Systems analysis and agroecosystems in transition:
Research Insights from South Asia with relevance for the South East

Timothy J. Krupnik and many, many colleagues and partners

Sustainable Intensification Program

International Maize and Wheat Improvement Center (CIMMYT)

CIMMYT MR
International Maize and Wheat Improvement Center

CGIAR Research Program on WHEAT

CGIAR RESEARCH PROGRAM ON Maize

CGIAR RESEARCH PROGRAM ON Climate Change, Agriculture and Food Security CCAFS

CIMMYT's research program on Sustainable Intensification

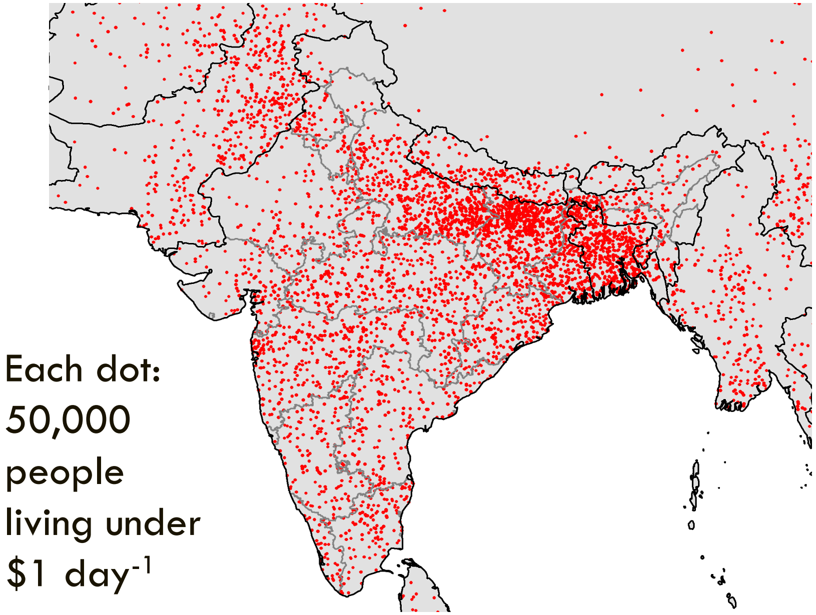
Resilient and productive farming systems

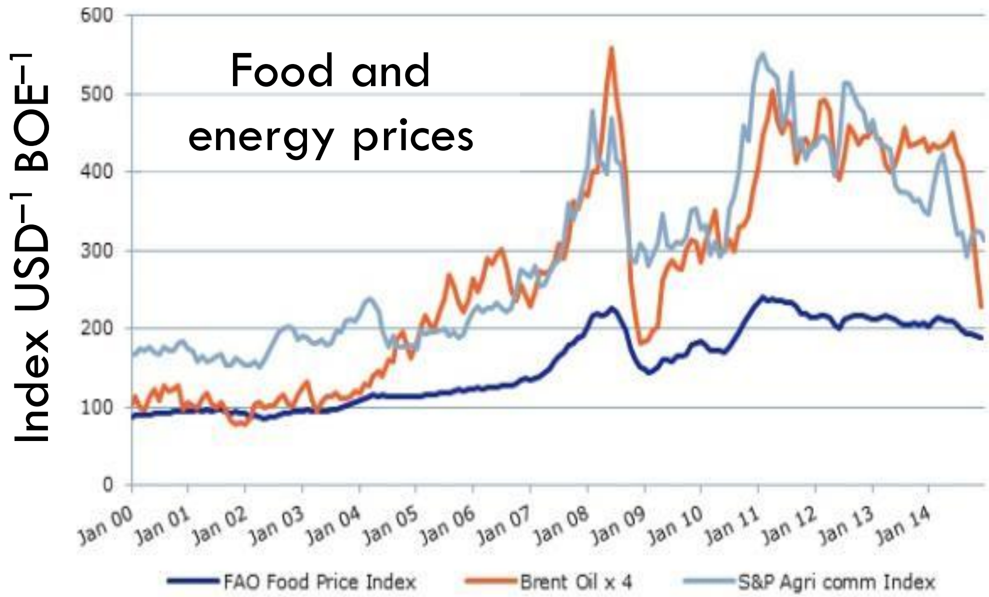
Socially acceptable and equitable

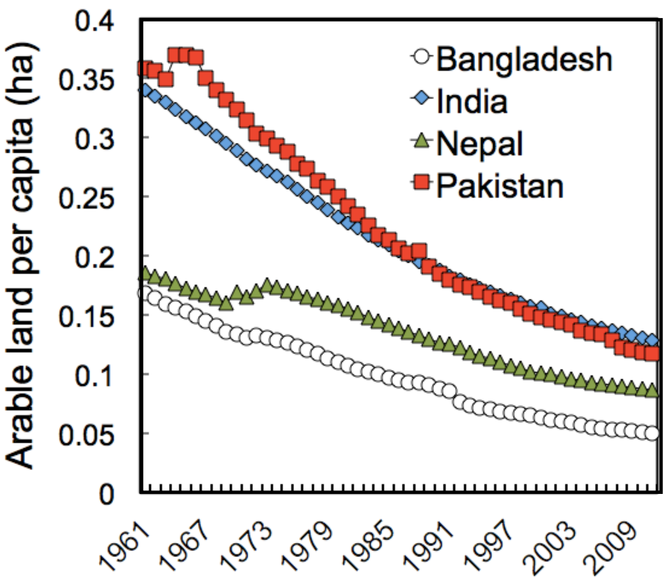
Profitable and equitable farming systems

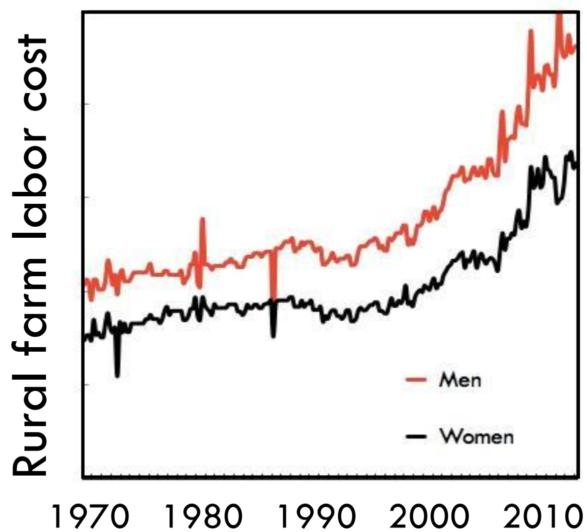
Mobilizing ecosystem services, lowering environmental Impact

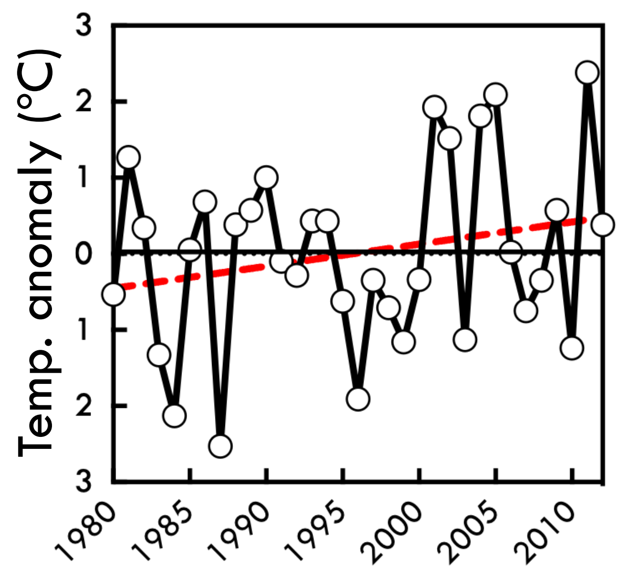
Population - Energy – Diets – Water – Labor – Land - Climate





