

ICAR-CIMMYT Research Partnership 2017

CIMMYT team and partners



Response to Action Taken Report (one example)

- **Wheat blast in Bangladesh is an emergent issue which is a threat to Indian wheat also. An action plan to be developed for India viewing the work done last year and to be done this year.**
 1. Integrated joint strategy developed
 2. Germplasm (India, CIMMYT and other countries) screened in Bolivia, USA, Bangladesh
 3. Blast tolerant varieties/lines identified and made available
 4. Collaborative blast resistance breeding strengthened
 5. Capacity development undertaken



Five research programs supported

- 1. Bread wheat improvement: High yielding, heat tolerant germplasm with other India relevant traits**
- 2. Wheat Blast: Resistant germplasm and pathogen surveillance**
- 3. Durum wheat improvement: Abiotic stress tolerant germplasm for Central and Peninsular India**
- 4. Quality Protein Maize (QPM) for food and feed needs in India**
- 5. Conservation Agriculture**



I: Bread wheat improvement: high yielding, heat tolerant germplasm with other India relevant traits

- 1. Breeding material generated: 2521 F1 (simple and top), 8042 F2-F5 selected bulk pops, 89828 F6/F7 progeny rows, 30392 advanced lines, 9540 entries in yield trial (2 reps) and 1092 entries in yield trials (3 reps, 6 management)**
- 2. Ten locations used in selection process:**
 - Five in Mexico (Cd. Obregon, Toluca, El Batan, Aqua Fria and Mexicali)**
 - Two in Africa (Njoro, Kenya and Kulumsa, Ethiopia)**
 - Three in BISA, India (for phenotyping and selection by all national partners)**
- 3. From above, nurseries and trials prepared and shipped to India for 2017-18 cycle**

Germplasm provided in 2017-18 cycle

Trial/Nursery	Sets (No.)	No. of lines
38th ESWYT (Elite Selection Wheat Yield Trial)	15	50
25th SAWYT (Semi-Arid Wheat Yield Trial)	26	50
16th HTWYT (Hot temperature Wheat Yield Trial)	20	50
25th HRWYT (High Rainfall Wheat Yield Trial)	4	50
50th IBWSN (International Bread Wheat Screening Nursery)	14	283
35th SAWSN (Semi-Arid Wheat Screening Nursery)	17	277
28th HRWSN (High Rainfall Wheat Screening Nursery)	3	157
12th SRRSN (Stem Rust Resistance Screening Nursery)	7	136
19th KBSN (Karnal Bunt Screening Nursery)	10	46
Total	116	1099

116 sets of international trials/nurseries having 1099 lines to 30 centres. All germplasm shared through ICAR-IIWBR



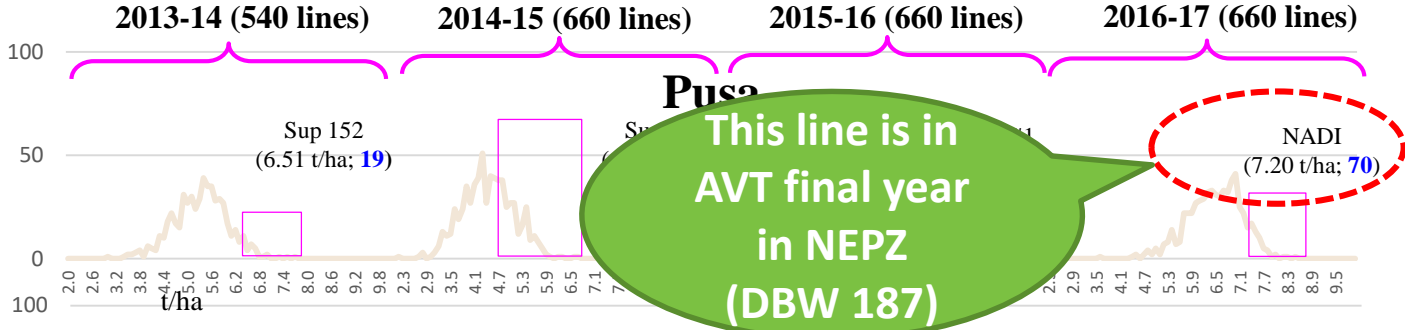
Germplasm focus – yield potential, climate resilience & other relevant traits

- Tolerance to heat – early, terminal
- Resistance to rusts, other diseases
- Grain Zinc
- Chapati and *roti* making quality
- *Now, wheat*

In 2017, two varieties identified for release were CIMMYT direct; two had CIMMYT parentage

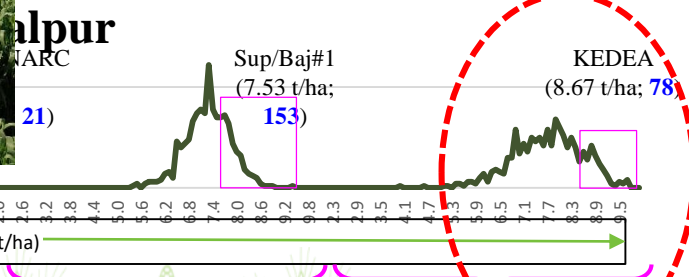
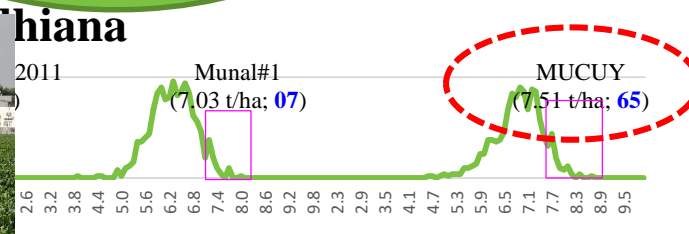
No.	Variety	Pedigree	Env.	Zone	Source
1	DBW 173	KAUZ/AA//KAUZ //PBW 602	IR-LS	NWPZ	CIMMYT x India cross
2	HI 1612	KAUZ//ALTAR84 .../HUITES	RI-TS	NEPZ	CIMMYT
3	DBW 168	SUNSU/CHIBIA	IR-TS	PZ	CIMMYT
4	UAS 375	UAS 320/GW 322//LOK 62	RF-TS	PZ	
5	HI 8777(d)	B93/HD 4672//HI 8627	RF-TS	PZ	
6	MACS 4028(d)	MACS 2846/ BHALEGAON3*2	RF-TS	PZ	CIMMYT x India cross

