Maize and Wheat Science for Improved Livelihoods

ML Jat

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International Maize and Wheat Improvement Center (CIMMYT)

CIMMYT MR

CIMMYT

Mission

Wheat and maize science for improved livelihoods

OSS develops high-yield, disease-resistant, semi-dwarf wheat and shuttle breeding

Norman Borlaug is awarded the Nobel Peace Prize

CIMMYT scientists win the World Food Prize

1940s | 1950s | 1960s | 1970s | 1980s/1990s | 2000s | 2010s

The Office of Special Studies (OSS) is created

The Green Revolution in India and Pakistan

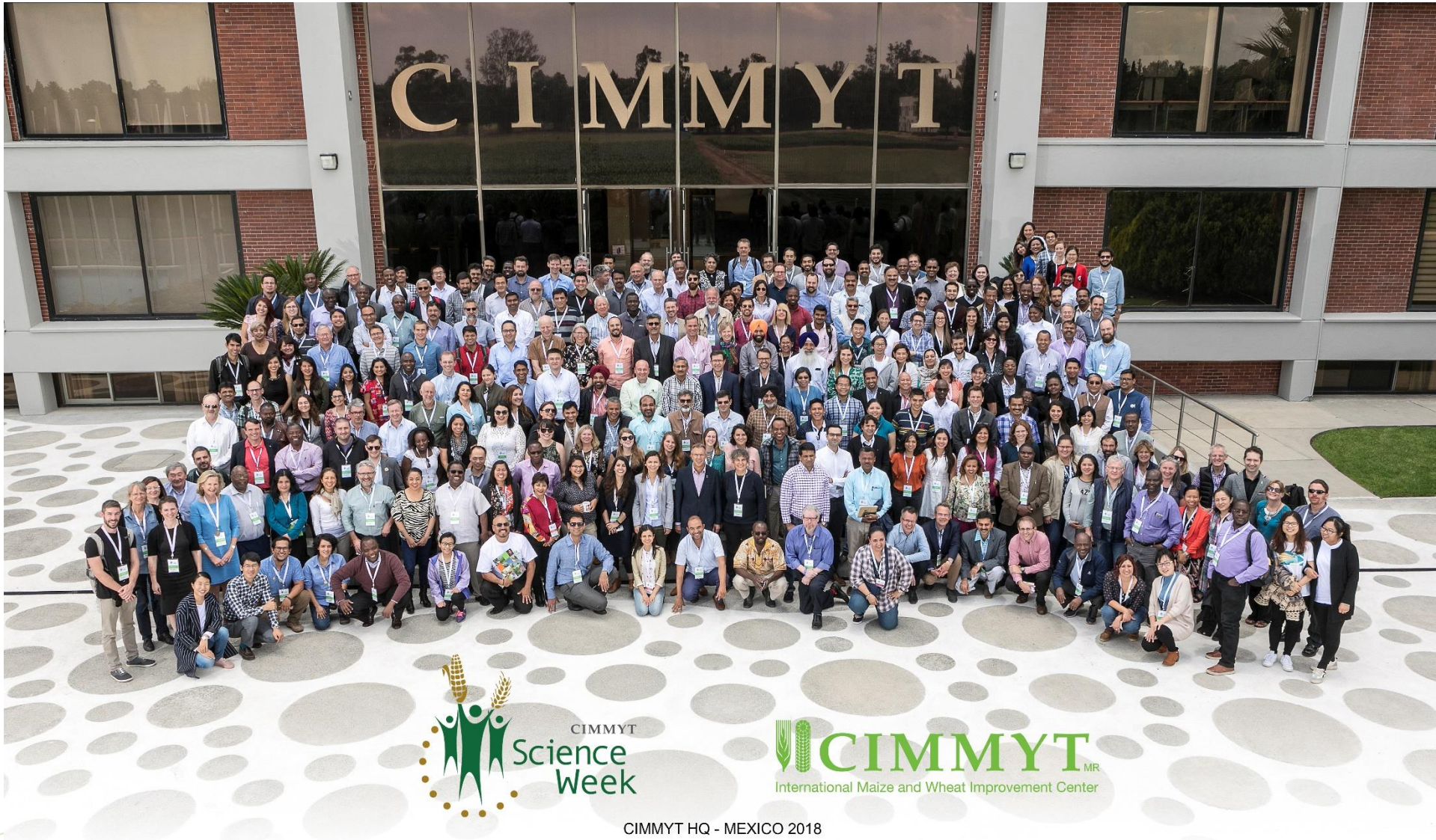
CIMMYT is officially founded

The Wellhausen-Anderson Plant Genetic Resources Center opens

CIMMYT responds to the food price crisis and expands globally

CIMMYT

BIG Family with Diversity of Culture and Scientific Skills



CIMMYT HQ - MEXICO 2018

Major Achievements

$ 2 billion annual benefits to farmers in developing countries.

50% of maize and wheat grown in the developing world **based on CIMMYT varieties.**

10,000 researchers and professionals worldwide **alumni of CIMMYT training.**

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Wheat Helps Feed the World

- Most widely cultivated cereal grain
- 20% of all calories and protein

2.5 billion people in **89** countries = Wheat consumers **<$2** a day

60% MORE | **WHEAT** THAN TODAY...

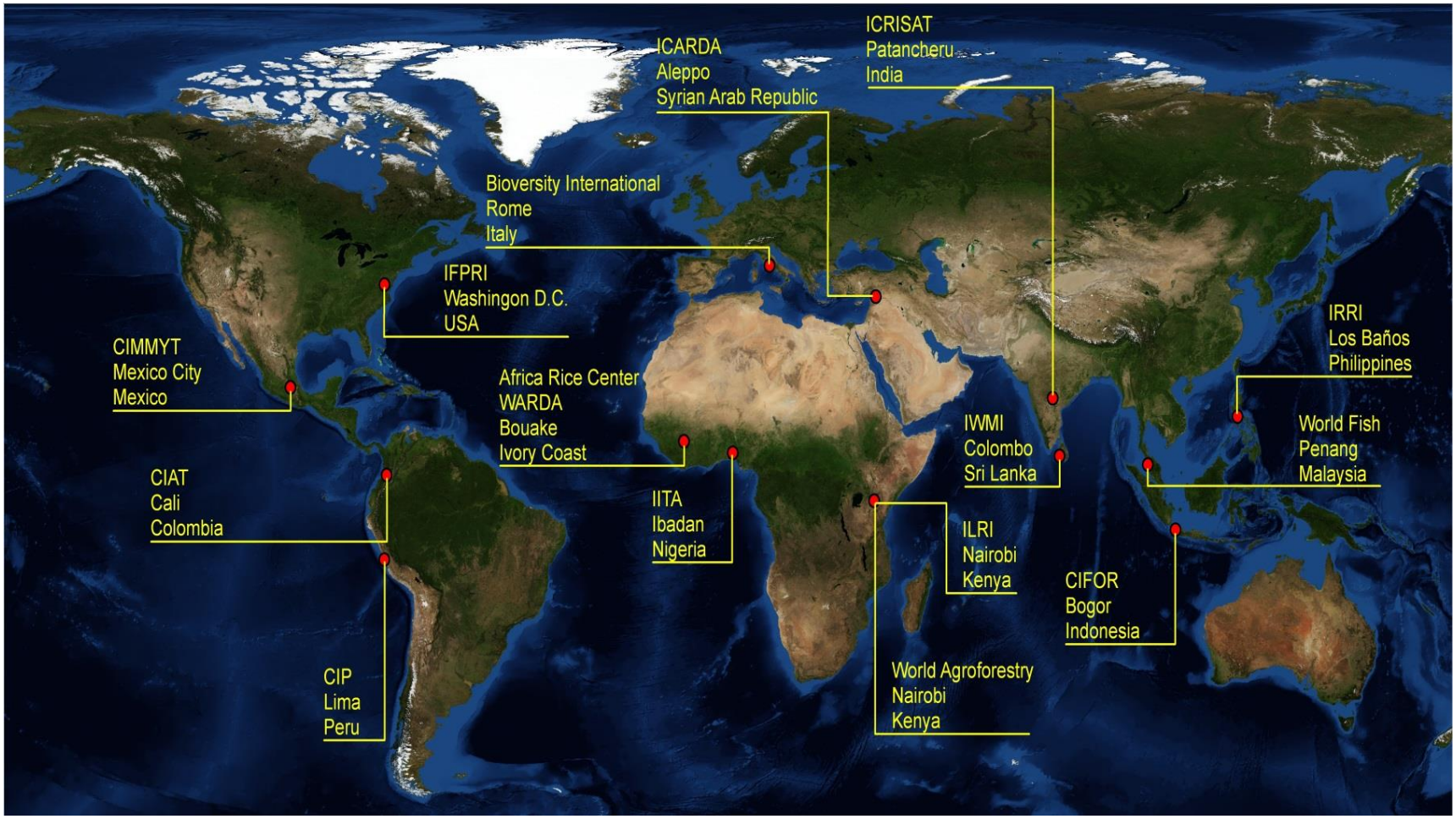
The amount the world will need to grow to meet consumer demand by 2050.

CIMMYT

Maize Helps Feed the World

- Preferred staple food to **900 million** people living on less than $2 a day.
- Maize provides **15-56% of total calorie intake** in sub-Saharan Africa, Latin America and Asia.
- 184 million hectares worldwide.

CIMMYT is Part of the CGIAR



CIMMYT MR

CIMMYT Around the World

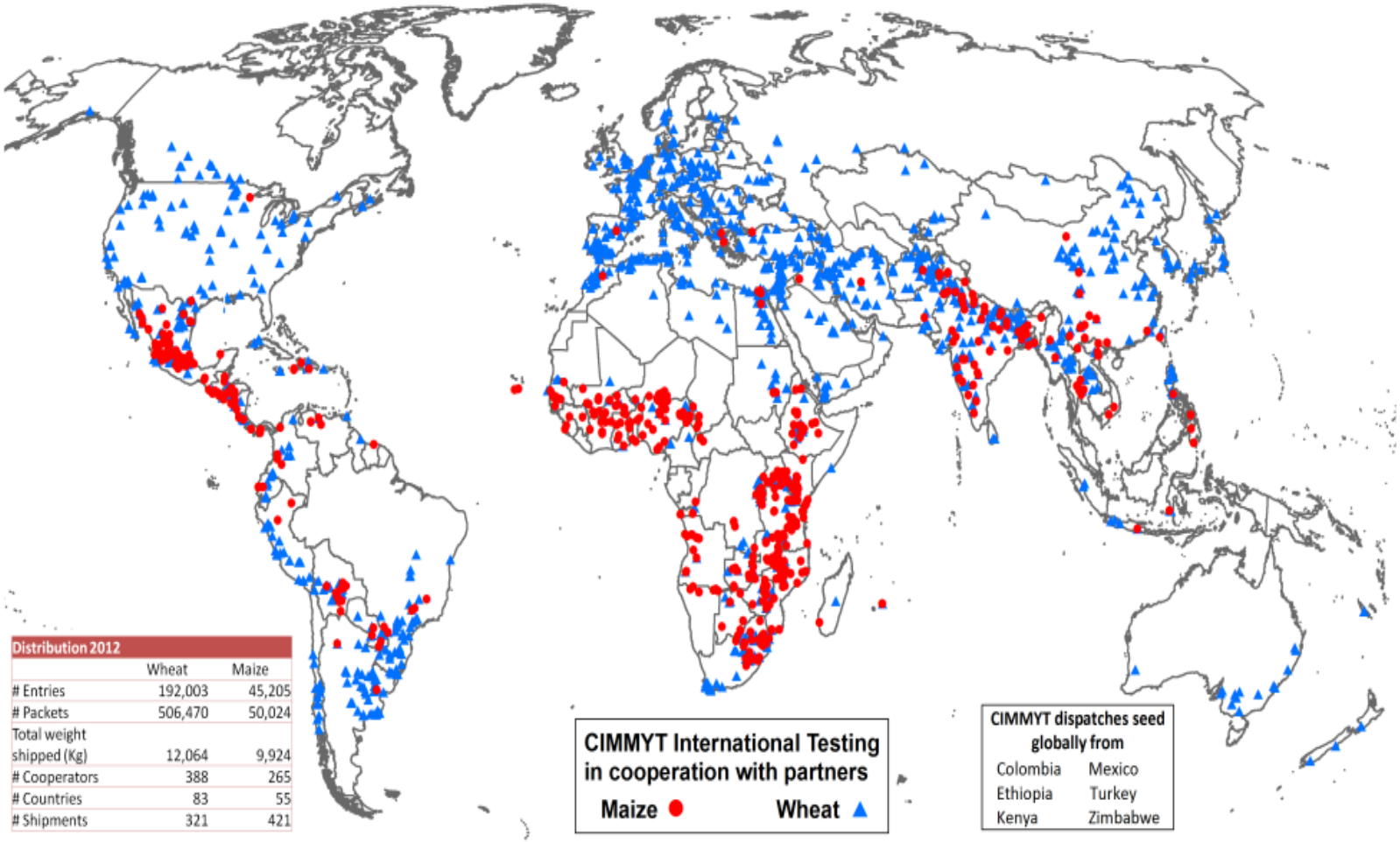
CIMMYT MR

The Germplasm Bank

- Wellhausen-Anderson Plant Genetic Resources Center, established in September 1996 with funding from the government of Japan.
- ISO-certified.
- 28,000 entires of maize and 138,000 of wheat.
- CIMMYT seed is made freely available: 500,000 packets of seed are sent to more than 600 partners each year.

