Transitioning Cereal Systems to Adapt to Climate Change

November 13-14, 2015

Funded through Award #2011-68002-30191 from USDA National Institute of Food and Agriculture

Increasing productivity in rain fed, semiarid systems by analyzing and remediating limiting factors

Bram Govaerts
Associate Director
CIMMYT, Mexico

Increasing productivity in rainfed, semi-arid systems by analyzing and remediating limiting factors

Bram Govaerts, Nele Verhulst and team

@BramACCIMMYT #4MasAgro b.govaerts@cgiar.org

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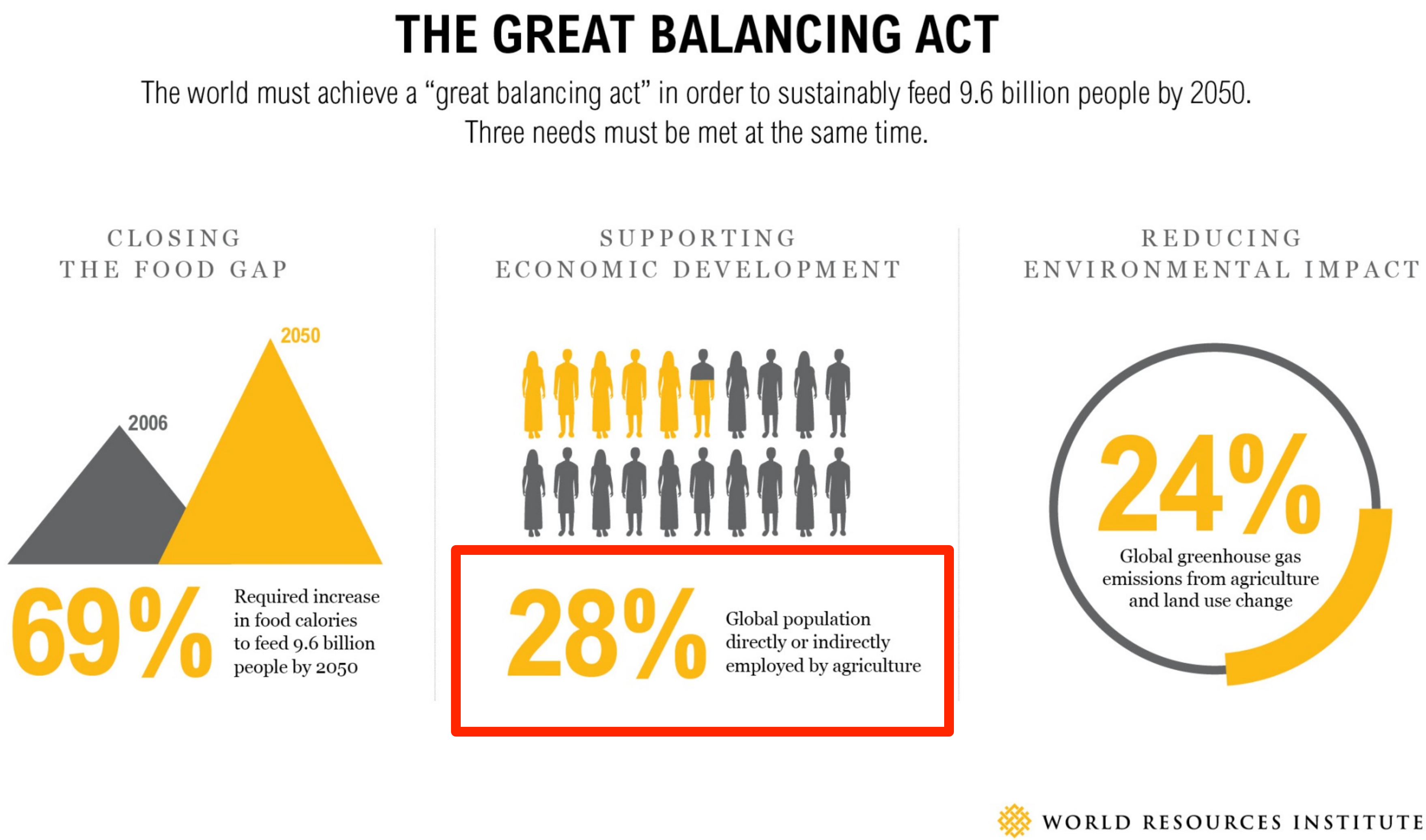
International scenario

International scenario



JBS

A Global Food Company

MARKET

"THE NEW CONSUMER"

LLOYD'S

Food insecurity a significant risk
to "global society"

Food safety/security issues create
"direct and indirect risks &
opportunities for businesses"

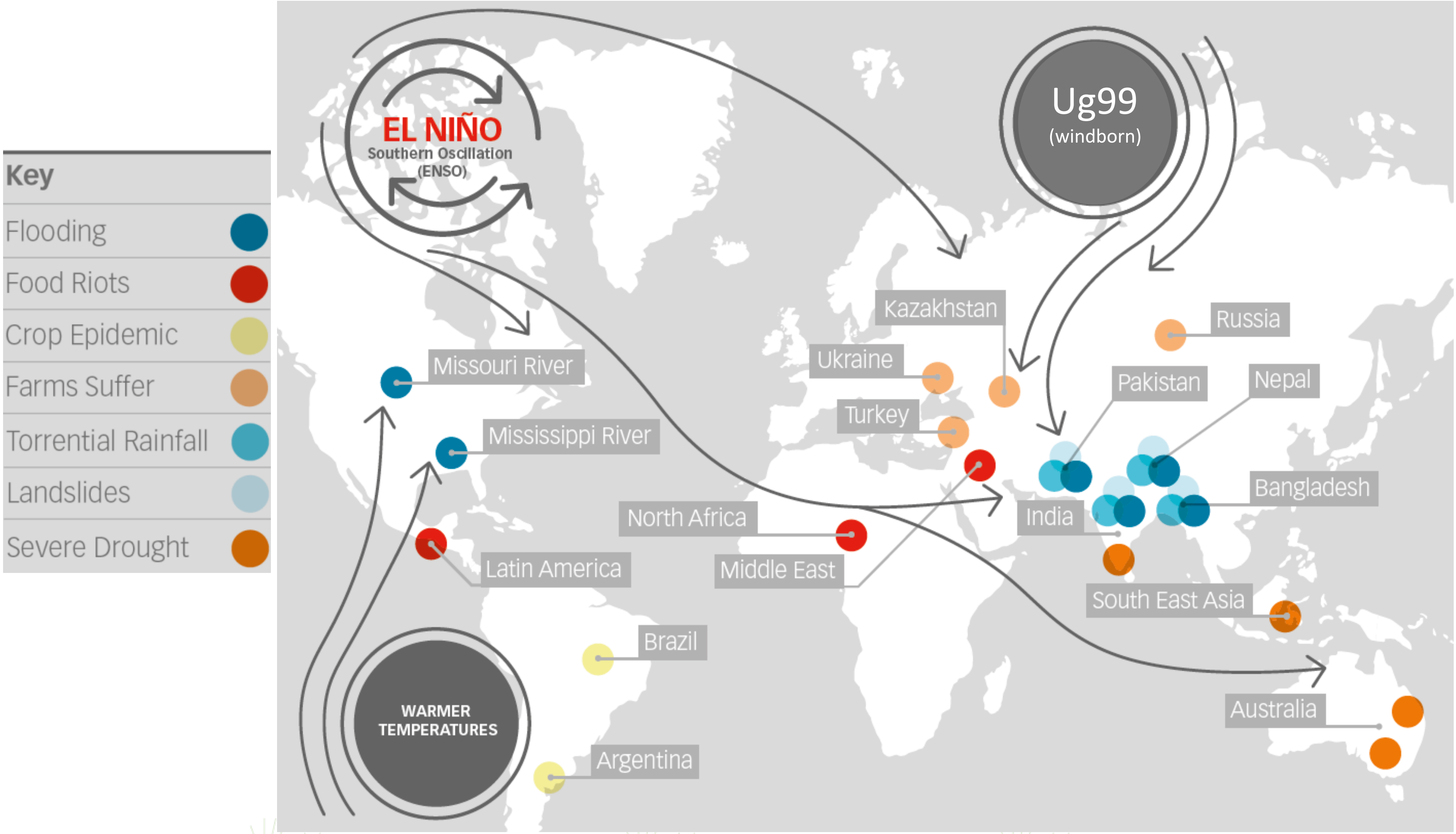
Insurance can play a large role in
risk mitigation/management
as well as innovation/investment

March, 2014

FEAST OR FAMINE

BUSINESS AND INSURANCE IMPLICATIONS OF FOOD SAFETY AND SECURITY

Lloyds food system shock scenario



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Wheat production losses

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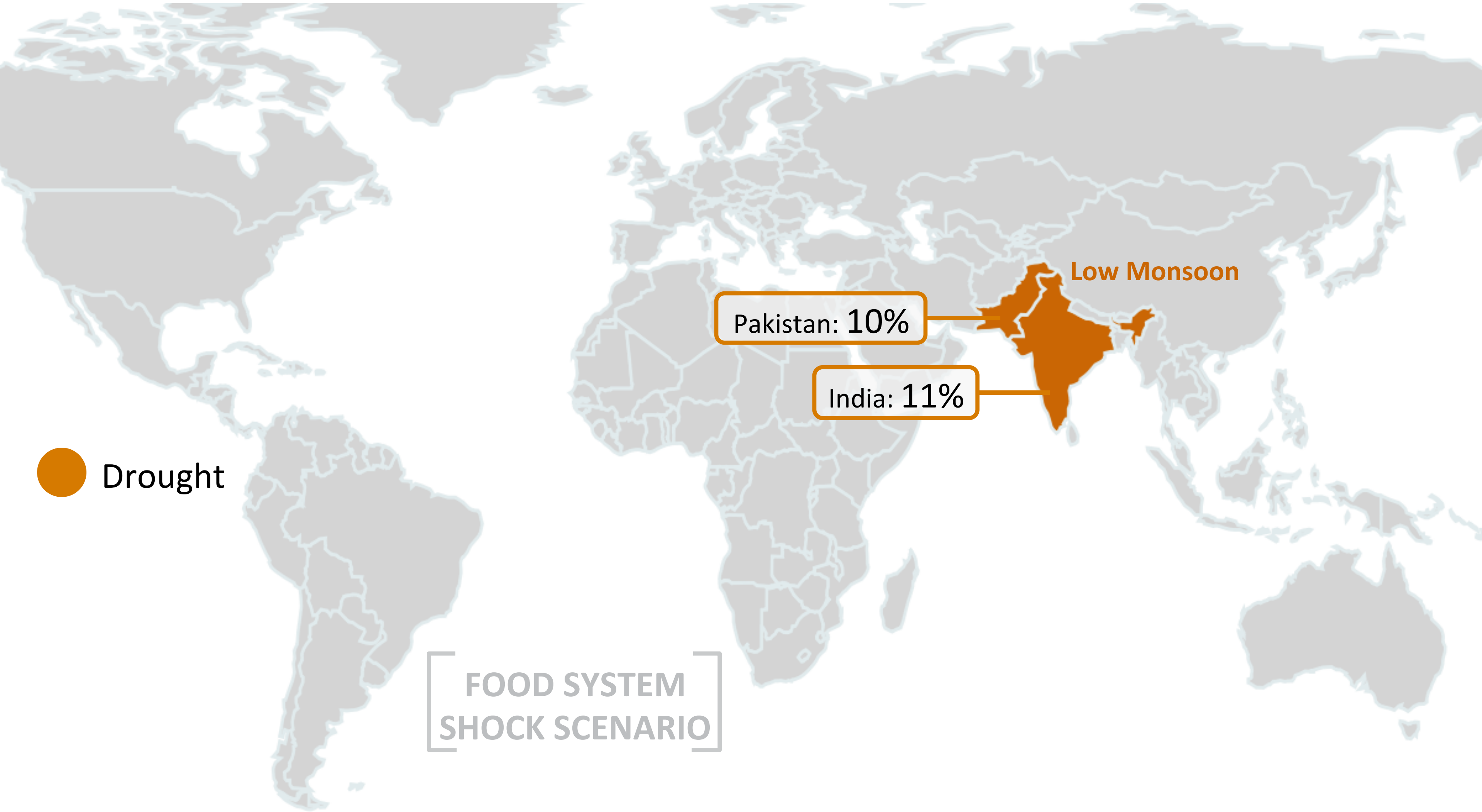
Wheat production losses



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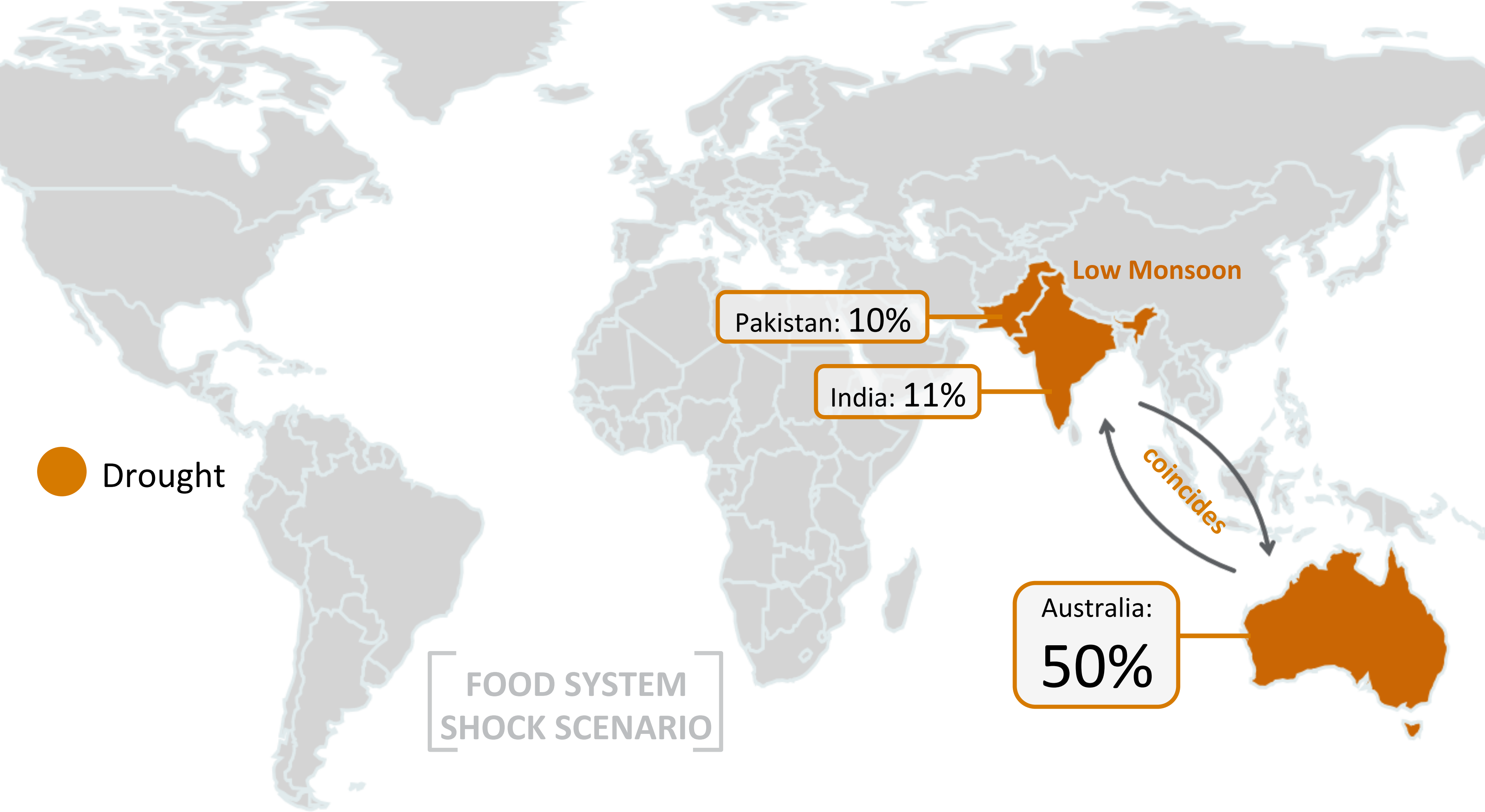
Wheat production losses



