Integrating Bundled Agronomic practices with Genetics are Crucial for Raising the Yield Potential under Current and Future Climates in South Asia

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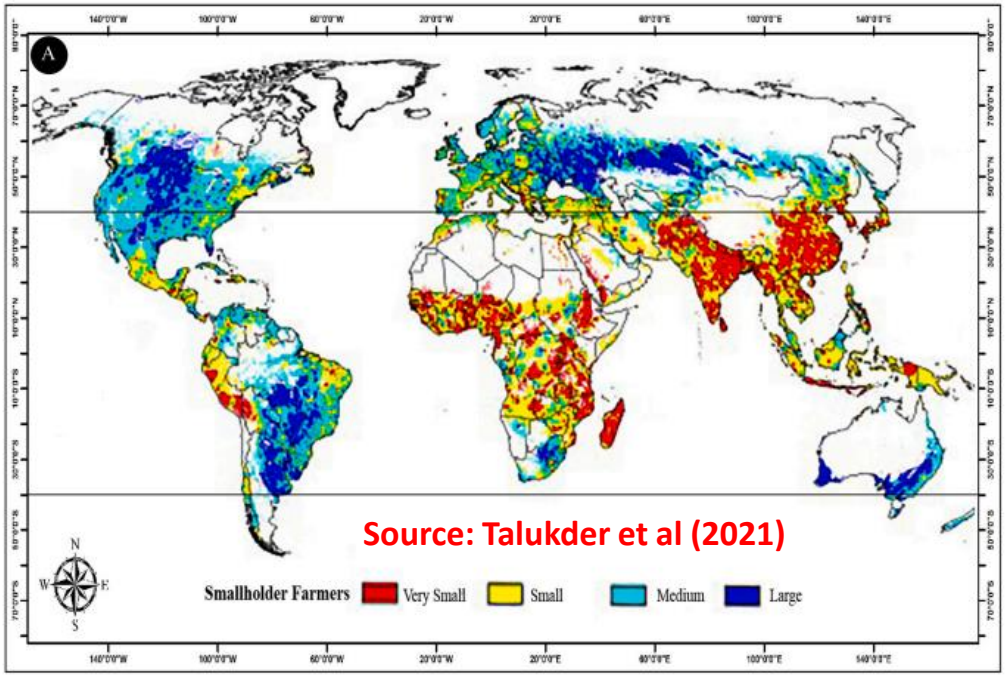
Smallholder Systems of South Asia has Unparallel Challenges

- Densely populated region with 1.7 billion people, by 2050, the number is expected to rise to 2.4 billion
- A global 'hotspot' for contemporary and future climate vulnerability
- 3-5 times higher pressure on natural resources
- Need more nutritious food from less and moreover degraded natural resources and higher climatic variability
- Smallholder's dominance: 450 million smallholder farmers of Asia produce 80% of food consumed in region



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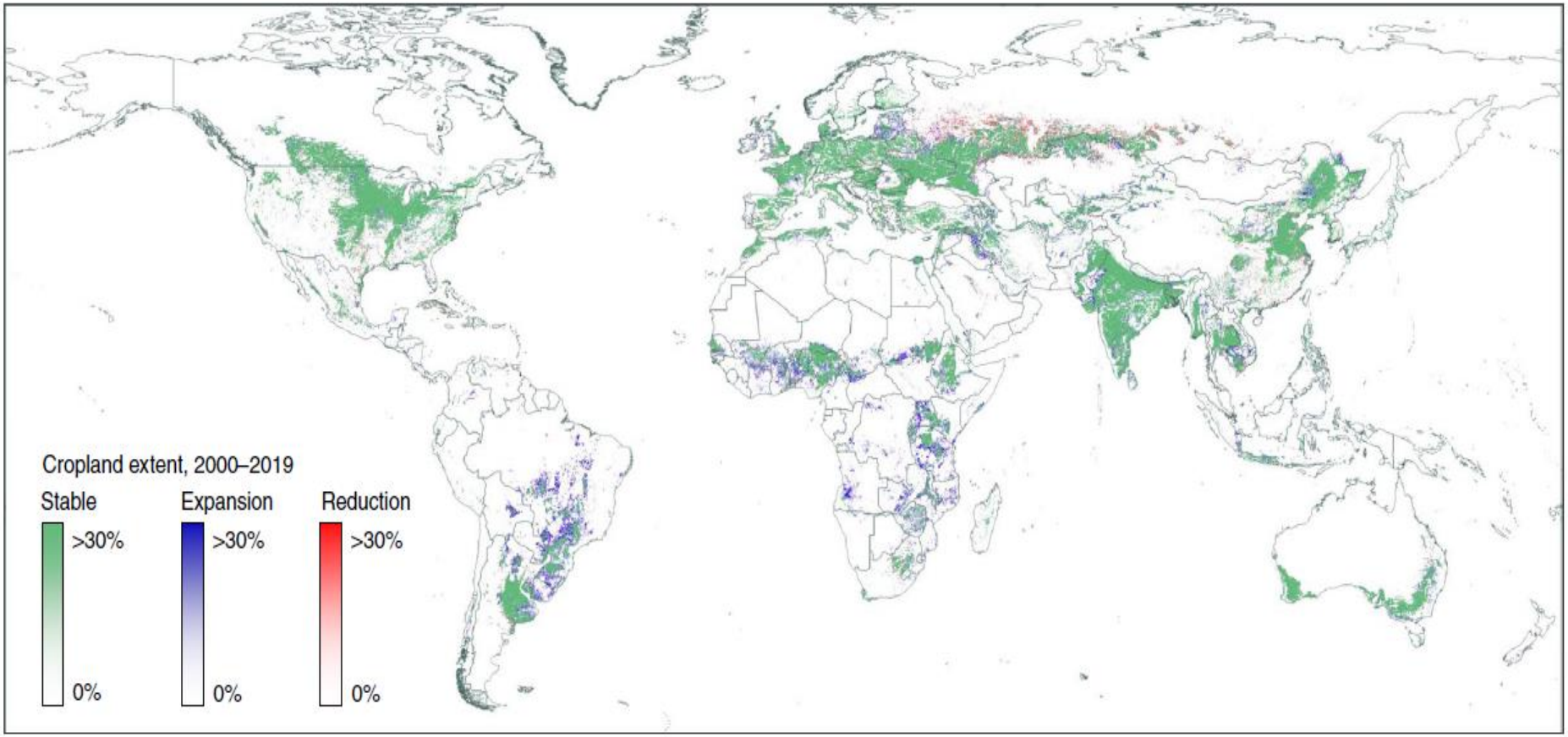
Global Cropland Extent and Change (2000–2019)



Potapov et al (2021), Nature Food

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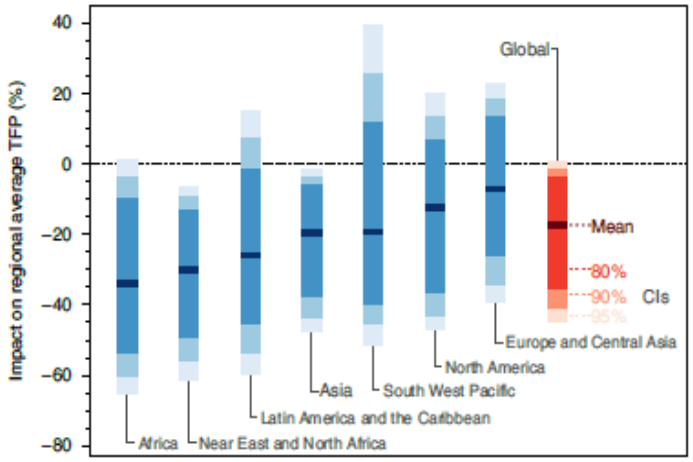
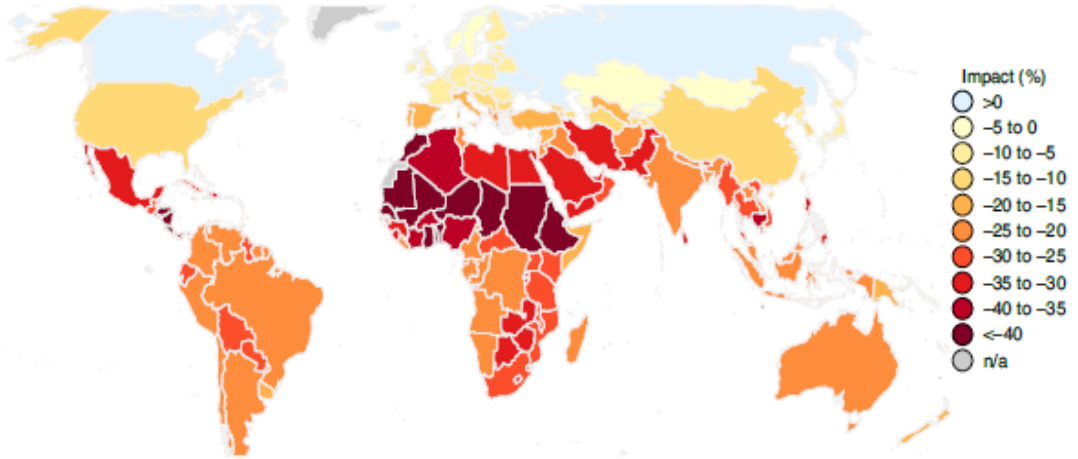
Impacts of Anthropogenic Climate Change on Global Agricultural Productivity Growth (1960-2015)





