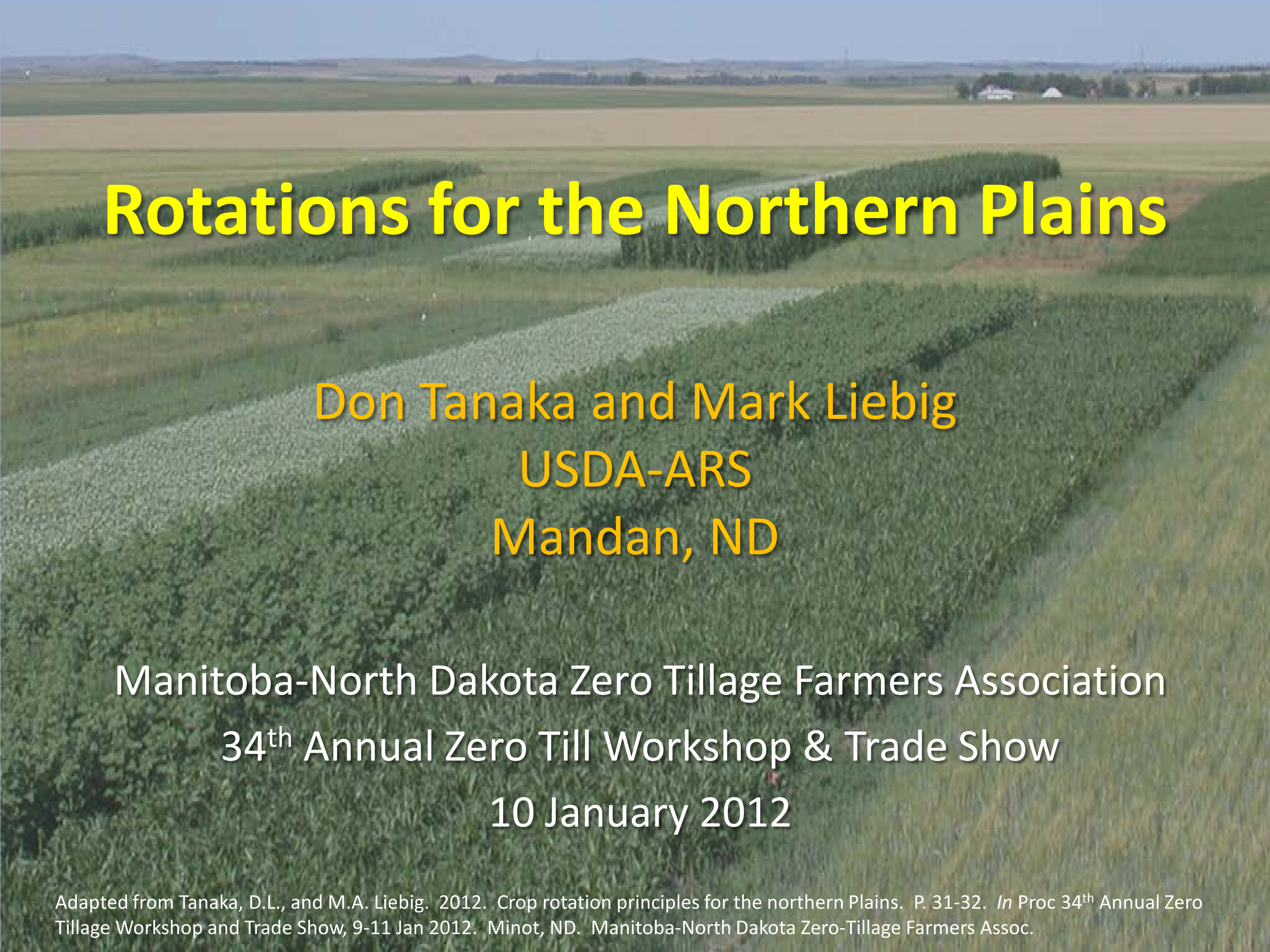


Rotations for the Northern Plains

Don Tanaka and Mark Liebig
USDA-ARS
Mandan, ND

Manitoba-North Dakota Zero Tillage Farmers Association
34th Annual Zero Till Workshop & Trade Show
10 January 2012

Adapted from Tanaka, D.L., and M.A. Liebig. 2012. Crop rotation principles for the northern Plains. P. 31-32. *In* Proc 34th Annual Zero Tillage Workshop and Trade Show, 9-11 Jan 2012. Minot, ND. Manitoba-North Dakota Zero-Tillage Farmers Assoc.

Overview

- Crop rotations in context
- Principles of sustainable crop sequencing
- Case study results from the Area IV SCD Cooperative Research Farm

Crop Rotations in the Northern Plains

Pre-European Settlement

- **Mandan, Hidatsa, Arikara**
  - Corn, bean, and squash (Three Sisters); sunflower, tobacco
- **Strategies for success**
  - Diversity
  - Recycling
  - Limited cultivation
  - Moisture conservation
  - Regional adaptation

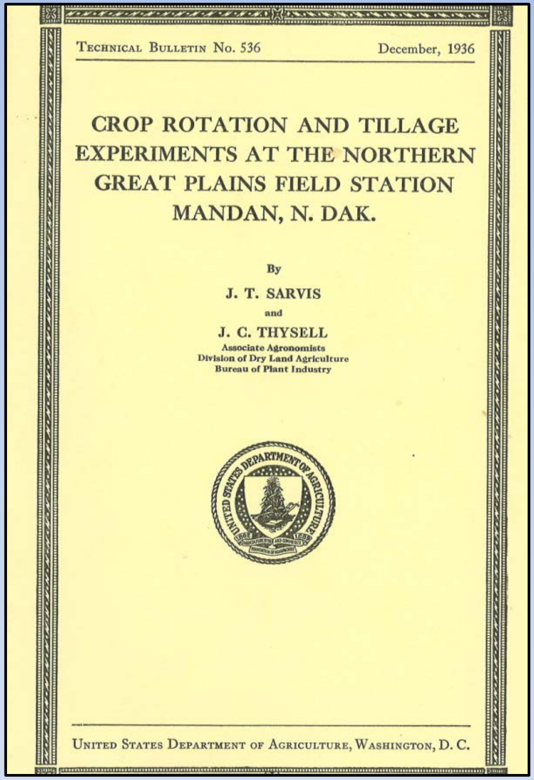
Kirschenmann, 2010

Crop Rotations in the Northern Plains

Post-European Settlement

Crop Rotations in the Northern Plains

- **Crop portfolio:** Flax, spring wheat, barley, oat, corn, alfalfa, bromegrass, potato…
  - Moisture retention a significant issue.
  - Erosion; Fertility depletion


Technical Bulletin No. 536 December, 1936

CROP ROTATION AND TILLAGE EXPERIMENTS AT THE NORTHERN GREAT PLAINS FIELD STATION MANDAN, N. DAK.

By

J. T. SARVIS

and

J. C. THYSELL

Associate Agronomists

Division of Dry Land Agriculture

Bureau of Plant Industry

United States Department of Agriculture, Washington, D. C.

