Report WP 1: Progress towards establishing a MLTVI and designing a ricebean marketing strategy

Doreen Buergelt
Rolf A.E. Mueller
CAU Kiel
Objective 1: Scrutinizing the ricebean supply-chain

Objective 4: Development of a market-based legumes traits value index (MLTVI)

Objective 5: Design of a marketing strategy for an improved ricebean

Discussion in this sequence:
- Objective 1 (RAEM)
- Objective 5 (RAEM)
- Objective 4 (DB)
FOSRIN > WP 1 > Objective1
> Analyzing the RB-SC

- General questions:
  - How to reduce loss of product value on the way from producers to consumers?
    - loss of quality
    - intermingling of qualities
    - loss of info about quality
    - etc
  - How to avoid unnecessary costs in the movement of a product from producers to consumer?
    - transport cost
    - storage costs
    - transaction costs

- Two perspectives:
  - Supply-chains are really networks
  - products = stuff + info about the stuff + other info
    ~ inspection attributes; experience attributes; metaphysical attributes
analyze the ricebean supply-chain for stages and linkages where product value may be compromised or lost;

base this analysis on a model of the legumes supply-chain in India and Nepal

for this purpose, use a network model consisting of:

- breeders who produce improved ricebean seed
- small-scale ricebean growers
- intermediaries at various market stages
- women-consumers of ricebean
FOSRIN > WP 1 > Objective1
> Data collection

- review of the grey literature on the legumes supply-chain in India and Nepal
- interviews with legumes market experts
- interviews with legumes market experts from all stages of the SC
- observation of transaction practices on organized legumes markets
Based on the data collected:

- quantify approximately the volume and value of legumes moved through the SC-links and
- identify
  - classes of SC-agents and their key activities
  - product related info linkages between the agents
  - formal and informal transaction relationships
  - formal rules and regulations as well as
  - informal norms and practices that govern the conduct of SC-agents
- model the legumes SC and pinpoint linkages where
  - value is dissipated
  - info integrity is threatened
What insights from the analysis of the legumes SC apply to the RB-SC?

- highly heterogenous product
- seasonal market presence (~ no all year storage)
- low volume
- no grades
- imprecise measures (e.g. sold by the cup!)
- no price and volume reporting
Potential of SNA for SC-Modeling

- Social Network Approach to SC-modeling

- Social Network Analysis
  - provides workable models of networks
  - relates network attributes to measures of network outcomes
  - provides a framework for collecting & organizing data
  - provides network researchers with essential tools
    - network diagrams
    - quantitative measures of network related attributes of network members
    - quantitative and qualitative measures of the whole network

- SNA benefits from spill-ins from graph theory
Mathematical foundation: **Graph theory** (Frank Harary)

A social network is defined by:

\[ S = \{N, L, G_d, A, C\} \]

- **N**: nodes represent the actors in a social network
- **L**: links or ties represent the relationships among actors
- **G_d**: sociograph or drawing of the nodes & links
- **A**: quadratic \((n \times n)\) adjacency matrix with elements \(a_{ij}\) representing the links between the nodes i and j
- **C**: a rectangular \((n \times l)\) matrix with l characteristics for the \(n\) actors

SNA is data intensive

- number of data for a network with \(n\) actors and \(l\) actor characteristics:
  \[
  (n \cdot l) + (n \cdot n) = n (l + n)
  \]

- an adjacency matrix is required for each type of relation between actors; for a network with \(r\) relations:
  \[
  DV = (n \cdot l) + r \cdot (n \cdot n) = n (l + r \cdot n)
  \]
Network diagrams
- have no dimensions
- obey several conventional norms & rules

Measures of network attributes
- (network) attributes of individual agents
  - degree - closeness - betweenness
- attributes of the network
  - completeness - diameter - density
  - cut points - cut sets - k cores
FOSRIN > WP 1
> Which graph is best? This?
FOSRIN > WP 1
> Or this?
FOSRIN > WP 1
> Or this?

circle layout
FOSRIN > WP 1
> Or one of these?
Where and how can farmers sell ricebean?