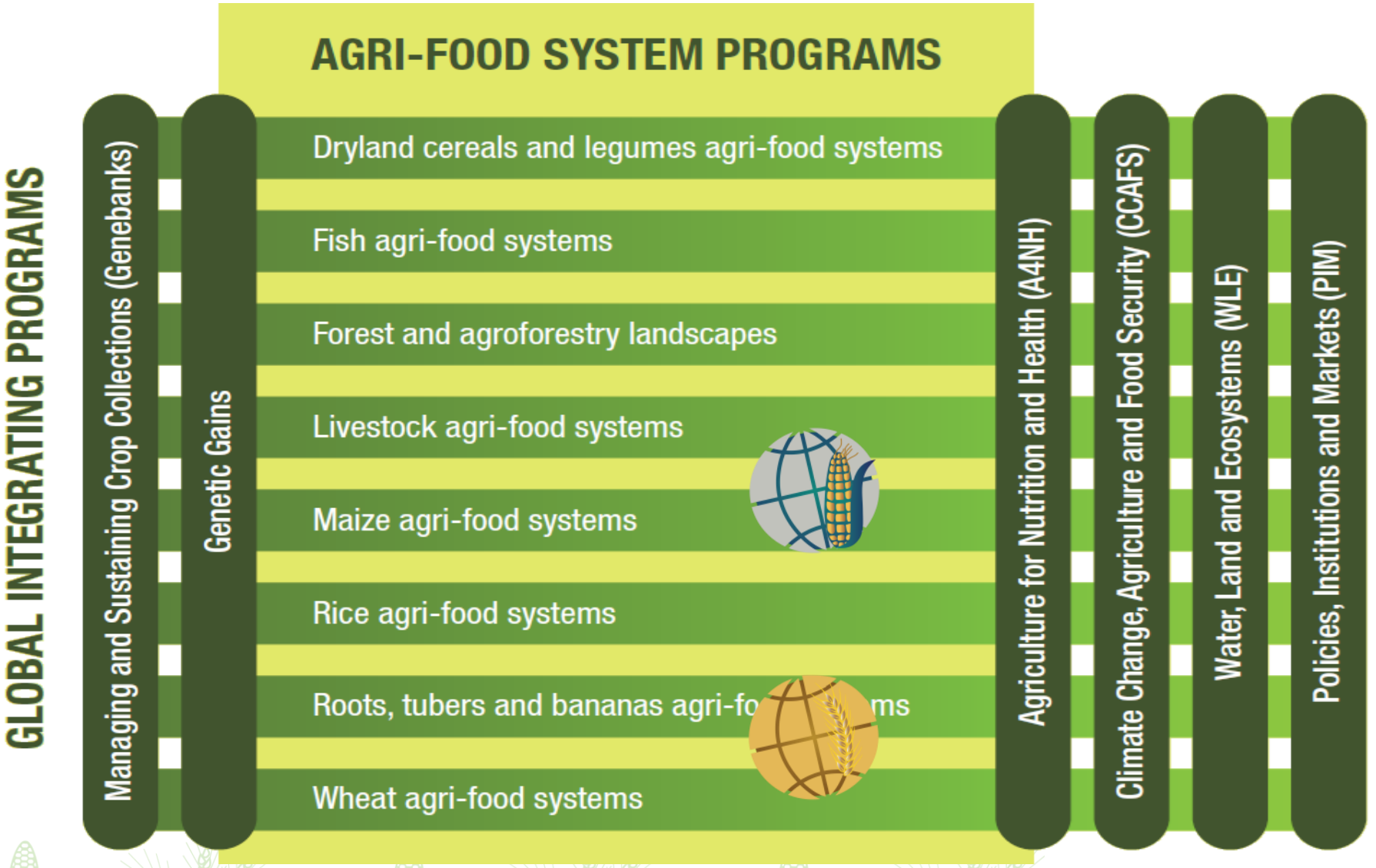
CIMMYT

Global Seed Distribution Network



CIMMYT

CGIAR: Working Within Agri-food systems



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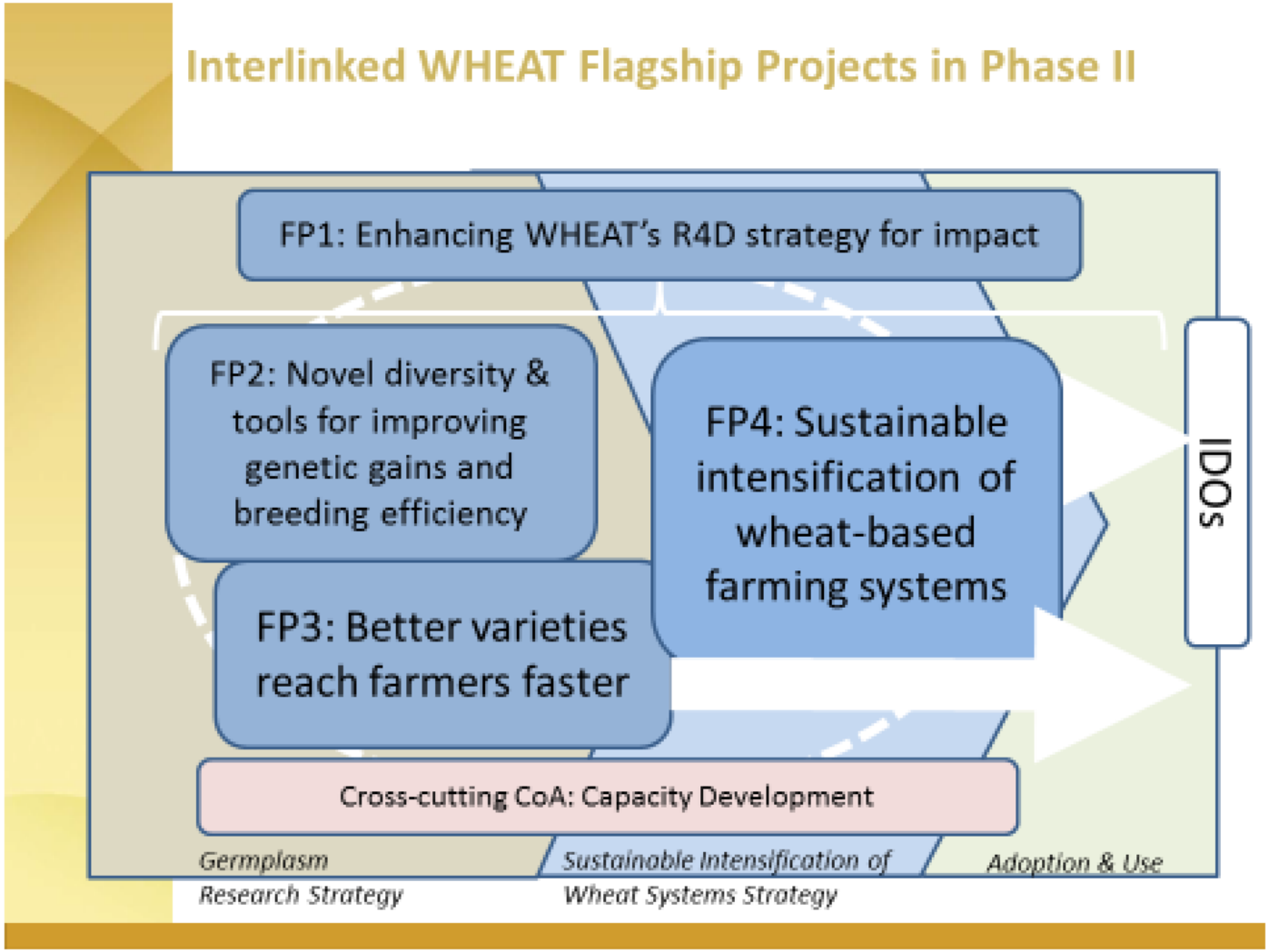
WHEAT Agri-Food Systems



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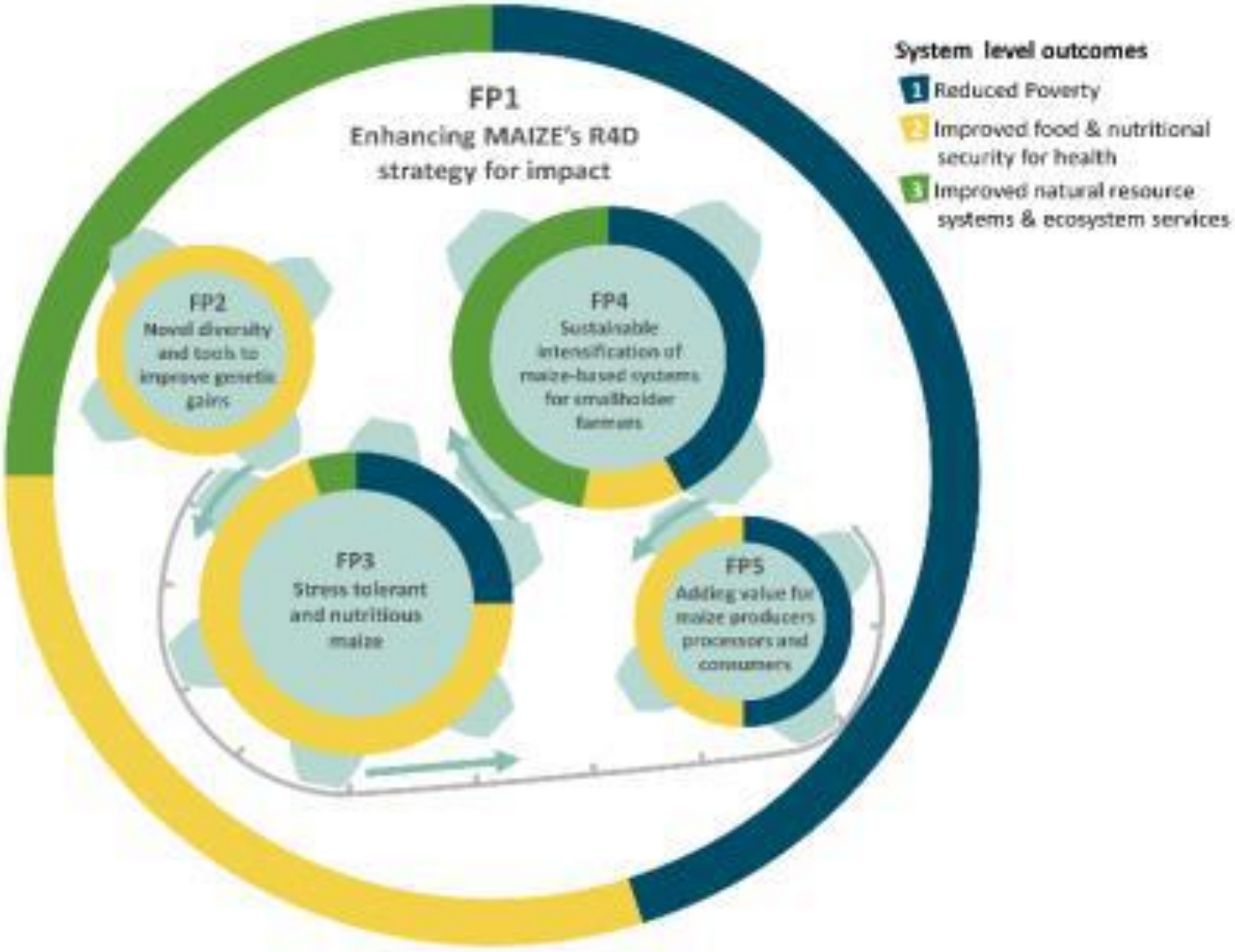
MAIZE Agri-Food Systems



