Adoption of zero-tillage wheat in the Eastern Indo-Gangetic Plains

Prospects for productivity growth and inclusive technology access

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Zero-tillage wheat: 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 cost savings and yield benefits, while improving soil quality (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 facilitates earlier wheat sowing, reducing risk of terminal heat stress
Surveys of farm households (N = 1,000) and ZT service providers (N = 245) conducted in Bihar in 2013.

Superior performance of ZT wheat vs. conventional-tillage wheat is confirmed in farmers’ fields: yield gain 498 kg/ha; economic gain 7,300 INR/ha (Keil et al. 2015).

Only 8.3% of sample households own a tractor → access to ZT technology depends on service providers (SPs).

Large and well-educated farmers with extensive social networks are most likely to engage in ZT service provision; but, among those, the smaller farmers are most likely to provide services at a large scale (Keil et al., 2016).

Larger-scale SPs are more likely to stay in business under less favorable subsidy conditions (economies of scale).
ZT service provision dynamics

No. ZT SPs in Bihar/EUP in
2012: 733
2013: 1,271
2014: 1,624
2015: 2,168
2016: 2,909
ZT service provision dynamics

- 229 out of 245 SPs surveyed in 2013 were revisited in 2016 (attrition 6.5%).
- 85% of SPs active in 2012 still provided ZT services in 2015.
- SPs who dropped out had significantly fewer clients than those who continued.

Table 1. Development of number of customers per zero-tillage service provider from 2013 to 2015, differentiated by survey district (values are means, values in parentheses are medians)

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<tr>
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<tbody>
<tr>
<td>Vaishali (N = 6)</td>
<td>20.7 (16)</td>
<td>21.0 (16)</td>
<td>20.7 (15.5)</td>
<td>20.5 (16)</td>
<td>-2.4</td>
<td>0.0</td>
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<td>Begusarai (N = 33)</td>
<td>25.1 (20)</td>
<td>21.2 (17)</td>
<td>22.9 (20)</td>
<td>31.1 (22)</td>
<td>46.6</td>
<td>29.4</td>
</tr>
<tr>
<td>Samastipur (N = 24)</td>
<td>42.6 (35)</td>
<td>31.7 (26.5)</td>
<td>42.3 (35)</td>
<td>53.9 (47.5)</td>
<td>70.3</td>
<td>79.3</td>
</tr>
<tr>
<td>Bhojpur (N = 60)</td>
<td>31.6 (24.5)</td>
<td>29.0 (22.5)</td>
<td>32.4 (22)</td>
<td>33.5 (25)</td>
<td>15.5</td>
<td>11.1</td>
</tr>
<tr>
<td>Buxar (N = 26)</td>
<td>22.6 (15)</td>
<td>22.3 (16.5)</td>
<td>23.0 (15)</td>
<td>22.4 (15)</td>
<td>0.5</td>
<td>-9.1</td>
</tr>
<tr>
<td>Lakhisarai (N = 45)</td>
<td>32.7 (25)</td>
<td>28.6 (22)</td>
<td>32.1 (25)</td>
<td>37.4 (30)</td>
<td>30.8</td>
<td>36.4</td>
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<tr>
<td>Overall (N = 193)</td>
<td>30.6 (22)</td>
<td>26.8 (20)</td>
<td>30.4 (24)</td>
<td>34.7 (25)</td>
<td>29.4</td>
<td>25.0</td>
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Determinants of ZT adoption
(Keil et al., 2017)

- In 2013, only 45% of sample households knew about ZT.
- Clear **scale bias in awareness and use of ZT**.
- Fellow farmers are most important info source → account for **role of social networks in the adoption process**.
- Social networks are formed among **farmers of similar socioeconomic status**.
- Network effects particularly important among the smallest-scale farmers → **target extension messages at farmers representing different social strata**.
- **Proximate ZT service provider (< 5 km)** is important prerequisite to ZT use → continue to work on increasing number of SPs, especially in districts still poorly covered.
- **Time-saving potential of ZT** valued by farmers, especially under increasingly unreliable monsoon rains → **highlight risk mitigation aspect of ZT**.
ZT use dynamics

- 961 out of 1000 HHs surveyed in 2013 were revisited in 2016 (attrition 3.9%).
- Overall, ZT use has increased by 32% over past 3 years, but dynamics vary across locations.
- 13% of ZT testers have discontinued the practice; main reason was lacking access to ZT services, followed by problems with weed infestation.
- In 2015/16 there was still a significant scale bias in awareness and use of ZT.
- Increase in ZT use has been more than proportionate among marginal farmers (< 1 ha) → scale bias is decreasing.
## Table 2. Basic farm characteristics, ZT related knowledge exposure, and use of ZT among sample households (HHs) in the 2012/13 and 2015/16 rabi seasons, differentiated by farm size terciles