- Collection centers but: low quantity
- Grading schemes but: heterogenous product & some important quality characteristics are not observable
- Providing market intelligence to producers and traders but: widely dispersed growers, most with only small marketable surplus
  - Mobile phone info center?
- Info & training for traders?
- Are there export opportunities
  - Ethnic Indians abroad?
  - Speciality products?
WP 1

2nd annual meeting FOSRIN
University of Kiel
Rolf A.E. Müller
Doreen Bürgelt
WP 1 - Content

- used chemical analyses
- results:
  - important differences between analysed pulses
  - compare ricebean to chickpea
  - present results of the regression
Physical Parameters

- Shape (elongated, kidney, round, angular, lentil-like)
- Color
- Foreign matter (dirt, other pulses…) in %
- 100 Seed Weight, g
- 100 Seed Volume, ml
- Water Absorption, %
- Volume Extension, %
Nutritional parameters

- Moisture
- Protein, % (Kjeldahl)
- Fat, % Soxhlet
- Total Minerals, Ash %,
- Carbohydrates, % (as difference)

for all these analyses: grind beans to 1mm
Nutritional compounds > Moisture

- weight sample and dish
- dry over night, 95-100°C
- re-weight
- weight lost = water content
Nutritional compounds > Protein

- Protein: Kjeldahl
  - quantitative determination of nitrogen N
  - solubilize sample by cooking with sulfuric acid, $\text{H}_2\text{SO}_4$ ($\text{K}_2\text{SO}_4$)
    - ammonium sulfate ($\text{NH}_4\text{SO}_4$)
  - distillation with water steam
  - neutralisation ($\text{NH}_4\text{SO}_4$) with NaOH ➔ $\text{NH}_3$
    - $\text{B(OH)}^-\text{_4} + \text{NH}_3 ➔ \text{NH}_4$
  - titration with $\text{H}_2\text{SO}_4$ (0,1 mol) and indicator
    - used $\text{H}_2\text{SO}_4$ depicts N content (1 ml $\text{H}_2\text{SO}_4$ 0,1 N = 1,4 mg N)
  - $\text{N} \times 6.25 = \%$ protein
Nutritional compounds > Fat

- dry flask over night at 100°C
- weight sample 5 g and flask
- wash sample for 4 hours with ether
- dry flask with collected fat to remove water
- reweigh flask, additional weight is fat
Nutritional compounds > Ash

- dried samples, weighted
- over night at 550°C in a furnace
- remnant = % ash
Nutritional compounds > Carbohydrates

Weender Analysis

- material
  - water (drying at 100°C)
  - anhydrous mass (ash at 550°C)
- organic mass
  - protein
  - fat
- mineral material

Carbohydrates = sample (100%) – moisture % - ash % - protein % - fat %
Sample collection (73) March 2007 in Nepal

- Left 40 at NARC
- Took 39 to Kiel (6 went to both as reference)

Whole beans
- Colour
- Form
- % Foreign matter
- Weight 100 seeds
- Seed volume
- Swelling capacity

Grounded beans (1mm)
- Moisture
- Fat
- Protein
- Ash
- Carbohydrates
pulse varieties
<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Unit</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price</td>
<td>in NRP/ kg</td>
<td>32.0</td>
<td>90.0</td>
<td>58.0</td>
</tr>
<tr>
<td>Weight</td>
<td>g/100 seeds</td>
<td>3.1</td>
<td>54.5</td>
<td>17.7</td>
</tr>
<tr>
<td>Water uptake capacity</td>
<td>in %</td>
<td>84.6</td>
<td>129.9</td>
<td>103.8</td>
</tr>
<tr>
<td>Seed Volume</td>
<td>ml/100 seeds</td>
<td>3.0</td>
<td>46.0</td>
<td>14.0</td>
</tr>
<tr>
<td>Swelling capacity</td>
<td>in %</td>
<td>66.7</td>
<td>175.0</td>
<td>131.3</td>
</tr>
<tr>
<td>Foreign material</td>
<td>in %</td>
<td>0.2</td>
<td>8.9</td>
<td>3.4</td>
</tr>
<tr>
<td>Water</td>
<td>in %</td>
<td>9.7</td>
<td>16.7</td>
<td>11.8</td>
</tr>
<tr>
<td>Ash</td>
<td>in %</td>
<td>2.5</td>
<td>5.2</td>
<td>3.7</td>
</tr>
<tr>
<td>Fat</td>
<td>in %</td>
<td>0.4</td>
<td>6.2</td>
<td>1.7</td>
</tr>
<tr>
<td>Protein</td>
<td>in %</td>
<td>15.0</td>
<td>26.9</td>
<td>23.5</td>
</tr>
<tr>
<td>Carbohydrates</td>
<td>in %</td>
<td>24.7</td>
<td>67.8</td>
<td>55.4</td>
</tr>
</tbody>
</table>
Important pulses in India

