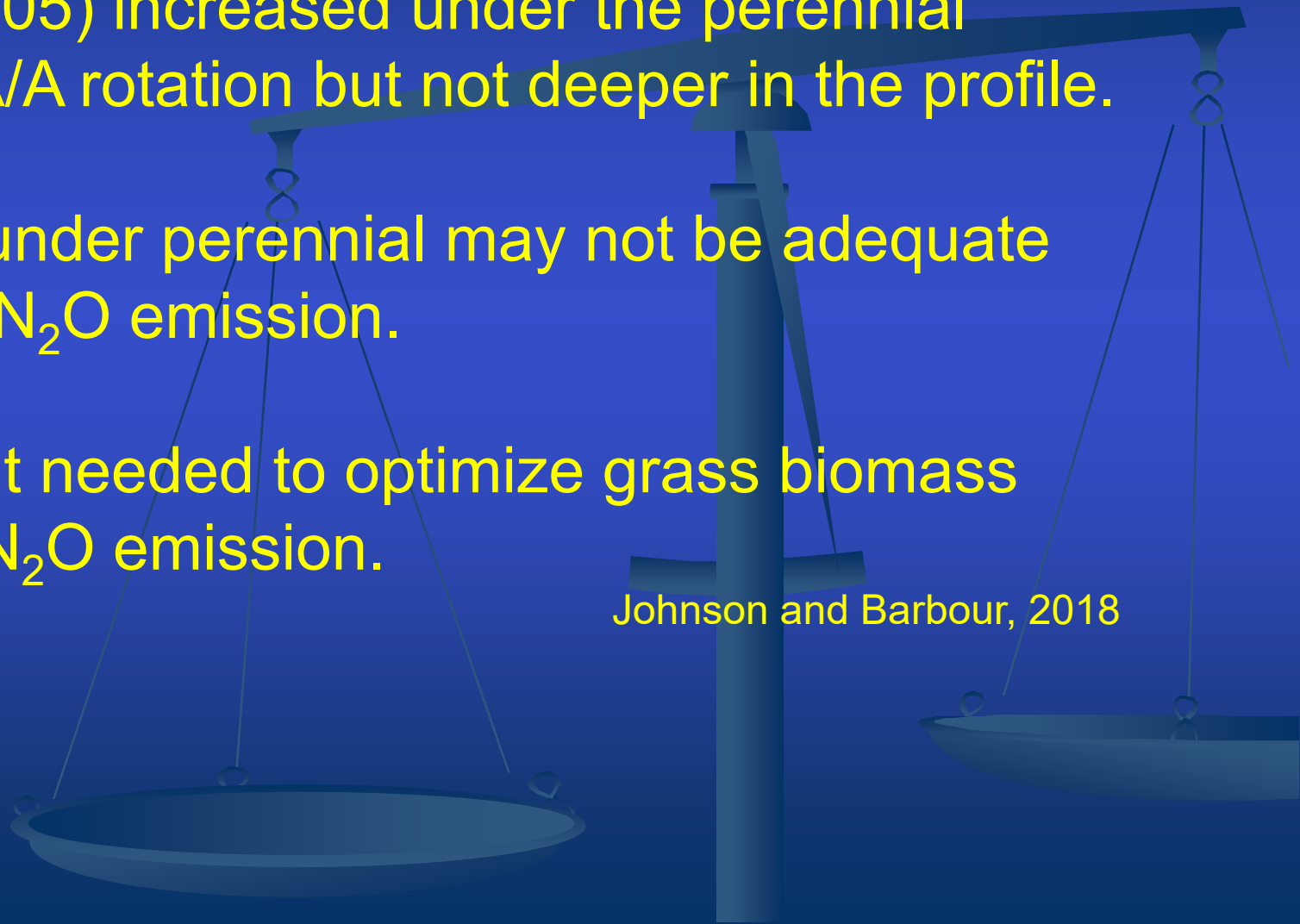


Soil sampling, GHG sampling occurred all four seasons, crop residue and grasses harvested annually

