The Cereal Systems Initiative for South Asia

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²International Development Enterprises (iDE)

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The **IMPACT** challenge: catalyzing durable change with millions of small and medium-scale farmers

CSISA’s 10-year vision of success aims to increase the incomes of 6 million farm families in South Asia by $350 pa by 2018 through widespread adoption of efficient and productive agronomic practices, marked increases in the cultivation of high-yielding and stress-tolerant cereal cultivars, better access to information, and progressive policies and strengthened markets that stimulate the same with results-oriented public and private investments.

**Real development ≠ demonstrating, piloting, or ‘reaching’**
CSISA: A ‘big tent’ initiative

Integrating disciplines and organizations

• Participatory development and dissemination of sustainable, productive, and profitable agricultural technology, support services and knowledge systems via innovation hubs (Objective 1)

• Future-oriented and process-based research (Objective 2)

• Breeding for high-yielding and stress-tolerant rice and wheat cereal varieties (Objective 3 and 4)

• Policy analysis and evidence-based ‘road maps’ (Objective 5)

• Strategic partnerships (public + private sectors) to increase the scale and longevity of interventions

• Strengthen markets and entrepreneurs, especially SMEs.

• Capacity development through training and mentorship
Agro-ecologies are distinct in cases over small distances

Drought, overuse of groundwater, acid soils
Seasonal inundation, flash flooding
Temperature / drought stress, arsenic
Limited-source surface irrigation
Flooding, cyclones, and tidal surges, salinity across the coastal belt

Entry points for sustainable intensification are diverse
CSISA’s innovations hubs span the diversity of production ecologies across the IGP. By necessity, the science and scaling of sustainable intensification is site-specific.

SI answers won’t come from single points.
Systems, social and economic capital are diverse

<table>
<thead>
<tr>
<th>Income source</th>
<th>Nanore</th>
<th>Simra</th>
<th>Sankorthu</th>
<th>Madhupur</th>
<th>Siva</th>
<th>Nazara</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agricultural crops</td>
<td>Cereals - Rice &amp; wheat</td>
<td>Rice, wheat, lentil, vegetables</td>
<td>Cereals - Rice, wheat, sugarcane crop</td>
<td>Cereals, pulses livestock, fish, poultry, horticultural crops</td>
<td>Cereals, pulses, livestock, fish, poultry, horticultural crops</td>
<td>Cereals, pulses, livestock, fish, poultry, horticultural crops</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Share of on-farm income %</th>
<th>90%</th>
<th>60%</th>
<th>25%</th>
<th>40%</th>
<th>50%</th>
<th>70%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Share of Off-farm income %</td>
<td>10%</td>
<td>40%</td>
<td>75%</td>
<td>60%</td>
<td>50%</td>
<td>30%</td>
</tr>
</tbody>
</table>

- **Cereals**: ↑
- **Pulses**: ↓
- **Livestock, fish and poultry**: ↓
- **Horticultural crops**: ↓
- **Sugar and fiber crops**: ↓

*Courtesy of Dr. KM Singh (ICAR –RCER)*
R&D Priorities: Coping with heat stress in the E. IGP

Present Day

Areas with ‘optimal’ and stress-prone conditions for wheat


Ortiz-Monasterio et al., 2008
Adapting cropping systems to a stress-prone present and an threatened future w/ integrated approaches

\[ y = 1E-05x^3 - 0.0111x^2 + 3.6482x - 388.55 \quad R^2 = 0.4457 \]

✓ Shorter duration rice (e.g. hybrids)
✓ Early rice establishment
✓ PH mechanization for rice
✓ Zero-tillage for wheat
✓ Land drainage

The thermal window for wheat in SA is shrinking
(wheat breeding ++++).
R&D Priorities: Pockets of intensive resource depletion is crop diversification the answer in the NW IGP?

- During the last decade Northern India’s groundwater levels have fallen as much as 30 cm per year.

### Alternative systems design explored with process-based field research: CA, diversification, +PA =

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Productivity(^1) (T/ha/yr)</th>
<th>Irrigation (mm/ha/yr)</th>
<th>Energy use (MJ/ha/yr)</th>
<th>Net return (US$/ha/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>13.0 c* (0)</td>
<td>2687 a (0)</td>
<td>74599 a (0)</td>
<td>1809 c (0)</td>
</tr>
<tr>
<td>2</td>
<td>15.8 a (21)</td>
<td>2073 b (-22)</td>
<td>60312 b (-19)</td>
<td>2227 b (23)</td>
</tr>
<tr>
<td>3</td>
<td>14.8 b (11)</td>
<td>1793 c (-33)</td>
<td>55114 c (-26)</td>
<td>2203 b (22)</td>
</tr>
<tr>
<td>4</td>
<td>14.5 b (11)</td>
<td>766 d (-71)</td>
<td>39981 d (-46)</td>
<td>2389 a (32)</td>
</tr>
</tbody>
</table>

\(^1\) Productivity in tons per hectare per year.