Production of different pulses in India 1991-2005

<table>
<thead>
<tr>
<th>Year</th>
<th>Pigeon pea</th>
<th>Chickpea</th>
<th>Lentil</th>
<th>Kidney bean</th>
<th>Black gram</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991-92</td>
<td>3.5</td>
<td>4.0</td>
<td>1.5</td>
<td>0.5</td>
<td>1.0</td>
</tr>
<tr>
<td>1992-93</td>
<td>4.0</td>
<td>4.5</td>
<td>2.0</td>
<td>0.5</td>
<td>1.5</td>
</tr>
<tr>
<td>1993-94</td>
<td>3.5</td>
<td>4.0</td>
<td>1.5</td>
<td>0.5</td>
<td>1.0</td>
</tr>
<tr>
<td>1994-95</td>
<td>4.0</td>
<td>4.5</td>
<td>2.0</td>
<td>0.5</td>
<td>1.5</td>
</tr>
<tr>
<td>1995-96</td>
<td>3.5</td>
<td>4.0</td>
<td>1.5</td>
<td>0.5</td>
<td>1.0</td>
</tr>
<tr>
<td>1996-97</td>
<td>4.0</td>
<td>4.5</td>
<td>2.0</td>
<td>0.5</td>
<td>1.5</td>
</tr>
<tr>
<td>1997-98</td>
<td>3.5</td>
<td>4.0</td>
<td>1.5</td>
<td>0.5</td>
<td>1.0</td>
</tr>
<tr>
<td>1998-99</td>
<td>4.0</td>
<td>4.5</td>
<td>2.0</td>
<td>0.5</td>
<td>1.5</td>
</tr>
<tr>
<td>1999-2000</td>
<td>3.5</td>
<td>4.0</td>
<td>1.5</td>
<td>0.5</td>
<td>1.0</td>
</tr>
<tr>
<td>2000-2001</td>
<td>4.0</td>
<td>4.5</td>
<td>2.0</td>
<td>0.5</td>
<td>1.5</td>
</tr>
<tr>
<td>2001-2002</td>
<td>3.5</td>
<td>4.0</td>
<td>1.5</td>
<td>0.5</td>
<td>1.0</td>
</tr>
<tr>
<td>2002-2003</td>
<td>4.0</td>
<td>4.5</td>
<td>2.0</td>
<td>0.5</td>
<td>1.5</td>
</tr>
<tr>
<td>2003-2004</td>
<td>3.5</td>
<td>4.0</td>
<td>1.5</td>
<td>0.5</td>
<td>1.0</td>
</tr>
<tr>
<td>2004-2005</td>
<td>4.0</td>
<td>4.5</td>
<td>2.0</td>
<td>0.5</td>
<td>1.5</td>
</tr>
</tbody>
</table>

source: Ministry of Agriculture, India
Important pulses in Nepal

Production of pulses in Nepal 1993-2005

* Field pea, Cowpea, Broad bean, Phaseolus, Masyng, Mungi etc.

