Climate-smart Agriculture:
Healthy Soils, Healthy Food, Healthy People

Rafiq Islam, Ph.D.

Director

Soil, Water, and Bioenergy Resources

OARDC-OSU South Centers

(islam.27@osu.edu)

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THE OHIO STATE UNIVERSITY

COLLEGE OF FOOD, AGRICULTURAL, AND ENVIRONMENTAL SCIENCES

Conduct mission-based research

- Basic research (academic // innovative)
- Applied research (collaborative / social / policy)

Provide education

- Academic education
- Professional development (in service)
- Capacity building

Disseminate evidence-based knowledge, information and technology

- Traditional outlets
- Electronic outlets


Existing collaboration
ARCTIC OCEAN
Greenland
Svalbard (Nor.)
ARCTIC OCEAN
United States
Canada
Iceland
Norway
Sweden
Finland
Russia
United Kingdom
Ireland
Den.
Neth.
Ger.
Pol.
Estonia
Latvia
Belarus
Ukraine
France
Spain
Portugal
ATLANTIC OCEAN
Morocco
Tunisia
Greece
Iran
Iraq
Kuwait
Mongolia
China
N. Korea
S. Korea
Japan
Nepal
Bhutan
Western Sahara
Algeria
Libya
Egypt
Jordan
Saudi Arabia
Laos
Taiwan
Mauritania
Mali
Niger
Chad
Eritrea
Oman
Yemen
Sudan
Djibouti
Bangl
Thailand
Vietnam
Philippines
PACIFIC OCEAN
Senegal
Guinea-Bissau
Sierra Leone
Cote d' Ivoire
Nigeria
Cam.
C.A.R.
South Sudan
Ethiopia
Somalia
Cambodia
Sri Lanka
Malaysia
Mexico
Guatemala
Honduras
Nicaragua
Costa Rica
Panama
Ven.
Guyana
French Guiana
Colombia
Ecuador
Suriname
Gabon
Dem. Rep. of Congo
Rep. of the Congo
Tanzania
Angola
Zambia
Malawi
Madagascar
Indonesia
Papua New Guinea
Solomon Islands
Fiji
New Caledonia
Australia
New Zealand
Peru
Brazil
Bolivia
Paraguay
Chile
Argentina
Uruguay
Namibia
Botswana
Zimbabwe
Mozambique
eSwatini
Lesotho
South Africa
INDIAN OCEAN
PACIFIC OCEAN
ATLANTIC OCEAN
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Scholarship/Fellowship Opportunities

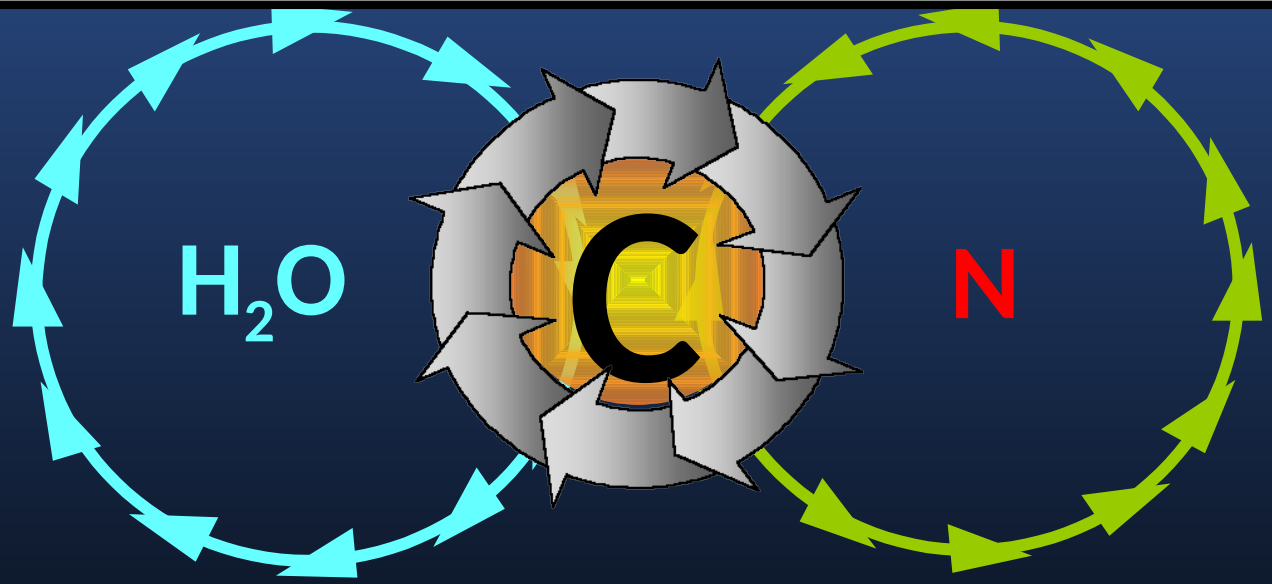
- USDA-Borlaug short-term scholar program (12 weeks)
- USDA-Faculty exchange fellowship program (6 months)???
- Ohio Sate University President's fellowship (Two-year post-doc)
- American Councils for International Education (ACIE)
- Faculty sponsored short-term fellowship program (2-6 months)**

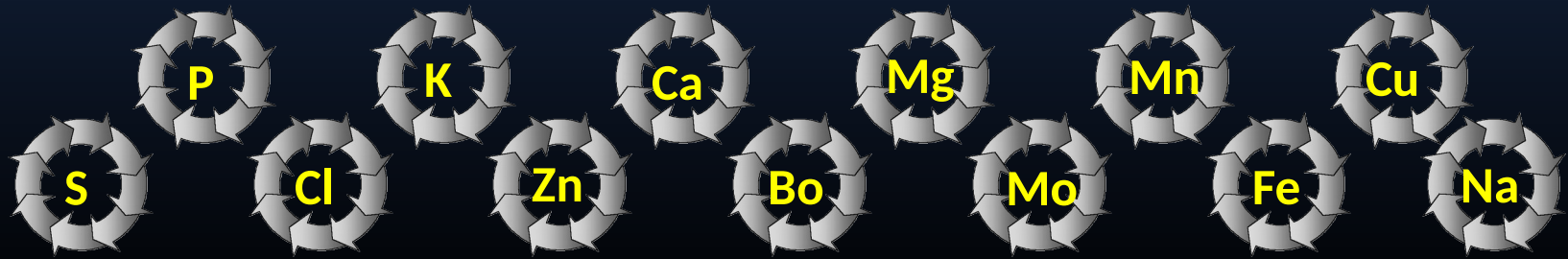
Fulbright Programs

- **Student Core Program**
  (Master's, Ph.D and Ph.D Dissertation Research Grant)
  - Financial support up to $35,000
  - One to two academic years depending on the length of their program
- **Visiting Scholar Program**
  Designed for academic scholars to conduct a full-time research project in the States from 3 to 12 months.
- **Community College Initiative (CCI) Program**
  U.S. Department of State provides educational grants for one academic year to community college students who want to study in the States.

All Ecosystem Components Including Human Beings are Influenced by Nature's Reactive Cycles: Water, Carbon, and Nitrogen

Carbon is the "Lord of the Rings".





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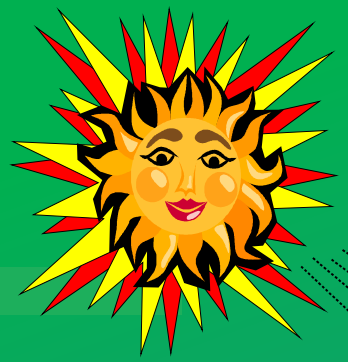
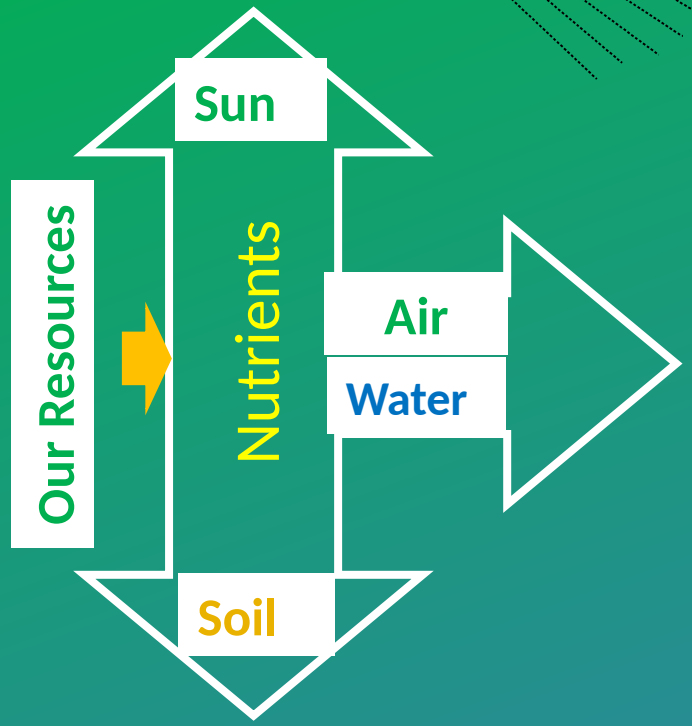
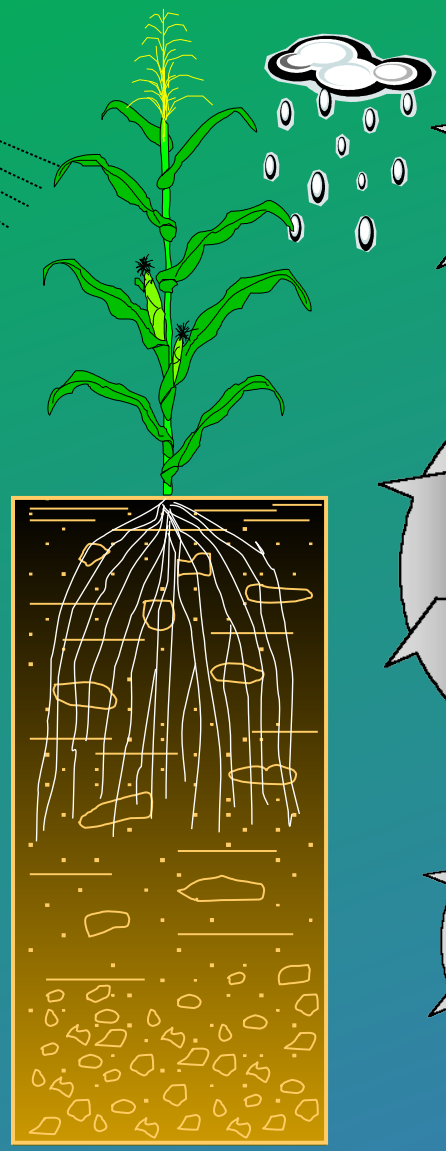
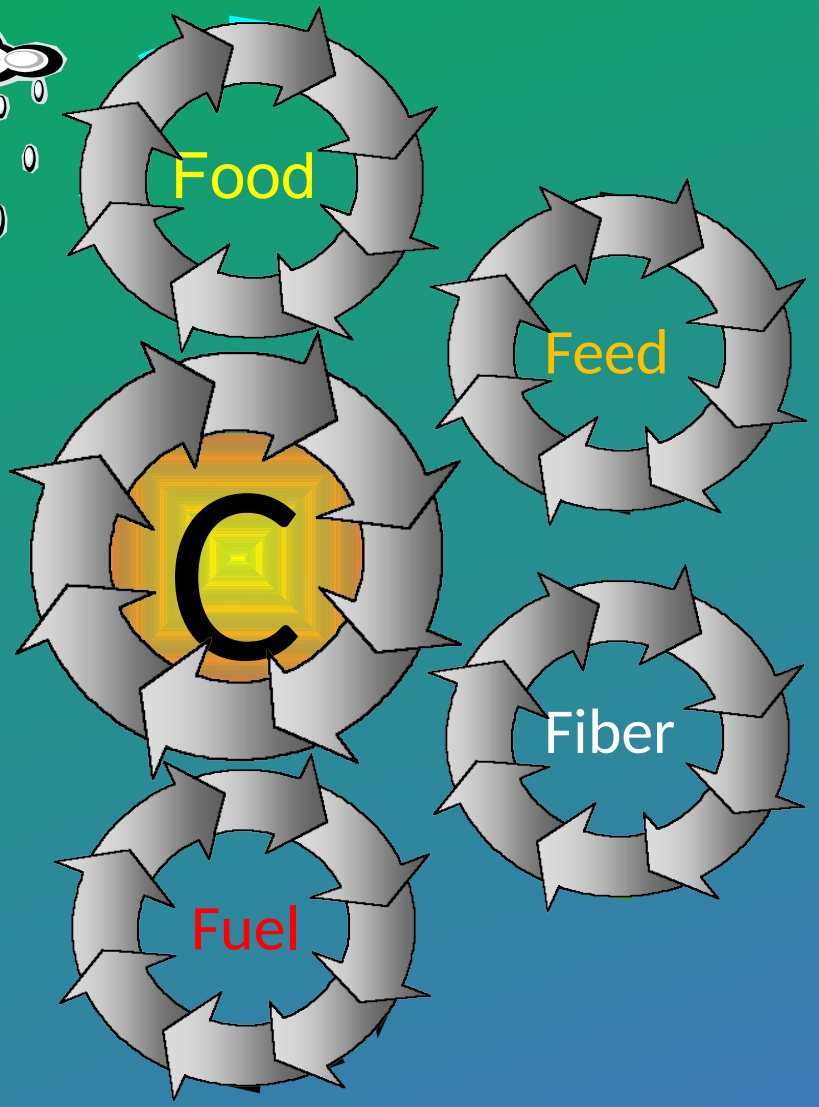
Ecosystem Services