"Crop growing is hazardous in regions of limited rainfall… …The country is better adapted to a mixed type of farming than to straight grain farming." (Page 72)

Crop Rotations in the Northern Plains

- **Spring wheat – fallow**
  - Water-use efficiency ≤40%
  - Declining soil health

- - Weed and Residue Management Technology - -

- **Opportunity/Flex crop rotations**
- **Annual sequencing**
  - Fixed or dynamic

Crop Rotations in the Northern Plains

- **Fixed sequencing**
  - Limited flexibility to address challenges/opportunities
  - Can lead to weed, insect, and disease infestations over time
- **Dynamic sequencing**
  - Decisions made annually based on externalities as well as management goals

DP-SW-C-SF

C-SB

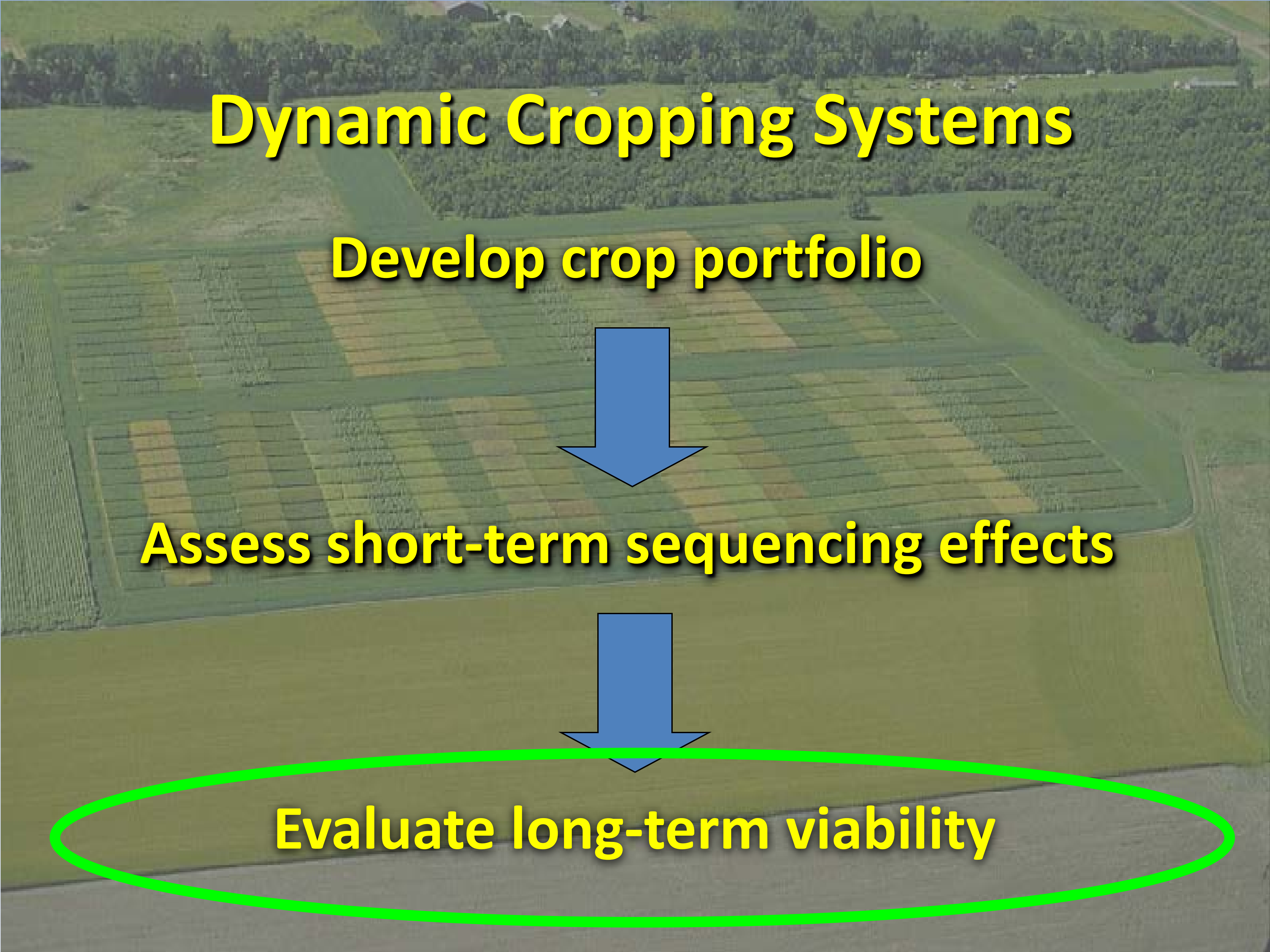
WW-C-DP

SW-SW-C-C-SB-SB

B-CA-SW-DP

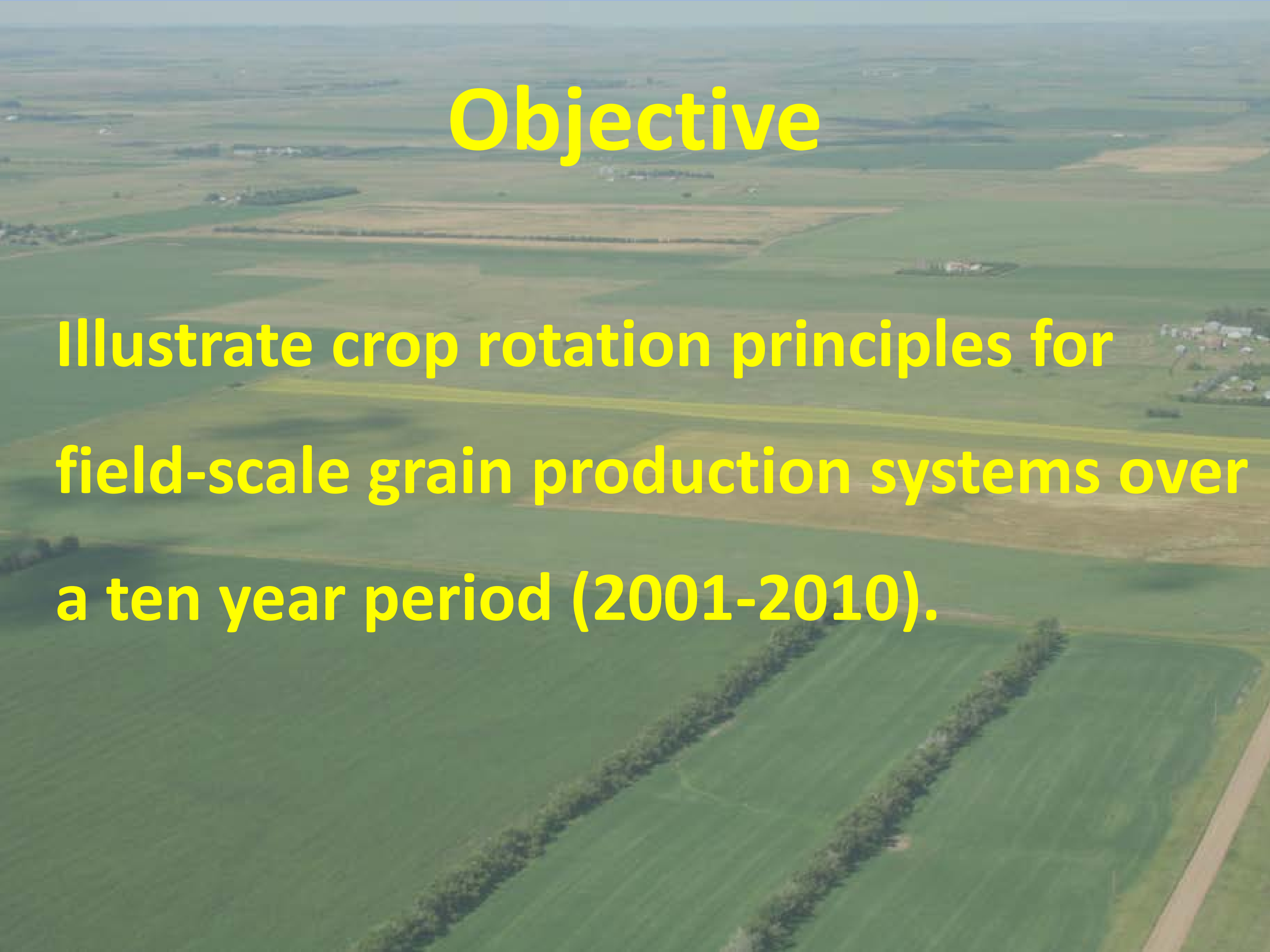
SW-CA

From Hanson et al. (2007)	Monoculture	Fixed-Sequence Rotations	Dynamic Cropping Systems
Crop portfolio	Single crop	Multiple crops; number dependent on regionally adapted species, economics, farmer knowledge, infrastructure	Multiple crops; number dependent on regionally adapted species, economics, farmer knowledge, infrastructure
