Can Meta-Analysis Help Clarifying Myths and Boost Adoption of Conservation Agriculture in South Asia?

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Presentation Structure

- **Background: why CA ?**
- **Technological advancements/science evidence on CA**
- **Pitfalls/myths for adoption of CA**
  - ✓ Philosophical: myths based on perceptions
  - ✓ Research Articulation & Targeting Related
  - ✓ Development/infrastructure related
  - ✓ Knowledge, Capacity & Skill related
  - ✓ Policy & Investment Priority Related
- **Meta analysis of CA in South Asia**

Transitioning Towards Sustainability

Need three non-linear stages

1. ***Efficiency*-focuses on making better use of resources within existing system configurations**
2. ***Substitution*- focus on replacement of technologies, practices etc**
3. ***Redesign* centers on composition and structure of agro-ecosystem involving social and institutional dimensions**

(Pretty et al., 2018)

Management Factors Critical for Transitioning Towards Sustainability

Factors	Energy/ Cost	Adaptive capacity	GHG/ GWP	Yield
Tillage-CE	20-25	*S	*S	*S
Biomass management	5-10	*S	*S	~
Water management	25-30	**S	**S	**S
Nutrient management	25-30	~	**S	**S
Others	5-20	~	~	~

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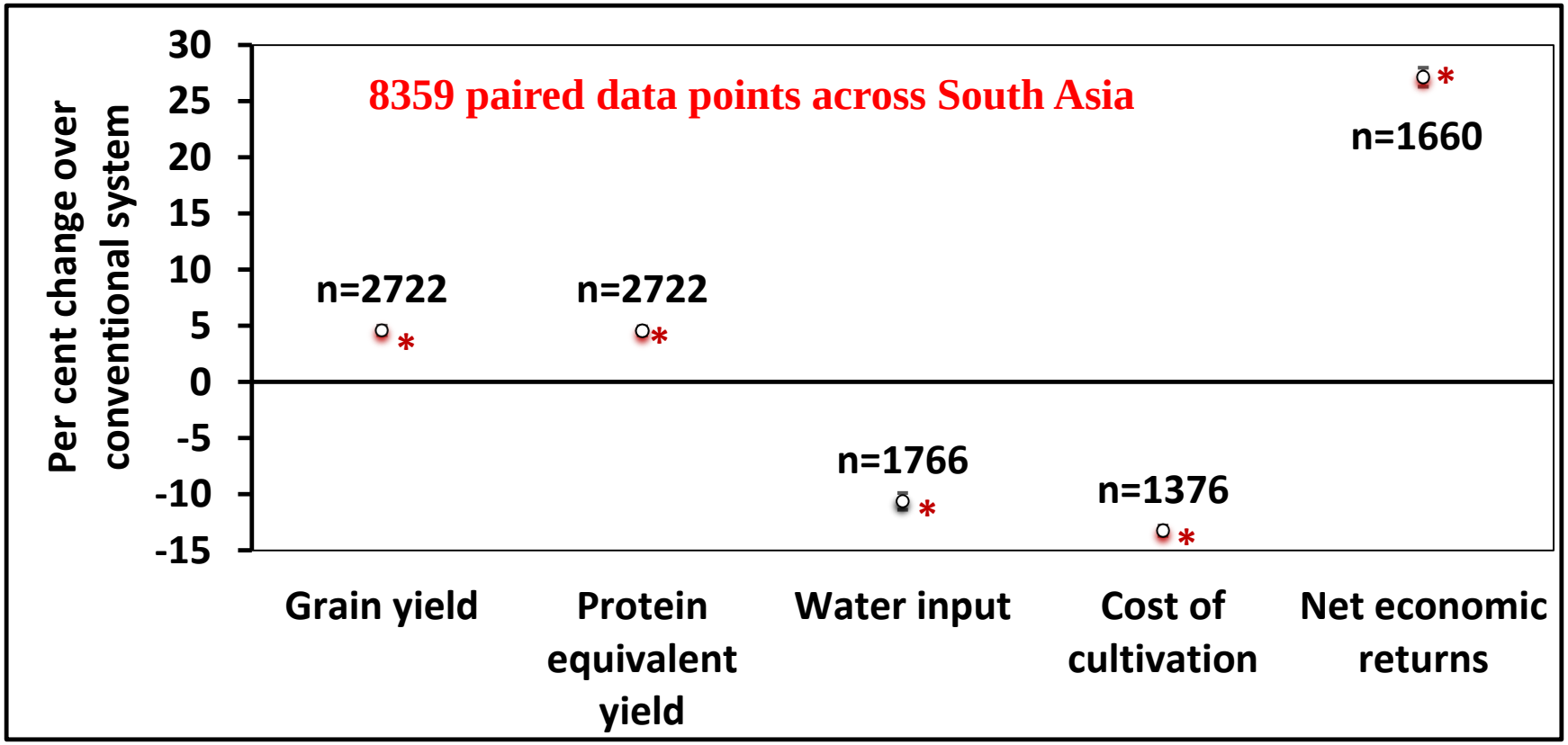
Conservation Agriculture (CA):

Provide opportunities for transitioning towards sustainability

Meta analysis: Multi-criteria performance of CA in major cereal based systems in South Asia



Yield & protein: 5, water: 10, Cost: 13, Income: 27

Jat et al (Forthcoming)

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Major pitfalls/myths and strategies for scaling and adoption of CA

1. Philosophical-perception
2. Research articulation & targeting
3. Development /infrastructure
4. Knowledge & capacity
5. Policy & investment priority related

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1. Philosophical: myths based on perceptions

- **Several myths around CA which are far away from their realities (Sharma, 2018) but largely responsible for restricting the scaling/adoption of CA**
  - ***Its for large farmers and not for small***
  - ***requires heavy machinery which is too costly and not available***
  - ***results in soil compaction and formation of hard pan***
  - ***results in low water infiltration, leading to waterlogging***
  - ***requires breaking of the cycle after some years***
  - ***increases weed infestations***
  - ***requires more chemical fertilizers/nitrogen***
  - ***increases insect and disease infestation***
  - ***accumulate the crop residues and may make a heap over time***
  - ***results in poor germinations and seedling emergence***
  - ***competes with crop residues which are fed to animals***
- **Classically agriculture systems grew with dominance of seed systems, there is a philosophical issue of equating the *'CA systems'* with *'seed systems'*, however the application of both are entirely different**

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2. Research Articulation & Targeting Related

- One size (doesn't) fits all
- Arguments around CA (*per se*) works and doesn't, rather than where and under what circumstance it works and where and under what circumstances it doesn't?
- Science based recommendation domains of CA
- Classical definition of CA (simultaneous application of 3 interrelated principles) limits the adoption of CA under many situations as either one cannot apply all principles or all are not needed simultaneously
- Research questions- What challenges, at what time scale (short-, medium and long-term), what circumstances (Socio-economic), intended to address??
- What's the 'discovery to delivery pathway'?