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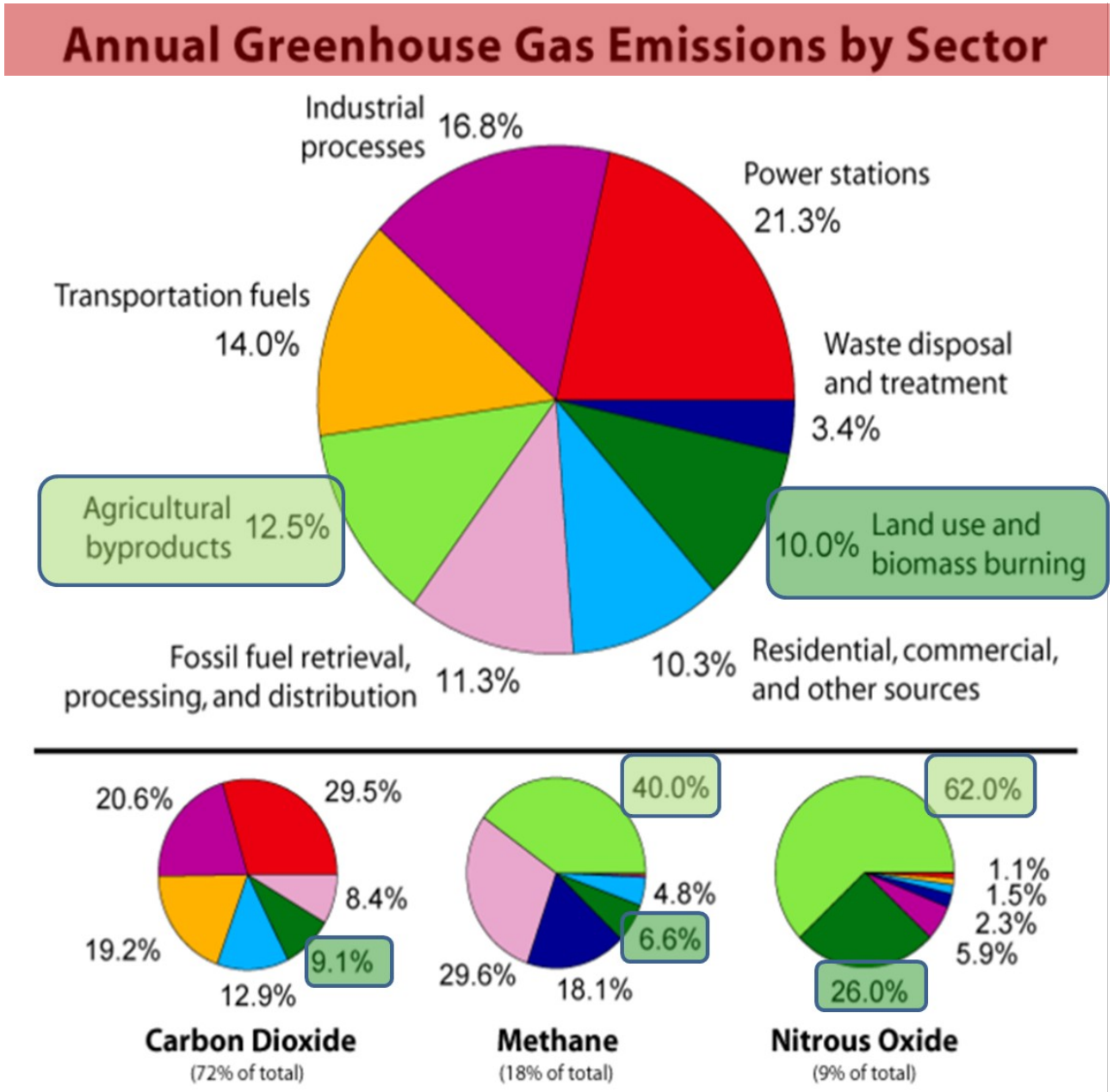
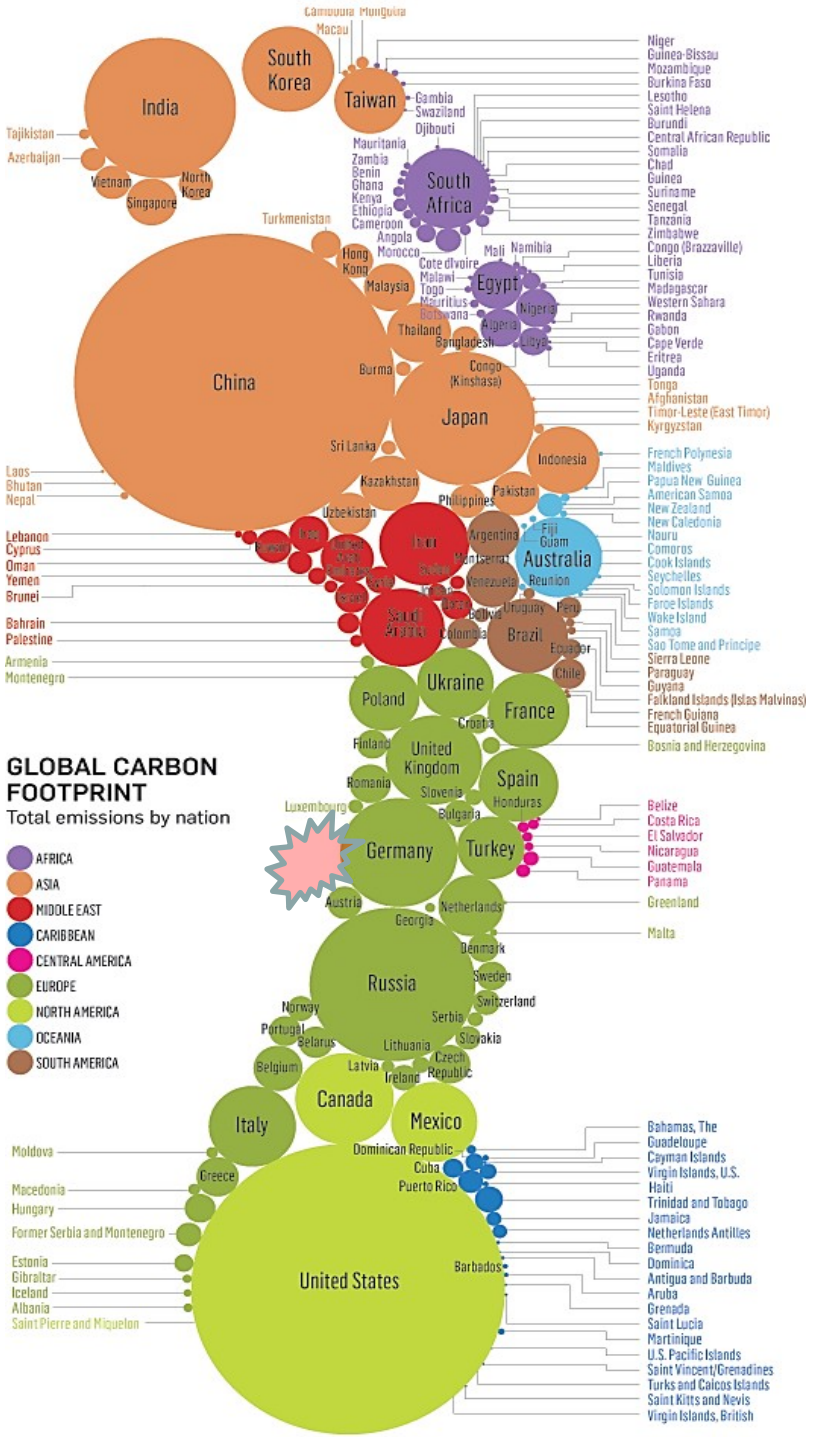
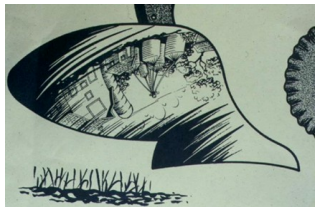




http://climatecolab.org/plans/-/plans/contestId/1300210/planId/1307202

Degradation of Ecosystem services (An example)



C, N & P input

Traditional management practices

Air quality

CO_2/CH_4

N_2O/NH_3

Soil transformations

Crop yield/ food quality

Nutrient-use efficiency

Soil quality

DOC

$NO_3/NH_4/DON$

SRP/DOP

Leaching

DOC/ sediment

$NO_3/NH_4/DON$

SRP/PP/DOP

Runoff

Water quality

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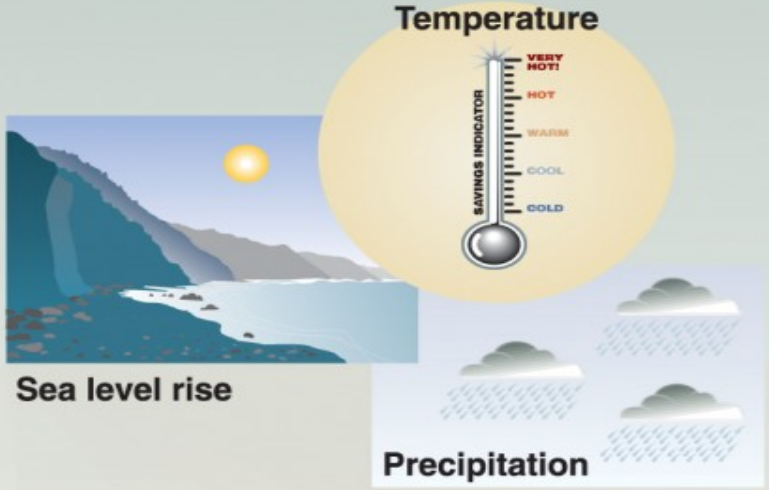
Islam (2012)

Potential climate change impact



Impacts on...

Health

Weather-related mortality
Infectious diseases
Air-quality respiratory illnesses

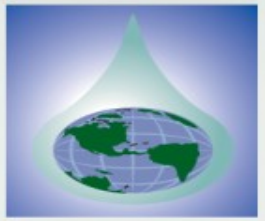
Agriculture

Crop yields
Irrigation demands

Forest

Forest composition
Geographic range of forest
Forest health and productivity

Water resources



Water supply
Water quality
Competition for water

coastal areas

Erosion of beaches
Inundation of coastal lands
additional costs to protect coastal communities

Species and natural areas

Loss of habitat and species
Cryosphere: diminishing glaciers

GRID Arendal UNEP

GRAPHIC DESIGN : PHILIPPE REKACEWICZ

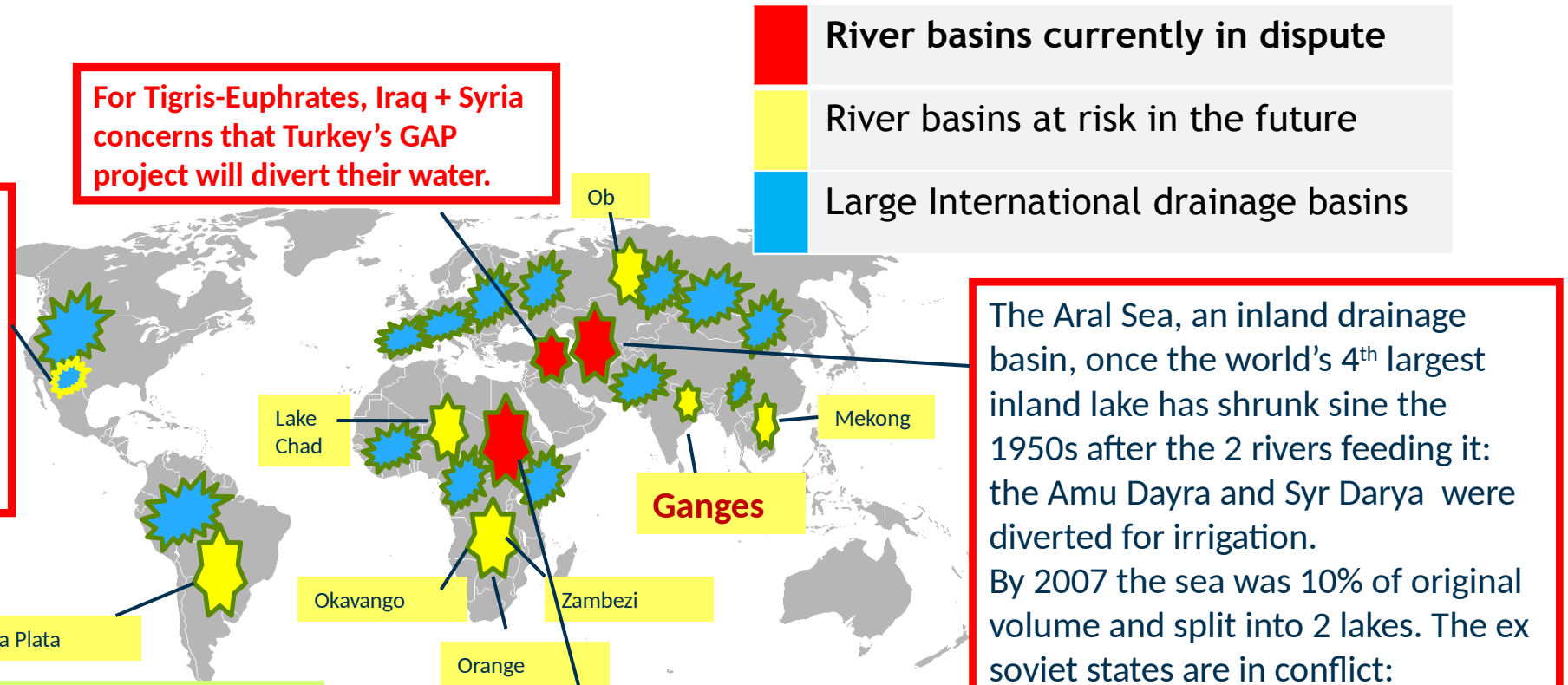
Source: United States environmental protection agency (EPA).