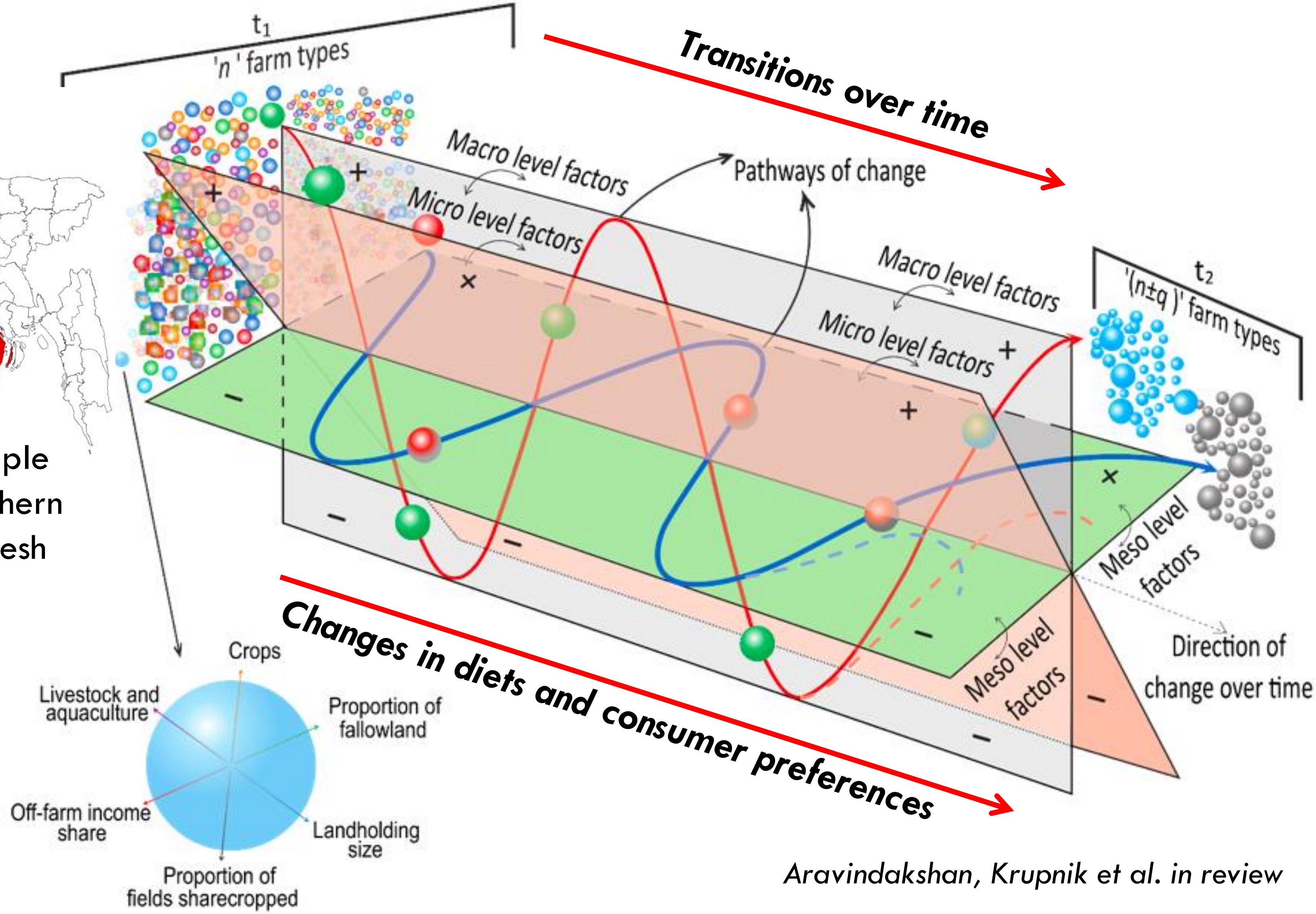






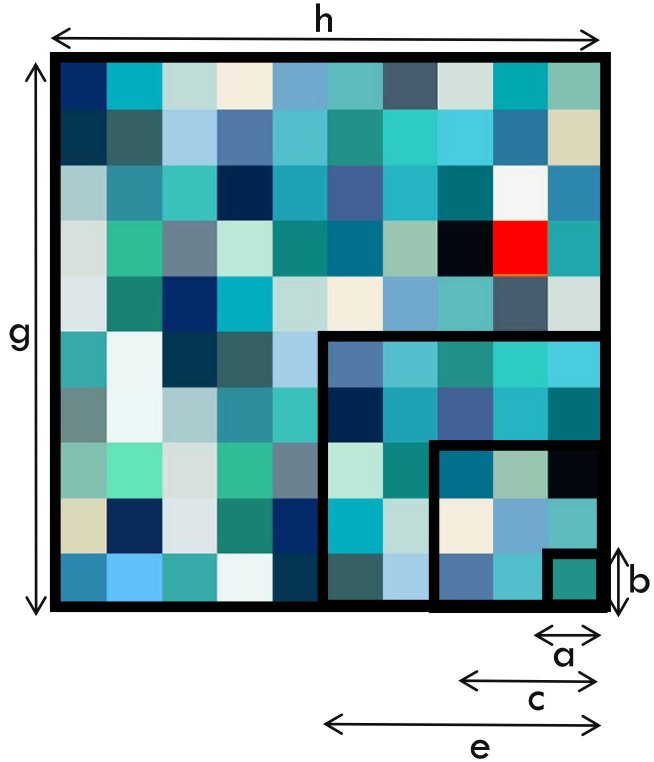
Socioecological systems in transition

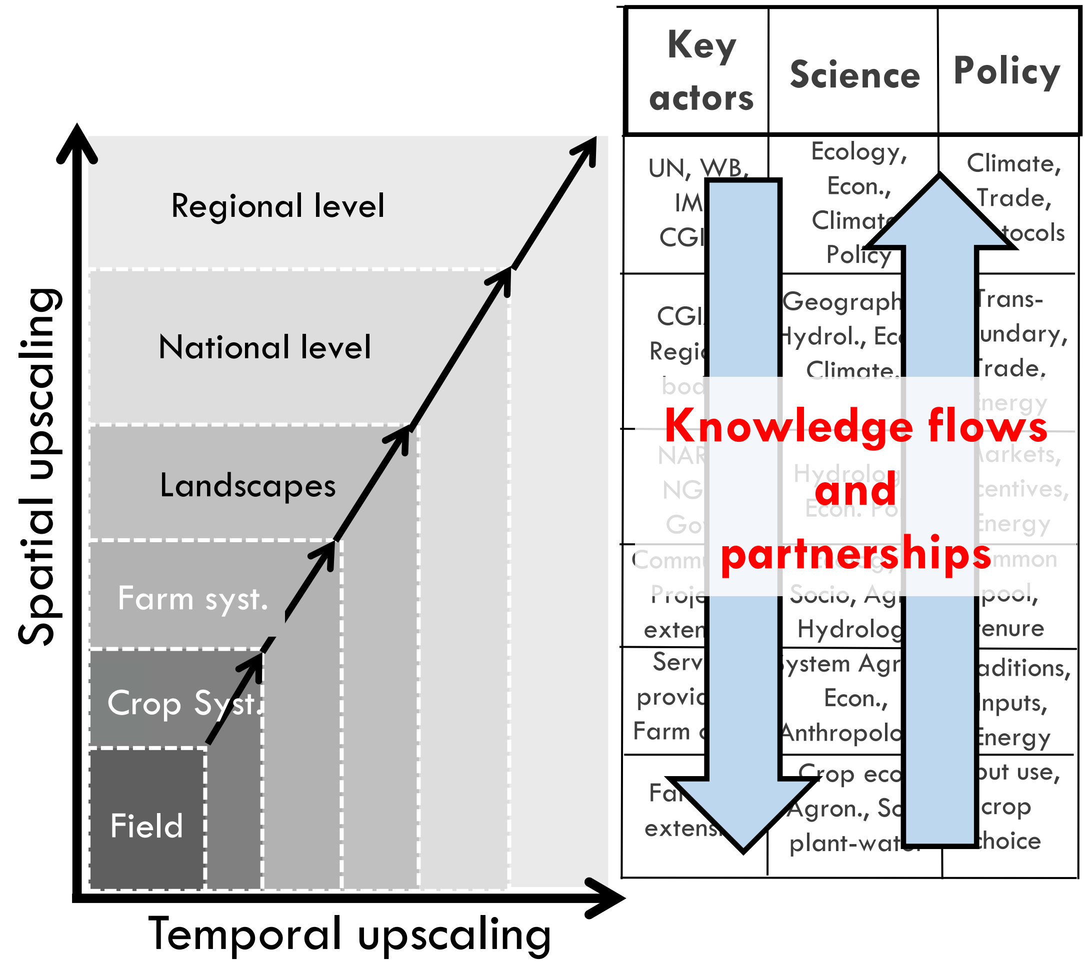
An example from Southern Bangladesh



Aravindakshan, Krupnik et al. in review

Systems analysis applied to agriculture





Cropping system = a x b
Farming system = c x d
Community = e x f
Landscape = h x g
Meso-landscape = (h x g) x *l*
National → Regional → Global

Based on & courtesy of Ewert et al, 2011; Ewert 2017

- Study of components, processes, procedures and interactions with the whole
- Goal: Efficiency, sustainability, resilience

Cropping systems scale

Farming systems scale

Landscape scale

Country scale

Regional market system scale

Multi-criteria rice-maize tillage systems analysis: Three years of farmer-managed experiments

Conventional

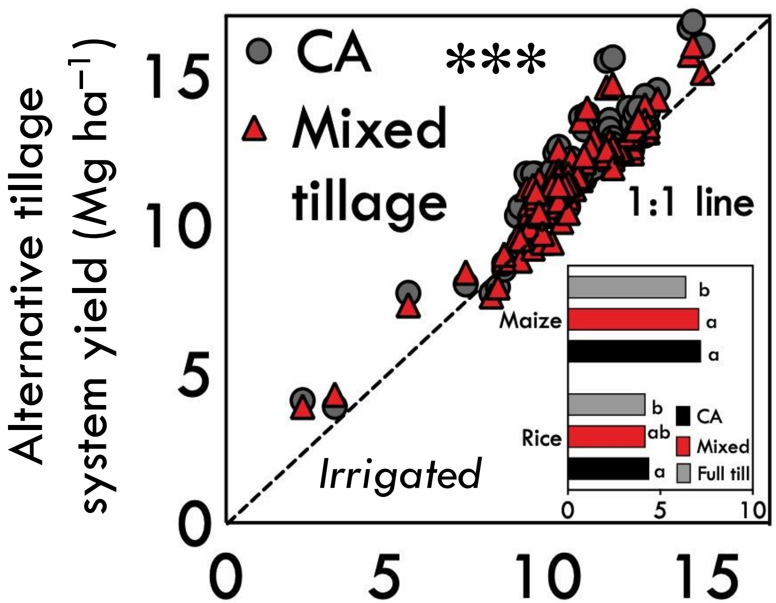
Monsoon rice

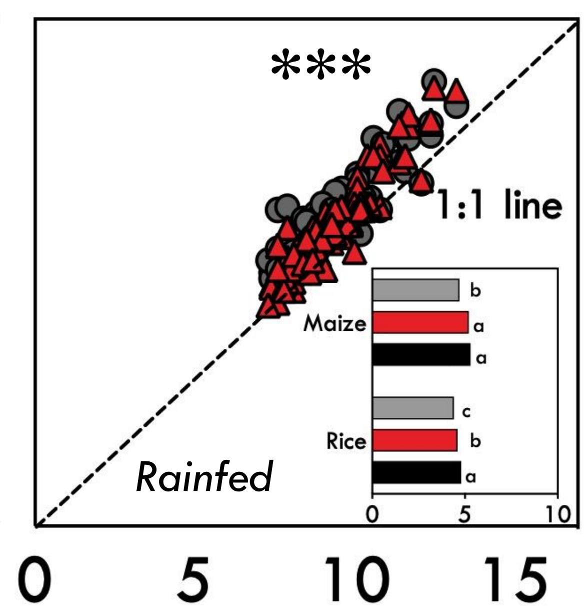
Winter maize

Conservation agriculture

Monsoon rice

Winter maize





Krupnik et al. 2018

Cropping systems scale

Farming systems scale

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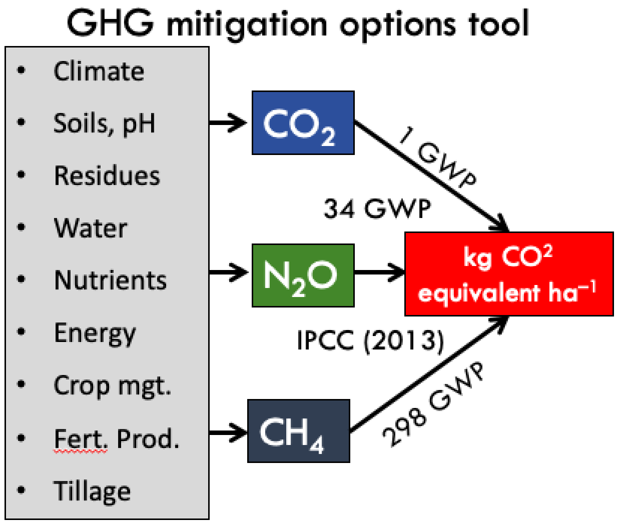
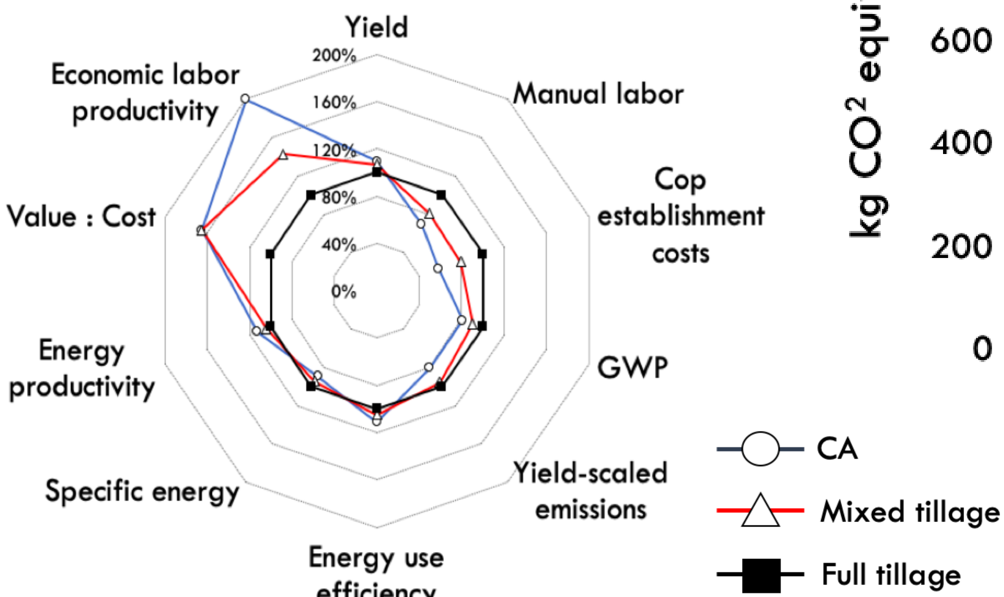
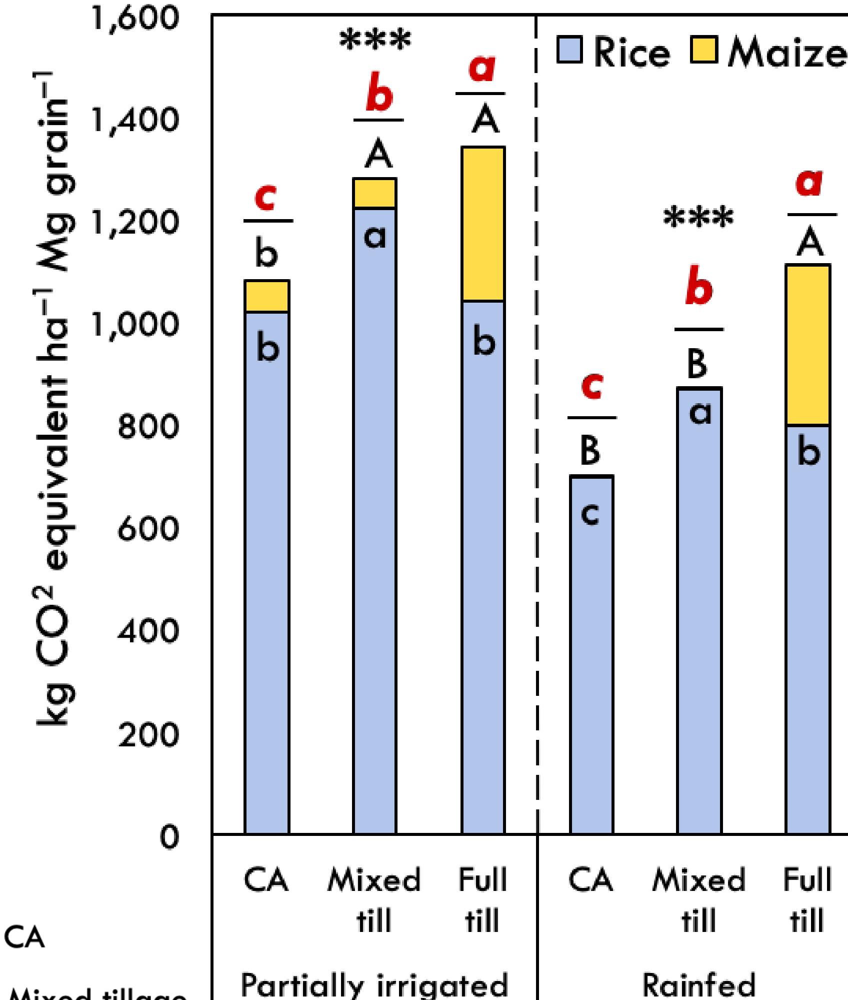
Multi-criteria rice-maize tillage systems analysis: Three years of farmer-managed experiments







Krupnik et al. 2018

Cropping systems scale

Farming systems scale

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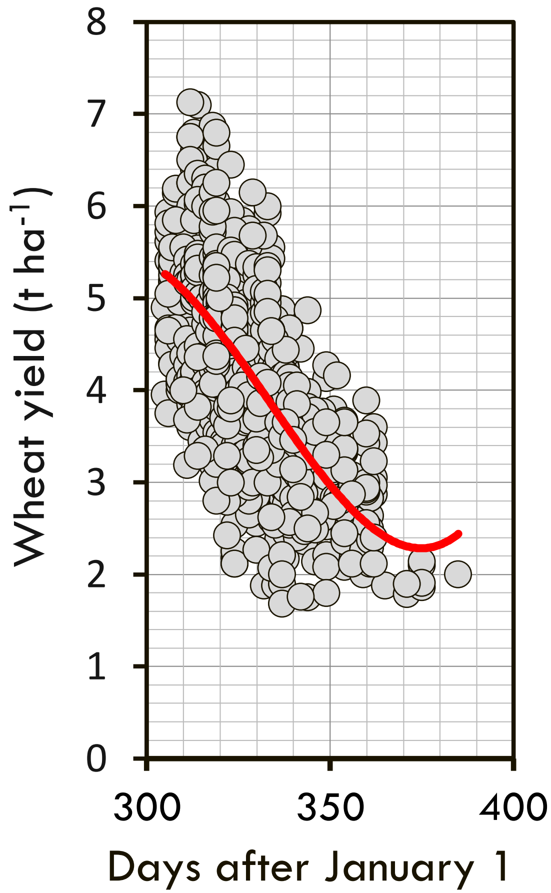
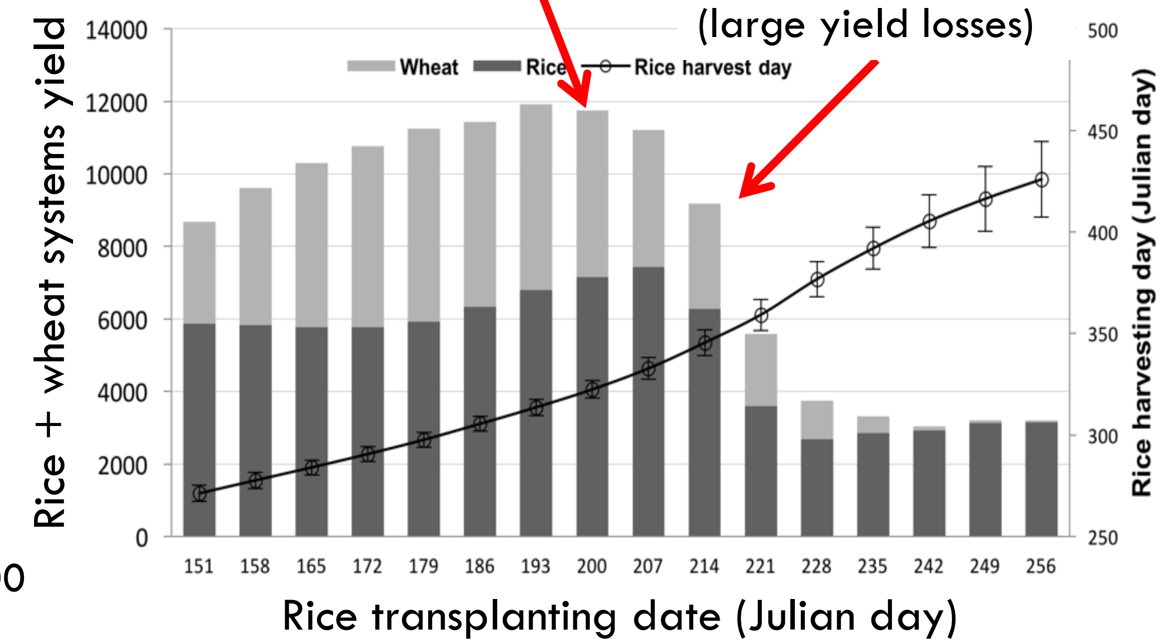
Simulation modeling to identify planting dates for yield stability in rice – wheat rotations



