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IPNI
INTERNATIONAL
PLANT NUTRITION
INSTITUTE

Managing Crop Nutrition in a Changing Climate

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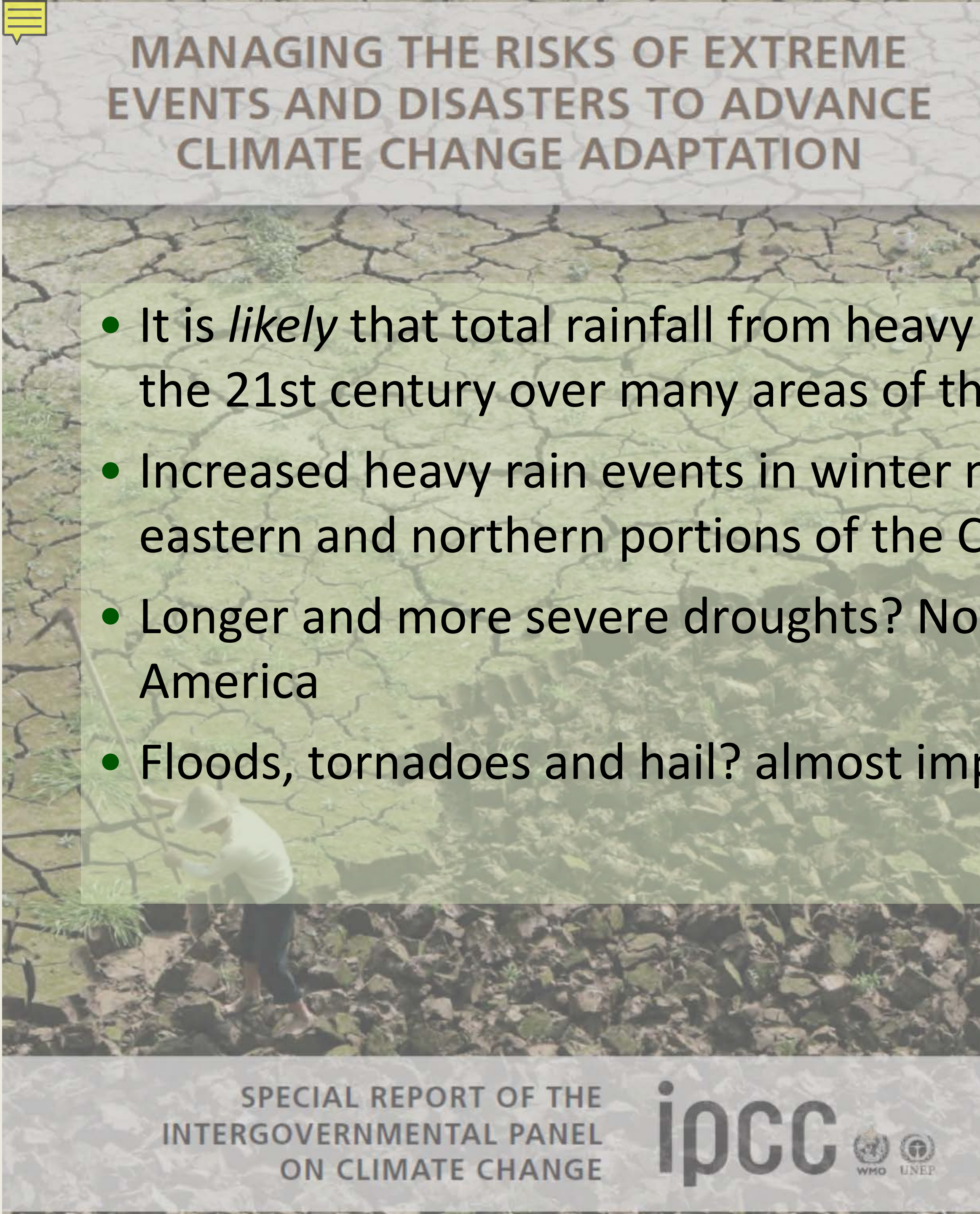
IPNI Mission:

"…to develop and promote scientific information about the responsible management of plant nutrition…"

Outline

- Climate Forecasts
  - IPCC SREX
  - Projections for tillage and cover crops
- Nitrogen-Climate Interactions Report
- Implication for plant nutrition
  - Source, rate, time and place
  - Farm, regional and policy levels
  - Adaptive management



IPCC SREX

594 pp

- It is *likely* that total rainfall from heavy rainfalls will increase in the 21st century over many areas of the globe
- Increased heavy rain events in winter months for most of the eastern and northern portions of the Corn Belt
- Longer and more severe droughts? Not in central North America
- Floods, tornadoes and hail? almost impossible to predict