Western-Siberian Plain

Round lakes formation as a 4th stage of circle succession of permafrost degradation (Kirpotin 2005)

Current and future water conflicts

As water supply/quality decreases, tensions will rise as different players try to access common water supplies.



For Tigris-Euphrates, Iraq + Syria concerns that Turkey's GAP project will divert their water.

Colorado: disputes between the 7 US states and Mexico it flows through. The river is so overused, that it no longer reaches the sea!. 90% abstracted before reaches Mexico

The Aral Sea, an inland drainage basin, once the world's 4th largest inland lake has shrunk sine the 1950s after the 2 rivers feeding it: the Amu Dayra and Syr Darya were diverted for irrigation.
By 2007 the sea was 10% of original volume and split into 2 lakes. The ex soviet states are in conflict: Uzbekistan , Turkmenistan and Kazakhstan.

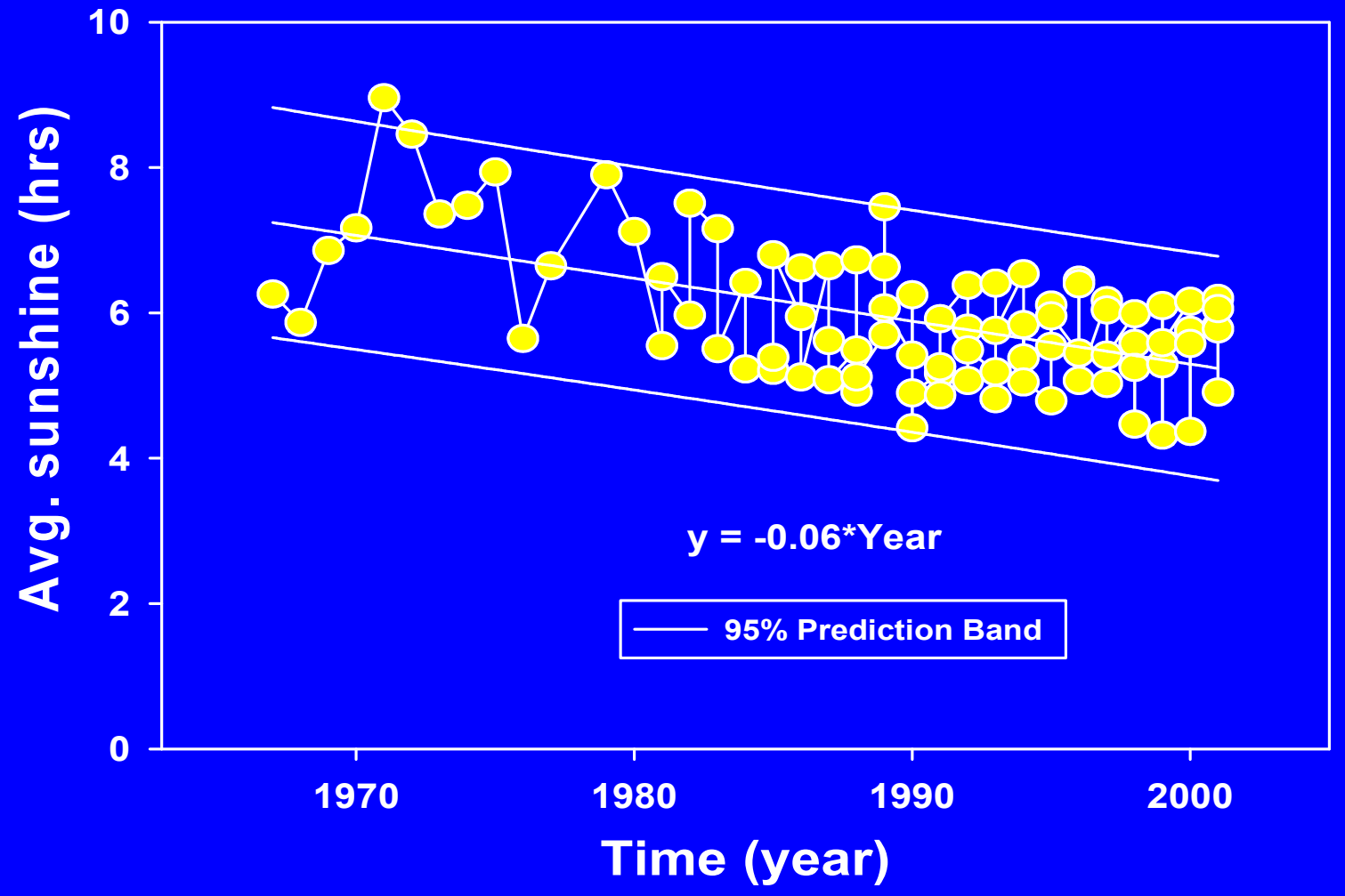
Nile hotly disputed between Ethiopia and Sudan ,who control its headwaters, and Egypt.

Note: although there have been rising tensions globally, many areas demonstrate effective management to diffuse the situation and create more equitable and sustainable demand-supply balance, such as the Mekong River Committee,& the Nile River Initiative

http://tamilmind.files.wordpress.com/2012/01/water_wars-in-future.jpg

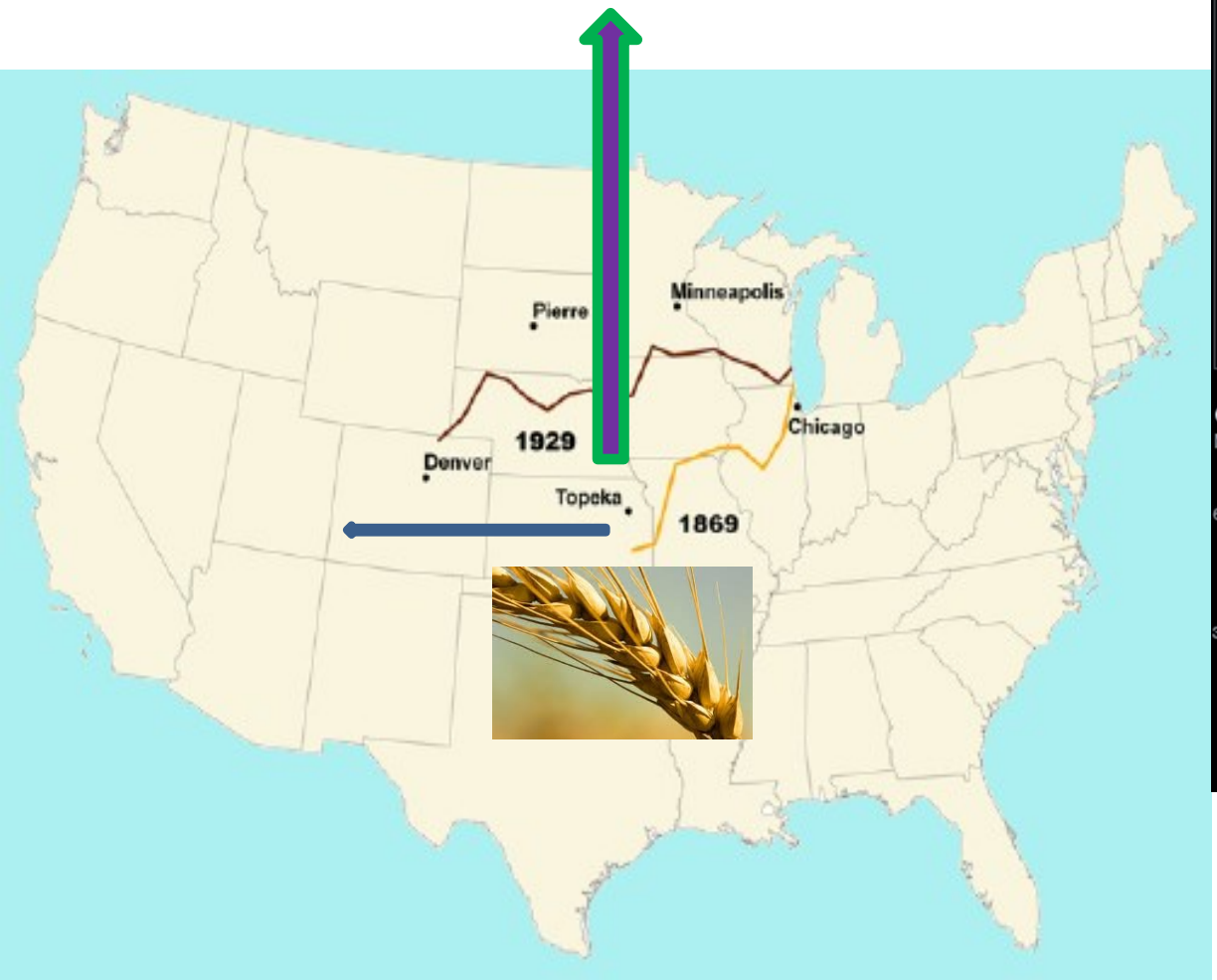
Brown clouds and solar dimming

Long-term climate data suggested that **Bangladesh**, Burma, Bhutan, India, Nepal, Pakistan, and Thailand will have shorter days for crop growth due to solar dimming.