CSISA research platform @ CSSRI, Karnal, India
The big questions require ‘business as unusual’ disciplinary excellence, trans-disciplinary integration, and analysis at nested spatial scales.

Will diversification ‘work’ for arresting groundwater depletion in the NW IGP?
R&D Priorities: **Palette of options**, not only ‘packages’ or prescriptions.
R&D Priorities: the challenge of closing yield gaps in ‘extensively’ managed crops in Nepal

Symptoms of root rot in lentil after heavy rains in Bardiya (Terai); the improved varieties typically fared worse than local variety.

Lentil production in western Nepal is risky, low input, and low output.

Sustainably enhancing productivity often requires management practices that reduce risk as a pre-condition for intensification.

Disease risk can be reduced by bed planting and drainage.
OPERATIONAL MODEL FOR CATALYZING SUSTAINABLE INTENSIFICATION

1. CSISA Innovates
   - Key activities: participatory research for development ('hub approach') and method up-scaling with public and private partners
   - Key outputs: actionable products from applied research

2. CSISA Produces
   - Adapted technologies
   - Decision tools
   - Business models
   - Training modules
   - Technology targeting
   - Multi-media outreach materials

3. CSISA Supports
   - Technology targeting
   - Catalyzing contract farming
     - Linkages to NARES and innovative farmers
   - Prototypes for commercialization
   - Certified crop advisor training
   - Decision tools
   -Govt. extension (e.g., KVKs, DAE, DoA)
   - Exposure visits
   - In-situ technology demonstrations
   - Innovative farmers
   - Input dealers
   - Service providers
   - Credit providers
   - New lending opportunities with mitigation strategies
   - Training of trainers
   - Technology demonstrations
   - Food security initiatives

Key outcomes: strengthened change agents for effective out-scaling

Sustained and profitable yield intensification for cereals in S. Asia
Why an Agricultural Innovation System (AIS) perspective?

‘a network of organizations, enterprises, and individuals focused on bringing new products, new processes, and new forms of organization into economic use…..’ (World Bank, 2006)

CSISA seeks to play complementary and catalytic roles in the context of AIS by strategically intervening at different scales (projects can’t do everything). **Ultimately, generating indirect beneficiaries is the key to scale and sustainability.**

Sustained change requires not one thing, but the orchestration of many
Going to Scale: Reaching women and other marginalized groups through existing social networks

What they know

What’s possible

Working with SHGs permits CSISA to efficiently gain access to farmers who are not well-linked to formal or informal sources of knowledge, inputs, or services.
Going to Scale: ICT tools mobilize science into site-specific recommendations for smallholders

Field history, management practices, risk preferences

Smartphone-based tools with simple user interfaces

Cloud-based spatial data and computational tools

Crop Manager module
- Site-specific nutrient management
- Better-bet agronomic practices
- GHG footprint

Databases and spatial information
- Variety traits
- Soil nutrient deficiencies / toxicities
- In-season adjustments of crop yield potential based on observed weather, management information, and climate forecasts

Actionable advice via Printed guidelines, Image on Smartphone, SMS

Dr. Roland Buresh, IRRI
Going to scale: Increasing access to capital-intensive technologies with service provision

CSISA supports >1,300 mechanized SPs in Bihar and EUP w/ tech + BDS

Simplifies training burden (reaching thousands to affect millions).

