

# Research, policy Approaches and implications for market/trade; Pakistan scenario



Dr. Shahid Mansoor, *Sitara-e-Imtiaz*

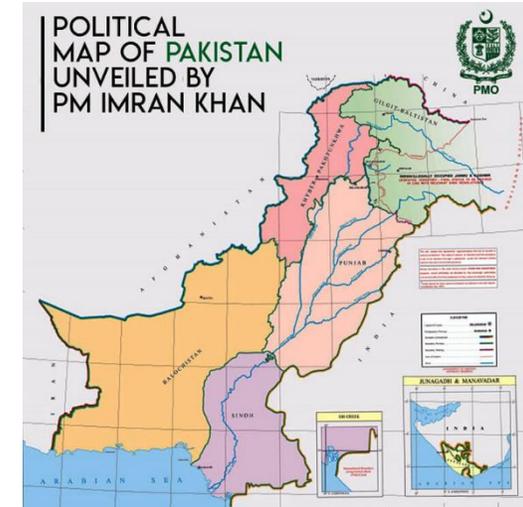
HEC Distinguished National Professor  
Fellow Pakistan Academy of Sciences

**DIRECTOR / PRINCIPAL**

National Institute for Biotechnology and Genetic Engineering (NIBGE),  
Faisalabad, Pakistan

# Pakistan; food security index

225,603 million  
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## Pakistan's Food and Nutrition Crisis at a Glance

Food-insecure population



37%

Stunting (Under 5Y)



40.2%

Wasting (Under 5Y)



17.7%

Underweight (Under 5Y)



28.9%

Moderate Anemia in children (Under 5Y)



48%

Moderate Anemia (women of reproductive age)



41.7%

E. Coll contamination of drinking water



36%



# New breeding technologies

New breeding technologies (NBTs) include

Genome editing/engineering technologies

- a) zinc finger nucleases
- b) transcriptional activator-like nucleases
- c) clustered regularly interspaced short palindromic repeats (CRISPR)/CRISPR-associated Cas9 systems
- d) Modified CRISPR/Cas9 for nucleotide change without DNA cutting