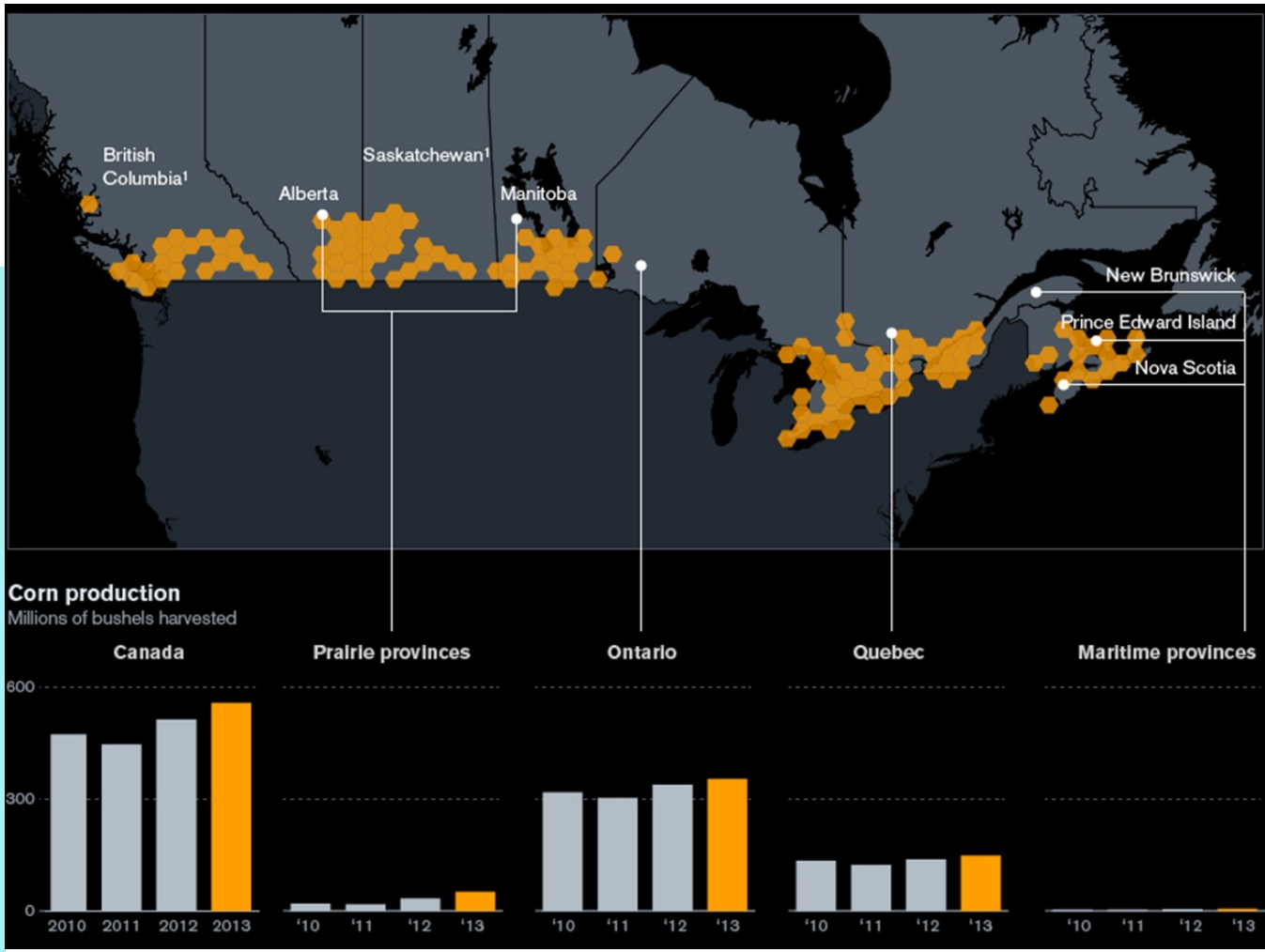


Ahsan et al. (2010)

Wheat production in the US//Canada



Canada's Climate Warms to Corn as Grain Belt Shifts North



http://www.theresilientearth.com/?q=content/case-doing-nothing-about-global-warming

Crop growth, yield and food quality

- **Corn, millet, sorghum, & sugarcane** are C_4 plants (highly efficient) at current levels of CO_2.

- **Soybeans, rice, wheat, barley, oats, cotton, & alfalfa** are C_3 plants (moderately efficient) at current levels of CO_2.

- The C_3 plants will be **more efficient** at high CO_2 levels. The C_4 plants will be affected – decrease in **crop yield & food quality.**

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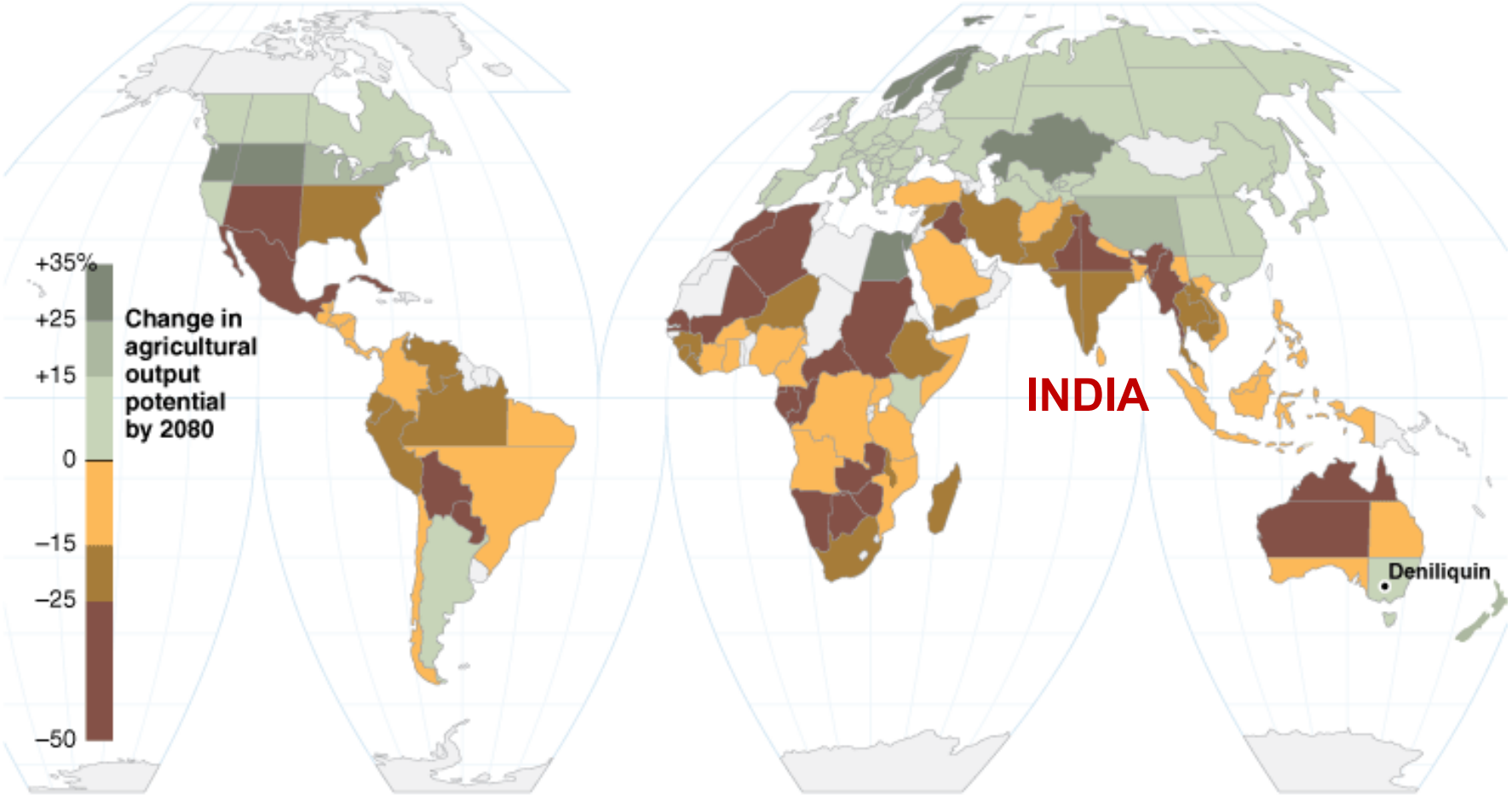
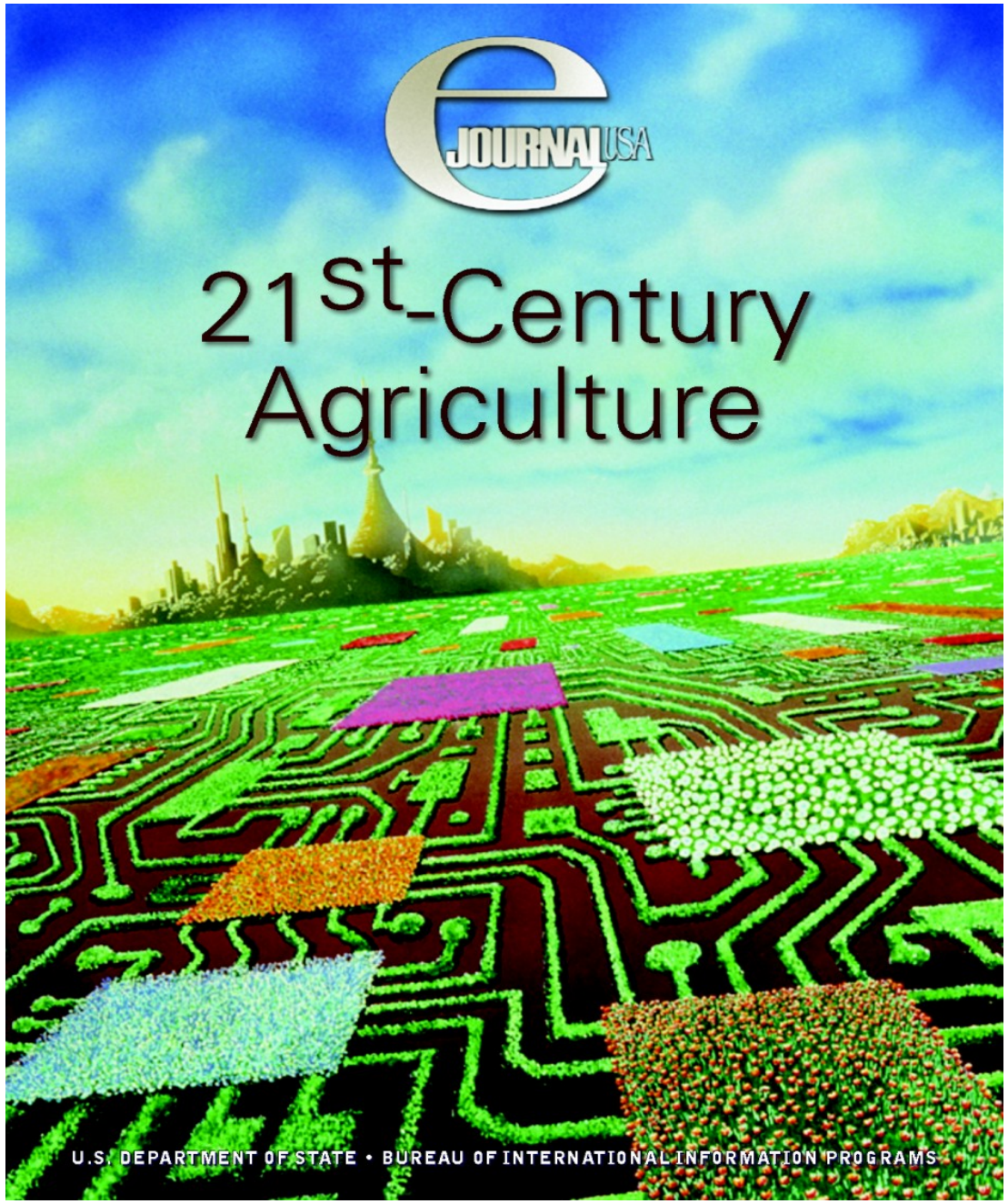
Farming in a Warmer World on Degraded Soils with a Shortage of Water

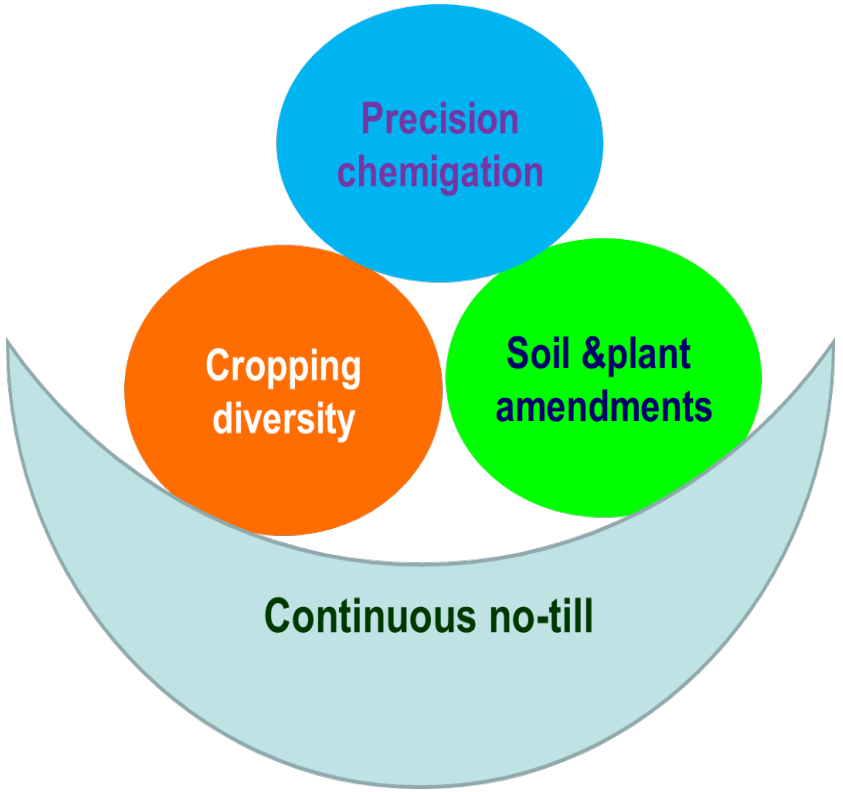
Crop forecasts show that some countries farther from the Equator could benefit from a warmer world, but others would be worse off by 2080 if global warming were to proceed unchecked. Long-range forecasts vary widely; the following is a synthesis of available forecasts by country or region.



Note: These figures assume that crops grow faster because of higher levels of carbon dioxide in the air. But some scientists say that the actual effects of global warming could be worse than shown here, because the benefits of extra carbon dioxide may not appear if crops lack proper rainfall, proper soil and clean air.