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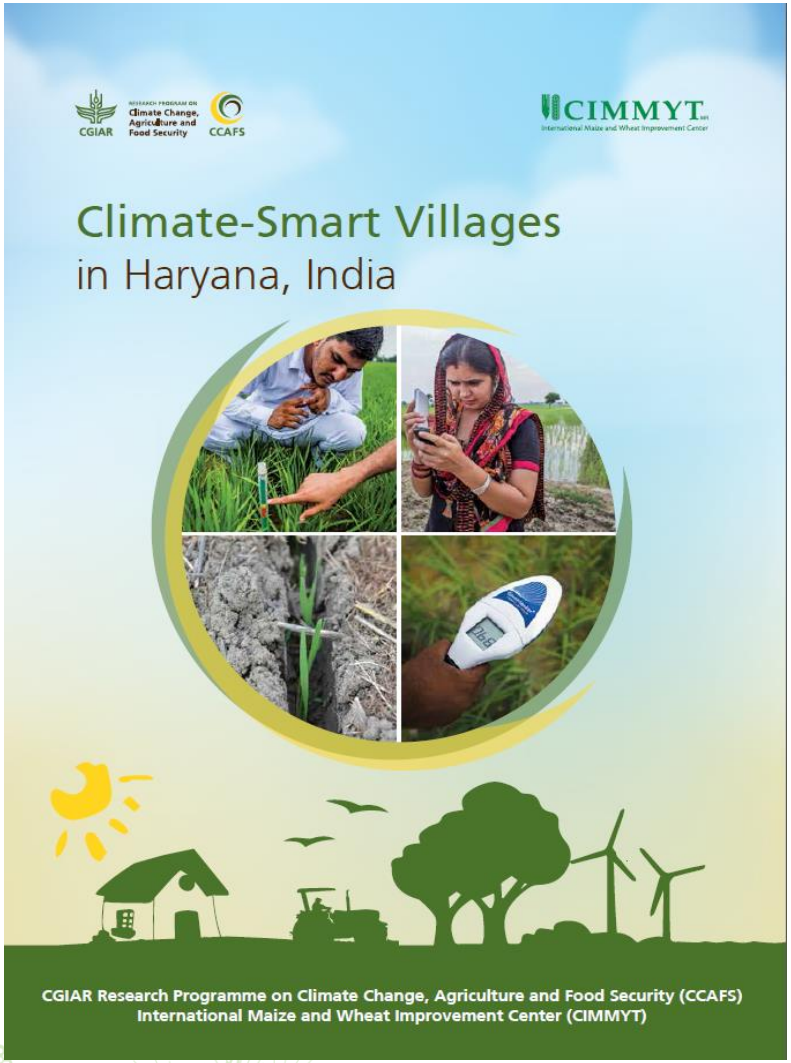
Climate Change, Agriculture and Food Security (CCAFS)

FP1 Priorities and policies for CSA
FP2 Climate-smart technologies and practices
FP3 Low emissions development
FP4 Climate services and safety nets



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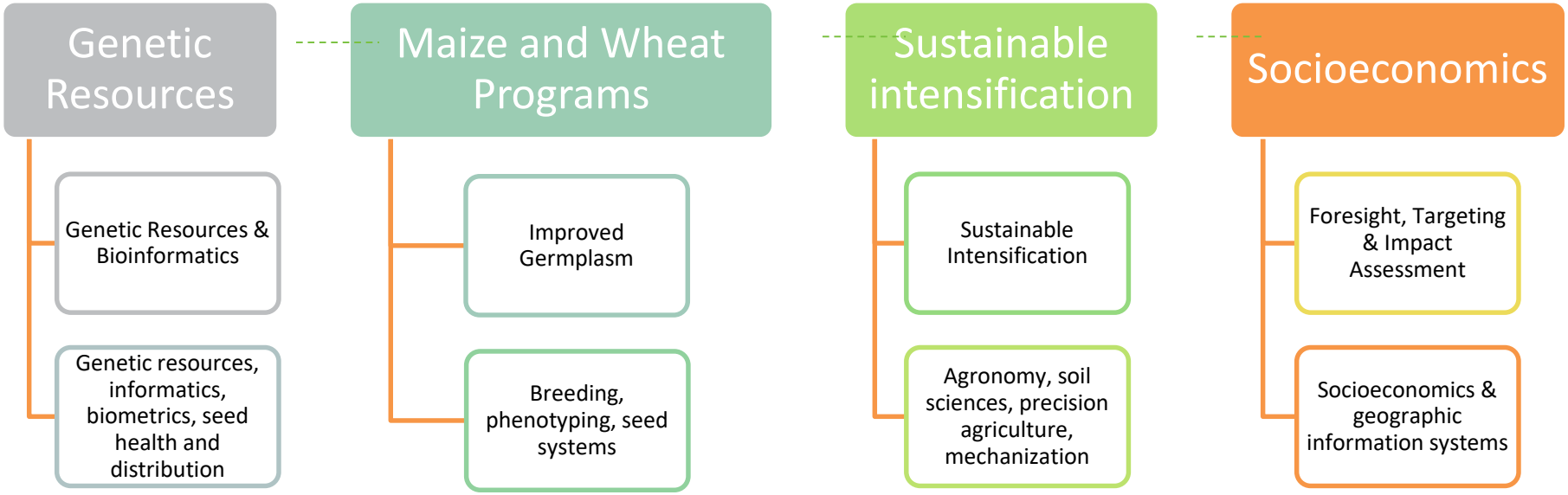
Borlaug Institute for South Asia (BISA):
A joint initiative of CIMMYT and ICAR (Govt of India)

To contribute to sustainable food security, poverty reduction and economic development in South Asia by facilitating collaboration between cutting-edge national, regional and international organizations in the area of agricultural research

CIMMYT

Scientific Excellence



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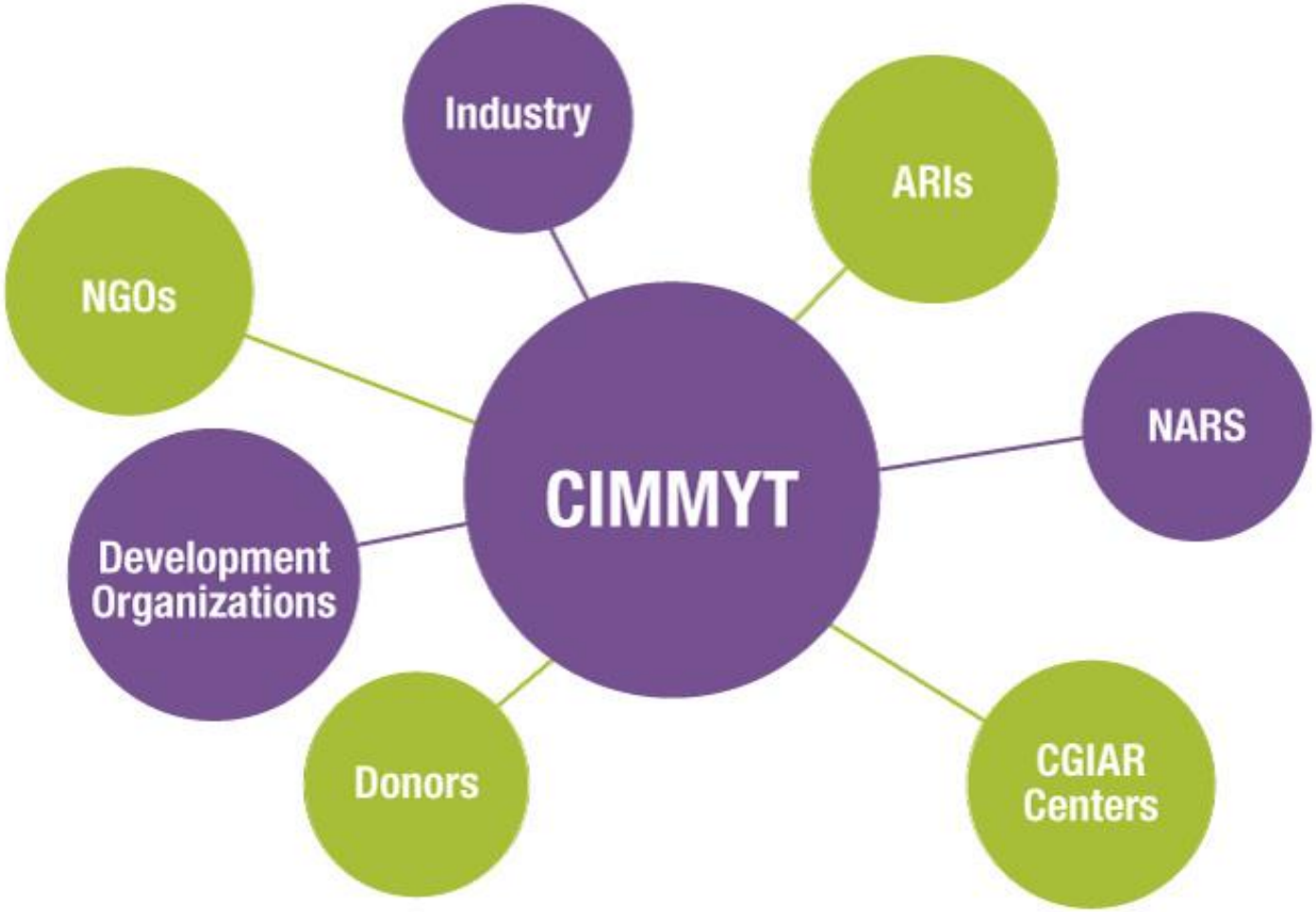
Impact through Partnerships



Capacity Building

50,000 days training given each year.

Technical courses

Farmers' days

Workshops

PhD/MSc students

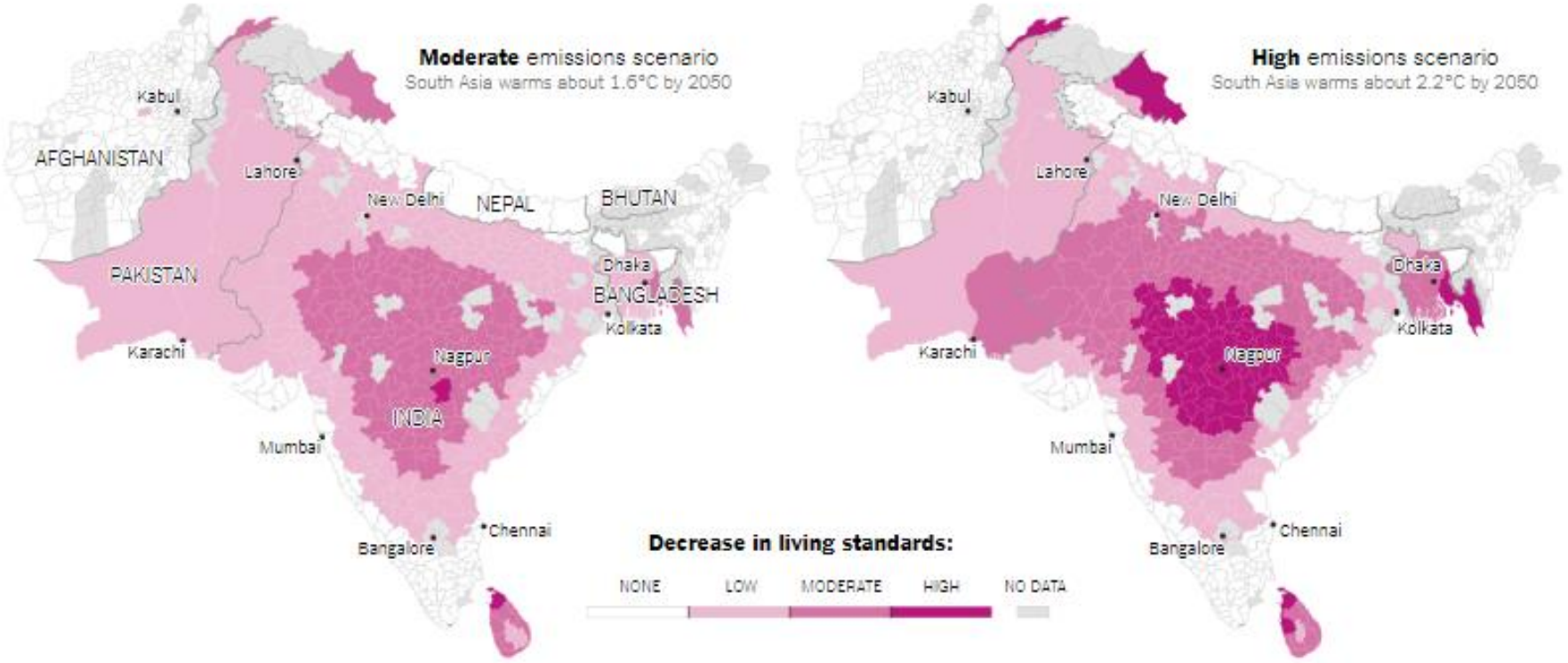
More than 10,000 scientific and professional alumni around the world.

