ISHA RETURN ON INVESTMENT MODEL

Prepared by Arthur D. Little, Inc.

Innovations in Soil Health for Sub-Saharan Africa

ROI Model and Summary – Jab Planter
Bill & Melinda Gates Foundation (‘BMGF’)
Meridian Institute
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1 Technology Description

The jab planter (called the "matraca" in Brazil) is a manual implement with "feeding hoppers" that can be loaded with seeds and/or fertilizer, and opened to release these inputs into the soil. Jab planters are able to plant seeds into untilled soil and through mulch, and are suited to reduced tillage farming systems. This tool allows for both seed and fertilizer to be placed in the soil with more precision (Figure 1).

Figure 1.
2 Smallholder Farmer Needs Being Addressed by the Technology

Adoption of the jab planter by the smallholder farmer will primarily have an impact on labor requirements. Manual planting and fertilizer application is extremely labor intensive, particularly for women smallholder farmers. Due to typically high cost of hired and/or bartered labor and the time demands on farmers, adoption of a technology to reduce the manual labor required for farm cultivation offers value. Studies have indicated that use of the jab planter requires up to four times less labor than planting by hand, and eliminates the need for tilling. The jab planter is widely used in parts of Brazil and China as a part of conservation agricultural practices, but can be applied across all farming practices.

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1 “Manual Direct Seeder or Hand Jab Planter” http://www.fao.org/ag/ca/3g.html
3 ROI Modeling and Analysis

3.1 Description

The Return on Investment Model and Analysis completed for the ISHA project has been developed specifically at the request of the Bill & Melinda Gates Foundation in order to analyze the potential return on investment (ROI) for a range of soil health and plant nutrition technologies under consideration by the ISHA project. The analyses and potential returns are developed and detailed from the perspective of the smallholder farmer. The models and assumptions have been developed using the same methodology to ensure comparability among specific ISHA technologies in which smallholder farmers may elect to invest.

The models and assumptions are described in detail and could be adapted to ROI analyses for different groups of smallholder farmers in different regions. The analyses could potentially also be used for other types of technologies aimed at smallholder farmers.

3.2 Arthur D. Little Inc. Return on Investment for Smallholder Farmers Methodology and Approach

The Arthur D. Little Inc. Return on Investment Modeling and Analysis methodology is comprised of three key steps:

A. Develop Baseline Smallholder Farmer Financial Model
B. Determine Technology-Specific Financial Model Assumptions
C. Calculate Return on Investment

Below is a summary of the approach developed and completed by Arthur D. Little Inc. to calculate the Return on Investment from the smallholder farmer perspective for potential new soil health and plant nutrition technologies.

- Estimated net operating profit generated for the smallholder farmer before and after investment in the technology, including detailed revenue enhancements (such as crop yield increase) and changes in cost structure (such as input and labor expenses).
- Identified and quantified the investments required by the smallholder farmer for successful adoption of the technology.
- Developed assumptions to reflect the opportunity costs incurred by the smallholder farmer as a result of investment in the technology.
- Modeled smallholder farmer financial operating results before and after adopting the new technology.
- Estimated and evaluated return on investment from the smallholder farmer perspective as a result of the new technology.
A consistent baseline model ensures a common starting reference point and facilitates the review of each technology vis-à-vis the other technologies being analyzed. Specific revisions to the baseline model then result from the analysis and review of each technology vis-à-vis its effect on smallholder farmer financial operating results. The Return on Investment is calculated applying the same approach for each technology.

A. Develop Baseline Smallholder Farmer Financial Model

Key assumptions for the baseline smallholder farmer are being used among all technologies under consideration to reflect a “typical” smallholder farmer and enable side-by-side review/comparison of the technologies. The key baseline assumptions are summarized in the table below.

<table>
<thead>
<tr>
<th>Location</th>
<th>Kenya</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of Crop</td>
<td>Maize</td>
</tr>
<tr>
<td>Gender</td>
<td>Male or Female</td>
</tr>
<tr>
<td>Size of Cultivated Area</td>
<td>0.5 Hectare</td>
</tr>
<tr>
<td>Yield</td>
<td>12 bags/hectare (90 kg/bag)</td>
</tr>
<tr>
<td>Farmgate Price Paid to Farmer</td>
<td>$25/bag</td>
</tr>
<tr>
<td>Seed Use Rate</td>
<td>20 kg/hectare</td>
</tr>
<tr>
<td>Seed Cost</td>
<td>$1.25/kg</td>
</tr>
<tr>
<td>Total labor</td>
<td>$100.00/hectare</td>
</tr>
</tbody>
</table>

- **Location:** The ROI model is conducted from the perspective of a smallholder farmer in Kenya.

- **Type of Crop:** Maize is assumed as the model crop being cultivated based on its status as a widely-grown and consumed source of food security and income. Maize represents 21% of all food crops harvested in sub-Saharan Africa, and the total demand for maize is projected to double in the next 40 years. In addition, maize has high versatility—the kernels provide food security due to their high content of essential vitamins and minerals and are therefore a staple food for 50% of the sub-Saharan population, while the leaves, stalk and cob are used as animal feed. The kernels are flexible for the farmer since they can be used either for family consumption or as a cash crop for income.

- **Gender:** The jab planter can be used by either a male or a female and is not biased towards one or the other. Furthermore, much of the manual labor that the jab planter eliminates (specifically planting) is currently provided by women and children.

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2 The key baseline assumptions are based on extensive and detailed review of a wide range of academic journal articles, economic studies, government databases, interviews with project Experts, and primary field research (discussions with smallholder maize farmers, aid workers, and expert stakeholders, such as the East African Grain Council, in Kenya and Ghana in August, 2009).