- **ACC has reduced global agricultural TFP by about 21% since 1961, a slowdown that is equivalent to losing the last 7 years of productivity growth**
- **India is at global average level**

Ortiz-Bobea et al, Nature Climate Change, April 2021

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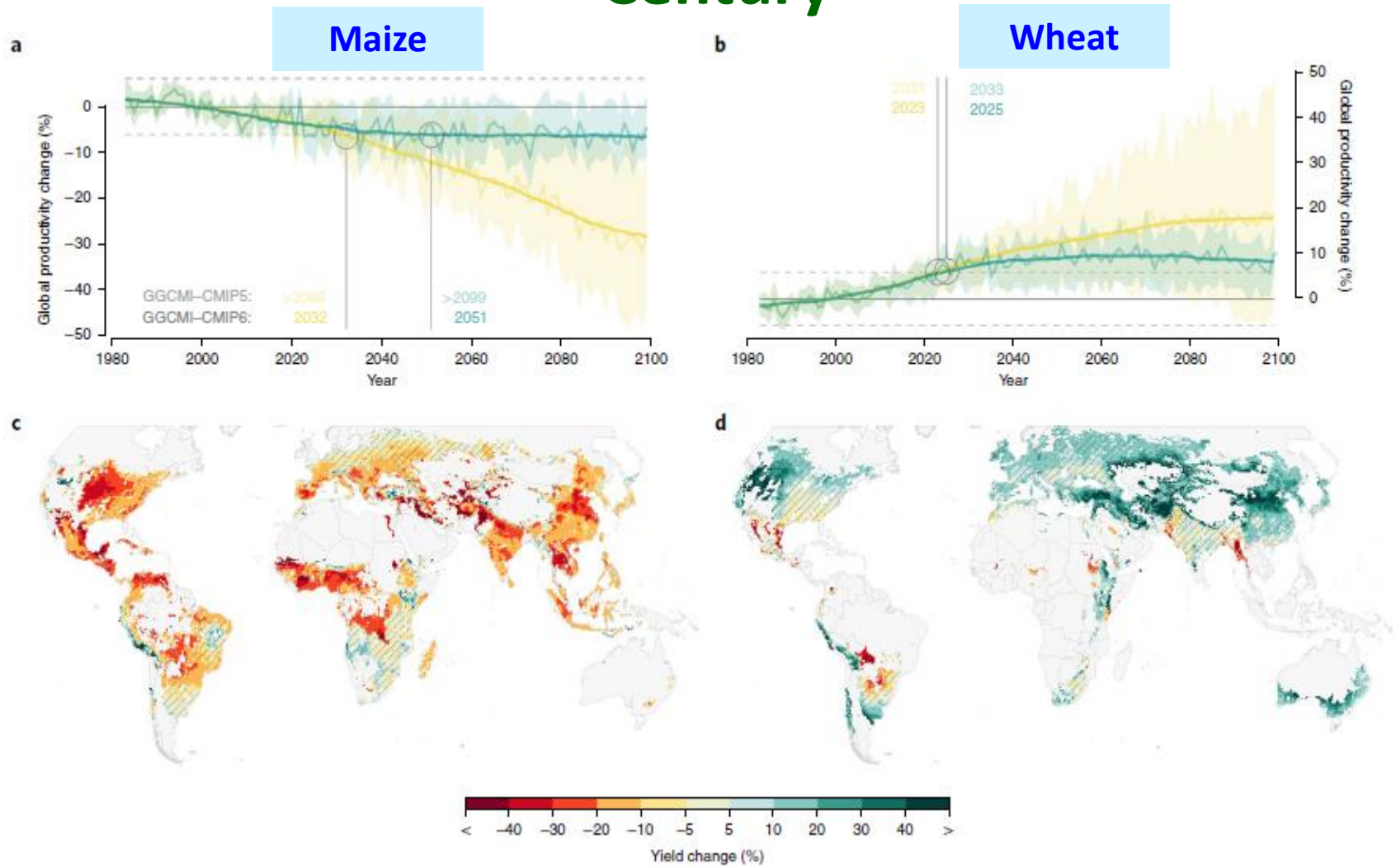
Projections of Global Crop Productivity for the 21st Century



Productivity time series for maize (**a**) and wheat (**b**) shown as relative changes to the 1983–2013 reference period under SSP126 (green) and SSP585 (yellow)

Jägermeyr et al (2021), Nature Food

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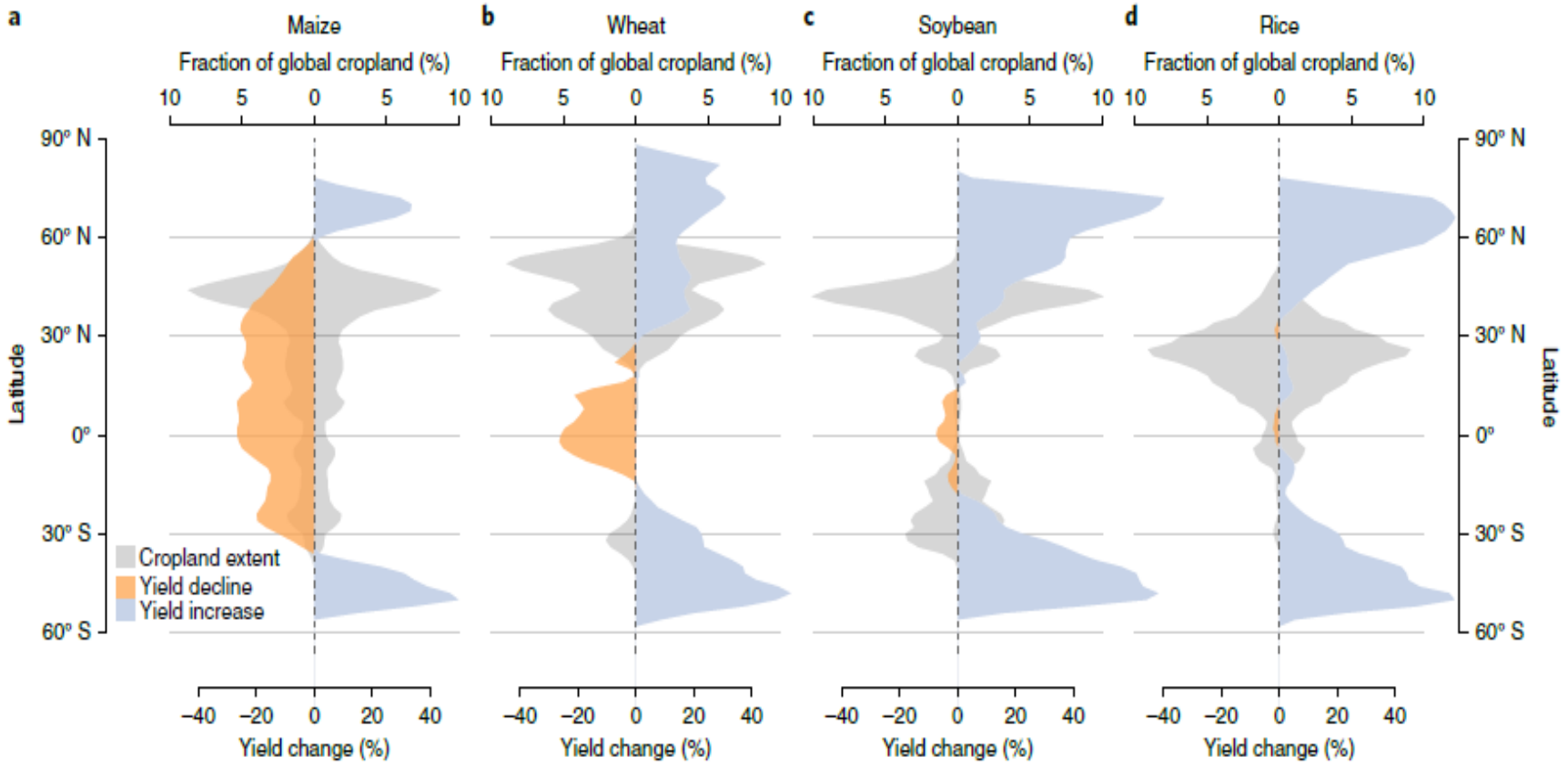
Latitudinal Profile of Crop Yield Changes