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Magnitude

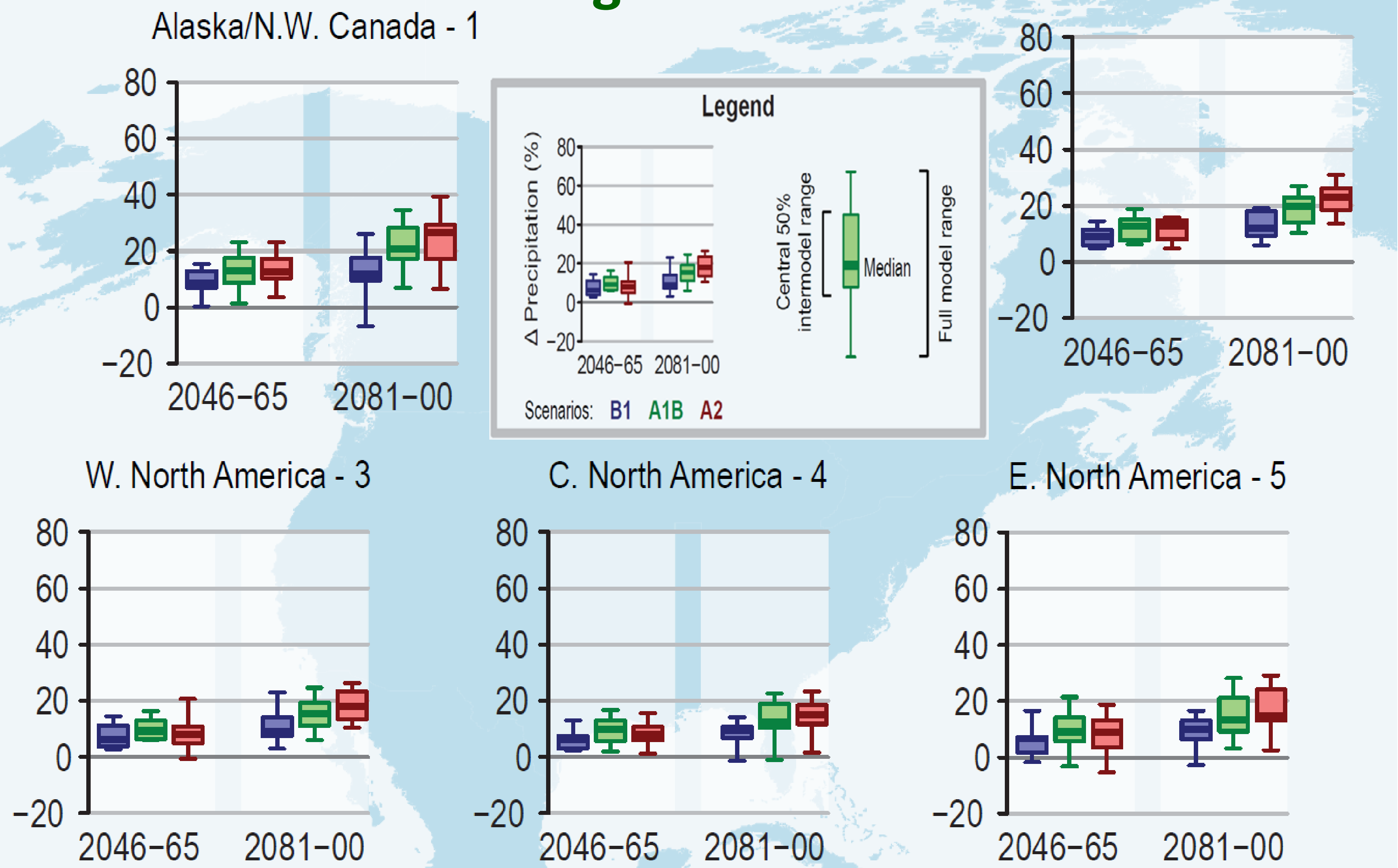
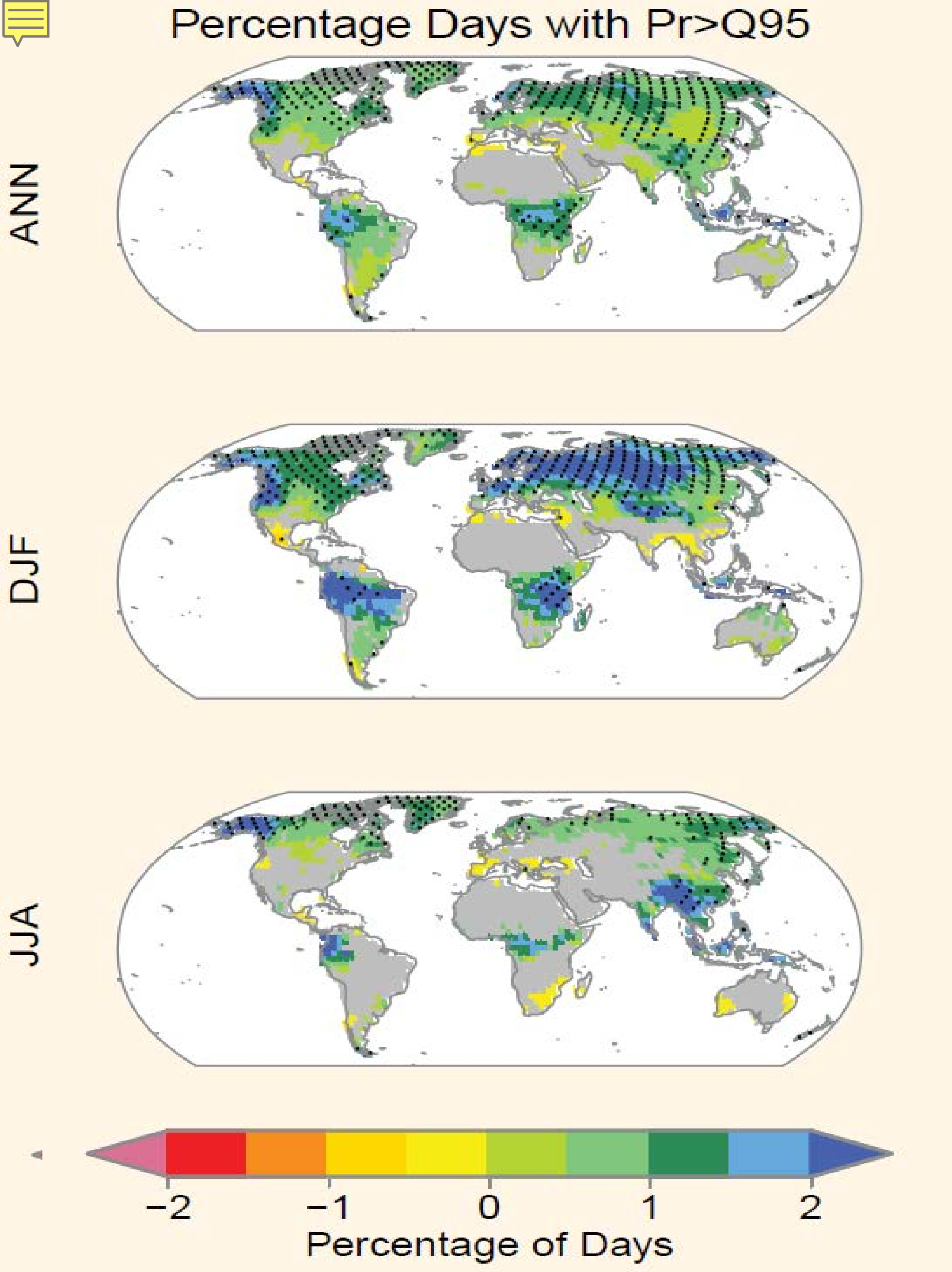