Grain yield of 8.67 t/ha obtained in 2017



Pre-release multiplication by IIWBR (2 acre)

DBW 187



2013-14 (540 lines)

2014-15 (660 lines)

2015-16 (660 lines)

2016-17 (660 lines)



Ug99 resistance evaluated at Kenya and best lines shared

Table 1. Mean stem rust severities of 699 entries based on seedling reactions with Ug99 recorded at Njoro, Kenya in 2016-off & main and 2017-off & main seasons. (Data recorded when susceptible checks became necrotic 10 to 14 days after 100% severity)

Category	Maximum severity	Entries	
	%	No.	%
Near-Immune Resistant	1	60	8.6
Resistant	5	92	13.2
Resistant -Moderately Resistant	10-20	73	10.4
Moderately Resistant	20	124	17.7



COMMUNICATIONS
BIOLOGY

**Stem rust in UK after 60 years;
80% cultivars susceptible.**

ARTICLE

DOI: 10.1038/s42003-018-0013-y

OPEN

Potential for re-emergence of wheat stem rust in the United Kingdom

Clare M. Lewis¹, Antoine Persoons¹, Daniel P. Bebber², Rose N. Kigathi^{1,3}, Jens Maintz¹, Kim Findlay¹,

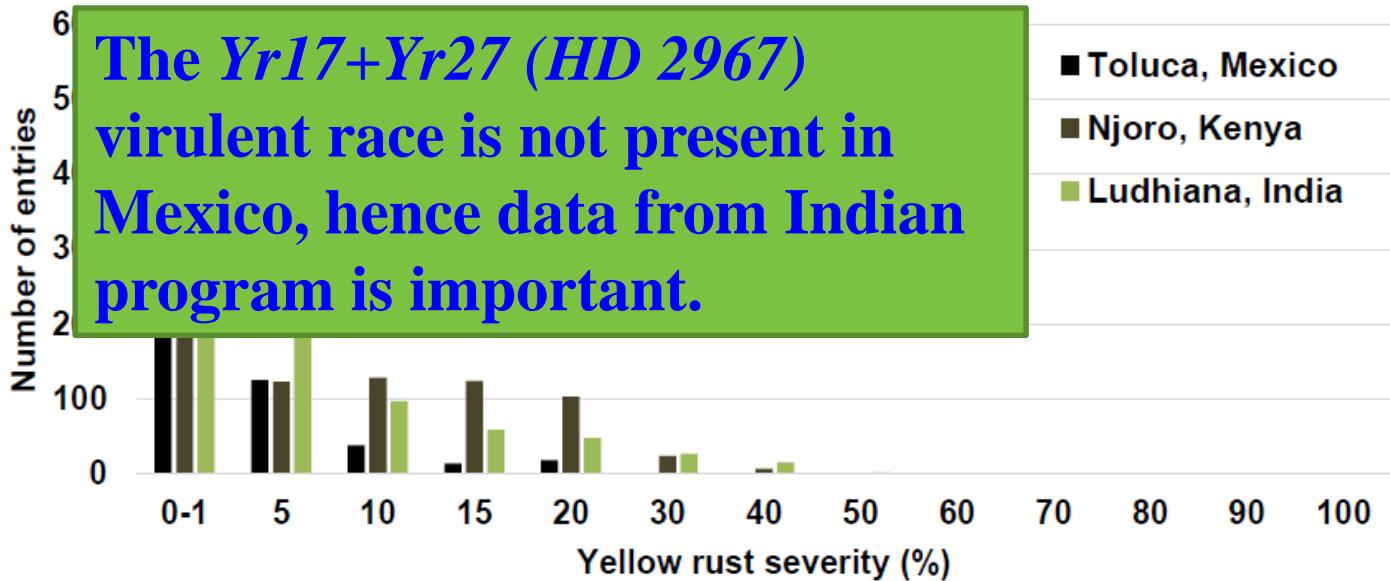


We tested 1092 top yielding CIMMYT lines at BISA (Ludhiana), Mexico & Kenya to understand and breed for yellow rust resistance. Best lines identified.

ME1: NW India



The *Yr17+Yr27* (HD 2967) virulent race is not present in Mexico, hence data from Indian program is important.