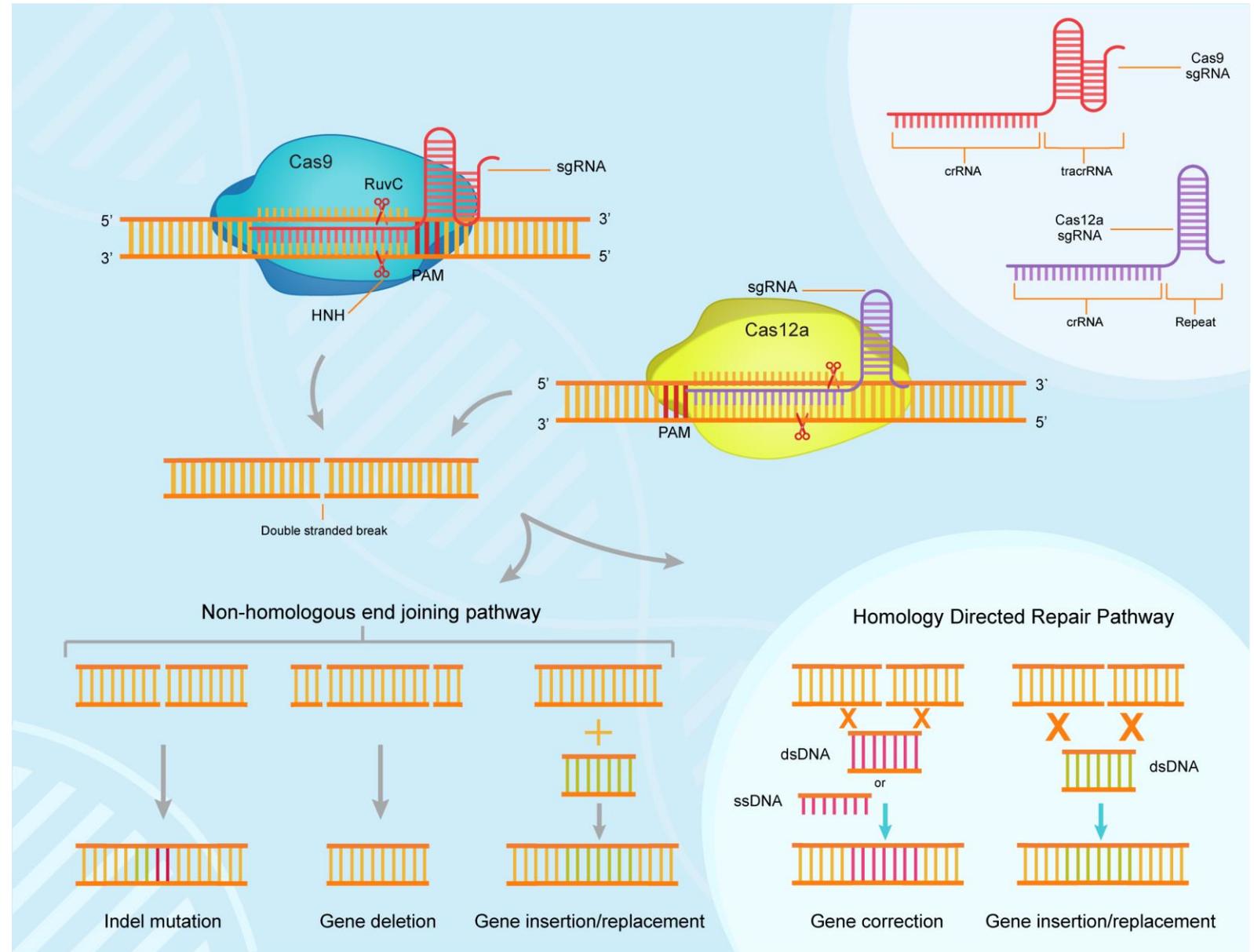


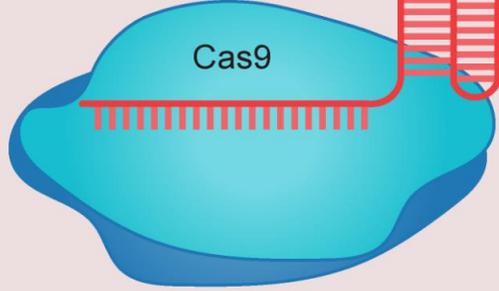
## Applications in food crops

- Rice; yield, better grain, nutritional value, herbicide tolerance
- Potato; virus resistance, sweetening control, stress tolerance
- Wheat; yield, disease resistance, nutritional value
- Cotton; disease resistance, better quality, nutritional value
- Oilseed crops; higher yield, better quality, nutritional value

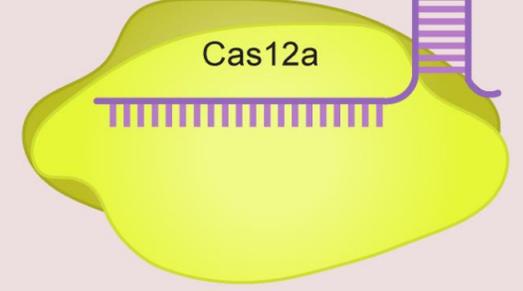
# Mechanism of CRISPR-Cas System

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dsDNA targeting



dsDNA targeting

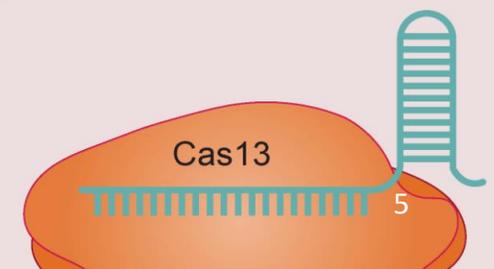
- Low yield ■
- Low quality ■
- Disease susceptibility ■
- Herbicide susceptibility ■
- Intolerance against abiotic factors ■