Study found

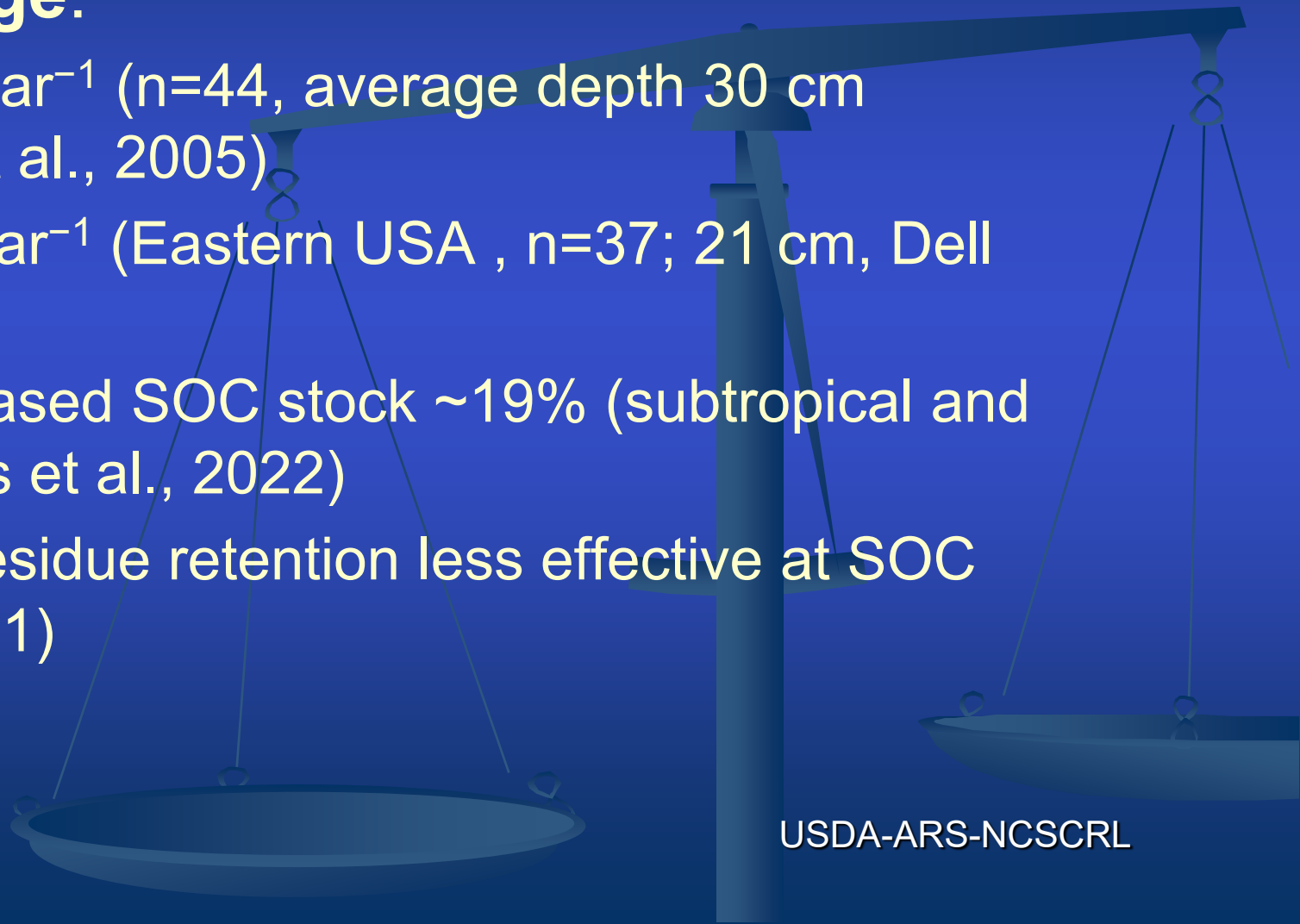
- SOC stocks (0-5 cm; P≤0.05) increased under the perennial grasses and in the W+A/A/A rotation but not deeper in the profile.
- SOC storage (10-years) under perennial may not be adequate to offset fertilizer induced N_2O emission.
- N management refinement needed to optimize grass biomass production and minimize N_2O emission.