Source: "Global Warming and Agriculture: Impact Estimates by Country," by William R. Cline, Peterson Institute, 2007.





Improved  health

Conservation Agriculture

No Till, Zero Till, or Direct Seeding

No “flow”

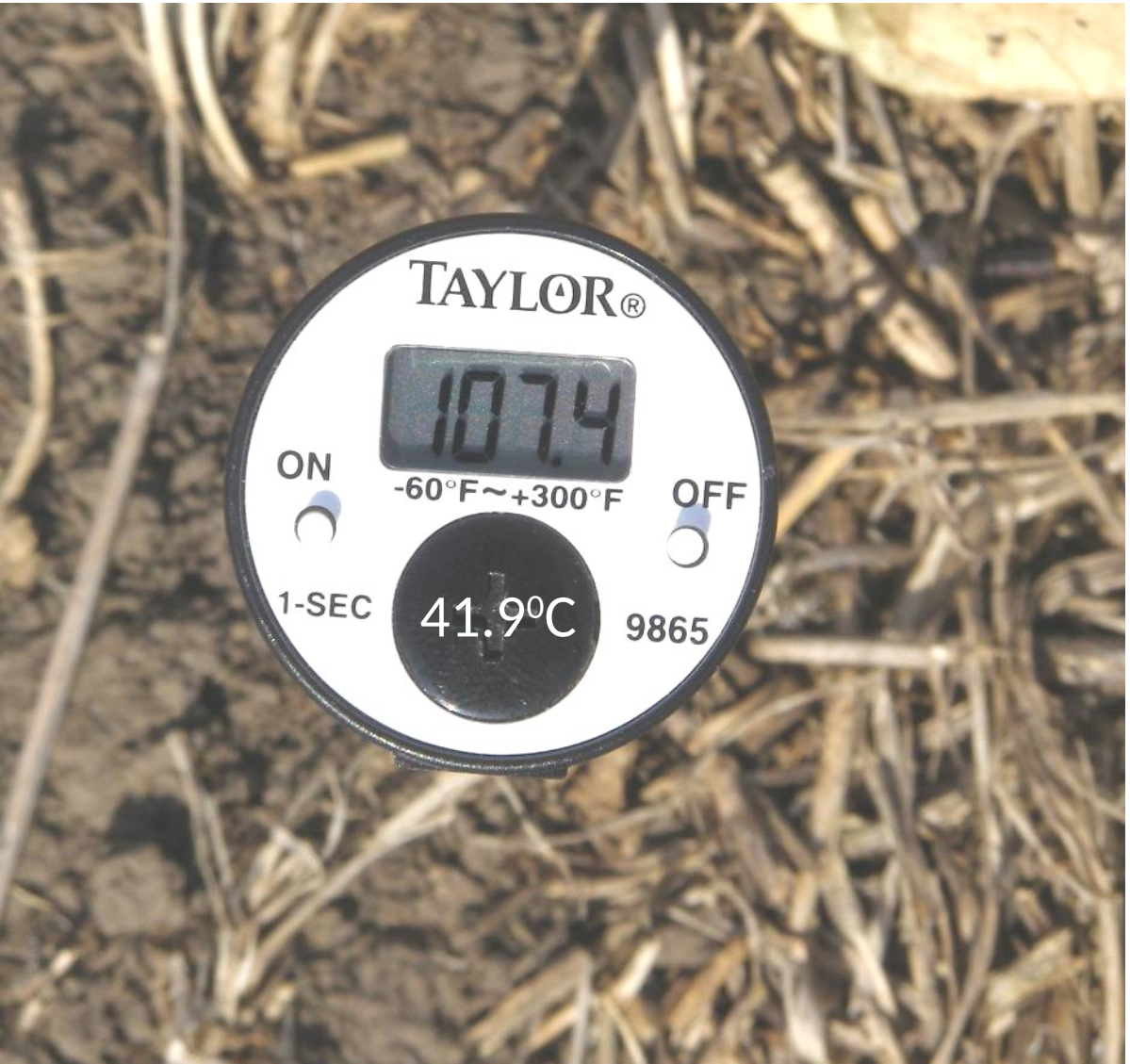
No “blow”

No “glow”

Conservation tillage and cover crops

Soil Temperature Differences

Conventional /No-till??

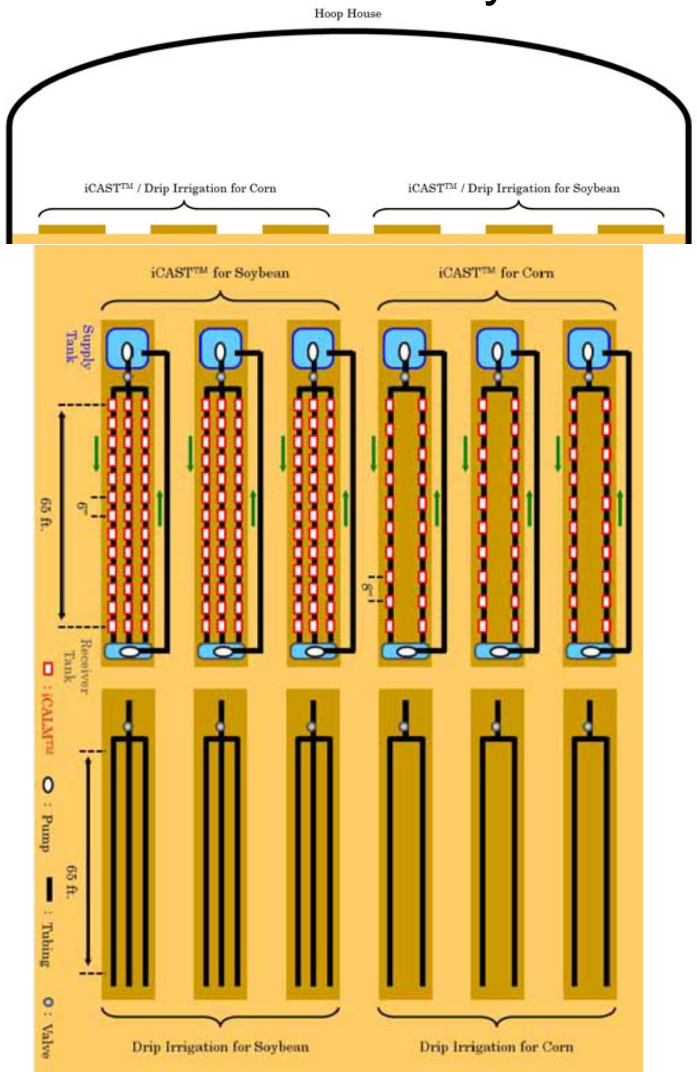


No-till + cover crops

Using radish to reduce SOIL COMPACTION and control soil-borne disease.

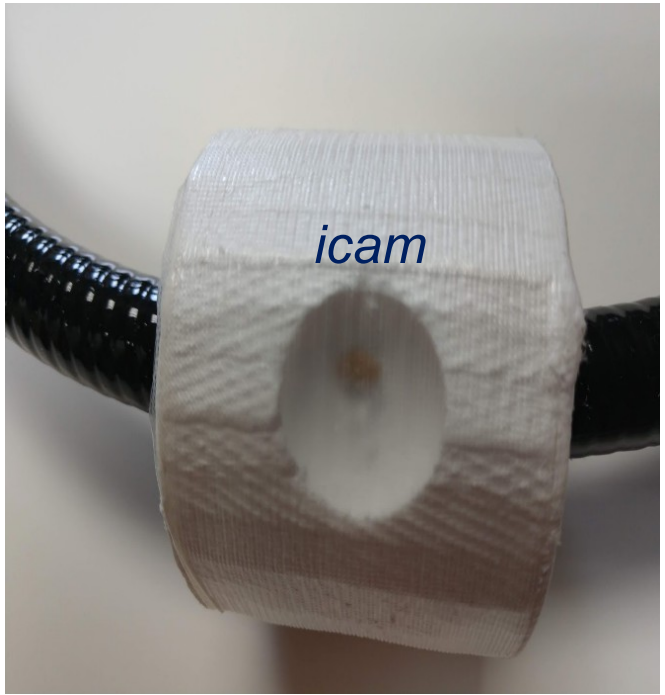
Climate-smart precision fertigation (iCAST)

Mitsui iCAST Technology: Growing corn and soybeans under ***simulated desert-like conditions*** with re-circulating water- and nutrient systems.



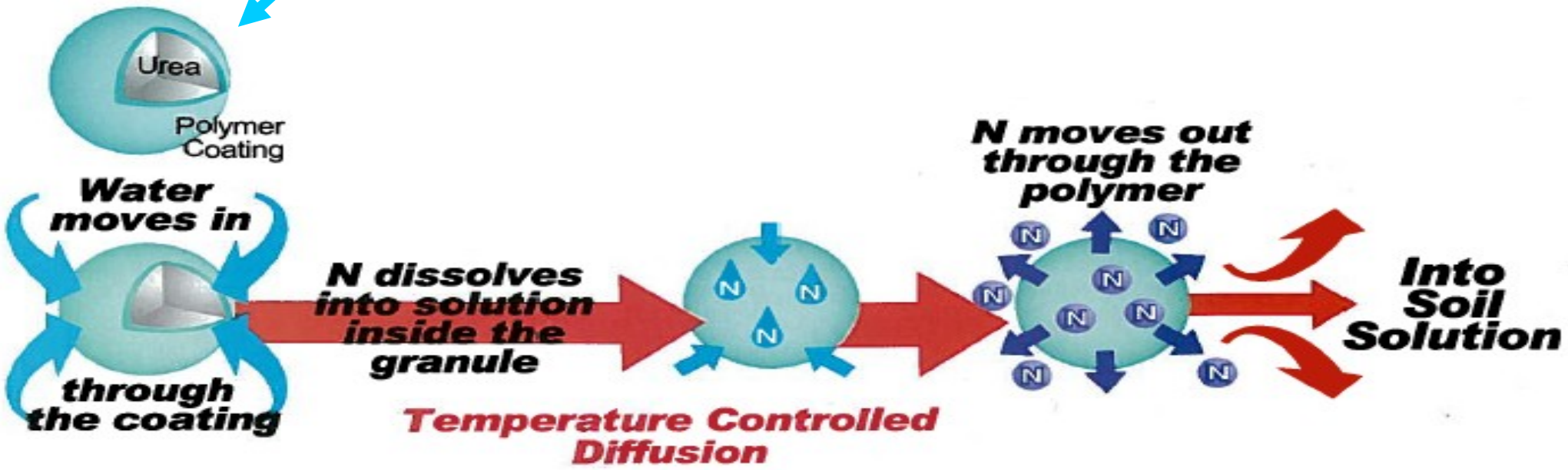
iCAST system

Results shown that 45% less water & 50% less nutrients required by iCAST than that of the drip irrigation (currently the most efficient).



Spraying Aspirin to reduce drought stress on soybeans at the Askaniyske State Experimental Farm, Kherson, Ukraine.

ESN
SmartNitrogen



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Improved crop varieties

Drought tolerant, efficient water and nutrient user, and salt-resistant crops.