Crop diversity	N/A	Diversity dependent upon length of fixed sequence	Diversity inherently high due to annual variation in growing conditions and marketing opportunities, as well as changes in producer goals
Crop sequencing flexibility	N/A	None, although fixed-sequence cropping systems that incorporate opportunity crops increase flexibility	High. All crops, in essence, are opportunity crops
Biological and ecological knowledge	Basic knowledge of agronomy	Some knowledge of crop interactions is necessary	Extended knowledge of complex, multi-year crop and crop by environment interactions
Management complexity	Generally low, though variable depending on crop type	Complexity variable depending on length of fixed sequence and diversity of crops grown	Complexity inherently high due to annual variation in growing conditions, markets, and producer goals


Dynamic Cropping Systems
Develop crop portfolio
Assess short-term sequencing effects
Evaluate long-term viability

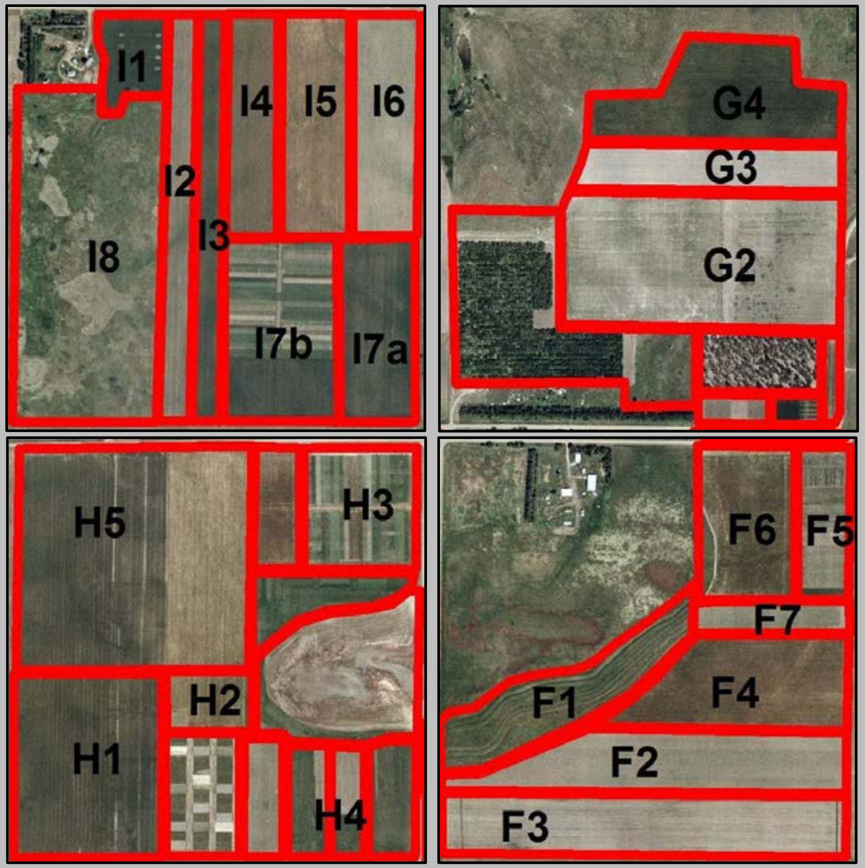
Objective

Illustrate crop rotation principles for field-scale grain production systems over a ten year period (2001-2010).



Location

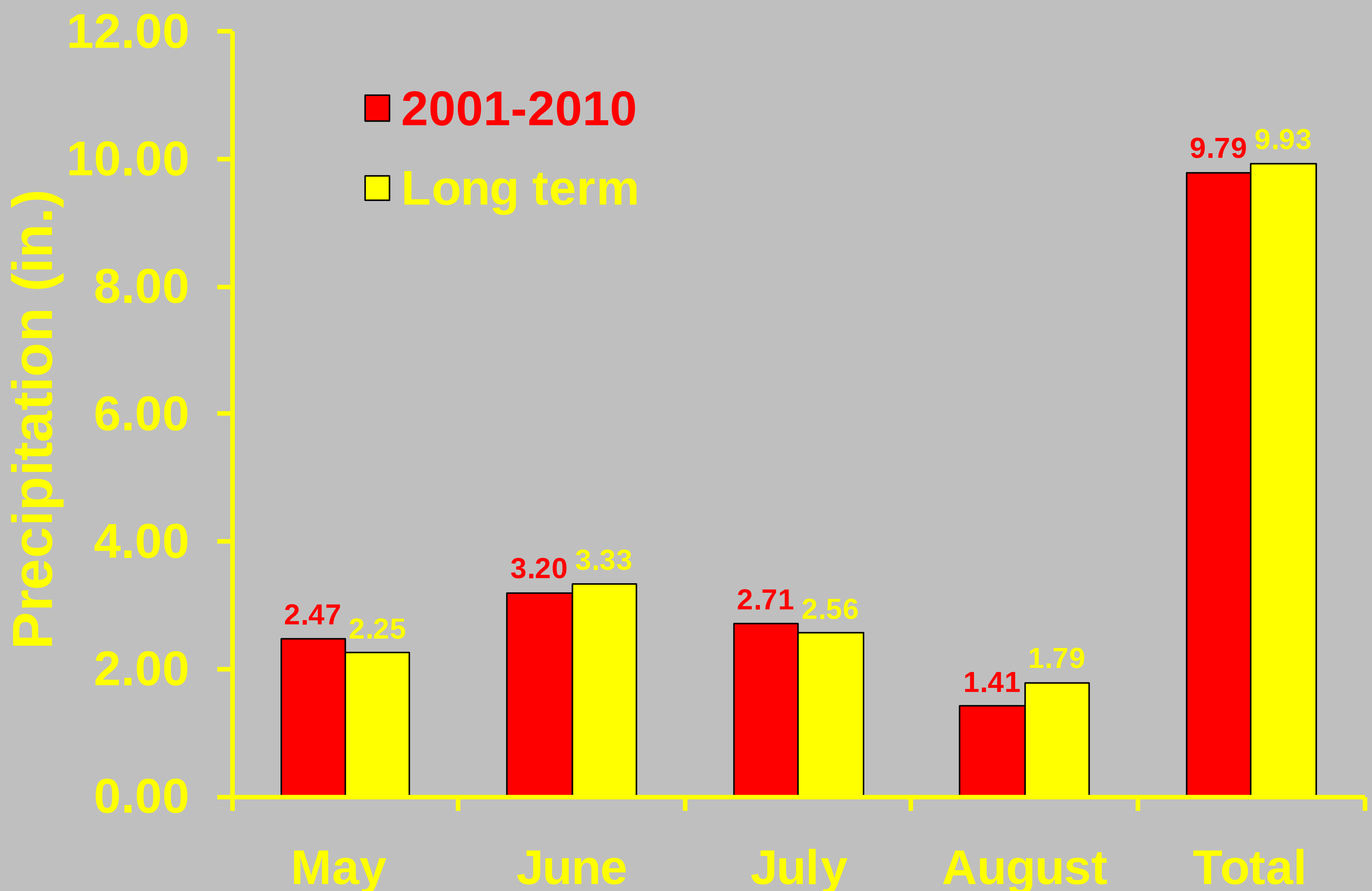
- SW of Mandan, ND
- Area IV SCD Cooperative Research Farm (1984-present)
- Four quarter sections (F, G, H, I)
- Approximately 400 acres.