Johnson and Barbour, 2018

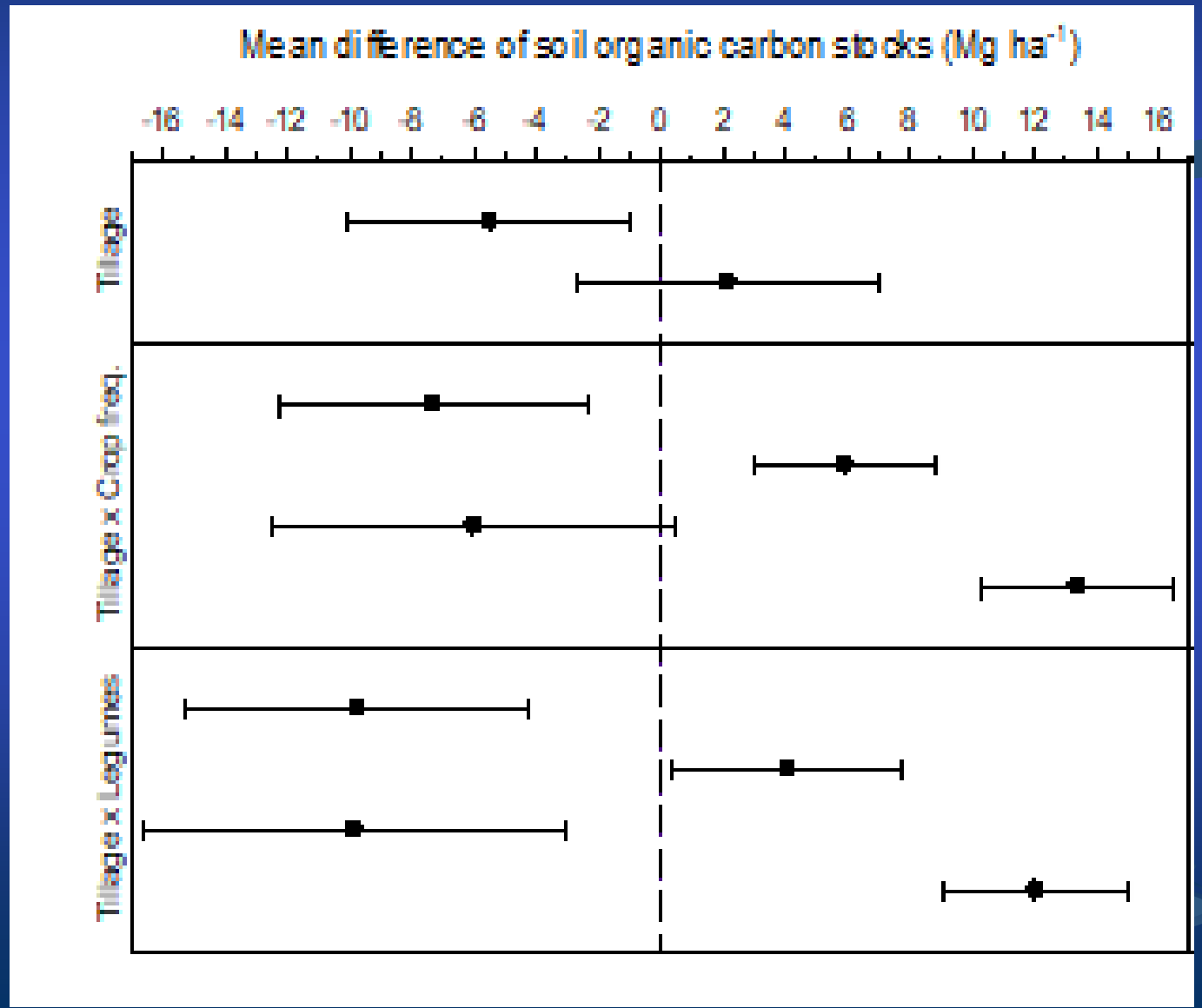


Agricultural management practices for croplands

- **Conservation/ no tillage**:
  - 0.40 ± 0.61 Mg C ha^{-1} $year^{-1}$ (n=44, average depth 30 cm Midwest USA Johnson et al., 2005)
  - 0.58 ± 0.71 Mg C ha^{-1} $year^{-1}$ (Eastern USA , n=37; 21 cm, Dell and Novak, 2005)
  - Reduced/No tillage increased SOC stock ~19% (subtropical and tropical soils N= 420, Das et al., 2022)
  - No tillage – without out residue retention less effective at SOC retention (Xiao et al., 2021)



