Our government wants a food safety net in which no citizen of ours would go hungry.

This requires enhanced agricultural production which is possible only by increasing productivity.

Our country has not witnessed any big technological breakthrough in agriculture after the Green Revolution.

We need technology which would address the needs of dry land agriculture. In addition, our agriculture should also be able to deal with new challenges like climate change, falling levels of ground water and deteriorating quality of soil.”
Role of BISA

Research Activities

✓ To Develop Highly – Productive & climate resilient maize/wheat varieties
✓ Develop new agronomic practices for sustainable intensification of Irrigated/ rainfed agriculture
✓ Promote smart mechanization for precision agriculture
✓ R4D to develop CSV for large multiplier on rural livelihoods

Capacity Building

✓ Cutting-edge biotech., bioinformatics tools & methods
✓ Rapid adaptation & dissemination of new varieties, technologies & approaches
✓ Train research community on farmer-participatory R&D & NGOs with champion farmers
BISA Research Centers

Ladhowal, Punjab
Area: 200 ha
RF: ~800 mm
Production: ~4.8 t/ha
Climate: Composite

Samastipur, Bihar
Area: 60 ha
RF: ~1200 mm
Production: ~2.5 t/ha
Climate: Humid sub-tropical

Jabalpur, MP
Area: 222 ha
RF: ~1500 mm
Production: ~2.5 t/ha
Climate: Sub-humid
Major Production Constraints in Vertisols

• Limited ground water
• Highly erosive black soils and difficult to work when Dry/or wet “Narrow window”
• Poor quality farm machinery prototype
• Low factor productivity due wide and deep cracks
Major Production Constraints in Vertisols

• Weeds and pests pressure
• BBF technology not picking up, large area remains ‘fallow’ (~4.5 mha in both Rabi and Kharif)
• Quality seeds & other Agri-inputs are limited & if yes, not available on time
• Narrow knowledge base and training facilities
### Shifts: Traditional to Conservation agriculture

<table>
<thead>
<tr>
<th>Traditional Practices</th>
<th>Conservation Agriculture</th>
</tr>
</thead>
<tbody>
<tr>
<td>1   Soils Tilled excessively, Top soil erodes</td>
<td>Minimal Tillage, erosion control</td>
</tr>
<tr>
<td>2   Residue removed/burnt</td>
<td>Residue retained</td>
</tr>
<tr>
<td>3   Uneven fields</td>
<td>Leveled fields/ humps removed</td>
</tr>
<tr>
<td>4   Compaction by machinery</td>
<td>Controlled Traffic</td>
</tr>
<tr>
<td>5   Green Manuring (Incorporated)</td>
<td>Brown Manuring (Retained)</td>
</tr>
<tr>
<td>6   Ex-situ Compost production</td>
<td>In-situ composting</td>
</tr>
<tr>
<td>7   Crop based soil management</td>
<td>System Based soil management</td>
</tr>
<tr>
<td>8   Single or sole crops</td>
<td>Diversified systems</td>
</tr>
<tr>
<td>9   Environmental pollution</td>
<td>Minimal pollution</td>
</tr>
<tr>
<td>10  Less water productivity</td>
<td>Water Saving/Increase productivity</td>
</tr>
</tbody>
</table>
Development of high yielding varieties

• Testing large number of candidate varieties
• Increased yield potential
• New research
  • Dual purpose wheat (additional income to farmers)
  • High tillering varieties to reduce seed rate
  • Genomic Selection (predict performance using DNA sequences) and HTP
• Heat tolerant varieties
• Disease resistant varieties (UG99)
Large scale testing of advanced lines

Evaluation & Phenotyping of wheat lines

Rabi 2017-18; >10 t/ha
Rabi 2018-19; > 9 t/ha

Grain yield of 600 lines in different env (2018-19)

- Pusa (7.08 t/ha)
- LDH_Timely (6.86 t/ha)
- LDH_Early (7.24 t/ha)
- Jabalpur (7.08 t/ha)
Enhanced Yield Potential

>1000 lines in 3 environments (CZ, NWPZ, NEPZ)
Achieved up to 10 t/ha yield (JBL), 9 t/ha at LDH

For the first time in South Asia, 10 t/ha grain yield achieved (location: BISA, India)
Yield during last 5 years, increasing trend

<table>
<thead>
<tr>
<th>Year</th>
<th>Pusa</th>
<th>Jabalpur</th>
<th>Ludhiana</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>4.4</td>
<td>6.4</td>
<td>5.39</td>
</tr>
<tr>
<td>2016</td>
<td>4.61</td>
<td>6.1</td>
<td>6.24</td>
</tr>
<tr>
<td>2017</td>
<td>7.08</td>
<td>6.58</td>
<td>7.04</td>
</tr>
<tr>
<td>2018</td>
<td>7.05</td>
<td>7.6</td>
<td>6.8</td>
</tr>
<tr>
<td>2019</td>
<td>7.08</td>
<td>8.3</td>
<td>6.9</td>
</tr>
</tbody>
</table>

Yield (t/ha)
Genomic selection (GS) in wheat

- Being used in CIMMYT wheat program
- Developing selection models for each zone at BISA stations
- BISA is lead center in GS in India in wheat
High Throughput Phenotyping

Manual
- Time taking
- Limited to smaller pop.
- Human error
- Higher CV
- Cost effective?
- No special equipment
- Good for HTP non-compatible traits