33% yield gains with early establishment and starter irrigation

Most common rice establishment date (large yield losses)



Balwinder Singh, McDonald, et al. in review

Cropping systems scale

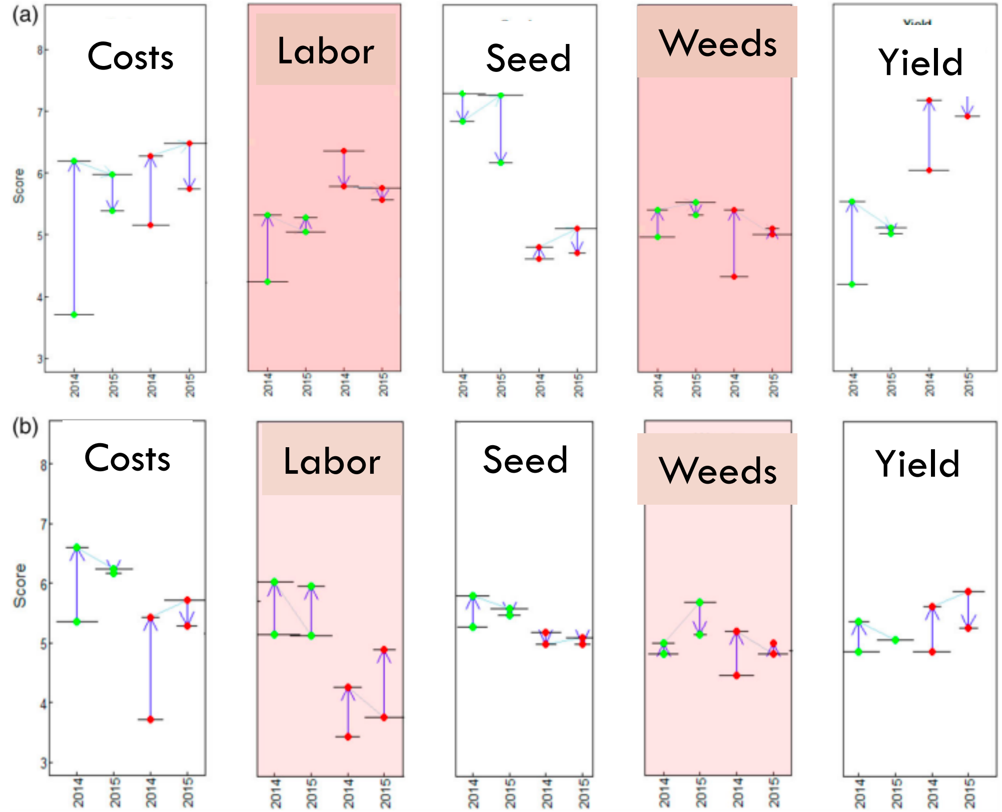
Farming systems scale

Landscape scale

Country scale

Regional market system scale

"Serious games" to improve evaluate management options for maize



Farmers' preference scoring for alternatives maize management practices

INTERNATIONAL JOURNAL OF AGRICULTURAL SUSTAINABILITY, 2018
VOL. 16, NO. 1, 74–93
https://doi.org/10.1080/14735903.2018.1423723

Routledge
Taylor & Francis Group

Check for updates

Exploring farmer perceptions of agricultural innovations for maize-legume intensification in the mid-hills region of Nepal

Victoria Alomia-Hinojosa[a], Erika N. Speelman[a,b], Arun Thapa[a], Hisiang-En Wei[a], Andrew J. McDonald[c], Pablo Tittonell[a,d] and Jeroen C. J. Groot[a]

WAGENINGEN UNIVERSITY & RESEARCH

CGIAR RESEARCH PROGRAM ON Maize

Cropping systems scale

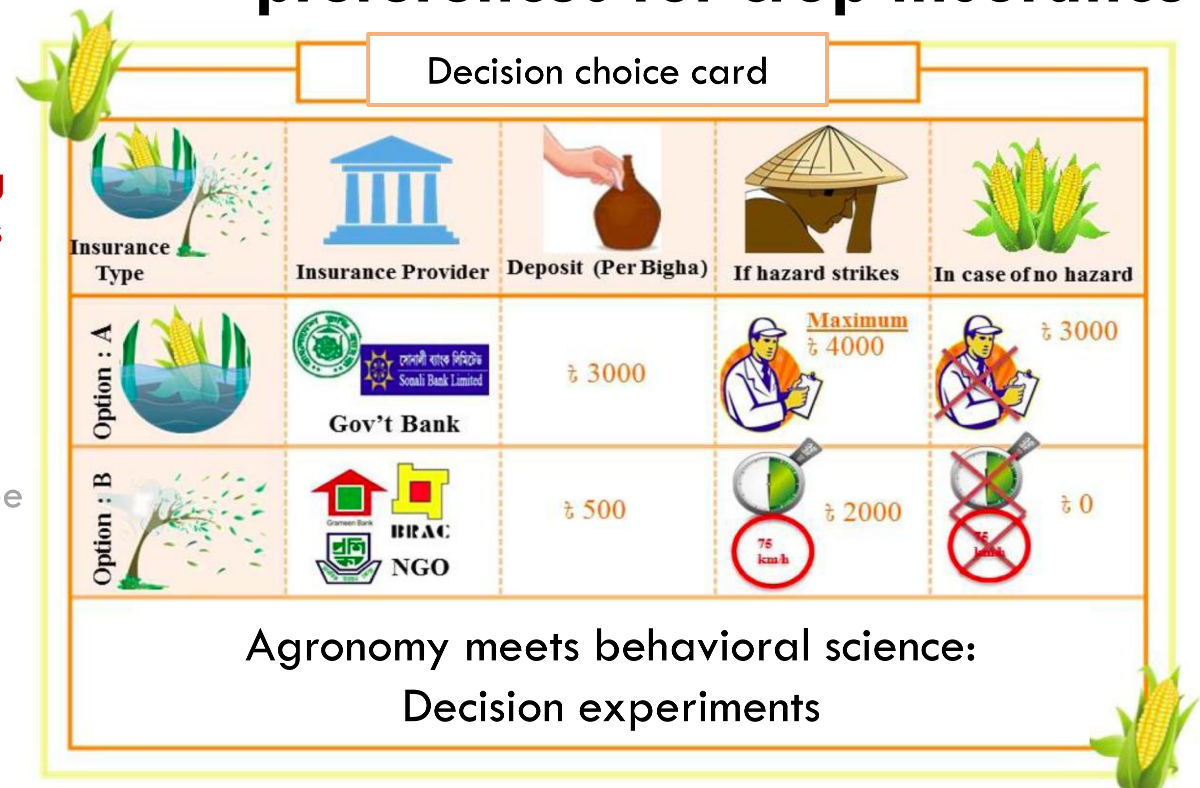
Farming systems scale

Landscape scale

Country scale

Regional market system scale

Evaluating gendered preferences for crop insurance for maize



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Contents lists available at ScienceDirect
Global Environmental Change
journal homepage: www.elsevier.com/locate/gloenvcha

The influence of gender and product design on farmers' preferences for weather-indexed crop insurance

Sonia Akter[a,b,*], Timothy J. Krupnik[c], Frederick Rossi[c], Fahmida Khanam[b]

Reg Environ Change
DOI 10.1007/s10113-017-1174-9

ORIGINAL ARTICLE

Climate change skepticism and index versus standard crop insurance demand in coastal Bangladesh

Sonia Akter[1,2] · Timothy J. Krupnik[3] · Fahmida Khanam[2,3]

Cropping systems scale

Farming systems scale

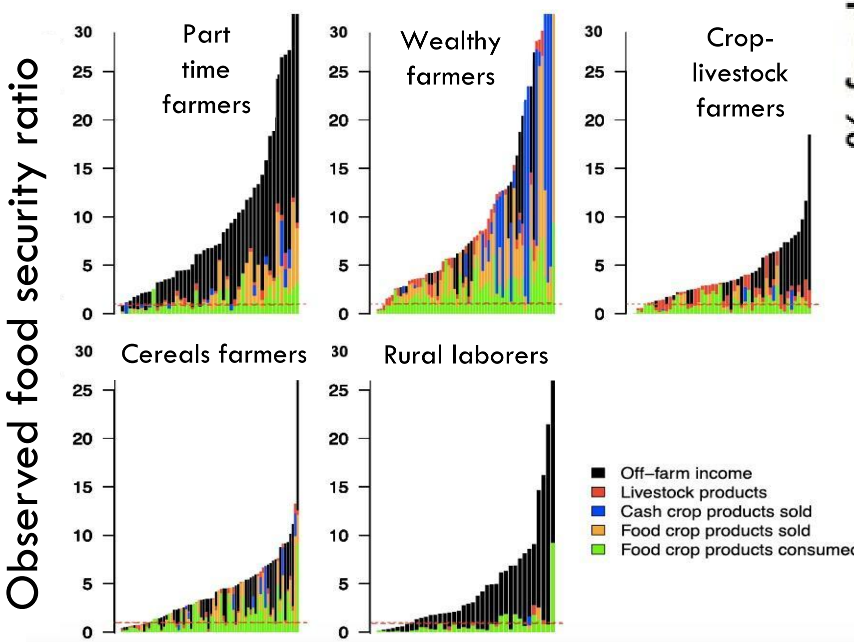
Landscape scale

Country scale

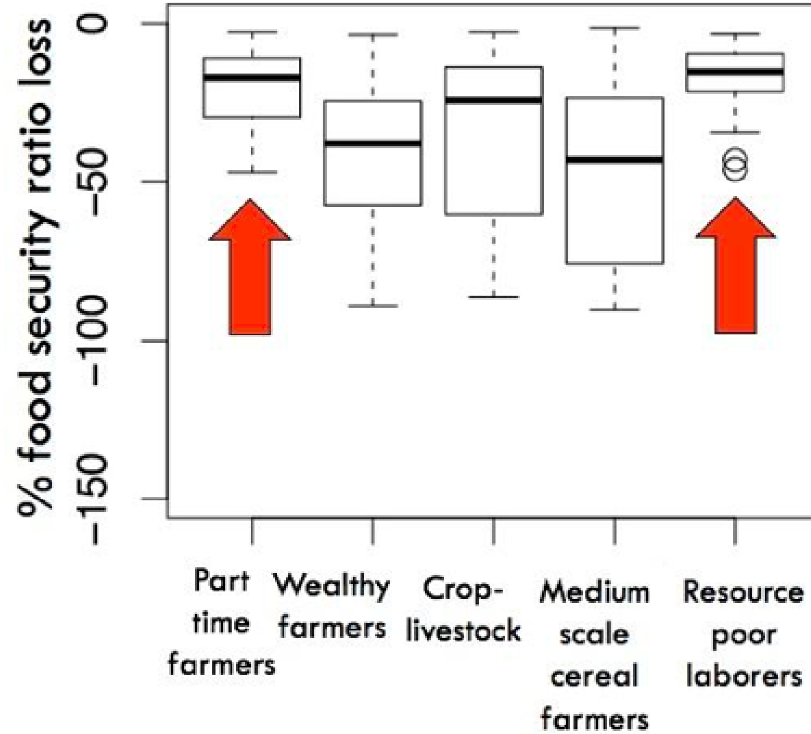
Regional market system scale

Resilience is livelihood context-specific:

Ex-ante assessment of food security with climate-smart agriculture



Simulated impact of catastrophic drought



Contents lists available at ScienceDirect

Agricultural Systems

journal homepage: www.elsevier.com/locate/agsy

Climate smart agriculture, farm household typologies and food security
An *ex-ante* assessment from Eastern India

Santiago Lopez-Ridaura[a], Romain Frelat[a,b], Mark T. van Wijk[b], Diego Valbuena[c], Timothy J. Krupnik[d], M.L. Jat[e,*]

Cropping systems scale

Farming systems scale

Landscape scale

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Regional market system scale

Defining safe environmental niches for cropping systems intensification

Mixed methods:

