Sustainable wheat intensification in the eastern Indo-Gangetic Plains

CSISA’s approach to scaling zero-tillage wheat in Bihar

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Overall Goal

To increase food-, nutrition-, and income security in South Asia through sustainable intensification of cereal-based systems
Converging challenges in South Asia

Climate Change
heat, drought, extreme events

Water
- groundwater
- surface water

Nutrients/Soils
- fertilizer cost
- depleted soils

Energy
- diesel cost
- biofuels

Insects/Diseases
- Yellow/Stem rusts
- Aphids and Stem borers

Demand
population growth
changing diets


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Integrated Research for Development

- Development of **sustainable intensification technologies + support services** to make technologies accessible
- Future-oriented **cropping systems research**
- Strengthen **markets and enterprise development**
- Relevant **policy analysis**
- Strategic **partnerships** (public + private sectors) to increase the scale and longevity of interventions
- Capacity development through **technical and business development training** (ToT approach)
Zero-tillage (ZT): background

- Bihar is a net-importer of wheat (Paulsen et al. 2012) and has the lowest wheat yields in the IGP, at 2.34 MT ha\(^{-1}\) over the period 2012/13 - 2013/14 (MoA 2015)

- Zero tillage (ZT) with residue retention in wheat has demonstrated considerable yield and economic benefits, while enhancing water use efficiency and facilitating early sowing (Mehla et al. 2000; Erenstein and Laxmi 2008; Chauhan et al. 2012; Gathala et al. 2013; Krishna and Veettil 2014; Keil et al. 2015)
ZT wheat performance in farmers’ fields

- Data from random sample of 1,000 wheat farmers in Bihar
- Yield gain of 498 kg/ha (19%) vs. conventional-tillage wheat
- Economic benefits from yield increase and cost savings are equivalent to 6% increase in annual household income
- Positive effect is robust across different agro-ecologies
- If broadly adopted, ZT wheat could play a major role in making Bihar self-sufficient in wheat

Source: Keil et al. 2015
ZT wheat adoption

- Two out of three sampled farmers who are aware of ZT use it.
- Among non-users, only 32% are aware of ZT → lacking awareness is likely a major cause for non-adoption.
- Farmers who tested ZT in wheat, expanded its use; in 2012/13, 77% of ZT users grew exclusively ZT wheat.
- Farmers value the time-saving potential of ZT, esp. under conditions of increasing variability of monsoon rains.
- Regression analysis shows a substantial scale bias in farmers’ awareness and adoption of ZT.
- Only 8.3% of sample households own a 4-wheel tractor → access to ZT technology depends on custom hire services.

**ZT custom hire services in Bihar/EUP**

Number of SPs in
2012/13: 733
2013/14: 1,271
2014/15: 1,624

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ZT service providers

- Data from 270 ZT service providers (SPs) documented by CSISA in 2013 in Bihar (census)
- All SPs are farmers who use ZT on their own farms
- Large and well-educated farmers with extensive social networks are most likely to engage in ZT service provision
- SPs service 20 farmers and 124 acres, on the average (median 15 farmers and 50 acres)
- The ‘small among the large’ farmers provide ZT services at the largest scale
- Small-scale SPs are likely guided by non-business motives
Conclusions & recommendations

- Intensify and outscale *awareness raising activities* for ZT; ensure that also the poorer farmers are reached
- **Increase the number of ZT SPs**, especially in districts poorly covered thus far
- **Target the smaller tractor owners** with purchase subsidies for ZT seed drills and business development training
- Investigate *technology adoption and business development dynamics* over time (currently on-going)
- Develop and test business models that **reduce transaction costs of servicing small farms**
References

## Characteristics of ZT service provision businesses

### Table 1. Major characteristics of zero-tillage (ZT) service provision businesses (2012/13)

<table>
<thead>
<tr>
<th>Stat. significance</th>
<th>1. ZT area serviced (acres)</th>
<th>2. No. of clients serviced</th>
<th>3. Days with ZT service provision</th>
<th>4. ZT area per client (acres)</th>
<th>5. ZT fee per acre (INR)</th>
<th>6. ZT gross margin per acre (INR)</th>
<th>7. ZT net profit per acre (INR)</th>
<th>8. ZT net profit (000 INR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;= 25 acres (N = 64)</td>
<td>15.7&lt;sup&gt;a&lt;/sup&gt;</td>
<td>10.1&lt;sup&gt;a&lt;/sup&gt;</td>
<td>14.9&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.6&lt;sup&gt;a&lt;/sup&gt;</td>
<td>459&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>192&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-293&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-2.8&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>&gt; 25 – 50 acres (N = 91)</td>
<td>39.4&lt;sup&gt;b&lt;/sup&gt;</td>
<td>17.1&lt;sup&gt;b&lt;/sup&gt;</td>
<td>22.6&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.9&lt;sup&gt;a&lt;/sup&gt;</td>
<td>423&lt;sup&gt;a&lt;/sup&gt;</td>
<td>204&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.3&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>&gt; 50 – 100 acres (N = 49)</td>
<td>78.0&lt;sup&gt;c&lt;/sup&gt;</td>
<td>22.5&lt;sup&gt;b&lt;/sup&gt;</td>
<td>29.2&lt;sup&gt;b&lt;/sup&gt;</td>
<td>5.7&lt;sup&gt;b&lt;/sup&gt;</td>
<td>446&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>203&lt;sup&gt;a&lt;/sup&gt;</td>
<td>50&lt;sup&gt;b&lt;/sup&gt;</td>
<td>4.4&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>&gt; 100 acres (N = 60)</td>
<td>405.4&lt;sup&gt;d&lt;/sup&gt;</td>
<td>32.3&lt;sup&gt;b&lt;/sup&gt;</td>
<td>30.3&lt;sup&gt;b&lt;/sup&gt;</td>
<td>28.5&lt;sup&gt;c&lt;/sup&gt;</td>
<td>480&lt;sup&gt;b&lt;/sup&gt;</td>
<td>282&lt;sup&gt;b&lt;/sup&gt;</td>
<td>191&lt;sup&gt;c&lt;/sup&gt;</td>
<td>85.4&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Overall (N = 264)</td>
<td>124.0</td>
<td>19.9</td>
<td>23.7</td>
<td>9.2</td>
<td>449</td>
<td>219</td>
<td>-17</td>
<td>19.7</td>
</tr>
</tbody>
</table>

*(**)[***][****] Difference between quartiles significant at the 10%(5%)[1%][0.1%] level of alpha error probability, based on multiple Mann-Whitney tests accounting for family-wise error; diverging superscript letters indicate statistical significance at least at the indicated level. ¹ Indian Rupees. 1 USD = 66.5 INR (Sept. 2013).