Soil and Landscape

- Evaluations were conducted on a nearly level (0-3% slope) Temvik-Wilton silt loam.
- The Temvik-Wilton series consists of very deep, well drained soils that formed in a silty loess mantle overlying glacial till.
- Fine-silty, mixed, superactive, frigid Typic and Pachic Haplustolls

Growing Season Precipitation



Field Management

- No-till management
- 750, 7340 JD seeders
- Weed control via pre- and post-emergent herbicide
- N and P adjusted to crop need and residual fertility.

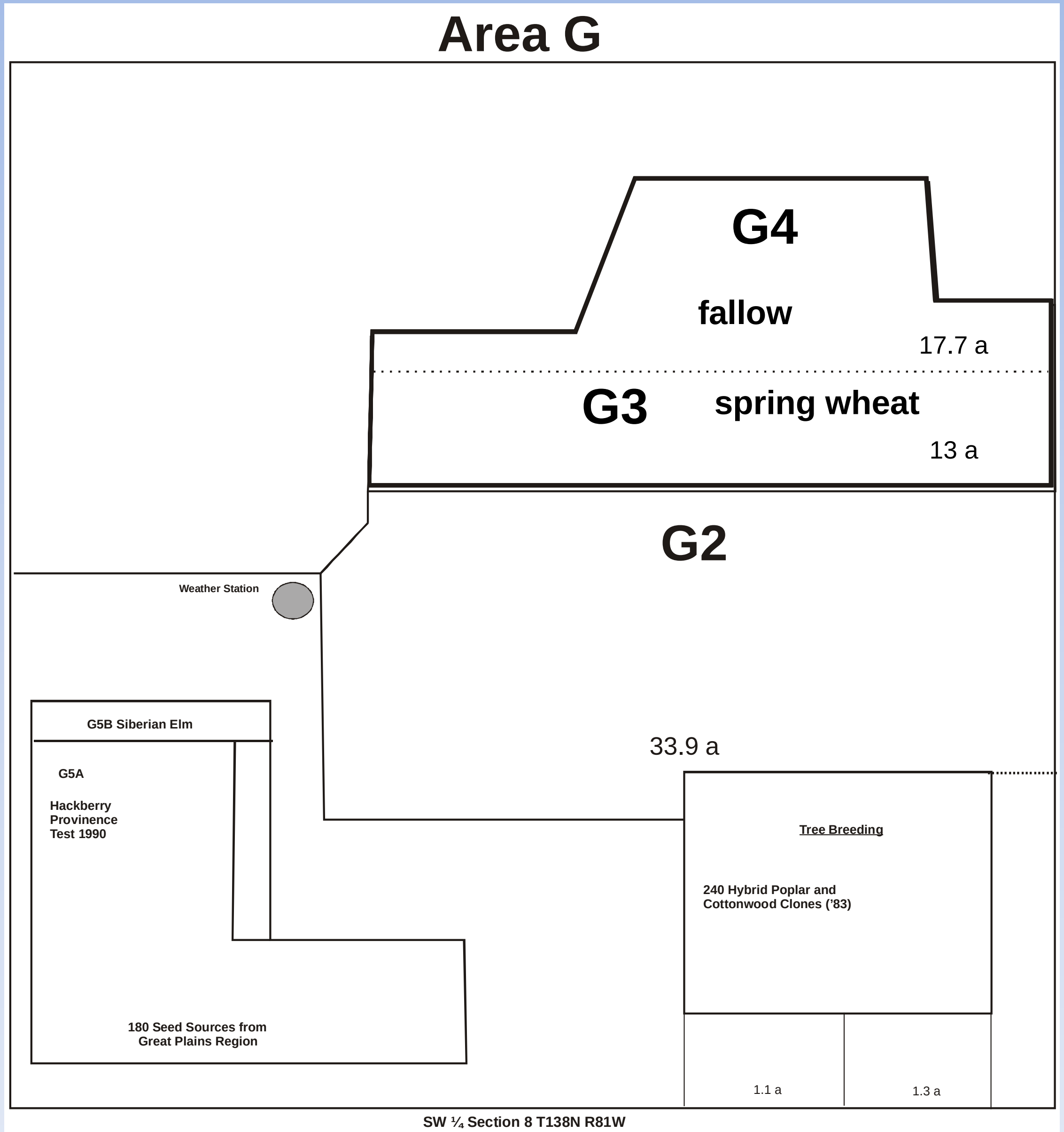
Cropping Systems

Cereal crop – Fallow

(2 yr system, G4 & G3)