CIMMYT

The New York Times, 28th June 2018

Global Warming in South Asia: 800 Million at Risk

By SOMINI SENGUPTA and NADJA POPOVICH JUNE 28, 2018



CIMMYT

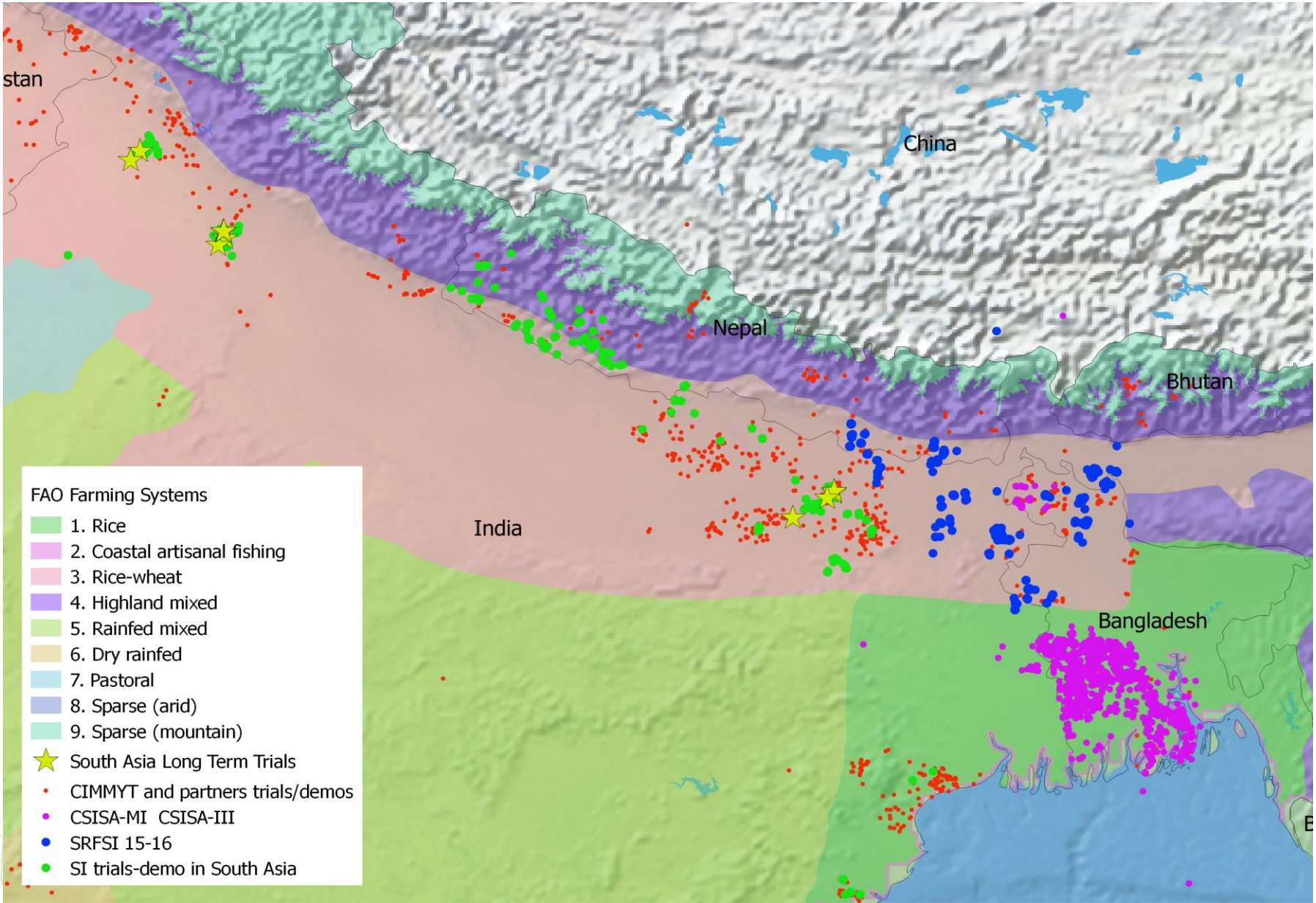
Our Research for Development Focus in South Asia

In addition to enhancement and exchange of high yielding stress tolerant germplasm of wheat and maize across nationals programs of wheat and maize in India, CIMMYT in close collaboration with NARS work at ground on following thematic research areas-

- **Abiotic stresses**
- **Biotic stresses**
- **G x E x M**
- **Sustainable intensification**
- **Climate Smart Agriculture**
- **Smart farm mechanization**
- **Precision agronomy**
- **Farming systems modelling, typologies and targeting**
- **Bio-fortification, quality**
- **Value chain, socio-economic and impacts**
- **Gender and youth in agriculture**
- **Business models and innovation systems**

CIMMYT

We are intensively working for addressing the agricultural challenges in diversity of farming systems



Few Specific Examples

1. Air pollution
2. Climate change/climate smart agriculture
3. Water
4. Conservation Agriculture
5. Scale appropriate mechanization
6. Precision agronomy and digital agriculture
7. Farming systems design and targeting
8. Technology led business models
9. Evidence based policy guidance

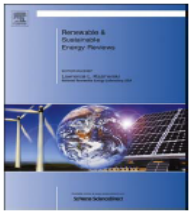
Air Pollution is a Serious Concern for Humanity

Renewable and Sustainable Energy Reviews 81 (2018) 693–706

Contents lists available at ScienceDirect

Renewable and Sustainable Energy Reviews

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



Burning issues of paddy residue management in north-west states of India

Shiv Kumar Lohan[a], H.S. Jat[b,*], Arvind Kumar Yadav[c], H.S. Sidhu[d], M.L. Jat[b], Madhu Choudhary[c], Jyotsna Kiran Peter[e], P.C. Sharma[c]

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'Air pollution killed 81k in Delhi & Mumbai, cost ₹70,000cr in 2015'

Vinamrata.Borwankar
@timesgroup.com

Mumbai: Air pollution contributed to a total of 80,665 premature deaths of adults over 30 years in Mumbai and Delhi in 2015, a two-fold jump from 1995, according to a new study at the Indian Institute of Technology, Bombay.

In economic terms, air pollution cost the two cities $10.66 billion (approximately Rs 70,000 crore) in 2015, or about 0.71% of the country's gross domestic product.

The study has said the impact on health and productivity as a result of exposure to pollution and the consequent burden of respiratory ailments rose with every passing decade.

▶2016 sets heat record for third year in a row, P 22

Researchers calculated impact using data on PM 10 (fine particulate matter measuring 10 microns), population and death rates.

With its higher pollution levels, Delhi recorded more premature deaths due to ingestion of PM10 from vehicle exhaust, construction dust and other industrial processes. Casualties went up from 19,716 in 1995 to 48,651 in 2015.

In Mumbai, the comparative figure rose from 19,291 to 32,014 in 20 years.

▶$10bn pollution cost, P 18

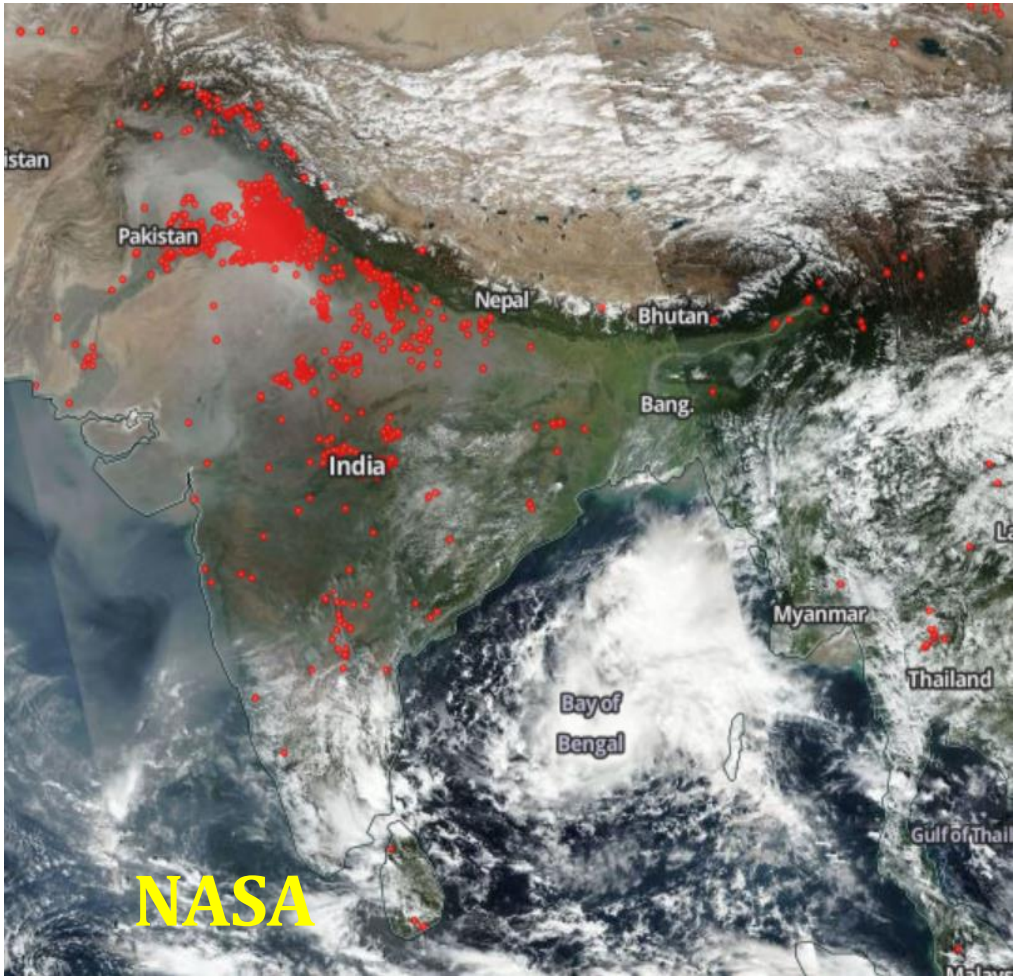
Delhi's Government Declares A Public Health Emergency As Air Pollution Chokes The City

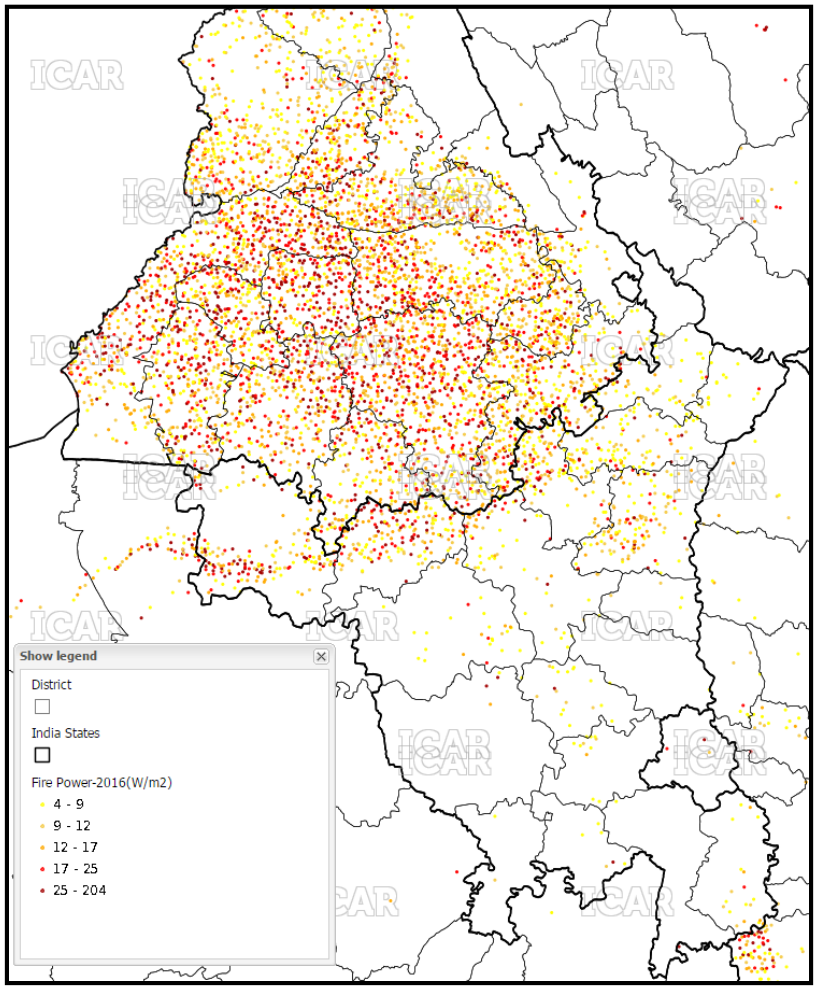
Leeza Mangaldas, CONTRIBUTOR
FULL BIO

Indian commuters drive amid heavy smog in New Delhi on November 7, 2017. Photo credit: AFP PHOTO / PRAKASH SINGH /Getty Images

India's capital city New Delhi was enveloped by toxic smog on Tuesday, forcing the Indian Medical Association to declare a public health emergency, advising citizens to stay indoors, and

Rice Residue Burning is a Major Concern in NW India





- Rice residue burning in NW India: 23 mt
  - Loss of >9 mt C (34 mt CO2-eq) per year
  - Loss of ~0.15 mt N (US$ 31 million)
  - Water, health

Each dot indicates active fire detected by satellite

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In-Situ Retention: Happy Seeder Technology

Field Crops Research 184 (2015) 201–212

Contents lists available at ScienceDirect

Field Crops Research

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

Development and evaluation of the Turbo Happy Seeder for sowing wheat into heavy rice residues in NW India

H.S. Sidhu[a], Manpreet Singh[b], Yadvinder Singh[b,*], J. Blackwell[c], Shiv Kumar Lohan[b], E. Humphreys[d], M.L. Jat[e], Vicky Singh[b], Sarbjeet Singh[f]

