

# Breeding and selection strategies to combine and validate QTLs for WUE and heat tolerance in China and India

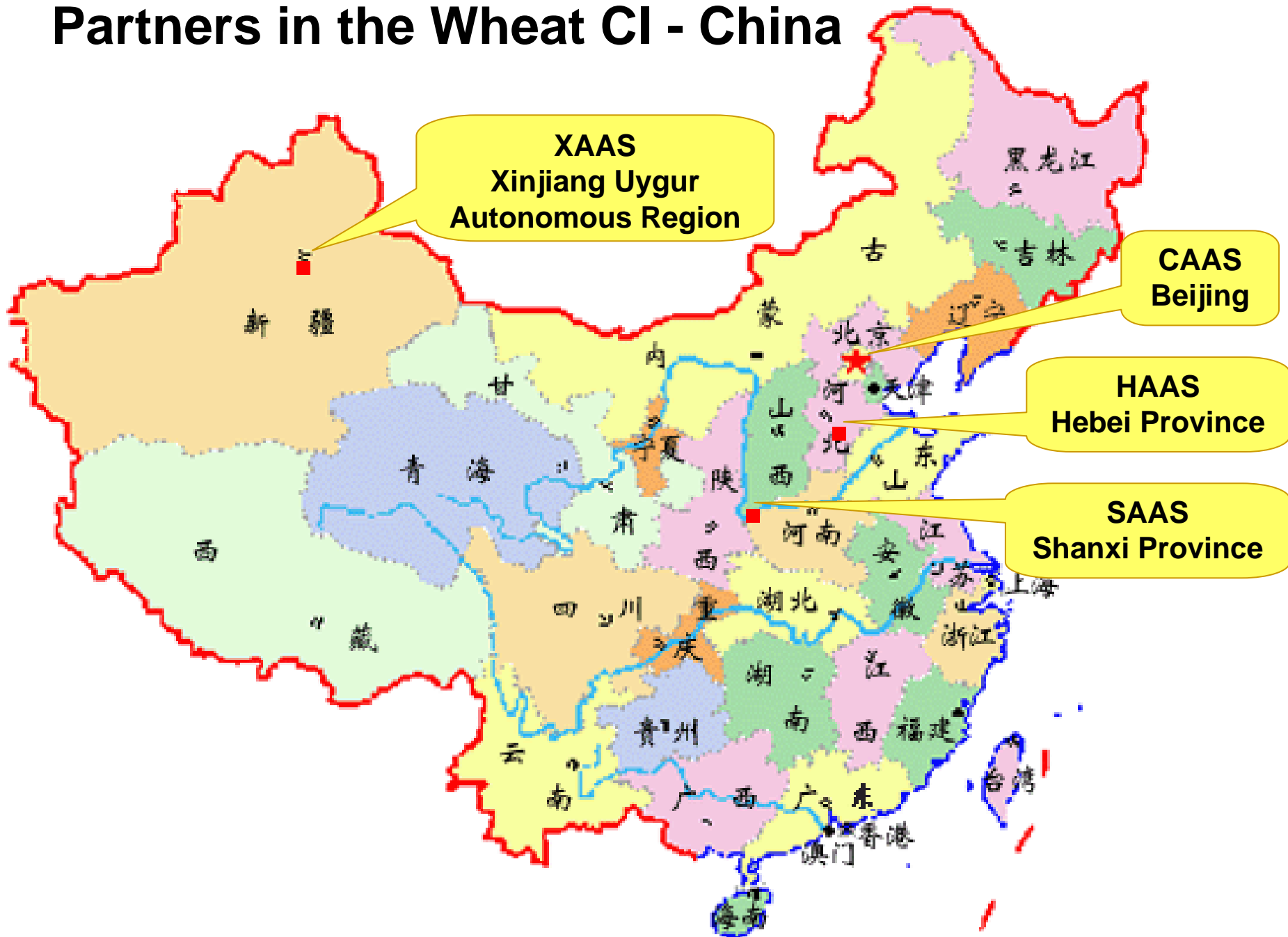


Wheat CI

# Rationale

- China and India are the world's biggest wheat producers
- Water for irrigation is projected to become increasingly limited in these regions
- Temperatures are projected to increase, particularly in south Asia
- Significant QTL information is now available in wheat for yield/WUE/heat tolerance
- Breeding for yield (including WUE/heat tolerance) has made small incremental gains
- A new breeding strategy is required to produce the WUE/heat tolerant wheat cultivars needed to address food security in southern and eastern Asia.