Landsat water ID

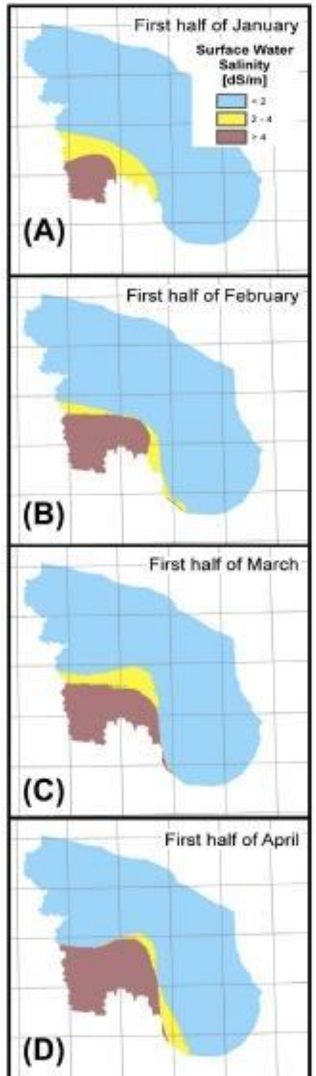
Landsat EVI for land use intensity

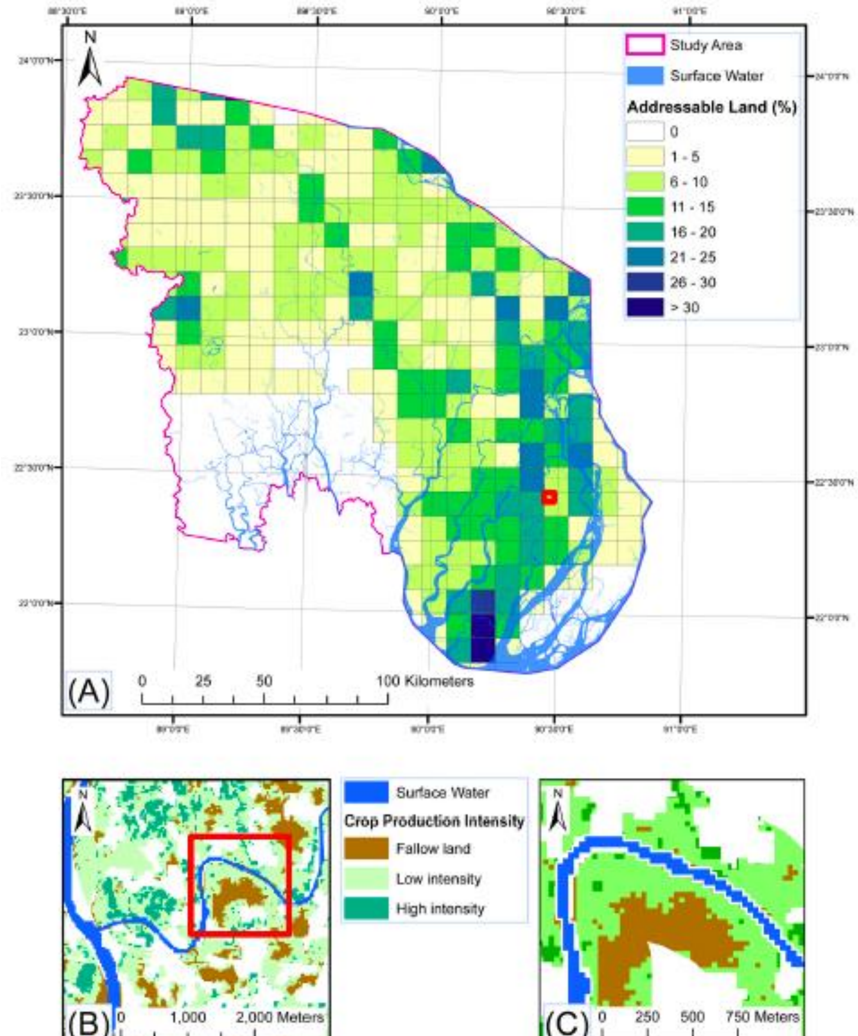
Temporal soil and water salinity matrix

Landscape elevation

Yield assessment

Irrigation targeting





Krupnik et al. (2017) Land Use Policy

Cropping systems scale

Farming systems scale

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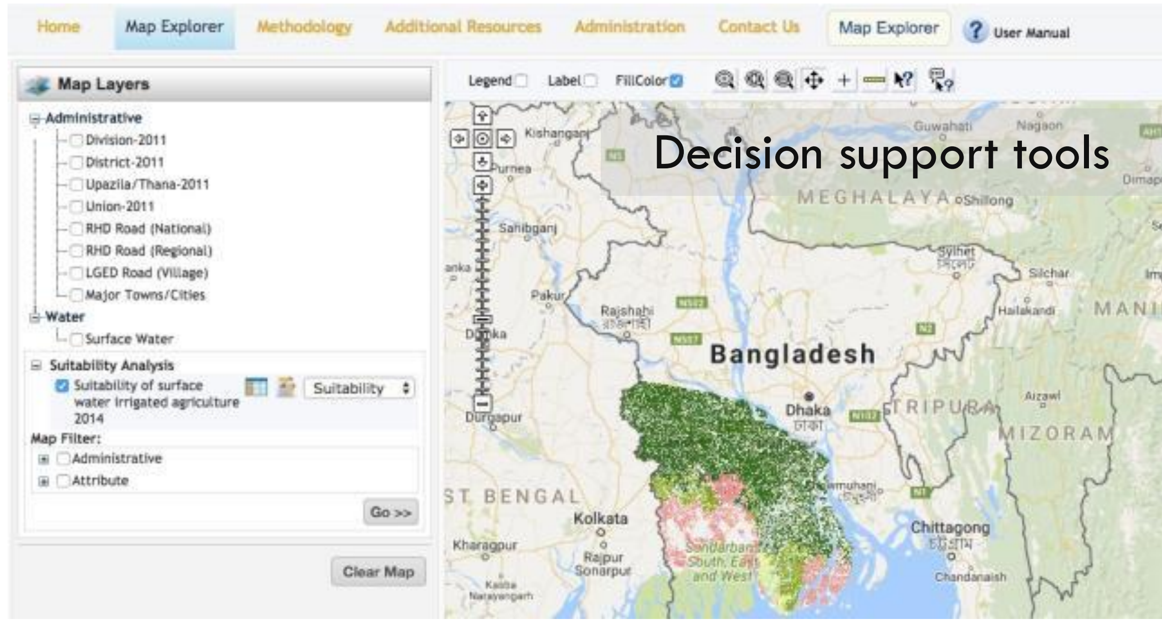
Research → Action → Development impact

- Cooperation with the governmental partners
- 86 km of canals rehabilitated & constructed
- >10,800 Mg year^{-1} new cereals produced



http://202.53.173.179/cimmyt/home.aspx

Combining weather forecasts, disease and crop modeling

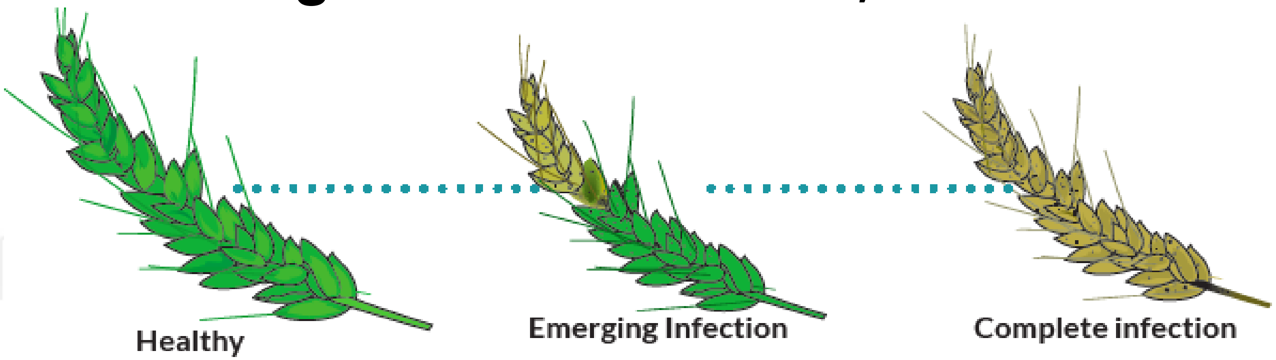
Cropping systems scale

Farming systems scale

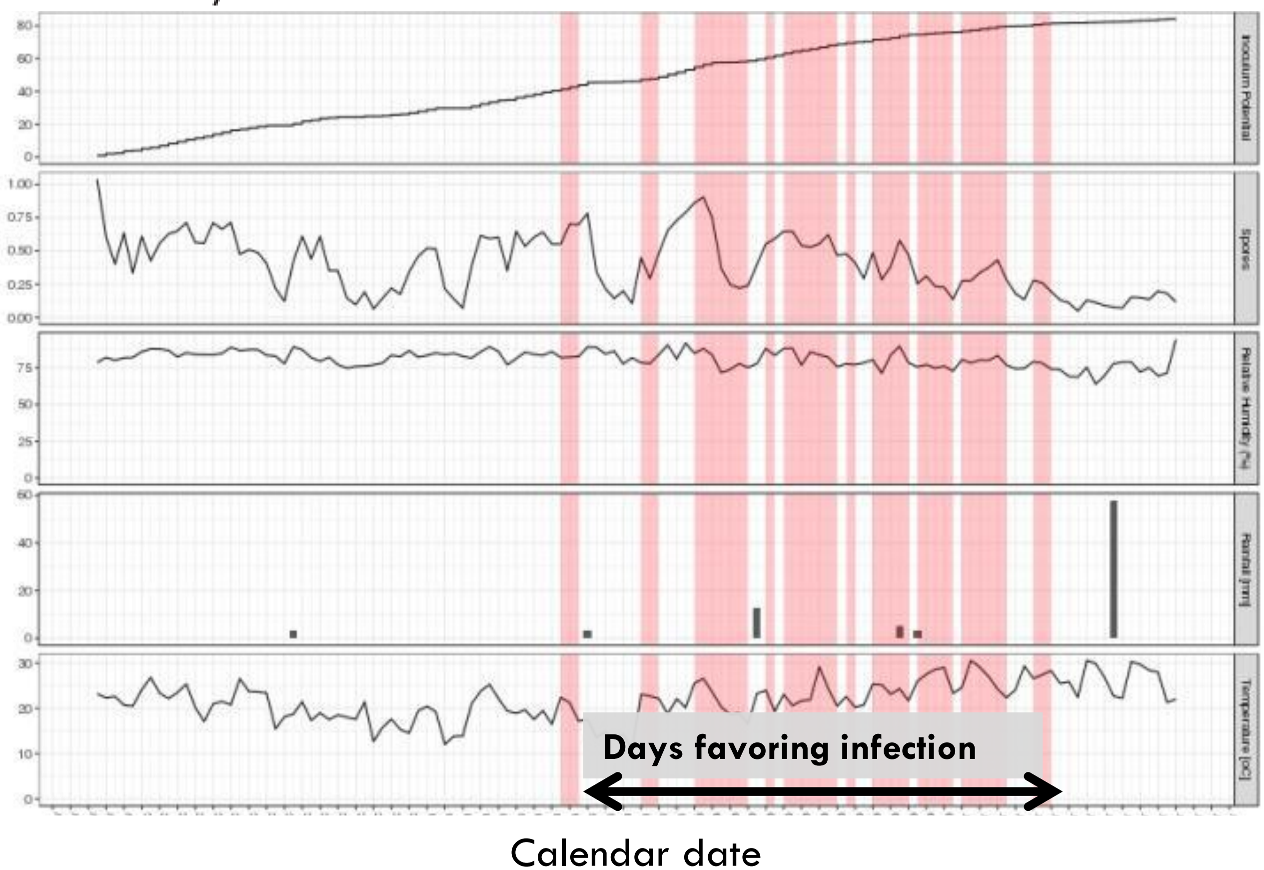
Landscape scale

Country scale

Regional market system scale



Beating back wheat blast disease



Temp. forecast

Precip. forecast

RH forecast

Fungal spore cloud model

Inoculum build-up model

Cropping systems scale

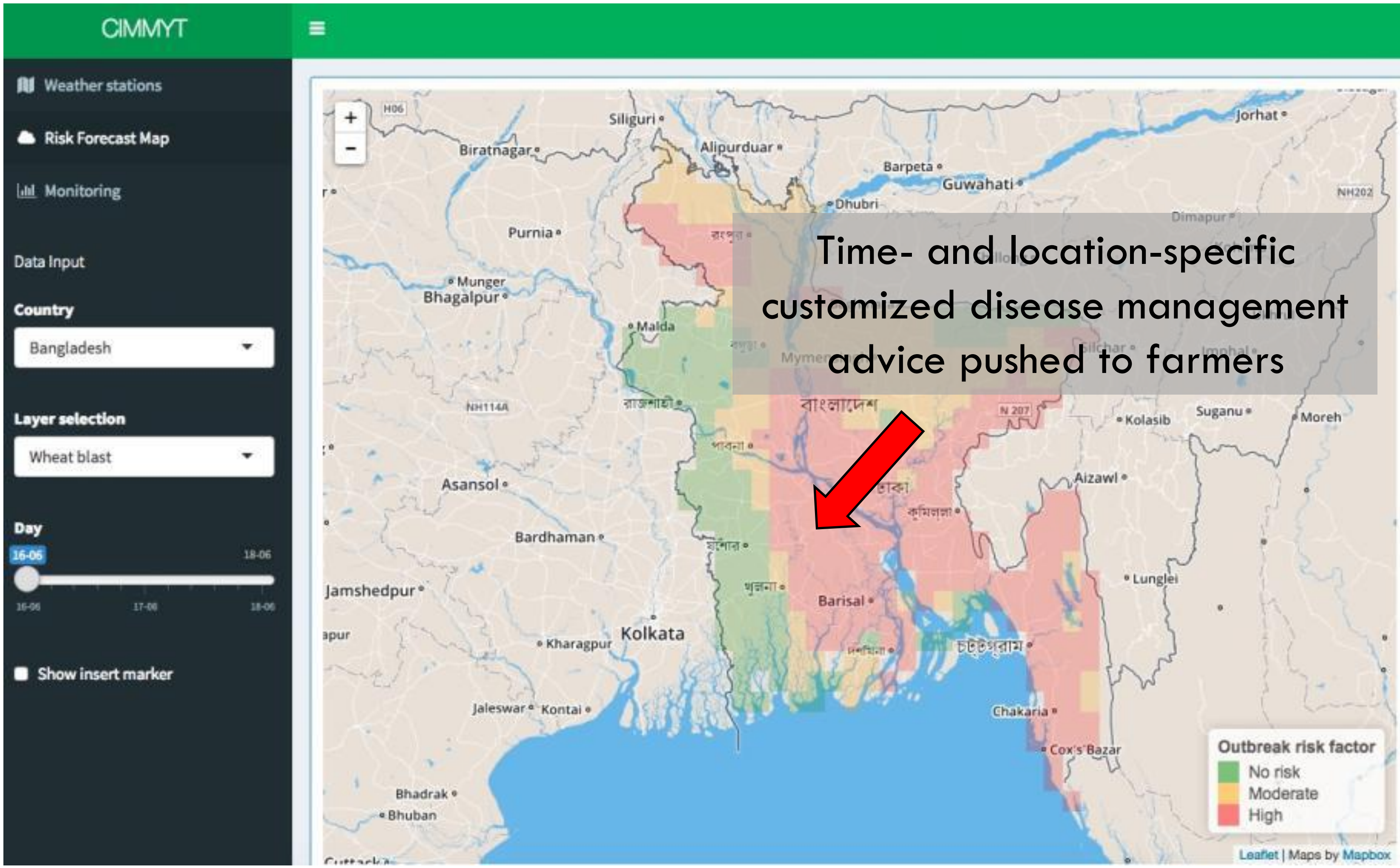
Farming systems scale

Landscape scale

Country scale

Regional market system scale

Early warnings of disease outbreak risk to be delivered by SMS five days in advance of outbreak