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[d] International Rice Research Institute, Los Baños, Philippines
[e] International Maize and Wheat Improvement Centre (CIMMYT), NASC Complex, New Delhi, 110012, India
[f] Dasmesh Mechanical Works Pvt. Ltd, Amargarh, Punjab, 148022, India

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Evidence Base From Long-term Research on Sustainable Intensification of Cereal Based Systems in NW-IGP

Improved productivity and soil health
(Productivity 1-1.5 t/ha/yr
SOC 2-4 t/ha/yr)

Reduced weather risks
(High adaptability and Low CV in crop yield)

Reduce Chemical load
(20-25 kg N/ha, Less herbicide)

More crop per drop: *Save irrigation water*
Rice-wheat-mungbean: 60-70 ha-cm/yr
Maize-wheat-mungbean:: 150-175 ha-cm/yr

More profit: Lower costs and higher yields
(Profit 20000-25000/ha/yr)

Lower GHGs emission
(~1.5 t CO2-eq/ha/yr)

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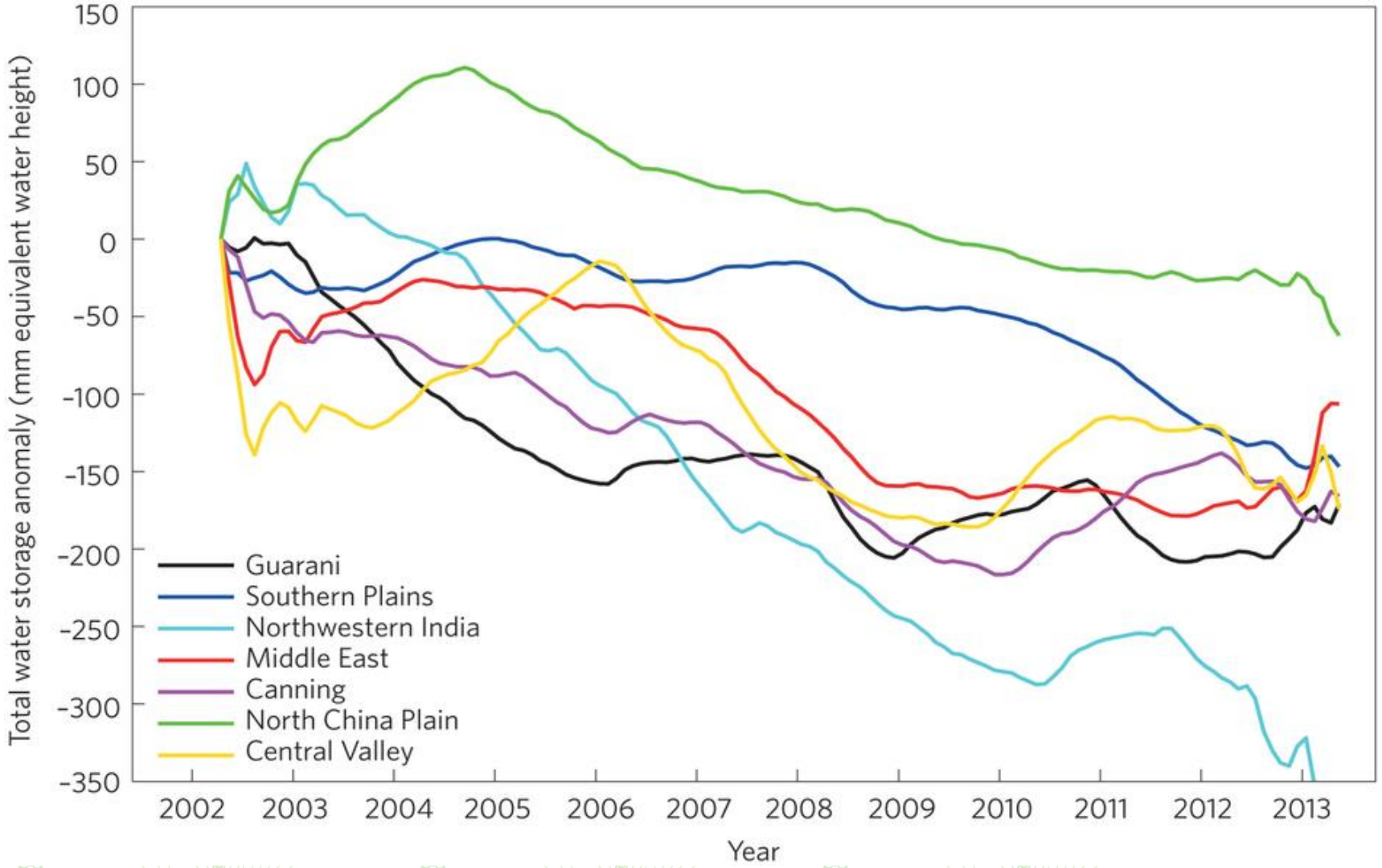
Unsustainable extraction of groundwater from world's major aquifers: NASA GRACE satellite mission



Source: Famiglietti, J.S. (2014) Nature 4, 945-947.

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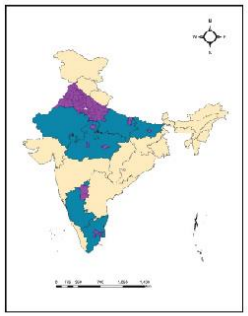
Laser Assisted Precision Land Leveling: Impact at Scale



Introduced in India during 2000-01 (RWC/CIMMYT-IRRI, ICAR)

Adoption: ~5 million ha in India

Direct employment generation: 350 person days/unit/yr

At current level (>35000 units): 10.5 million person days/yr8

Indirect employment: manufacturing, transport, services

Yield gains in RW system (5 mha, 0.5 t ha-1 yr-1)- >2 mt yr-1;

Electricity saving for irrigation in RW systems of IGP

Water saving in RW system (5 mha, 18 ha-cm ha-1 yr-1) = 10 km3 yr-1

Other possible benefits- GHG mitigation, savings in subsidy bill etc

Source: Jat et al, 2006; 2009a,b; 2011; 2015; Aryal et al, 2015

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Portfolio: Layering precision water & nutrient management in CA based rice-wheat system

- **Layering sub Surface drip (SSD) irrigation system in CA based RW system produced (over conventional till rice-wheat)-**
  - ✓ **~1.0 t/ha/year higher RW yield**
  - ✓ **With ~70 cm less irrigation water**
  - ✓ **Double irrigation water productivity**
  - ✓ **38% increase in PFP-N**
  - ✓ **7.5 % lower environmental footprints**

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Addressing Food-Energy-Water (FEW) Nexus
(Layering CA with Fertigation, Solar energy)

System magt	Irrigation method and energy source	System yield (t ha^{-1} yr^{-1})	System net income (USD ha^{-1} yr^{-1})	System water use (cm ha^{-1} yr^{-1})	System energy use (kWh ha^{-1} yr^{-1})
ZTDSR-ZTW	SSD with solar power	12.33c	2094	96d	3663
ZTDSR-ZTW	Flood	11.94c	2000	167e	6151
TPR-CTW	Flood	12.18c	1909	181f	6686
PBM-PBW	SSD with solar power	13.67a	2357	29a	1249
PBM-PBW	Furrow irrigation	13.24ab	2318	49b	1714
CTM-CTW	Flood	12.56bc	2087	59c	2027

- CA + micro-irrigation within RW system: same yields with 85 cm /ha/yr less water, half energy use and USD 185/ha/yr higher income
- CA + micro irrigation in MW system: 1.5 t/ha/yr more yield, 152 cm water saving with one quarter energy use and USD 450 /ha/yr more profit compared to conventional RW system in NW India

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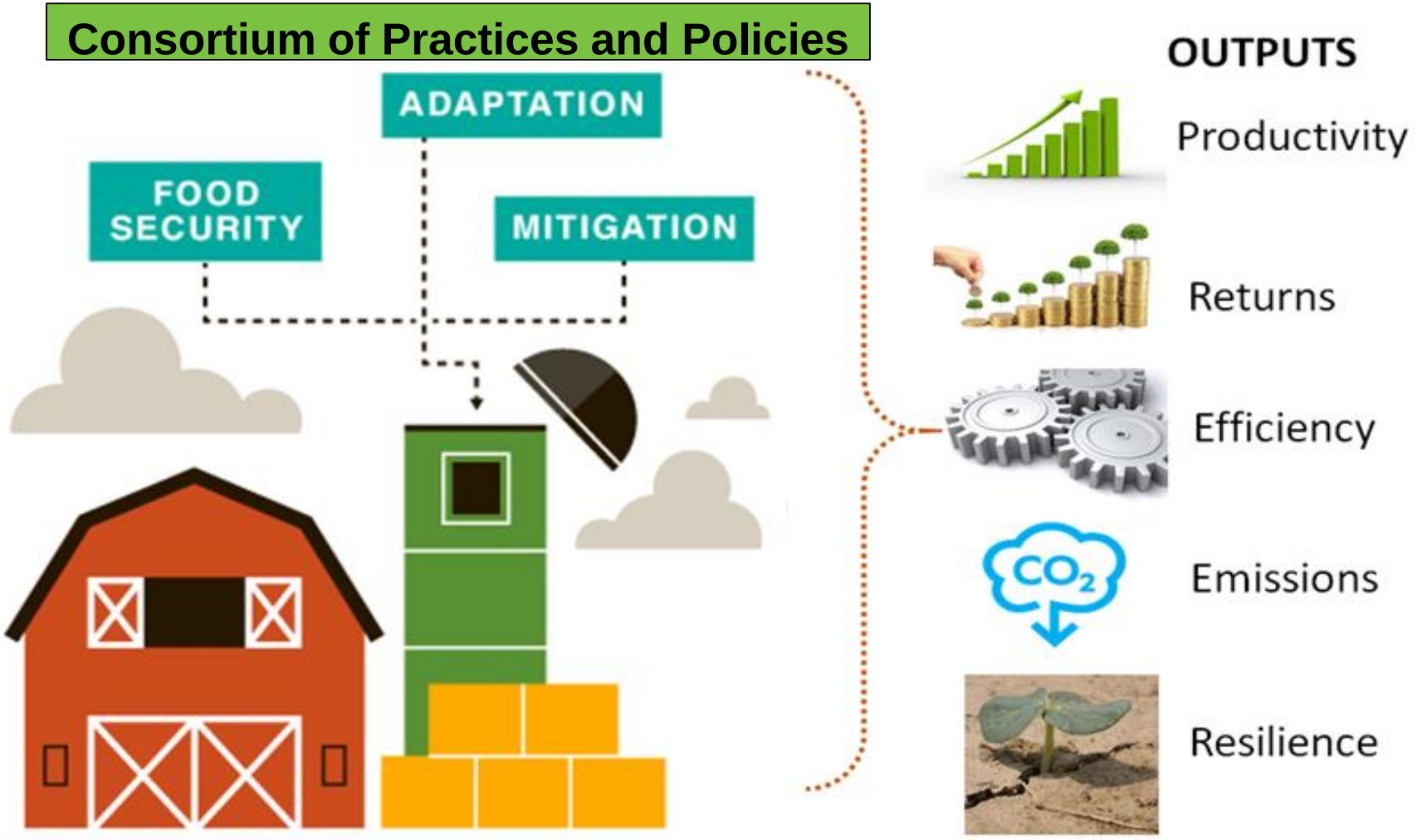
Climate-Smart Agriculture ?