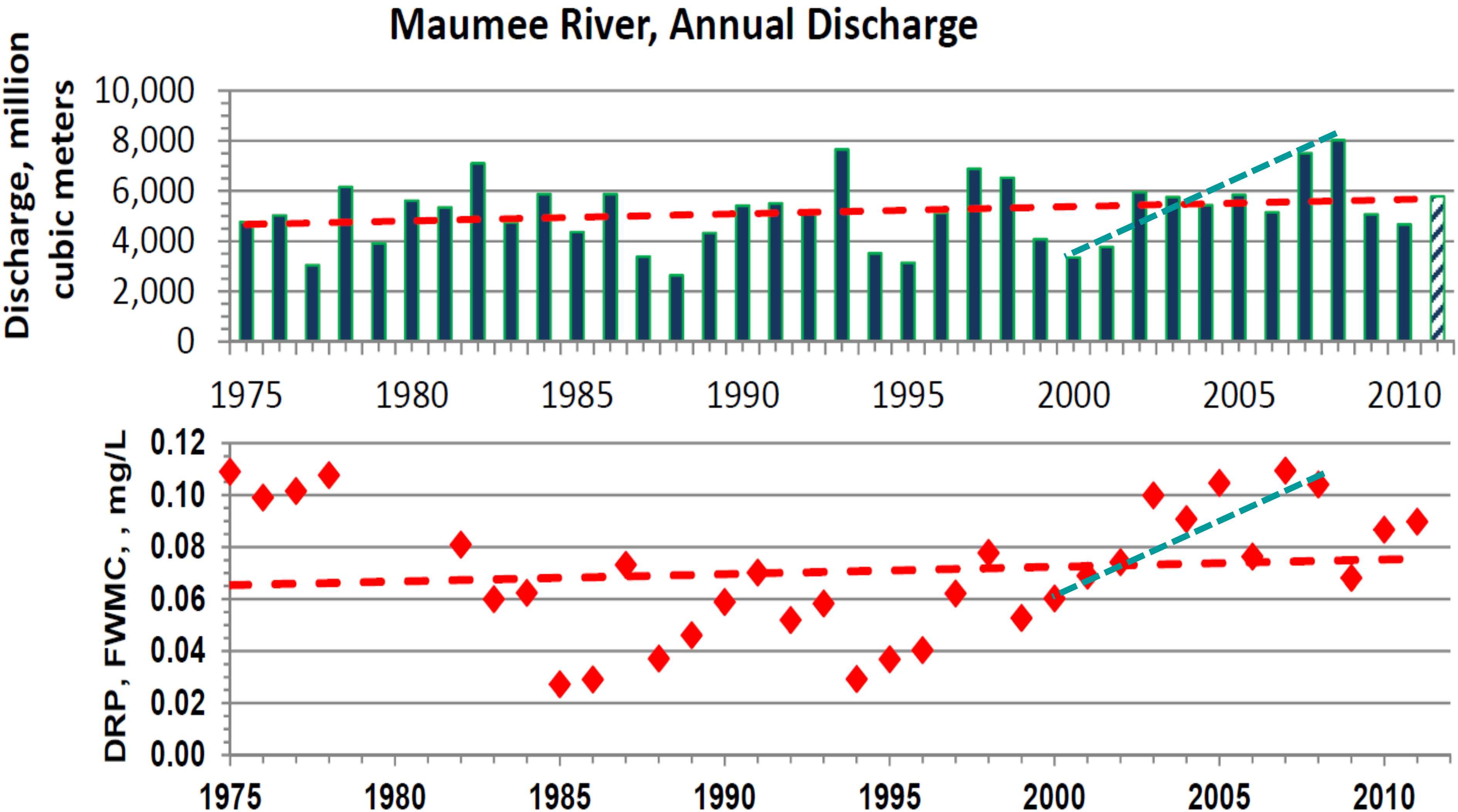
Figure 3-7a | Projected changes (%) in 20-year return values of annual maximum 24-hour precipitation rates, compared to 1981-2000 (IPCC, 2012).