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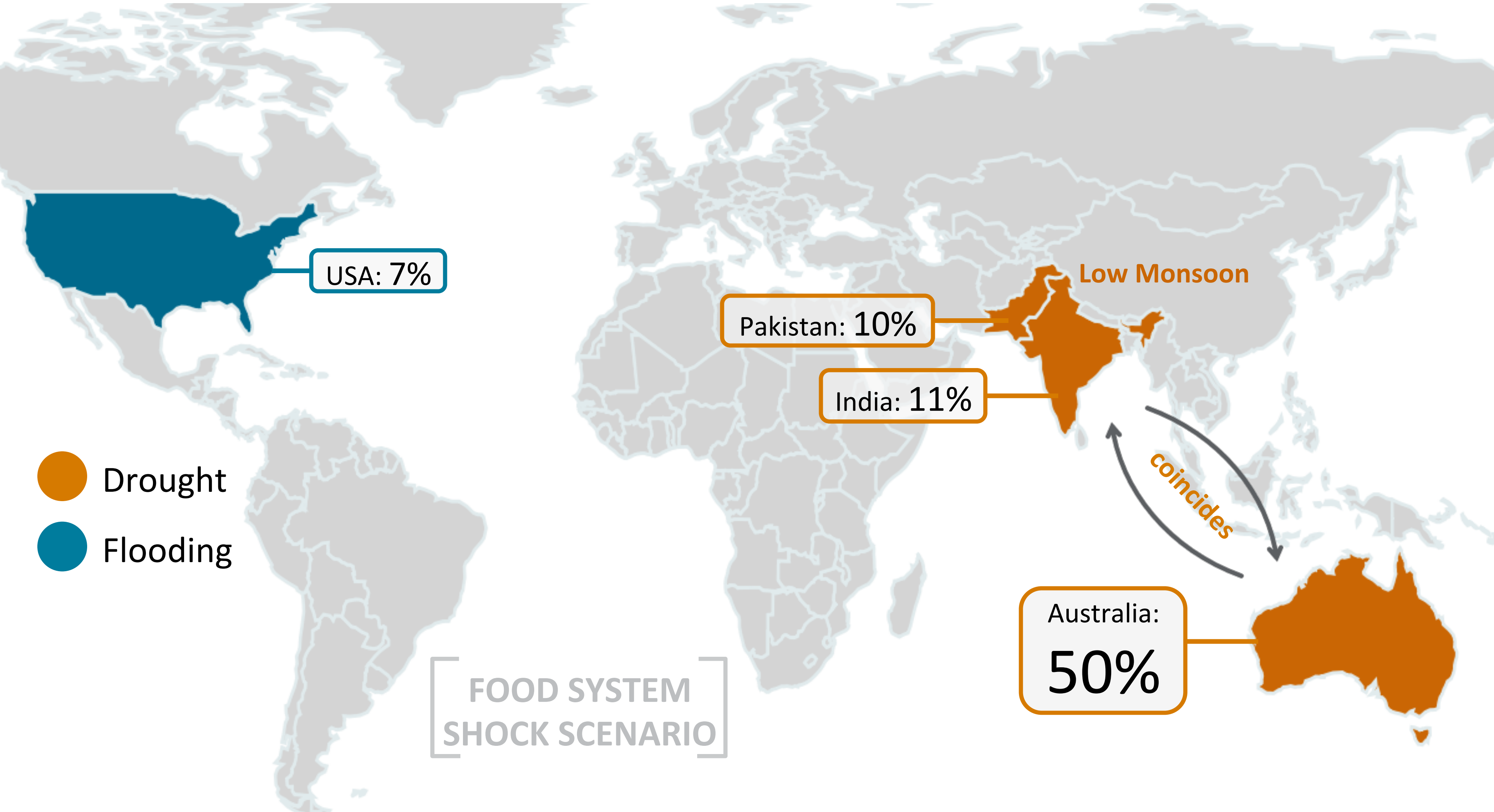
Wheat production losses



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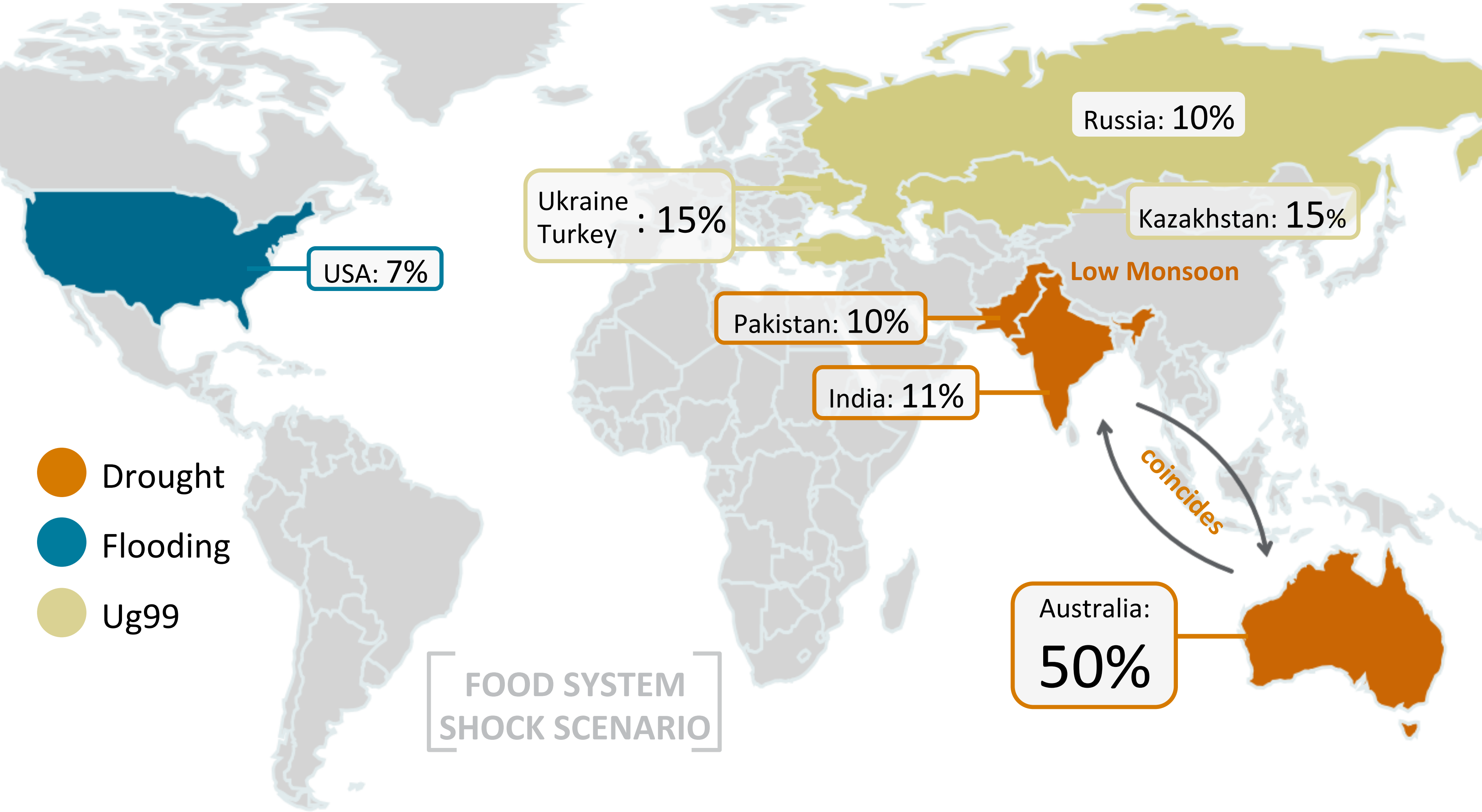
Wheat production losses



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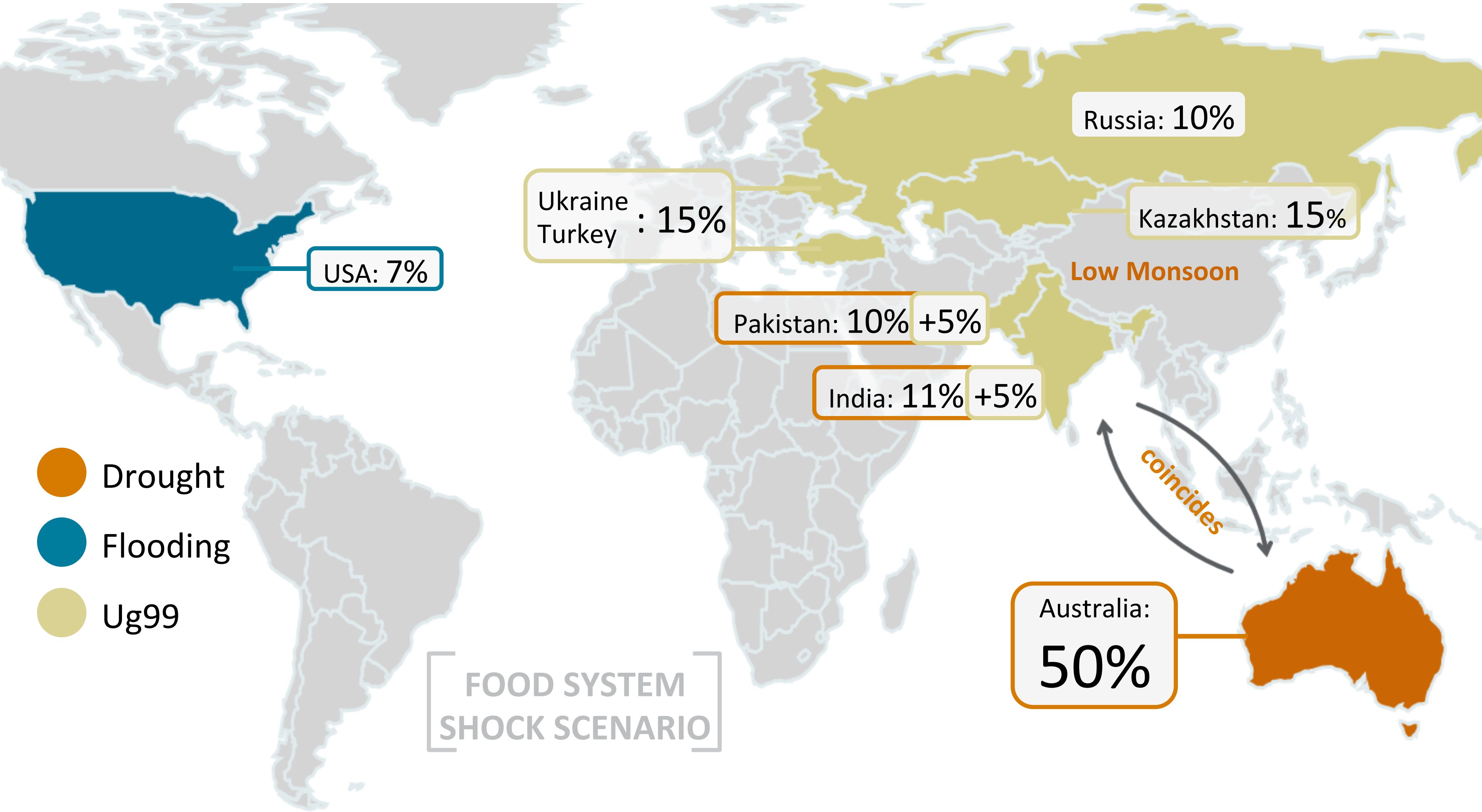
Wheat production losses