Phenocart
- Faster
- Larger pop.
- Human error
- Higher CV
- Cost effective
- Simple to design
- Medium type of equipment
- Computation needed

UAV
- Faster
- Much larger pop.
- Human error
- Higher CV
- Cost effective
- Special equipment
- Computation tools needed
High throughput phenotyping in field

DEM for lodging and yield loss estimation using UAV

Digital FieldBook and barcodes in breeding

Daljit Singh, KSU

Application: Crop insurance
## Dual purpose wheat (Additional income)

- **Ludhiana**
  - Fodder: 7.18 t/ha
  - Yield (Cut): 4.77 t/ha
  - Yield (Un-Cut): 5.18 t/ha

- **Jabalpur**
  - Yield (Cut): 6.03 t/ha
  - Yield (Un-Cut): 6.64 t/ha

Harvest between 50-55 days
Reduced seed rate to reduce input cost

100 kg/ha seed rate need to revise
25 & 75kg/ha gave surprising results

Due to:
New varieties
Improved agronomy
More precision etc
Believing by seeing

Picture based insurance and advisory to farmers
Welcome to visit BISA farms & breeding trails, select material and use in your program
Seed is freely available for research and evaluation
Germlasm exchange & collaboration

- All CIMMYT/BISA material is freely available
- Hundreds of international trials provided to research centers in India
- Best selected material is provided to agricultural universities
  - JNKVV, RVSKVV
  - Common trials with state universities
  - Students visit and exposure with new tools and technologies
  - Training and capacity building
Capacity building (Ph.D.) – Long term training

Registered in RVSKVV Gwalior

4 Students from Afghanistan at Ludhiana Supported by USAID

Completed
Laser leveling?

Laser land leveling is leveling the field within certain degree of desired slope using guided laser beam throughout the field.
Why laser leveling

- Land looks leveled but even than wide topographic variation exist
- Wide variability in crop yields at various levels
  - Field, village, block, district or region
- Better distribution of water
- Water savings
- Improved nutrient use efficiency (Urea)
- Option for precision farming
- Higher crop productivity
Farmers Response

- Increase in water application efficiency
- Saving in irrigation water (20-30%)
- Better crop stand
- Improved weed control efficiency
- Less area under bunds or ridges
- Very good for Bed/Ridge farming
- Reduced labor requirement for irrigation
- Automatic irrigation system (Less load on operator)
Farmers Response (Training)
Three Principles

- No/Minimum Tillage
- Soil Cover with residue
- Crop rotation

Three Benefits

- Enhanced Productivity
- Richer Resources
- Climate Adaptation

< < < < Choosing Directions > > > > sustainability cannot be the option

It needs to be biophysically and socio-economically sustainable.

Sustainability also demands confronting climate change.
Conservation Agri. & Mechanization

Supporting/Enabling elements – Declining Farmers income, Labour Shortages, Degradation of Natural Resources (Soil, Water & Environment), Climate Change & Sustainability of Agriculture

Challenges – Land Holding, Economic Condition, seasonal use, size & shape of Fields, terrain, machine v/s Labour and mind set (CA Course)
Conservation Agri. & Mechanization

Nursery of Transplanting Rice
Conservation Agri. & Mechanization

Key Drivers:
For farmer: labour, cost
For Govt: water
For researchers: sustainability
Rice trans-planter video
Conservation Agri. & Mechanization

Maize Planter with inclined plate seed metering system
Possible Residue Management Solutions

- Collection
- Residue incorporation (most difficult)
- Burning
  - Complete burning (mostly practiced)
  - Partial burning
- Residue Mulch
Harvester video
## Mulch effect on moisture conservation

<table>
<thead>
<tr>
<th>Depth of layers (cm)</th>
<th>Moisture content (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>without mulch</td>
</tr>
<tr>
<td>7.5</td>
<td>7.0</td>
</tr>
<tr>
<td>15</td>
<td>9.0</td>
</tr>
<tr>
<td>30</td>
<td>11.0</td>
</tr>
<tr>
<td>60</td>
<td>13.0</td>
</tr>
<tr>
<td>90</td>
<td>15.0</td>
</tr>
<tr>
<td>120</td>
<td>17.0</td>
</tr>
</tbody>
</table>

*Graph showing the effect of mulch on moisture conservation.*
Weed matter growth in mulched and un-mulched plots

Weed matter after 45 days of sowing

Weed matter after 90 days of sowing
Quantity of Nutrient available in Rice Straw in one hectare

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Quantity kg/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>39</td>
</tr>
<tr>
<td>P</td>
<td>6</td>
</tr>
<tr>
<td>K</td>
<td>140</td>
</tr>
<tr>
<td>S</td>
<td>11</td>
</tr>
</tbody>
</table>
A Technology having ‘Multiple Wins’

Residue management using turbo happy seeder

- Improved soil health
- More crop per drop
- Lower costs and higher profits
- Reduced water risks
- Less weeds
- Lower GHGs emission

Improve

More

Less

Lower

Lower
Automated irrigation system

PC screen to save and feed data to send wireless signal to the controller

Wireless com b/w control & RTU

RTU solar powered send wired command to solenoid valve
Training facility

INNOVATION & TRAINING CENTER
BISA JABALPUR

Training to champion farmers, service provider & Extension agents
Title here

Women farmer video