# Partners in the Wheat CI - China



# Partners in the Wheat CI

<b>Chinese partners (Coordination: Ruilian Jing)</b>	<b>Rainfall (mm)</b>	<b>Crop cycle</b>	<b>Irrigation</b>	<b>Rain shelter</b>
Chinese Academy of Agricultural Sciences (CAAS)	580	WW	+	+
Hebei Academy of Agricultural Sciences (HAAS)	510	FW	+	+
Shanxi Academy of Agricultural Sciences (SAAS)	490	FW	+	+
Xinjiang Academy of Agricultural Sciences (XAAS)	180	SW	+	+



**600 m<sup>2</sup> Rain-out Shelter at CAAS**

# Partners in the Wheat CI

<b>Indian partners (Co-ordination: Vinod Prabhu)</b>	<b>Rainfall (mm)</b>	<b>Crop cycle</b>	<b>Irrigation</b>	<b>Rain shelter</b>
Indian Agricultural Research Institute (IARI) New Delhi	580	SW	+	(+)
National Research Center for Plant Biotechnology (NRCPB) New Delhi	510		+	
Punjab Agricultural University (PAU)	490	SW	+	(+)
JNKVV Powarkheda (Madhya Pradesh)	180	SW	+	



Greenhouse facilities at NRCPB

***Objective 1.* Implementation of standardized drought and heat phenotyping protocols to physiologically evaluate genetic populations and germplasm resources in China & India**

- Establish drought & heat phenotyping protocols at key locations in China and India
- Train local scientists in the physiological dissection of plant response to drought & high temperature
- Phenotype an international core set of stress tolerant germplasm and key Chinese and Indian cultivars and breeding lines
- Validation of QTLs under local conditions

## ***Objective 2. Combining QTLs in a marker assisted recurrent selection scheme to improve WUE/heat tolerance***

- Parents genotyped and combined on the basis of contrasting QTLs for WUE/heat tolerance & yield
- F3 lines developed by tracking markers linked to QTLs
- F4 phenotyped (multi-environment trials), genotyped and selected lines recombined on the basis of QTL linked markers and genetic background
- Second cycle of recurrent selection begins/first cycle products enter mainstream breeding for reselection

P1 x P2

Parents representing contrasting QTLs genotyped (year 1).  
(Crosses may be simple, tops or doubles)



F1

Increased in the green house (year 1)



F2

Progeny selected using associated QTL markers (year 2) - greenhouse



F3

Plots representing individual plants under irrigation – all progeny genotyped  
(year 2)



F4

Multi-environment trials (3-4 tests) under drought pressure in the field under managed stress. Yield, rust, genotype and map-marker selection used to select lines (year 3). Gene effects estimated.



F5

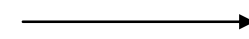
Best lines enter  
breeding program



Intercross selected lines based on  
marker information (year 3)