Yield changes (SSP585, 2069–2099) are shown as latitude averages for maize (**a**), wheat (**b**), soybean (**c**) and rice (**d**), based on crop simulations in all grid cells, unconstrained by current cropland extent (bottom *x* axis)

Jägermeyr et al (2021), Nature Food

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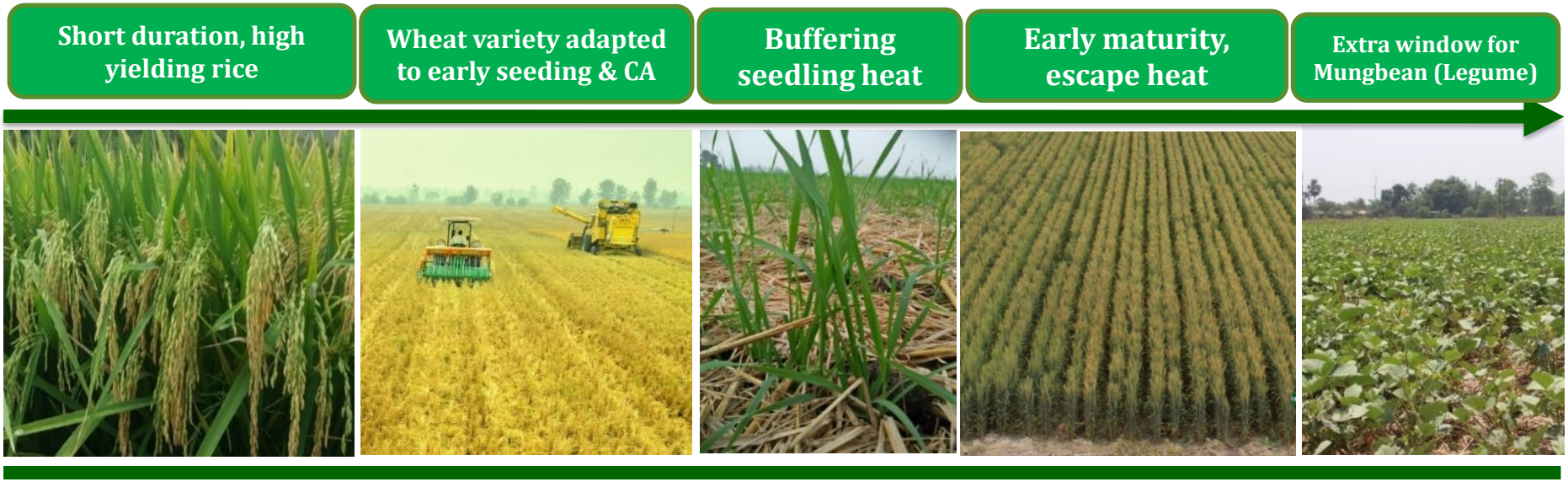
Optimizing Cropping Systems through Integrating Agronomic Management and Genetic Innovations

Windows of Opportunity Reducing Climatic Risks, Increasing productivity and Income



Source: ML Jat (CIMMYT)

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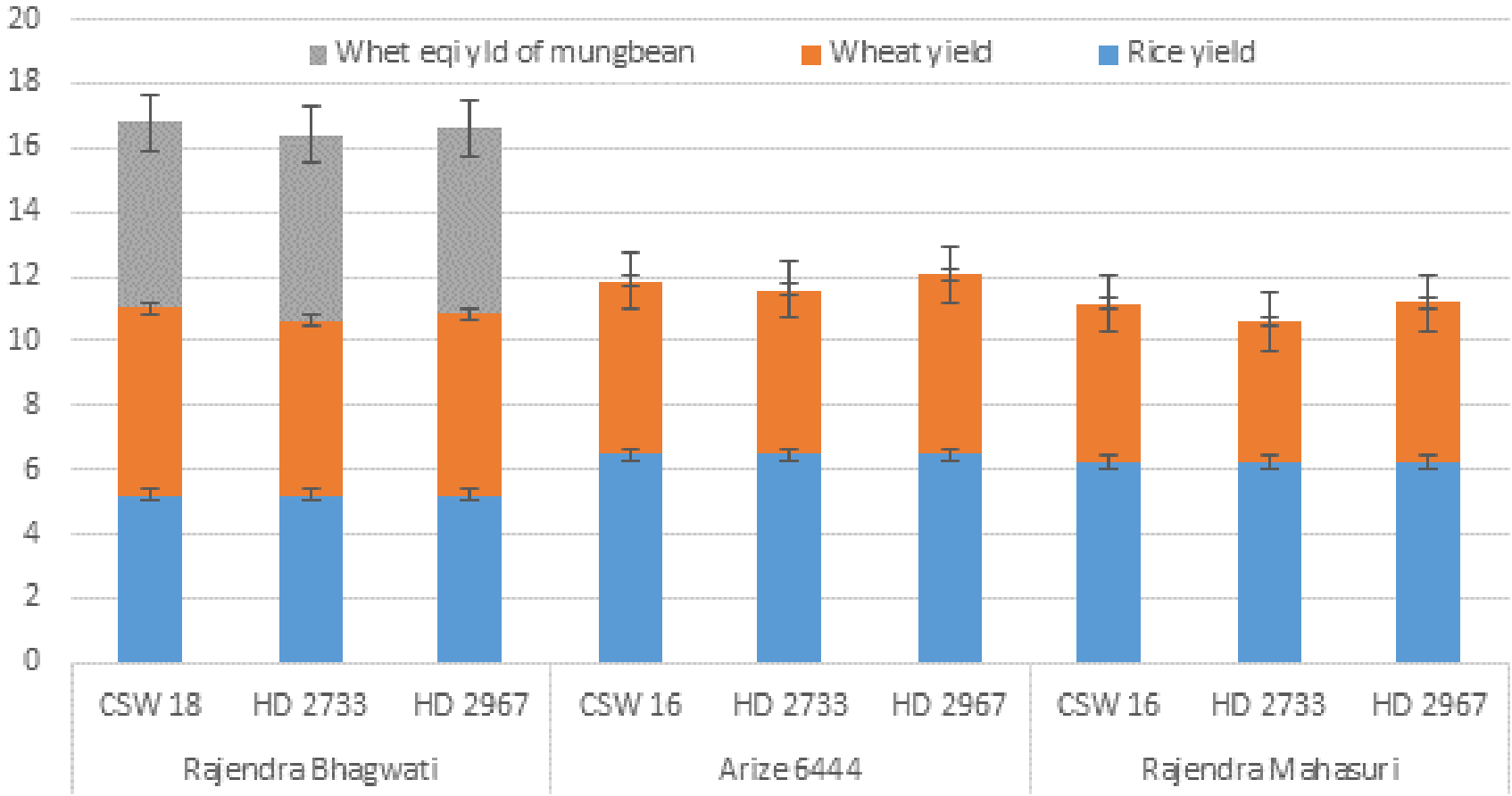
System Optimization for Sustainable Intensification: Example from EIGP