Collaboration with the University of Passo Fundo (Brazil), BMD, BARI, DAE

Cropping systems scale

Farming systems scale

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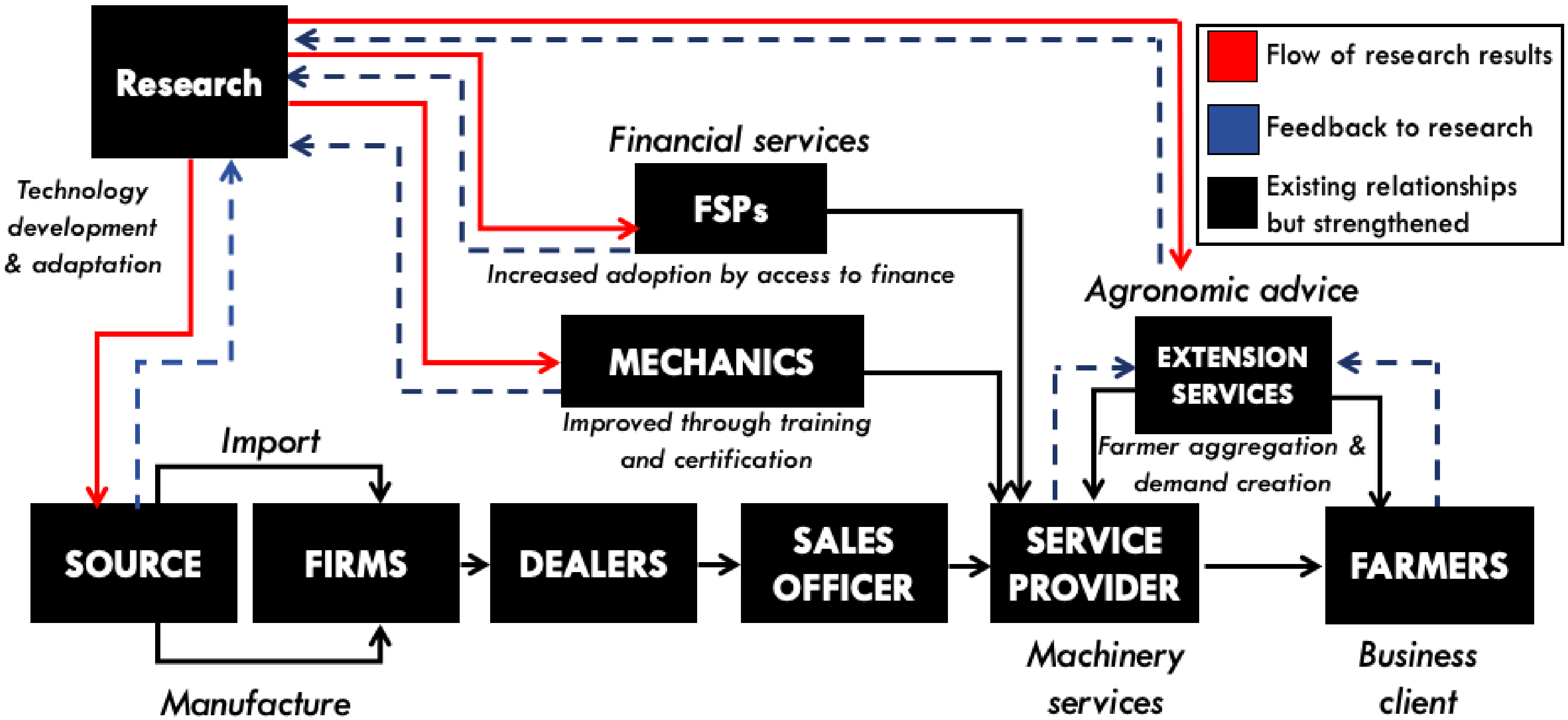
Regional market system scale

Regional to local and public and private Alignment to scale-out appropriate mechanization



- Manufacture improvement + imports + supply + sales
- 5,000 service providers, 200,000 farmers, > 120,000 ha
- >$5 million of private sector investment in five years
- 25% of new service providers enter market without contact from CIMMYT

Conclusions and implications

- Rapid pace of farming systems change
- Sustainable and agroecological intensification (are not so different!)
- Systems analysis methods provide insights and tools manage agricultural transitions for desirable outcomes
- Strong interest in developing partnerships for relevant research in South East Asia

CIMMYT International Maize and Wheat Improvement Center

CGIAR RESEARCH PROGRAM ON Climate Change, Agriculture and Food Security CCAFS

CGIAR Research Program on WHEAT

CGIAR RESEARCH PROGRAM ON Maize

Thank you!

Any questions?

t.krupnik@cgiar.org

Extra slides after this

Applied Science Partnerships

Translating research into practical action and impact at scale

In this presentation

1. Agroecosystems in transition: examples from South Asia
2. Systems analysis: What is it and how can we use it?
3. Examples of applied research at multiple scales
4. Implications for applied research for development in South East Asia

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Cropping systems scale

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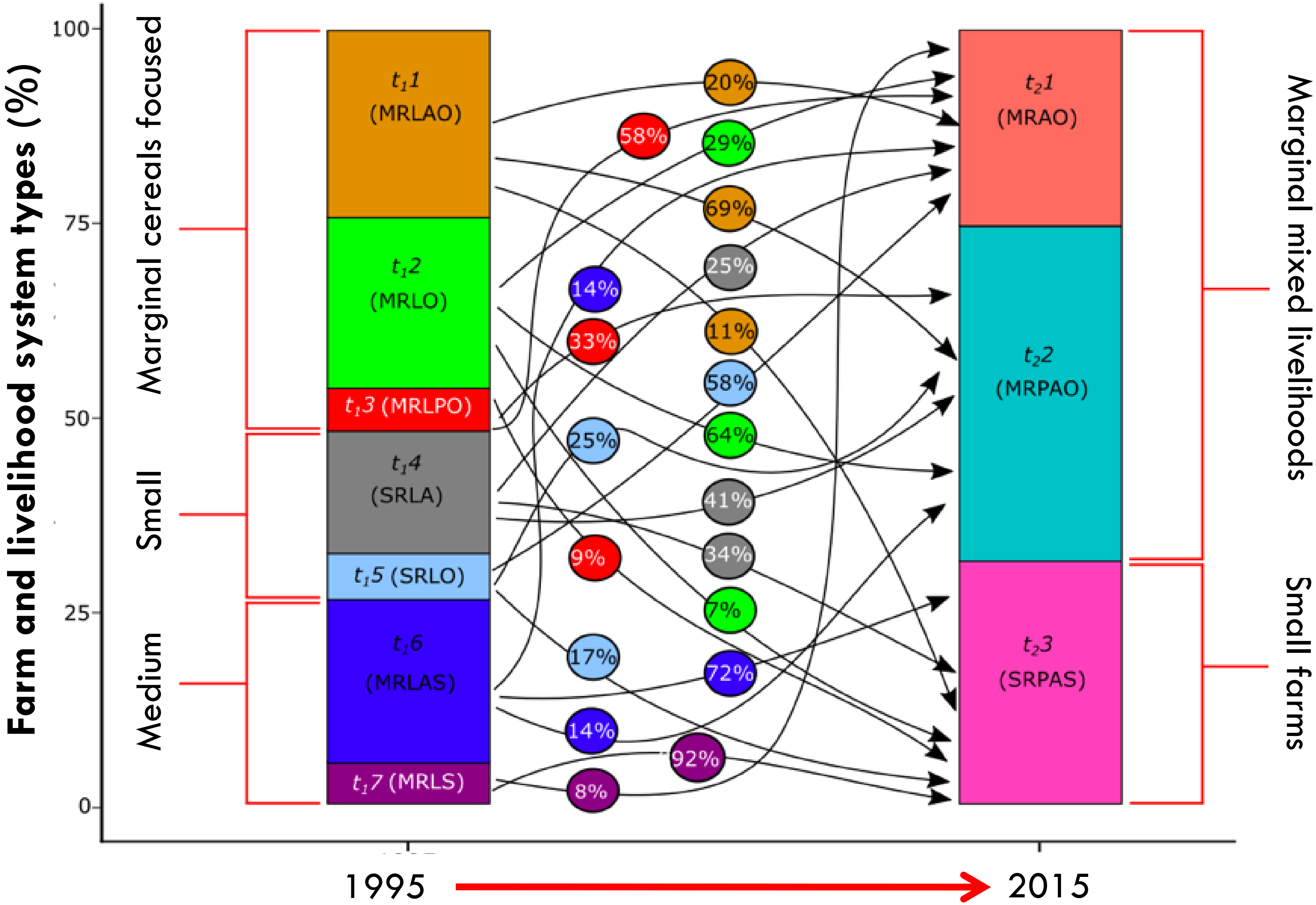
Farm diversity and typologies change over time



Aravindakshan, Krupnik et al. in review

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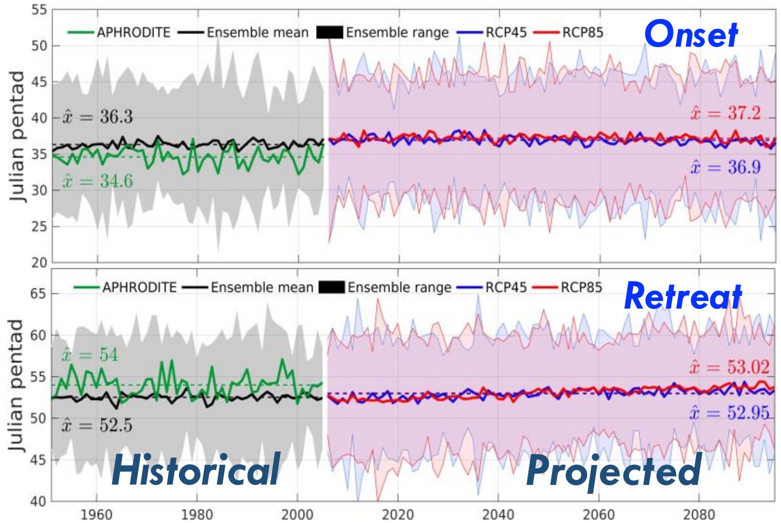
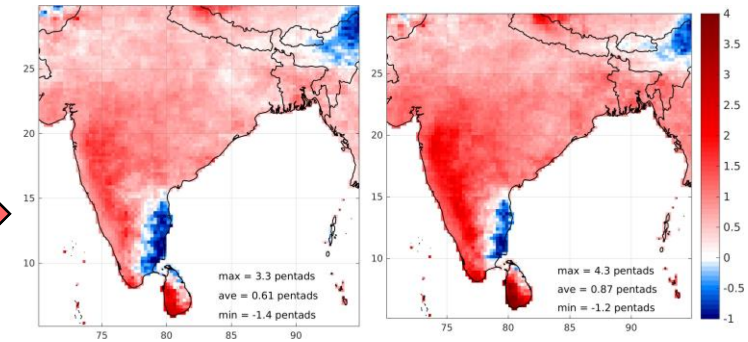
Monsoon onset and retreat affects rice yield variability



Onset shift

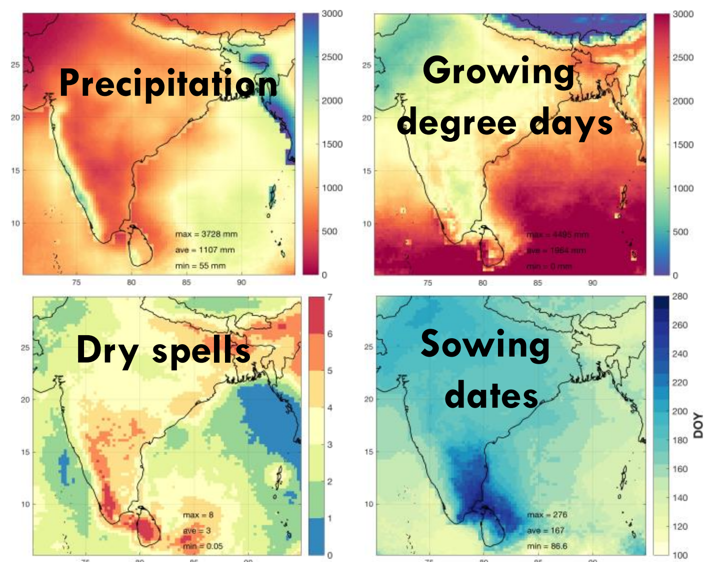
RCP45 *minus* historical

RCP85 *minus* historical

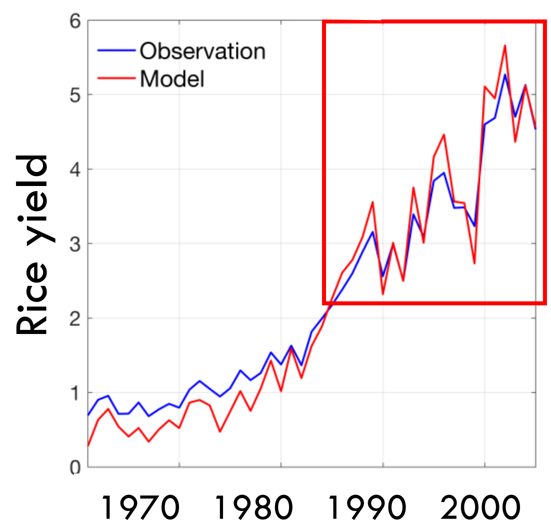


- High temperatures (global warming)
- Heat risks to rice development
- Onset and sub-seasonal forecasting for management advisories