- Revisit the scope of CA principles for Intensive (double/triple cropping) and irrigated systems of South Asia
- Locally adapted component technologies (seed variety, water, nutrient, weed, pest etc)

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Eight Years of CA based Sustainable Intensification of Cereal Systems in NW India: Productivity, Profitability, Soil quality and Environmental footprints

Scenario	Productivity (Mg ha^{-1})	Irrigation water (mm ha^{-1})	Energy requirement (MJ ha^{-1})	Net return (USD ha^{-1})	Organic carbon (%)	Total GWP (t CO_2 eq ha^{-1})
Conventional RW	12.40	2557	75225	1361	0.45	6.3
CA based RW	13.17 (6)	1868 (-27)	57833 (-23)	1629 (20)	0.90 (100)	4.9 (-22)
CA based MW	14.09 (14)	738 (-71)	39376 (-48)	2122 (56)	0.84 (87)	4.5 (-29)

*In parenthesis= % change over conventional system

Source: ICAR-CSSRI-CIMMYT Collaborative Long-term Research platform

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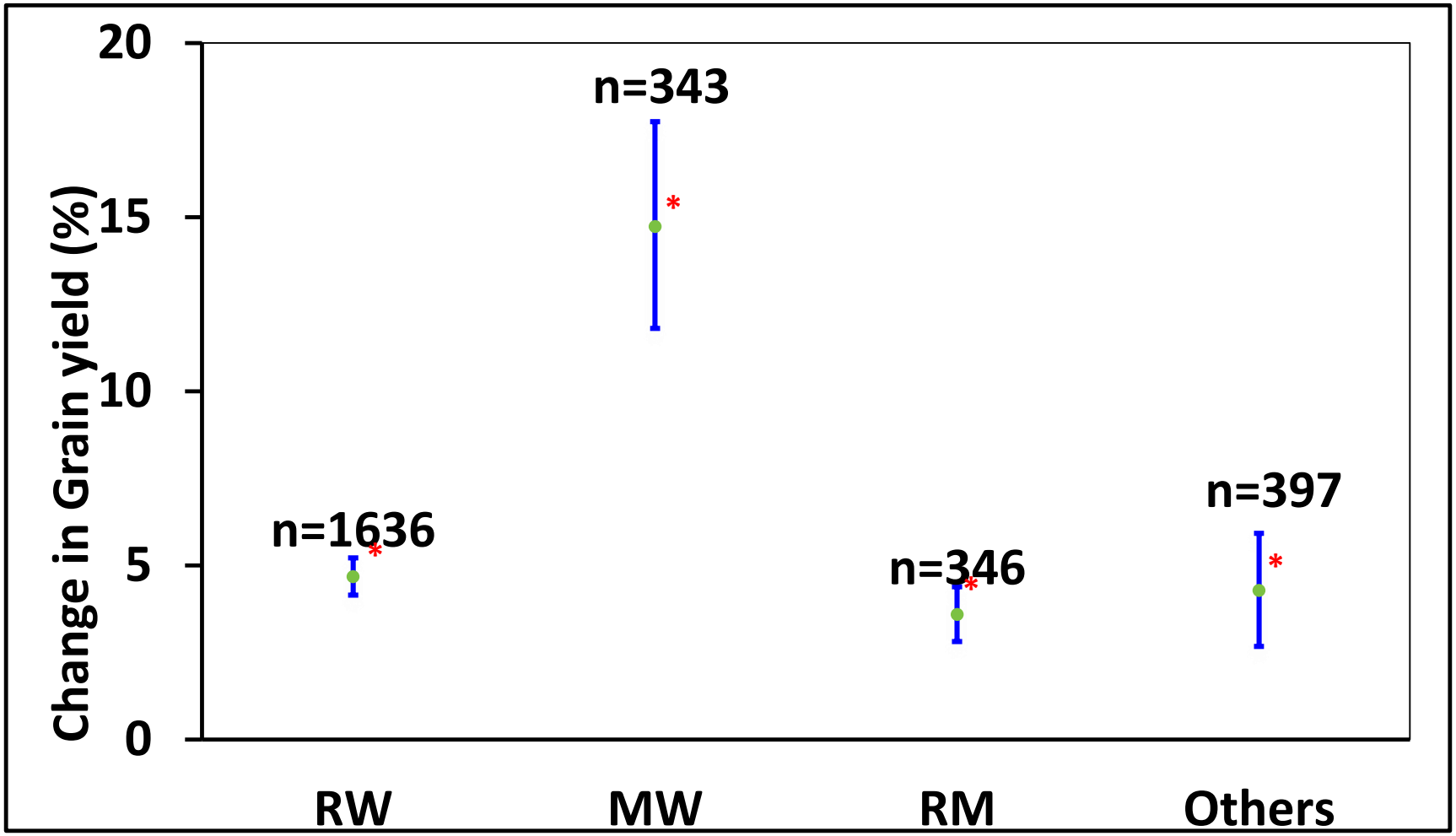
Meta analysis: performance (yield) of CA in different cropping systems and soil types



Jat et al (Forthcoming)

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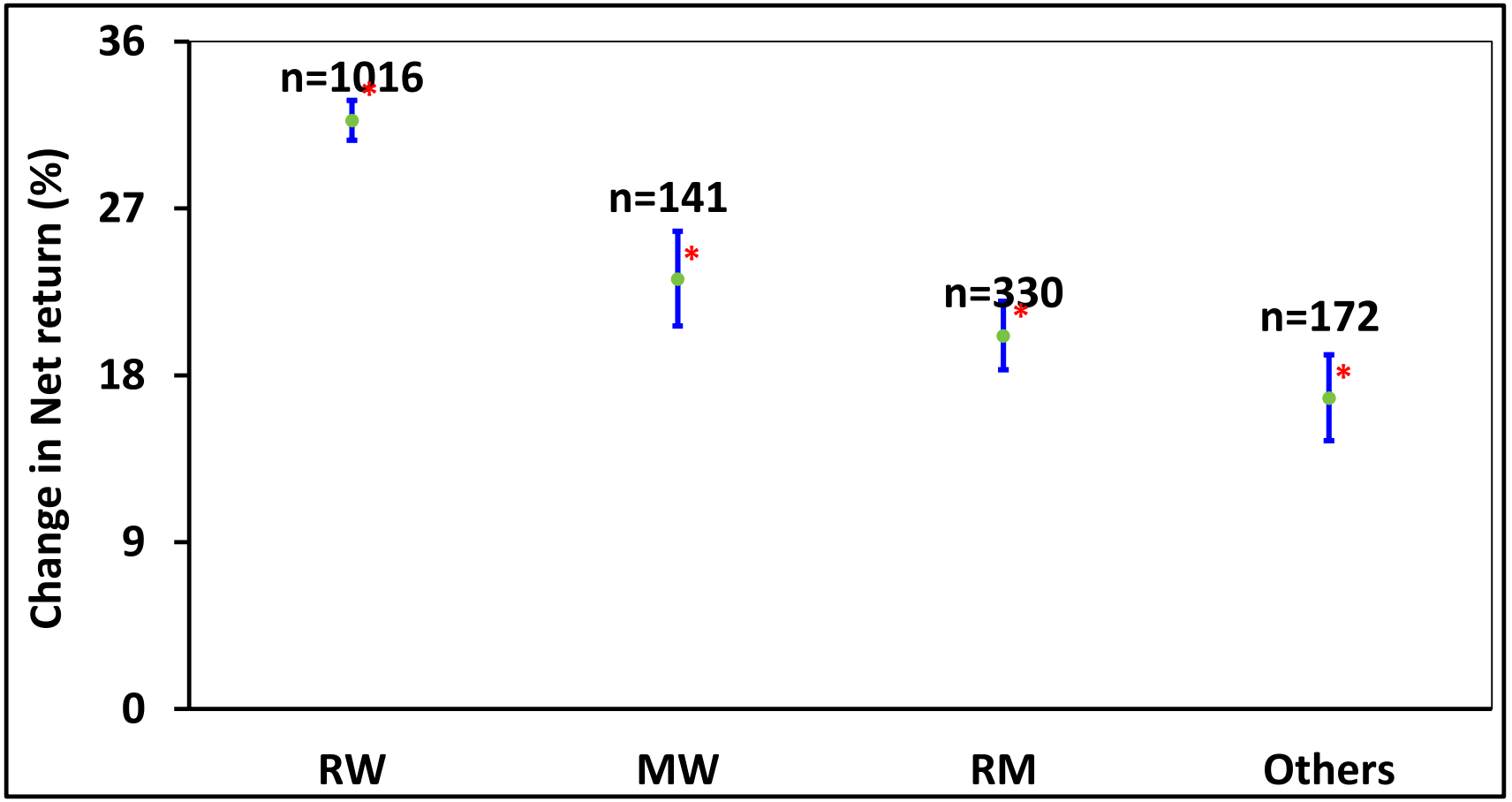
Meta analysis: performance (income) of CA in different cropping systems and soil types