II: Wheat Blast Research

Promising lines in wheat trials evaluated against wheat blast at Bolivia, USA & B'desh; 40 lines from India in 2016-17 cycle

In current cycle, 100 Indian lines already planted in Jessore and Mexico (for Bolivia)



2NS/2AS Genotyping Results

- Lines with the 2NS translocation showed significantly reduced severity, however highly significant variation occurred for resistance.
- 9 Indian lines out of 40 showed 2NS (23%)
- 44% CIMMYT lines showed 2NS (35/80)
- Frequencies in Bangladeshi and Nepali lines were low - 5% and 12%, respectively
- A few non 2NS resistant lines identified; one (Cupesi) released in Bolivia



Important for India

1st blast resistant variety released in Bangladesh as (Bari Gom 33); also biofortified.

- Kachu/Solala; 2NS segment for blast resistance
- + 7 ppm Zn advantage; 5-10% higher yield than the best check; Yield = 5 t/ha



Large scale faster dissemination in Bangladesh; seed made available to India.
It is in UP state trial as BHU 35

Capacity building and learning on wheat blast

- **Three scientist visited USA, Bolivia and Mexico (July-August 2017 – one month training program)**
- **Two young Indian scientists participated in the surveillance and monitoring workshop for wheat blast in Bangladesh (Feb-March 2017)**
- **Three Indian scientists participated in two days of brainstorming sessions held at Dhaka, July 13-14, 2017**



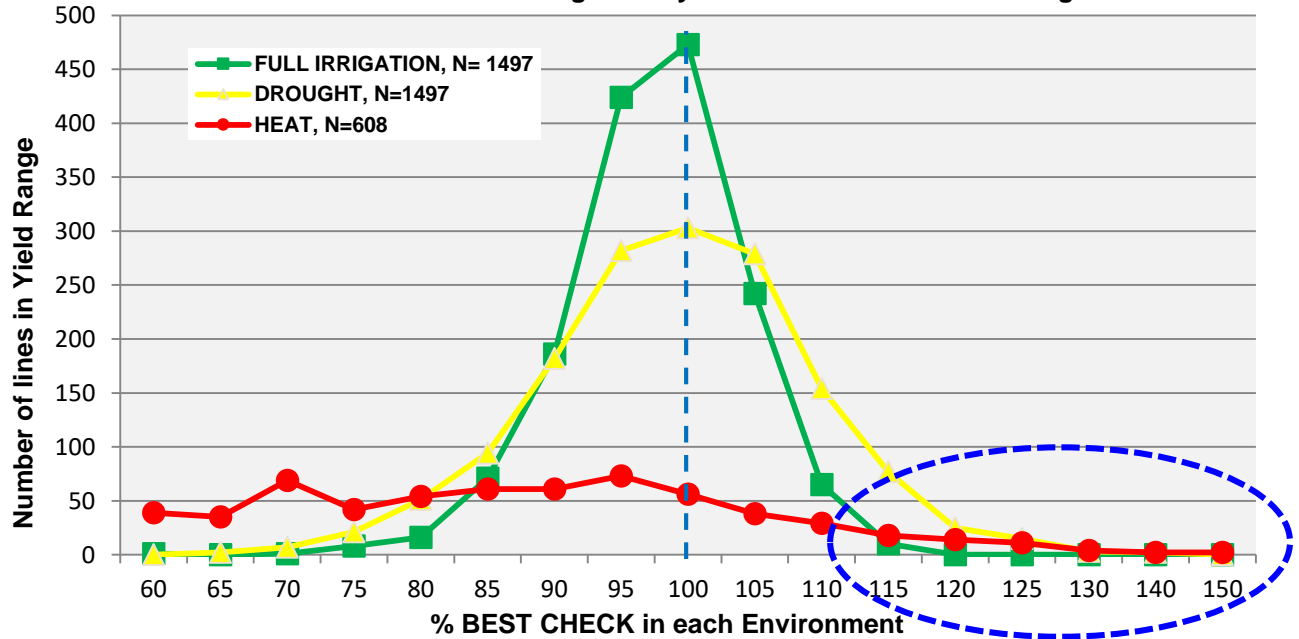
III: Durum wheat improvement: Development of abiotic stress tolerant durum wheat germplasm for Central and Peninsular India

- 1. Breeding material generated: 1425 F1s (simple and top), 3812 F2-F4 selected bulk pops, 24816 F5-F7 progeny rows, 3519 advanced lines (1 rep, 2 env) and 1498 lines (2/3 reps) in 3 management conditions**
- 2. Breeding material, advanced lines grown in 5 locations;**
 - Four in Mexico (Cd. Obregon, Toluca, El Batan and Mexicali)**
 - One in Kulumsa, Ethiopia**
- 3. From above, nurseries and trials shipped to India for 2017-18 cycle**