26 yrs

Crop – Fallow System



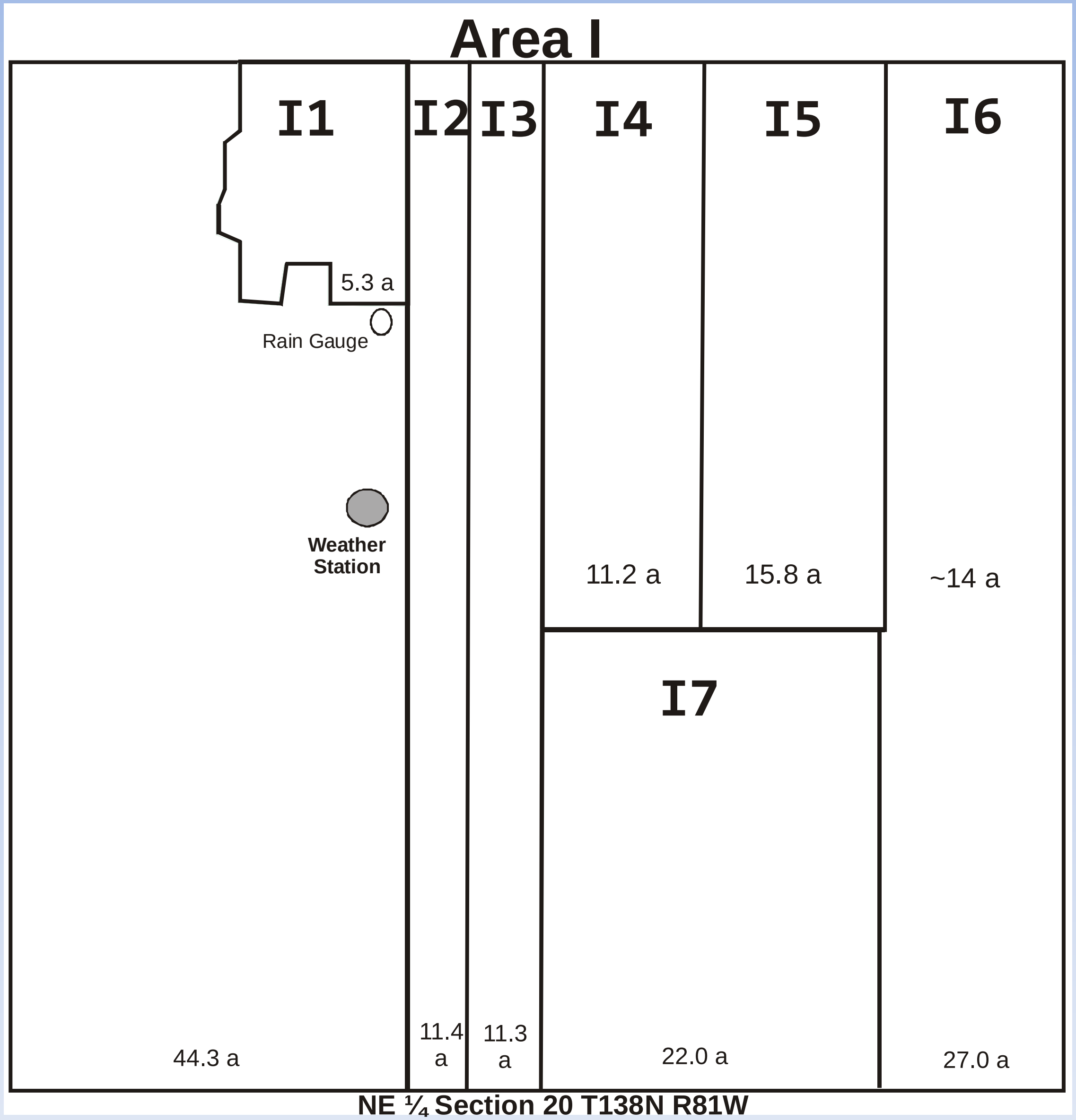
Cropping Systems

Continuous spring wheat

(monoculture, I1)

26 yrs

Continuous Wheat



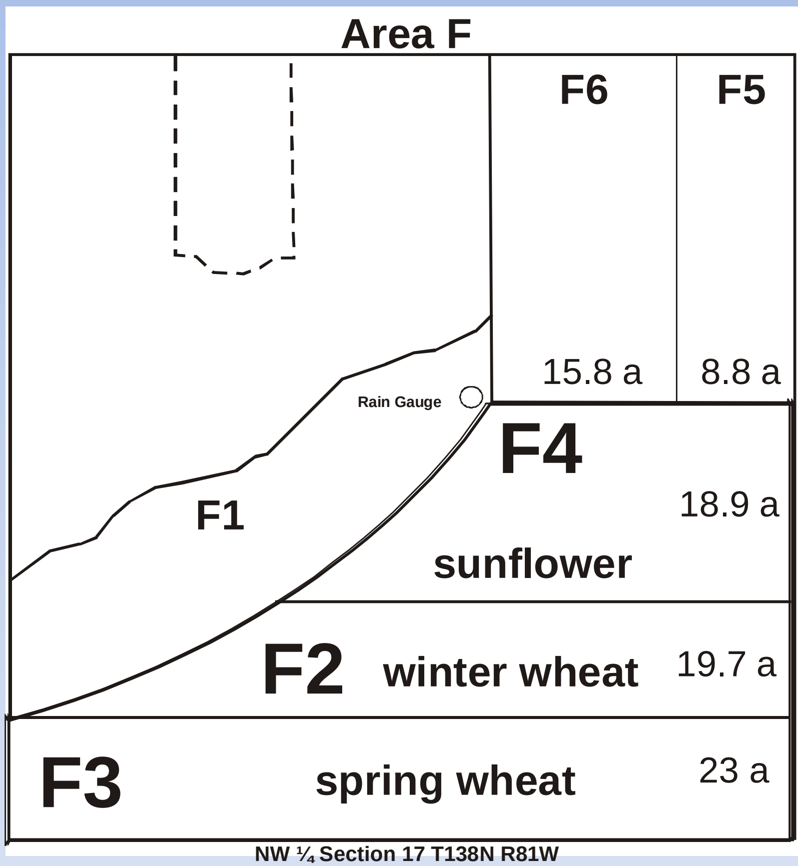
Cropping Systems

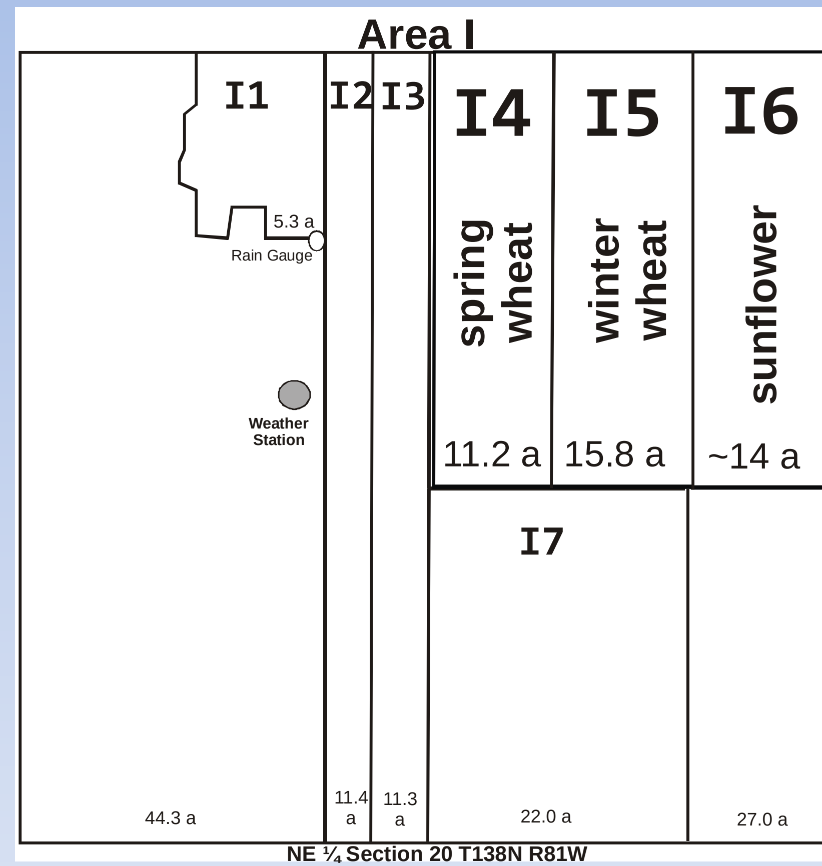
Spring cereal - winter wheat - sunflower