Jat et al (Forthcoming)

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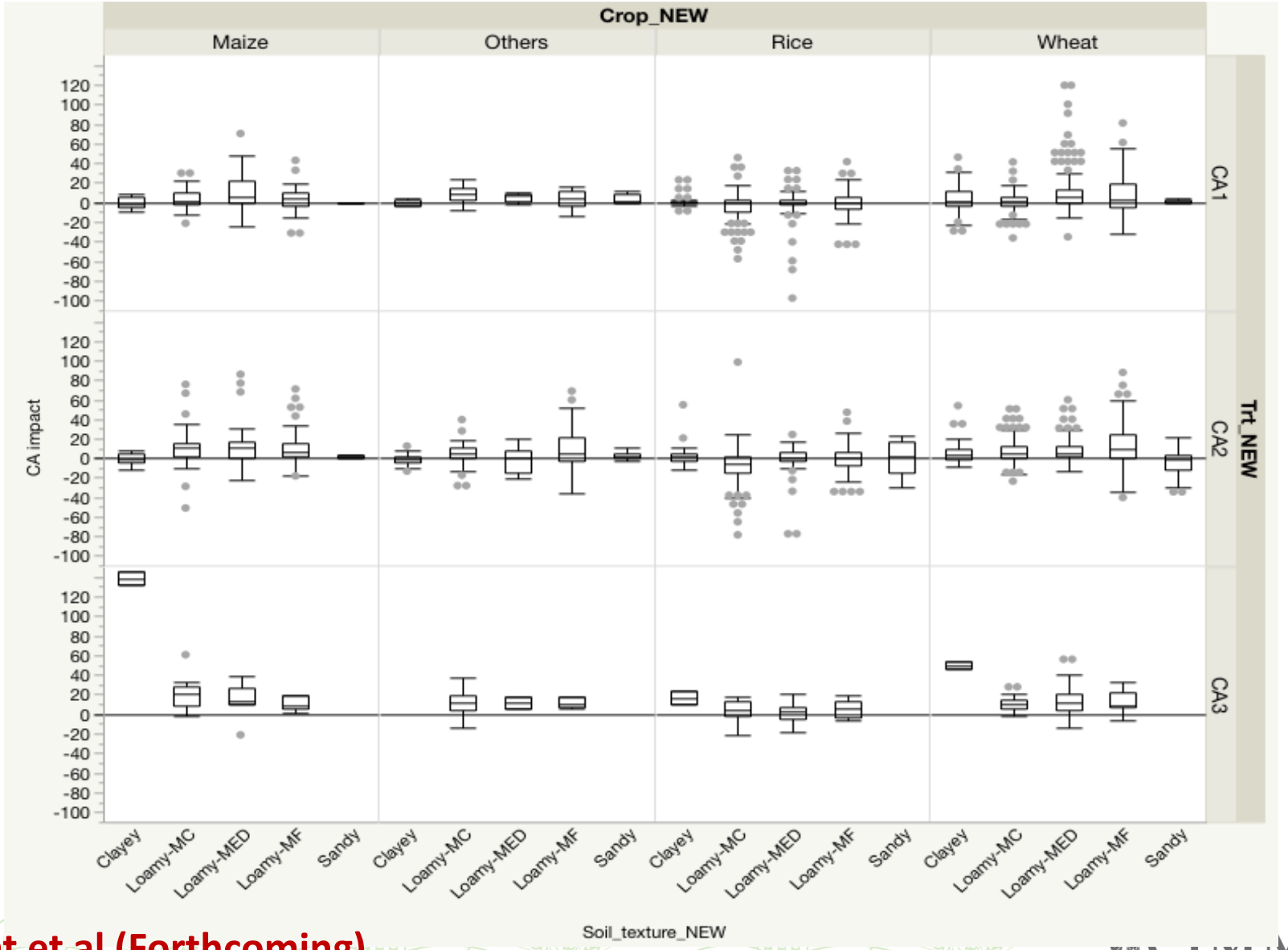
Meta analysis: performance of CA components in different crops under various soil types



Jat et al (Forthcoming)

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Meta-Analysis: Alternate Rice Production Systems

SCIENTIFIC REPORTS

OPEN

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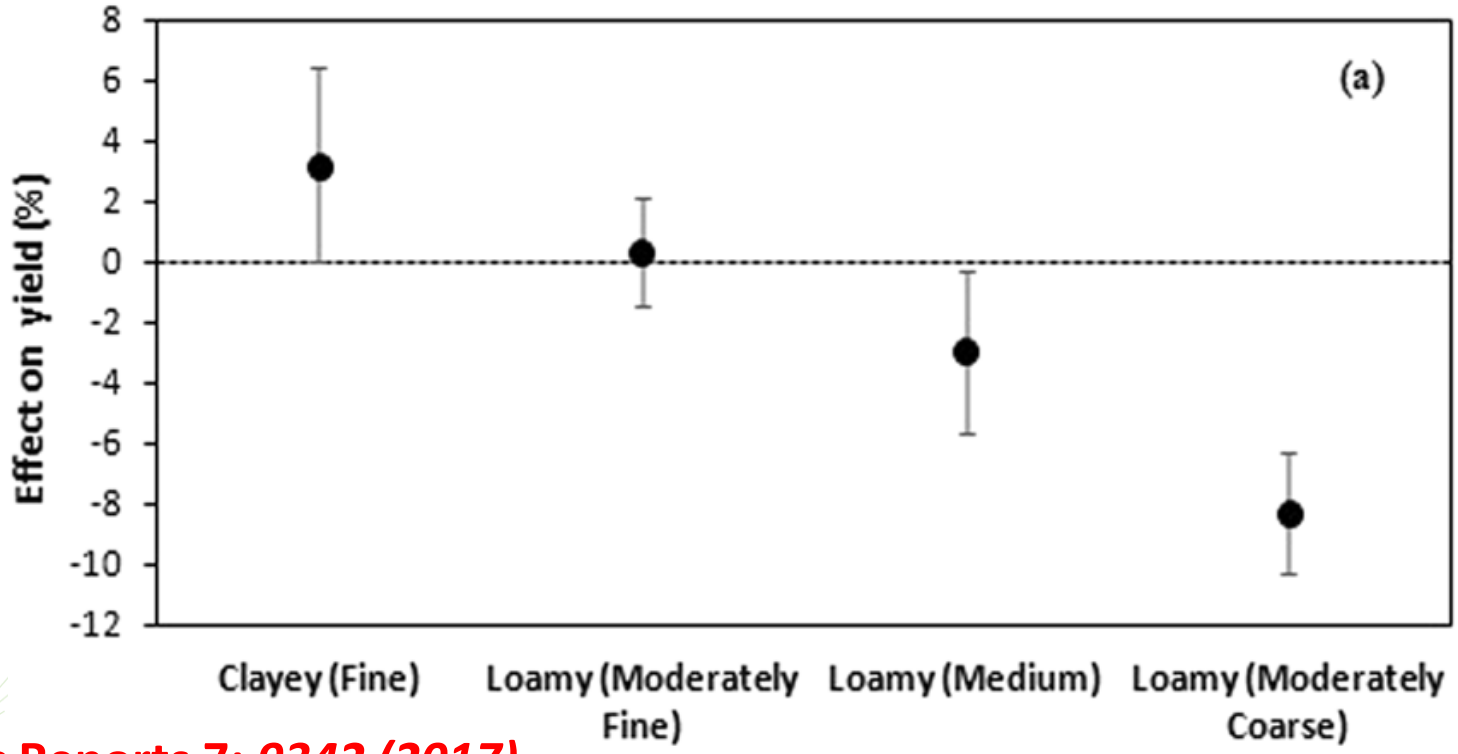
A global analysis of alternative tillage and crop establishment practices for economically and environmentally efficient rice production