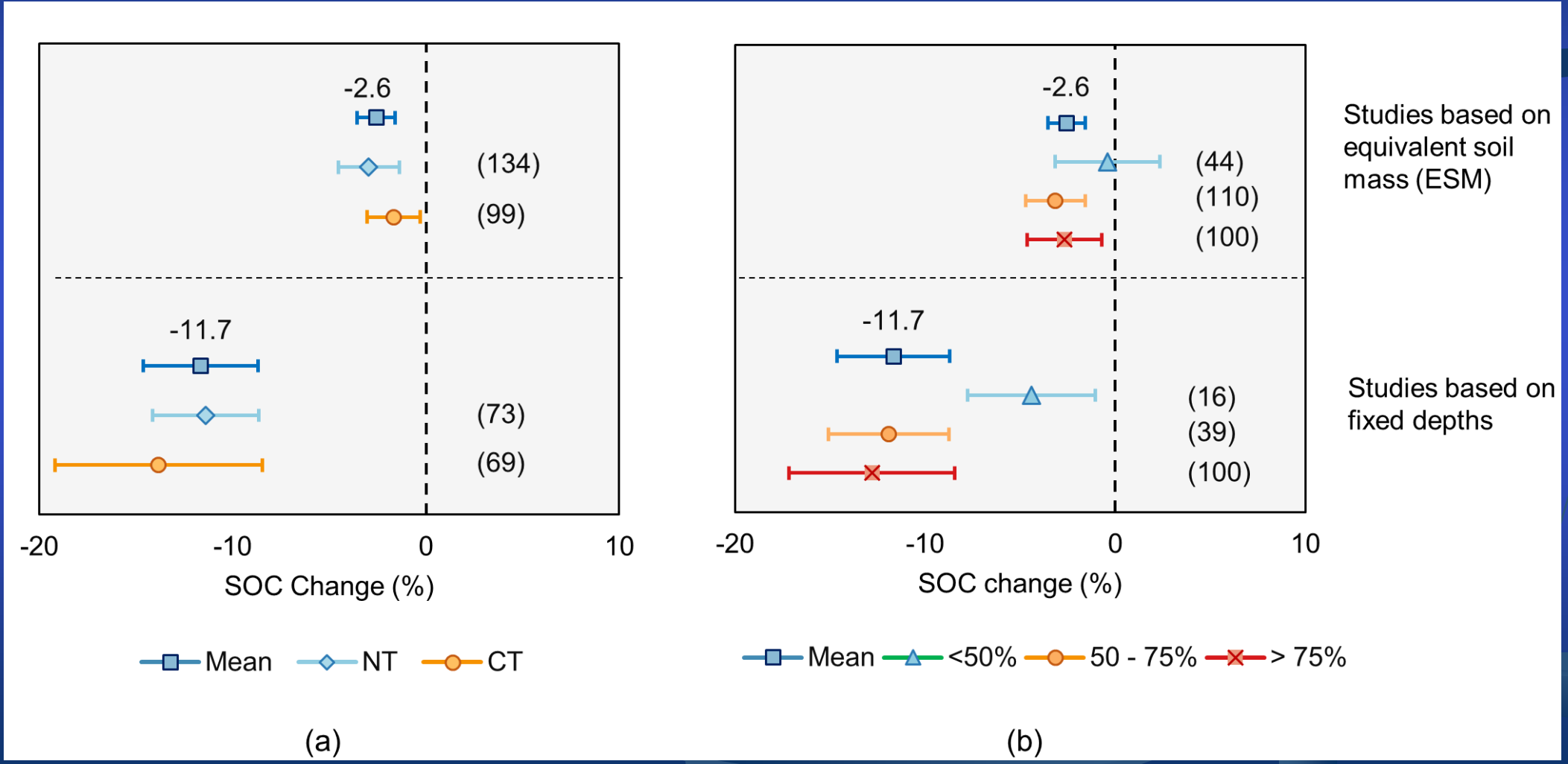
Mean differences SOC stocks in ag. soils according to tillage system, crop frequency and use of legumes as compared pretreatment baselines in the cumulative 0-100 cm soil layer. Meta-Analysis – from 121 studies, 19 countries, 6 continents. Nicoloso and Rice 2021 SSSAJ



Slide: Courtesy of Dr. CW Rice

Residue management –

- Residue retention promotes C accumulation (Li et al., 2020)
- Harvesting <50% corn residue reduced C-stock loss (Xu et al., 2019)



- **Crop rotation and cover crops**
  - Corn provides high plant C-stocks (Mathew et al., 2020)
  - Perennials and cover crops > grain only or grain + legume (King and Blesh, 2018)
  - Cover crop benefits modulated by type, soil, and climatic
    - 0.32 ± 0.08 Mg C ha^{-1} $year^{-1}$; n=139, 37 sites (Poeplau and Don, 2015)
    - 15% increase tropical/subtropical n=248 (Das et al., 2022)
    - Impact on N_2O – equivocal n=106; 26 studies (Basche et al., 2014)

Agricultural management practices

- **Residue management –**
  - Residue retention promotes C accumulation (Li et al., 2020)
  - Harvesting <50% corn residue reduced C-stock loss (Xu et al., 2019)
  - Harvesting maize residue tended to decrease N_2O emission (Jin et al., 2014 Bioenergy Res.)
  - Meta-analysis N_2O increased but nitrate leaching decreased w/residue retention (n=178, temperate soil Li et al., 2021)