Natural selection
Breeding & genetics research

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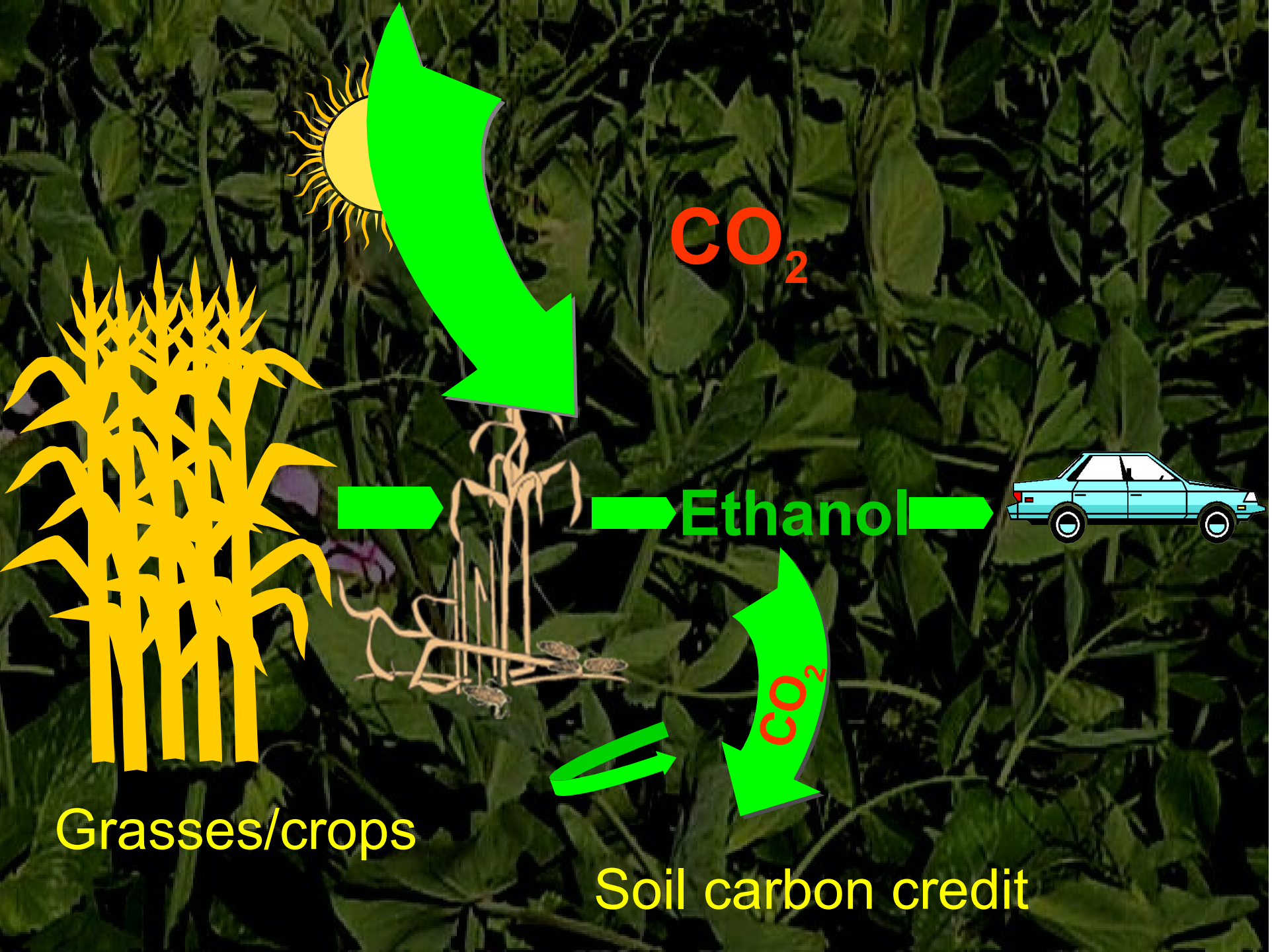

Renewable energy and specialty crops


Guayule Plantations
(for latex production)


Warm-season grass


Dandelions (Buckeye Gold)
for latex (high-quality rubber)


Miscanthus giganteus
08 22 2012 11:24

Hemp (strain of *Cannabis sativa* for **Cannabidiol** (CBD) is a type of cannabinoid, a chemical found naturally in cannabis (marijuana and hemp) plants. Also, for fiber.

Recycling municipal (Biosolids) and industrial wastes (FGD-gypsum) from coal-power plants as fertilizer//amendments.

Results

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Fig. 1: Conservation agriculture impacts on corn, soybean, and wheat yields

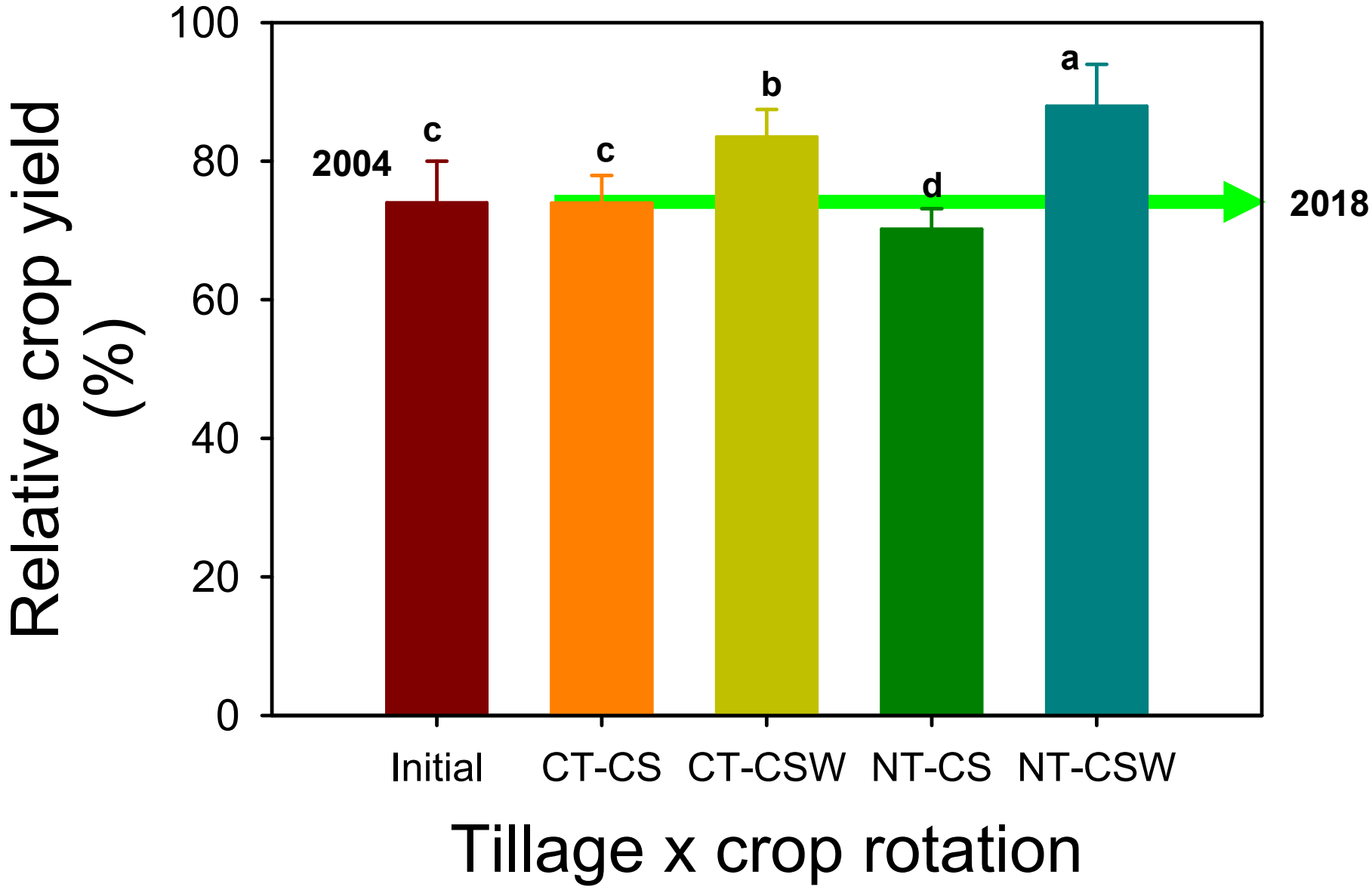

Fig. 2: Salicylic acid (aspirin) effects on soybean yield (based on 2018/19 data).

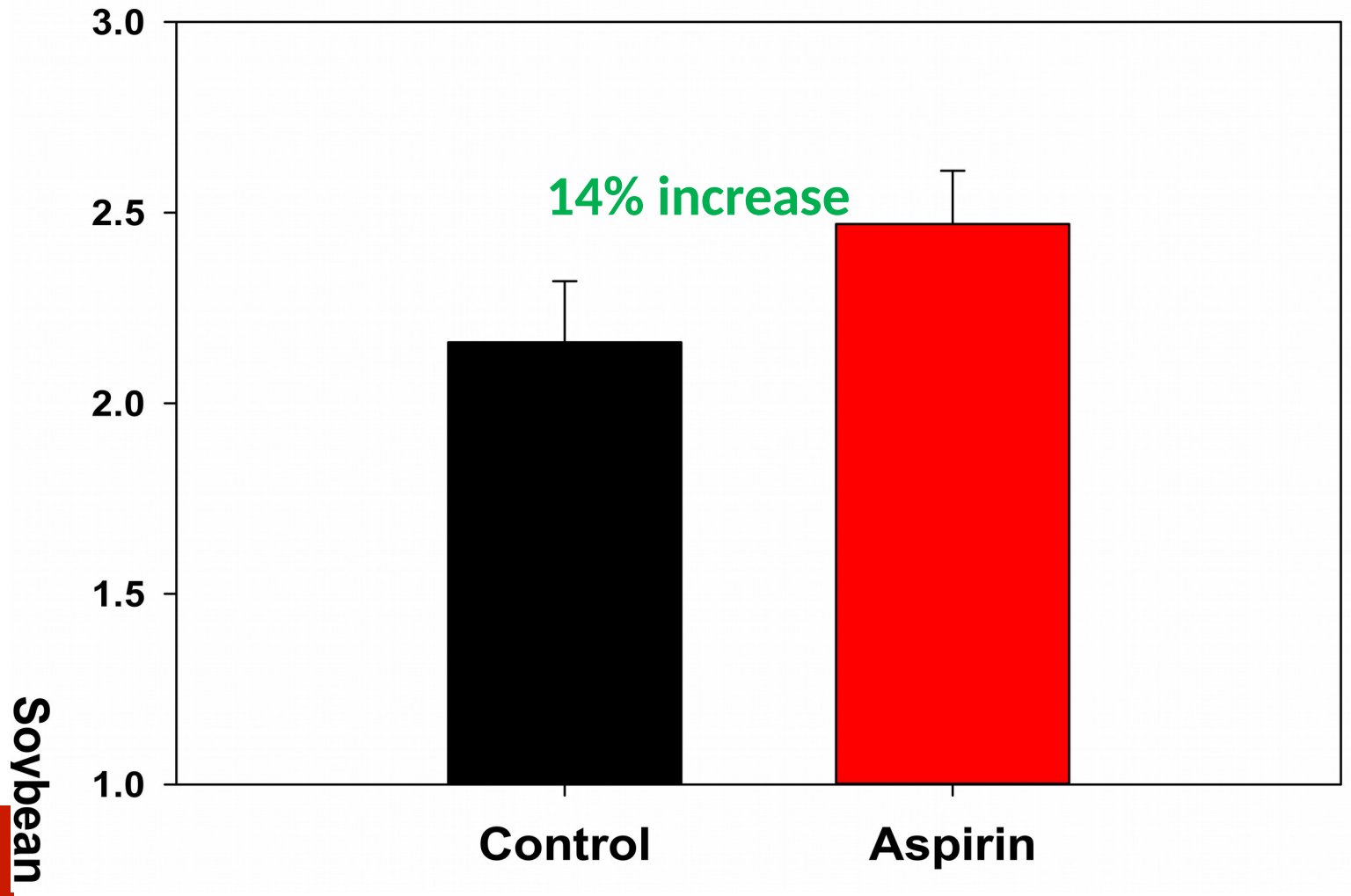

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Fig. 3: Tillage and cropping diversity (with cover crops) effects on corn and soybean crude protein content (based on 2012 to 2017 data)

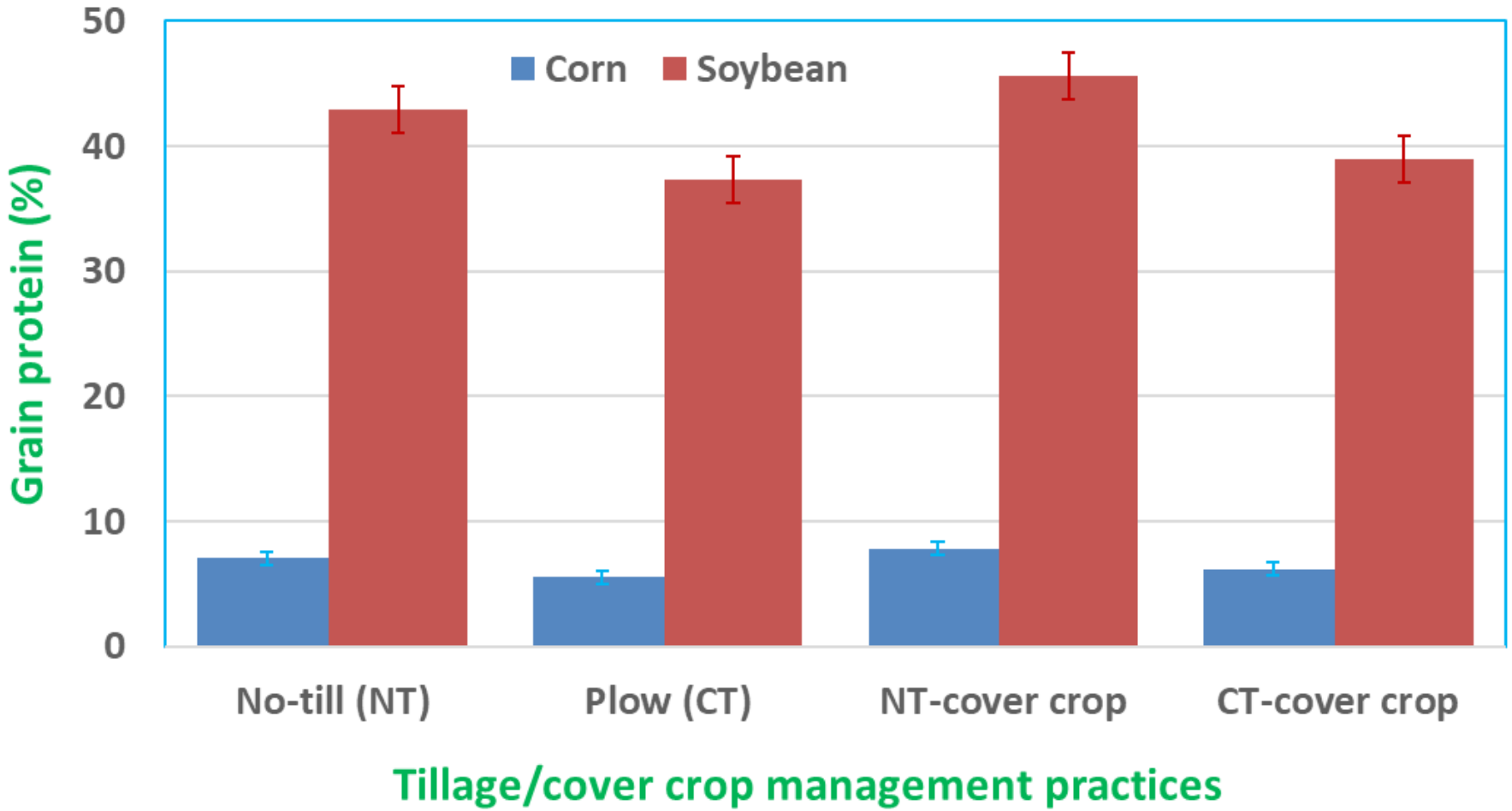

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Fig. 4: Tillage effects on most essential **amino acid profiling** of soybean grain (based on 2017 data)