Debashis Chakraborty[1], Jagdish Kumar Ladha[2], Dharamvir Singh Rana[3], Mangi Lal Jat[4], Mahesh Kumar Gathala[5], Sudhir Yadav[2], Adusumilli Narayana Rao[6], Mugadoli S. Ramesha[2] & Anitha Raman[6]



Nature Scientific Reports 7: *9342 (2017)*

3. Development/infrastructure related

- **CA based machinery needs are entirely different from that of intensive tillage based machinery**
  - ✓ **Supply uncertainty and price issues**
- **Local CA machinery manufacturing, after sale services and availability of spare parts (SPARES and REPAIRS) are lacking in most parts of the region except that of in parts of north-west India**
- **Private sector investment in CA machinery manufacturing infrastructure in most parts of the region are lacking**
  - ✓ **Market uncertainty challenges**

- **Scaling of CA for impact at scale needs infrastructure development on manufacturing of CA machinery through establishment of sub-regional, state level manufacturing hubs for supply of locally adapted and demand driven machinery**

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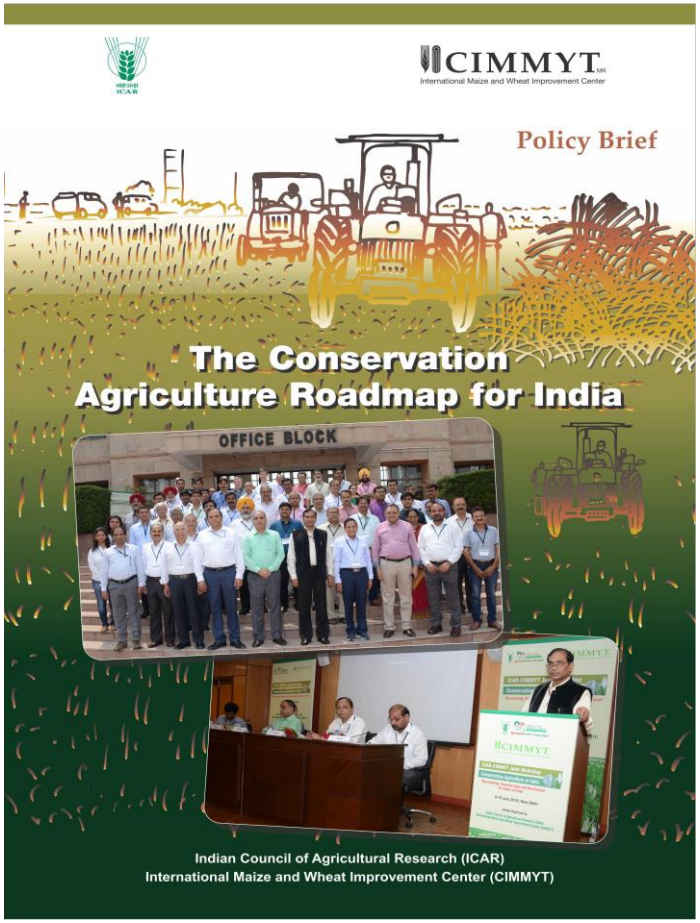
4. Knowledge, Capacity & Skill related

- Large knowledge, capacity and skill gap on CA
- Application of CA principles are very site-specific- capacity and skills of stakeholders is critical for successful implementation of CA
- The agronomic management practices for CA still revolves around conventional tillage based systems.
- CA in course curriculum in universities?
- With some exceptions, there are no any practical training course on CA to develop the skills of the range of stakeholders
- No tracking mechanism

- There is a need for reorientation of capacity and skill development programs.
- Developing/strengthening knowledge networks on CA are critical for cross learning and confidence building for scaling.



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Advanced Course on CA@CIMMYT India

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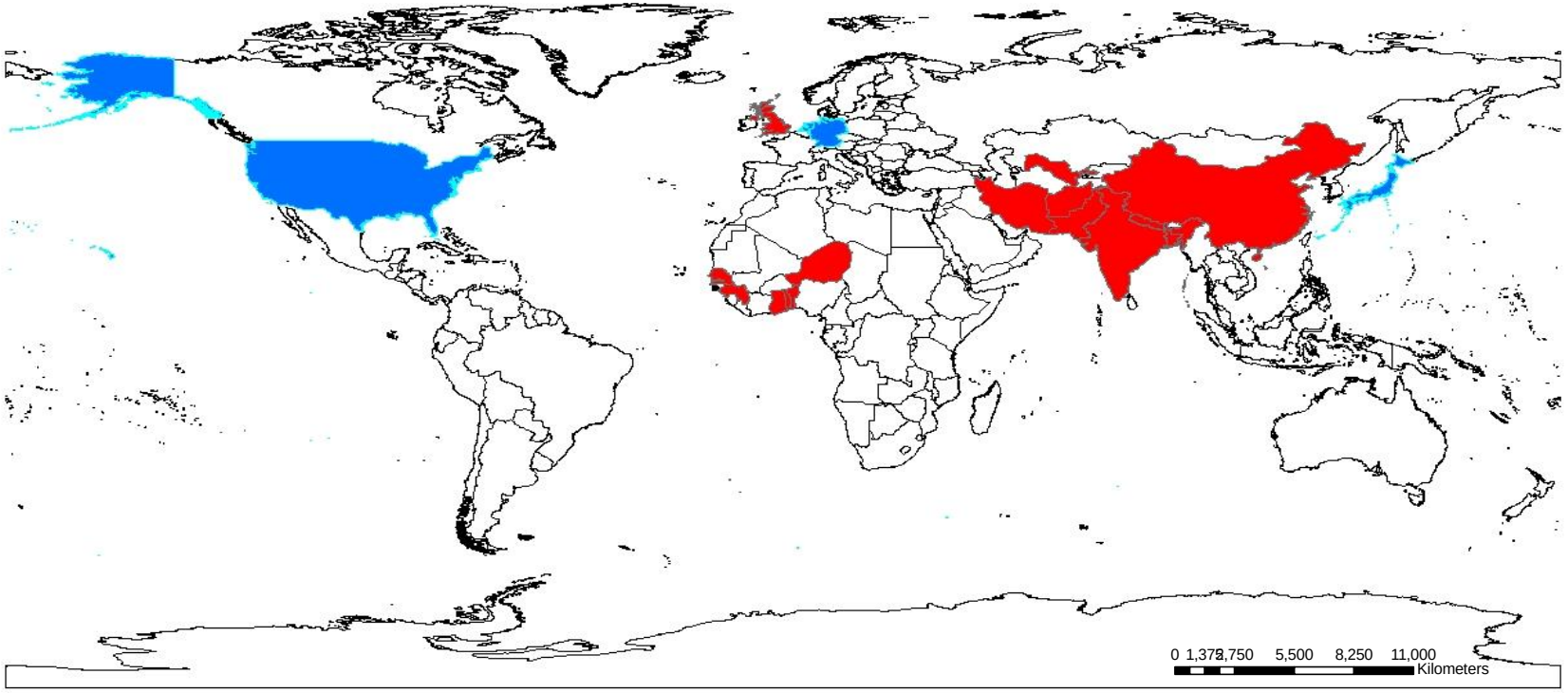