Reduces $ barriers to innovation for capital-intensive technologies

Requires an emphasis on BDS, including new models of demand aggregation to democratize access for smallholders.
Going to Scale: Re-orienting the role of EAS towards supporting intermediaries rather than only farmers

Table 14. Sources of information on new wheat and rice varieties, differentiated by district (Percentage of households, values >= 10 in bold)

<table>
<thead>
<tr>
<th>Districts</th>
<th>Vaishali</th>
<th>Begusarai</th>
<th>Lakhisarai</th>
<th>Ara</th>
<th>Buxar</th>
<th>Samastipur</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice/Wheat</td>
<td>R W</td>
<td>R W</td>
<td>R W</td>
<td>R W</td>
<td>R W</td>
<td>R W</td>
<td>R W</td>
</tr>
<tr>
<td>No. of households</td>
<td>32 49</td>
<td>18 27</td>
<td>4 53</td>
<td>31 37</td>
<td>155 200</td>
<td>12 17</td>
<td>252 383</td>
</tr>
<tr>
<td>Govt. extension</td>
<td>13 20</td>
<td>0 2</td>
<td>3 0</td>
<td>2 2</td>
<td>0 0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>KVK</td>
<td>16 8</td>
<td>0 0</td>
<td>0 0</td>
<td>1 4</td>
<td>0 0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>CSISA</td>
<td>3 8</td>
<td>0 2</td>
<td>0 0</td>
<td>0 0</td>
<td>0 0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Agr. university</td>
<td>0 0</td>
<td>0 0</td>
<td>0 0</td>
<td>0 0</td>
<td>0 0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Seed dealer /seed co.</td>
<td>19 22</td>
<td>50 6</td>
<td>3 5</td>
<td>14 13</td>
<td>8 12</td>
<td>17 2</td>
<td></td>
</tr>
<tr>
<td>Service provider</td>
<td>0 0</td>
<td>0 0</td>
<td>3 0</td>
<td>8 10</td>
<td>0 0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Fellow farmer/Relat.</td>
<td>47 39</td>
<td>50 89</td>
<td>90 95</td>
<td>72 66</td>
<td>75 71</td>
<td>72 59</td>
<td></td>
</tr>
<tr>
<td>Radio</td>
<td>0 0</td>
<td>0 0</td>
<td>0 0</td>
<td>0 0</td>
<td>0 0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Own initiative</td>
<td>3 2</td>
<td>0 2</td>
<td>0 0</td>
<td>0 0</td>
<td>0 0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

R stands for Rice and W stands for Wheat.

Input companies and formal extension band together with CSISA to increase the capacity of agro-dealers with knowledge and new products.
Going to Scale: Strengthening the science of **decision making** of how and why farmers chose to innovate

✓ What innovations are actionable and profitable?

✓ Literacy / numeracy: how must information be conveyed?

✓ Opportunity costs

✓ Role of uncertainty and risk

✓ Differences among farmers

FUNCTIONAL TYPOLOGIES to guide interventions
CSISA-M.I. - Strengthening value chains to scale agricultural machinery, irrigation, and aligned services in southern Bangladesh
What constrains crop productivity in Bangladesh’s Feed the Future zone?

Increasing labor scarcity and cost
400% labor increase in last decade (Kumar and Ladha, 2011)

Growing energy and fuel costs
500% increase in last 15 years (BBS 2003)

Limited irrigation
Abundant water resources, few pumps (MoA and FAO 2012)

Gap between farmers’ and attainable yields
Salinity, extreme weather, late crop establishment, climate change related and drought risks, low input use efficiency

Low crop intensity
50% of 13 million farmers grow only 1 crop. land (MoA and FAO 2012).

Limited knowledge of, and access to, innovative technologies
Access to resource conserving practices and farm machinery lacking
Objective 1: Sustainable intensification through decentralized surface water irrigation

- Fuel efficient at low lifts, enabling lower cost irrigation

- Government of Bangladesh policy underscores need to expand surface water irrigation in the Feed the Future zone.
Objective. 2: Broad access to agricultural mechanization services

Power-tiller attachments: Facilitating precision agriculture

Typical power tiller: \(\approx 450,000\) in Bangladesh

- Reduced tillage
- Earlier planting
- Fuel savings
- Precision seeding + fertilizing
- Local service provision to reach even marginal farmers
**Obj. 3**: New models of public-private partnerships to support irrigation and ag. mechanization technical capacity

- The current focus on *technology development* hampers *product commercialization*. CSISA-MI supports improved designs and business models.
- CSISA-MI forges partnerships to overcome supply chain weaknesses (mechanics, technology optimization, and agronomic advice).
How are we approaching technology scaling in CSISA-MI?
Understanding that technology commercialization is more than just an engineering problem...

How to make it desirable for consumers?

How to make it viable for the market?

How to make the technology feasible?
Recognizing that systemic market weaknesses will need to be addressed for sustainability...