More intense precipitation in winter

Figure 3-6 | Projected annual and seasonal changes in % of days with Pr > Quantile 95 for 2081-2100 with respect to 1980-1999, based on 17 GCMs contributing to the CMIP3 (IPCC, 2012).

Western Lake Erie Watershed

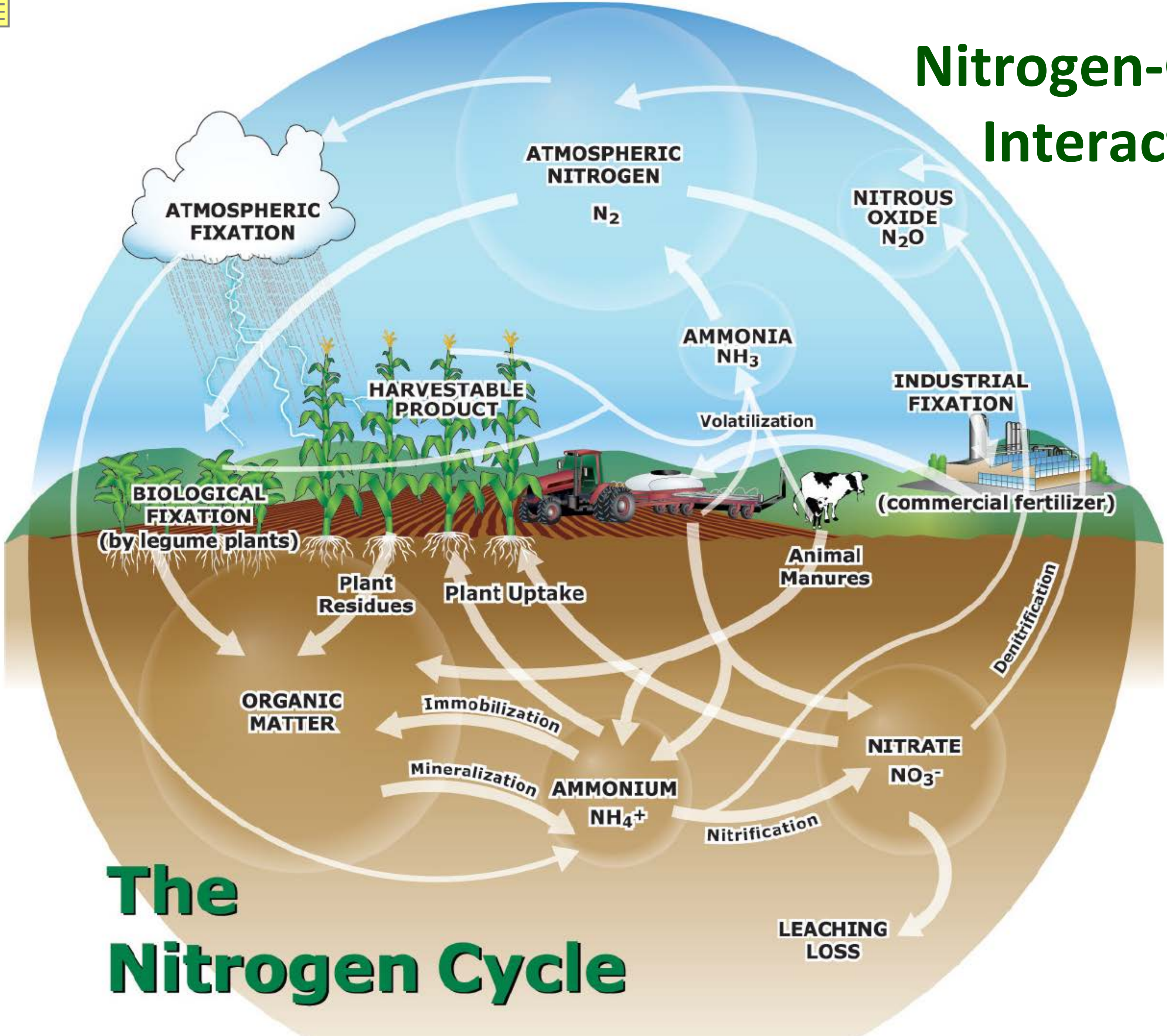


Baker, 2011, National Center for Water Quality Research, Heidelberg University

Climate change and crop yield

- **DSSAT models** predict 41% to 77% increases in biomass and yield of 'biofuel wheat' in southern Saskatchewan in the 2050s compared to 1961-1990, for IPCC A1B, A2 and B1 scenarios combined effects of increased temperature, precipitation and CO_2 (Wang et al., 2012, CJPS)
- **BUT** these models did not account for heat shock >32°C during grain filling

