Feeding Research
Feeding Innovation

Alan J Duncan

ILRI Seminar Series
Mar 30, 2015
Addis Ababa
Seminar framework

Conventional nutritional research

Conventional systems research

Research on innovation systems

Research that stimulates innovation

Feeding Research

Feeding Innovation
QUALITY TRAITS STEM/LEAF OF SIX COMMON BEAN GENOTYPES HARVESTED AFTER GRAIN MATURITY IN 2013/14 CROPPING SEASON AT BAKO-TIBE DISTRICT, ETHIOPIA. N=3.

Mesfin Dejene, PhD Student, Univ Queensland (unpublished)
QUALITY TRAITS STEM/LEAF OF SIX COMMON BEAN GENOTYPES HARVESTED AFTER GRAIN MATURITY IN 2013/14 CROPPING SEASON AT BAKO-TIBE DISTRICT, ETHIOPIA. N=3.

Mesfin Dejene, PhD Student, Univ Queensland (unpublished)
Qualitative traits stem/leaf of six common bean genotypes harvested after grain maturity in 2013/14 cropping season at Bako-Tibe District, Ethiopia. N=3.

Mesfin Dejene, PhD Student, Univ Queensland (unpublished)
Message:
1. Lots of variation in legume residue quality that could be exploited for improving livestock diets
Conventional nutritional research

Conventional systems research

Feeding Research
Feeding Innovation

Research on innovation systems

Research that stimulates innovation
Trends in livestock feed sourcing

Aklilu Mekasha: Connections between climate change, land use change and feed resource availability in Ethiopia
Trends in livestock feed sourcing
Trends in livestock feed sourcing

Trends in livestock feed sourcing

Previously:
All grazing

<table>
<thead>
<tr>
<th>Area</th>
<th>30-40 years ago</th>
<th>Present</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liben (pastoral)</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>Mieso (agro-pastoral)</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>Tiyo (highland)</td>
<td>100%</td>
<td></td>
</tr>
</tbody>
</table>

% of diet
Grazing • Crop residue • Agro-industrial byproducts • Cultivated forage crops • Other feeds from crop lands

Trends in livestock feed sourcing

Previously: All grazing
Now: some crop products

% of diet

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</tbody>
</table>

Trends in livestock feed sourcing

Marked decline in grazing

Trends in livestock feed sourcing

Marked increase in crop residues

- **Grazing**
- **Crop residue**
- **Agro-industrial byproducts**
- **Cultivated forage crops**
- **Other feeds from crop lands**

Trends in livestock feed sourcing

Agro-industrial byproducts emerging

Almost zero planted forage
How does use of crop residues vary along an intensification/productivity gradient?
How does use of crop residues vary along an intensification/productivity gradient?

Kobo
low intensity
How does use of crop residues vary along an intensification/productivity gradient?

Kobo
low intensity

Nekemte
medium intensity

Systemwide Livestock Programme
How does use of crop residues vary along an intensification/productivity gradient?

- Kobo: low intensity
- Nekemte: medium intensity
- Kakamega: high intensity
How does use of crop residues vary along an intensification/productivity gradient?

Kobo
low intensity

Nekemte
medium intensity

Kakamega
high intensity
## Indicators of intensification across a gradient

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Kobo (low)</th>
<th>Nekemte (medium)</th>
<th>Kakamega (high)</th>
<th>Trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household head education (in years)</td>
<td>1.1</td>
<td>3.4</td>
<td>7.6</td>
<td>↑</td>
</tr>
<tr>
<td>On farm income out of total income (%)</td>
<td>86</td>
<td>80.3</td>
<td>39.9</td>
<td>↓</td>
</tr>
<tr>
<td>Total cultivated land (hectares)</td>
<td>1.6</td>
<td>1.5</td>
<td>0.4</td>
<td>↓</td>
</tr>
<tr>
<td>Livestock pressure (TLU/ha total area)</td>
<td>3.7</td>
<td>4.4</td>
<td>18.6</td>
<td>↑</td>
</tr>
<tr>
<td>Labor availability (working members/ha total area)</td>
<td>3.1</td>
<td>3.8</td>
<td>22.7</td>
<td>↑</td>
</tr>
<tr>
<td>Food self-sufficiency index</td>
<td>0.72</td>
<td>0.74</td>
<td>0.32</td>
<td>↓</td>
</tr>
<tr>
<td>Livestock output marketed (%)</td>
<td>0.18</td>
<td>0.19</td>
<td>0.34</td>
<td>↑</td>
</tr>
</tbody>
</table>

Duncan et al, Crop residue allocation to livestock feed, soil improvement and other uses along an intensification gradient in Eastern Africa. Submitted to AGEE
### Indicators associated with use of crop residue for soil, feed and other uses