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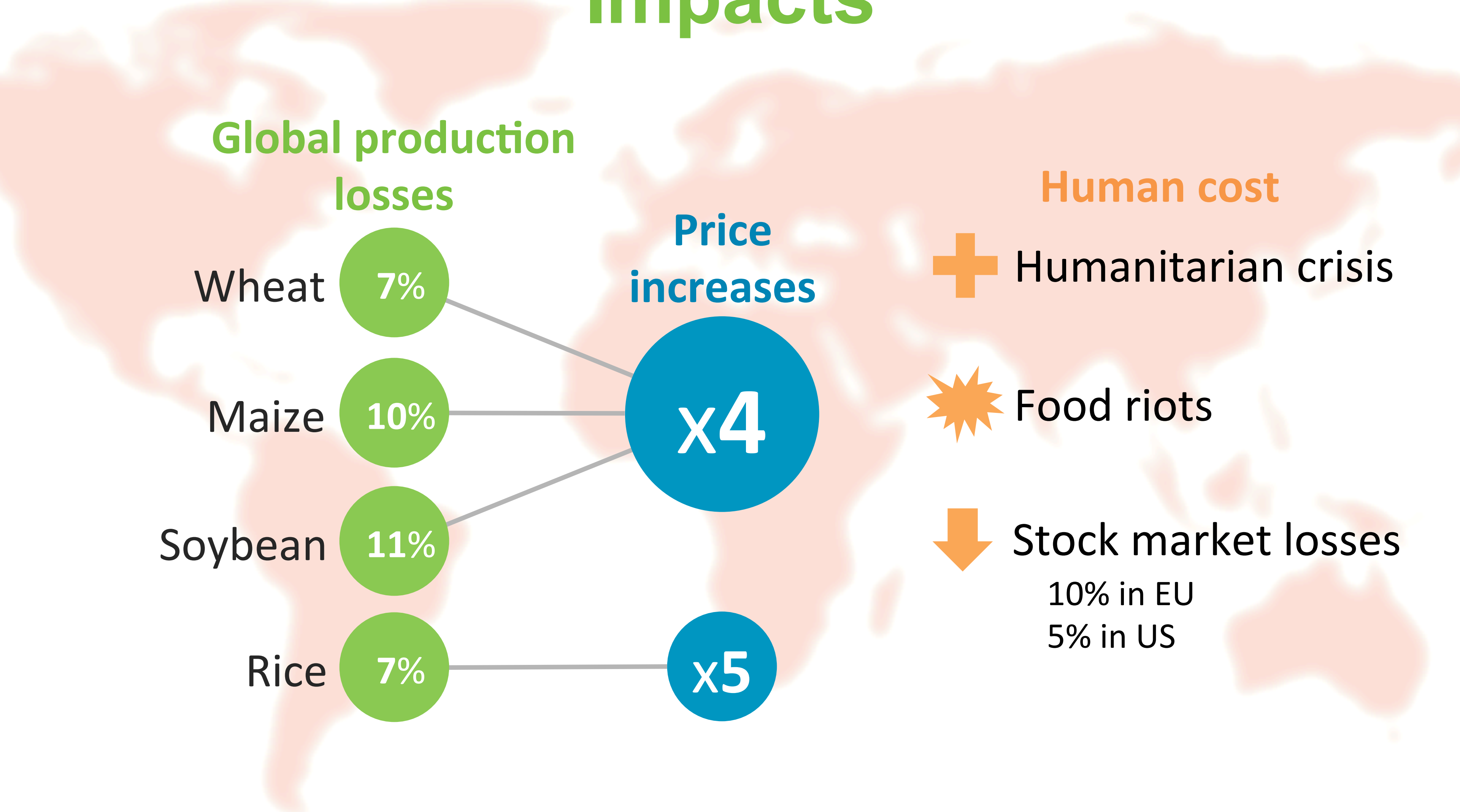
Impacts



Global production losses
Wheat
7%
Maize
10%
Soybean
11%
Rice
7%
Price increases
x4
x5
Human cost
Humanitarian crisis
Food riots
Stock market losses
10% in EU
5% in US

Integrated sustainable production

- Semi-arid, rainfed production systems: water = principal factor limiting crop productivity and risk factor
- Need to optimize rainfall use efficiency to cope with
  - heavy rainfall events
  - prolonged drought
- Further increase productivity by addressing other limiting factors like nutrient deficiencies
- Integration with a resilient the value chain
- Development of innovation networks

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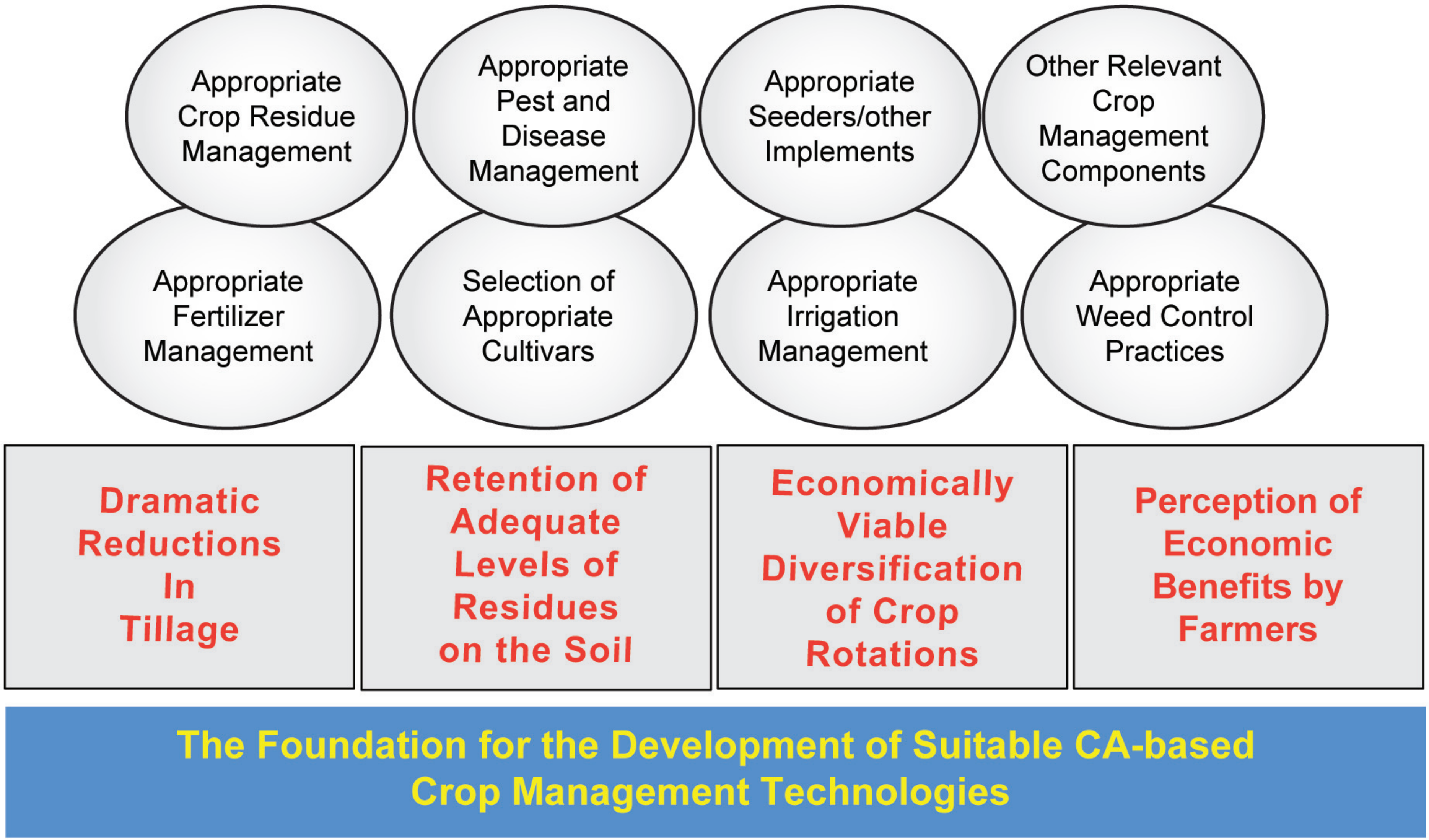
Conservation agriculture

- Based on three principles:
  - Minimal soil movement
  - Soil surface cover => rational
  - Crop rotation => economic
- Adapted to production system

The Four Principles of Conservation Agriculture Provide the Foundation to Develop, Validate and Deliver CA-based Crop Management Technologies

Appropriate Crop Management Component Technologies Must be Specifically Developed for Each Crop Production System



Long term trials

- in contrasting agro-ecological environments in Mexico

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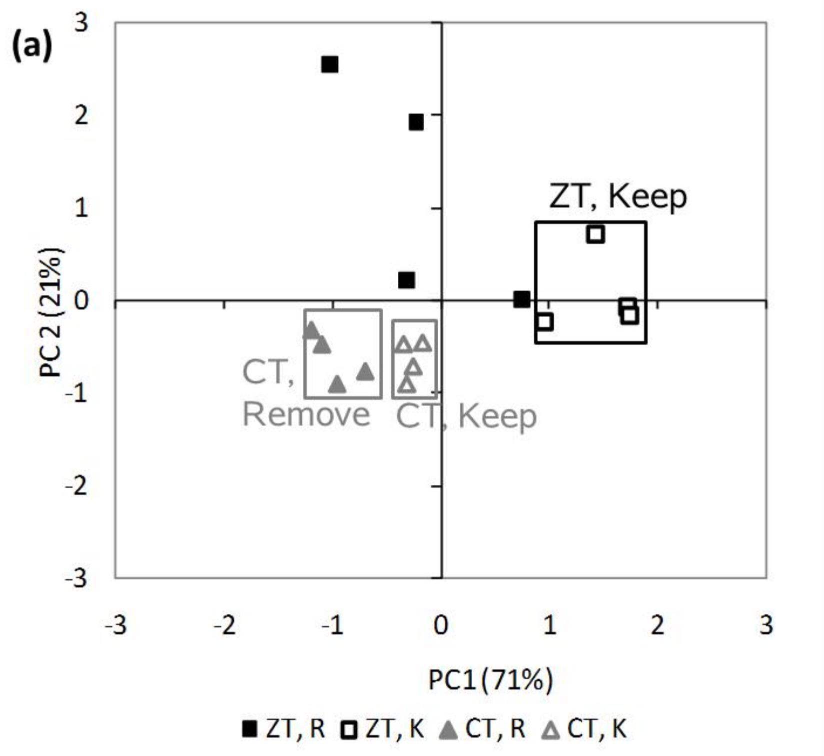
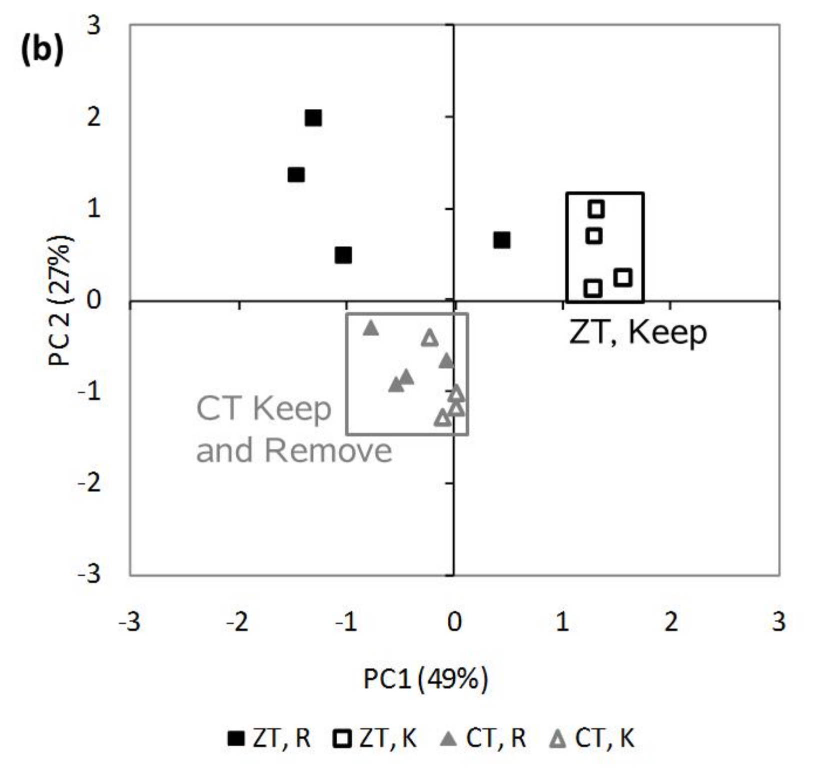
CA and soil quality

- Rainfed conditions in Central Mexico

Chemical soil quality



Physical soil quality



(Govaerts et al., 2006)

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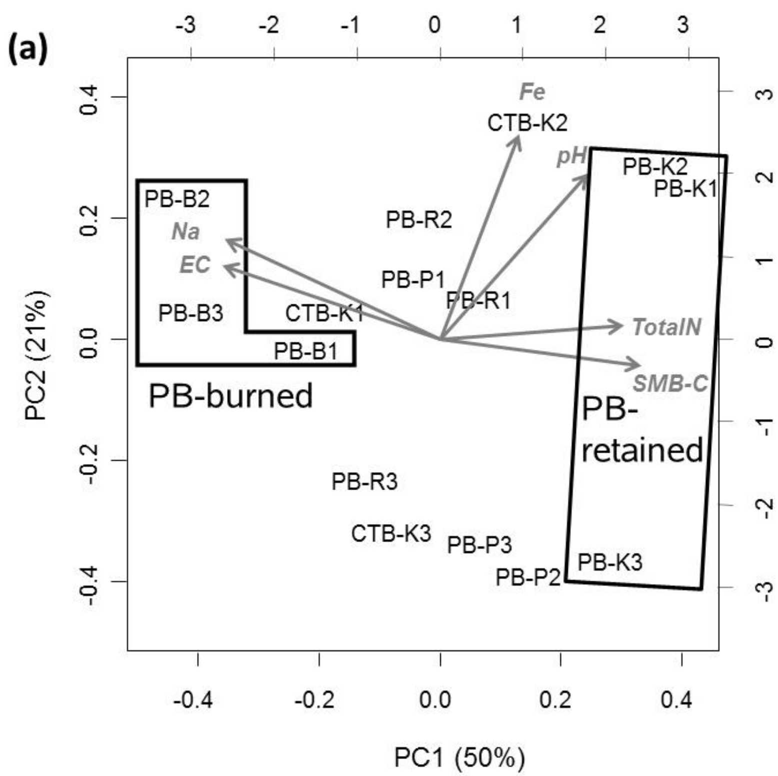
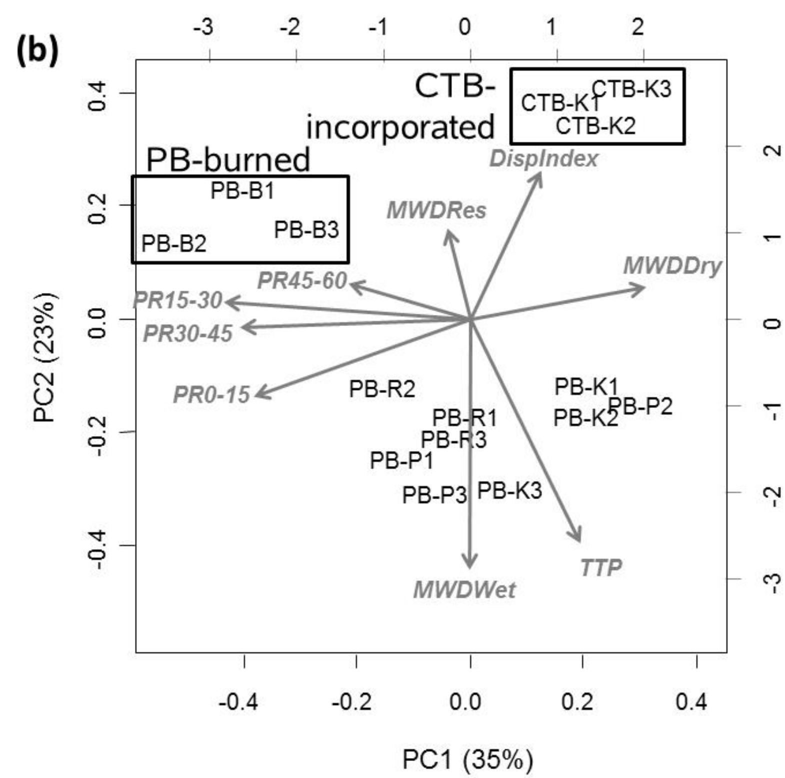
CA and soil quality