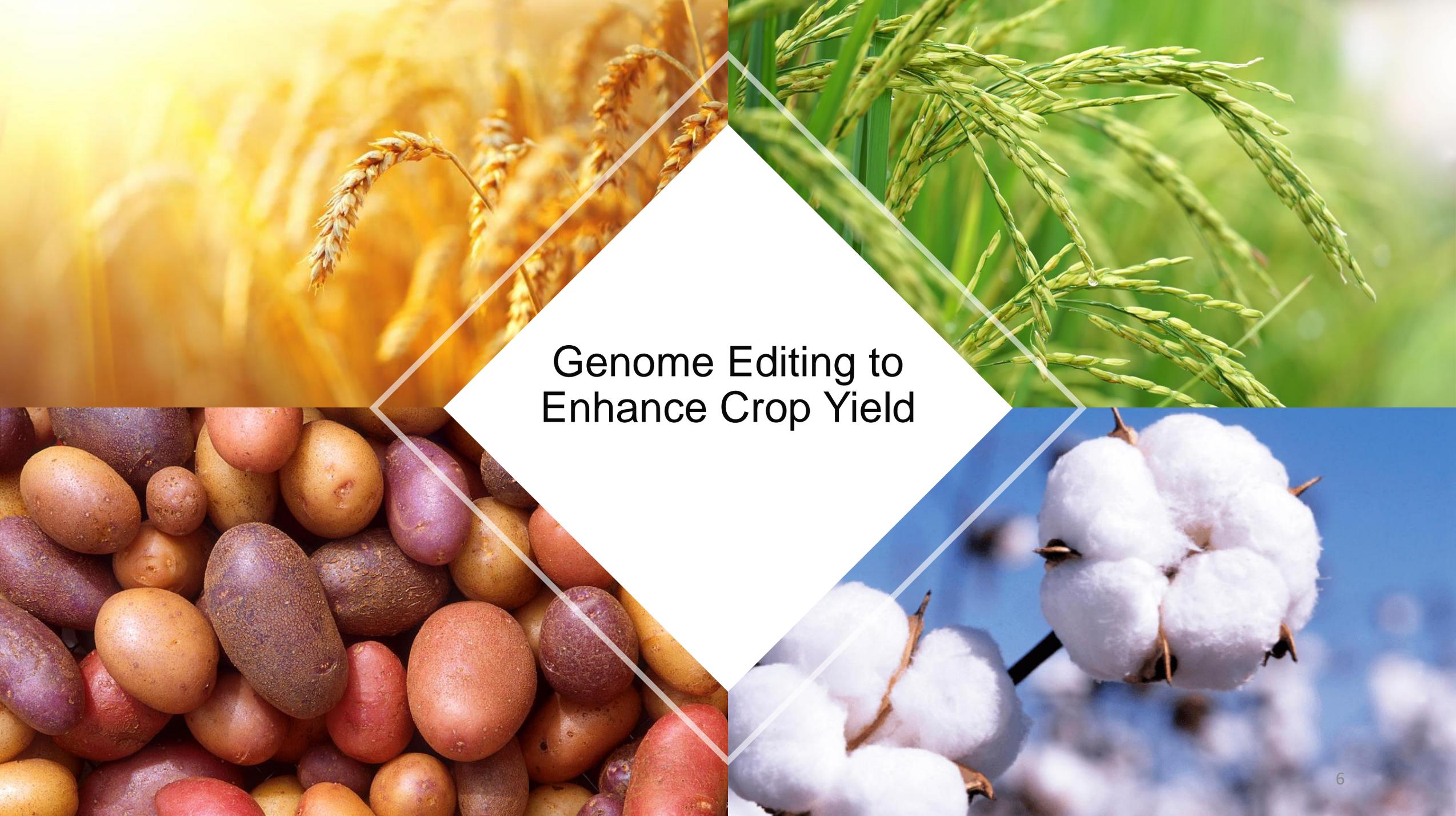


CRISPR-Cas mediated improvements



- Yield enhancement ■
- Quality improvement ■
- Disease resistance ■
- Herbicide resistance ■
- Tolerance against abiotic factors ■