<table>
<thead>
<tr>
<th></th>
<th>Soil</th>
<th>Feed</th>
<th>All other uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total cultivated land (hectares)</td>
<td>3.43***</td>
<td>3.005**</td>
<td>-2.117**</td>
</tr>
<tr>
<td>Livestock pressure (TLU/ha total area)</td>
<td>-0.142**</td>
<td>0.20***</td>
<td>-0.007</td>
</tr>
<tr>
<td>Livestock output marketed (%)</td>
<td>-6.8**</td>
<td>16.0**</td>
<td>-5.992**</td>
</tr>
<tr>
<td>Improved seed variety (dummy)</td>
<td>-0.116</td>
<td>4.878*</td>
<td>-1.375</td>
</tr>
<tr>
<td>Travelling time to crop outputs market (hour)</td>
<td>-0.46</td>
<td>2.04***</td>
<td>-0.861</td>
</tr>
</tbody>
</table>

As land size increases availability of CR for soil and livestock feed also increases.
## Indicators associated with use of crop residue for soil, feed and other uses

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As livestock pressure increases, allocation to feeding increases and to soil decreases.
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As livestock marketing increases allocation to feeding increases and to soil decreases.
## Indicators associated with use of crop residue for soil, feed and other uses

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Use of improved crop inputs gives more potential to feed residues to livestock.
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Restricted market access seems to favour feeding of residues to livestock.
Indicators associated with use of crop residue for soil, feed and other uses

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As land size increases availability of CR for soil and livestock feed also increases.
As livestock pressure increases allocation to feeding increases and to soil decreases.
As livestock marketing increases allocation to feeding increases and to soil decreases.
Use of improved crop inputs gives more potential to feed residues to livestock.
Restricted market access seems to favour feeding of residues to livestock.

Messages:
1. Livestock intensification could have negative effects on soil health.
2. Intensifying crop production could be quickest route to improving livestock feed availability.
Conventional nutritional research

Conventional systems research

Research on innovation systems

Research that stimulates innovation

Feeding Research

Feeding Innovation
Are innovation platforms effective at stimulating change? Case of MilkIT IP’s

Bageshwar

Sult
Are innovation platforms effective at stimulating change? Case of MilkIT IP’s
Women farmers discussing their problems in an IP meeting in Kolseer village, Uttarakhand
### IP Meetings Summary

<table>
<thead>
<tr>
<th>Type meeting</th>
<th>Sult [no. of meetings]</th>
<th>Bageshwar [no. of meetings]</th>
</tr>
</thead>
<tbody>
<tr>
<td>DVC (IP core)</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Feed (IP core)</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>follow up (DVC &amp; feed)</td>
<td>53</td>
<td>149</td>
</tr>
<tr>
<td>Training/exposure (DVC)</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Institutional (DVC)</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>60</strong></td>
<td><strong>162</strong></td>
</tr>
</tbody>
</table>

Ravichandran, Teufel et al (unpublished)
Meeting objectives - Sult

Ravichandran, Teufel et al (unpublished)
Meeting objectives - Sult

![Bar graph showing meeting objectives, Sult.](image)

Ravichandran, Teufel et al (unpublished)
Meeting objectives - Sult

Ravichandran, Teufel et al (unpublished)
Meeting objectives - Bageshwar

Ravichandran, Teufel et al (unpublished)
Meeting objectives - Bageshwar

Ravichandran, Teufel et al (unpublished)
Meeting objectives - Bageshwar

Ravichandran, Teufel et al. (unpublished)
Institutional participation in IP meetings - Bageshwar
[no. of meeting participations]

- Anchal (dairy coop): 8
- Agri Dept: 4
- AnimHusb Dept: 3
- IFAD (ILSP prog): 1
- ILRI: 1
- Banks: 4
- NABARD (DevBank): 3
- KVK/VPKAS (Agri.Res): 4
- Forest Dept: 0

Ravichandran, Teufel et al (unpublished)
Early outcomes.......
Men with school kids - dairy collection centre in Baseri village
IDBI is a (semi-)commercial bank which provided loans for purchasing cross-bred cows.
Aanchal (State Dairy Coop) relaxed membership rules to allow smaller farmer groups to join....
Preliminary impact study

- 24 selected and 24 control settlements
- 4 HHs (2 men/2 women) in each settlement
- Captured changes in income through linking to markets
- Changes in the production through IP involvement
Impact study results

Milk Sales

Milk Sales (l/d/hh)

control households  IP households

Ravichandran, Teufel et al (unpublished)
Impact study results

Milk Yield

- **Milk Production (l/cow/d)**
  - **IP households**
    - Average: 3.5
  - **Control households**
    - Average: 2.5

Ravichandran, Teufel et al (unpublished)
Impact study results

Income From Milk Sales

Income (INR/hh/year)