- Irrigated conditions in northwestern Mexico

Chemical soil quality



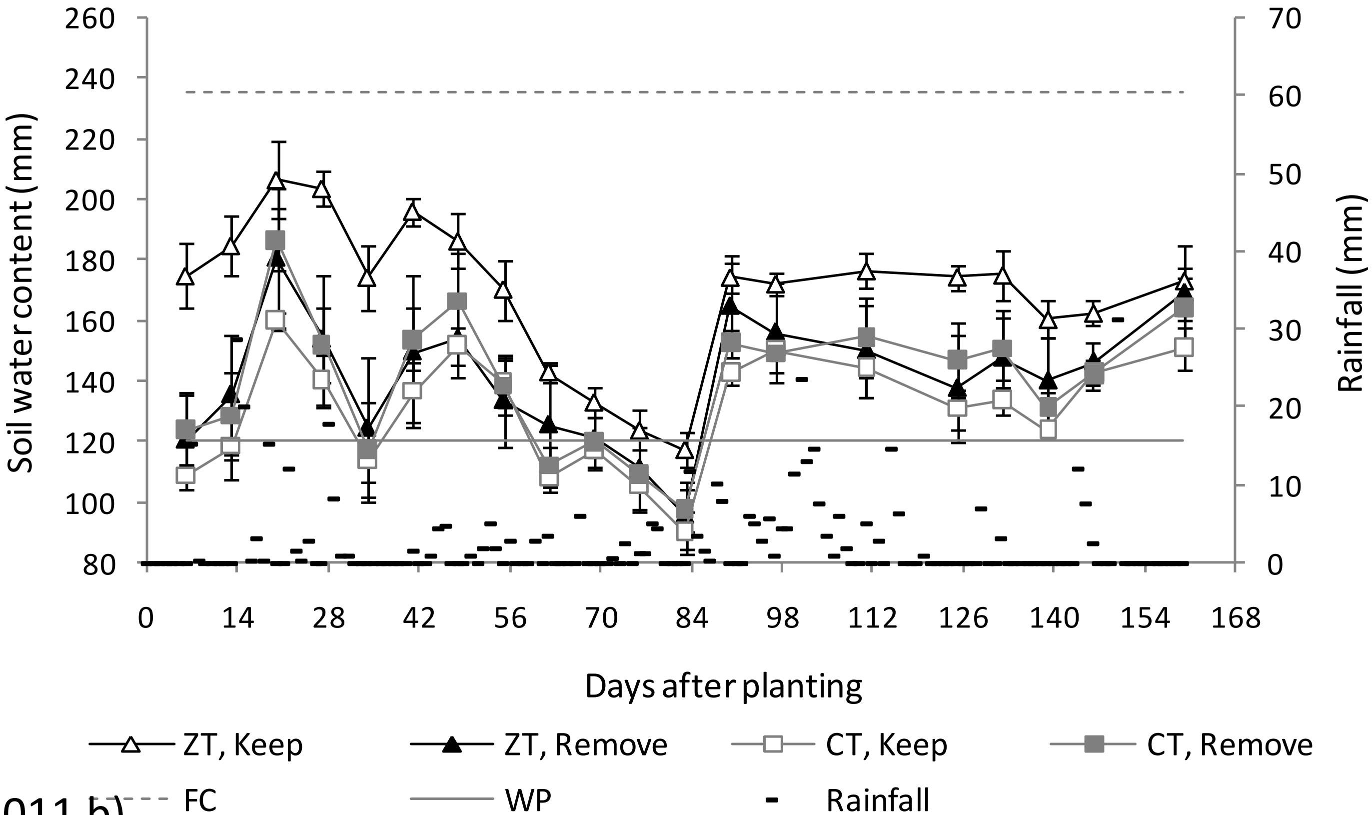
Physical soil quality



(Verhulst et al., 2011 a)

Rainfed conditions in central Mexico

- Soil water content (0-60 cm) in 2009 season (with severe drought 30-83 days after planting)



(Verhulst et al., 2011 b)

Rainfed conditions in central Mexico

- Maize yield (t ha^{-1} at 12% H_2O)

Management practice	2008		2009		1997-2009	
ZT, Keep	7.88 (0.20)	a	7.42 (0.63)	a	5.65 (0.02)	a
ZT, Remove	5.65 (1.26)	a	3.63 (0.30)	b	4.43 (0.27)	b
CT, Keep	6.65 (0.11)	a	2.71 (0.17)	b	4.59 (0.05)	b
CT, Remove	7.18 (0.96)	a	3.28 (0.67)	b	4.31 (0.23)	b

Conservation agriculture

Farmer practice

(Verhulst et al., 2011 b)

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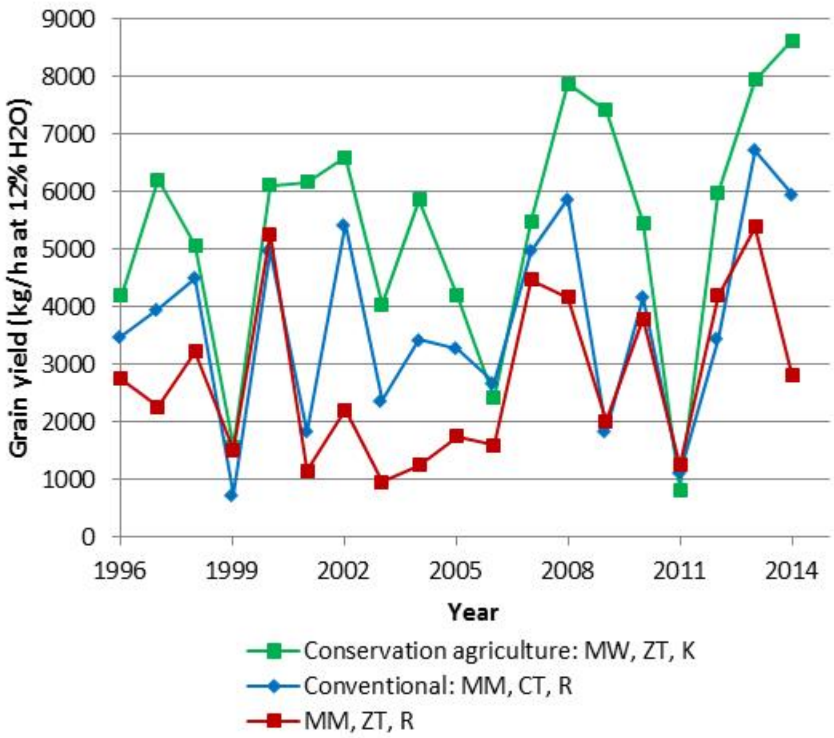
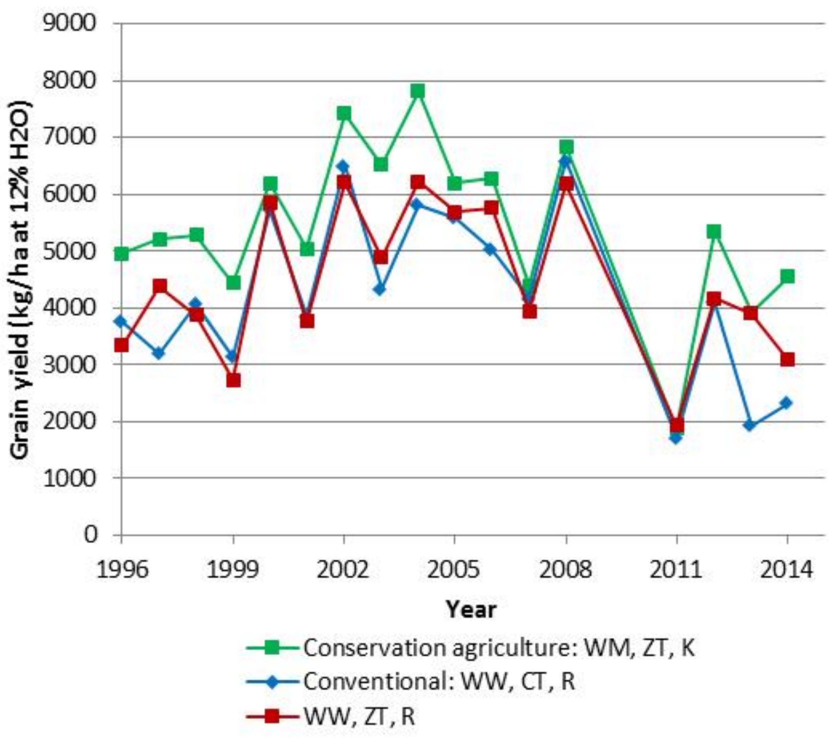
Results from LTT

- CA increases yield compared to conventional practices as well as resilience

Maize



Wheat



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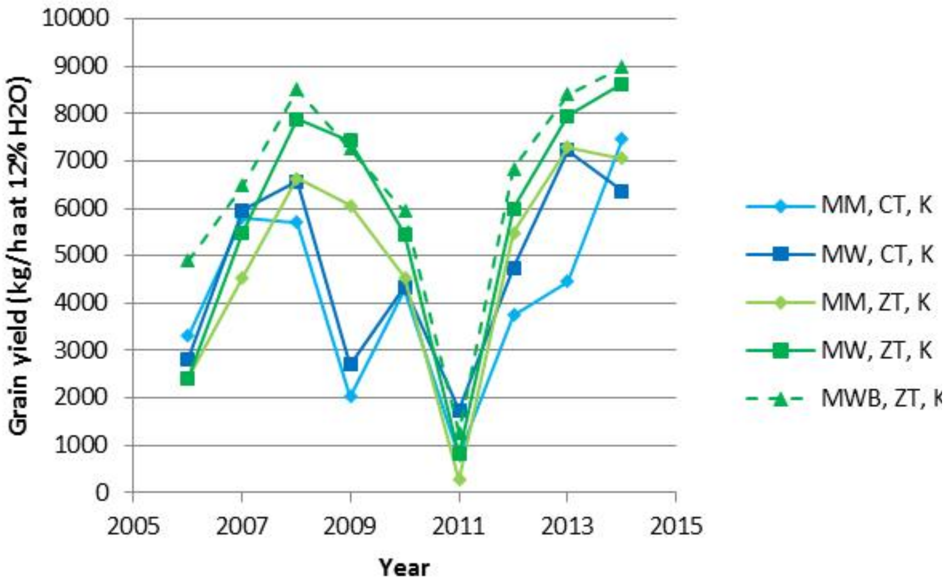
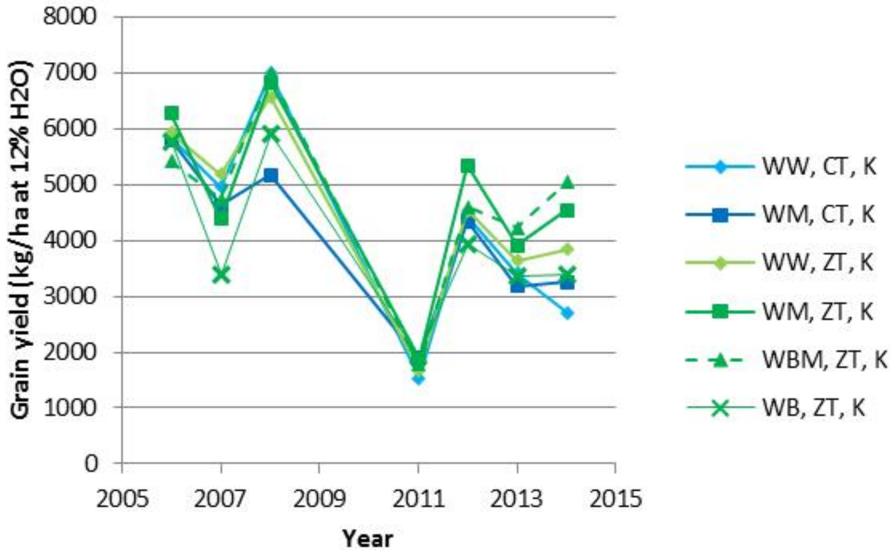
Results from LTT

- CA increases yield compared to conventional practices, and more so in more diverse crop rotations