- **NRM:** Agronomy, Soil Science
- **Agril Engineering:** Farm Machinery & Power Engineering, Soil Water Engineering
- **Crop Sciences:** Plant Physiology, Plant Breeding
- **Social Sciences:** Agricultural Extension, Agricultural Economics, Agricultural Statistics, Agri-Business Management

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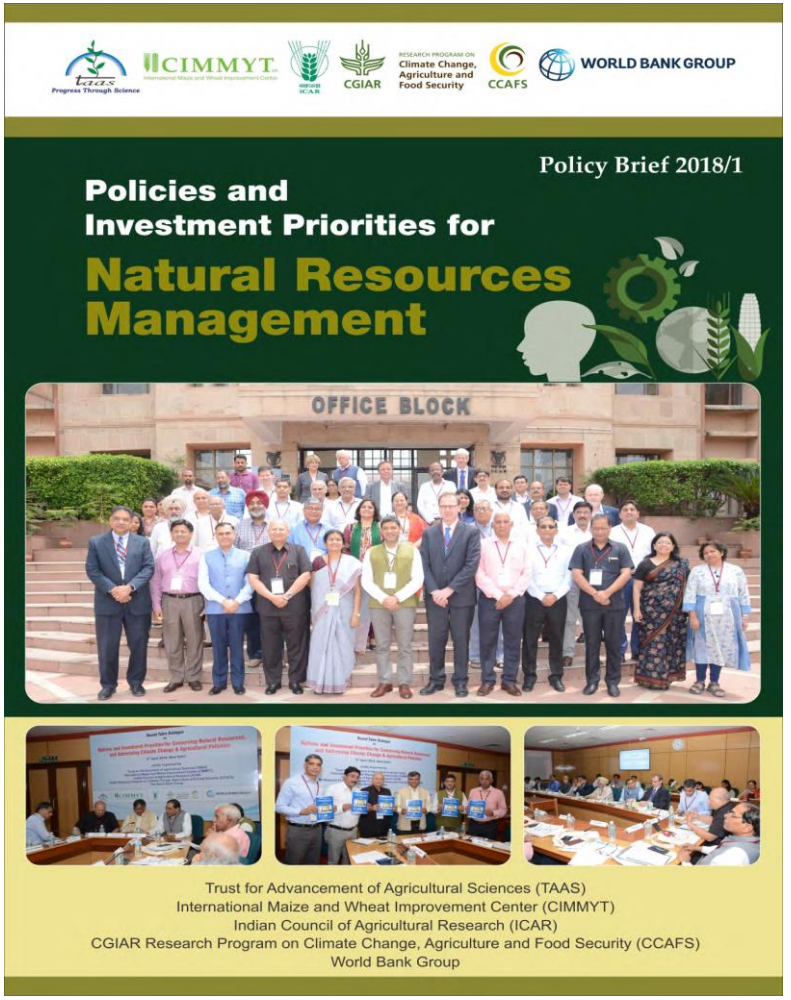
5. Policy & Investment Priority Related

- **Foresight for investments**
- **Return over investments (RoI) in terms of private and public costs & benefits**
- **The investments on agriculture considering short-term goals and quick-fixes are many a times counter-productive and delimits the scaling of CA**
- **Investments on more innovative, futuristic and sustainable agriculture technologies such as CA and linking with country commitments such as Sustainable Development Goals (SDGs).**
- **Subsidy v/s incentives for efficiency**



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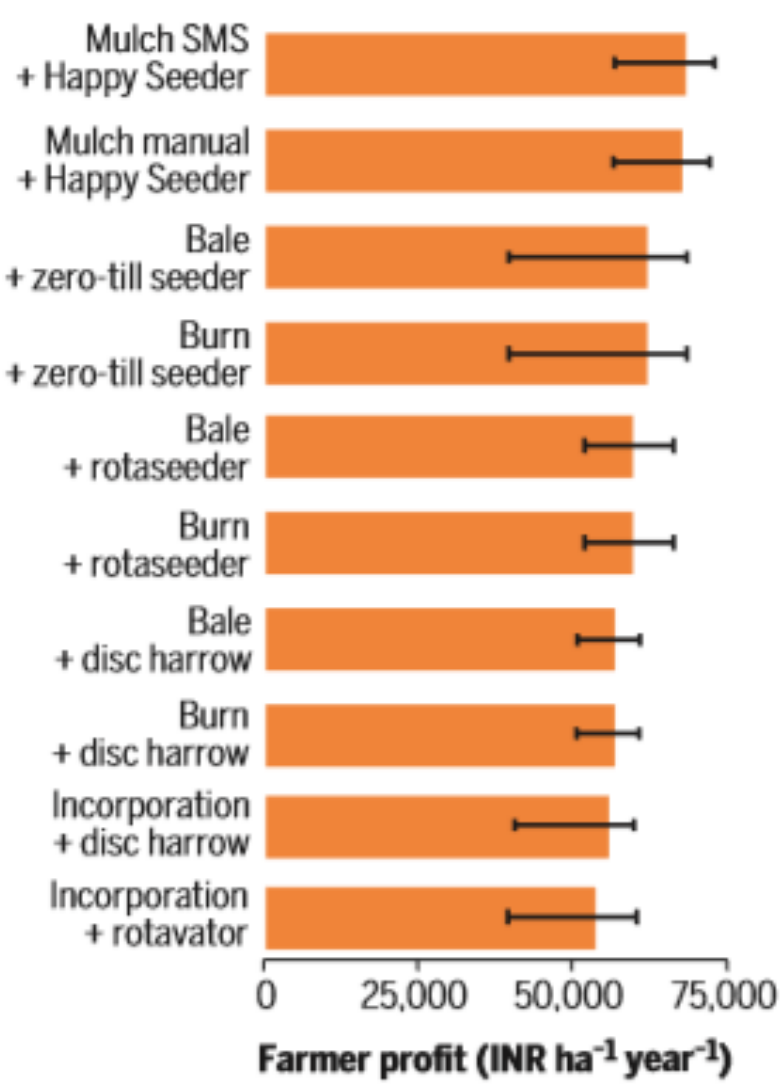
Profitable Residue Management Alternatives