Multi cross F1

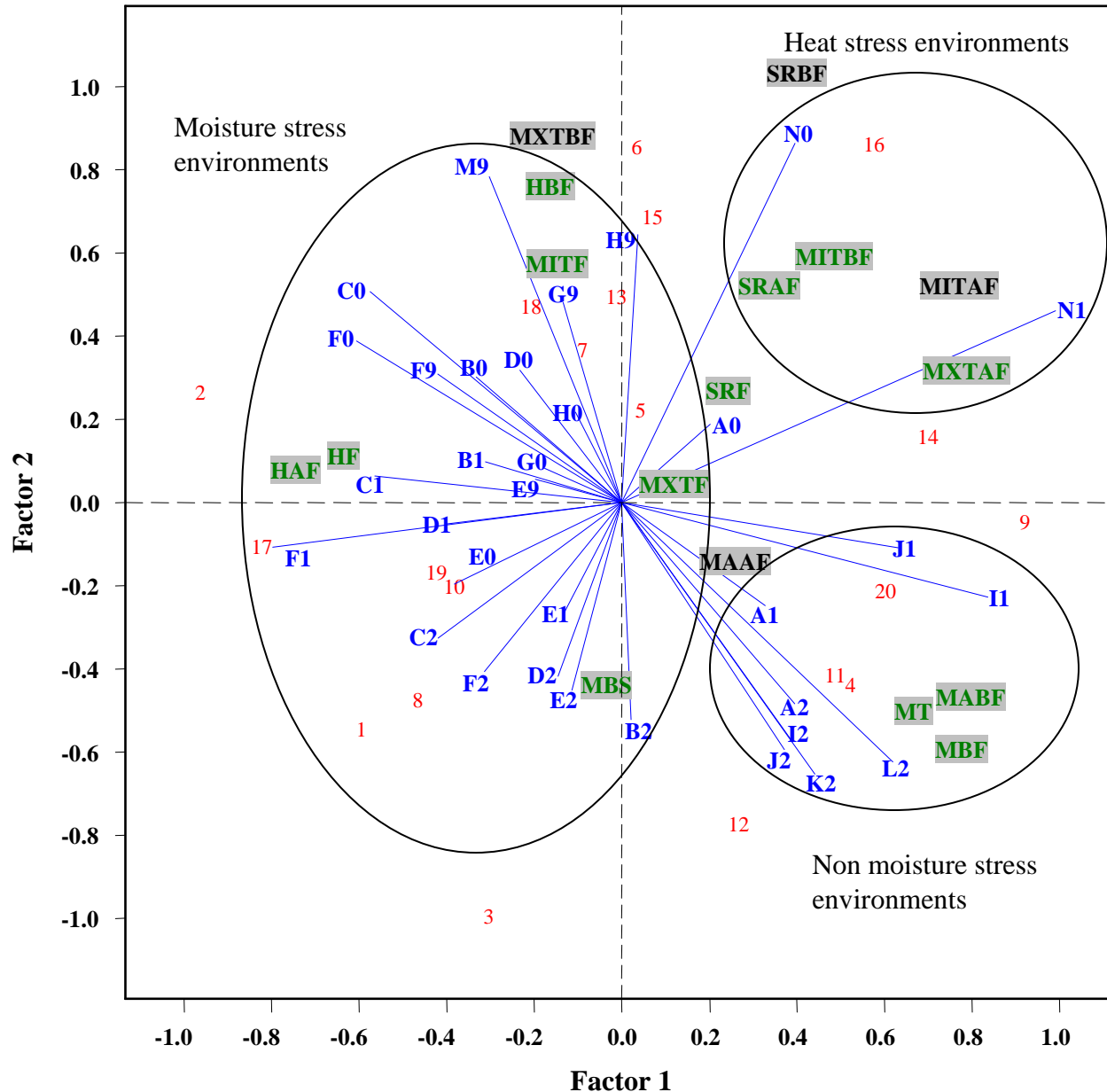


Repeat  
second cycle  
(years 4 – 6)