Maize



Wheat



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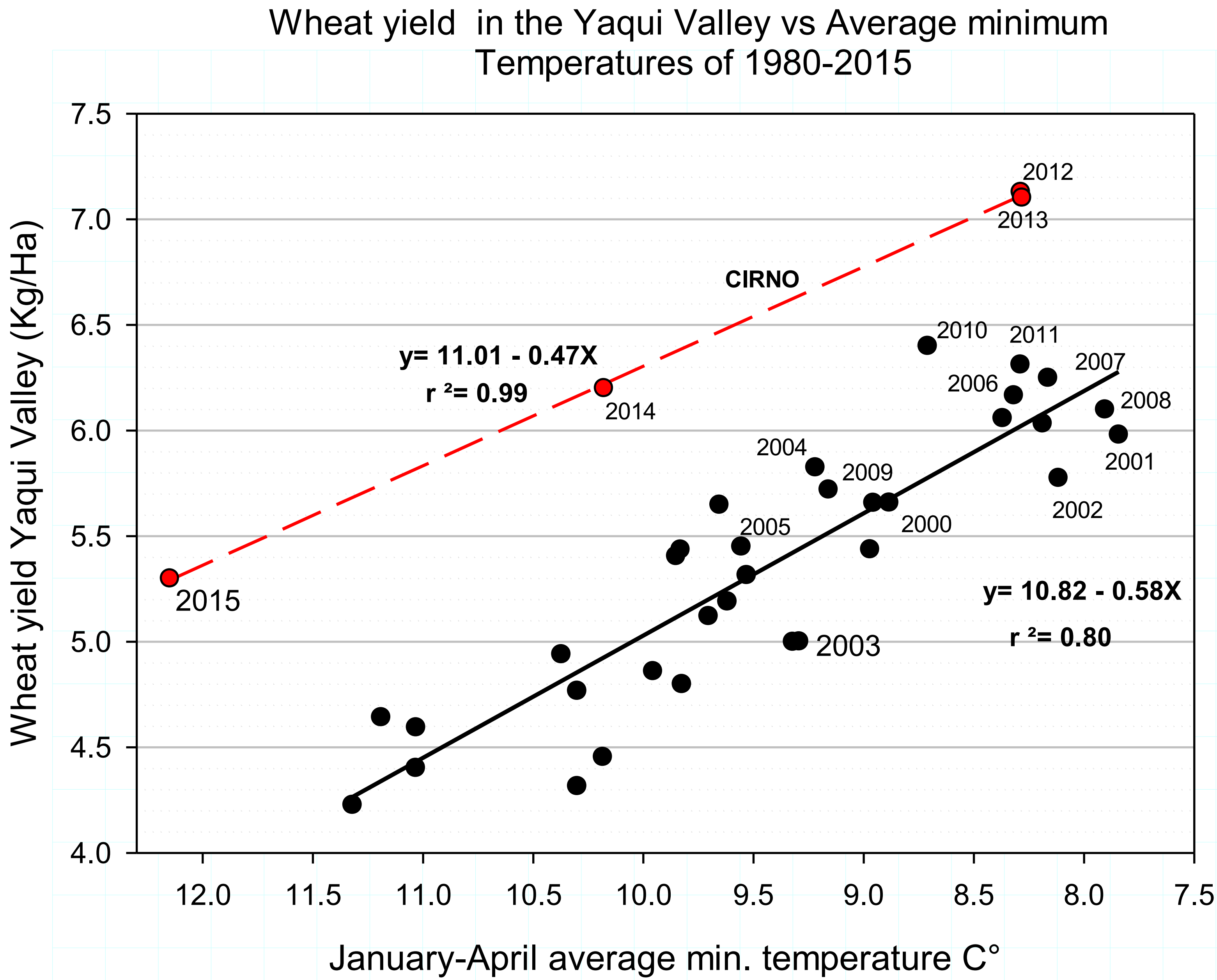
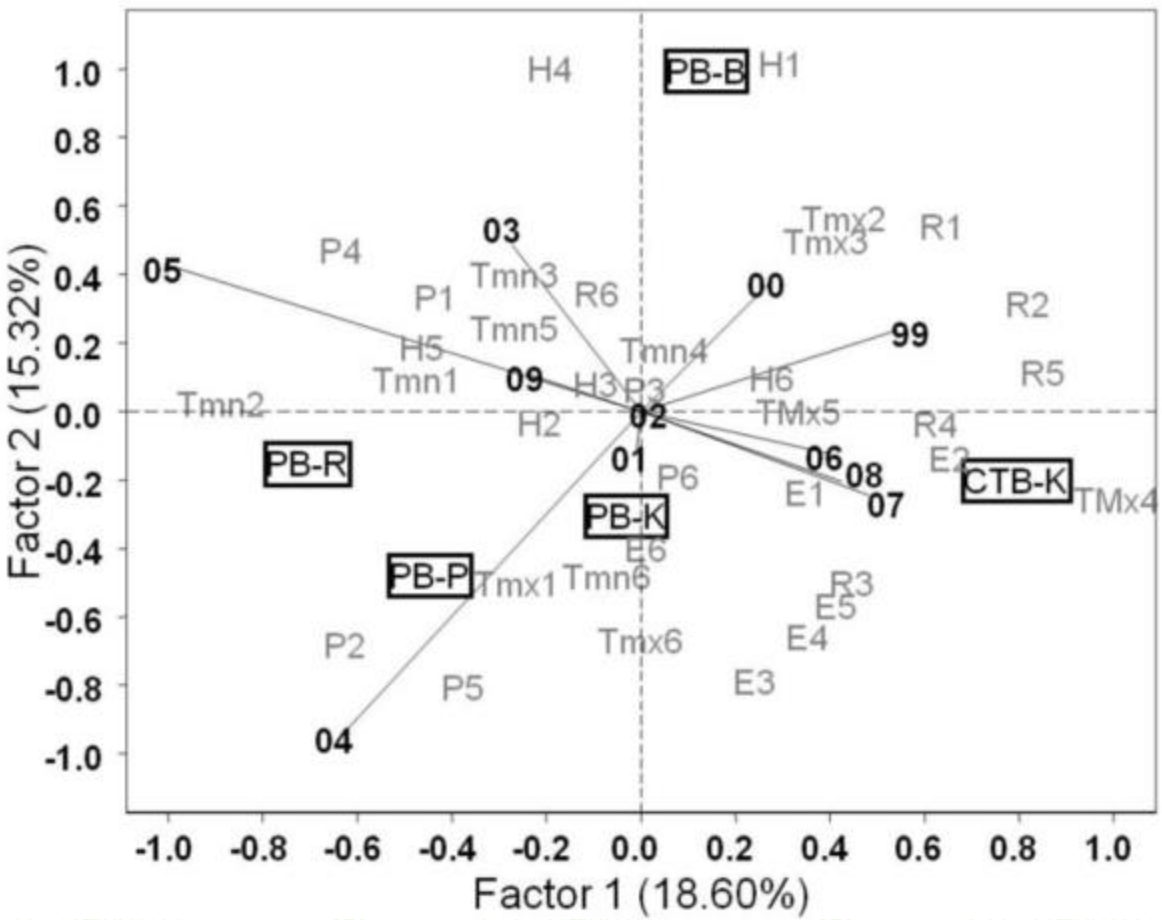


Ortiz-Monasterio y Lobell, 2015

Yield: system × year interaction explained by climatic co-variables



Years: 1999-2009
Climatic variables:
H= relative humidity
Tmn= minimum temp
Tmx= maximum temp
R= radiation
E= ET_0
P= precipitation

1, …, 6= Periods of the growing season
1 ≈ emergence
2 ≈ tillering
3 ≈ stem elongation and booting
4 ≈ head emergence
5 ≈ flowering
6 ≈ grain filling

Verhulst et al., 2011 d

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Optimize the second limiting factor

- Maize-wheat rotation and wheat monoculture
- Permanent beds (PB) and conventionally tilled beds (CB)
- 4 fertilizer treatments:

Trt	N dose (urea) at planting	N dose (urea) at V4/1st node	Abbreviation
1	0 kg N/ha	0 kg N/ha	0 N
2	80 kg N/ha	0 kg N/ha	80 N planting
3	0 kg N/ha	80 kg N/ha	80 N V4/1st node
4	40 kg N/ha	40 kg N/ha	40 N planting - 40 N V4/1st node

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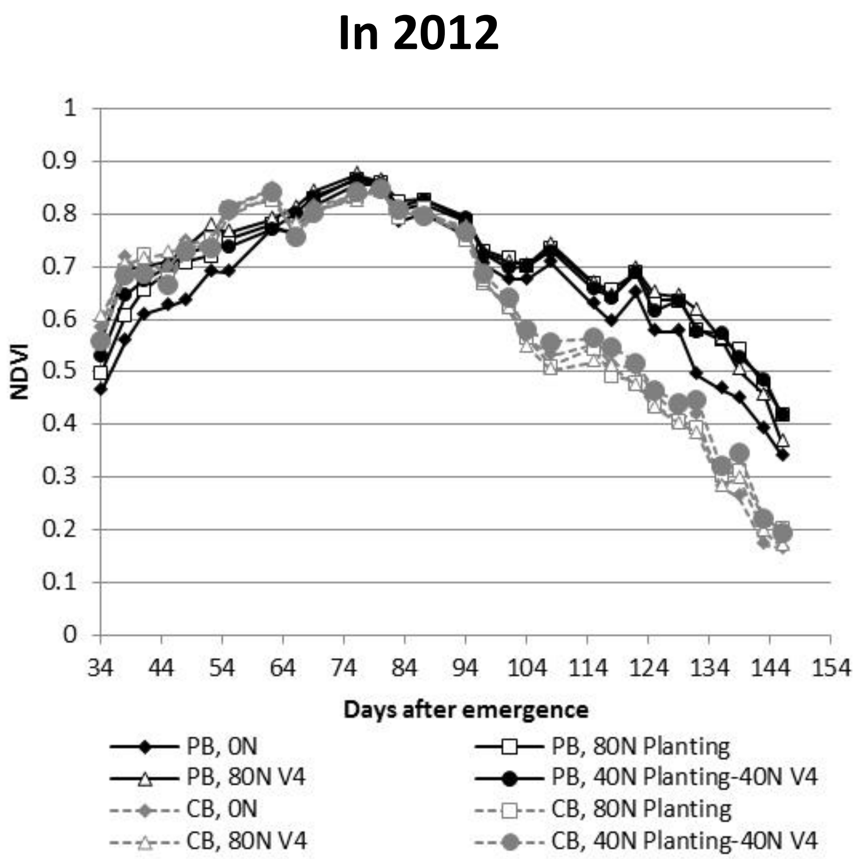
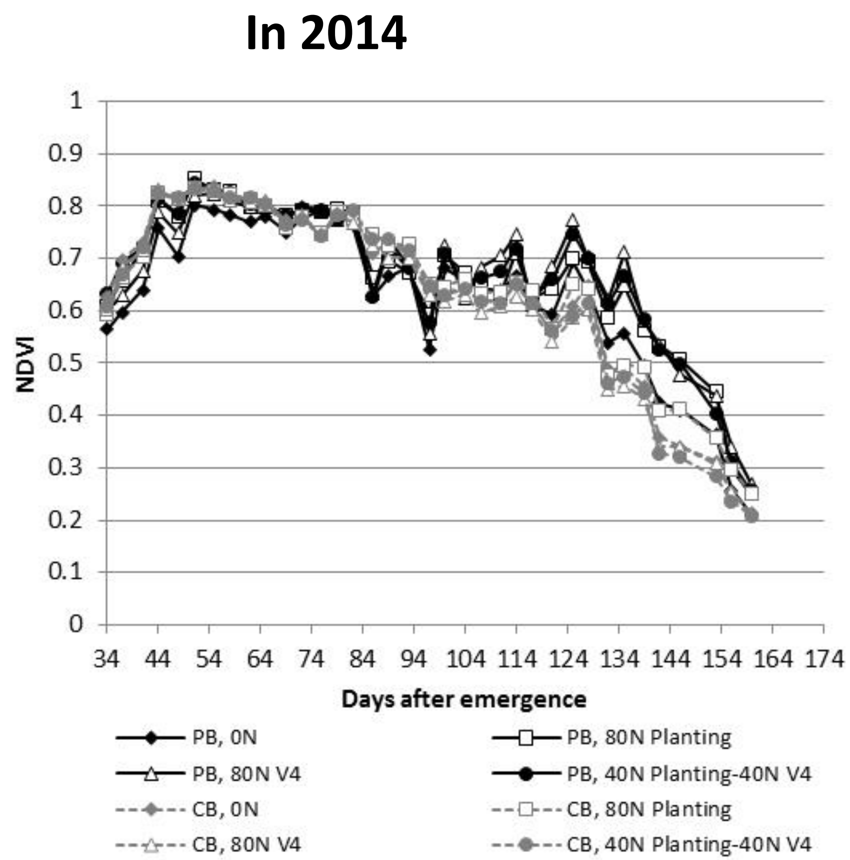
Fertilizer experiment - maize

- NDVI: CB (grey) values decrease faster than in CA

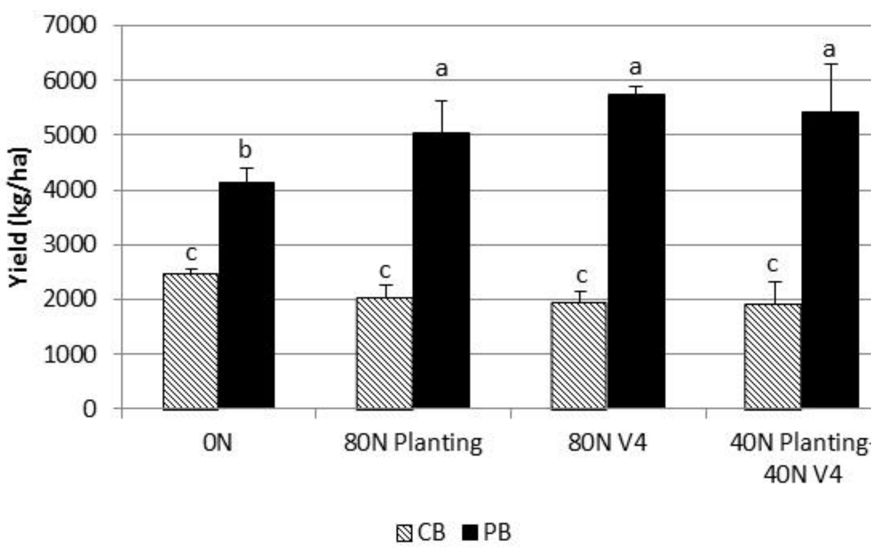




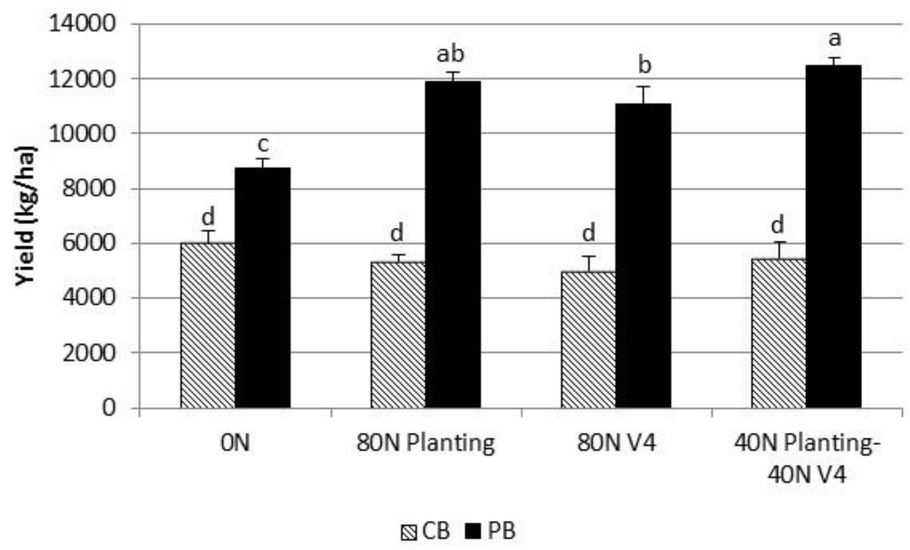
Fertilizer experiment - maize

- Yield:
  - Under CB: low yields, fertilizer does not increase yield
  - Under CA:
    - Without fertilizer yield higher than under CB
    - Fertilizer application increases yield

