DryArc – understanding complexity in smallholder farming systems for scaling impactful interventions

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What is an Innovation Systems Approach?

The goal: In support of ICRISAT’s vision, ISD creates and uses knowledge, methodologies and tools to create innovations, understand entry points/tradeoffs and leverage actors towards profitable resilient and sustainable agri-food systems at scale.

An innovation systems approach harnesses the conditions needed to create demand for technologies and creates the knowledge that may be used to bring about such changes...innovations most often emerge from a systems of actors collaborating, communicating and learning.
Crop livestock systems:
Agro-ecological and economic interactions
Agro-ecological and economic interactions between crops, livestock and markets

Household financial needs: Food, Education, health, construction etc.

Crop Production
- Cereals
- Legumes

Livestock Production
- Chickens
- Goats
- Dairy
- Beef

Value chains
- Markets

Income
- Household financial needs
- Off farm income

MK

Markets
Innovation Platform approaches:

(1) developing functional networks to facilitate desirable change
Innovation Platform approaches: (2) Visioning and road map

- Vulnerable state
  - Weak social capital (internal/external)
  - Lack of knowledge on crop livestock technologies
  - Lack of land ownership

- Resilient and profitable state
  - Barriers + solutions

- Pathways:
  - Increase social capital
  - Increase knowledge of crop and livestock technologies
  - Increase land ownership

- Reduce poverty

- Example:
  - Fertilizer distribution
  - Market access
  - Training programs
Innovation Platform approaches:
(3) Diagnoses

Mapping Goat VCs

VC Functions
- Input provision
- Goat production
- Intermediary trade
- Transformation
- Retailing
- Consumption

VC Actors
- NGOs
- Vet/DLPD
- Smallholder farmers
- Local agro-dealers
- Traders
- Abattoir
- Rural butchery
- Urban butchery
- Supermarket & restaurants
- New national, regional markets
- Urban Consumer
- Local schools, hospitals
- Local butchery
- Smallholder farmers
- Local agro-dealers
- RDC/EMA
- RDC/Urban council
- LPD, VET, CARE, World Vision, ORAP, ICRISAT: Input supply, capacity devpt, market linkages
- ARIBANK: credit access

VC Support Services
Innovation Platform approaches:
(3) Diagnoses

Challenges/Opportunities for Goat VC

- **VC Functions**
  - Input provision
  - Goat Production
  - Intermediary Trade
  - Transformation
  - Retailing
  - Consumption

**VC Challenges**
- Poor infrastructure (roads, markets, water)
- Poor information flow and communication
- High input/raw material prices
- Feed shortages
- Poor support services (livestock, vet)
- Poor local input supply/use (pvt/gvt)
- Gvt input subs. harm agrodealers
- No access to proper credit facilities
- Change in market demand
- Droughts

**Opportunities**
- Use of contracts when doing business
- Collective action (formation of cooperatives to reduce transaction costs)
- Interest in feed/fodder/suppl. feed
- Provision of credit facilities
- Potential for agro-dealer net
- Improvement in production practices
- Use of auction as trading platform
- Availability of abattoirs
- Diversification
- Policy support
- Change in market demand
- High demand for (quality) livestock

- Innovation Platform approaches:
  - (3) Diagnoses
Value chain models – beef project, Sumbawa Indonesia – feed-lotting and improved processing

Source: Ben Henderson, CSIRO
Value chain models – beef project, Sumbawa Indonesia – feed-lotting and improved processing

Source: Ben Henderson, CSIRO
Value chain models – feed-lotting, improved processing, breed herd improvement

Source: Ben Henderson, CSIRO
Innovation Platform approaches:

(4) Iterative process of prototyping, evaluation and scaling

Institutional uptake of technologies and processes at higher administrative levels

IP as mechanisms for co-creating innovations, with the potential of going to scale

Promoting innovation through existing networks, involving extension, policy makers, private sector
Scaling through multi-disciplinary networks

Scaling as part of participatory technology development, engagement and visibility processes:
- IPs + innovations - in different contexts, similar mechanisms
- Innovations only - large uptake without IPs, where there is relevance

Open structures for experimentation and knowledge sharing
- Disseminate innovations in other areas and countries
- Integrate innovations with other components, e.g. pen fattening, goat/cattle market initiatives, goats for welfare groups
- Private sector responses, e.g. sale of mucuna seed, links to abattoirs

Lasting trustworthy networks of actors for accelerating knowledge diffusion, adaptation, uptake

At least 14 districts in Zim and expanding to Mozambique and Malawi
INTEGRATED ASSESSMENT - Bio-economic Modelling Tool

Crop Modeling Using Climate Data
- Inputs:
  - Climate
  - Soil
  - Management Practices
  - Prices/Costs
  - Labour
  - Machinery

Livestock Growth Modeling
- Outputs:
  - Crop
  - Forage
  - Cattle
  - Labour Allocation
  - Profits

Economic Modeling
- Feasible/Profitable Strategies

Fodder Availability
What is CLEM?