Genome Editing to  
Enhance Crop Yield

# Potential Genes Targets in cotton

## Abiotic Stress

### Drought

RGLG2  
OMTN2  
OMTN3  
*OsiSAP7*  
GhWRKY17  
GhWRKY15

### Salinity

*PagGla*  
*PagGlb*  
GmWRKY13  
ZmWRKY17  
*CmWRKY17*

### Temperature

PIF3  
*AtVDAC1*

### Heavy Metals

*OsMATE1*  
*OsMATE2*  
miRNA399

### Radiation

*OsGIRP1*

## Biotic Stress

Cry1Ac

Cry2Ab

Hvt

Vip3A

CP4-ESPS

## Yield

*GmCIF1*

*GmC/VIF2*

*BIG SEEDS1 (BS1)*

*TaGW2 A,B,D*

*TaTEF-7A*

*TaGS5-3A*

*WR1*

*CPC1*

*KTN1*

*GhHB12*

*GhMYB24*

# CRISPR/Cas9 based Genome Editing in Rice for Yield Improvement

Rice yield determining traits

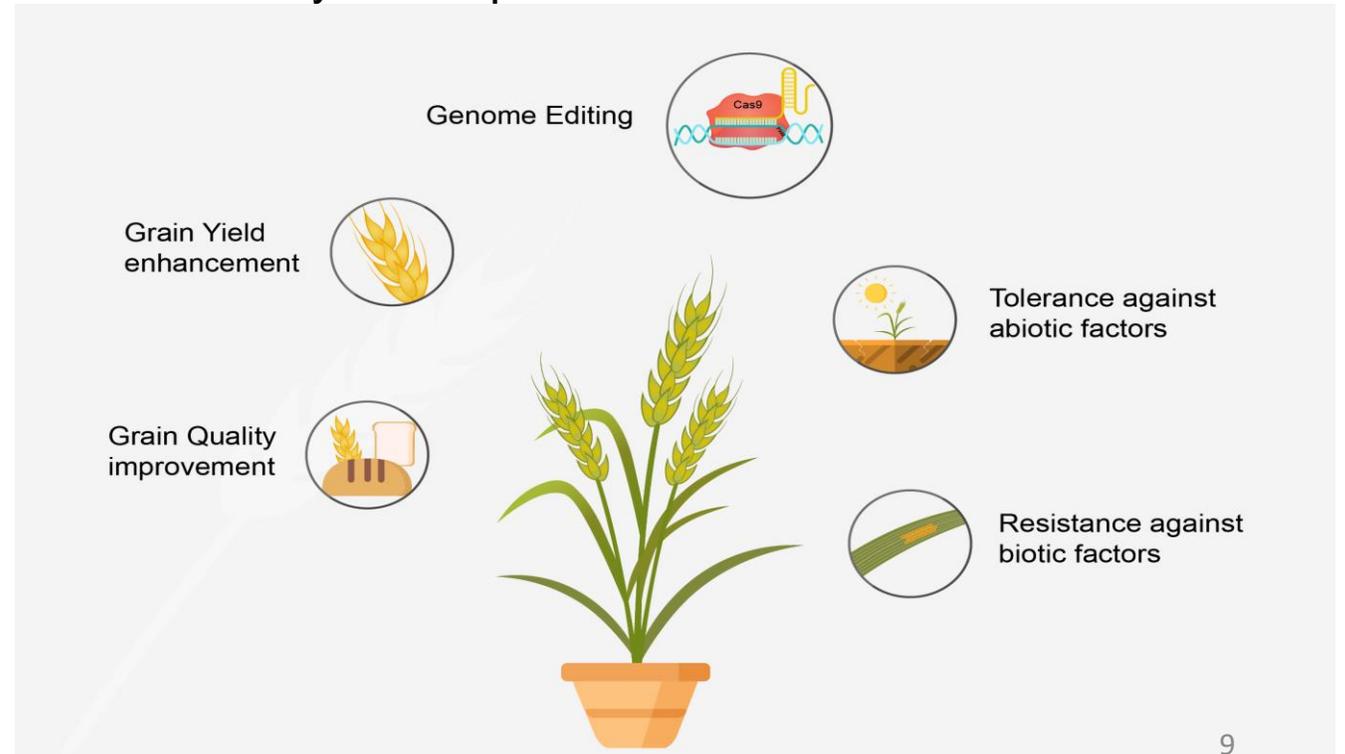
1. Number of panicles
2. Number of grains per panicle
3. Grain weight