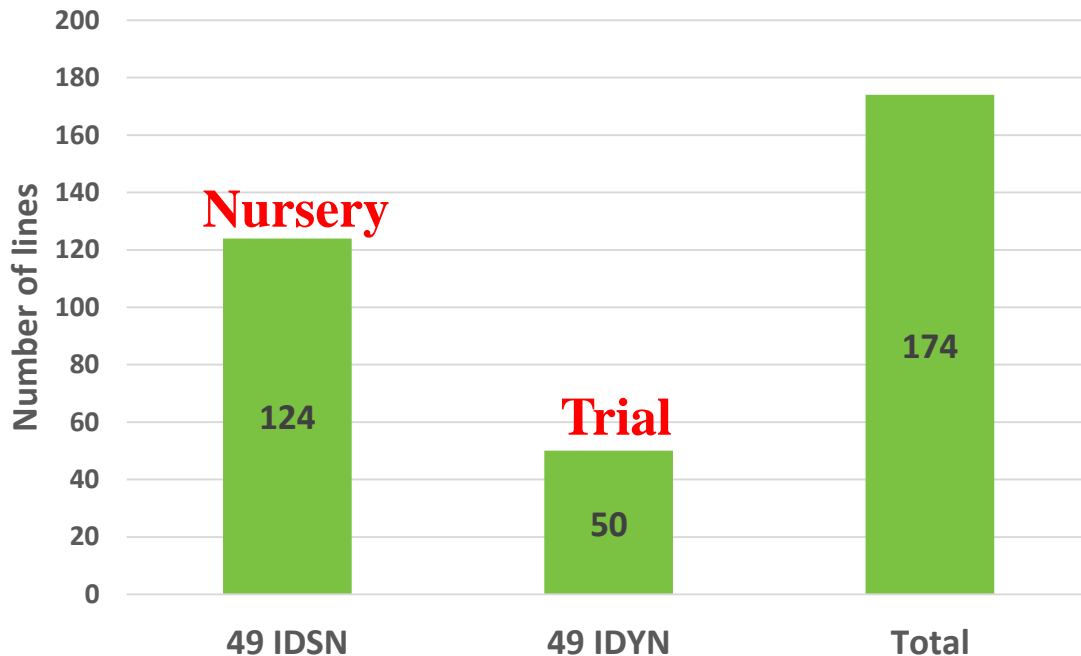


III: Durum wheat improvement:

Frequency distribution of Yield of advanced lines tested for yield potential and abiotic stress tolerance during 2017 by CIMMYT's Durum Wheat Program



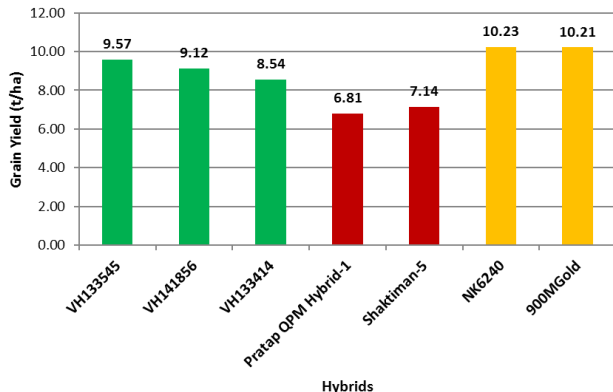
Durum germplasm shared with 10 centers



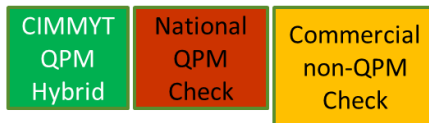
IV: Quality Protein Maize (QPM)

CIMMYT QPM Hybrids for Indian Agro-ecologies: VH133545, VH141856, and VH133414 enter AICRP IET trials and State MLTs

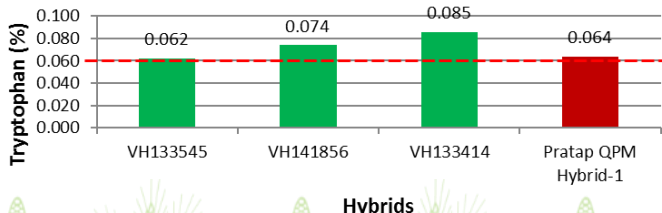
Grain Yield of CIMMYT QPM Hybrids Vs National QPM Checks & Commercial Non QPM Checks
No. of Locations: 4



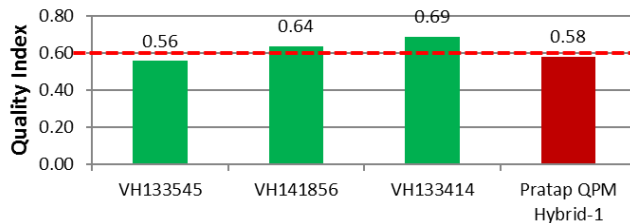
- 2016 dry season evaluation across four locations
- QPM quality of hybrids verified
- Hybrids promoted for on-farm testing in Kharif 2017



Tryptophan level of CIMMYT QPM Hybrids Vs National QPM Check



Quality Index of CIMMYT QPM Hybrids Vs National QPM Check



Hybrids for Indian Agro-ecologies - Advanced Testing

VH133545, VH133414 sent for on-farm demonstrations

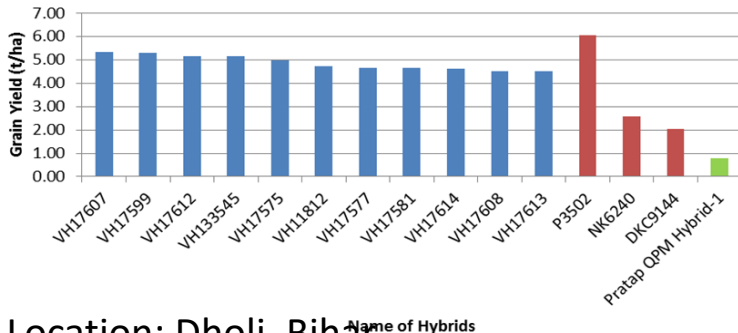
Trialing Stage	Trial Name	Hybrid Name	Testing locations	Testing Year/Season	Name of Locations	Collaborator
NR (National Release)	AICRP (IET)	VH133545	All India	2017 Kharif	GBPUAT Pantanagar	N.K. Singh
NR (National Release)	AICRP (IET)	VH141856	All India	2017 Kharif	GBPUAT Pantanagar	N.K. Singh
NR (National Release)	AICRP (IET)	VH133414	All India	2017 Kharif	OUAT Orissa	D. Swain
NR (National Release)	AICRP (IET)	VH142007	All India	2018 Kharif (proposed)	SKUAST J&K	Zahoor A Dar
Stage 5.2	FFT (Farmers Field Trial)	VH133545	Various	2017 Kharif	GBPUAT Pantanagar	N.K. Singh
Stage 5.2	FFT (Farmers Field Trial)	VH133414	Various	2017 Kharif	OUAT Orissa	D. Swain
Stage 5.1	FFT (Farmers Field Trial)	VH133545, VH141733	Various	2017 Kharif	BISA-Ludhiana	H.S. Sidhu