Jat et al

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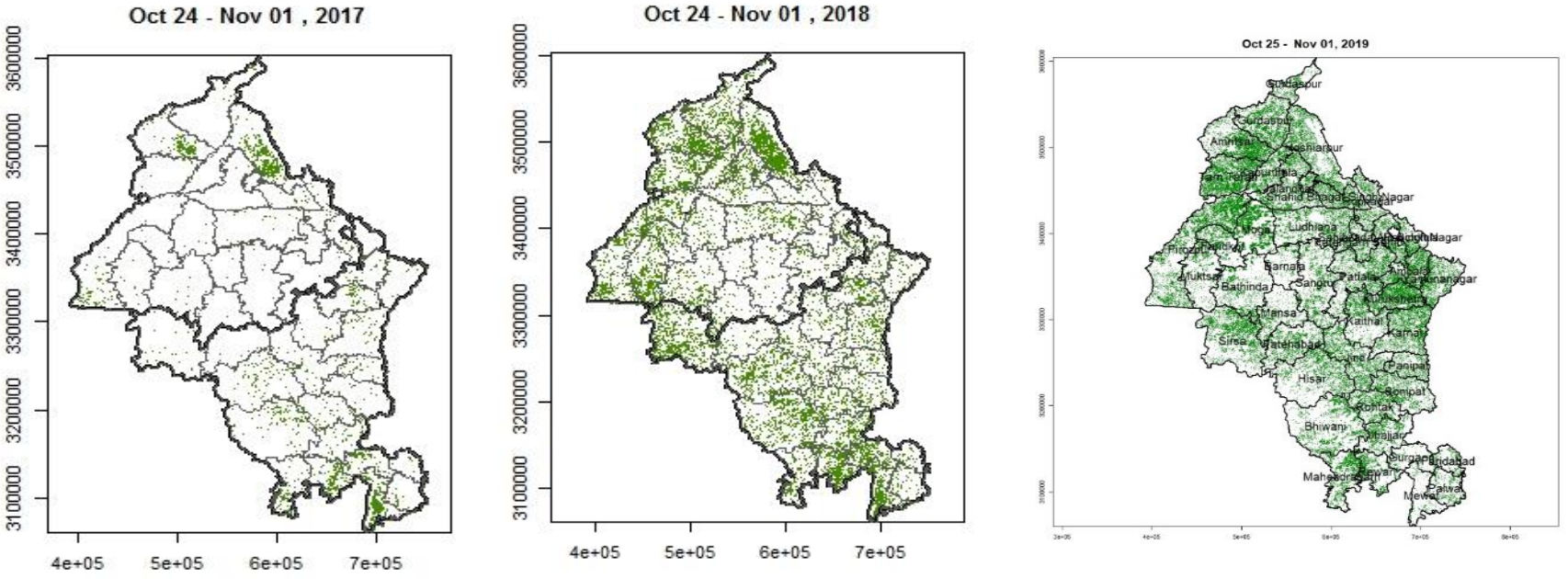
Systemic Innovations: Impact at Scale in India:

Wheat seeding advancement trends in Western IGP (2017-18 to 2019-20)



- **Combination of adapted varieties and conservation agriculture based mechanization led to advanced seeding (1 million ha wheat is planted in October)**
- **Capturing residual soil moisture (increased WUE, NUE)**
- **Escaping terminal heat**

Source: CIMMYT-ICAR/NARS- BMZ funded project

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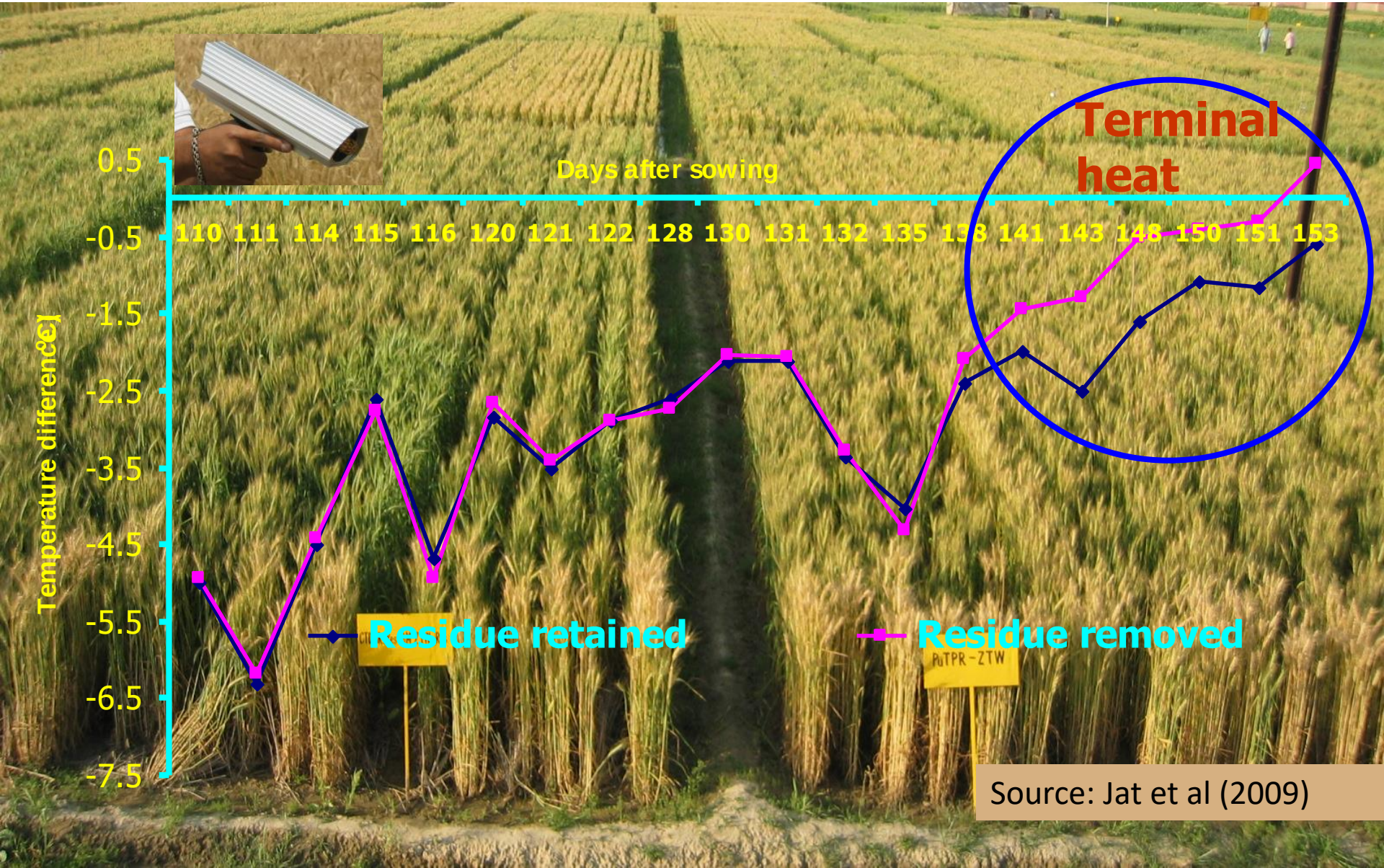
Management (CA) Effects on Wheat Adapting to Terminal Heat



Source: Jat et al (2009)

Management (CA) Effects on Wheat Adapting Wheat to Climate Risks (Excess Rains at Grain Filling, 2014-15, NW India)

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Management (CA) Effects on Wheat Adapting Wheat to Climatic Risks at early Growth (74 mm Rain in a day, January 2019: Punjab, India)