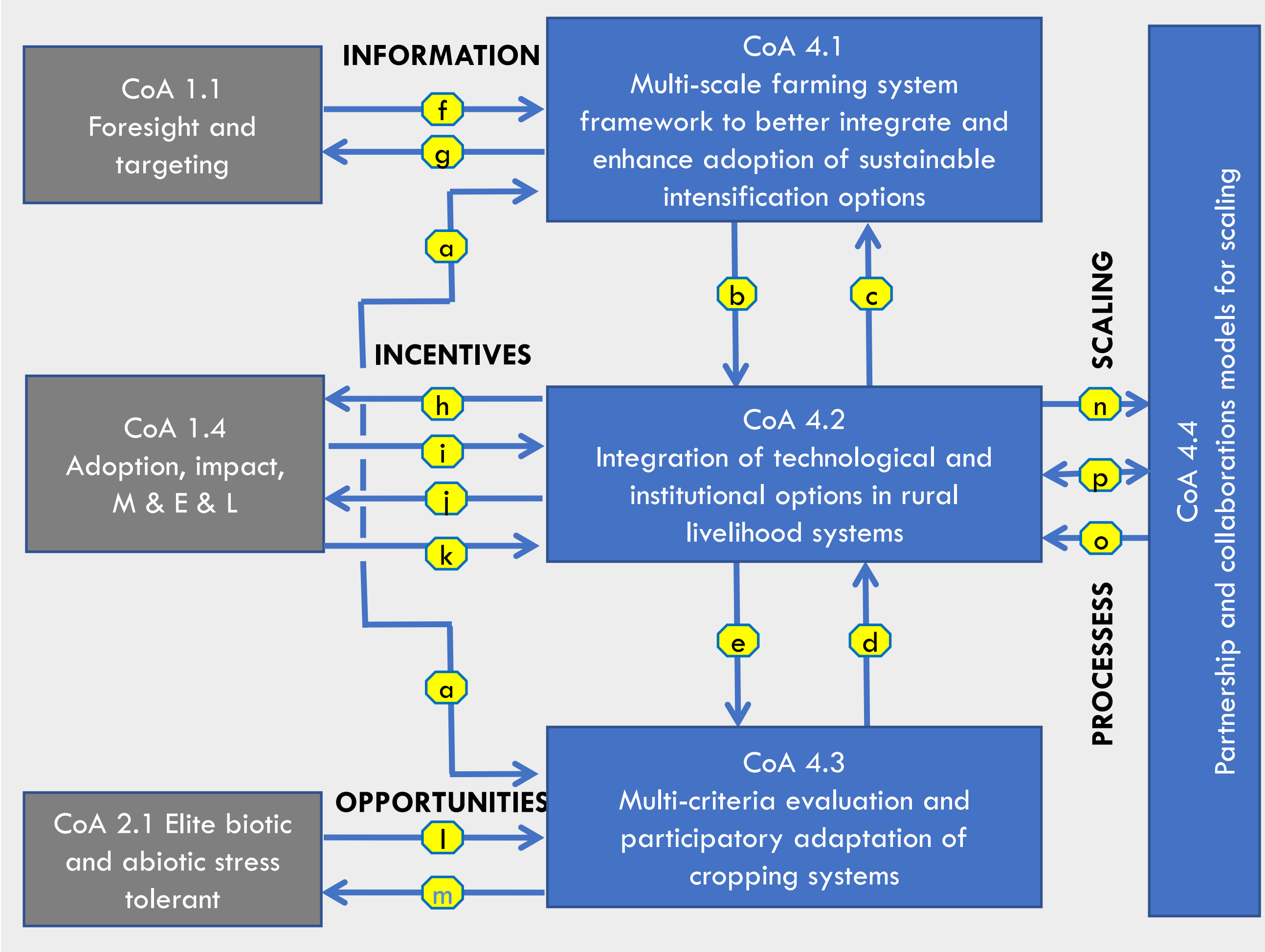
Subseasonal climate metrics



Statistical crop modeling



Courtesy C. Montes



CIMMYT's research program on Sustainable Intensification

CoA 4.1
- Farming systems analysis to guide targeting of interventions) for specific environmental and agroecological contexts
- Understanding and prioritization of actual and potential demand for SI options across geographies

CoA 4.2
- Understanding of farmer decision making processes and adoption patterns.
- Decision support systems
- Institutional arrangements evaluated for SI potential

CoA 4.3
- Proof of concepts, and knowledge on crop management interventions
- Participatory technology adaptation
- Options to lower yield gaps, improve productivity, efficiency, yield stability.

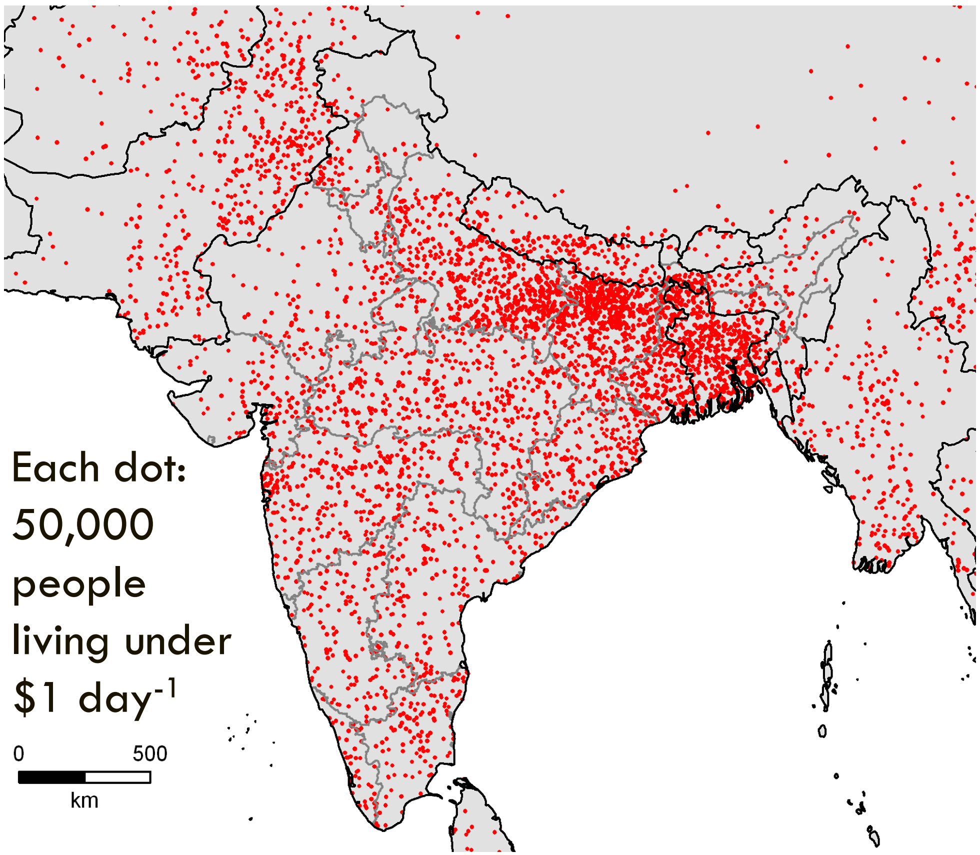
CoA 4.4
- Business model research and development
- Partnerships for scaling SI interventions and assessment of partners' capacity
- Innovation capacity development R&D

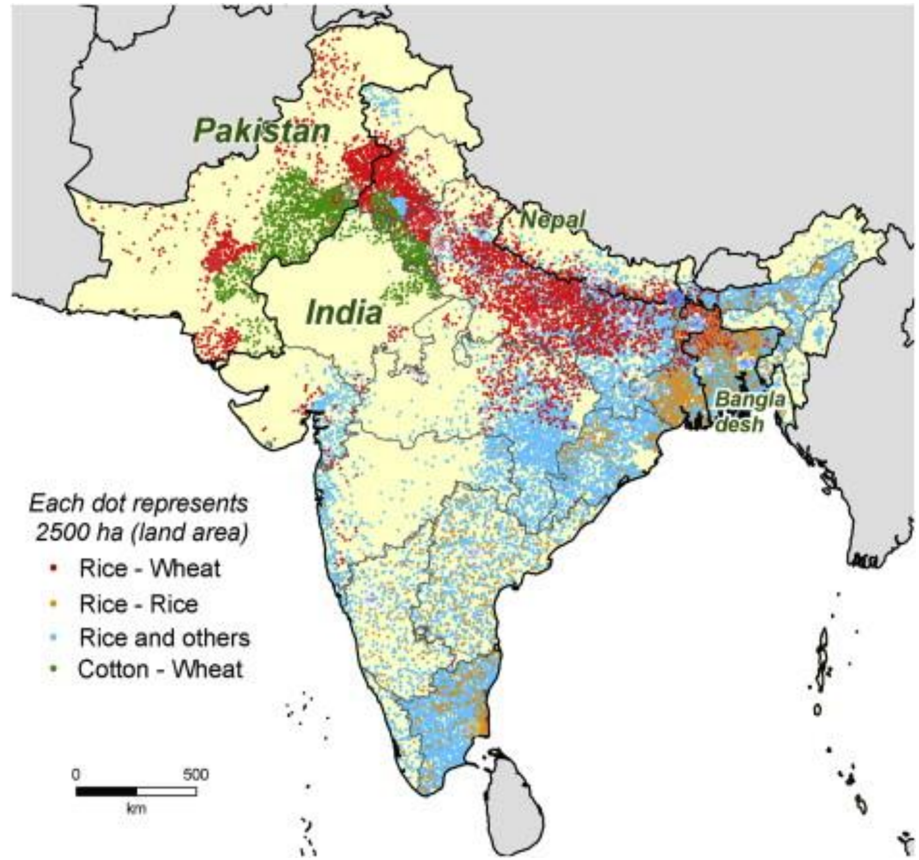
Integrated knowledge for development and performance feedback to research

a - 4.3 to 4.1 Integration of agronomy performance into systems analysis
 - 4.1 to 4.3 Prioritization for further field scale research in CRPs agro-ecologies
b - Inform participatory research design and prioritized technologies to be integrated according to agro-ecologies and farm types
c - Feedback loop and improvement of framework
d - Agronomy/technical know-how to participatory research actors
e - Feedback on in-situ performance of technologies and their integration for further improvement by agronomists

f - Meta-level targeting information to systems analysis
g - Feedback loop on meta-level foresight and targeting
h - Methodological support to SI scaling.
i - Provides prototyped decision support tools/Systems
j - Feedback to participatory approaches and DST/DSS
k - Provide adoption figures + process indicators to CoA 1.4
l - Supply of promising germplasm for targeted environments
m - Feedback on G×E×M, with emphasis on closing yield gaps
n - Business model intelligence to leverage public-private partnerships
o - Innovation capacity research and development
p - 4.2 to 4.3 integration from research from practice and back (feedback)

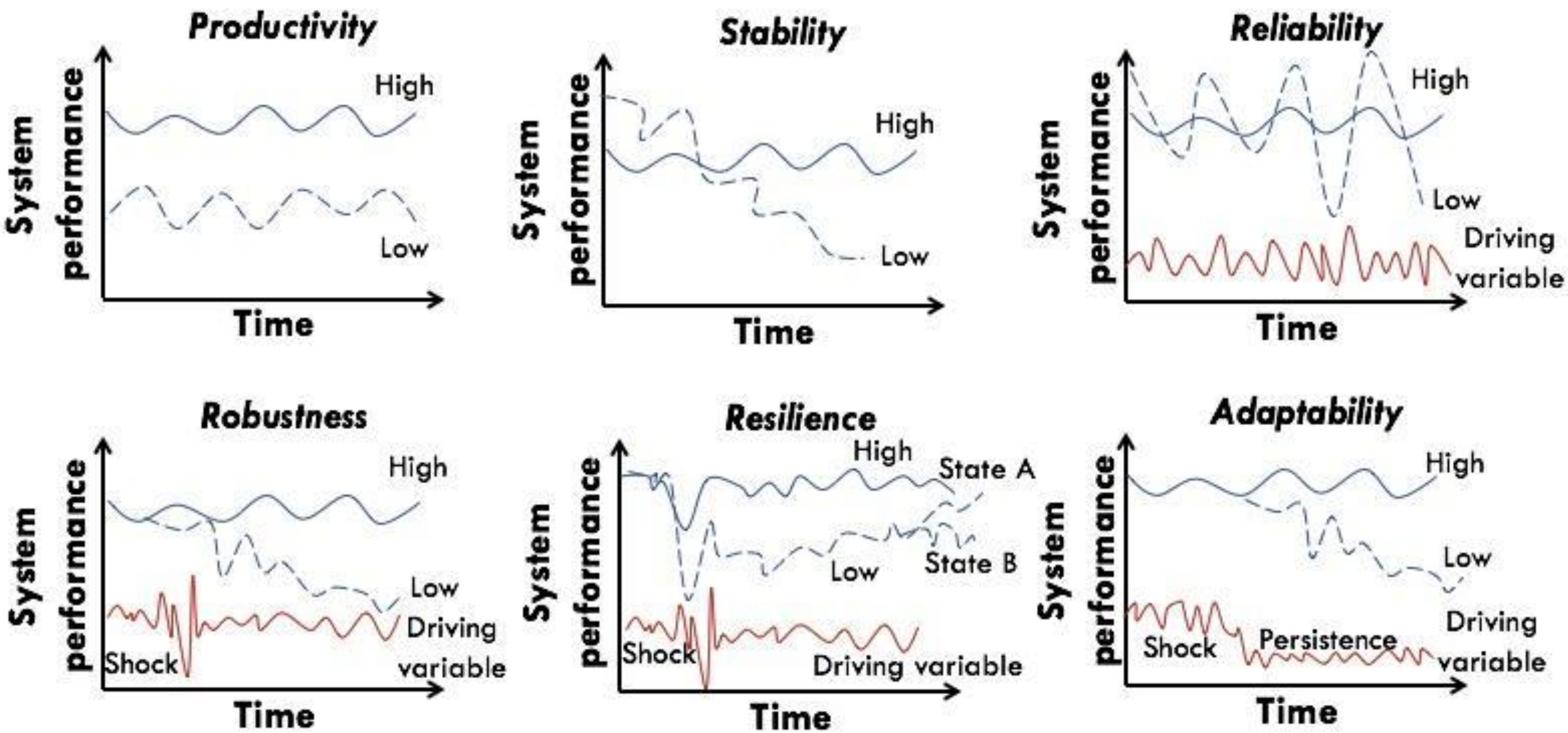
Dense poverty and diverse farming systems





- Rice–wheat systems: Over 13.5 million ha, suppling calories to 1.6 billion people.
- Origins of the ‘green revolution’, with important second and third generation environmental and social equity problems