Promising new QPM hybrids identified



CIMMYT QPM Hybrid

Comparative performance of CIMMYT QPM hybrids Vs commercial QPM & Non OPM checks under waterlogging stress



Location: Dholi, Bihar

Comparative performance of CIMMYT QPM hybrids Vs commercial QPM & Non QPM checks under optimal environment



Location: Dharwad, Karnataka

QPM Germplasm Exchange

QPM Germplasm from CIMMYT-India

Recipients: ICAR-IIMR, AICRP-Maize Centers & SAUs

Year	ICAR-IIMR, AICMIP Centers & SAUs		
	Institutions	Unique lines	Seed packets
2013	5	35	35
2014	22	114	660
2015	4	15	15
2016	2	4	4
2017	5	54	88
Total	38	222	802

Recent QPM Germplasm shared with ICAR-IIMR

Generation	# lines
QPM S4	154
QPM S3	48
QPM S2	127
QPM BC1S2	254
Total	583

Shipment Date: 12 Feb 2018

2017 QPM Germplasm from CIMMYT-Mexico Recipients

QPM	
Early	Medium /Late
43	73

V. Conservation Agriculture Based Sustainable Intensification

No	Major Activities	Outputs
1.	Long-term strategic research on CA based sustainable intensification in major production across IGP	<ul style="list-style-type: none">• Generated evidence on yield trends, adaptation, GHG mitigation and soil health• Soil quality index and its relationship with wheat yield
2.	Developing water and energy smart portfolio for sustainable intensification of cereal based systems in North-West IGP	<ul style="list-style-type: none">• Developed and validated decision tools and techniques for precision water and nutrient management in CA to provide new evidence on FEW nexus
3	Development/Validation/Refinement of scalable CA machinery	<ul style="list-style-type: none">• A CA plot planter developed for G x E x M interaction research



V. Conservation Agriculture Based Sustainable Intensification

No	Major Activities	Outputs
4	Assessing and capturing genotype x environment x management (GxExM) interaction under futuristic sustainable intensification	<ul style="list-style-type: none">• Significant interactions found in all combinations
5	Farming System Modelling	<ul style="list-style-type: none">• Optimization of resources for designing efficient farming systems for doubling farmers income
6	Sensors & decision tools for scaling precision N-management in Indo-Gangetic plains	<ul style="list-style-type: none">• Validation of algorithm of GreenSeeker for maize & GreenSeeker and Nutrient Expert precision farming of rice and wheat• Meta-data analysis across IGP



V. Conservation Agriculture Based Sustainable Intensification

No	Major Activities	Outputs
7.	Evidence base, technologies, strategies, demonstrations on sustainable and scalable in-situ management solutions to curb crop residue burning & Impact analysis	<ul style="list-style-type: none">• Generated science based evidence• A business model of Happy Seeder technology• Intensive campaigns for creating awareness• A pilots of residue burning free village
8	Capacity development on CA/SI in wheat and maize based farming systems	<ul style="list-style-type: none">• Two International training course on CA and Science of Farming Systems-FarmDesign• One National training course on FarmDesign• > 50 researchers including 11 students



Expenditure details (2017)		INR crores	
Research collaboration	ICAR Window III	CGIAR contribution	Total
Bread wheat improvement - yield potential, heat tolerance and othe relevant traits*	2.47	12.5	14.97
Wheat blast research	0.74	1.2	1.94
Durum wheat improvement - yield potential, biotic and abiotic toleracne and quality.	0.89	3.2	4.09
Maize breeding - QPM	0.61		0.61
Conservation Agriculture	1.29	2.0	3.29
Total	6.00	18.90	24.90
*Last grant of 0.47 crores released in October 2017 was included			



Plan for 2018-19

1. Bread wheat improvement: Advanced lines and germplasm with focus on
 - a) High yield potential under various management focusing >9 t/ha potential; joint trial to be done
 - b) Heat tolerance – both early and late
 - c) Resistance to major diseases including rusts
 - d) Chapatti and bread making quality
 - e) Capacity building and exchange program
2. Blast resistance:
 - a) Finding new sources of resistance with high yield
 - b) Screening Indian germplasm for blast resistance in Bangladesh, Bolivia and USA
 - c) Developing breeding populations that includes high yield and other core traits along with blast resistance
 - d) Capacity building and networking with other countries



Plan for 2018-19

3. Durum wheat improvement:

- a) Yield potential for central and peninsular India
- b) Abiotic stress tolerance – heat and drought
- c) Quality parameters
- d) Capacity building and exchange program

4. Quality Protein Maize (QPM) for food and feed needs

- a) Yield potential for central and peninsular India
- b) Abiotic stress tolerance
- c) Quality parameters

5. Conservation Agriculture

- a) Long term research in CA
- b) Nutrient and water use efficiency
- c) Farming System Modeling
- d) Promotion of conservation agriculture
- e) Capacity development and exchange program



Budget proposed for 2018 in INR crores

Research collaboration	ICAR Window III	CGIAR contribution	Total
Bread wheat improvement - yield potential, heat tolerance, rust resistance and other relevant traits	3.00	12.50	15.50
Wheat blast research	1.00	1.50	2.50
High Zn (biofortified wheat)	1.00	4.80	5.80
Durum wheat improvement - yield potential, biotic and abiotic tolerance and quality	1.00	3.20	4.20
Maize breeding - QPM	0.70		0.70
Conservation Agriculture	1.50	2.00	3.50
Total	8.20	24.00	32.20



Key partners

1. ICAR Institutes

- IIWBR, IIMR, CSSRI, IARI, RCER, IIFSR, CSSRI, NRRI, ATARI, CRIDA...