Nitrogen-Climate Interactions



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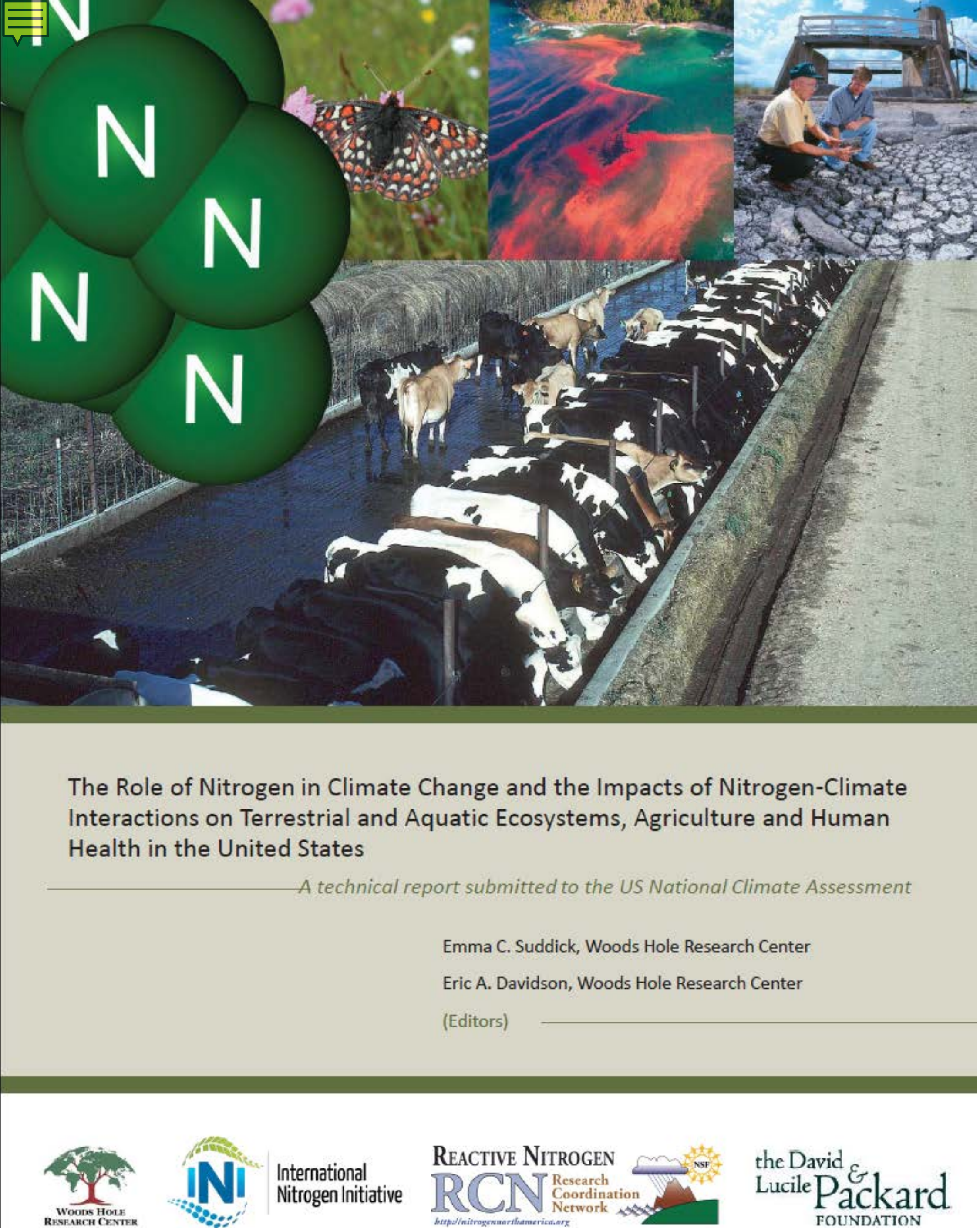
Nitrogen-Climate Interactions



- 7 chapters
- 208 pages
- "improved nutrient use management will be increasingly challenging under climate change scenarios of more variable climatic patterns"

Climate and soil organic N

- **Soil N mineralization** increased by temperature but reduced by higher C/N ratios (Brevik, 2012, Soil Horizons)
- **Nutrients:** "Soil C sequestration under elevated CO_2 is constrained both directly by N availability and indirectly by nutrients [P, K, Mo] needed to support N_2 fixation" (van Groenigen et al, 2006, PNAS)
- **Progressive N limitation:** "Soil N supply is probably an important constraint on global terrestrial responses to elevated CO_2" (Reich et al, 2006, Nature)
- **Air quality research:** Climate change to increase N deposition in eastern USA by 3 to 14% by 2055 (Civerolo et al, 2008, Atmos Environ)

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Climate change and water quality

- **Prince Edward Island:** nitrate leaching not affected more than 1% by future climate scenarios for 2040-2069, but increases 5 to 30% with more corn and soybeans, less pasture (DeJong et al, 2008, CJSS).
- **Sweden:** "Simulations… indicated an increased rate of N mineralisation (+2 kg ha^{-1} $year^{-1}$) and increased N leaching to the drain pipes (+0.06 kg ha^{-1} $year^{-1}$) as a result of climate change" (Ulén and Johansson, 2009).
- **Chesapeake Bay:** "Assuming that farmers do not respond to changes in temperature, precipitation, and atmospheric CO_2 levels could lead to mistaken conclusions about the magnitude and direction of environmental impacts" (Abler et al, 2002).