Indicators of agricultural systems performance



Multiple indicators – multiple goals – multiple contexts

Based on Lopez Ridaura

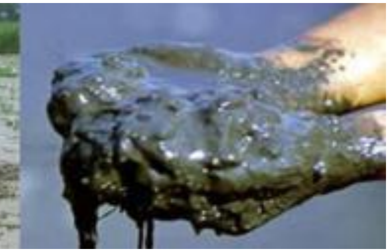
Cropping systems scale

Farming systems scale

Landscape scale

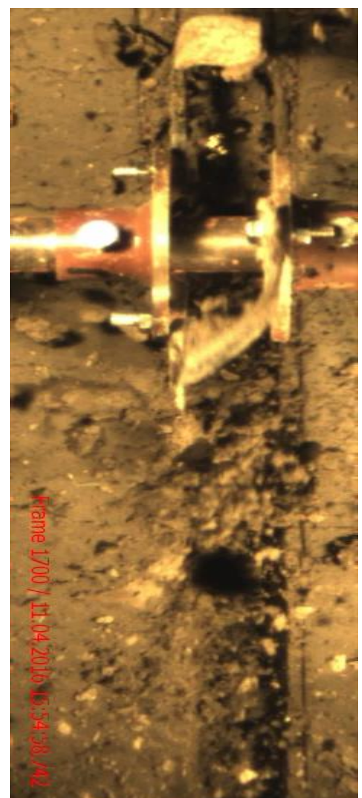
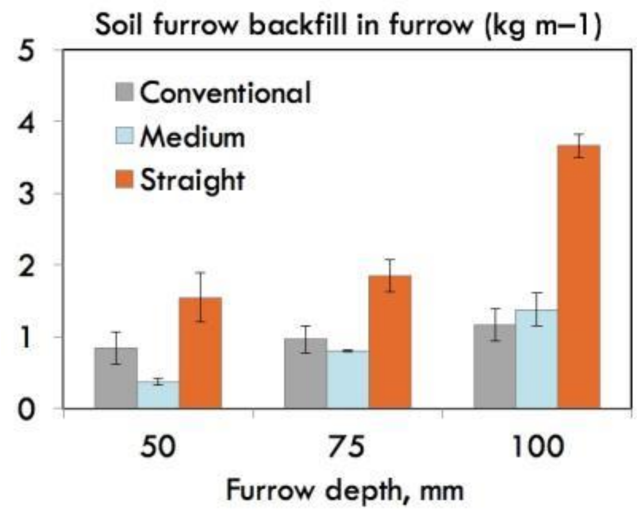
Regional scale



Low intensity, high drudgery → Appropriate mechanization ← High intensity, low efficiency

Improving strip tillage blade design for two-wheel tractors on heavy clays


Contents lists available at ScienceDirect

Soil & Tillage Research

journal homepage: www.elsevier.com/locate/still

ELSEVIER

Strip-tillage using rotating straight blades: Effect of cutting edge geometry on furrow parameters

M.A. Matin[a,b,*], J.M.A. Desbiolles[a], J.M. Fielke[a]

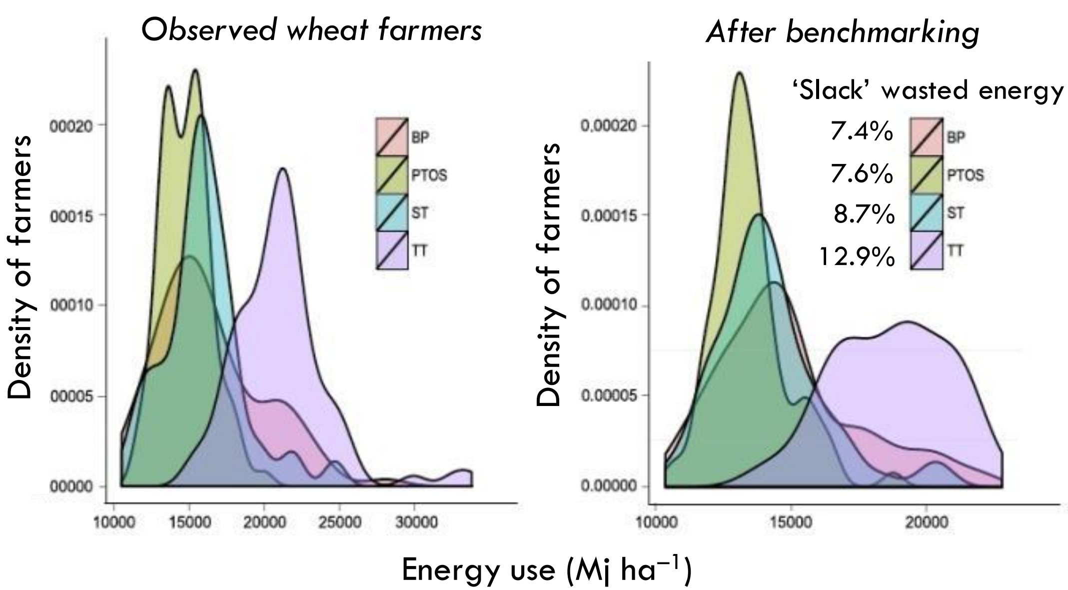
Cropping systems scale

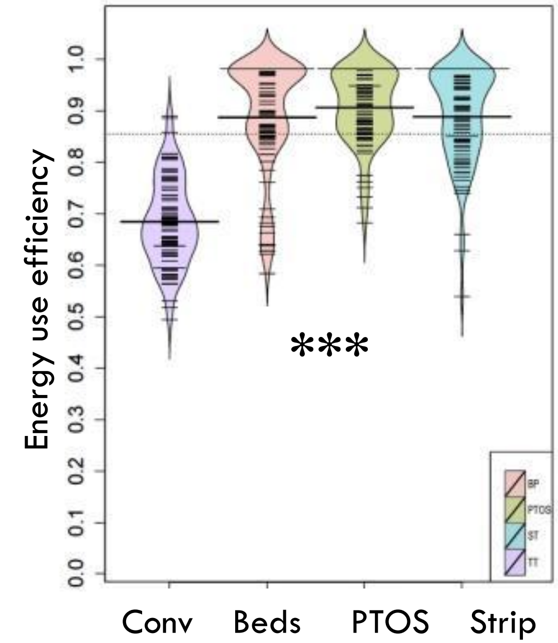
Farming systems scale

Landscape scale

Regional scale

Improving energy use efficiency:
Data envelope analysis of two-wheel tractor tillage options





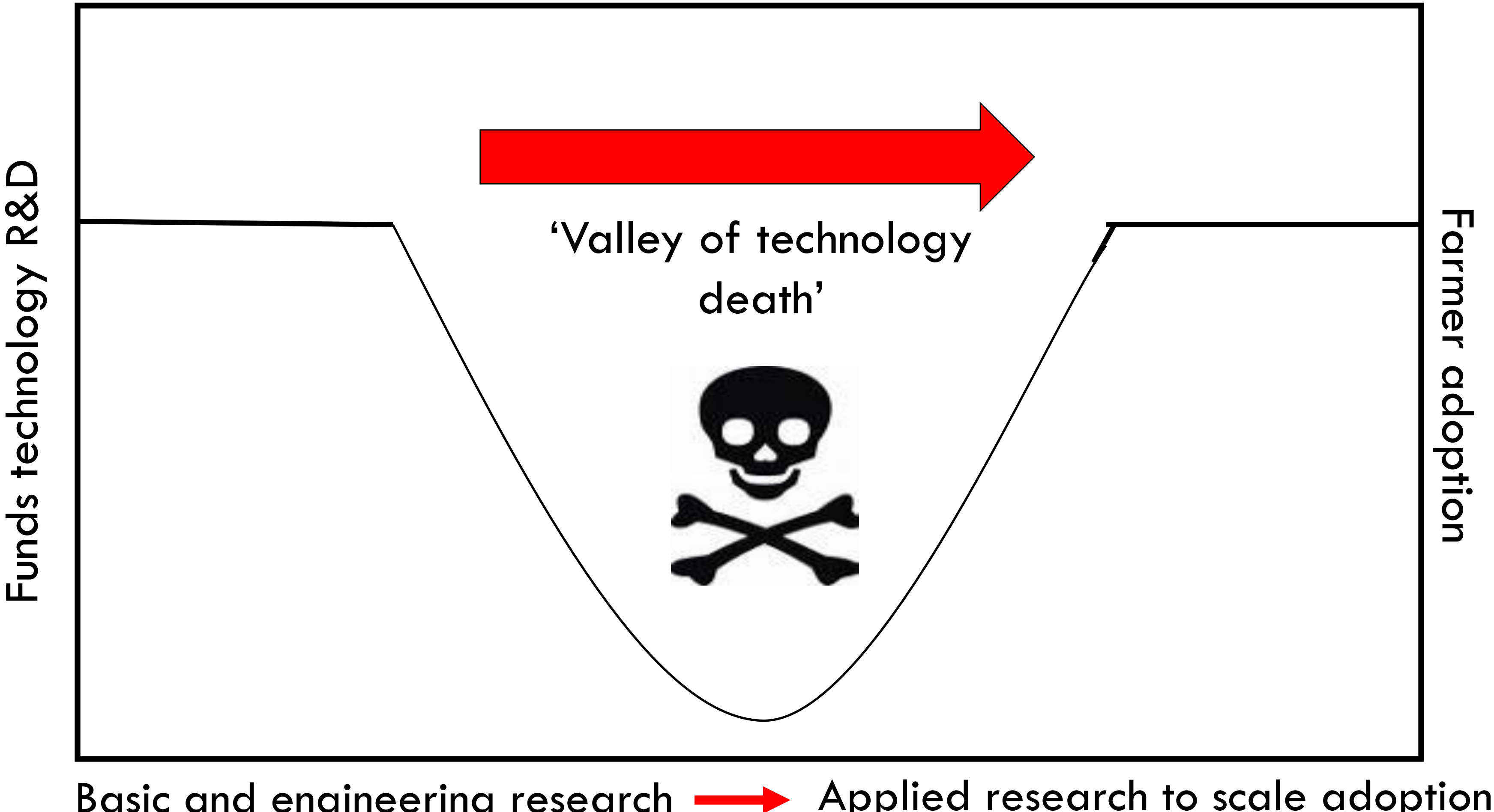

Contents lists available at ScienceDirect

Energy

journal homepage: www.elsevier.com/locate/energy

What does benchmarking of wheat farmers practicing conservation tillage in the eastern Indo-Gangetic Plains tell us about energy use efficiency? An application of slack-based data envelopment analysis

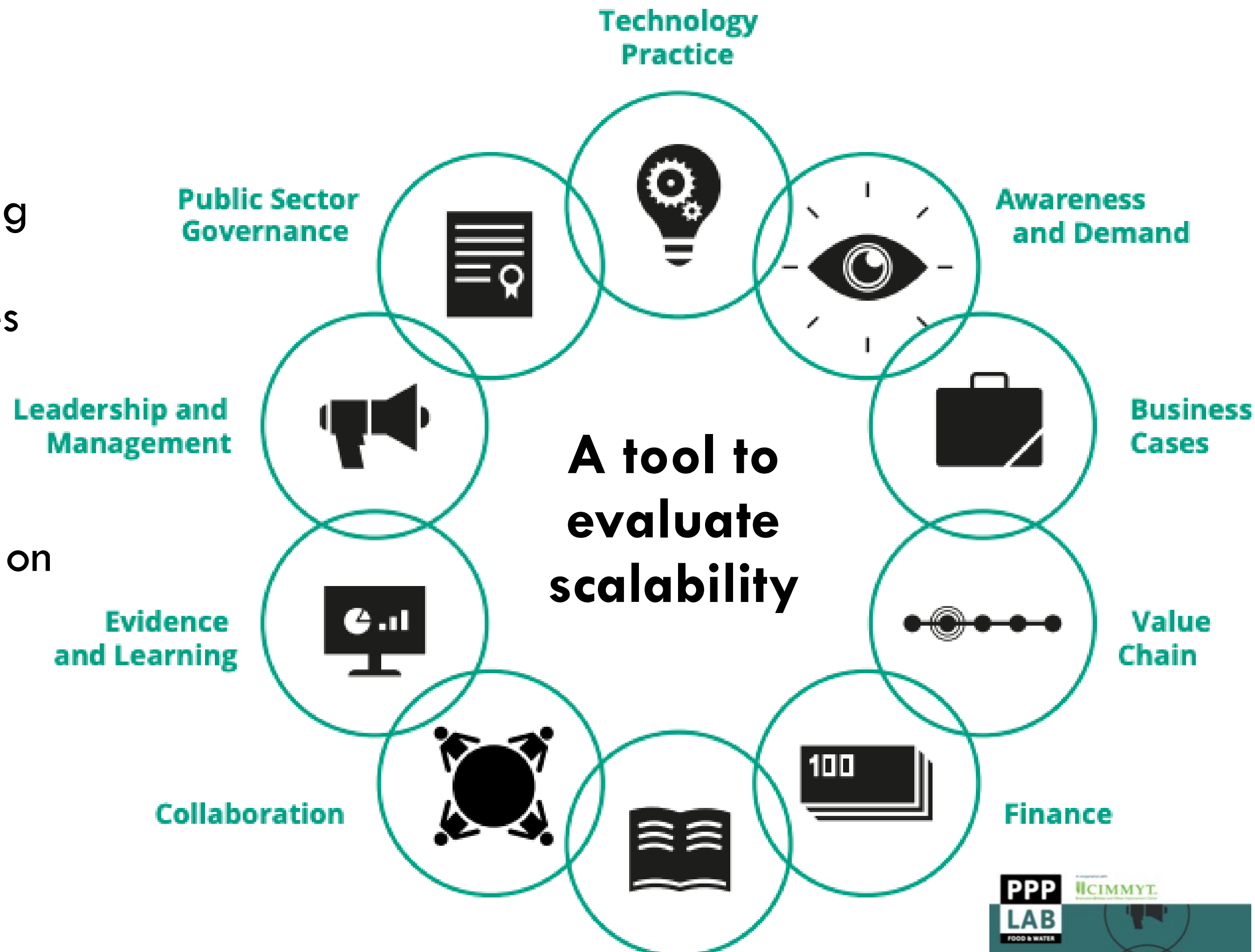
Sreejith Aravindakshan [a, b, *], Frederick J. Rossi [b], Timothy J. Krupnik [b]



- Business model research and development
- Partnerships for scaling SI interventions
- Innovation capacity development R&D

