Challenges before Indian agriculture

To meet the demand of growing population

Increase the production

Increased production should be environmentally and economically sustainable
Limited scope for further expansion in area

Increased production has to largely come by increased agriculture productivity and associated factor productivity (energy, nutrients, water, labour, land and capital)

Agriculture intensification on tillage based production system led to degradation of natural resources (land and water) and is not sustainable

Sustainable production intensification
- Productive
- Remunerative
- Minimize the impact of climate change
- Mitigate factors causing climate change
- Enhance Biodiversity

Conservation agriculture addresses all these issues
Conservation agriculture system

No or minimum mechanical soil disturbance

Organic mulch soil cover

Crop species diversification

Other smart or good modification
World wide area under CA

In 1973-74 CA covered 2.8 m ha

1999 Area increased to 45 mha

2003, it further increased to 72 m ha

Current area 157 m ha so increased @ 8.3 m ha per year

Maximum area in USA, Brazil, Argentina

In India 1.5 m ha (2013) but recently lot of farmers are now adopting it under rice-wheat cropping system
Reasons for comparatively lesser adoption of CA in India

- Mind set
- Lack of awareness
- Lack of Proper machinery
- Poor investment capacity of Indian farmers
- Lack of proper herbicide
- Lack of CA adapted varieties and hybrids
CA provides opportunity for further yield consolidation through breeding

Genetic gain study shows positive correlation between crop duration and yield

Increased duration exposed the wheat crop to terminal heat stress in North western plain zone. Strong indication of yield fluctuation in yield in Haryana (Slide 2).

Increased duration and seeding early will stabilizing yield at higher level and removes uncertainty
Increased duration has been an important gain for yield gain.

Trend for days to maturity in last three decades

Days to maturity

Year of varietal release

\[ y = 0.225x - 313.5 \]

\[ R^2 = 0.884 \ (p=0.05) \]
Increased duration with delayed heading

Trends for days to heading in last three decades

Days to heading

Year of varietal release

- PBW 343
- HD 2967
- HDCSW 18

- $y = -0.025x^2 + 103.6x - 10400$
  $R^2 = 0.931 \ p=0.000005$

- $y = 0.423x - 752.0$
  $R^2 = 0.767 \ p=0.00018$
y = 0.0015x + 7.3106
R² = 0.00024

y = 0.0002x - 0.911x² + 1796.2x - 1E+06
R² = 0.50717

Biomass (t/ha)
Relation between sink strength and grain yield
Targeted traits to break the yield ceiling

- Increase the duration
- Delay the heading
- Prolong the stem elongation phase
- Improve the sink strength
- Increase the biomass
However, all these traits have conflict under conventional tillage.

Increased duration expose the crops to terminal heat stress.

Delayed heading reduces the grain filling duration.

Increased biomass and sink strength leads to lodging.

Evaluation under conventional tillage normal sown condition leads to poor yield realization in these genotypes.
Productivity of wheat in Haryana in seven years

Yield (Kg/ha)

Year


4614 4215 4624 5183 4452 4722 4000
Approach I: exploit variation in stem elongation phase

Time to flowering +ive degree days
Stem elongation +ive spike weight
Spike weight +ive florets fertility
Approach II: Increase duration  
Basic Objective:  
Yield maximization without environmental degradation  

Flowering in wheat: Vernalistion gene  
Ppd gene  
Flowering per se gene  

Three fundamental vernalisation response gene have been discovered till now  

Vrn-1  
Vrn -2  
Vrn-3  

Vrn -1 comprises  
Vrn-A1, Vrn- B1, and Vrn-D1 genes on the long arms of chromosome5  
These are upregulated by vernalization treatment, and their over expression can accelerate flowering and maturity of wheat (Yan et al., 2003).
Vrn- A1 allele

The Vrn-A1a allele: An insertion of a fold back repetitive element, as well as a duplicated region in the promoter, causing a strong effect on vernalization response and resulting in the complete elimination of the vernalization requirement.

Vrn B1 allele and Vrn D1 allele resulted from either insertion or deletion in the intron region. Vrn D1b have strong effect on flowering and results in facultative growth habit.
Early seeding under CA helps in differentiating the potential yield of the genotypes.
Conclusion

• Increase duration by exploiting mild vernalisation gene

• Increase duration should come by delayed heading

• Increased duration should be compatible with early seeding

• Increase biomass and fruiting sites

• Exploit genotype x management interaction for better anchorage
Reasons for HD CSW 18 not being out yielding under early seeding and CA

HD CSW 18:

Prolonged tillering and delayed heading (vernalisation reqt) 102 days
High biomass
Increased floret fertility
Very good sink strength

Some of the other entries with very strong vernalisation requirement were heading even later than HD CSW 18

CSW 57
110 days, 26-28 spikelets and yield 61.43 q/ha

Entry No 77 (CL 1705/HD2687):
103 days Very high tillering, 26-28 spikelets and yield 51.59
Entry with very high tillering and vernalization requirement
HDCSW 18 under zero till in Punjab
HD 3117 under late sown in New Delhi
HD 3117
Pritam Singh in Panipat
CA adapted experimental hybrid
HD CSW 18 at maturity