- Control households
- IP households

Ravichandran, Teufel et al (unpublished)
Innovation system: networks of organization, enterprise and individuals focused on bringing new products, new processes and new forms of organization in to social and economic use together with the institutions and policies that affect their innovation behaviour and performance (World Bank, 2012)
Innovation system structure and function

Structural elements

- **Actors**
  - Civil society
  - Companies
  - Knowledge institutes
  - Government
  - NGOs

- **Institutions**
  - Hard
  - Soft

- **Interactions**
  - At level of networks
  - At level of individuals

- **Infrastructure**
  - Physical
  - Knowledge
  - Financial

Functions

- Entrepreneurship
- Knowledge development
- Knowledge diffusion
- Resource mobilization
- Market formation
- Guidance of search


Applying the Structural-functional analysis to the Ethiopian dairy sector

Entrepreneurship
• Weak in Ethiopian smallholder systems

Creation of legitimacy
• Relatively weak – no dairy board

Resource mobilization
• Weak government investment in dairy

Knowledge development
• Strong national research system

Knowledge diffusion
• Relatively weak – good coverage of extension but of low capacity

Market formation
• Weak, especially around input markets

Guidance of search
• Good targets for agriculture but not for smallholder dairy

## Defining systemic instruments

<table>
<thead>
<tr>
<th>Functional weakness</th>
<th>Effect</th>
<th>Focus for instrument</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entrepreneurship and market formation</td>
<td>Lack of cross-bred cows</td>
<td>Foster establishment of heifer rearing businesses</td>
</tr>
<tr>
<td>Knowledge diffusion</td>
<td>Lack of technical skills at smallholder level</td>
<td>Link extension agents with ICT approaches</td>
</tr>
<tr>
<td>Knowledge diffusion and market formation</td>
<td>Lack of effective input and service delivery systems</td>
<td>Provide incentives for input supply start-ups</td>
</tr>
</tbody>
</table>

Kebebe E., Duncan A. J., Klerkx L., de Boer I.J.M., Oosting S.J., Understanding socio-economic and policy constraints to dairy development in Ethiopia through innovation systems function analysis. *Agricultural Systems* (in review)
Conventional nutritional research

Conventional systems research

Research on innovation systems

Research that stimulates innovation

Feeding Research

Feeding Innovation
Development of participatory tools to guide feed entry points
What is your main problem?
What is your main problem?

Feed
What feed technologies have you got?
Business as usual

Planted forage
Urea treated straw
Multi-purpose trees

photo: Neil Palmer/CIAT
Business as usual

OK, let’s try those

photo: Neil Palmer/CIAT
How does FEAST work?

1. Focus group discussion exercise
   - Overview of **farming system** and livestock feed issues
   - **Milk marketing**, veterinary services
   - **Major problems** for livestock production and possible solutions

2. Individual farmer survey
   - Quantitative information on **crop-livestock production**, **feed availability**, **feeding rations**
   - Standardized graphical outputs

3. Data analysis and developing interventions
   - Enter data in **FEAST template**
   - Based on results develop **ideas** for **intervention**
How does FEAST help?

- Labour
- Input supply
- Health
- Markets
- Farmers’ issues
- Farmers’ solutions

photo: Neil Palmer/CIAT
How does FEAST help?

- Labour
- Health
- Input supply
- Markets
- Farmers’ issues
- Farmers’ solutions

photo: Neil Palmer/CIAT
Techfit – what is it?