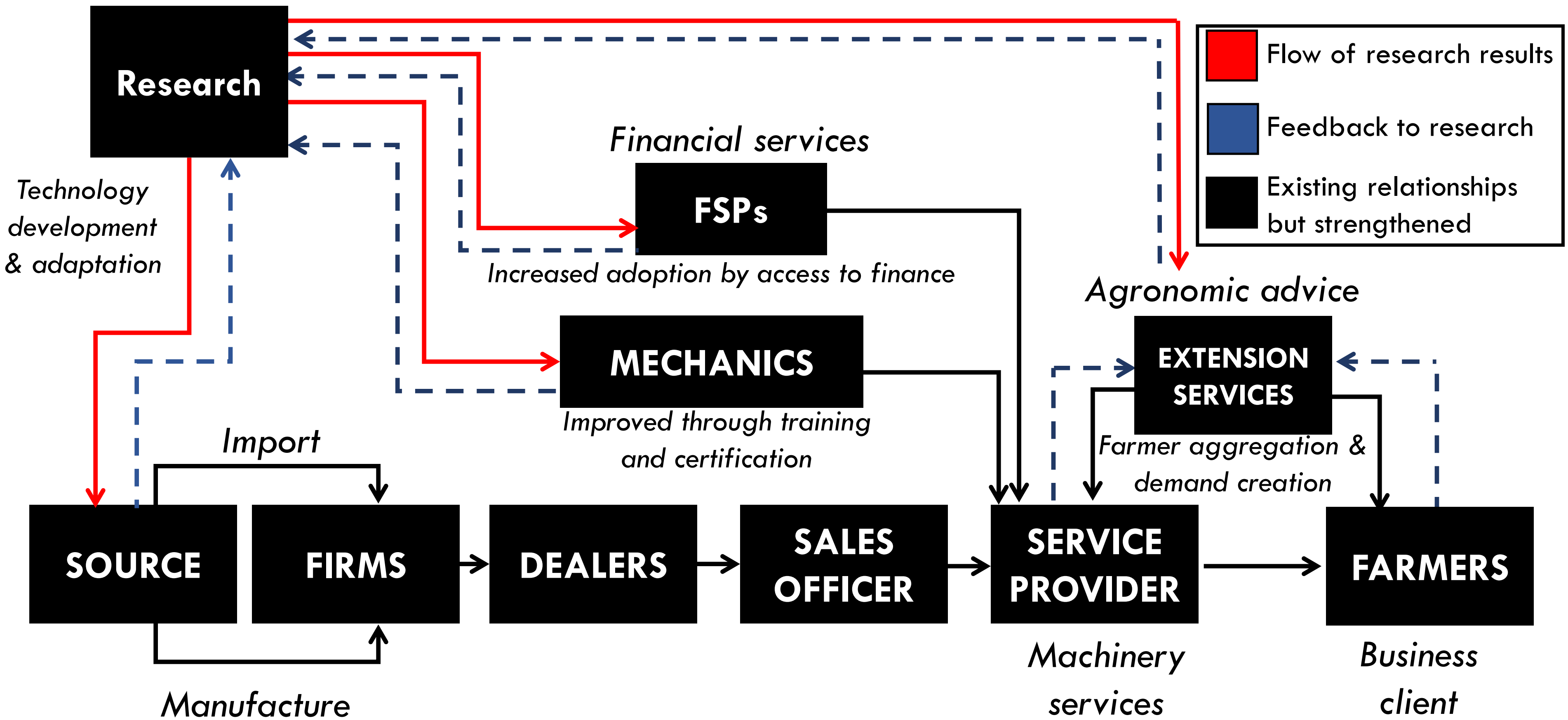
The science of scaling (understanding, learning, planning, action)

- Scaling scan release
- High-profile CRP scaling events and workshops (Larry Cooley, Johannes Linn, etc.)
- Steering committee of the International Community of Practice on scaling with IFAD and USAID
- Help desk on scaling for scientists



CGIAR
RESEARCH PROGRAM ON Maize

Aligning research with scaling through value chains



- 3,000 service providers, 190,000 farmers across 100,000 + ha, >$2.5 Mill of private sector investment in four years (Bangladesh & Nepal)
- 25% of new service providers enter market without contact (Bangladesh & Nepal)
- 250 new service providers across Sub-Saharan Africa
- Organization of machinery hire-points across five states (Mexico)
- Close to a million ha under SI in Latin America

CGIAR RESEARCH PROGRAM ON Maize

Cropping systems scale

Farming systems scale

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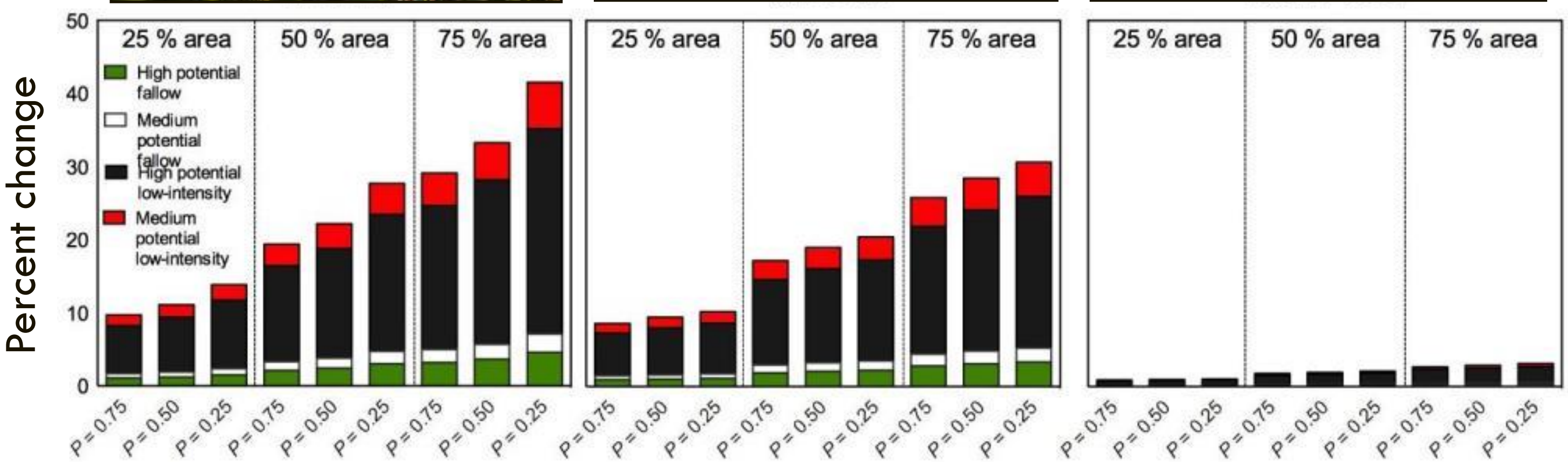
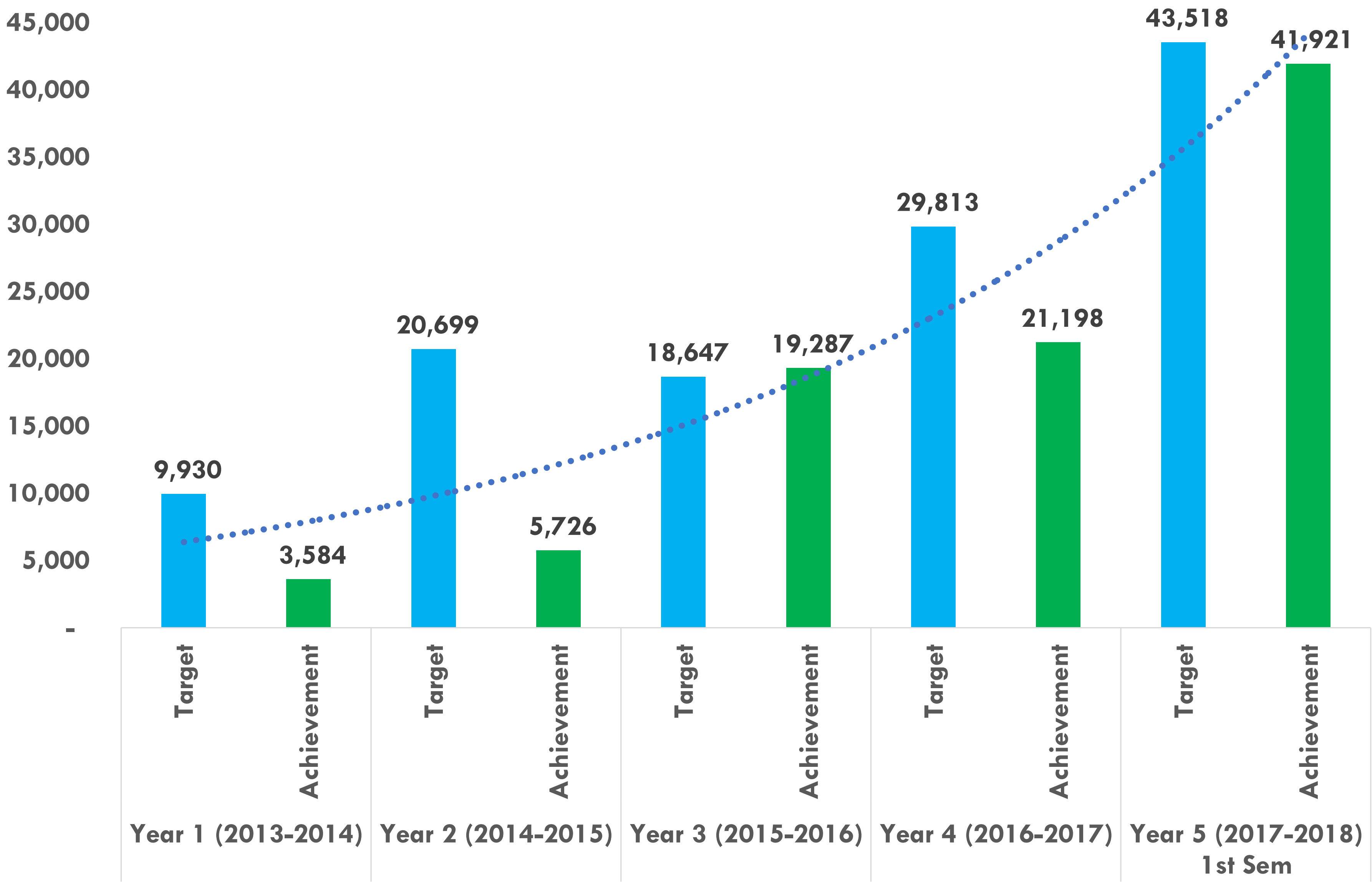
How much more can be produced without exacerbating soil salinity?



Maize (n = 550) Wheat (n = 513) Rice (n = 553)

Krupnik et al. (2017) Land Use Policy



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30,000
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-
9,930
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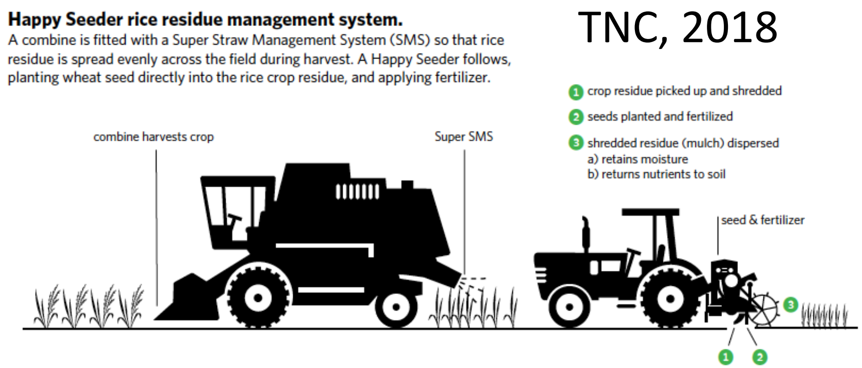
5,726
18,647
19,287
29,813
21,198
43,518
41,921
Target
Achievement
Year 1 (2013-2014)
Year 2 (2014-2015)
Year 3 (2015-2016)
Year 4 (2016-2017)
Year 5 (2017-2018) 1st Sem

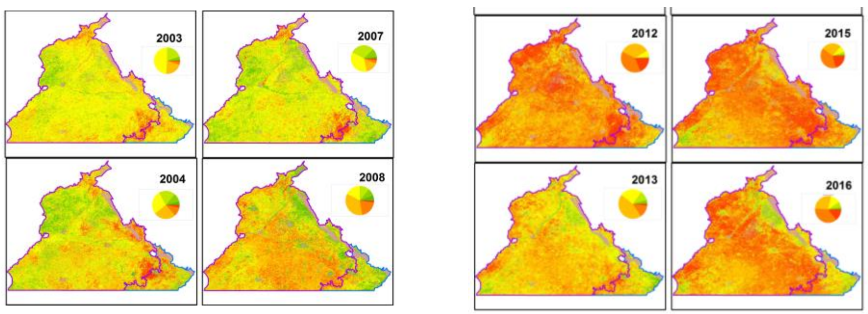
#1 How can the spread of ‘Happy Seeder’ technology be accelerated to facilitate *in situ* straw retention?



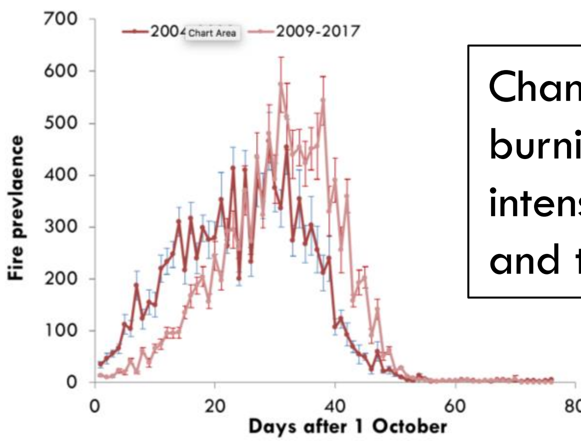
TNC, 2018

Proven technology, generous subsidies, low uptake – why?

#2 Managing policy tradeoffs: Are efforts to reduce consumptive groundwater use in the Punjab exacerbating regional air pollution?



Rice establishment dates before and after 'Punjab Preservation of Sub-Soil Water Act' in 2009



Change in burning intensity and timing

Singh, McDonald, et al., in prep