- **Considering the full range of variation, the maximum profit the average farmer can gain by switching from the most common burning system to the most profitable Happy Seeder system is 22,254 INR/ha (+44%).**
- **On the other hand, the farmer could, in the worst-case scenario, lose 4012 INR/ha (–7%) by switching**
- **The relative profitability of the Happy Seeder option suggests that farmers could transition away from burning while improving their bottom line**

Source: Science, 9 AUGUST 2019, VOL 365 ISSUE 6453

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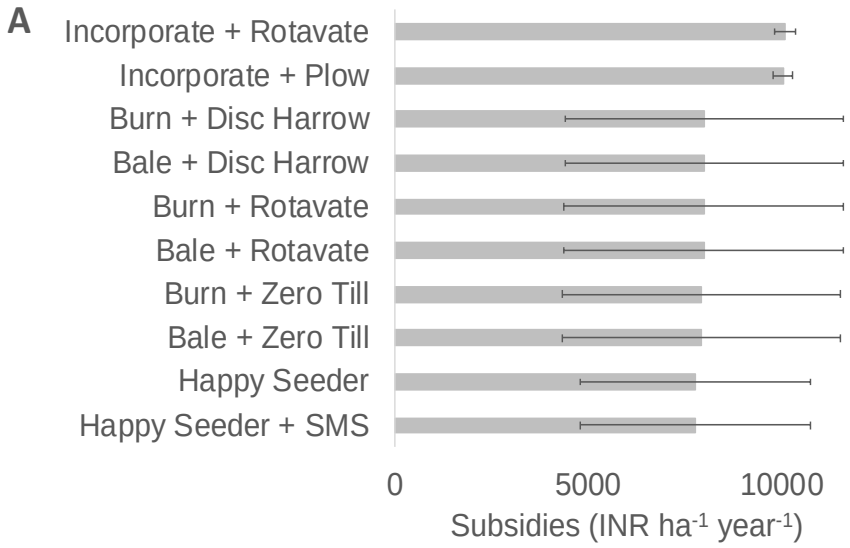
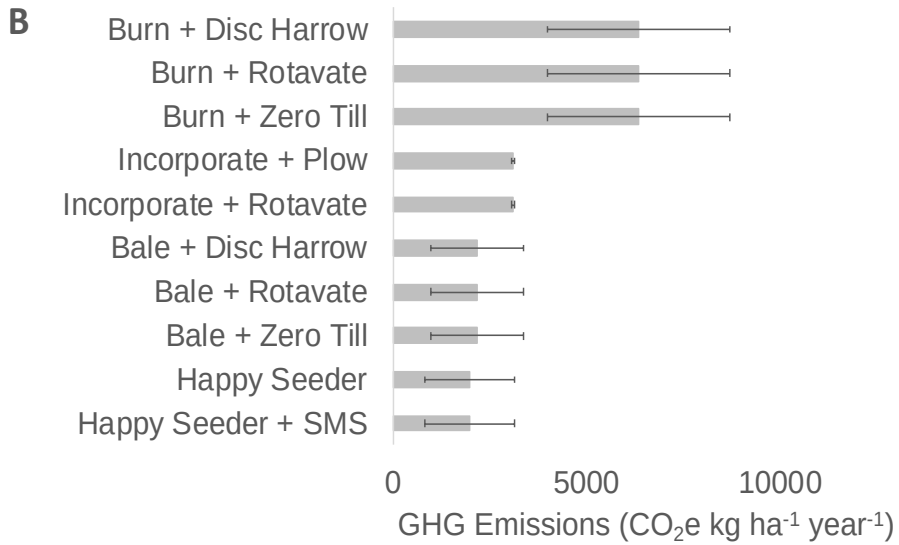
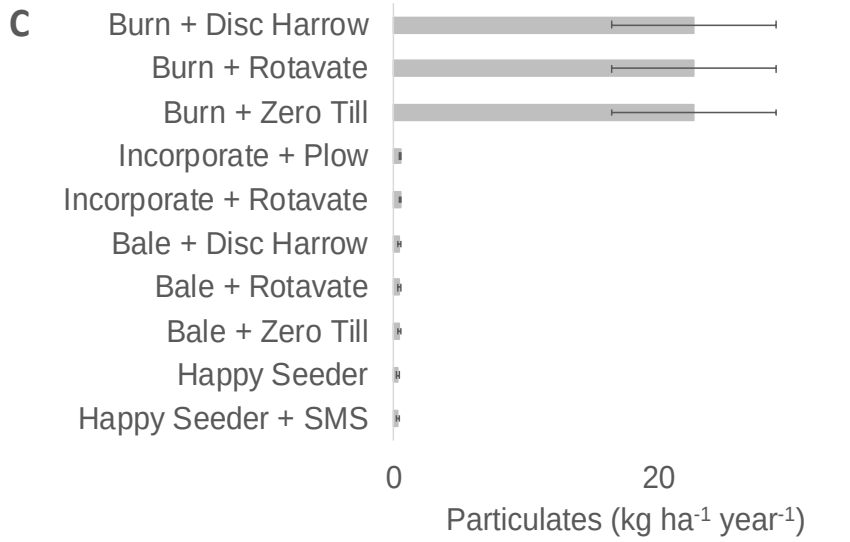
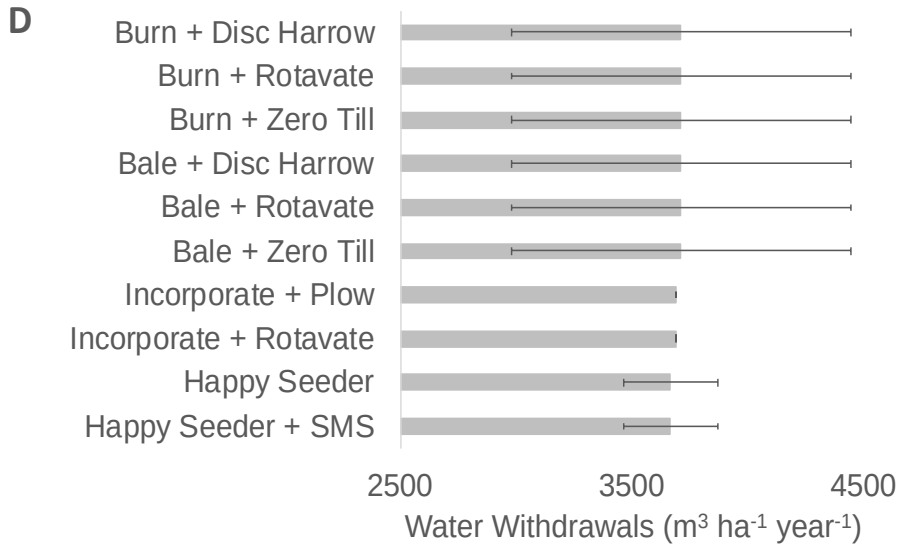
Public costs per hectare of alternate crop residue management strategies