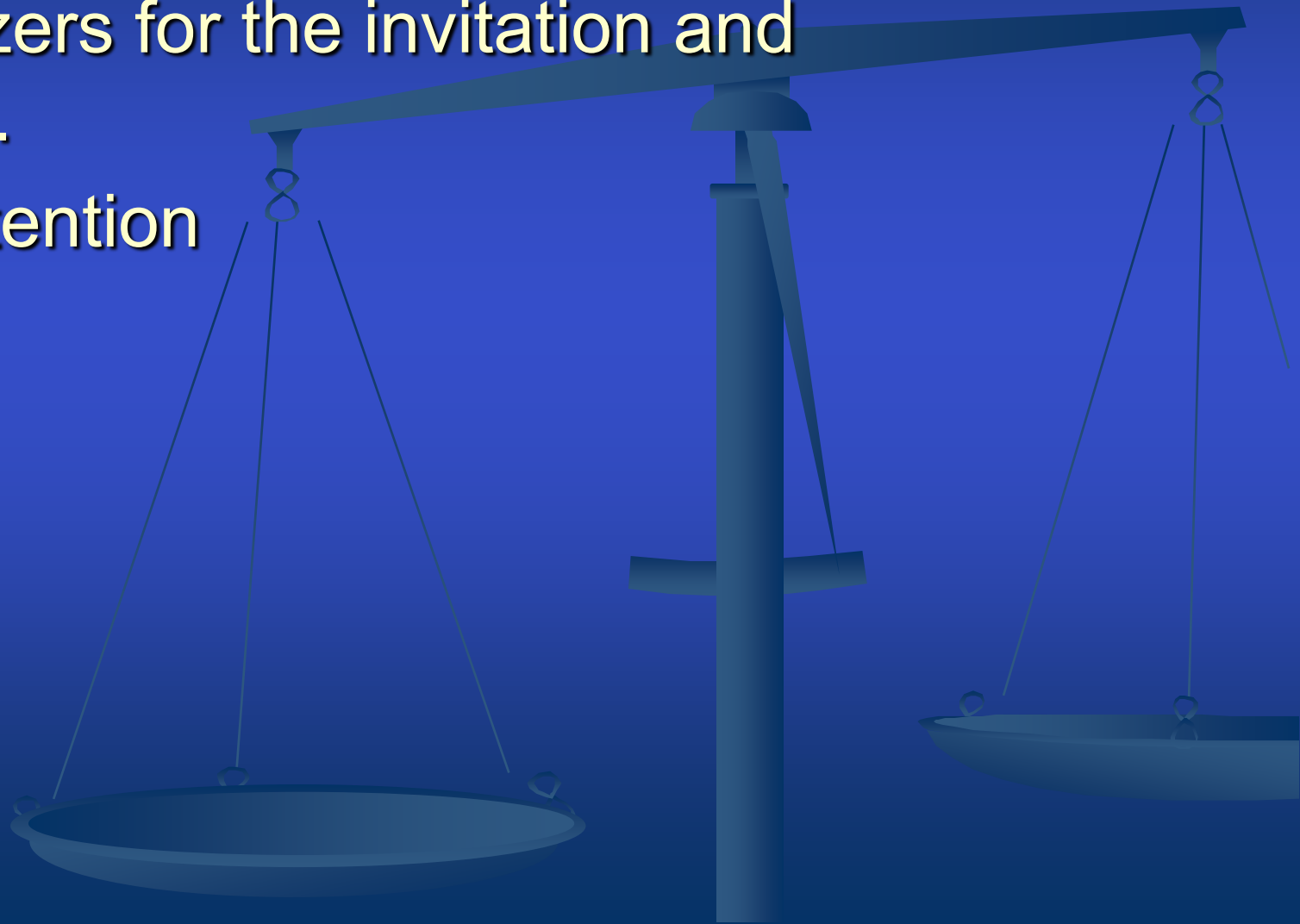
Concluding comments

- Empirical studies one-step in the process
- Aggregated via-meta-analyses – expand understanding among regions, environment
- Models, Life-cycle analyses rely on solid studies to inform, validate and calibrate

- Goal – Agricultural practices that provide food, feed, fiber and fuel while increasing soil carbon and healthy resilient soils - for today and tomorrow

Acknowledgements

- Thank-you the organizers for the invitation and opportunity to present.
- Thank-you for your attention



Additional resources

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