Ongoing analysis of the market system is required to ensure that weaknesses are identified and interventions designed.
That investment must continually enter the system for scaling to occur... (and not from projects)
What are we doing to make it work?
Assessing the market for agro-machineries in Bangladesh: identifying opportunities and systemic constraints

Improved Seeder-Fertilizer Attachments for Two-Wheeled Tractors

- Lack of support services including mechanics, finance, spare parts.
- Market volume currently low at $250k/year in imports – mainly projects. Potential of $105m market in CSISA areas. >$ 20m potential value to be captured by LSPs.

Table 12: Market size of seeder attachments

<table>
<thead>
<tr>
<th>Hub</th>
<th>Number of small farmers</th>
<th>Number of seeders</th>
<th>Value for importers/manufacturers</th>
<th>Value for Service Providers</th>
<th>Additional income to farmers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barisal</td>
<td>916,934</td>
<td>23,563</td>
<td>1,201,695,830</td>
<td>848,255,880</td>
<td>5,516,484,652</td>
</tr>
<tr>
<td>Faridpur</td>
<td>790,503</td>
<td>13,246</td>
<td>675,530,974</td>
<td>476,845,393</td>
<td>4,755,846,840</td>
</tr>
<tr>
<td>Khulna</td>
<td>995,100</td>
<td>11,069</td>
<td>564,521,470</td>
<td>398,485,744</td>
<td>3,986,749,185</td>
</tr>
<tr>
<td>Jessore</td>
<td>545,251</td>
<td>25,771</td>
<td>1,314,320,634</td>
<td>927,755,742</td>
<td>3,280,354,718</td>
</tr>
<tr>
<td>Dinajpur</td>
<td>746,105</td>
<td>23,776</td>
<td>1,212,575,558</td>
<td>855,935,688</td>
<td>4,887,383,318</td>
</tr>
<tr>
<td>Total (Taka)</td>
<td>3,993,893</td>
<td>97,424</td>
<td>4,968,644,466</td>
<td>3,507,278,446</td>
<td>24,028,173,713</td>
</tr>
<tr>
<td>Total (US$)</td>
<td></td>
<td></td>
<td>62,109,000</td>
<td>43,841,000</td>
<td>30,035,300</td>
</tr>
</tbody>
</table>
Testing a hypothesis that service provision through decentralized commercial providers can be a vehicle for wide-spread adoption...

Grafting onto existing pathways: 450,000 power tillers in Bangladesh and existing ‘fee for service’ model in operation
Engaging with lead Bangladeshi firms which have the capacity to scale up agro-mechanization

RFL Group

- Leading manufacturer of cast iron, PVC, and plastic products. Agreement with RFL Metal Ltd.
- 12,000 employees, 17 associated companies (incl. property, agro-dealerships, ground water tube wells).
- $300m revenue (2012). Dealer network and distribution channels.

Advanced Chemical Industries (ACI) Ltd.

- Family of companies specializing in seed, fertilizer, crop care, public health, motors, livestock and fisheries, etc. Project agreement is with ACI Motors.
- Specialist in quality farm machineries and light commercial vehicles.
- Little exposure to date in FtF zone
- Net turnover $282m; gross profit of $73m (2012).
Forging institutional partnerships with lead firms to take them beyond ‘project thinking’

Building trust & confidence in the partnership
Intervening in the supply chain to facilitate technology adoption

Interventions to drive technology (supply)
Joint-venture agreements for:
- Consumer promotion: ‘discount model’
- Rural marketing and promotion (demos)
- Commission based sales team
- After sales service

CSISA-MI

Interventions to develop LSP businesses (demand)
- Building market access to farmers’ groups
- LSP capacity development (through ToT)
- Creation of FBAs to sustain access to market

Interventions to strengthen LSP support services (supporting services)
Access to services for improved machinery operations

SOURCE → RFL → DEALER → SALES OFFICER → LSP → FARMER

Import

Existing demand

Customer for the technology
Customer for the service

Manufacture from 2015
Intervening to strengthen key services in the market system

Testing and technology development services
Machinery optimization through PPP and HCD

Import

SOURCE

COMPANIES

DEALER

SALES OFFICER

LSP

FARMER

Mechanics services
Improved through training and certification

Extension service
Improved agriculture through organization and development of FBAs

Agronomic advice services

SAAOs

MECHANICS

Research

Development Corp

CSISA-MI

Testing and technology development services

Financial services
Increased technology adoption through access to commercial finance