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www.nature.com/scientificreports

SCIENTIFIC REPORTS

OPEN

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

Received: 7 June 2017
Accepted: 28 July 2017
Published online: 24 August 2017

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]

Alternative tillage and rice establishment options should aim at less water and labor to produce similar or improved yields compared with traditional puddled-transplanted rice cultivation. The relative performance of these practices in terms of yield, water input, and economics varies across rice-

CA in Maize Systems: Adapting Climate Risks (200+ mm in 3 days in end of June 2017) in Haryana, India

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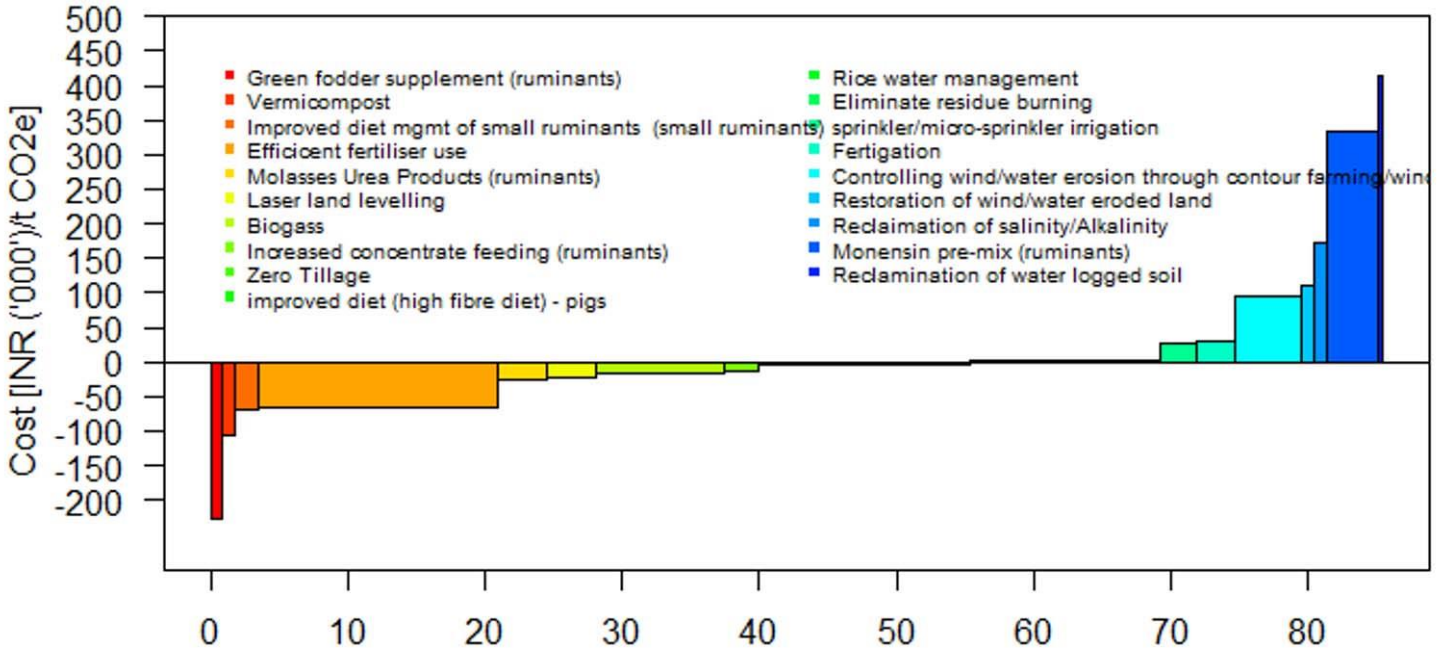
Identifying cost-effective opportunities for climate change mitigation in India



- All options are climate smart
- Technical Mitigation potential = 86 $MtCO_2e$/year
- 80% of mitigation potential achieved via cost saving options

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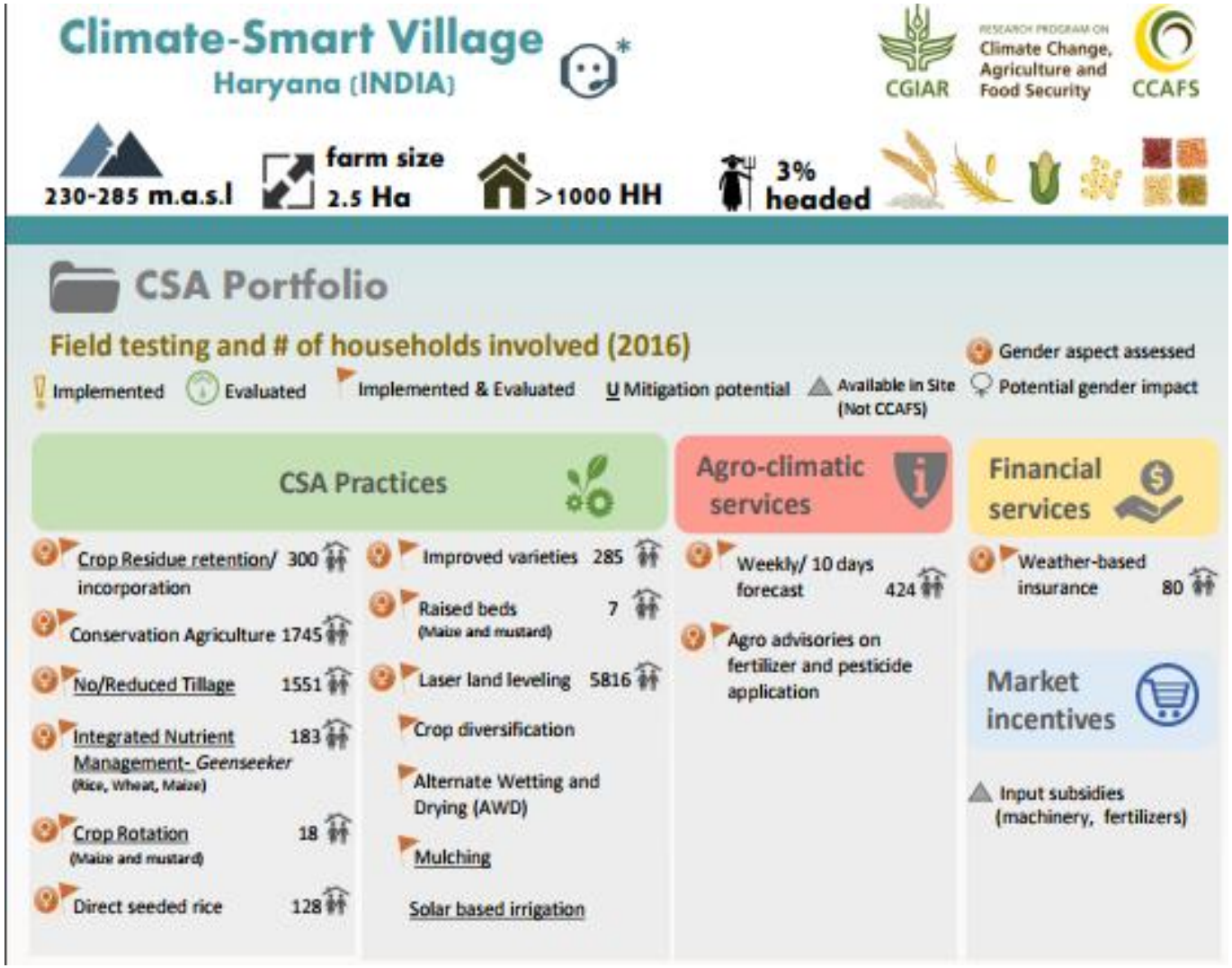
Evidence base from Climate Smart Villages



Participatory approaches for developing portfolios of climate smart practice helps in showcasing the multiple benefits in real farming conditions with better replicability of outputs

Pilots of CSVs across South Asia

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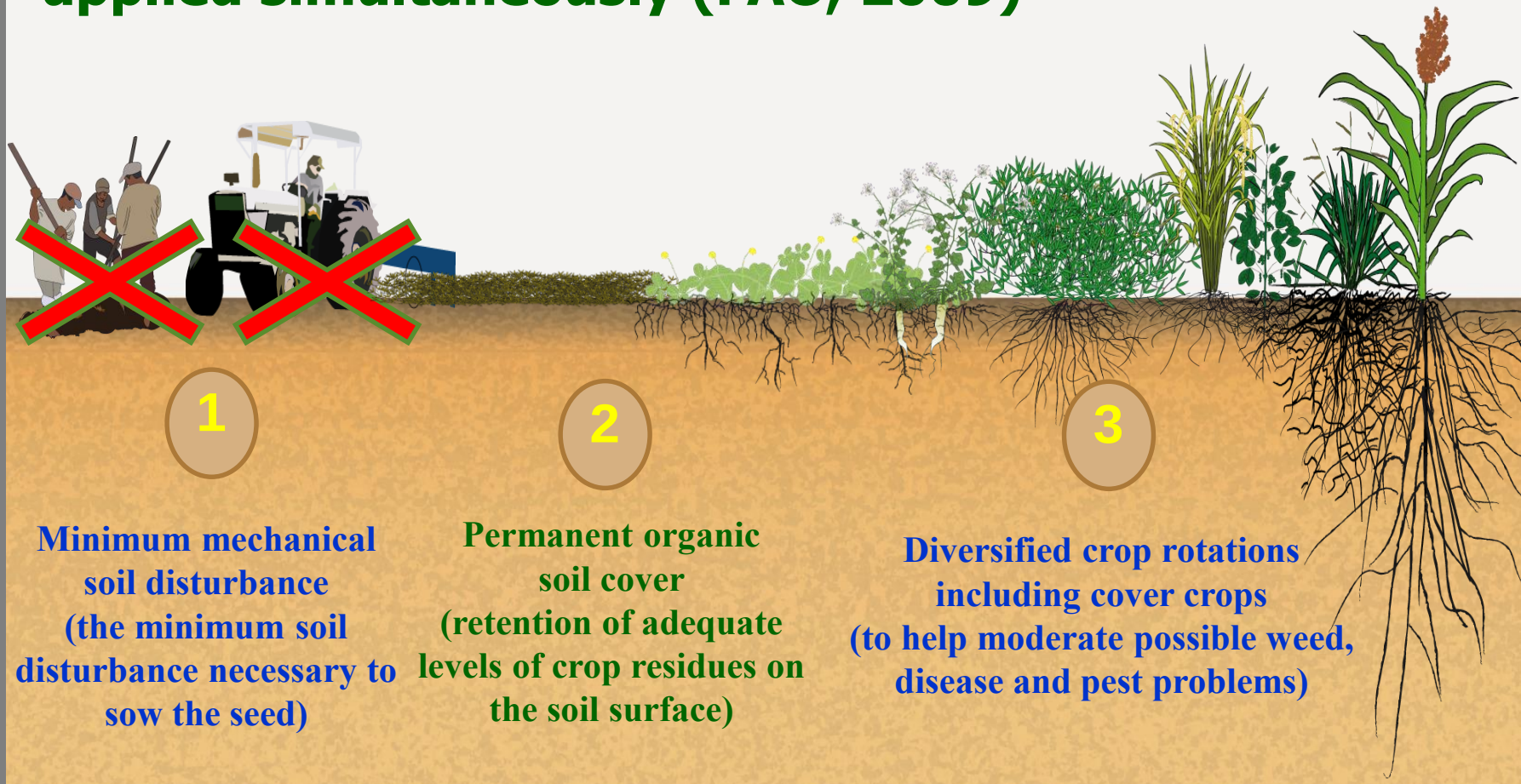
Conservation agriculture systems

Conservation Agriculture is based on three principles applied simultaneously (FAO, 2009)



1

Minimum mechanical soil disturbance (the minimum soil disturbance necessary to sow the seed)

2

Permanent organic soil cover (retention of adequate levels of crop residues on the soil surface)

3

Diversified crop rotations including cover crops (to help moderate possible weed, disease and pest problems)

Sustainable intensification through scale appropriate mechanization

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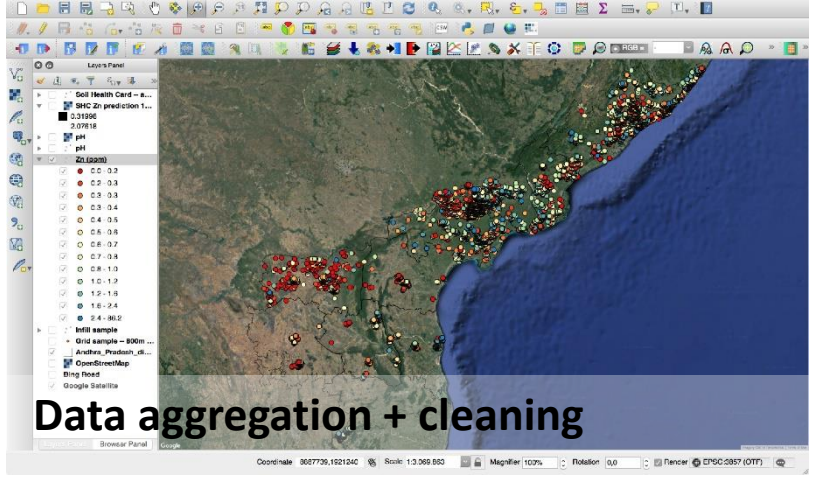
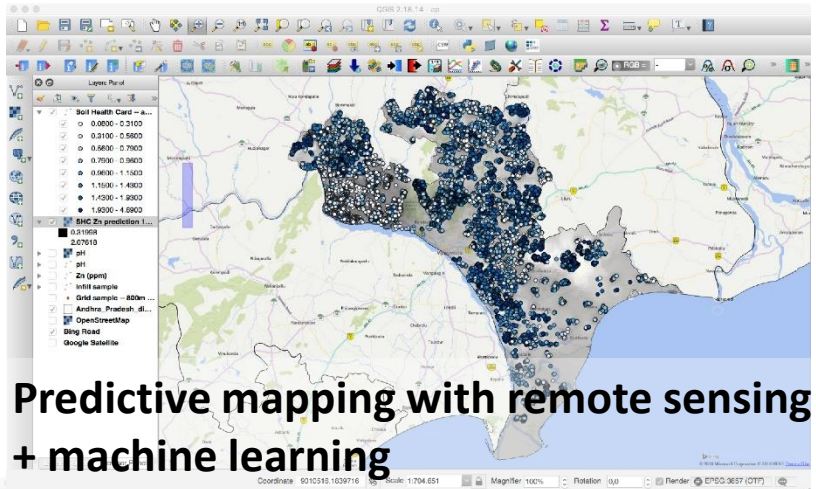
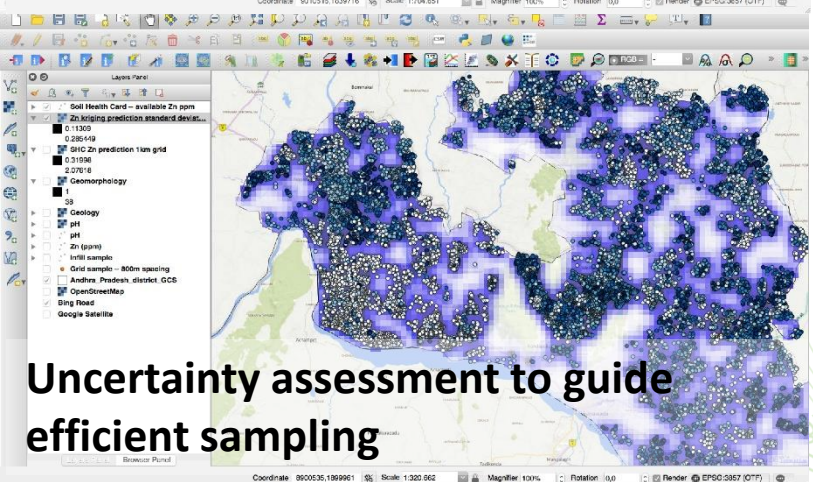
Sustainable Intensification in intensive systems