# Constraints/Challenges

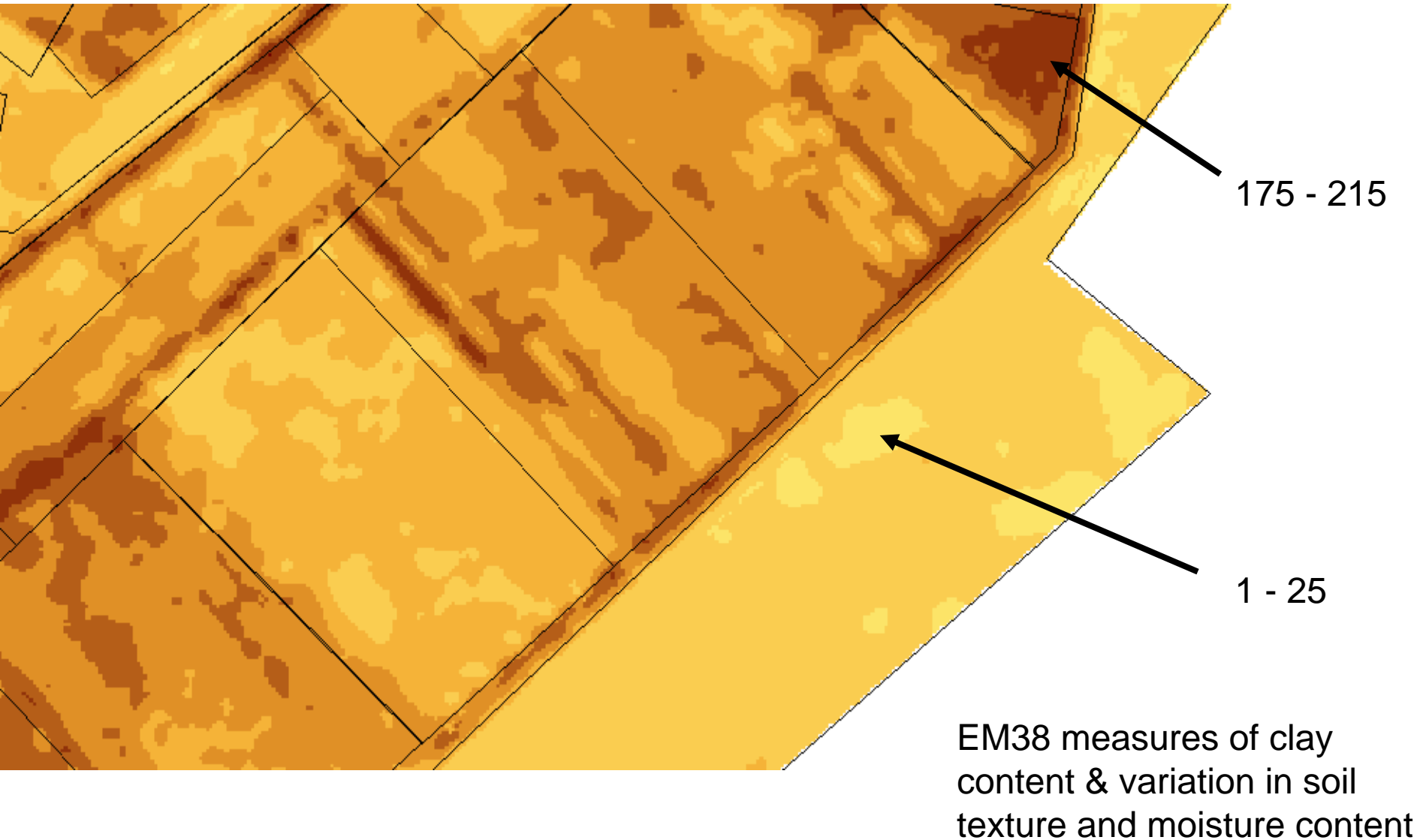
- Expression of QTLs under local Indian and Chinese conditions
- The additive nature of the targeted QTLs
- The focus on winter wheat in China will slow progress as offseason nurseries are not effective
- Rain shelter capacity/access
- Combining pedigree/phenotypic/genotypic data to enhance breeding efficiency
- The relevance of the managed stress environments to the wider target area

# Accurate phenotyping: what managed stress to apply? .



The relationship among genotypes, environmental variables and environments

# Accurate field based phenotyping: importance of controlling spatial variation (PBI Narrabri, Australia)



# Outputs and Impact

- Genetic diversity for stress response validated and found useful under Chinese and Indian conditions
- Phenotyping protocols and managed stress selection environments established and used to differentiate materials
- A MARS strategy is adopted by local breeders and used to improve the stress response of wheat in China & India
- Pedigree, phenotypic and genotypic data stored and managed using ICIS & associated tools
- New cultivars with enhanced stress response suitable for local markets developed and deployed