2. SAUs/Central universities

3. Other public sector institutions (national, international)

- HarvestPlus, KARI for Ug99: BARI, Bolivia Gov and USDA-ARS, Cornell Uni., KSU, BISA, Wageningen University, IPNI

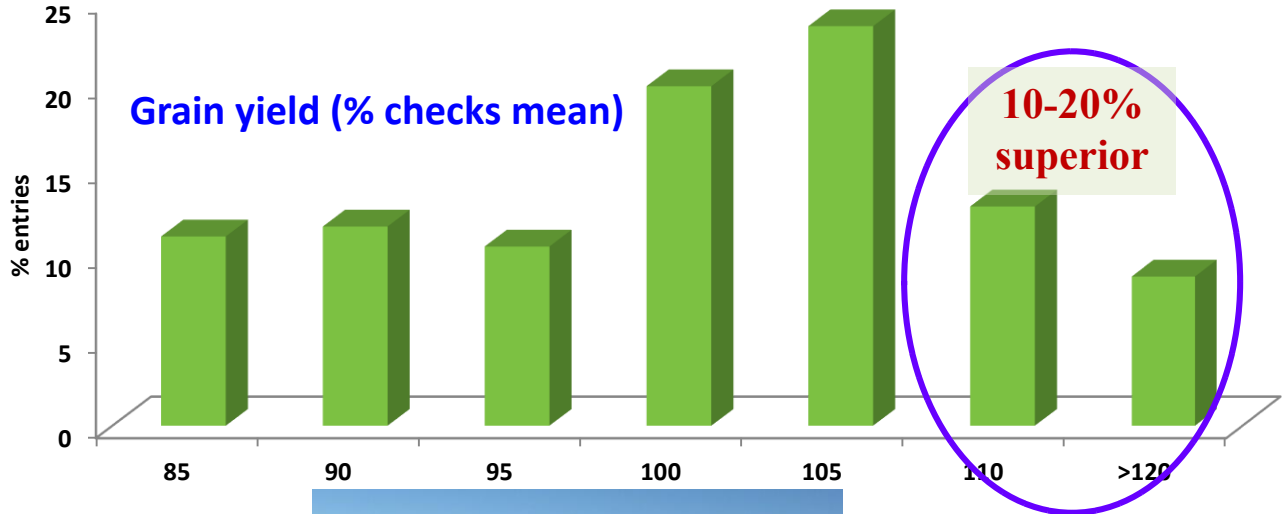


Other Activities



Success in breeding biofortified wheat shows that grain zinc trait can be mainstreamed

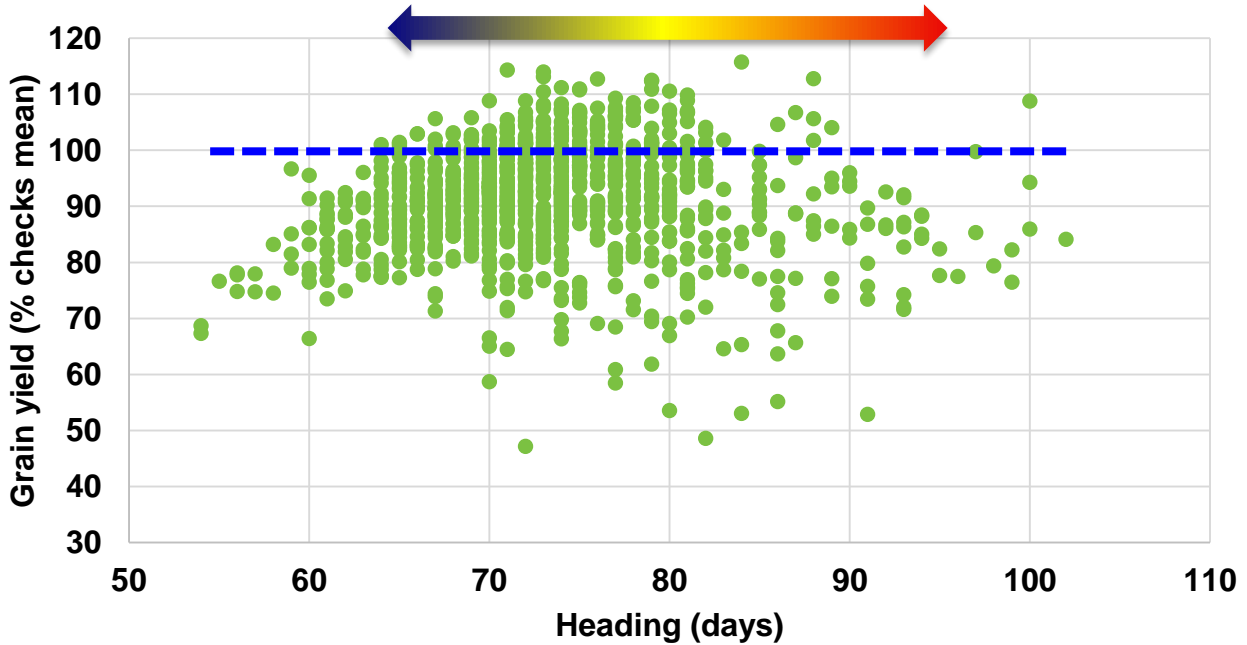
Grain yield under drought stress, Obregon 2016-17



