From land tenure information to bundled agricultural support services: embedding imagery inside smallholders value chains

D. Annerose et al.
The volume of rural land transactions is low and cannot yet support a **standalone commercial service**

### Observations (Kofa)
- Over 75% of parcels are inherited or given (no monetary transaction)
- Less than 25% of parcels are rented or purchased over a 50+ years time horizon for this JotBi survey
- Est. rental or purchase annual rate << 1%
- Land 2015 value: USD 6K/ha (purchase), USD 80/ha (rent)
- Est. value of annual land market transactions over target area < 10K USD

### Access to land

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>inherited</td>
<td>3,786</td>
<td>74.0</td>
</tr>
<tr>
<td>gift</td>
<td>71</td>
<td>1.4</td>
</tr>
<tr>
<td>govt. alloc.</td>
<td>21</td>
<td>0.4</td>
</tr>
<tr>
<td>rental</td>
<td>516</td>
<td>10.1</td>
</tr>
<tr>
<td>purchase</td>
<td>528</td>
<td>10.3</td>
</tr>
<tr>
<td>unknown</td>
<td>192</td>
<td>3.8</td>
</tr>
<tr>
<td><strong>total</strong></td>
<td>5,114</td>
<td>100</td>
</tr>
</tbody>
</table>

### Analysis
- Land saturation is different from pressure on land tenure, which starts with high land use / land value conversion rates associated with pioneer urbanization fronts
- Land tenure transactions are often seen as a ‘free’ public service provided by the government
- No market depth = no land tenure business *strictu sensu*
- Rural smallholders cannot be the paying customers (less so: sole paying customers) of a land tenure service
- [quote PCST] *Obsession with the ‘last mile’ may encourage scientists natural propensity towards megalomania* [unquote]
Agronomic advisory services: who needs them (really), and who pays for them?

- If no tractable business model behind standalone land tenure service to smallholders, how about agronomic advisory services?
  - ISABELA’s 2d value proposition was intended to embed agronomic advisory (the “content”) inside the land tenure service (the “container”)

- Fertility trials as a Trojan Horse? farmers need fertilizers, not the imagery!
  - STARS-ONE as a field-level agronomy optimization support
    - technically possible
    - demand from smallholder farmer? not yet, potential unclear
  - More a savvy Trojan Horse for next-gen advisory services

Back to the drawing board – is our value proposition then:
- *can we help smallholders optimize fertility management directly with our magnificent imagery? MOST LIKELY, NO – difficult to create business traction – cannot activate business at scale through this angle*
- Or rather: *can we use imagery to indirectly facilitate smallholders access to fertilizer? MOST LIKELY, YES*
• Targeting smallholders as main beneficiaries doesn’t mean they need to be regarded as direct recipients, users, or customers of information (imagery-derived, or else)
• More impact on smallholders can be achieved from engaging top-tier partners, who are actually the direct, ‘next users’ of the services

Bundling services in a multi-client business model including input credit, index-based insurance, input supply, etc. based on RS crop productivity indices brings cost of imagery services to an estimated few $/ha

STARS served to confirm what we already knew: services bundling and tiering are essential
How can satellite imagery help develop composite indices for smallholder-friendly agricultural insurance?

- In a specific geography x crop (e.g. Nioro, maize): ‘**maximum attainable yield**’ in a good year is **3,200 kg/ha**
- **Start of season**: all producers subscribe insurance contract with ‘**insurable attainable yield**’ of **2,240 kg/ha** as base
- Attainable and insurable yields are prorated on seasonal climate outcome (bad, modest, medium, good)
- **End of season**: MANOBI collects **actual farmer yields**, function of climate and practice
- **Payouts**: based on start of season insured capital, climatic outcome, **insured attainable yield** (function of climate), **actual farmer yields** at end of season (function of climate and management)

<table>
<thead>
<tr>
<th></th>
<th>Failed start</th>
<th>Bad year</th>
<th>Poor year</th>
<th>Med. year</th>
<th>Good year</th>
<th>Good year</th>
<th>Good year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cumulative rainfall</td>
<td>-</td>
<td>300</td>
<td>420</td>
<td>480</td>
<td>600</td>
<td>800</td>
<td>850</td>
</tr>
<tr>
<td>Potential Attainable Yield</td>
<td>640</td>
<td>1,280</td>
<td>1,920</td>
<td>3,200</td>
<td>3,500</td>
<td>3,500</td>
<td></td>
</tr>
<tr>
<td>Insured Attainable Yield</td>
<td>350</td>
<td>1,000</td>
<td>1,600</td>
<td>2,240</td>
<td>3,000</td>
<td>3,000</td>
<td></td>
</tr>
<tr>
<td>Actual Farmer Yield</td>
<td>-</td>
<td>350</td>
<td>700</td>
<td>1,060</td>
<td>1,230</td>
<td>3,000</td>
<td>3,300</td>
</tr>
<tr>
<td>Payout</td>
<td>-</td>
<td>160,000</td>
<td>FALSE</td>
<td>FALSE</td>
<td>FALSE</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Loss for sub-optimal practices</td>
<td>-</td>
<td>29,000</td>
<td>58,000</td>
<td>86,000</td>
<td>101,000</td>
<td>-</td>
<td>-</td>
</tr>
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- **Case1**: early season drought = failed start > seed cost paid to farmer
- **Case 2**: good year > no payout
- Otherwise: sliding payout scale based on maximum attainable yield, potential attainable yield, actual farmer yield and retail cost
- **Not covered**: losses due to sub-optimal farmer practice
Consortium ➔ 50 millions ha in 5 years
STARS contributed to the emergence of a PPP joint-venture on digital agriculture.
Suite of bundled services:

- **Optimized smallholder input retail** using RS of field-level attainable yield gaps, inverse modeling using in-situ soil data, ExM typologies, etc.
- **Consolidated & expanded smallholder risk reduction** through composite index-based insurance products based on satellite data (DG, Sentinel2, etc.)
- **Field-scale agricultural land valuation** based on multi-year simulations of various agricultural enterprises as parcel level combinations of genotypes-by-management-by-environment (GxExM)
- **Advisory services** combined with land delineation, associated with digital finance = franchised farm advisory and network chain optimization services

Fertilizer recommendations

<table>
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<tr>
<th>Proofs of concept (subdivision):</th>
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<tbody>
<tr>
<td>- hybrid biophysical + socioeconomic targets</td>
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<tr>
<td>- nested sampling frames</td>
</tr>
<tr>
<td>- parcel boundaries</td>
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<tr>
<td>- cropped area/species</td>
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<tr>
<td>- Crop performance monitoring</td>
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<td>- quantified yield gaps</td>
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<td>- fertilizer doses optimized</td>
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**YR1 products graduated to pilots (district) + new proofs of concept:**
- rain gauge indices designed
- remote sensing indices designed
- contracts for enhanced risk management (fertilizer)
- imagery-based apps & advisory services

**YR1 products graduated for upscaling (region) + Financial services**

**YR2 products graduated to pilots + new proofs of concept:**
- mainline commercial banks connected to farmers
- multi-year agricultural parcels simulation & valuation

**YR2 products graduated for upscaling (region) + Adv. servcs.**

**YR3 products graduated to pilots + new proofs of concept:**
- distributed land tenure services w/ financial services
www.manobi.com

Daniel Annerose
CEO, MANOBI
daniel.annerose@manobi.net
Tel: +221 338692050