source: Ministry of Agriculture, Nepal
Comparison Chickpea-Ricebean II

- Weight
- Carbohydrates %
- Water uptake capacity
- Swelling capacity
- Volume

Chickpea - Ricebean
<table>
<thead>
<tr>
<th></th>
<th>B</th>
<th>Standard Error</th>
<th>Stand. B</th>
<th>T</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Konstante)</td>
<td>4.272</td>
<td>0.664</td>
<td>0.631</td>
<td>6.435</td>
<td>0.000</td>
</tr>
<tr>
<td>Dummy_mung bean</td>
<td>0.341</td>
<td>0.049</td>
<td>0.631</td>
<td>6.907</td>
<td>0.000</td>
</tr>
<tr>
<td>Dummy desi chickpea</td>
<td>0.083</td>
<td>0.054</td>
<td>0.211</td>
<td>1.528</td>
<td>0.146</td>
</tr>
<tr>
<td>Dummy yellow pea</td>
<td>-0.210</td>
<td>0.051</td>
<td>-0.534</td>
<td>-4.149</td>
<td>0.001</td>
</tr>
<tr>
<td>Dummy kabuli chickpea</td>
<td>0.281</td>
<td>0.055</td>
<td>0.519</td>
<td>5.094</td>
<td>0.000</td>
</tr>
<tr>
<td>Dummy Cowpea</td>
<td>0.136</td>
<td>0.032</td>
<td>0.381</td>
<td>4.291</td>
<td>0.001</td>
</tr>
<tr>
<td>Dummy Lalitpur 3</td>
<td>0.152</td>
<td>0.024</td>
<td>0.457</td>
<td>6.410</td>
<td>0.000</td>
</tr>
<tr>
<td>Dummy Patan 1</td>
<td>0.088</td>
<td>0.029</td>
<td>0.245</td>
<td>3.010</td>
<td>0.008</td>
</tr>
<tr>
<td>Dummy Patan 2</td>
<td>0.053</td>
<td>0.026</td>
<td>0.150</td>
<td>2.067</td>
<td>0.055</td>
</tr>
<tr>
<td>Dummy Patan 3</td>
<td>0.155</td>
<td>0.025</td>
<td>0.395</td>
<td>6.241</td>
<td>0.000</td>
</tr>
<tr>
<td>Dummy Kalimati 1</td>
<td>0.101</td>
<td>0.029</td>
<td>0.284</td>
<td>3.503</td>
<td>0.003</td>
</tr>
<tr>
<td>Dummy Kalimati 2</td>
<td>0.028</td>
<td>0.027</td>
<td>0.072</td>
<td>1.050</td>
<td>0.309</td>
</tr>
<tr>
<td>Dummy Malekhu</td>
<td>0.140</td>
<td>0.030</td>
<td>0.421</td>
<td>4.618</td>
<td>0.000</td>
</tr>
<tr>
<td>kidney</td>
<td>0.218</td>
<td>0.039</td>
<td>0.487</td>
<td>5.637</td>
<td>0.000</td>
</tr>
<tr>
<td>yellow</td>
<td>-0.038</td>
<td>0.022</td>
<td>-0.141</td>
<td>-1.678</td>
<td>0.113</td>
</tr>
<tr>
<td>green</td>
<td>-0.182</td>
<td>0.040</td>
<td>-0.551</td>
<td>-4.604</td>
<td>0.000</td>
</tr>
<tr>
<td>log weight</td>
<td>1.297</td>
<td>0.680</td>
<td>3.232</td>
<td>1.907</td>
<td>0.075</td>
</tr>
<tr>
<td>log water uptake</td>
<td>-0.844</td>
<td>0.294</td>
<td>-0.248</td>
<td>-2.872</td>
<td>0.011</td>
</tr>
<tr>
<td>log volume</td>
<td>-1.593</td>
<td>0.747</td>
<td>-4.018</td>
<td>-2.132</td>
<td>0.049</td>
</tr>
<tr>
<td>log swelling</td>
<td>0.245</td>
<td>0.192</td>
<td>0.142</td>
<td>1.279</td>
<td>0.219</td>
</tr>
<tr>
<td>log ash</td>
<td>-0.778</td>
<td>0.188</td>
<td>-0.499</td>
<td>-4.129</td>
<td>0.001</td>
</tr>
<tr>
<td>log carbo</td>
<td>-0.493</td>
<td>0.301</td>
<td>-0.397</td>
<td>-1.637</td>
<td>0.121</td>
</tr>
</tbody>
</table>
### Regression II