2012



2014



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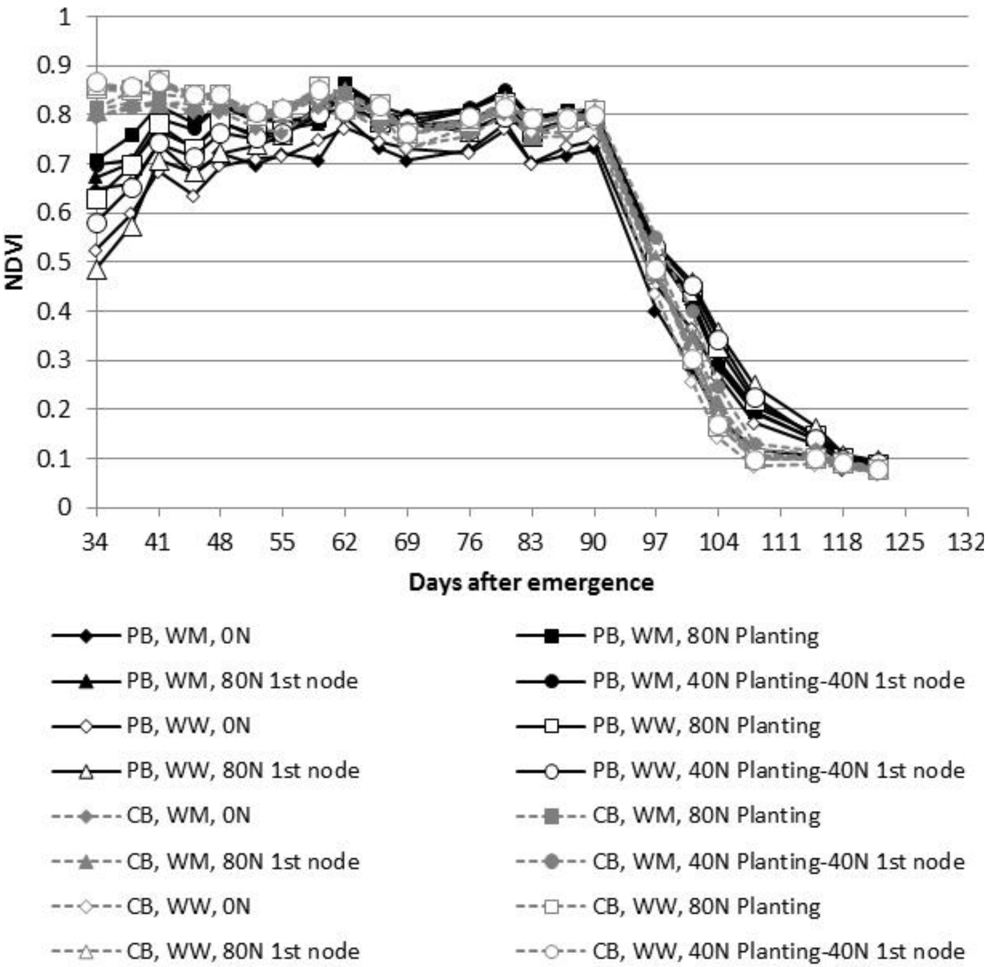
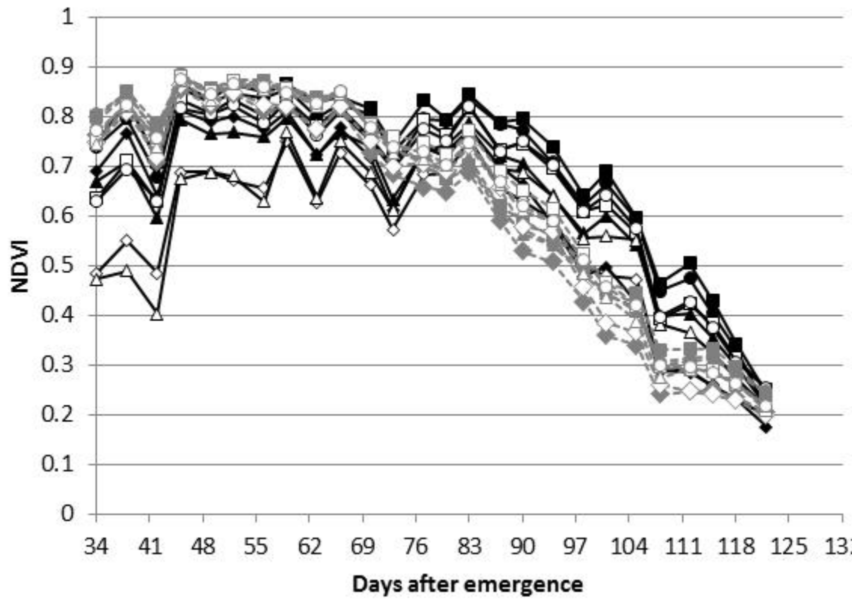
Fertilizer experiment - wheat

- NDVI

In 2012



In 2014



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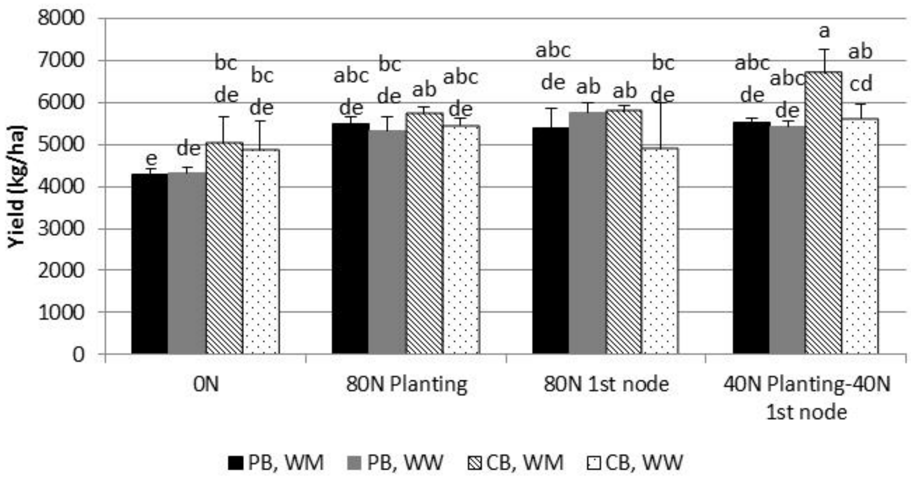
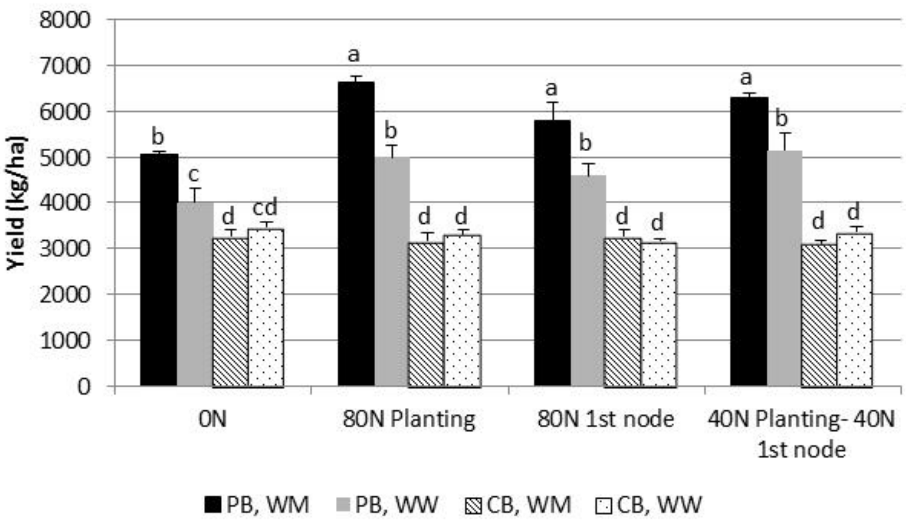
Fertilizer experiment - wheat

- Yield:
  - In 2012, few differences
  - In 2014 under CB: low yields, fertilizer does not increase yield
  - In 2014 under PB with monoculture: higher yield than CB & fertilizer increases yield; lower yield than with rotation (tan spot)
  - In 2014 under CA: higher yield than both other tillage-rotation practices & fertilizer increases yield

2012



2014



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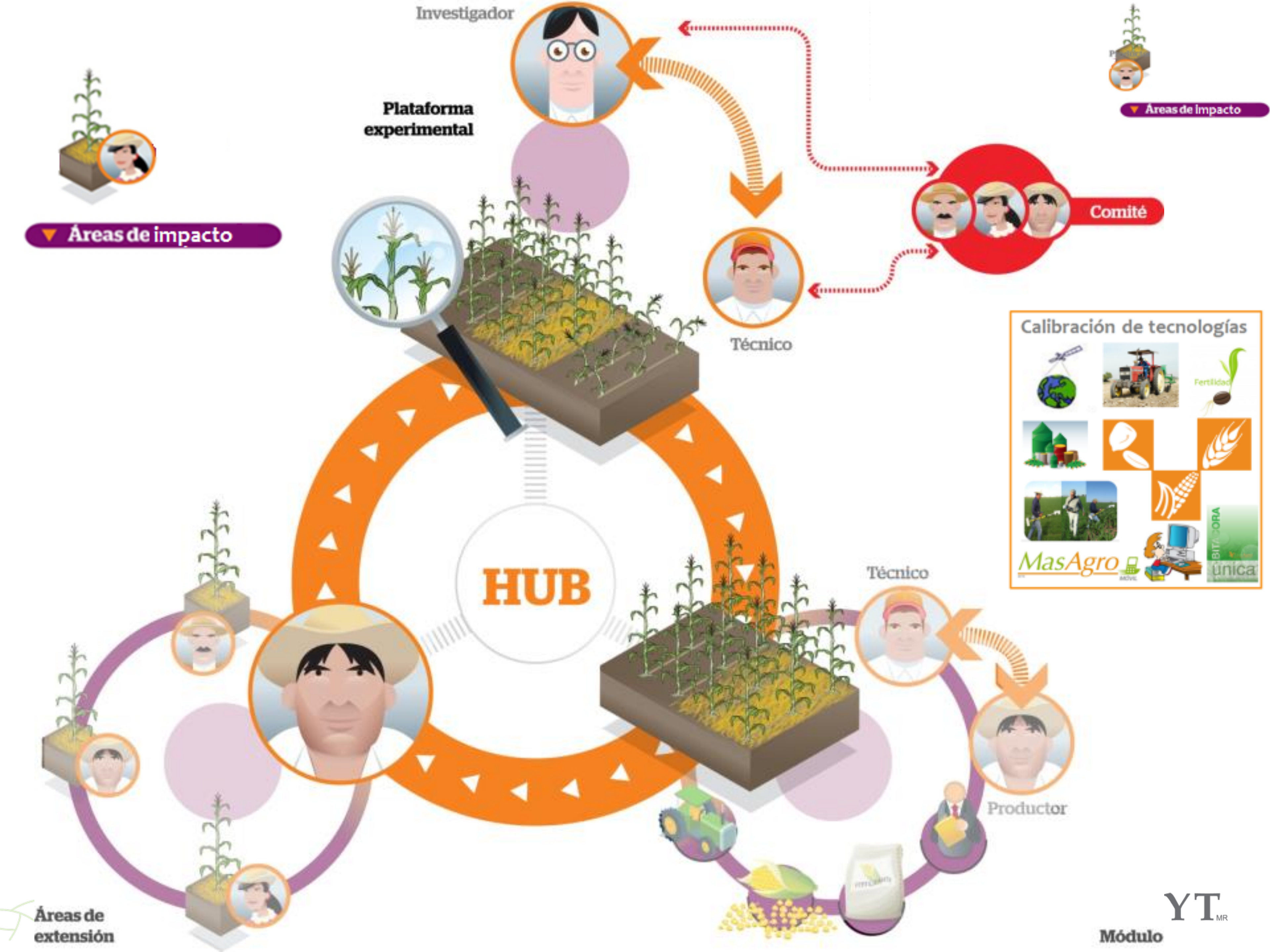
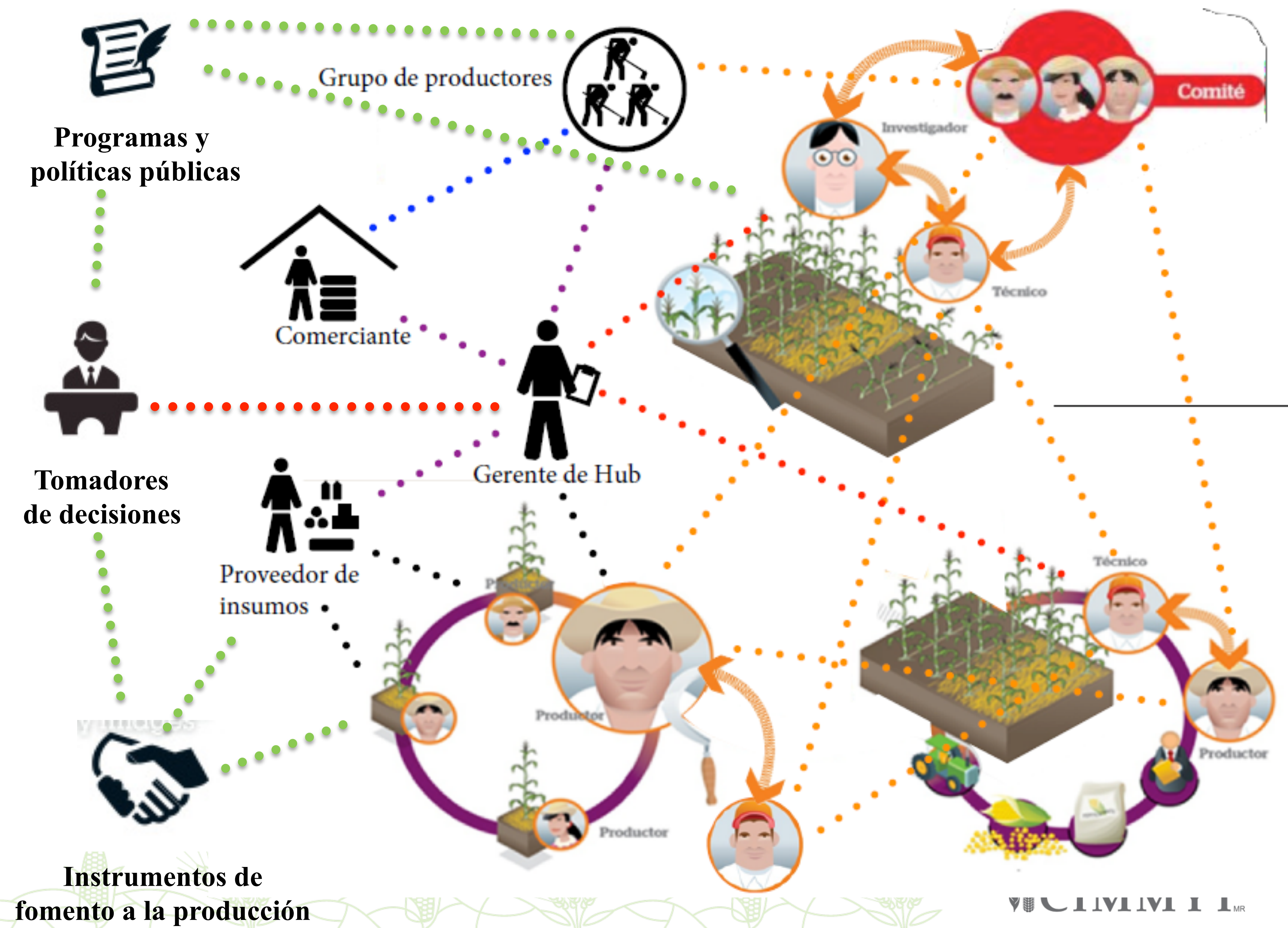
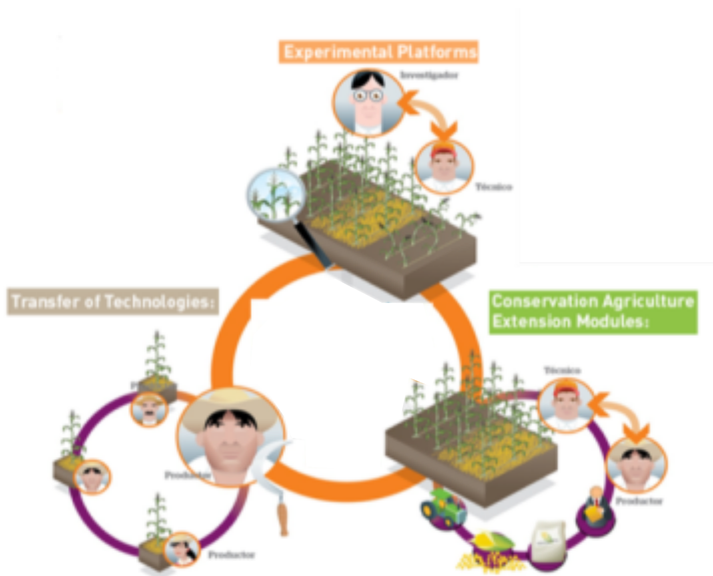
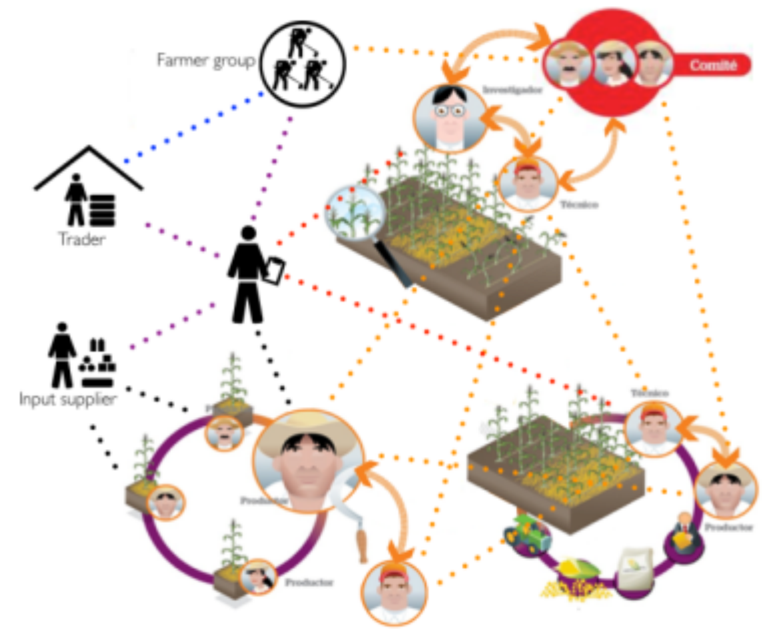