1

New collaborations in Bihar, Odisha, and Andhra Pradesh endeavors to power decision-making and agro-advisory at scale by efficiently

2

developing reliable predictions of soil properties at scale

INSET: MAPPING SOIL CONCENTRATIONS OF ZINC IN ANDHRA PRADESH

3

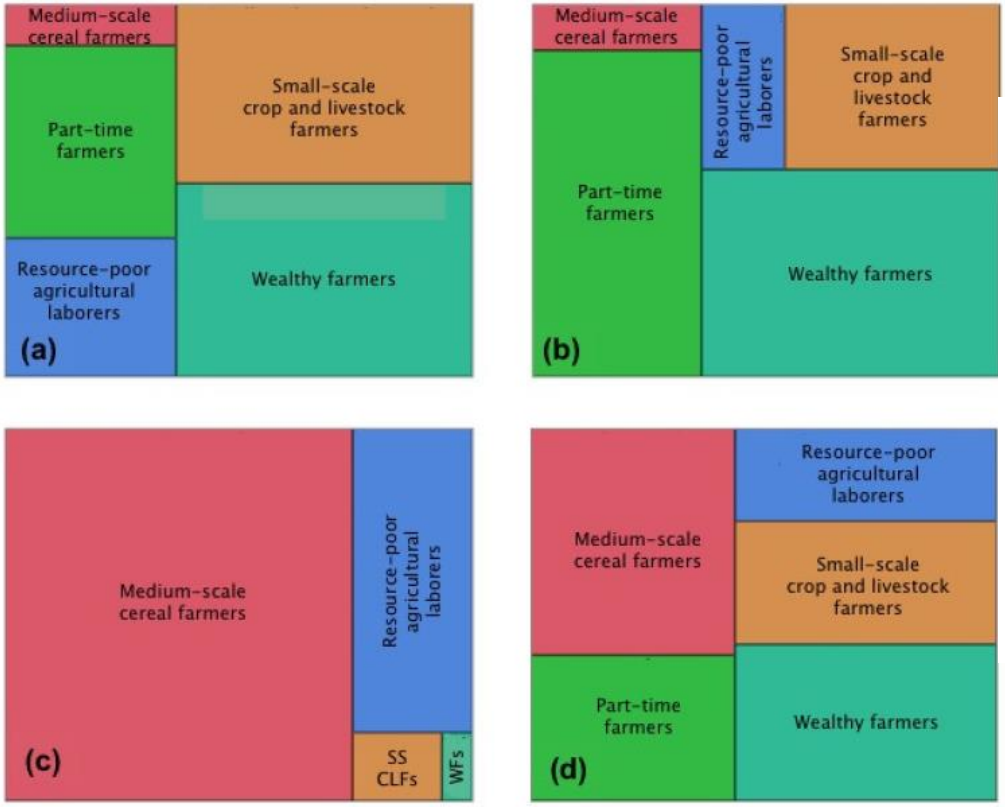
Digital soil mapping:

combines legacy point data (e.g. from AICRP) with remote sensing co-variates and advanced geo-statistics + machine learning to predict soil properties at scale

Sensor technologies and decision tools for smallholder farmers

One Size Doesn't Fit All-Technology Targeting is a Must

Farm household typologies and food security: An *ex-ante* assessment from Eastern India



Agricultural Systems 159 (2018) 57–68

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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,*]

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[d] International Maize and Wheat Improvement Center (CIMMYT), Sustainable Intensification Program and MAIZE CGIAR Research Program, House10/B, Road 53, Gulshan-2, Dhaka 1213, Bangladesh
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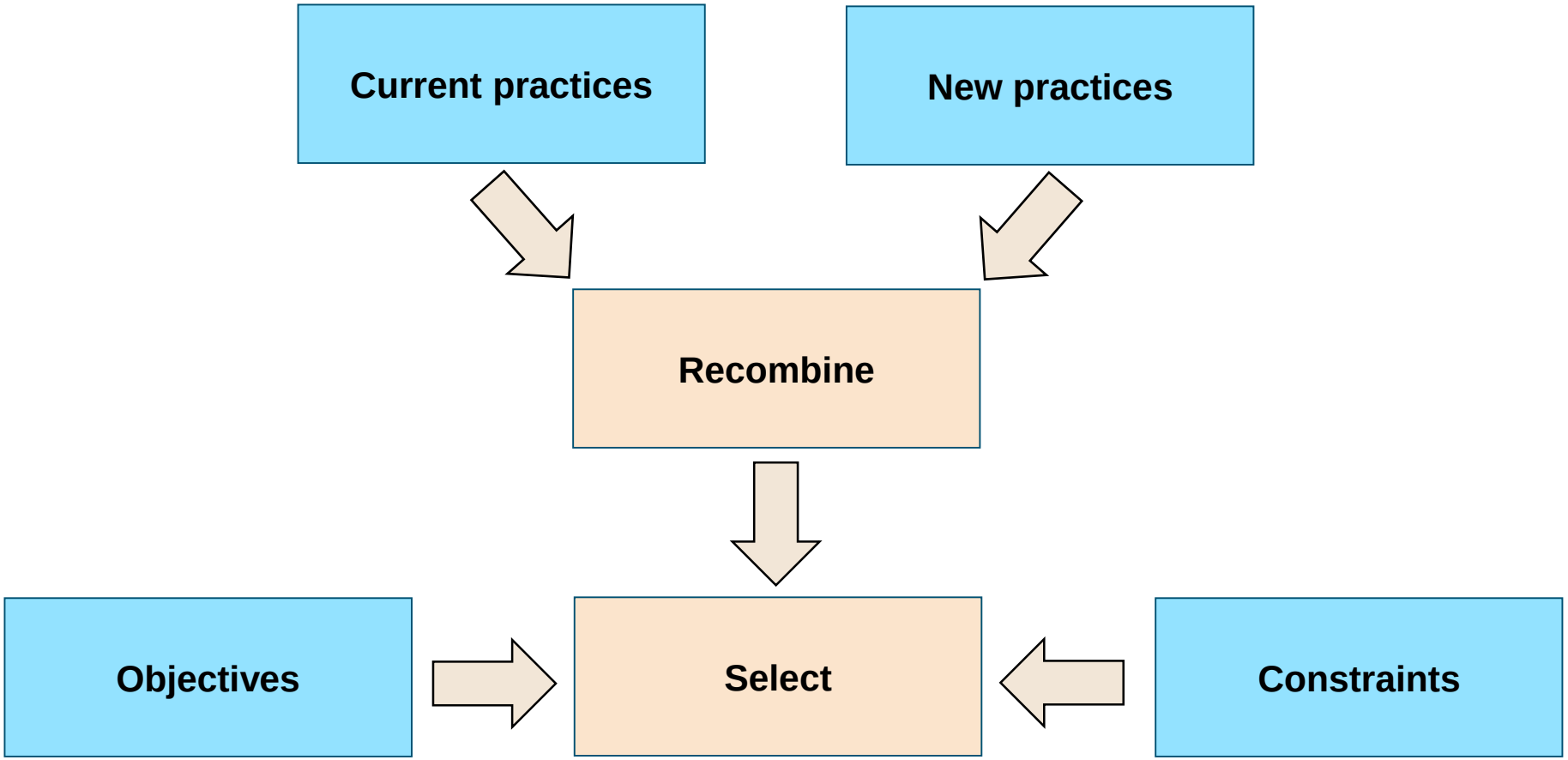
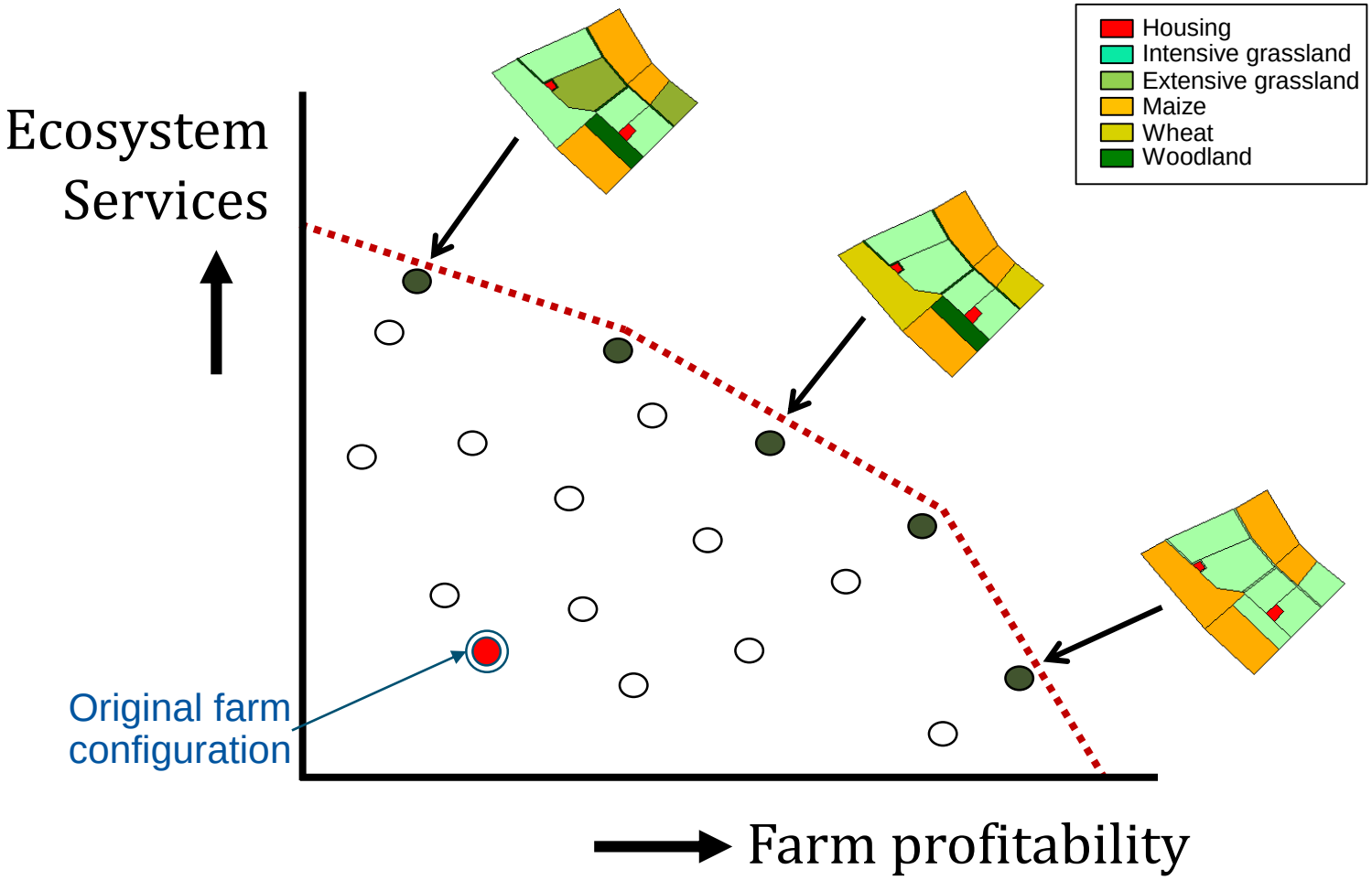
a. Begusarai, b. Samastipur, c. Nawada, d. across distts