<table>
<thead>
<tr>
<th></th>
<th>B</th>
<th>stand. B</th>
<th>T</th>
<th>significancce</th>
</tr>
</thead>
<tbody>
<tr>
<td>kidney</td>
<td>0.218</td>
<td>0.487</td>
<td>5.637</td>
<td>0.000</td>
</tr>
<tr>
<td>yellow</td>
<td>-0.038</td>
<td>-0.141</td>
<td>-1.678</td>
<td>0.113</td>
</tr>
<tr>
<td>green</td>
<td>-0.182</td>
<td>-0.551</td>
<td>-4.604</td>
<td>0.000</td>
</tr>
<tr>
<td>log weight</td>
<td>1.297</td>
<td>3.232</td>
<td>1.907</td>
<td>0.075</td>
</tr>
<tr>
<td>log water uptake</td>
<td>-0.844</td>
<td>-0.248</td>
<td>-2.872</td>
<td>0.011</td>
</tr>
<tr>
<td>log volume</td>
<td>-1.593</td>
<td>-4.018</td>
<td>-2.132</td>
<td>0.049</td>
</tr>
<tr>
<td>log swelling</td>
<td>0.245</td>
<td>0.142</td>
<td>1.279</td>
<td>0.219</td>
</tr>
<tr>
<td>log ash</td>
<td>-0.778</td>
<td>-0.499</td>
<td>-4.129</td>
<td>0.001</td>
</tr>
<tr>
<td>log carbo</td>
<td>-0.493</td>
<td>-0.397</td>
<td>-1.637</td>
<td>0.121</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>R</th>
<th>R²</th>
<th>adjusted R²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.988</td>
<td>0.975</td>
<td>0.935</td>
</tr>
</tbody>
</table>

---

<table>
<thead>
<tr>
<th></th>
<th>B</th>
<th>stand. B</th>
<th>T</th>
<th>significancce</th>
</tr>
</thead>
<tbody>
<tr>
<td>kidney</td>
<td>0.190</td>
<td>0.459</td>
<td>3.675</td>
<td>0.002</td>
</tr>
<tr>
<td>angular</td>
<td>0.137</td>
<td>0.447</td>
<td>3.320</td>
<td>0.004</td>
</tr>
<tr>
<td>round</td>
<td>-0.313</td>
<td>-1.142</td>
<td>-8.892</td>
<td>0.000</td>
</tr>
<tr>
<td>brown</td>
<td>-0.166</td>
<td>-0.578</td>
<td>-5.305</td>
<td>0.000</td>
</tr>
<tr>
<td>yellow</td>
<td>-0.179</td>
<td>-0.727</td>
<td>-7.466</td>
<td>0.000</td>
</tr>
<tr>
<td>red</td>
<td>-0.133</td>
<td>-0.266</td>
<td>-2.280</td>
<td>0.036</td>
</tr>
<tr>
<td>log_weight</td>
<td>1.534</td>
<td>3.793</td>
<td>2.925</td>
<td>0.009</td>
</tr>
<tr>
<td>log_water uptake</td>
<td>-0.471</td>
<td>-0.135</td>
<td>-1.870</td>
<td>0.079</td>
</tr>
<tr>
<td>log_volume</td>
<td>-1.815</td>
<td>-4.555</td>
<td>-2.923</td>
<td>0.009</td>
</tr>
<tr>
<td>log % ash</td>
<td>-0.554</td>
<td>-0.324</td>
<td>-2.215</td>
<td>0.041</td>
</tr>
<tr>
<td>log % carbo</td>
<td>-0.578</td>
<td>-0.454</td>
<td>-2.013</td>
<td>0.060</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>R</th>
<th>R²</th>
<th>adjusted R²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.984</td>
<td>0.969</td>
<td>0.932</td>
</tr>
</tbody>
</table>