Investigador
Plataforma experimental
Áreas de impacto
Áreas de impacto
Comité
Técnico
Calibración de tecnologías
Fertilidad
MasAgro
BITÁCORA
única
HUB
Técnico
Productor
Áreas de extensión
Módulo
YT MR


Programas y políticas públicas
Grupo de productores
Comité
Investigador
Técnico
Comerciante
Gerente de Hub
Tomadores de decisiones
Proveedor de insumos
Productor
Productor
Productor
Técnico
Productor
Instrumentos de fomento a la producción

Research on the model per se





- Transfer-of-technology
- technology focus
- CA
- hub = 3 structures
- linear

- brokering
- actor focus
- sustainable intensification
- hub = network
- dynamic network

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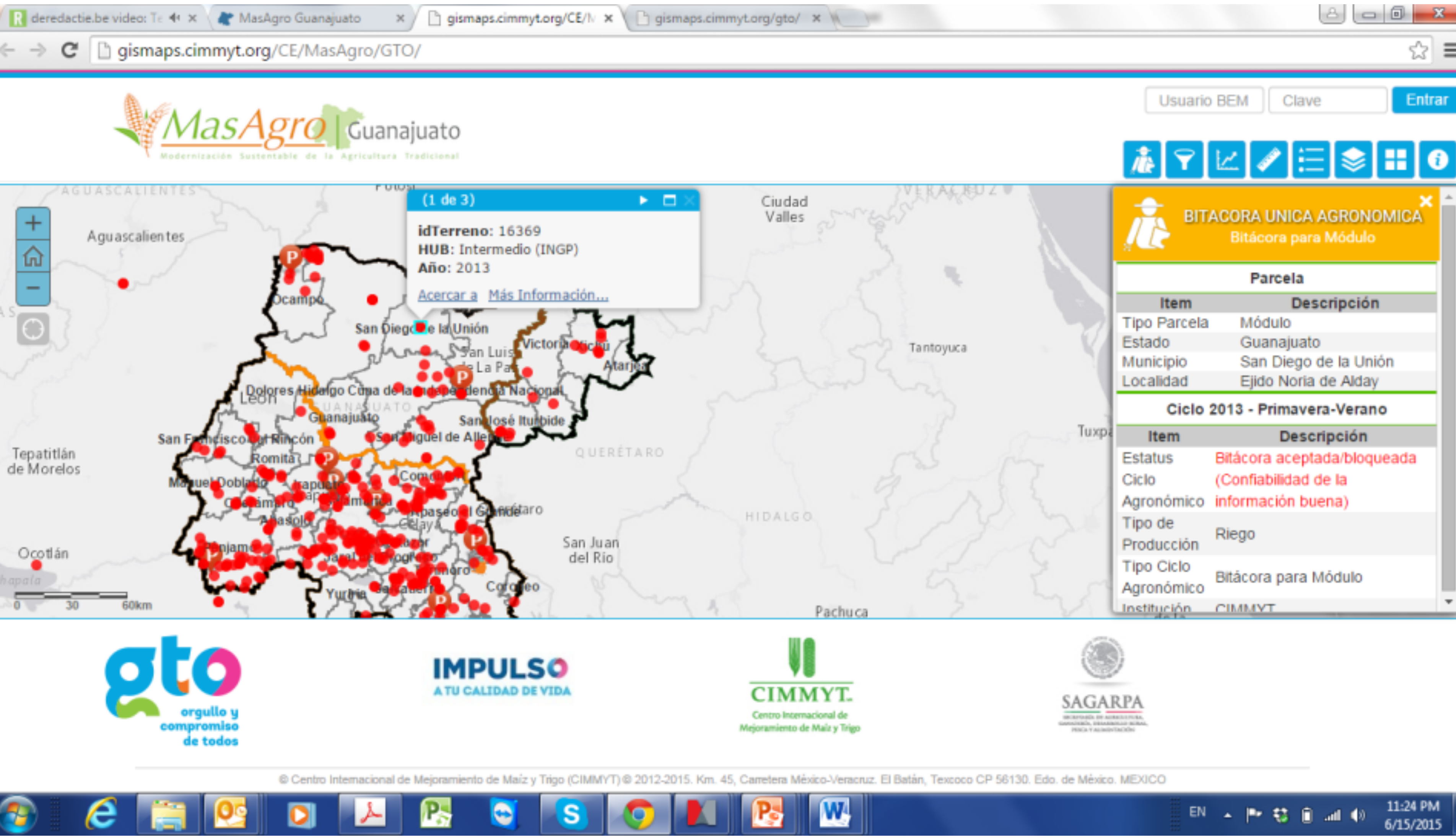
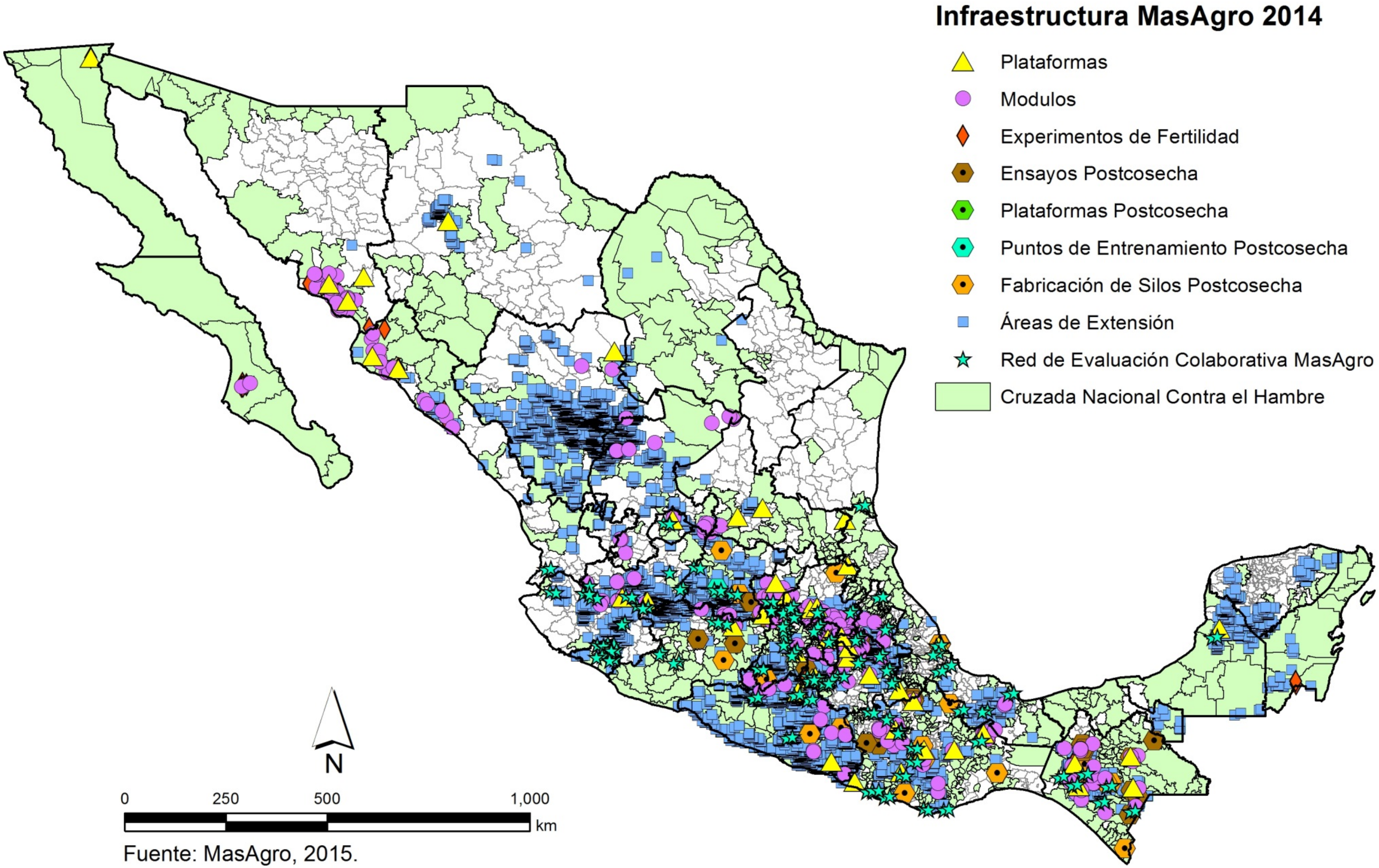
M&E4L → SDG



gismaps.cimmyt.org/CE/MasAgro/GTO/
MasAgro Guanajuato
Usuario BEM
Clave
Entrar
(1 de 3)
idTerreno: 16369
HUB: Intermedio (INGP)
Año: 2013
Acercar a
Más Información...
BITACORA UNICA AGRONOMICA
Bitácora para Módulo
Parcela
Item
Descripción
Tipo Parcela
Módulo
Estado
Guanajuato
Municipio
San Diego de la Unión
Localidad
Ejido Noria de Alday
Ciclo 2013 - Primavera-Verano
Item
Descripción
Estatus Ciclo Agronómico
Bitácora aceptada/bloqueada (Confiabilidad de la información buena)
Tipo de Producción
Riego
Tipo Ciclo Agronómico
Bitácora para Módulo
Aguascalientes
Ciudad Valles
Tantoyuca
QUERÉTARO
HIDALGO
San Juan del Río
Pachuca
Tepatitlán de Morelos
Ocotlán
gto
orgullo y compromiso de todos
IMPULSO
A TU CALIDAD DE VIDA
CIMMYT
Centro Internacional de Mejoramiento de Maíz y Trigo
SAGARPA
© Centro Internacional de Mejoramiento de Maíz y Trigo (CIMMYT) © 2012-2015. Km. 45, Carretera México-Veracruz. El Batán, Texcoco CP 56130. Edo. de México. MEXICO
11:24 PM
6/15/2015



Fuente: MasAgro, 2015.