<table>
<thead>
<tr>
<th>Farm size tercile</th>
<th>(1) Mean cultivable area (ha)</th>
<th>(2) Mean size of largest irrigable plot (ha)</th>
<th>(3) % HH heads with education &lt;5th grade</th>
<th>(4) % HH heads belonging to Scheduled castes</th>
<th>(5a) % HHs knowing how ZT works</th>
<th>(5b) % HHs knowing how ZT works</th>
<th>(6a) % HHs using ZT</th>
<th>(6b) % HHs using ZT</th>
<th>(7) Increase in use rate (%)</th>
</tr>
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<tr>
<td>Smallest (N = 324)</td>
<td>0.28&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.20&lt;sup&gt;a&lt;/sup&gt;</td>
<td>42.42</td>
<td>22.73</td>
<td>27.2</td>
<td>67.0</td>
<td>29.6</td>
<td>55.0</td>
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<tr>
<td>Middle (N = 313)</td>
<td>0.89&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.47&lt;sup&gt;b&lt;/sup&gt;</td>
<td>29.59</td>
<td>10.06</td>
<td>42.0</td>
<td>77.0</td>
<td>38.3</td>
<td>35.3</td>
<td></td>
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<tr>
<td>Largest (N = 318)</td>
<td>2.70&lt;sup&gt;c&lt;/sup&gt;</td>
<td>1.21&lt;sup&gt;c&lt;/sup&gt;</td>
<td>19.57</td>
<td>4.35</td>
<td>65.3</td>
<td>91.8</td>
<td>52.2</td>
<td>20.6</td>
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<tr>
<td>Stat. sig.</td>
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<tr>
<td>Whole sample (N = 955)</td>
<td>1.28</td>
<td>0.62</td>
<td>30.61</td>
<td>12.42</td>
<td>44.9</td>
<td>78.5</td>
<td>40.0</td>
<td>32.0</td>
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*<sup>**(**)[***]</sup> Statistically significant at the 5% (1%) [0.1%] level of alpha error probability.

<sup>1</sup> Based on multiple Mann-Whitney tests, accounting for family-wise error.

<sup>2</sup> Based on Chi-square test.
Implications for CSISA

- **Overall increase in use of ZT** is encouraging.
- **Scale bias still significant, but gap is narrowing;** gap may be further narrowed through extension messaging targeted at small-scale farmers (more efficient use of social networks for within-village diffusion).
- Emphasize **risk-reducing aspect of ZT** (facilitates earlier wheat sowing).
- **Increase number of ZT SPs** in districts still poorly covered.
- Ensure that **weed control** is adequately addressed in technical training of SPs and awareness raising activities for farmers.
- Add **business development training** with **improved targeting** to SPs who are poised for growth to boost and sustain ZT related service economy.
- **Mainstream ZT into NARES partners’ programming.**
**ZT diffusion scenarios**

- **Constant growth scenario:** ZT SPs 35% p.a.; Customers per SP 10% p.a.
- **Variable growth scenario:** ZT SPs 50% p.a. in years 1 – 3, 30% p.a. in years 4 – 5, then 20% p.a.; Customers per SP 5% p.a., 5% p.a., and 10% p.a., respectively.

![Graph showing ZT diffusion scenarios with x-axis from 2015 to 2030 and y-axis from 0 to 4500000. The graph includes two lines: one for constant growth scenario and one for variable growth scenario. The y-axis is labeled 'Number of adopting households.' The x-axis represents years from 2015 to 2030.](image)

*Figure 1. Projected diffusion of zero-tillage wheat within and beyond CSISA Phase III, based on different growth scenarios*

Alwin Keil, Workshop ‘Green Revolution in Eastern India’, New Delhi, 09 Oct 2017
Mainstreaming ZT scaling

- **Promote the concept of ZT & related service provision** ➔ district- and state-level consultations with DoA, SAUs and others to foster favorable policy environment.

- **Enhance availability of ZT drills** ➔ interactions with ZT drill manufacturers ➔ target: increase number of ZT SPs by 35% per year.

- **Build ZT service provision capacity** ➔ transition from direct training to training of trainers (ToT); expand training portfolio to include business development training; major strategic entry point for ToT activities are district-level *Krishi Vigyan Kendras* (KVKs).

- **Sustain the business model of ZT SPs** ➔ support emergence of network for spares and repairs; encourage business portfolio expansion into other mechanization services.

- **Enhance efficiency of policy support through better targeting** ➔ e.g. target purchase subsidies for ZT drills to those SPs who are poised for growth.
Thank you for your interest!
References