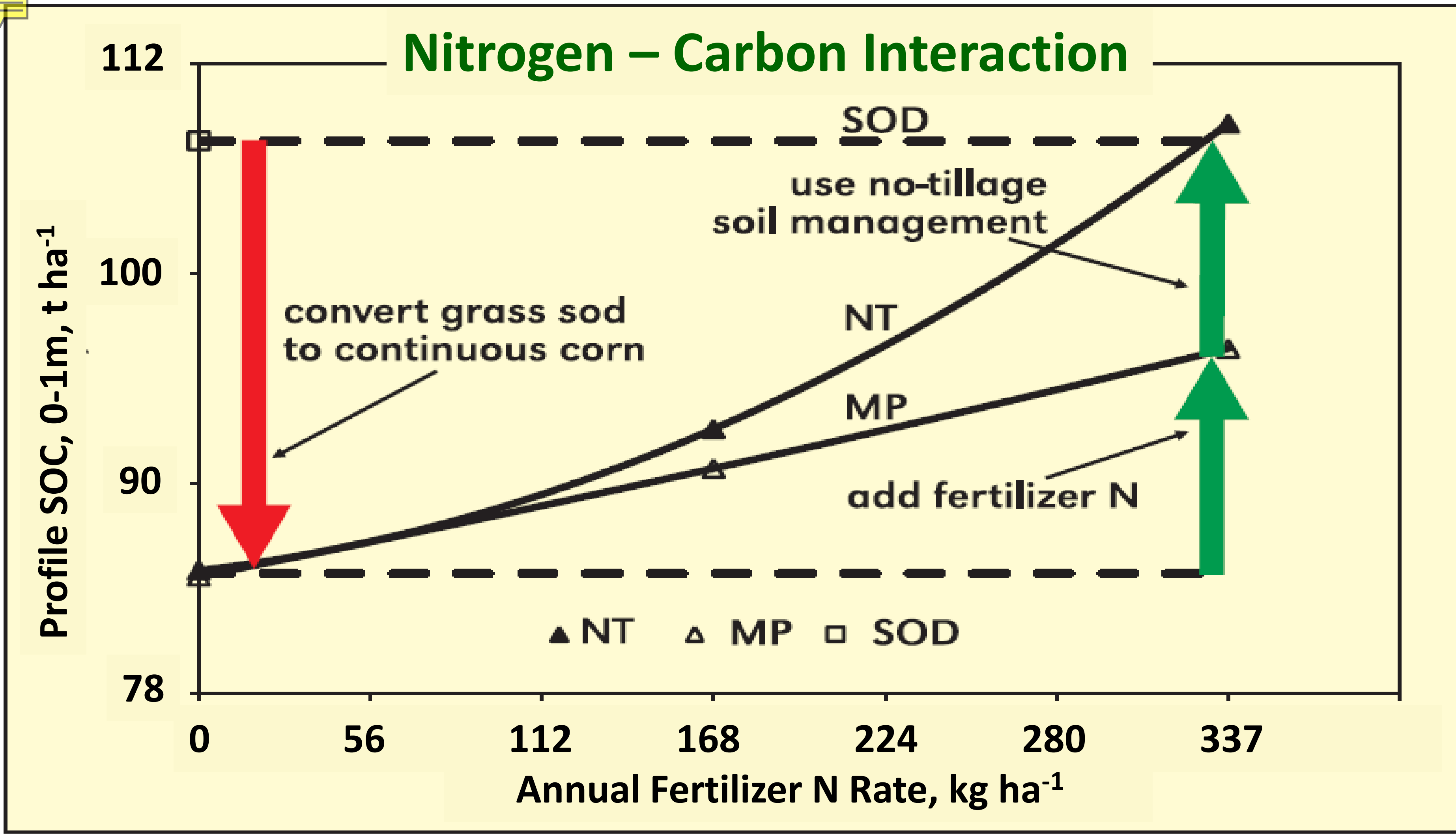

Figure 5. The impact of fertilizer N on total profile SOC levels found after 39 years of cropping to continuous corn with a winter cereal cover crop.