- Two biofortified wheat varieties were notified in 2017
- 18 HPYT & 11 HPAN sent to India in 2017; all good traits included

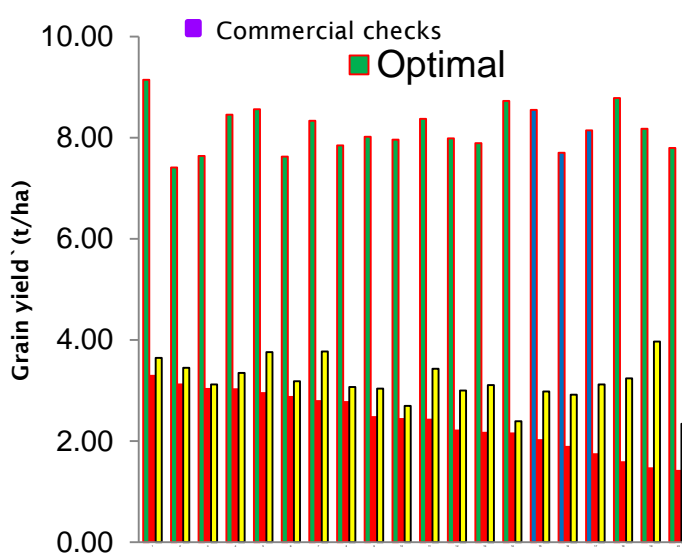
Source: Ravi Singh and Govindan Velu

High yield under early heat is independent of phenology
So we can breed for high yield under early sowing with a range of maturity



Days to heading and grain yield performance of 1092 new wheat breeding entries under early sown conditions in Mexico
“BMZ funded project with India”

Water Stress Resilient Hybrids



Water stress resilient hybrids

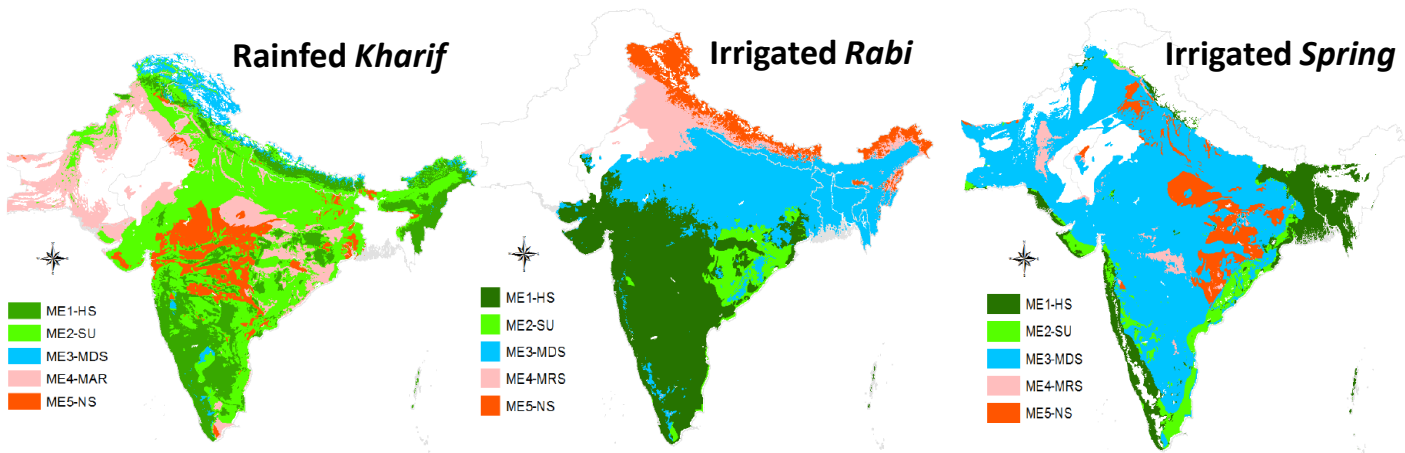
High-yielding heat stress-resilient hybrids selected by partners for exclusive licencing

Partners	Type	2015	2016	2017
UAS, Bangalore	Public	8		
GBPUAT, Pantnagar	Public	6		2
UAS, Dharwad	Public		3	
KSSC, Karnataka	Public		1	
SKUAST, Srinagar	Public	2		1
OUAT, Bhubaneswar	Public	5		
UAS, Raichur	Public	5	3	4
BAU, Sabor	Public		2	
Ajeet Seeds	SME	2	1	5
Vikkys Agrisciences	SME			3
Lall Seeds, Odisha	SME			1
Srimad Seeds, Odisha	SME			1
Sai Bhavya Seeds	SME			2
Kaveri Seeds, India	SME		1	
Pioneer HiBred , India	MNC		2	

At High (>40°C) Temp. + High (>5kPa) VPD



Mapping maize mega-environment (MME, 1st DRAFT)



ME1= Highly suitable; ME2= Suitable; ME3= Moderately suitable; ME4=Marginally suitable; ME5= Not suitable