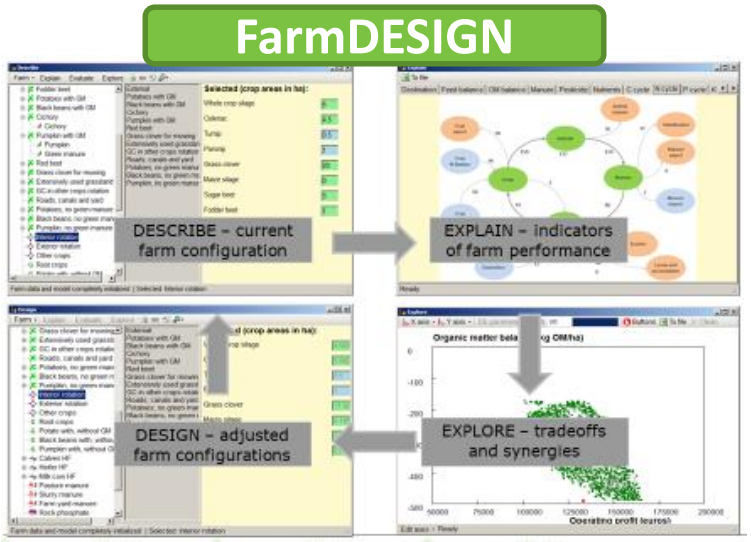
Exploring windows of opportunity



Targeting with Clarity of Objectives



Challenges require comprehensive system-level approaches & joined-up policies



Farming system approach:

Farmer Income,

Livelihoods,

Nutrition,

Soil Health,

Climate Resilience,

Environmental Foot Prints

Synergies and Tradeoffs

Selected (crop areas in ha):	
Rice-Wheat	0.3
Orchard	0.22
boundary plantation	0.04
Fish	0.1
Sorghum-potato-Maize	0.3
sugarcane	0.4
napier grass	0.1

Selected (crop areas in ha):	
Rice-Wheat	0.349
Orchard	0.22
boundary plantation	0.193
Fish	0.1
Sorghum-potato-Maize	0.261
sugarcane	0.219
napier grass	0.154

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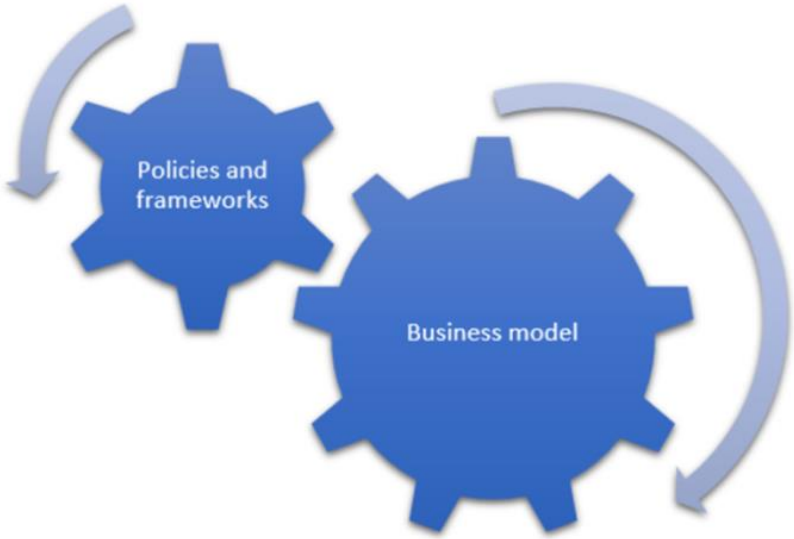
Technology led business models for scaling



Enhancing the role of private sector in scaling agriculture technologies

Business models of SMEs as a mechanism for scaling Climate Smart Technologies: The case of Punjab, India

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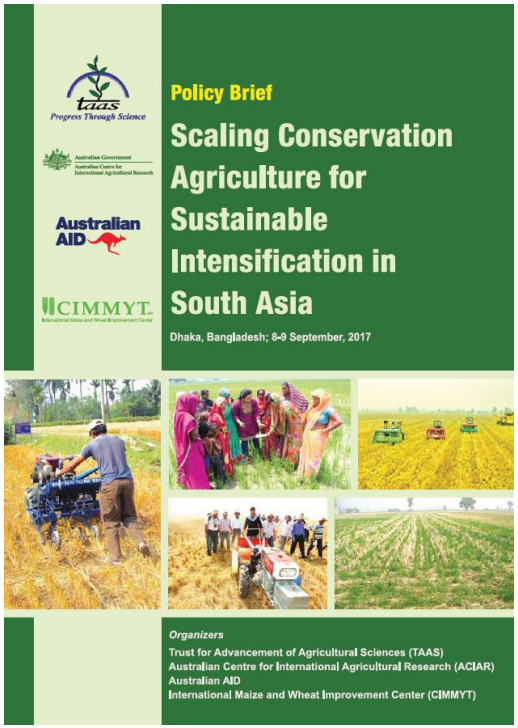
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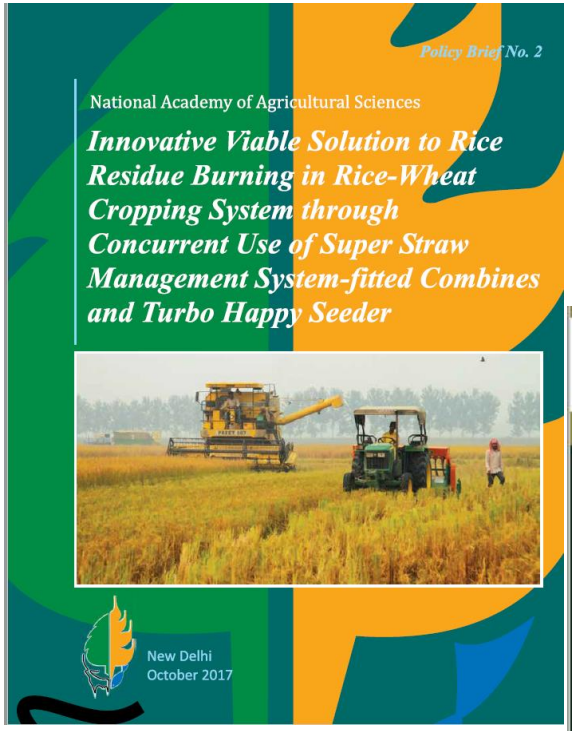
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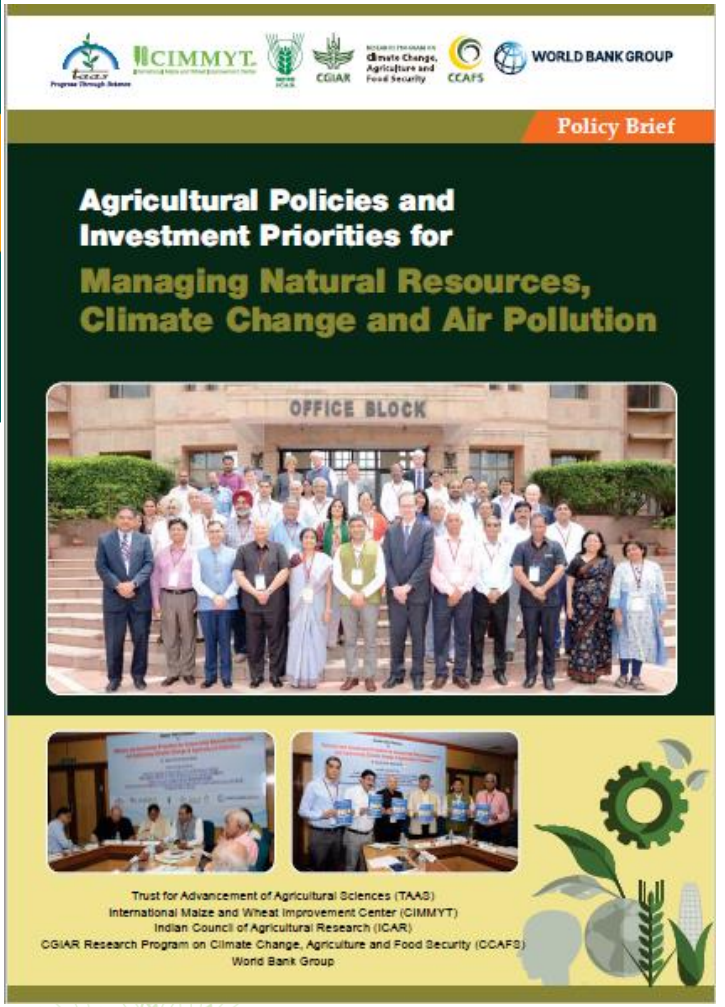
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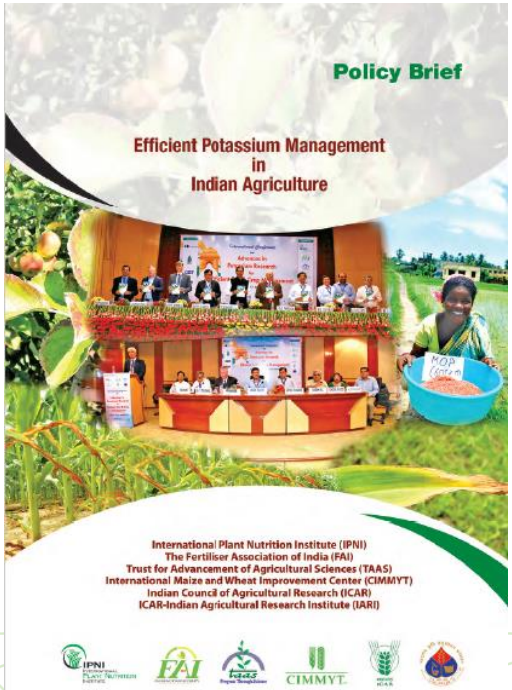
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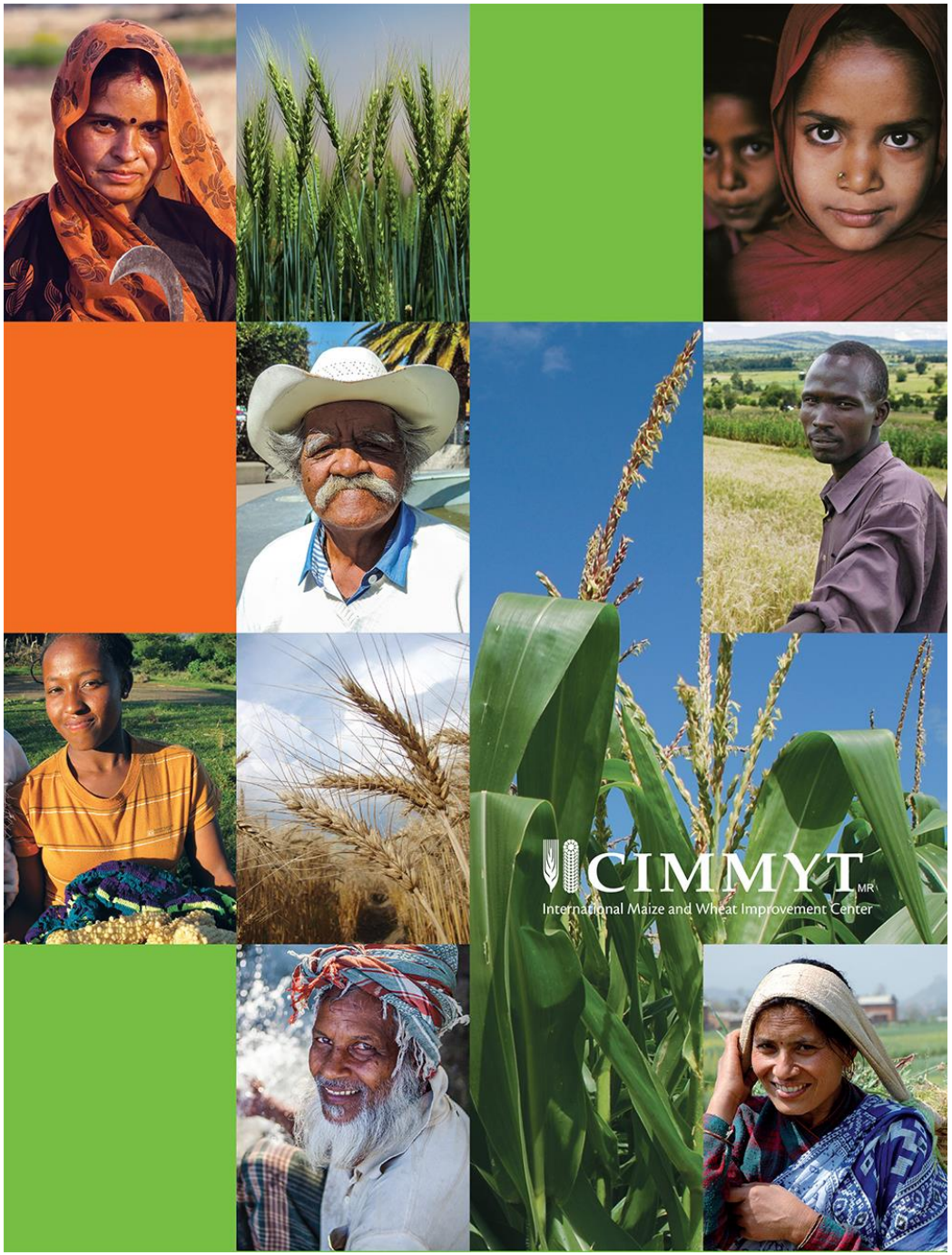

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