Source: ML Jat (CIMMYT)

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Management (CA) Effects on Wheat Adapting Wheat to Climatic Risks (Excess Rains at Grain Filling, 2020-21, NW India)

Source: ML Jat (CIMMYT)

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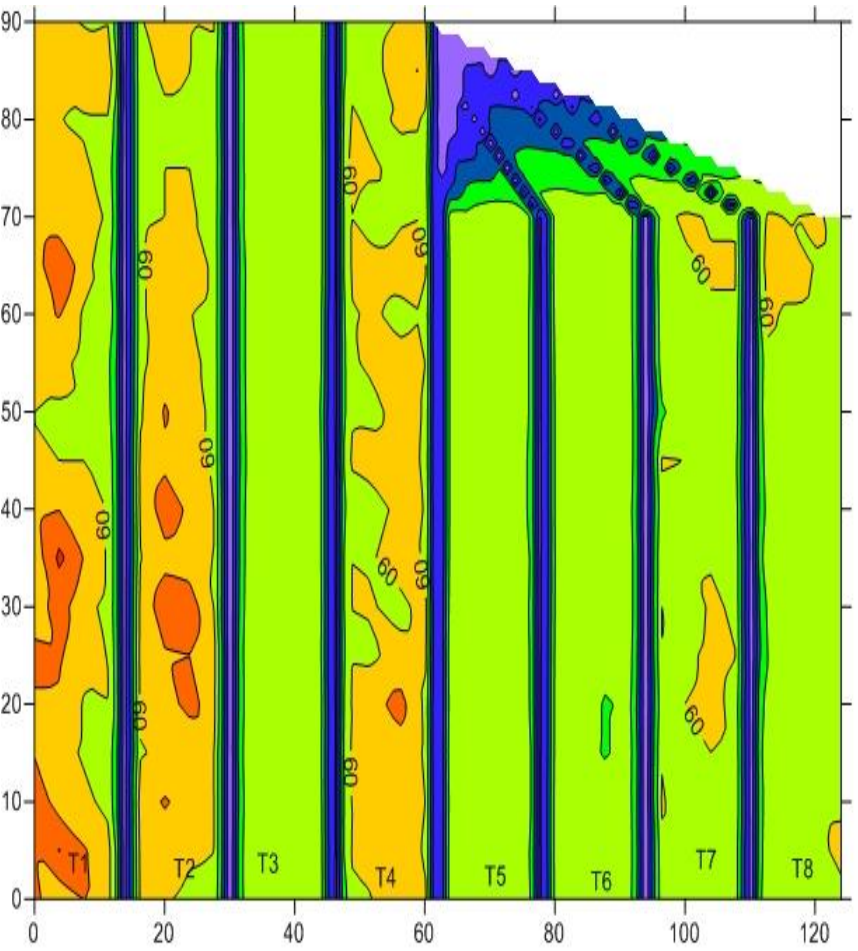
CA and Salt Stress Variability: An Example from RW system of EIGP



- T1: conv rice-wheat
- T2: conv rice-ZT wheat
- T3: Direct drilling of both rice and wheat on permanent beds
- T4: Zero-till DSR-conventional wheat
- T5: zero till DSR-Zero till wheat without residue
- T6: zero till DSR-Zero till wheat with residue
- T7: unpuddled transplanted rice followed by ZTW
- T8: wet DSR-zero till wheat

Jat et al (2013)

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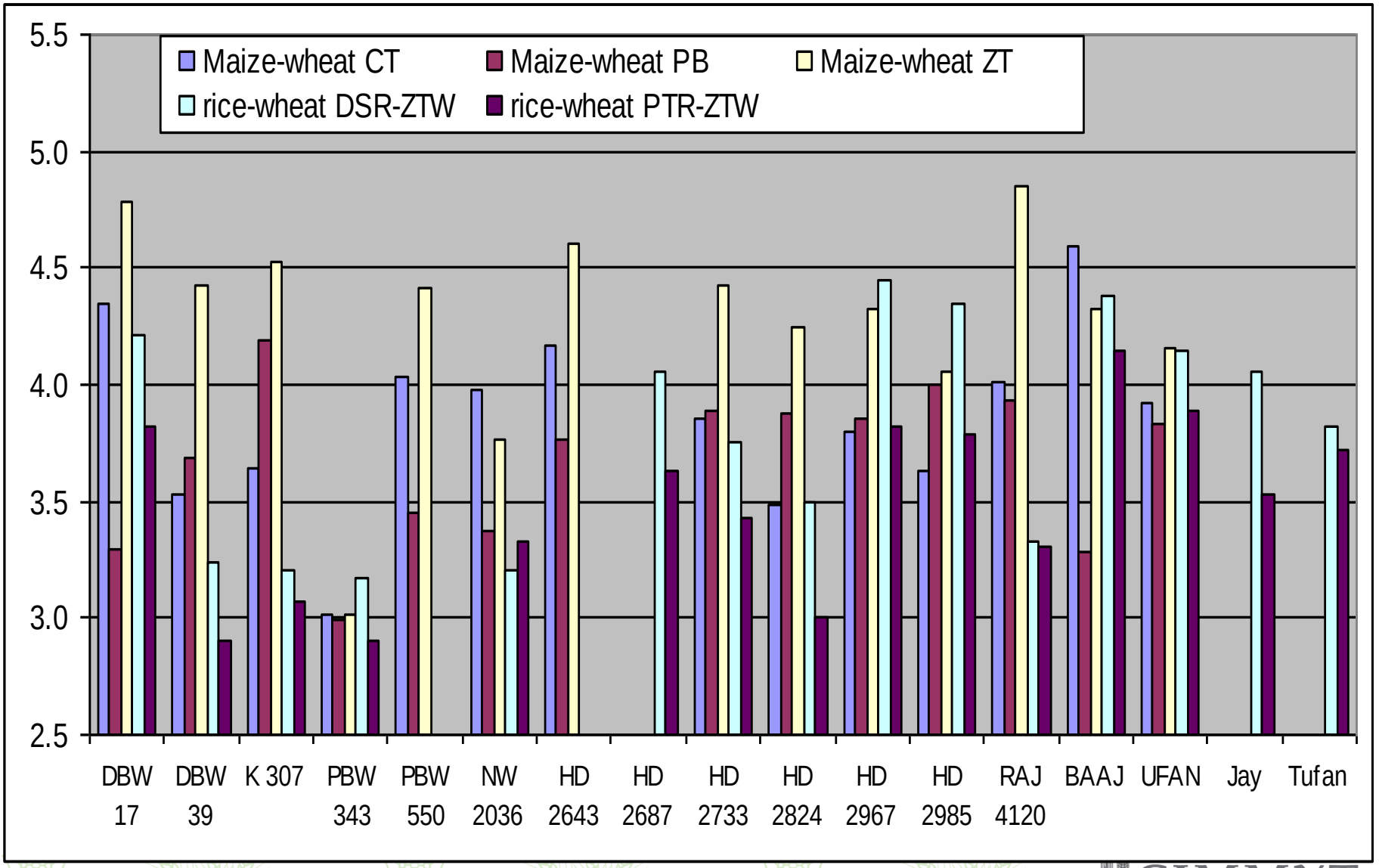
Performance of released wheat cultivars under different crop establishment in 2 cropping systems (RW and MW) in EIGP