Gene	Function
<i>OsD27</i>	Negatively regulates no. of tillers
<i>OsGN1a</i>	Negatively regulates no. of grains
<i>OsTGW6</i>	Negatively regulates grain size
<i>OsGW2</i>	Negatively regulates grain size



# Integrative Approach Involving Breeding and CRISPR Mediated Genome Editing to Improve Wheat Yield

- Combining two trade-off traits such as grain number and grain size/weight in the hybrid progeny
- Target-specific genome editing through CRISPR/Cas to knockout negatively regulating genes of wheat yield e.g., **TaGW2**, **TaCKX2.1**, **TaCKX2.2**, and **TaD27** genes
- CRISPR/Cas-mediated multiplexing to target such genes simultaneously can improve commercial wheat varieties



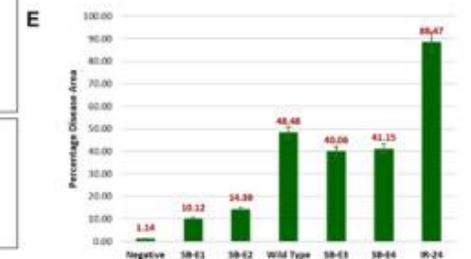
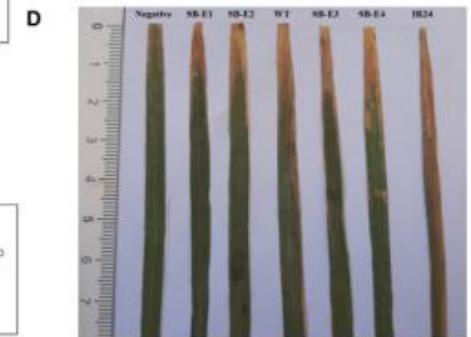
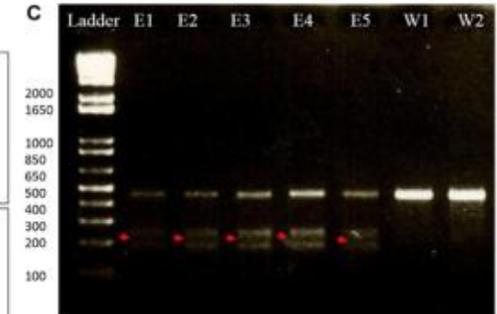
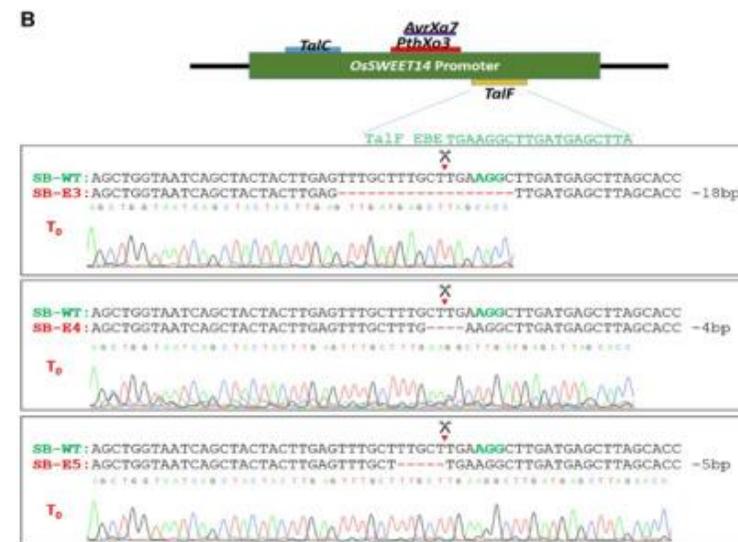
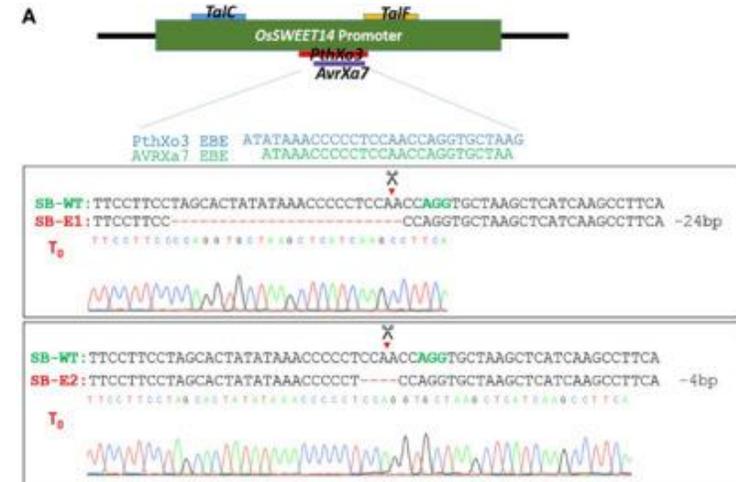
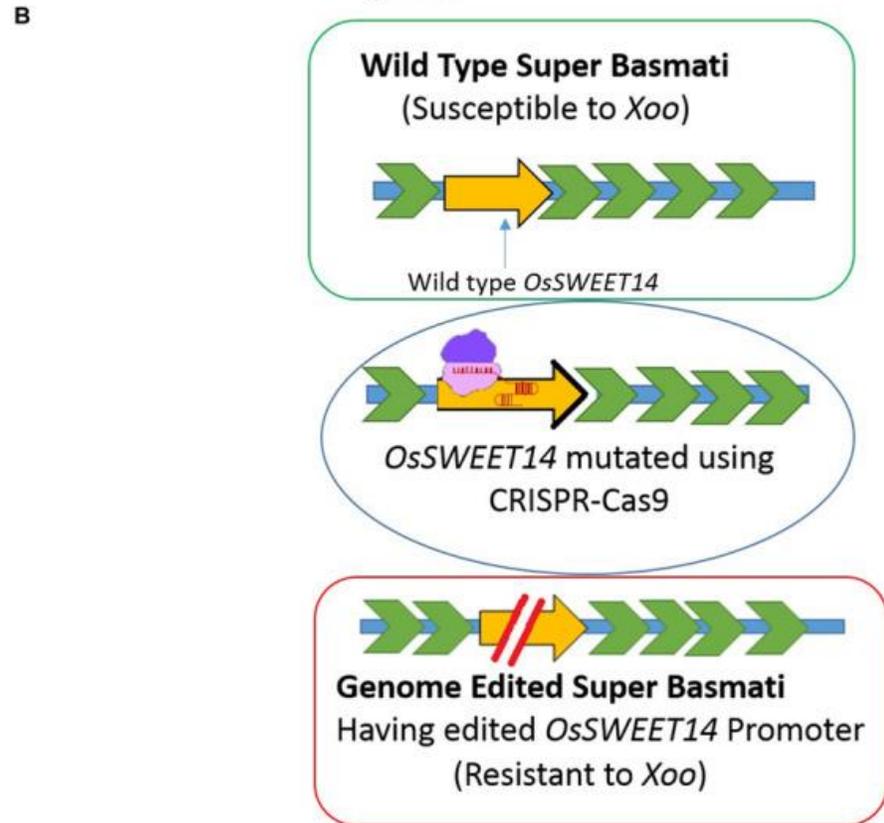