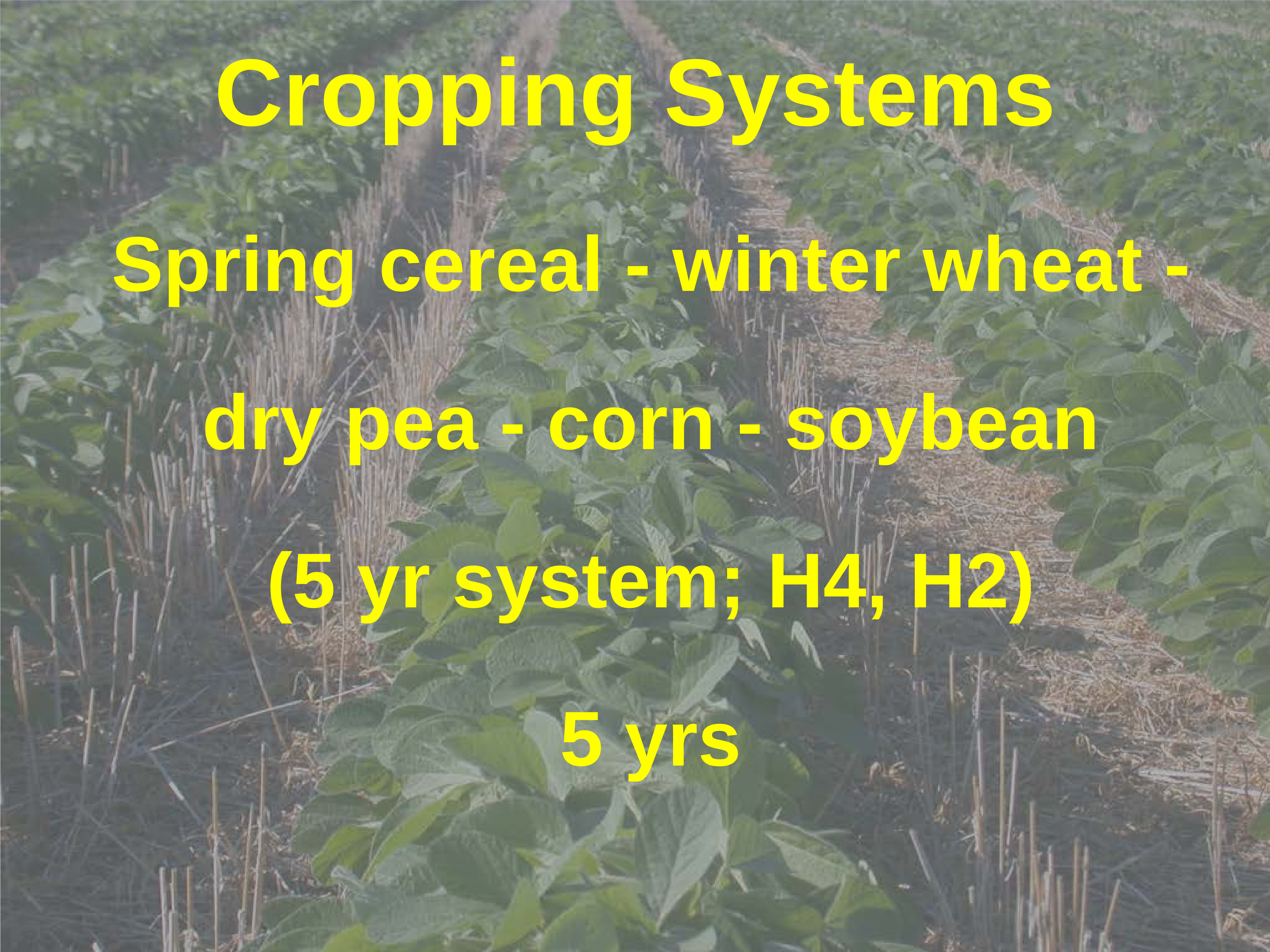
(3 yr system; F3, F2, F4 and I4, I5, I6)

26 yrs

3 Year System







Cropping Systems

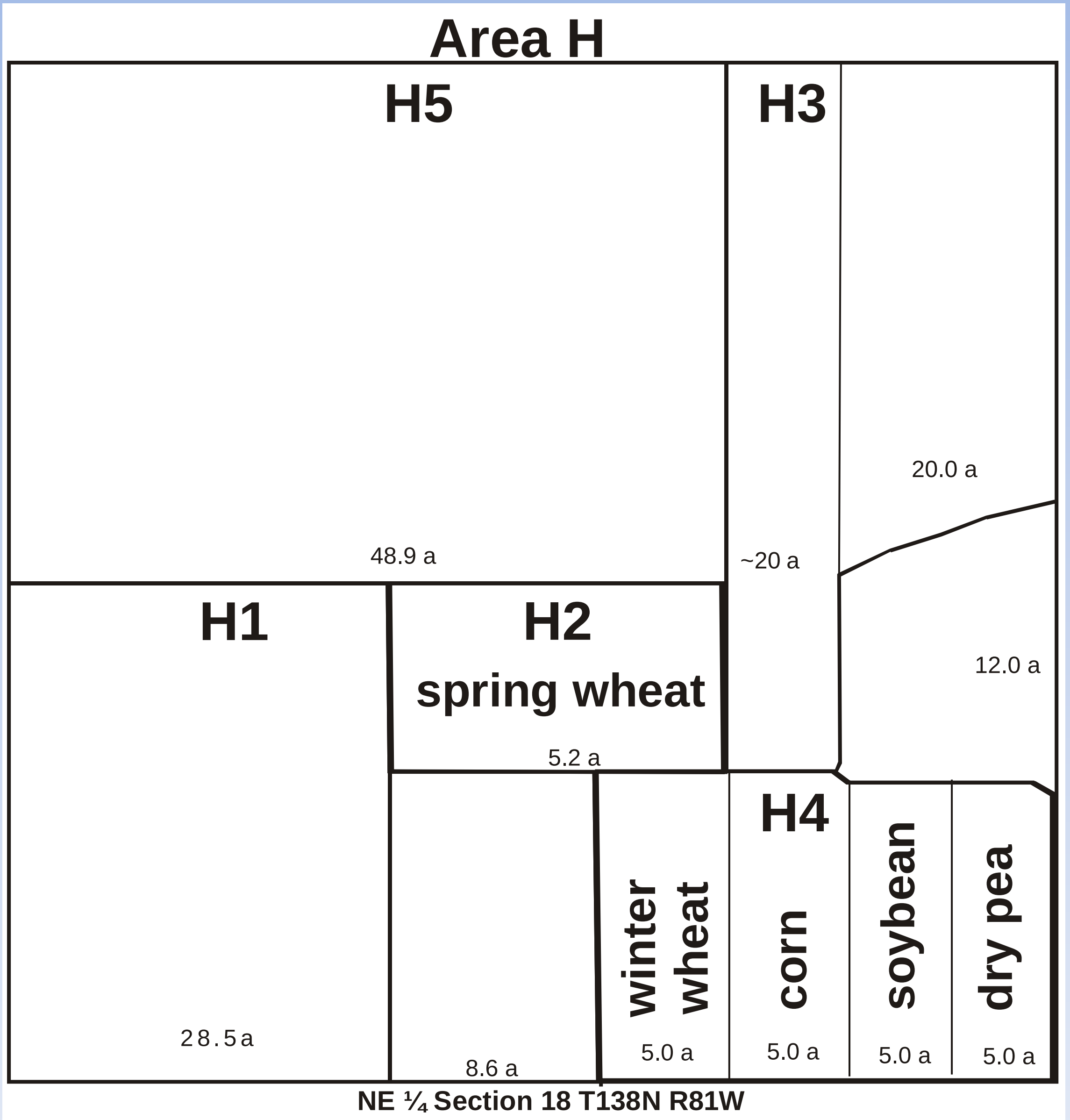
Spring cereal - winter wheat -

dry pea - corn - soybean

(5 yr system; H4, H2)