Source: Jat et al

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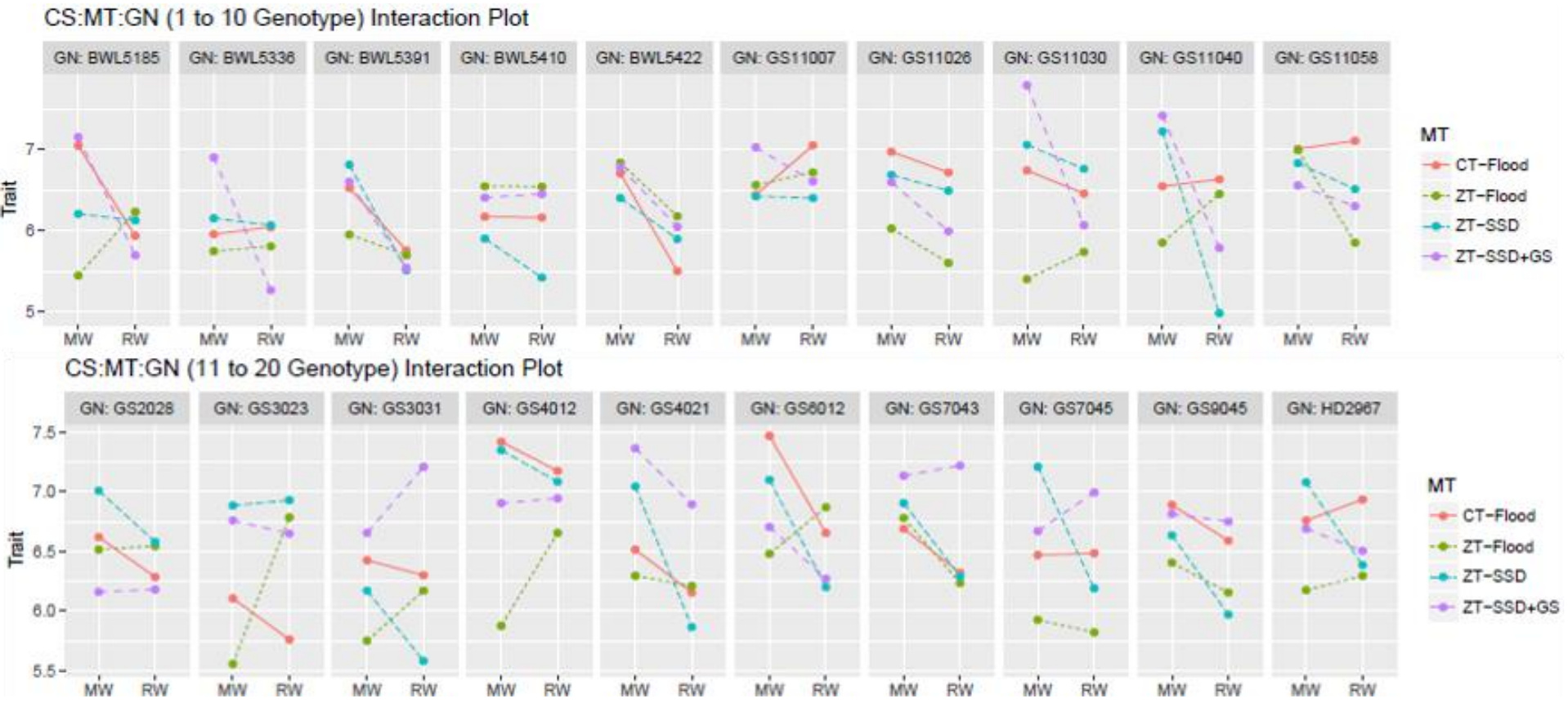
Genotype x Environment x Management:
Opportunities for Realizing Yield Potential



- **Significant interactions of genotypes with cropping systems and management**
- **For targeting genotypes for future agronomic domains, G x E x M research is important for realizing the yield potential of genotypes**

Source: Sidhu, Jat et al

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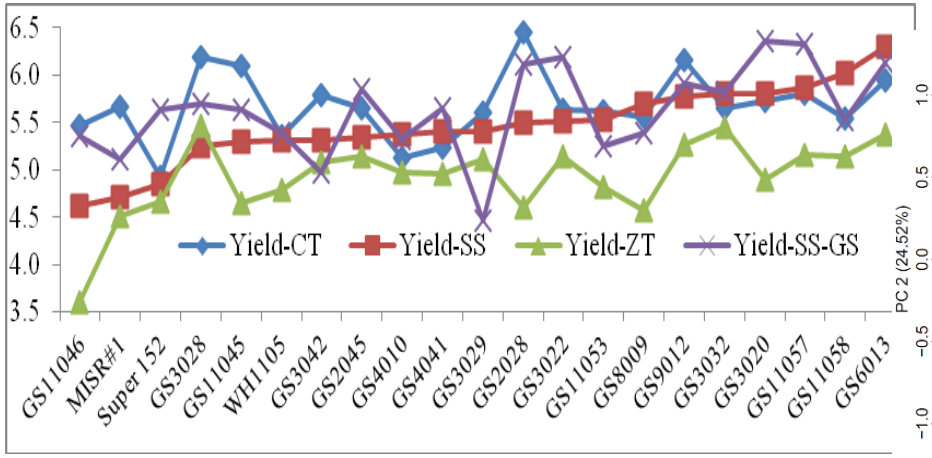
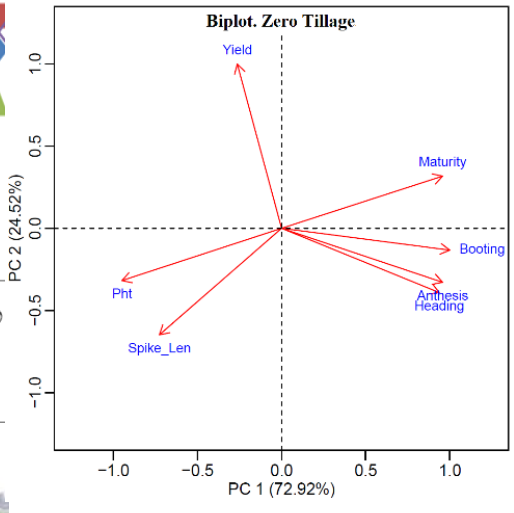
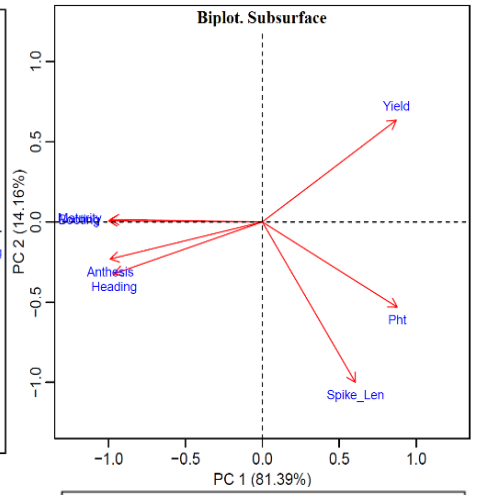
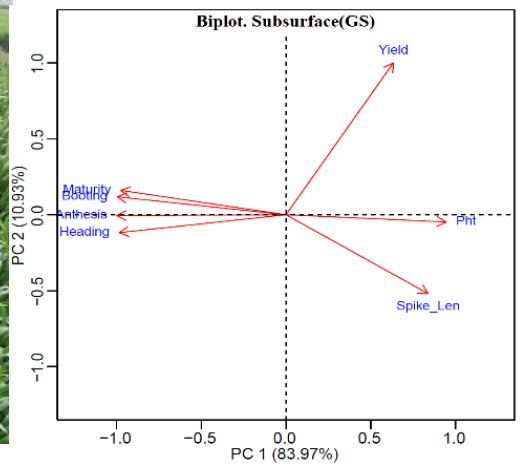
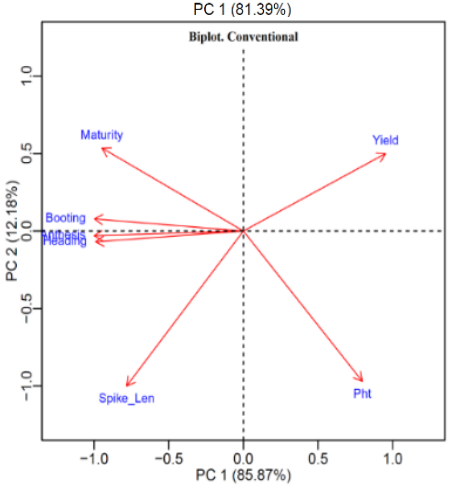
Capitalizing on G x E x M interactions: Wheat











Source: Jat et al 2018

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Genotype x Environment x Management in Wheat (Grain yield t/ha)