FSPs

Increased technology adoption through access to commercial finance

Customer for the technology

Customer for the service
What do we expect to see in technology scaling? Focusing on outcomes at the commercialization stage…

- **Consumer insights**
  - Opportunities identified
  - Constraints identified
  - Intent statement formulated

- **Research & development**
  - PSAs interest secured
  - Design brief formulated
  - Rapid prototyping with PSAs
  - Co-creation of improved products

- **Piloting & demo**
  - Investment from PSAs
  - Business Strategy formulated
  - Early adoption of the technology
  - Co-creation of improved products

- **Commercialization**
  - Trigger
  - Uptake
  - Enterprise Performance
  - Sector Growth

- **Time**
  - Higher levels of investment
  - More PSAs enter the market
  - Growth in ancillary service providers
  - Spontaneous adoption of technology
  - Product diversification and new innovations

**Timeline:**
- Opportunities identified
- Constraints identified
- Intent statement formulated
- PSAs interest secured
- Design brief formulated
- Rapid prototyping with PSAs
- Co-creation of improved products
- Investment from PSAs
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- Trigger
- Uptake
- Enterprise Performance
- Sector Growth
- Higher levels of investment
- More PSAs enter the market
- Growth in ancillary service providers
- Spontaneous adoption of technology
- Product diversification and new innovations
In Summary: Initial results/ challenges (after 8 months)

- Agreements for some $672,000 investment by RFL/ACI. Project investment of $190,000 in JV (3.5:1). To date, $363,000 investment realized from private partners for scale-up.
- 1,200 pumps imported and retailed through RFL distribution network in southern Bangladesh.
- All 70 seeder-fertilizer drills sold (complete consignment).
- Some machineries require further optimization and refinement to become more marketable. HCD process underway.
- Commercial model is working though overcoming traditional mindsets (in public and private sector) remains an ongoing challenge.
In Summary: Initial results/ challenges (after 8 months) – where are we with our pilot technologies?
In Summary: Finding the right model is key scale-up

- 13 million people in Southern Bangladesh rely on agriculture (MoA 2012)

Business as usual will not achieve scale

- Concentration on value chains and local agricultural machinery service providers to reach farmers at scale

Systems development for scaling up through markets
In Summary: Ongoing course corrections – you don’t know what you’ll face until you start down the road...
Going to Scale: Knowledge networks are the ‘glue’ for innovation, but differ significantly even at the intra-state level in India.
<table>
<thead>
<tr>
<th>Entry points in SA for Sustainable Int.</th>
<th>Water productivity</th>
<th>Labor scarcity</th>
<th>Soil degradation</th>
<th>Climate resilience</th>
<th>Yield</th>
<th>Profitability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conservation agriculture (CA)</td>
<td>***</td>
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<td>*</td>
<td>***</td>
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<tr>
<td>Site-specific nutrient management</td>
<td></td>
<td>**</td>
<td>**</td>
<td>**</td>
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<td>***</td>
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<tr>
<td>Scale-appropriate mechanization</td>
<td>***</td>
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<tr>
<td>Laser land leveling</td>
<td>***</td>
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<tr>
<td>Elite germplasm</td>
<td>**</td>
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<tr>
<td>System intensification (more crops/yr)</td>
<td>*</td>
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<tr>
<td>Post-harvest storage</td>
<td></td>
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<tr>
<td>Improved livestock feeding</td>
<td></td>
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<td></td>
<td>***</td>
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<tr>
<td>Strengthened seed systems</td>
<td>*</td>
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<td></td>
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<td>***</td>
</tr>
</tbody>
</table>
Going to scale: **market availability** of agricultural machinery in Nepal is an on-going challenge.

Business intelligence on Nepal markets to India and Chinese manufacturers.

Forging connections to national entrepreneurs with robust distribution networks → getting projects out of brokering / importing role so that markets develop.
R&D Priorities: Systems intensification, cultivar selection, irrigation, and crop management in Nepal

**Rajkumar (hybrid)**
Profit/ha = $427 – 1032

**Arun-2 (OPV)**
Profit/ha = $47 – (-458)

**Kanchan (hybrid)**
Profit/ha = $159 – 338
Agriculture transformations can be accelerated

The rice revolution in South America

Variety revolution (semi-dwarfs – 2 t / ha)

350 new varieties released

Creation of FLAR

Agronomic Revolution (management gain 2 t / ha)

1968

1995

2002

Peter Jennings, FLAR, 2005

Courtesy of A. Dobermann