• A whole farm enterprise model tracking all **Resources** (assets) used by farm **Activities**
  • **Resources** (e.g. animals, crops, fodder, labour, land, money, water)
  • **Activities** (e.g. grow crops, manage animals, feed animals, manage fodder, manage manure, feed household)

• CLEM can test a range of farm improvement strategies in a multitude of crop and livestock enterprises, while tracking impacts on nutrition, natural resources, and highly constrained resources (e.g. labour).

**CLEM is in Beta release – undergoing final Validation and Documentation**
## Cereal Legume Livestock intensification and market integration

<table>
<thead>
<tr>
<th>Nkayi</th>
<th>Baseline</th>
<th>Fertilize Crops &amp; feed residues to livestock</th>
<th>............</th>
<th>Cereal Legume Livestock &amp; Markets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crop GM</td>
<td>$ 22</td>
<td>$ 225</td>
<td></td>
<td>$ 263</td>
</tr>
<tr>
<td>Livestock GM</td>
<td>$ 188</td>
<td>$ 462</td>
<td></td>
<td>$ 1,051</td>
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<tr>
<td>Net Cash Income</td>
<td>$ 88</td>
<td>$ 362</td>
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<td>$ 930</td>
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<tr>
<td>CV of HEI</td>
<td>25%</td>
<td>18%</td>
<td></td>
<td>14%</td>
</tr>
<tr>
<td>Efficiency metrics</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>HEI/mm Rain</td>
<td>$0.62/mm</td>
<td>$1.15/mm</td>
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<td>$2.05</td>
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<tr>
<td>HEI/Labor</td>
<td>$1/day</td>
<td>$1.86/day</td>
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<td>$5.67/day</td>
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<tr>
<td>HEI/ha</td>
<td>$113/ha</td>
<td>$208/ha</td>
<td></td>
<td>$317/ha</td>
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</tbody>
</table>
Integrated Bio-Economic Modelling help evaluate ex-ante impact of various CSA options

ENTRY POINTS

- Climate Risk
- Production Risk
- Market Risk

Mitigate Risk

Whole-Farm Systems Modeling

OUTCOMES

- Diversification of farming systems – Livestock, Trees etc.
- Technical Efficiency
- Investment Decisions

Increase Resilience
### Integrated Bio-Economic Modelling to for Agricultural Risk Management: Case of Mahbubnagar district, TS (% net increase in returns)

<table>
<thead>
<tr>
<th></th>
<th>Insitu Moisture Conservation</th>
<th>Recommended Nitrogen Levels</th>
<th>Insitu+ Recommended Nitrogen</th>
<th>Farm Ponds</th>
<th>Farm Ponds+ Recommended Nitrogen</th>
<th>Fertilizer+Irrigation Interventions &amp; Better Livestock Integration</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group 1</strong></td>
<td>16</td>
<td>8</td>
<td>25</td>
<td></td>
<td></td>
<td>106</td>
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<tr>
<td><strong>Group 2</strong></td>
<td>8</td>
<td>8</td>
<td>17</td>
<td>6</td>
<td>14</td>
<td>39</td>
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<tr>
<td><strong>Group 3</strong></td>
<td>8</td>
<td>7</td>
<td>16</td>
<td>10</td>
<td>18</td>
<td>48</td>
</tr>
</tbody>
</table>

Integration of livestock and perennials proved more profitable and resilient
What have we learnt?

• Multi-stakeholder processes are effective in facilitating change through improved markets and social learning, and scaling.

• Farmers respond to market signals and invest in agricultural production when returns on investments are real.

• Feed production is crucial in increasing the production of high quality animal products, therefore to generate income.

• Farmers understand the role of legumes in improving overall farm productivity (animal and soil) However, both legume and livestock markets are crucial in driving technology adoption.

• Integrated systems increase resilience and sustainability.
Climate Analysis – Exposure Index

Mandal wise climate exposure index for baseline climate

Mandal wise climate exposure index for Mid-century RCP 8.5
Tracking adoption of Chickpea: Andhra Pradesh

Table:

<table>
<thead>
<tr>
<th>Districts</th>
<th>2000-01</th>
<th>2005-06</th>
<th>2012-13</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anantapur</td>
<td>34,777</td>
<td>51,304</td>
<td>84,493</td>
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<tr>
<td>YSR (Kadapa)</td>
<td>30,343</td>
<td>69,258</td>
<td>117,903</td>
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<tr>
<td>Kurnool</td>
<td>68,113</td>
<td>140,511</td>
<td>196,793</td>
</tr>
<tr>
<td>Prakasam</td>
<td>35,129</td>
<td>128,288</td>
<td>159,524</td>
</tr>
</tbody>
</table>

Legend:
- 01. Water bodies
- 02. Chickpea (2000-01)
- 03. Chickpea expansion (2005-06)
- 04. Chickpea expansion (2012-13)

Adoption of water harvesting structures

Monitoring changes in the cultivation of pigeonpea and groundnut in Malawi using time series satellite imagery and its relationship to export and import dynamics. (Prep).

Gumma et al., 2019.
APPRECIATE YOUR ATTENTION