Source: Science, 9 AUGUST 2019, VOL 365 ISSUE 6453

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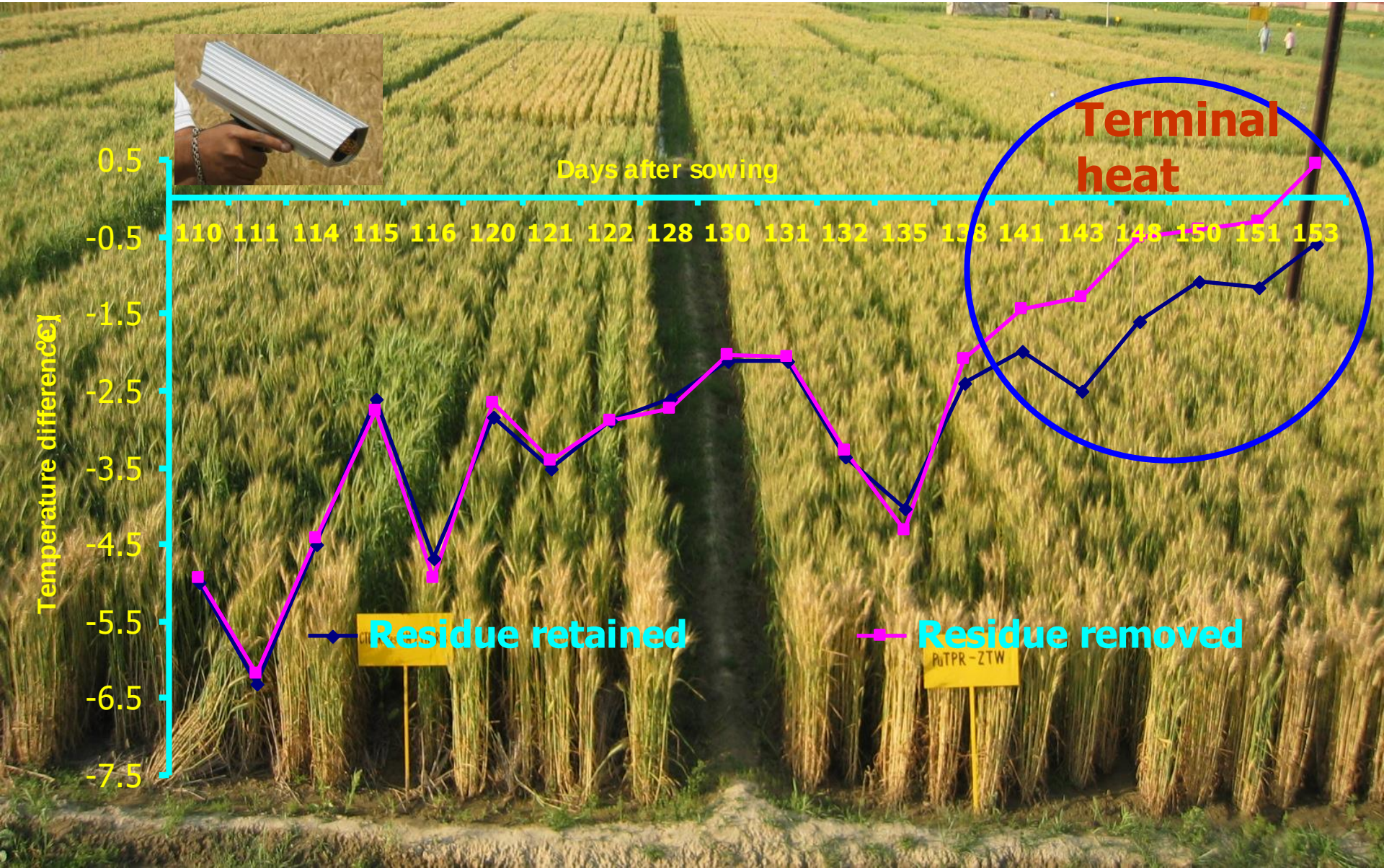
Wheat Beats the Heat with CA



No-till Wheat Under Extreme Climate Risks:

(Excess Rains at Wheat Grain Filling in 2014-15)

Excess Rains in January 2019: Ludhiana, India

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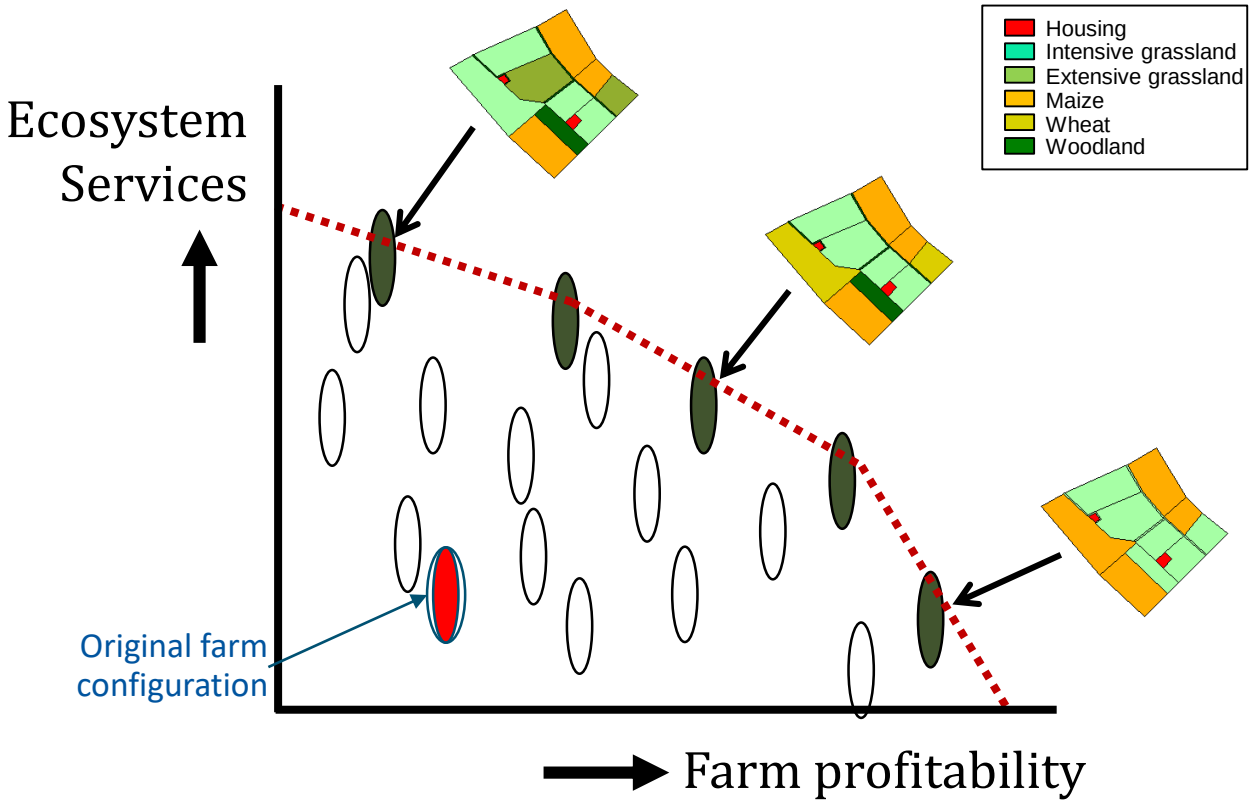
Science of Scaling for Impact

Targeting with Clarity of Objectives



Business Models for Scaling

Journal of Cleaner Production 210 (2019) 1109–1119

Contents lists available at ScienceDirect

Journal of Cleaner Production

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

Business models of SMEs as a mechanism for scaling climate smart technologies: The case of Punjab, India