5 yrs

5 Year System



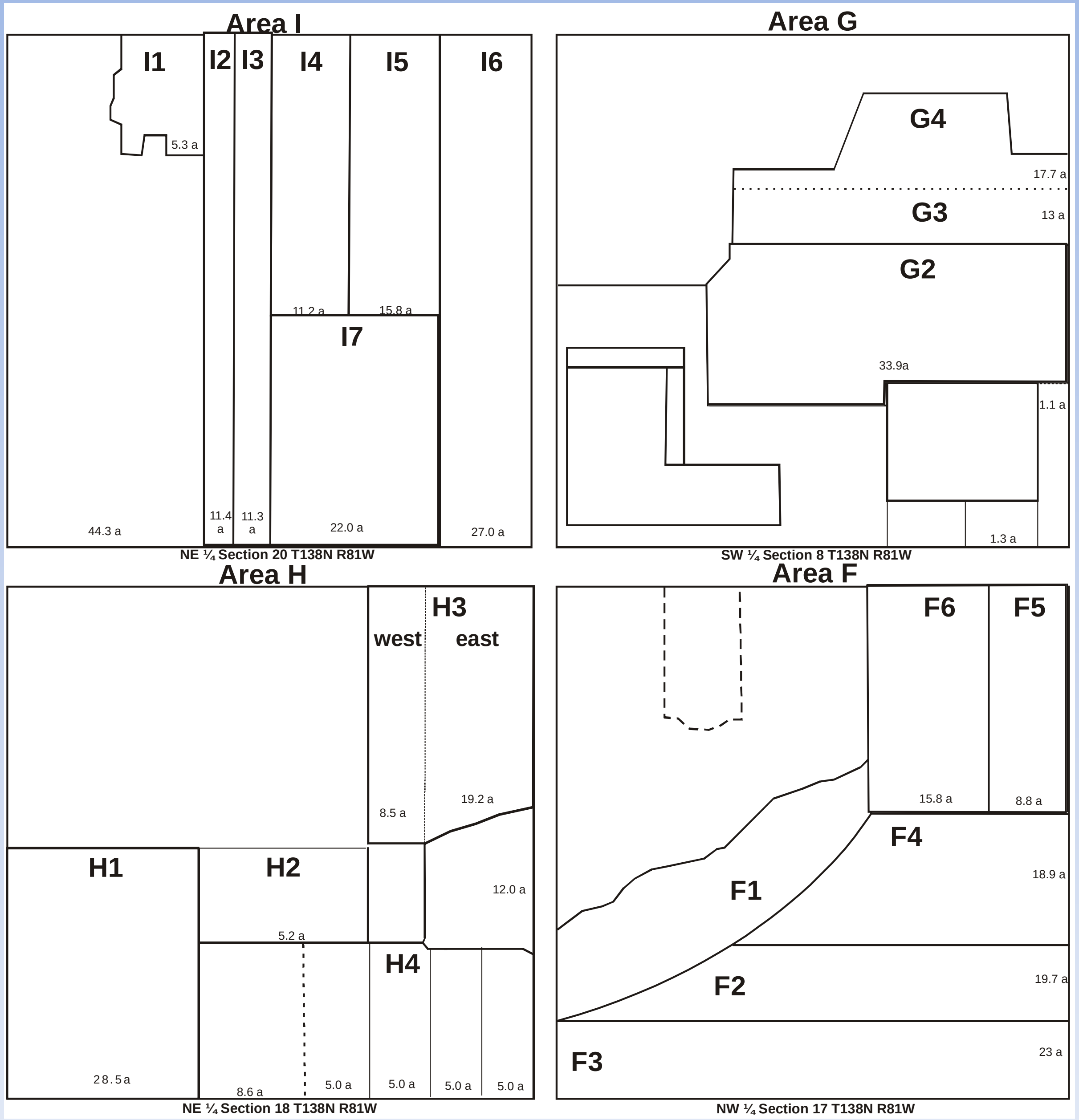
Cropping Systems

Dynamic Cropping System

(long-term systems; H1, H3, F5, F6, G2, I2, I3, I7)