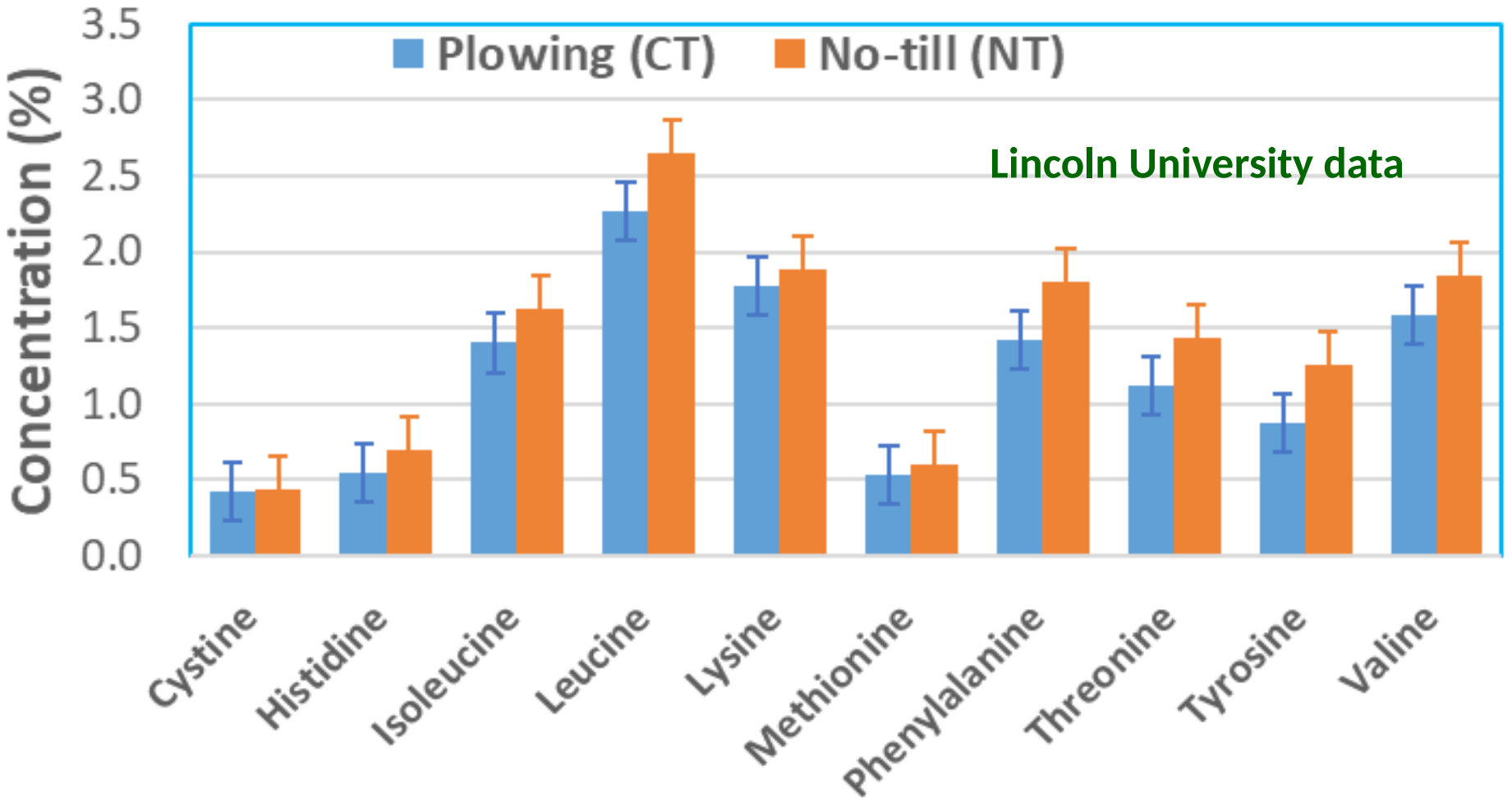

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Fig. 5: Tillage effects on **amino acid profiling** of soybean grain (based on 2017 data)

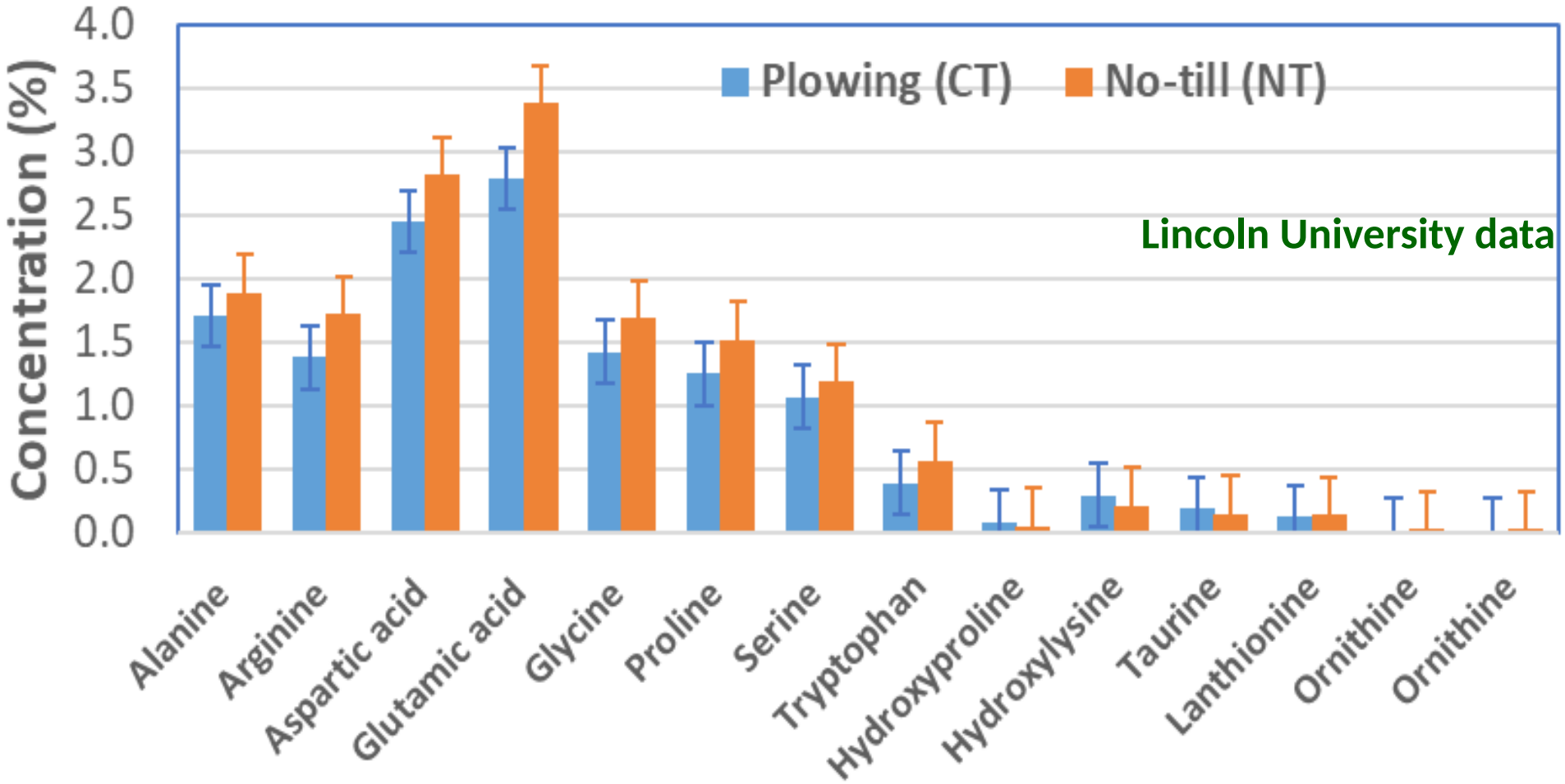

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Fig. 6: Tillage and cover crops effect on **macronutrient density** of corn grain (based on 2018 data)

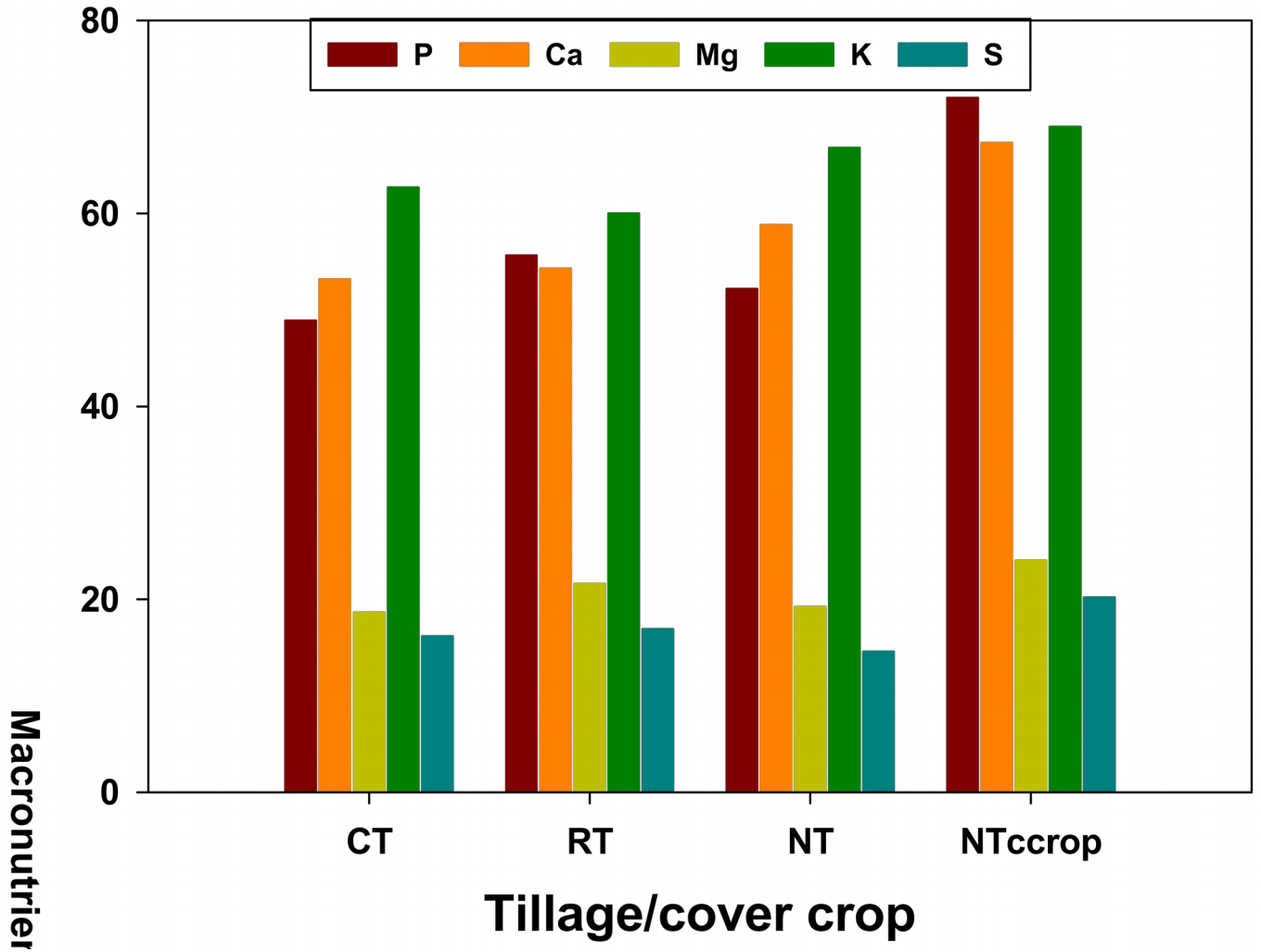

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Fig. 7: Tillage and cover crops effect on **micronutrient density** of corn (based on 2018 data)