A.E. Groot [a, *], J.S. Bolt [a], H.S. Jat [b], M.L. Jat [c], M. Kumar [c], T. Agarwal [c], V. Blok [d]

[a] Climate Change Group, Wageningen Environmental Research, Wageningen University & Research, Droevendaalsesteeg 3, 6708 PB the Netherlands
[b] ICAR-Central Soil Salinity Research Institute (CSSR), Karnal, Haryana, India
[c] Researcher International Maize and Wheat Improvement Centre (CIMMYT), NASC Complex, New Delhi, India
[d] Management Studies Group, Wageningen University, Wageningen University & Research, the Netherlands

The Power of Technology + Enabling Policy
No-till Example from Punjab, India

- **Primary data from 46 villages in 6 districts of Punjab (January 2019)**

	2016-17	2017-18	2018-19
ZT drill	1289	1291	1294
Happy Seeder	8	64	247
Area under ZT	845	7500	28372
Scenario	No strict imposing ban	Imposing ban without investment	Imposing ban with investment

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TURBO HAPPY SEEDER

landforce
TURBO HAPPY SEEDER

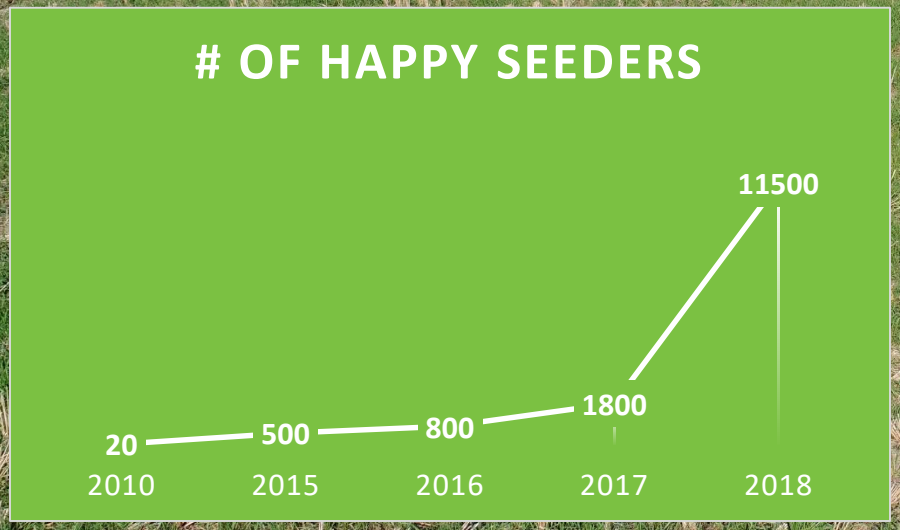
Impact at scale- Happy Seeder

The Indian EXPRESS

Tuesday, December 25, 2018

Punjab agriculture secretary: Direct sowing in 17 per cent of wheat area

800000 ha in Punjab & Haryana in 2018-19



- Long term investment for science evidence
- Policy support & investment
- Private sector capacity & business models
- Human capital
- Public and private benefits

'Transitioning Towards CA Mediated Sustainability'

- **Long-term process research- Science Evidence**
- **Participatory on-farm validation and refinement: backward and foreword integration**
- **Multi-disciplinary (CA is Agriculture and not just Agronomy & Engineering) and multi-stakeholder (farmer centric) approach**
- **Science evidence backed policy informing**
- **Science of scaling: Business models and social inclusivity**
- **Capacity (Confidence) development**

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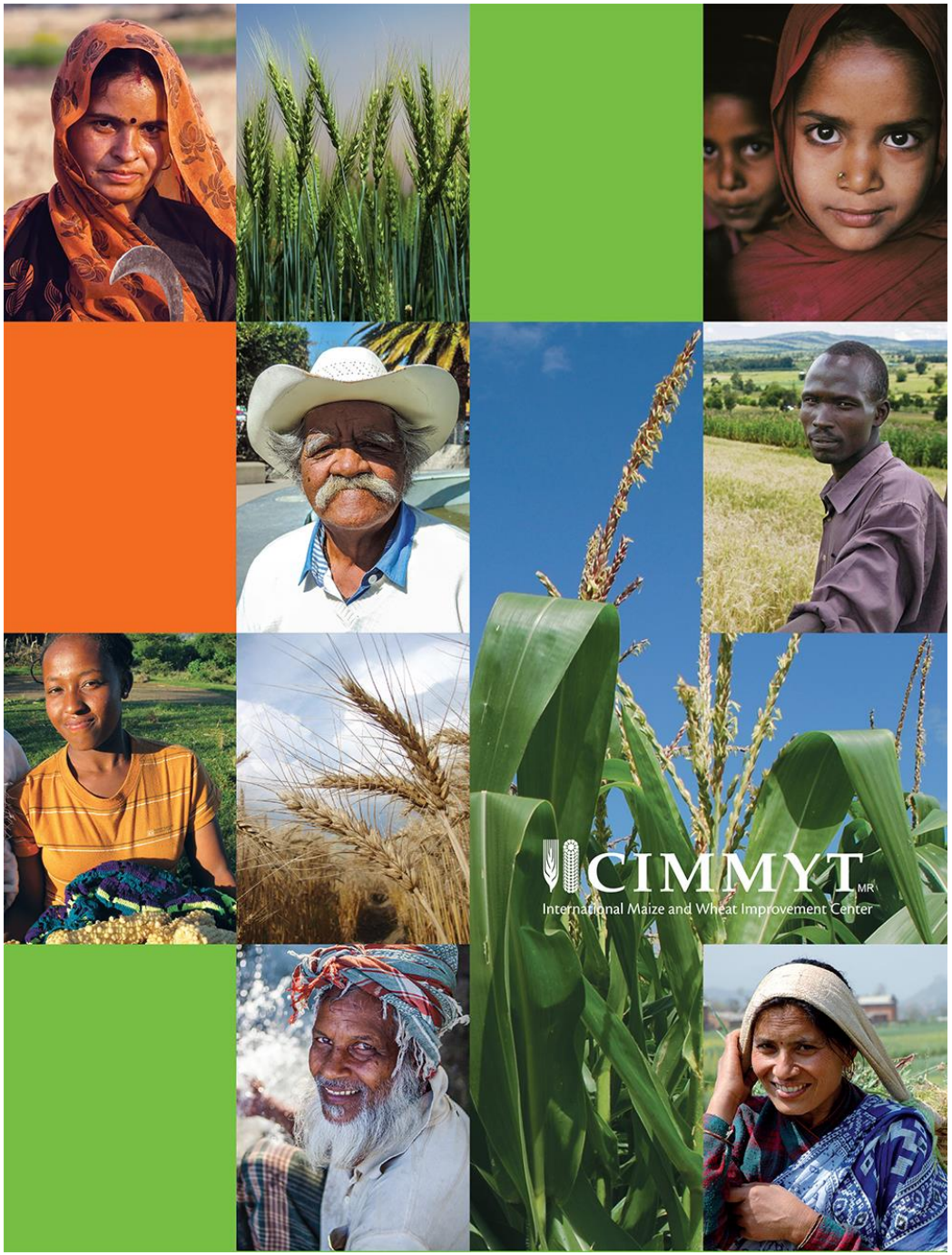

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