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Pulverization of dry foders and crop residues</td>
</tr>
<tr>
<td>2</td>
<td>Chopping of dry feeds</td>
</tr>
<tr>
<td>3</td>
<td>Chemical treatment: urea treatment</td>
</tr>
<tr>
<td>4</td>
<td>Soaking in water</td>
</tr>
<tr>
<td>5a</td>
<td>Wet by-products: horticultural and brewers waste</td>
</tr>
<tr>
<td>5b</td>
<td>Wet by-products: Enset / banana leaves and stems</td>
</tr>
<tr>
<td>6</td>
<td>Dry by-products: Cereals</td>
</tr>
<tr>
<td>7</td>
<td>Protein by-products</td>
</tr>
<tr>
<td>8</td>
<td>Energy supplementation</td>
</tr>
<tr>
<td>9</td>
<td>Balanced concentrate supplements</td>
</tr>
<tr>
<td>10</td>
<td>Blocks: Urea molasses mineral licks</td>
</tr>
<tr>
<td>11</td>
<td>Powder: Commercial mineral licks</td>
</tr>
<tr>
<td>12</td>
<td>Supplementation with green fodder</td>
</tr>
<tr>
<td>13</td>
<td>Hay making</td>
</tr>
<tr>
<td>14</td>
<td>Silage making</td>
</tr>
<tr>
<td>15</td>
<td>Legume leaf and seed meals</td>
</tr>
<tr>
<td>16</td>
<td>Purchased crop residues or hay</td>
</tr>
<tr>
<td>17</td>
<td>Collective action to improve communal area management</td>
</tr>
<tr>
<td>18</td>
<td>Rehabilitation of degraded pastures</td>
</tr>
<tr>
<td>19</td>
<td>Grasses in cut &amp; carry systems</td>
</tr>
<tr>
<td>20</td>
<td>Grasses for managed grazing systems</td>
</tr>
<tr>
<td>21</td>
<td>Irrigated fodder production</td>
</tr>
<tr>
<td>22</td>
<td>Herbaceous legumes, grown in monoculture or mixed with grasses</td>
</tr>
<tr>
<td>23</td>
<td>Fodder trees and shrubs</td>
</tr>
<tr>
<td>24a</td>
<td>Roots and tubers: Sweet potato vines</td>
</tr>
<tr>
<td>24b</td>
<td>Roots and tubers: Cassava foliage</td>
</tr>
<tr>
<td>25</td>
<td>Short duration and annual fodder crops</td>
</tr>
<tr>
<td>26</td>
<td>Thinnings, tops and leaf strips</td>
</tr>
<tr>
<td>27</td>
<td>Crop - forage intercropping</td>
</tr>
<tr>
<td>28</td>
<td>Cereal and legume varieties with better straw quality</td>
</tr>
<tr>
<td>29a</td>
<td>Dual purpose legumes</td>
</tr>
<tr>
<td>29b</td>
<td>Creep feeding - calves, lambs, kids, piglets</td>
</tr>
<tr>
<td>30</td>
<td>Calf feeding: rearing on milk replacers</td>
</tr>
<tr>
<td>31</td>
<td>Improved feed troughs to reduce wastage</td>
</tr>
<tr>
<td>32</td>
<td>Chopping of green fodder and forages</td>
</tr>
<tr>
<td>33a</td>
<td>Complete feeds for ruminants</td>
</tr>
<tr>
<td>33b</td>
<td>Complete feeds for pigs</td>
</tr>
<tr>
<td>34</td>
<td>Amino acid supplementation</td>
</tr>
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# How does Techfit work?

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<th>Key technology attributes</th>
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<td>Land</td>
<td>Land</td>
</tr>
<tr>
<td>Labour</td>
<td>Labour</td>
</tr>
<tr>
<td>Credit</td>
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<td>Input</td>
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</tr>
<tr>
<td>Knowledge</td>
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</tr>
<tr>
<td>Water</td>
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<table>
<thead>
<tr>
<th>Key constraint</th>
<th>Key constraint mitigation</th>
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<tbody>
<tr>
<td>Quantity, quality, seasonality</td>
<td>Suitability for system</td>
</tr>
<tr>
<td>What is the system?</td>
<td>Suitability for commodity</td>
</tr>
<tr>
<td>Mixed intensive, agro-pastoral</td>
<td>Impact on productivity</td>
</tr>
<tr>
<td>etc</td>
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<tr>
<td>What is the commodity?</td>
<td></td>
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<tr>
<td>Dairy, sheep fattening etc</td>
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How does Techfit work?

Key context attributes:
- Land
- Labour
- Credit
- Input
- Knowledge
- Water

Key technology attributes:
- Land
- Labour
- Credit
- Input
- Knowledge
- Water

Key constraint:
- Quantity, quality, seasonality

What is the system?
- Mixed intensive, agro-pastoral etc

What is the commodity?
- Dairy, sheep fattening etc

Key constraint mitigation:
- Suitability for system
- Suitability for commodity
- Impact on productivity

Score
What do these tools do?

- Give ideas for feed interventions
  - Appropriate
  - Owned by farmers
  - Fit the context

- Change knowledge, attitude, practice of those who use them
  - Broader thinking
  - Better understanding of farmer constraints
How will we test this?

- Baseline survey of Knowledge, attitudes and practices
- Application of FEAST in various modes
  - Use of FEAST blended learning materials with ILRI
  - Use of FEAST blended learning materials without ILRI
  - Use of FEAST with no support
  - No use of FEAST
- Repeat survey to assess:
  - Interventions emerging
  - Knowledge, attitudes, practices
Conventional nutritional research

Conventional systems research

Research on innovation systems

Research that stimulates innovation

Feeding Research

Feeding Innovation
“There are no magic enzymes and no magic rumen bacteria that can exceed physico-chemical limitations” (Van Soest, Nutritional Ecology of the Ruminant, 1994)
The Struggle

“For at least some problems, there is something useful about the ‘the struggle’ - that is, the need for a community to identify its challenges and grapple iteratively with the solutions” Owen Barder – Centre for Global Development
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Colleagues who contributed....

Cross-discipline, cross-centre, cross-programme....
better lives through livestock

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