Grove et al. 2009. Better Crops with Plant Food 93(4):6-8 – Kentucky, USA

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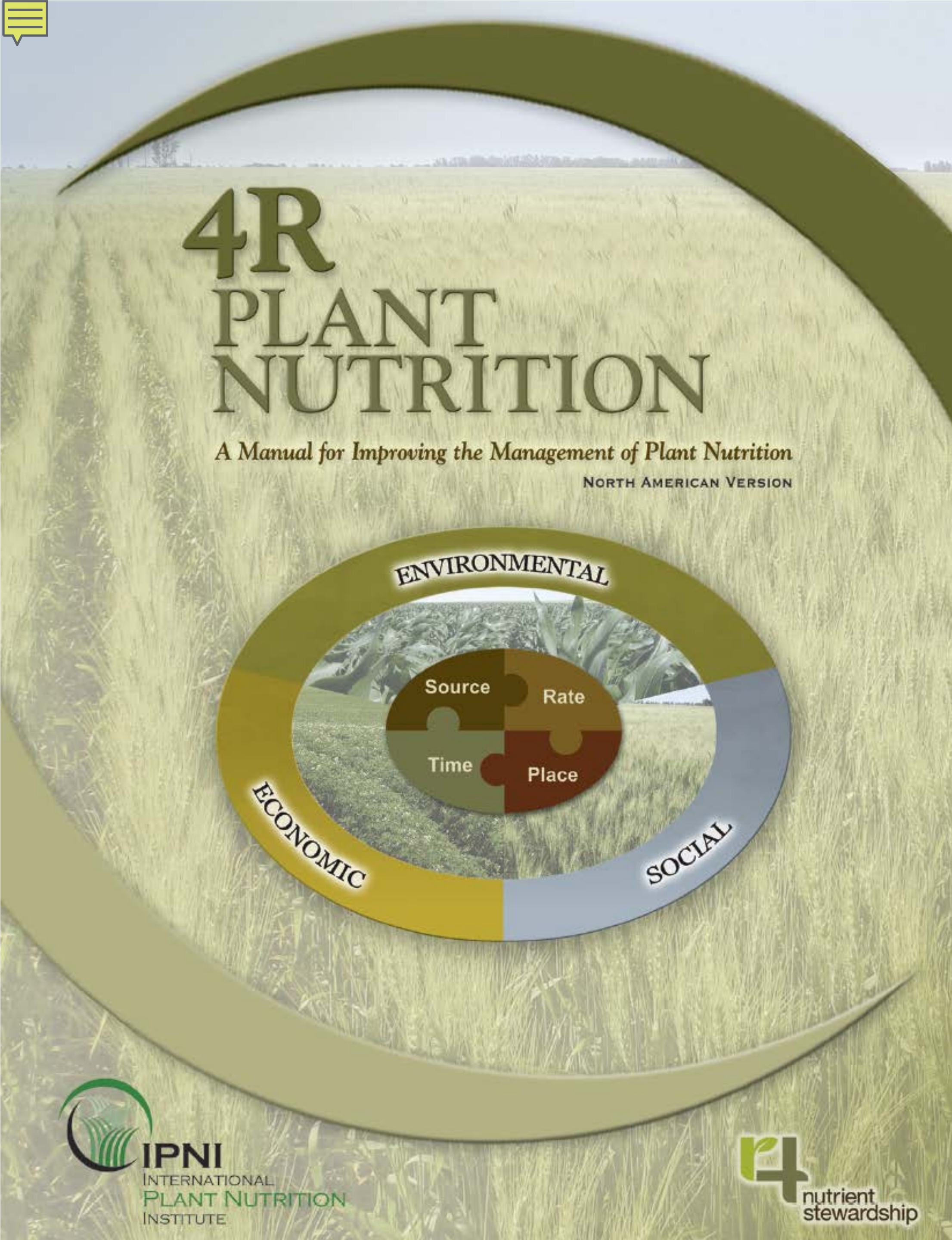
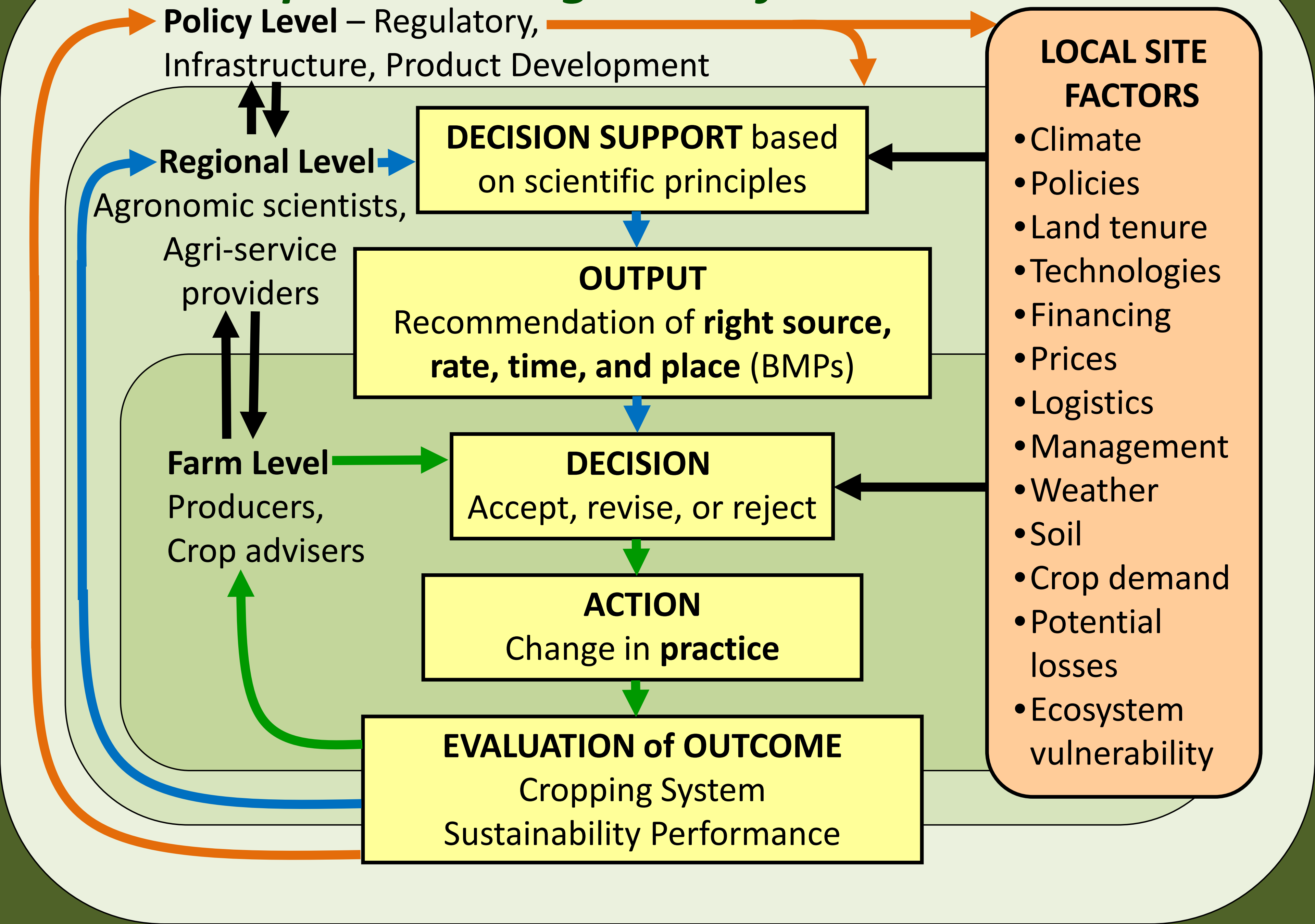


http://nane.ipni.net

4R Adaptive Management for Plant Nutrition



4R Context

- Changing climate will change the mix of crops and rotations, production potentials, and opportunities for cover crops.
- More intense winter rain could lead to greater importance for conservation tillage and cover crops.
- Implications for source, rate, time and place of nutrient application.