Partners:

- ICAR-Indian Institute of Maize Research (IIMR), India
- Bangladesh Agricultural Research Institute (BARI), Bangladesh
- National Maize Research Program (NMRP), Nepal
- Maize & Millet Research Institute (MMRI), Pakistan
- CIMMYT-Asia Maize Program

Funding: CRP-MAIZE Agri-food system

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

**Improved productivity
& 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)**



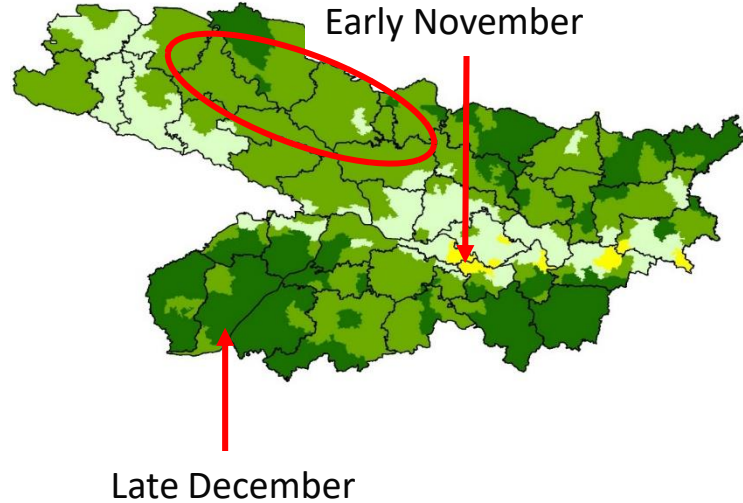
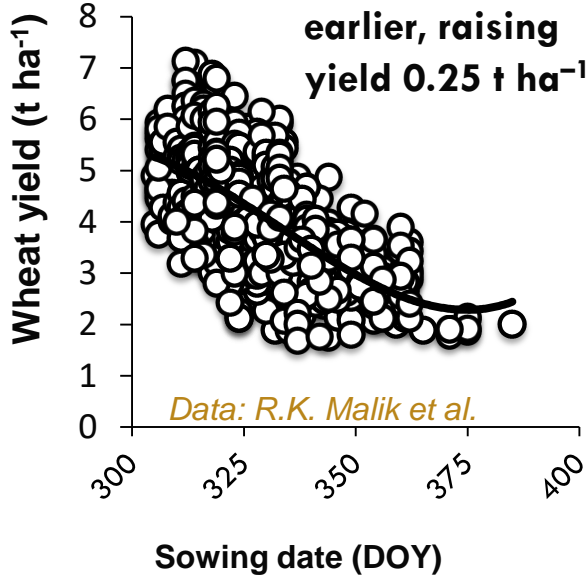
More crop per drop:
*Rice-wheat-mungbean:
60-70 ha-cm/yr
Maize-wheat-mung:
150-175 ha-cm/yr*

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

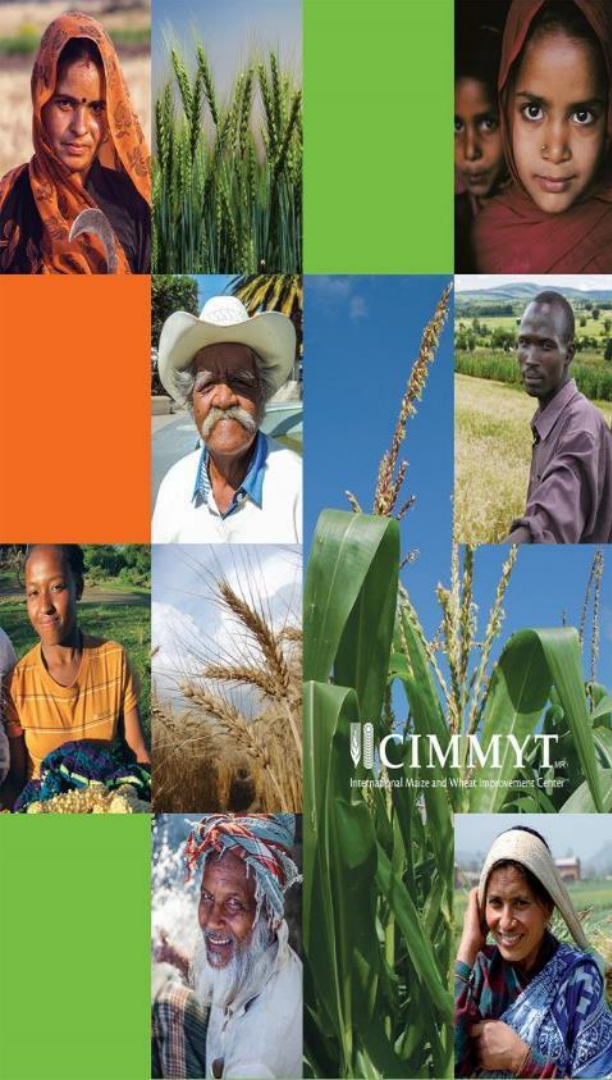
**Lower GHGs
emission
(~1.5 t CO₂-eq/ha/yr)**

Wheat resilience to heat in EGP for increasing farmers income

Bihar: Sowing date moved 5 d earlier, raising yield 0.25 t ha⁻¹



Ex Ante: \$255 m annual profitability increase w/ 5 d advance in Bihar + EUP.
→ Regional wheat sufficiency.



Thank you for your support!

www.CIMMYT.org