Genotypes	Rice-wheat systems			Maize-wheat system		
	CT	ZT	ZT-SSD	CT	ZT	ZT-SSD
HD- 277	5.02	6.13	6.46	6.04	6.38	7.20
HD-2967	5.22	5.92	5.25	6.48	5.77	6.20
HD-3086	5.05	4.58	5.35	5.58	5.68	6.06
DBW-71	5.79	4.70	5.93	5.88	6.51	6.58
MACS-6222	5.46	6.18	5.04	6.49	6.67	6.61
AKAW-4731	4.83	3.54	4.49	5.01	4.82	4.64
VL-804	5.05	5.53	5.43	5.53	6.46	5.94
NP-890	5.73	6.09	6.48	5.61	6.54	7.15
PXW 34-052 (UK-218)	4.47	4.67	4.84	4.44	5.72	4.56
PXW 291-062 (UK-272)	5.51	4.99	4.91	5.75	6.49	5.31
PXW 811-061 (UK-166)	5.75	5.54	5.70	6.33	6.63	5.83
PXW 264-091 (UK-15)	4.06	4.32	3.98	4.61	4.79	4.48
PXW 264-083 (UK-20)	3.86	3.94	3.77	3.44	3.86	4.15
PXCIM 49-073 (UK-1620)	5.35	4.12	4.18	5.20	5.79	5.48
PXBAJ 081 (UK-1638)	5.41	4.49	5.09	5.11	4.98	5.77
Average	5.10	4.98	5.13	5.43	5.81	5.73

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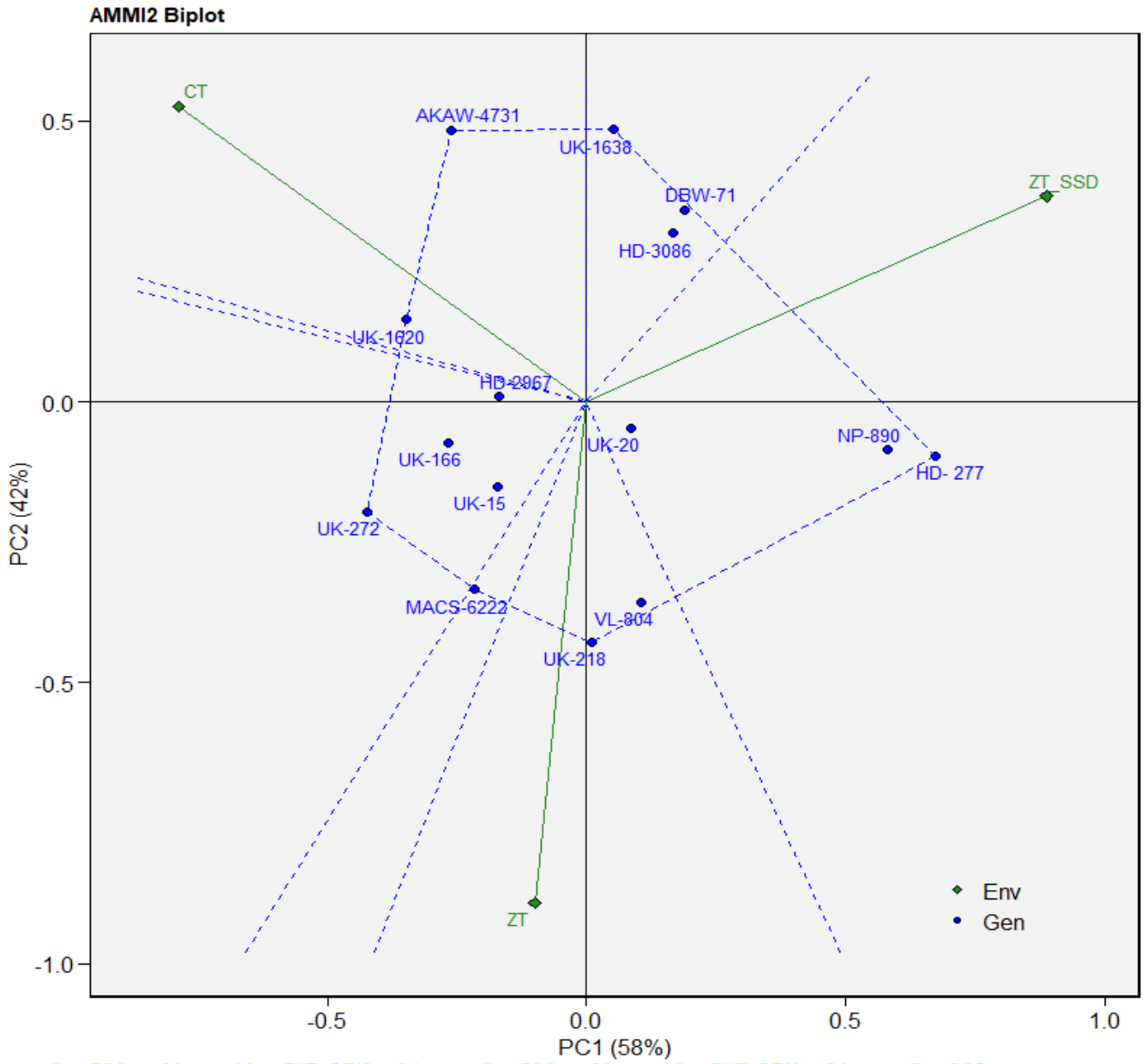
AMMI2 Biplot
CT
AKAW-4731
UK-1638
DBW-71
ZT_SSD
HD-3086
UK-1620
HD-2967
UK-166
UK-20
NP-890
HD- 277
UK-15
UK-272
MACS-6222
VL-804
UK-218
ZT
Env
Gen
0.5
0.0
-0.5
-1.0
PC2 (42%)
-0.5
0.0
0.5
1.0
PC1 (58%)

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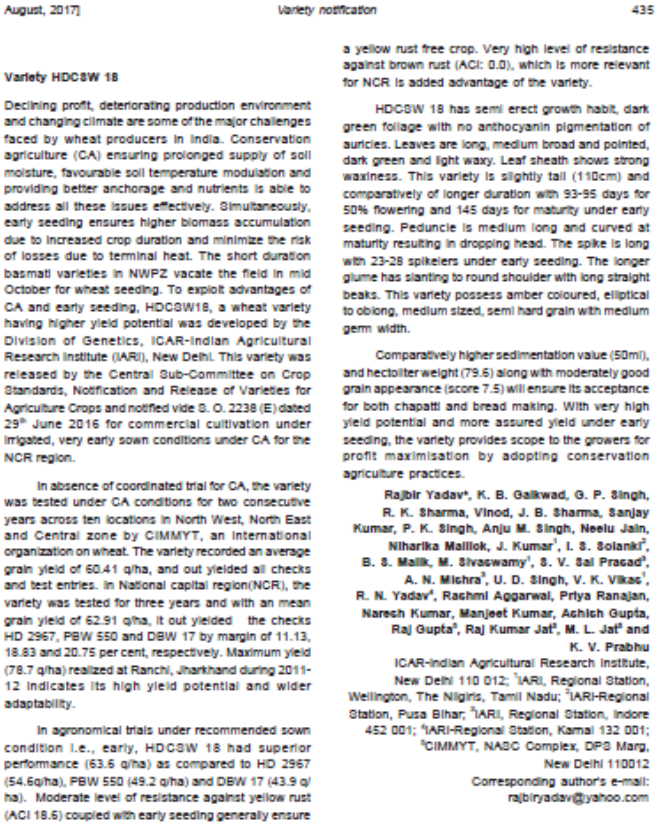
Wheat Varieties Developed and Released for CA



August, 2017] *Variety notification* 435

Variety HDCSW 18

Declining profit, deteriorating production environment and changing climate are some of the major challenges faced by wheat producers in India. Conservation agriculture (CA) ensuring prolonged supply of soil moisture, favourable soil temperature modulation and providing better anchorage and nutrients is able to address all these issues effectively. Simultaneously, early seeding ensures higher biomass accumulation due to increased crop duration and minimize the risk of losses due to terminal heat. The short duration basmati varieties in NWPZ vacate the field in mid October for wheat seeding. To exploit advantages of CA and early seeding, HDCSW18, a wheat variety having higher yield potential was developed by the Division of Genetics, ICAR-Indian Agricultural Research Institute (IARI), New Delhi. This variety was released by the Central Sub-Committee on Crop Standards, Notification and Release of Varieties for Agriculture Crops and notified vide S. O. 2238 (E) dated 29th June 2016 for commercial cultivation under irrigated, very early sown conditions under CA for the NCR region.