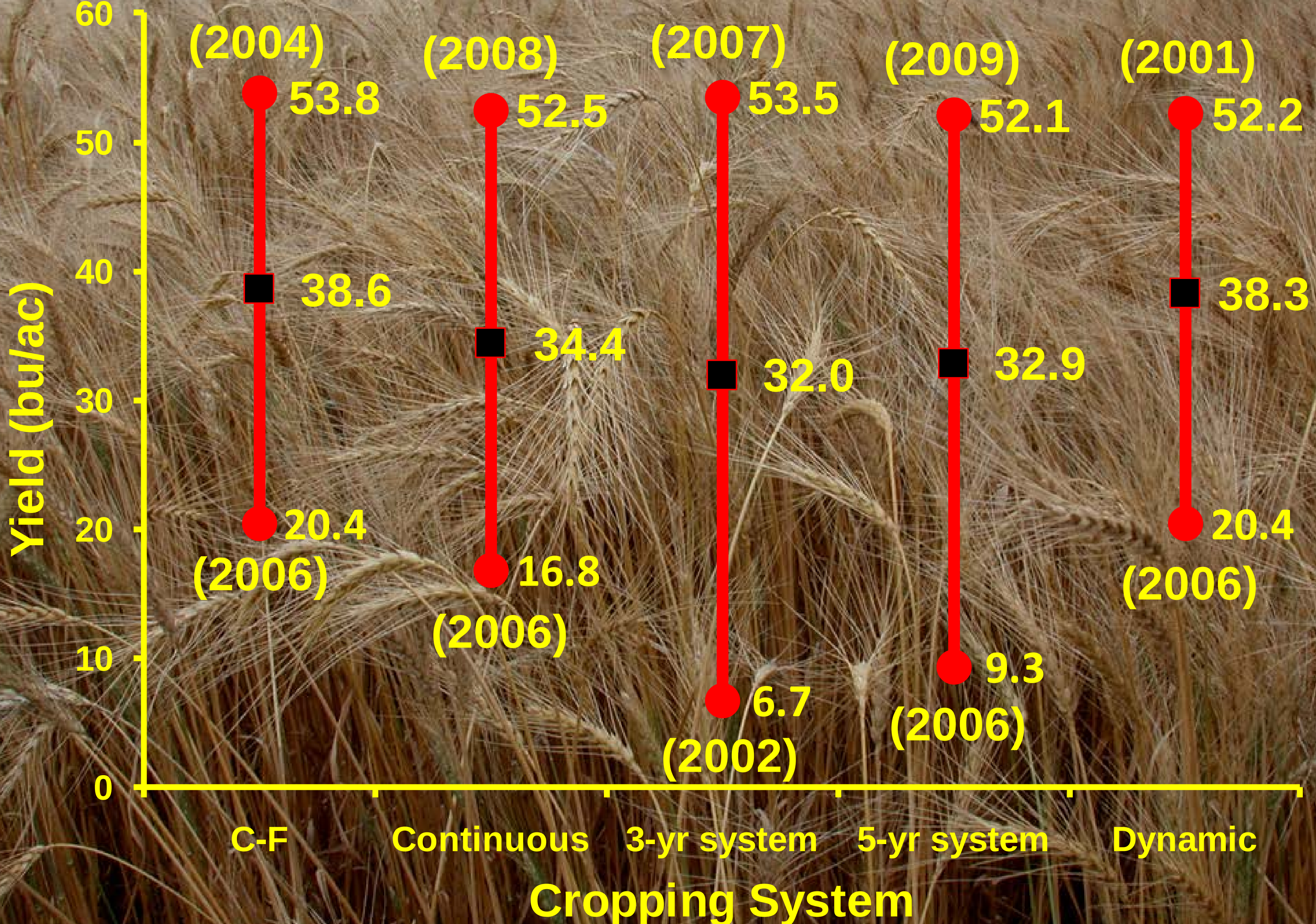
10 yrs

Dynamic System

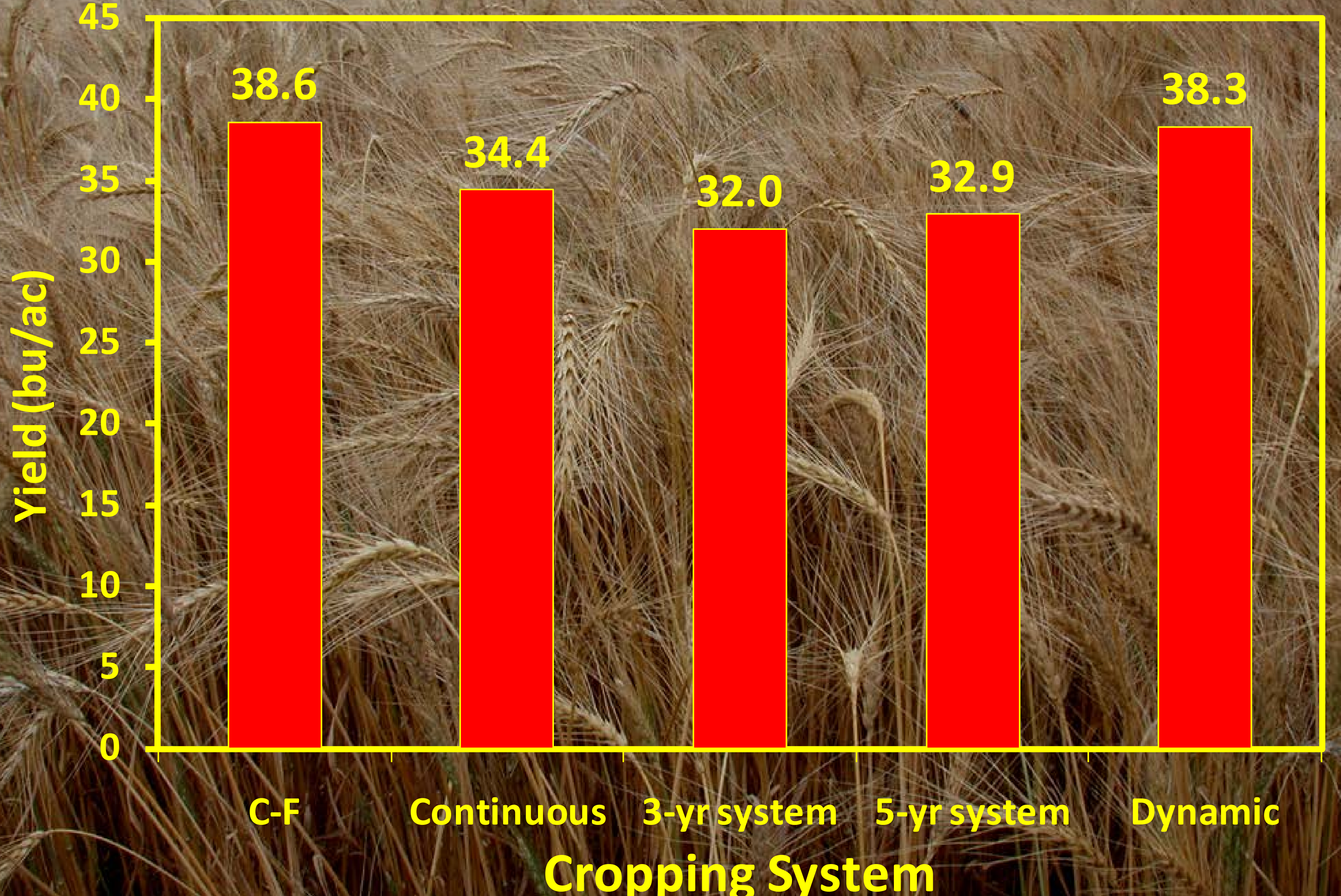



Used spring wheat as indicator crop
10 yr (2001-2010)

System range in crop yields



Spring wheat average yield

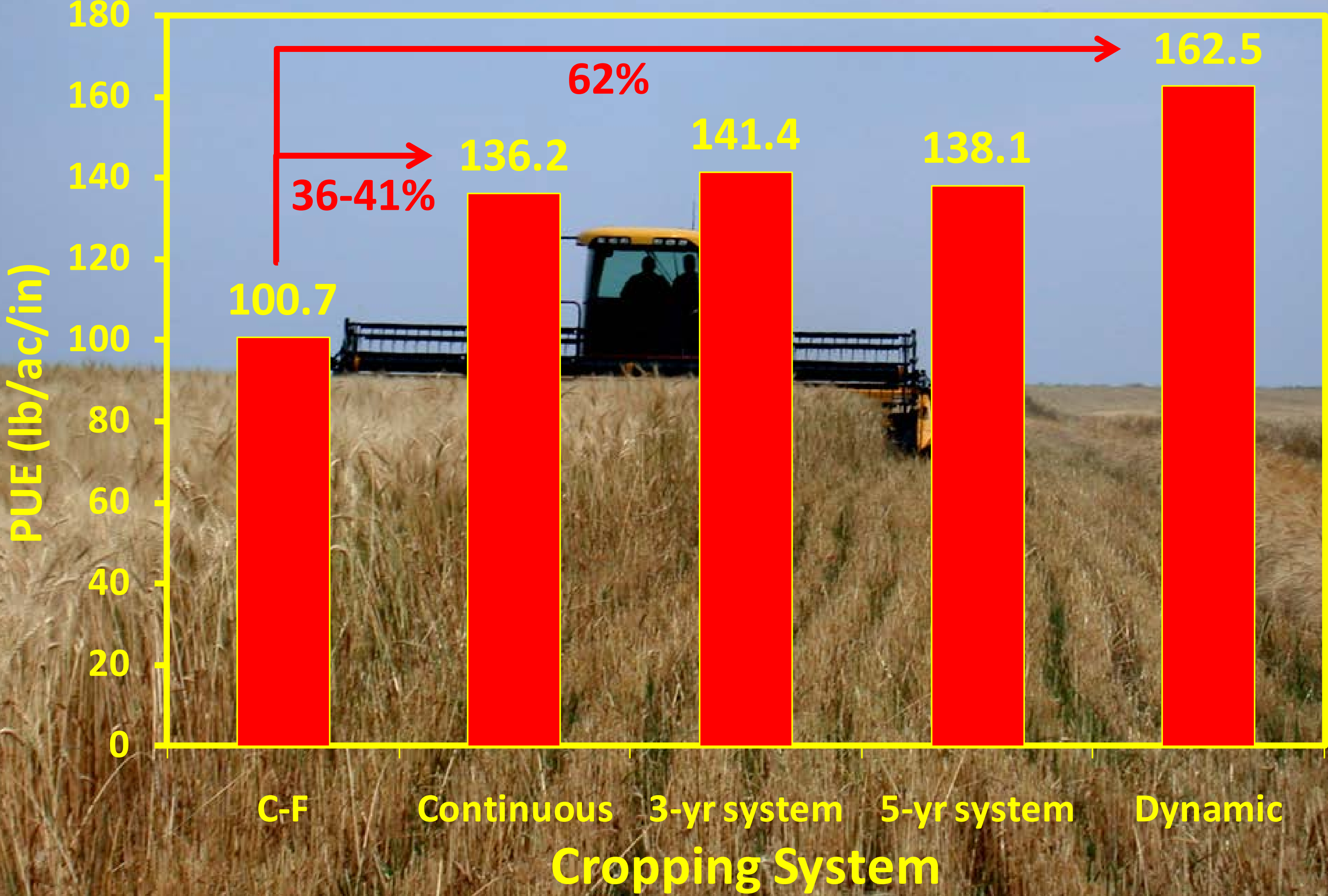


Precipitation Use Efficiency

PUE = seed yield / precipitation
(from harvest of previous crop to the harvest of current crop)

Units: lbs/ac/inch of precipitation

PUE of each system



Summary

- Cropping systems need to be greater than 3-yr to take advantage of crop diversity.

Summary (cont.)

- Continuous spring wheat might produce yield as great as diverse cropping systems, but require greater management inputs.

Summary (cont.)

- Among continuous cropping options, Dynamic Cropping Systems provide opportunity for greatest diversity, yield stability, and precipitation use efficiency.

Acknowledgments

- **Don Tanaka, Robert Kolberg, Marv Hatzenbuhler et al.**
- **Supervisors of the Area IV SCD Cooperative Research Farm**

Thank You

Northern Great Plains Research Laboratory

USDA-ARS, Mandan, ND

http://www.mandan.ars.usda.gov/