Right Source

- **Form:** rising [CO_2] and implications for NH_4^+ versus NO_3^-
- Plant dependence on NH_4^+ versus NO_3^- changes with [CO_2] (Bloom et al, 2002; Epstein and Bloom, 2005)
- If preference for NH_4^+ increases, greater crop response may be expected from:
  - nitrification inhibitors (nitrapyrin, dicyandiamide)
  - other means of slowing the conversion of ammonium to nitrate (urease inhibitors, polymer coated urea, later time of application)
- Adapting to higher [CO_2] could thus lead to less nitrate leaching
- Forms suitable for placement in conservation tillage

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Right Rate

- Proportional to crop demand
- Will attainable crop yield be harder to predict?
- Adapting N rates to weather:
  - More variable crop yield and rainfall-related N losses may make it more important.
  - Cover crop response to surplus N may make it less important.

Right Time

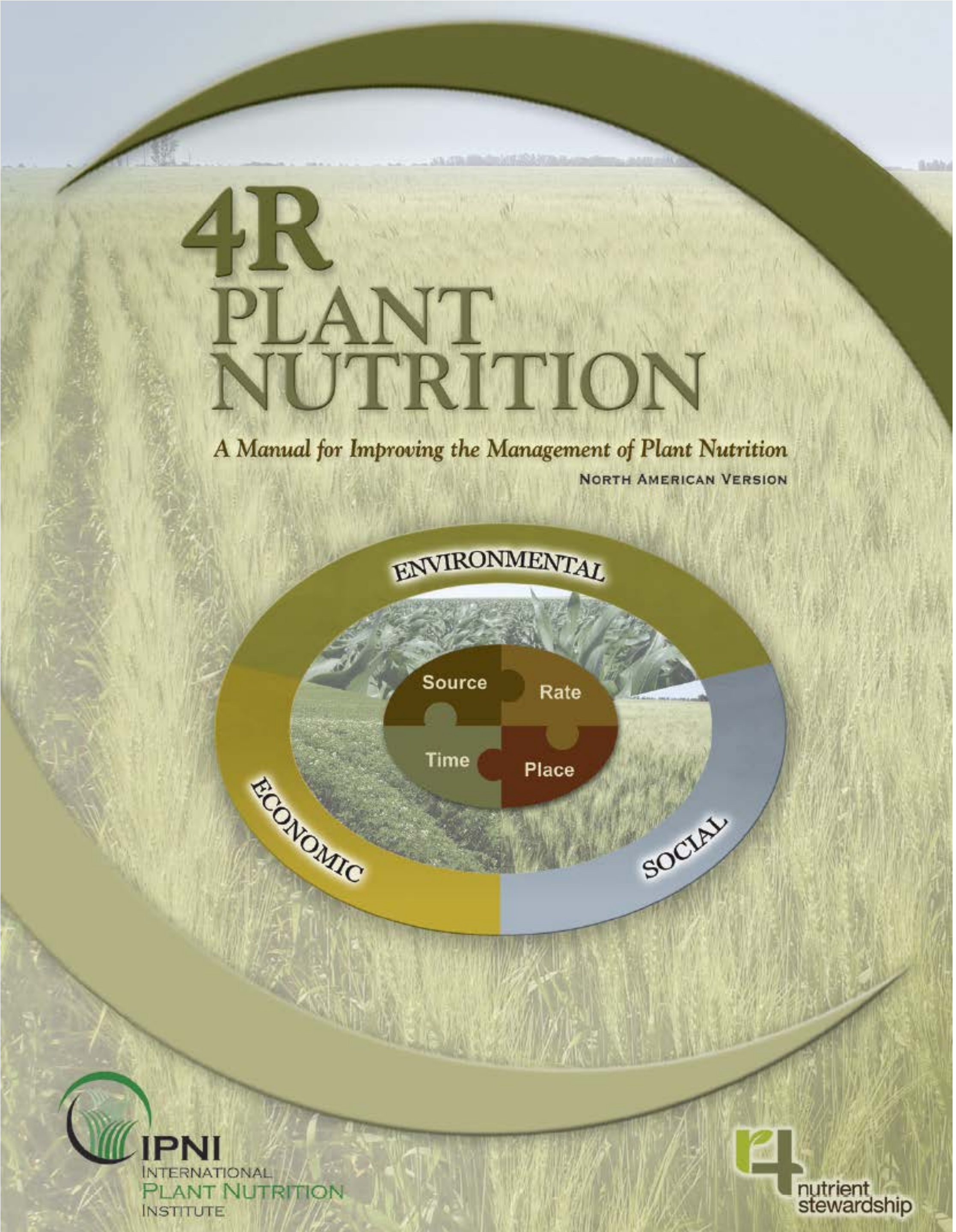
- If winter rains are more intense, fall application, even for P and K, may be less effective
- If crop yields are more variable, more benefit to split applications [more decision points]

Right Place

- If winter rains are more frequent and intense:
  - More impact on water quality from:
    - Fall-applied P left on the surface
    - Stratification of P in soil
  - More benefit from band-applied P

Summary

- Adaptation to a warmer climate with enriched CO_2 and more intense rainstorms will require us to adapt source, rate, time and place of nutrient application to conservation soil management (tillage, fertility and organic matter).
  - More emphasis on source, timing and placement options.
  - More emphasis on including weather—past, current, and forecast—in decision support for crop nutrition.



Comments Welcome

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