In absence of coordinated trial for CA, the variety was tested under CA conditions for two consecutive years across ten locations in North West, North East and Central zone by CIMMYT, an international organization on wheat. The variety recorded an average grain yield of 60.41 q/ha, and out yielded all checks and test entries. In National capital region(NCR), the variety was tested for three years and with an mean grain yield of 62.91 q/ha, it out yielded the checks HD 2967, PBW 550 and DBW 17 by margin of 11.13, 18.83 and 20.75 per cent, respectively. Maximum yield (78.7 q/ha) realized at Ranchi, Jharkhand during 2011-12 indicates its high yield potential and wider adaptability.

In agronomical trials under recommended sown condition i.e., early, HDCSW 18 had superior performance (63.6 q/ha) as compared to HD 2967 (54.6q/ha), PBW 550 (49.2 q/ha) and DBW 17 (43.9 q/ha). Moderate level of resistance against yellow rust (ACI 18.6) coupled with early seeding generally ensure a yellow rust free crop. Very high level of resistance against brown rust (ACI: 0.0), which is more relevant for NCR is added advantage of the variety.

HDCSW 18 has semi erect growth habit, dark green foliage with no anthocyanin pigmentation of auricles. Leaves are long, medium broad and pointed, dark green and light waxy. Leaf sheath shows strong waxiness. This variety is slightly tall (110cm) and comparatively of longer duration with 93-95 days for 50% flowering and 145 days for maturity under early seeding. Peduncle is medium long and curved at maturity resulting in dropping head. The spike is long with 23-28 spikelets under early seeding. The longer glume has slanting to round shoulder with long straight beaks. This variety possess amber coloured, elliptical to oblong, medium sized, semi hard grain with medium germ width.

Comparatively higher sedimentation value (50ml), and hectoliter weight (79.6) along with moderately good grain appearance (score 7.5) will ensure its acceptance for both chapatti and bread making. With very high yield potential and more assured yield under early seeding, the variety provides scope to the growers for profit maximisation by adopting conservation agriculture practices.

Rajbir Yadav[a], K. B. Gaikwad, G. P. Singh, R. K. Sharma, Vinod, J. B. Sharma, Sanjay Kumar, P. K. Singh, Anju M. Singh, Neelu Jain, Niharika Mallick, J. Kumar[1], I. S. Solanki[2], B. S. Malik, M. Sivaswamy[1], S. V. Sai Prasad[3], A. N. Mishra[3], U. D. Singh, V. K. Vikas[1], R. N. Yadav[4], Rachmi Aggarwal, Priya Ranajan, Naresh Kumar, Manjeet Kumar, Ashish Gupta, Raj Gupta[5], Raj Kumar Jat[5], M. L. Jat[5] and K. V. Prabhu

ICAR-Indian Agricultural Research Institute, New Delhi 110 012; [1]IARI, Regional Station, Wellington, The Nilgiris, Tamil Nadu; [2]IARI-Regional Station, Pusa Bihar; [3]IARI, Regional Station, Indore 452 001; [4]IARI-Regional Station, Karnal 132 001; [5]CIMMYT, NASC Complex, DPS Marg, New Delhi 110012

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PBW 869: Wheat Variety Developed and Released for Early Seeding+CA in Punjab

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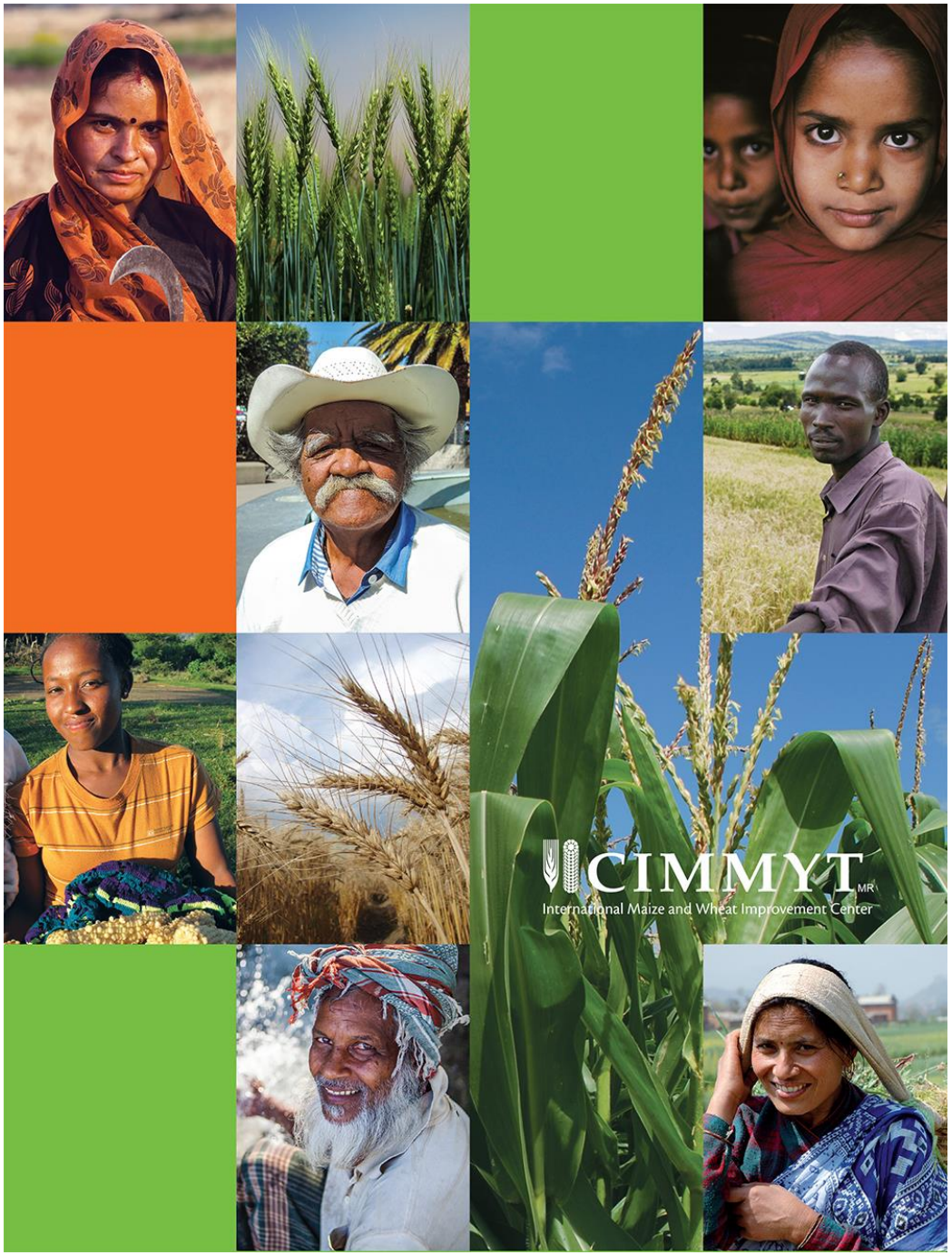
Key Messages

- **Understanding the functional variability at molecule, organs, whole plant and at the population level, and its integration with diversity at the level of nucleotide and genes will be relevant for the development of new genotypes by integrating the GxExM interaction.**
- **Plant ideotypes required for changing patterns of environmental stresses as well as evolving management practices will be guiding forces for the breeding outcome.**
- **The key physiological processes like phenology, water and other input use efficiencies, radiation and CO2 use efficiency need to be assessed under changing climatic condition and evolving management practices.**
- **Modern breeding tools under such a situation could prove quite handy for steering recombination between desirable genetic factors and select on the basis of genetic values.**



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