Results on the ground

Strategic partners and potential collaborators

440.000 ha with technologies and improved agronomic practices

1.000.000 ha with indirect influence

Over **200.000 producers**

21% **women**

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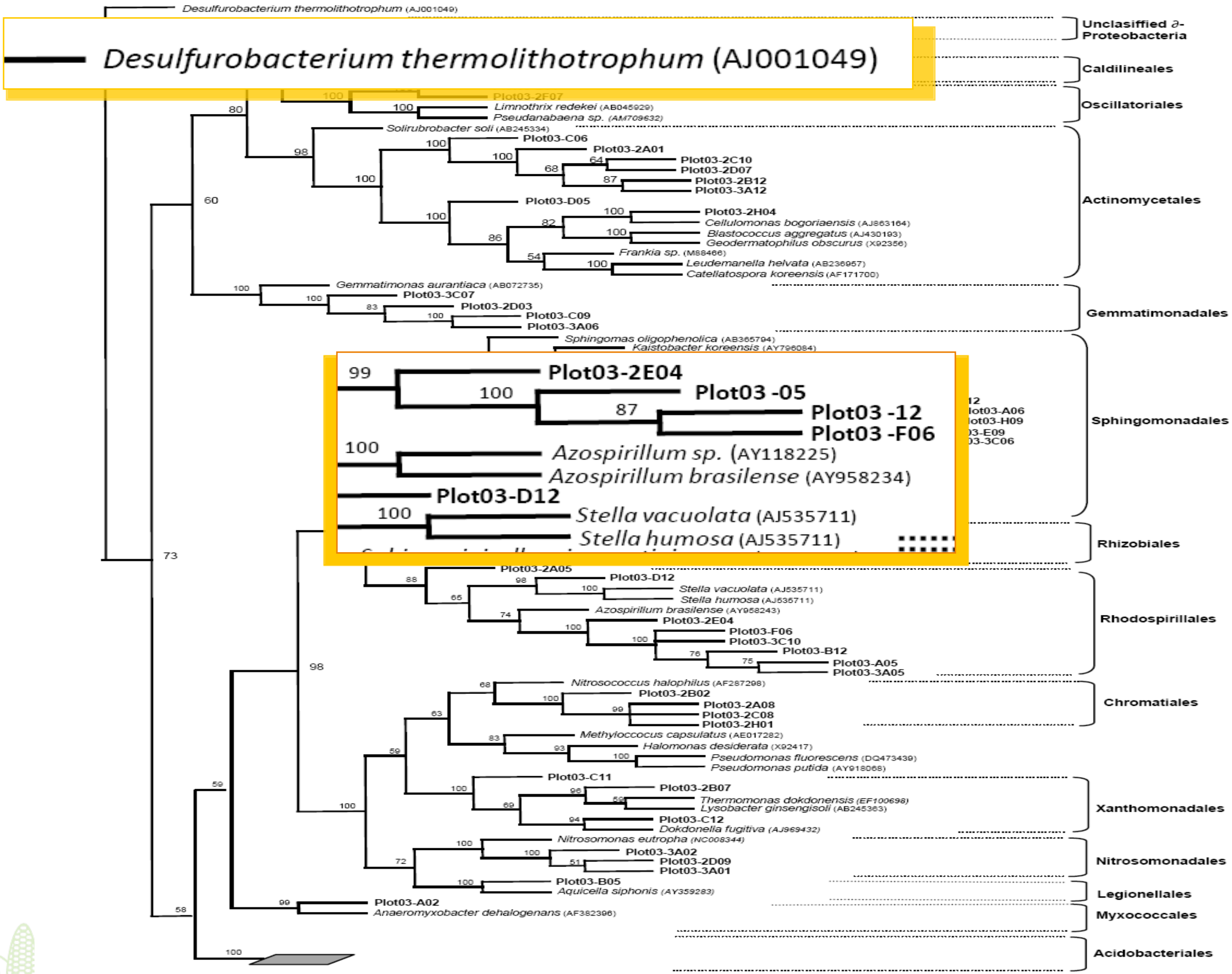
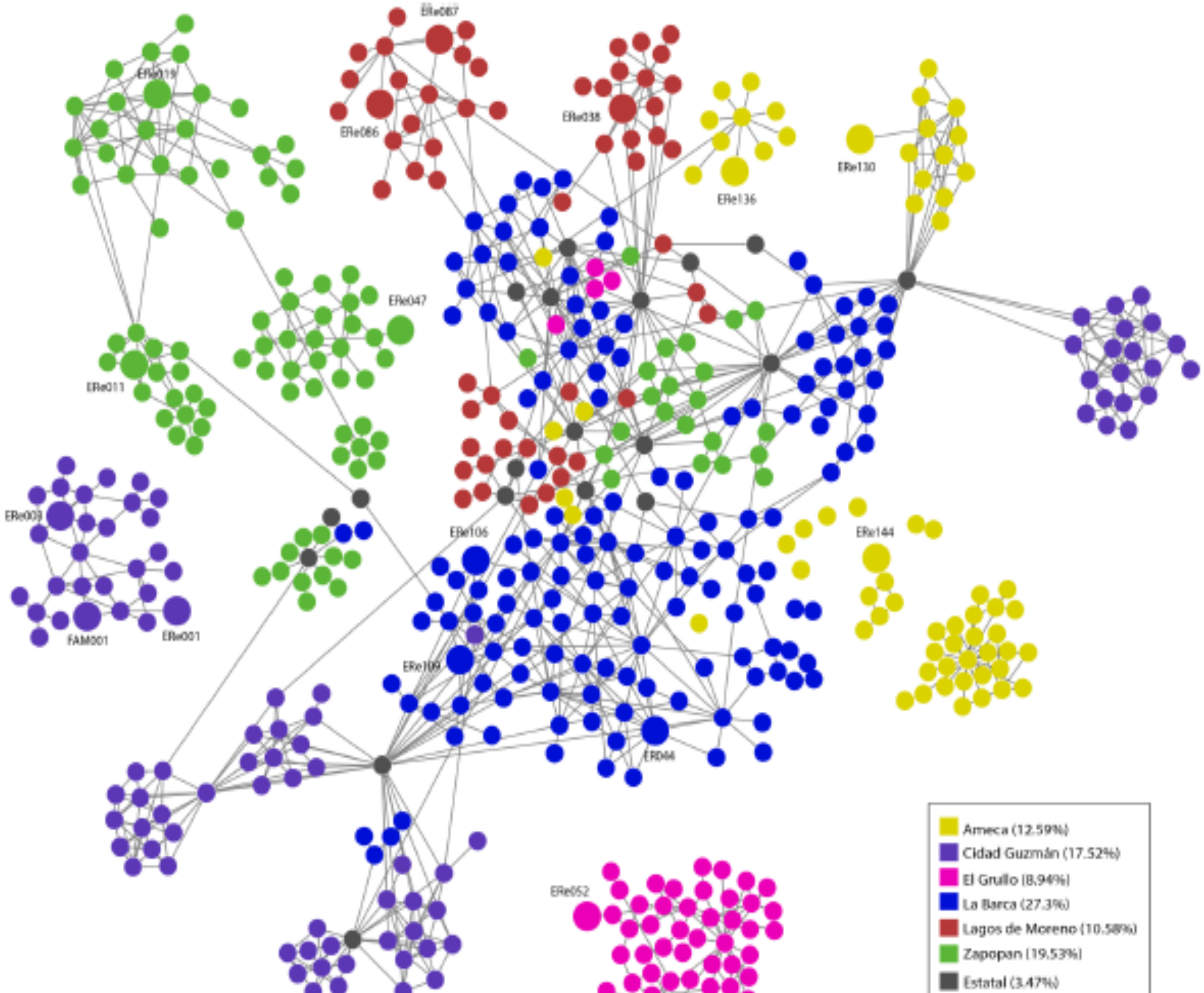


(Ceja-Navarro et al., 2010)

Mapping of Interventions




big
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petabytes
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future
development
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nas
process
technology
research
science
world
internet
technologies
volume
million
size
learning
billion
management
government
mapreduce
terabytes
initiative
national
well
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flow
year
business
terms
countries
even
end
times
real
economic
parallel
cost
critiques
sensor
between
many
approaches
amount
analytics
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high
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state
use
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applications
institute
determine
people
trends
challenges
work
databases
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include
every
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replication
hypothesis
limits
scientific
worldwide
framework
computer
second
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queries
ability
database
handle
users


eronica
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Wes
Whitney
Will
Yesenia

Knowledge Systems for Sustainability

To equip humanity with the ability to manage the complex risks emerging from mounting pressures on Earth's food, water, and energy systems, by mobilizing science and technology across multiple disciplines and across public, private and civil sectors to provide system-oriented, scale-appropriate, actionable solutions.

IIASA International Institute for Applied Systems Analysis

The Earth Institute Columbia University

Oak Ridge National Laboratory

CSIRO

Battelle The Business of Innovation

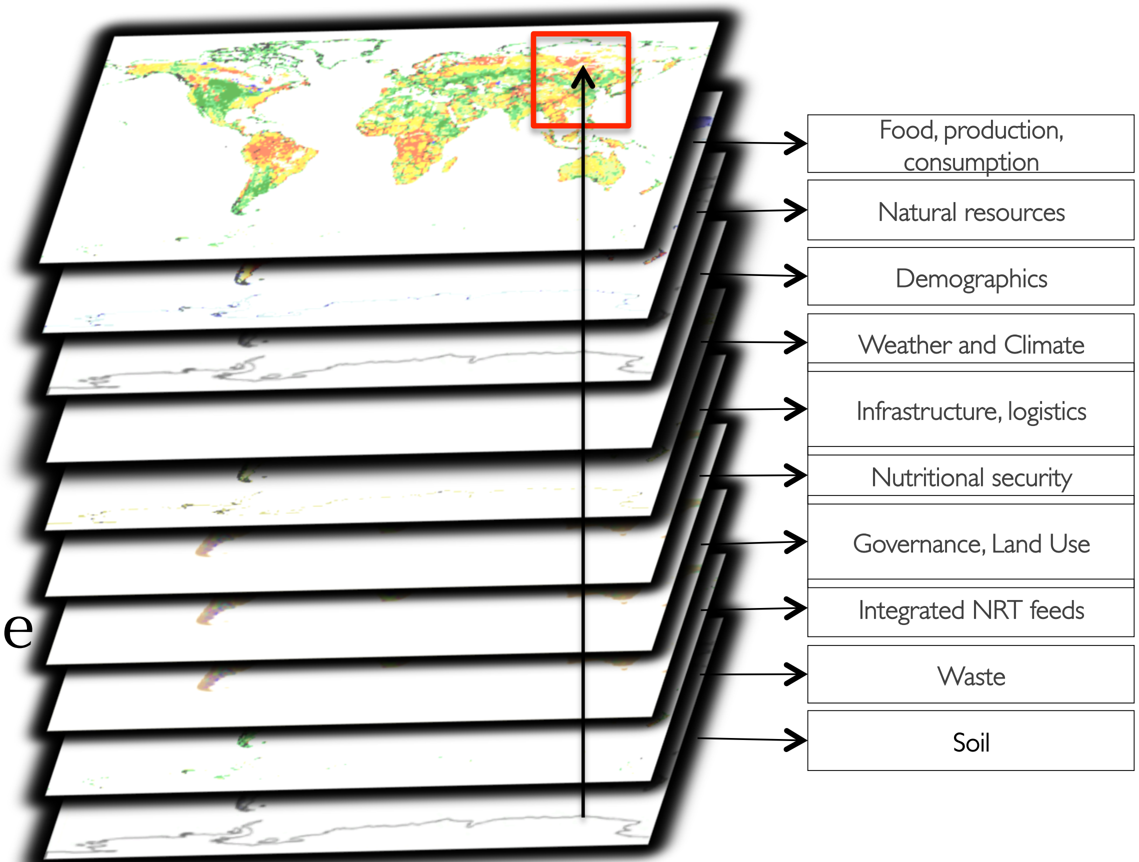
CIMMYT

Wisconsin University of Wisconsin-Madison

Photos: Yann Arthus-Bertrand

Core Product: Knowledge systems that allow us to scan for patterns, zero in on places, learn from our actions at scale

- *Data, information, and knowledge* assets
- *Modeling* of complex systems
- *Learning systems*
- *Decisions* about management that advance securities

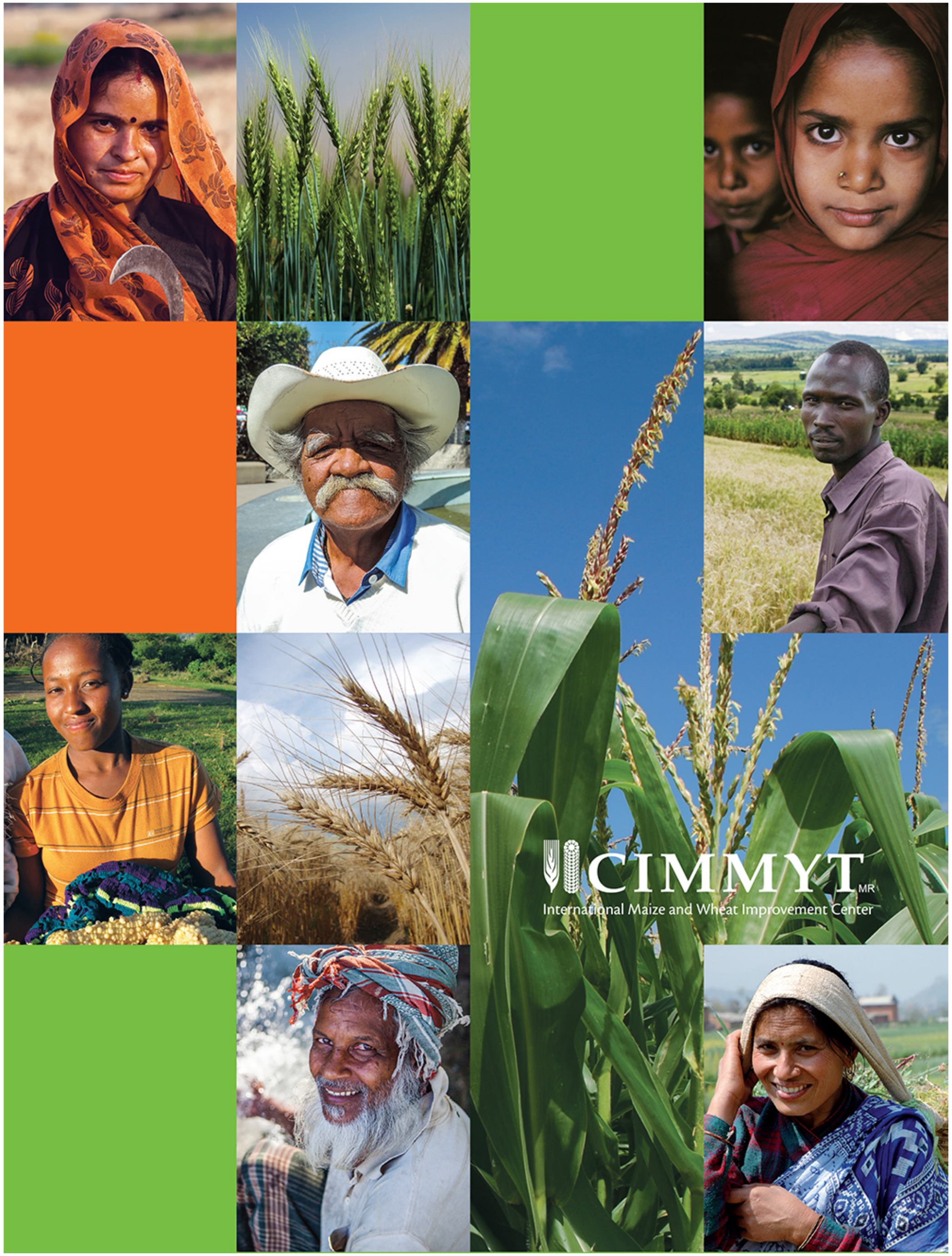


Importable and exportable actionable insights shared between critical decision makers such that scalable, repeatable actions can be replicated

Innovation

Inspiration

Intensification



Thank you for your interest!

Transitioning Cereal Systems to Adapt to Climate Change

REACCH

Regional Approaches to Climate Change –

PACIFIC NORTHWEST AGRICULTURE

Thank you!

University of Idaho

Washington State University

USDA NIFA

United States Department of Agriculture
National Institute of Food and Agriculture

Oregon State University OSU

CHS

Pacific Northwest Farmers Cooperative

Monsanto