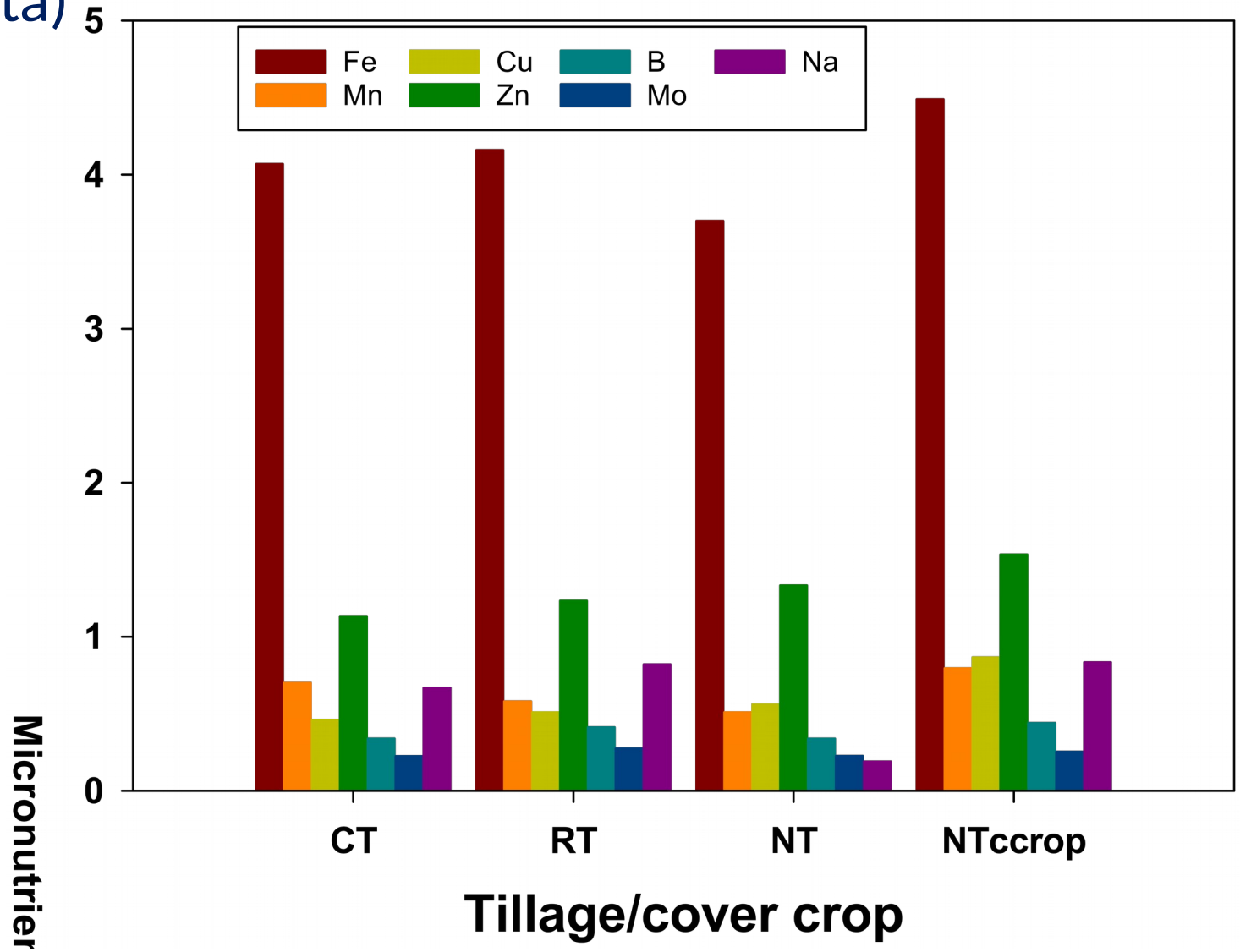

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Fig. 8: Tillage and salicylic acid effect on nutrient density of corn and soybeans (based on 2018 data)

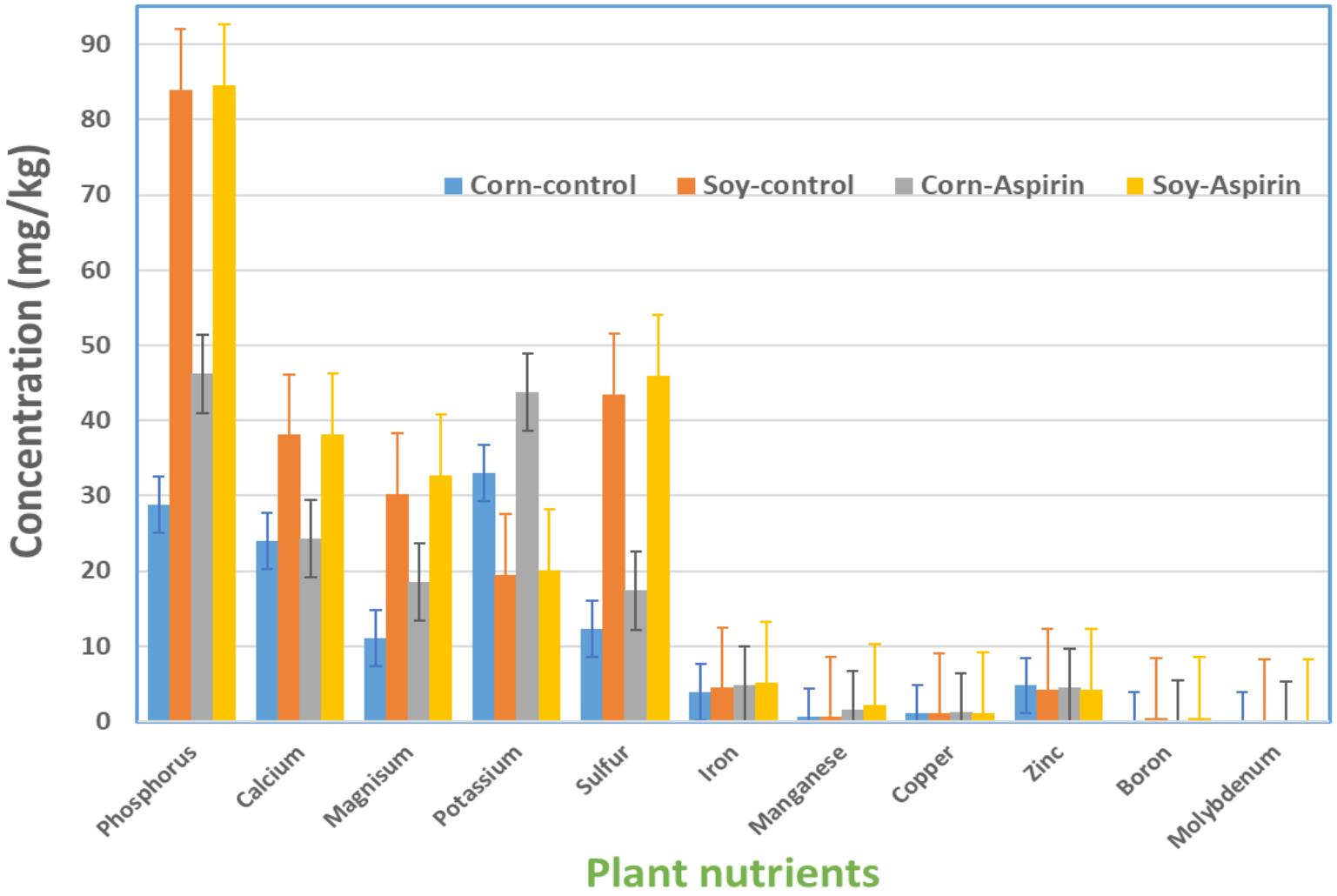
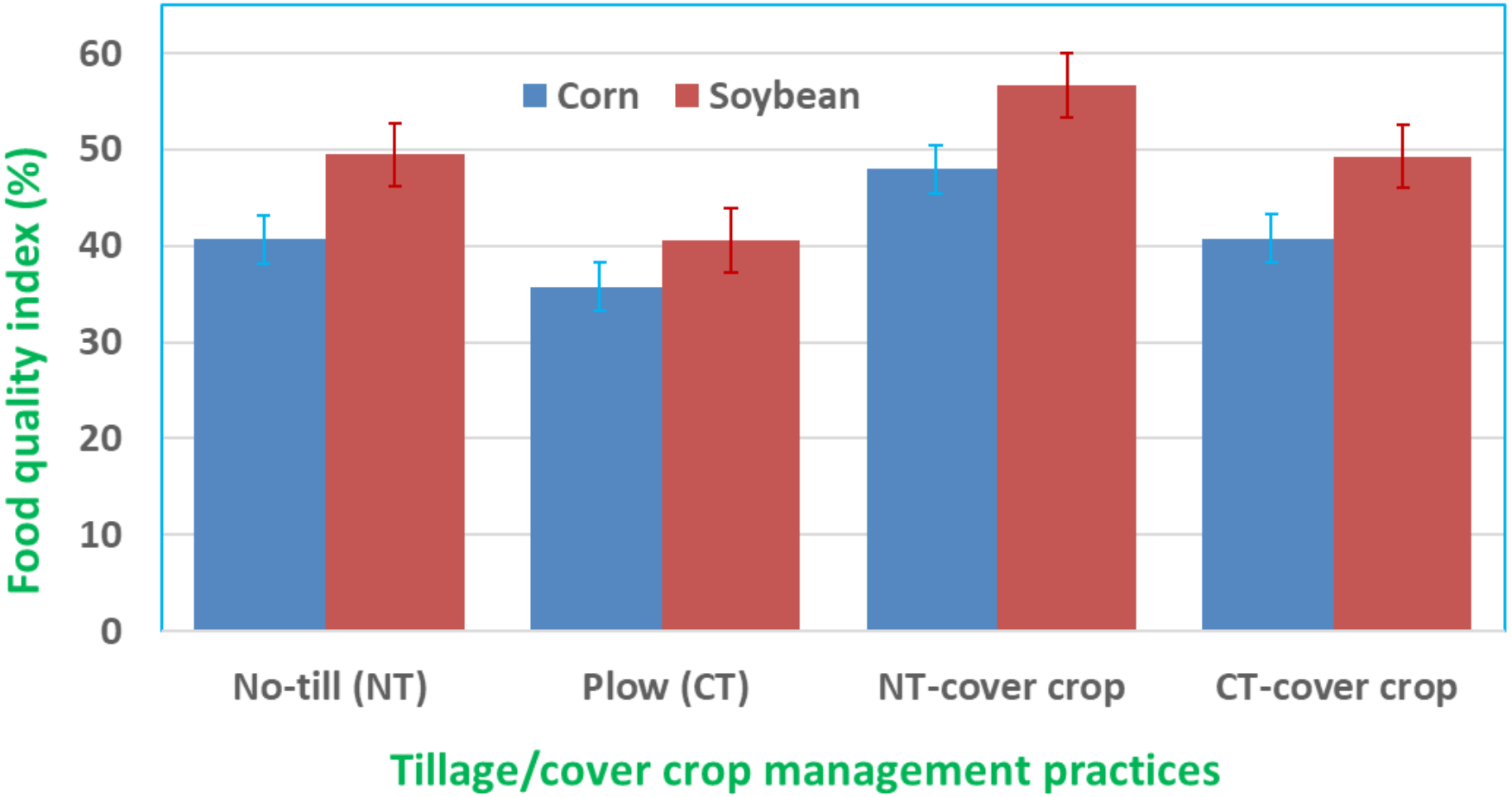


Fig. 9: Tillage and cropping diversity effects on **food quality** of corn and soybean (based on 2017 data)



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Conclusions

- Climate change//ecosystems degradation **WILL** affect crops/food quality.
- Conservation agriculture supports economic crop production.
- No-till cropping diversity increased crop yields & improve food quality.
  - *Protein content*
  - *Amino acids*
  - *Nutrient density*
- Chemical inducing (Aspirin) improve crop's drought tolerance
  - *Amino acid (proline)*
  - *Nutrient density*

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Thanks

Healthy People

Healthy Food

The Miracle We Take For Granted

CFAES