# Genome Editing to Counter Diseases



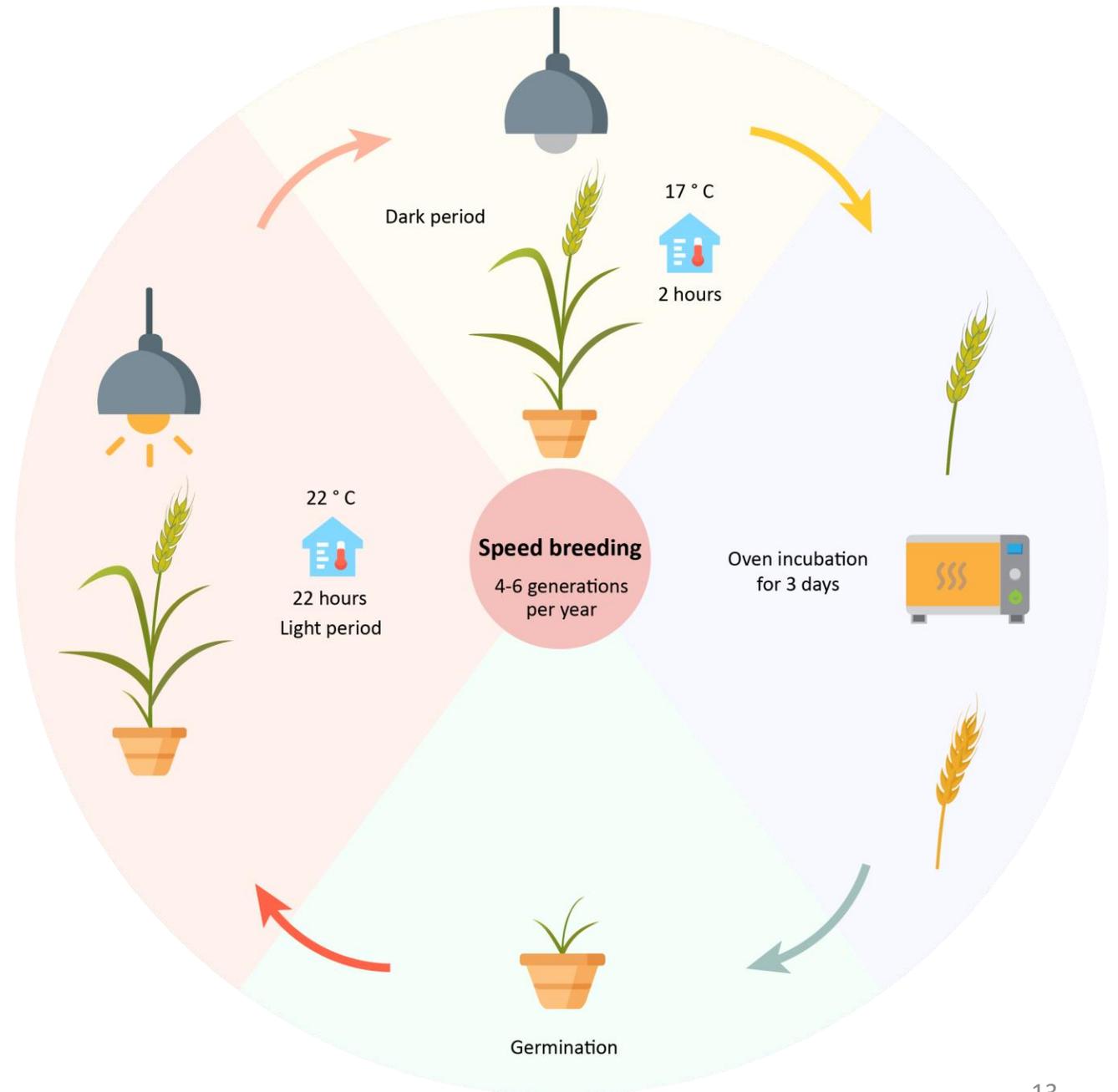


# Genome Editing in Super Basmati Rice for Resistance Against Bacterial Blight



Speed breeding approach can facilitate the process of generation advancement

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# Regulatory scenario for genome edited crops

- A positive and enthusiastic response among research community and funding agencies
- Several groups have started work on different crops
- A brain-storming session held at NIBGE with Technical Advisory Committee of NBC
- A case-to-case basis approach for approval was agreed by NBC
- Emphasis is on tissue culture independent approach

## Take home message

- Climate change, population increase, and environmental degradation pose major threats
- New breeding technologies offer fast track genetic gain
- Use of speed breeding can reduce the time required for breeding new varieties
- A positive and enthusiastic approach exists in Pakistan