3 “Emerging Technologies to Benefit Farmers in sub-Saharan Africa and South Asia.” http://www.nap.edu/catalog/12455.html

4 “Crop Production.” http://www.fao.org

- Size of Cultivated Area: A typical smallholder farmer has a farm size of 2 hectares, of which 25% is used for growing maize resulting in cultivation area of 0.5 hectare.

- Yield: The typical maize yield is 12 bags/hectare with each bag containing 90 kg of maize kernels. Maize is sold at a price of $25/bag, for total revenue of $150 from a 0.5 hectare plot.

- Seeds: Seeds are planted at a rate of 20 kg/hectare, and typically cost the farmer $1.25/kg for a total cost of $12.50 to cover a 0.5 hectare plot.

- Total Labor: Labor can be divided up into seven key tasks, each of which represents a proportion of the total labor estimated at 100 days per hectare. The key tasks include:
  - Land Preparation: 18.2 days/hectare
  - Planting: 7.5 days/hectare
  - Fertilizing: 4.4 days/hectare
  - In-crop Weeding: 38.7 days/hectare
  - Harvesting: 24.5 days/hectare
  - Threshing: 6.7 days/hectare

- Total Baseline Labor Costs of $50.00 are estimated based on an estimated wage rate of $1.00 (80KES) per day for smallholder farmer tasks, and labor requirements to cultivate a 0.5 hectare plot. The resulting labor costs associated with each aspect of crop cultivation are estimated as follows:
  - $9.10 for land preparation
  - $3.75 for planting
  - $2.20 for fertilizing
  - $19.35 for weeding
  - $12.25 for harvesting
  - $3.35 for threshing

From the Baseline assumptions, the Baseline Net Income of the smallholder farmer is calculated. The Baseline Net Income is the result of subtracting the cost of inputs, equipment expenses, and labor from the revenue generated.

Revenue generated from the baseline model is $150 based on the assumption that 6

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6 Source of Estimate: ADL synthesis of discussions with Expert Advisors (Jo Anderson, Rob Delve, Saidou Koala, Pieter Pypers, Paul Seward)

7 Source of Estimate: ADL synthesis of discussions with Expert Advisors (EAGC, Mike Robinson, Paul Seward)

8 Source of Estimate: ADL synthesis of discussions with Expert Advisors (Mike Robinson, Paul Seward)

9 First Hand Field Data from Malawi: Augustine Langintuo, AGRA

10 Source of Estimate: in-depth expert interview with Paul Seward, FIPS-Africa and discussions with representatives from East African Grain Council, Kenya
bags of maize kernels are produced from a 0.5 hectare plot (based on a production rate of 12 bags/hectare) and sold at a price of $25 each.

Baseline Total Expenses of $62.50 are comprised of the following items:

- Seeds ($12.50) and
- Labor ($50)

Baseline Net Income of $87.50 is calculated as follows:

Baseline Revenue – Baseline Total Expenses – Baseline Net Income

$150.00 - $62.50 = $87.50

B. Determine Technology-Specific Assumptions

<table>
<thead>
<tr>
<th>Jab Planter</th>
<th>$30.00 amortized over 3 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Labor</td>
<td>$91.80/hectare</td>
</tr>
</tbody>
</table>

Following the adoption of the jab planter technology, certain baseline assumptions are adjusted as a result of increased input costs and reduced labor costs.

- **Jab Planter**: Reliable, high quality jab planters are produced in Brazil and sold at a price of $30.00, with a useful life of 3 years\(^{11}\). This results in an effective cost of $10 to the farmer for one growing season. This assumption implies that production capacity for similar jab planters could be established locally, rather than importing jab planters from abroad (i.e. Brazil)

- **Total Labor**: The jab planter is a labor saving technology, which eliminates the need for soil tilling during land preparation and reduces the labor needed for planting. The total amount of time needed for land preparation is 18.2 days/hectare, of which 15.5 days/hectare (124 hours/hectare) is dedicated to clearing the land of weeds\(^{12}\). The remaining 2.7 days are assumed to be used for tilling. The use of a jab planter leaves only the weed clearing labor of 15.5 days/hectare. In addition, the jab planter reduces the labor required for planting from 7.5 days/hectare to 2.0 days/hectare\(^{13}\). Based on an estimated total labor savings of 4.1 days for a 0.5 hectare plot, the revised Baseline Total Labor Expense becomes $45.90

From these new, technology-specific assumptions, the potential new net income of the smallholder farmer (New Technology Net Income) is calculated.

1. The New Technology Revenue as a result of using a jab planter is assumed to remain the same ($150.00) since its benefits are solely related to labor savings

2. In addition to the $12.50 required to purchase seeds, the farmer incurs the

\(^{11}\) Source of Estimate: Validation by experts attending the London Workshop, May 2009

\(^{12}\) Source of Estimate: Leonard Gianessi, CropLife

\(^{13}\) “Manual Direct Seeder or Hand Jab Planter” http://www.fao.org/ag/ca/3g.html
following expenses when using a jab planter:

- Expense of $10.00 annually in each of three years for the jab planter, which represents ($30.00) amortized over its three-year useful life
- Labor expense totaling $45.90

The New Technology Expenses therefore total $68.40

New Technology Net Income is calculated as follows:


$150.00 – 68.40 = $81.60

**Incremental Investment Required**

The Incremental Investment Required by the smallholder farmer relative to growing a single crop using herbicide technology totals $5.90, based on the sum of the following:

- Amortized Jab Planter Expense: $10.00
- Net decrease in labor required: ($4.10)

**C. Calculate Return on Investment**

The Return on Investment as a result of using the a jab planter is the ratio of the change in net income, less the Technology-Specific Cost of Capital, divided by the Incremental Investment required, as shown below:

\[
\frac{\text{Change in Net Income} \ - \ \text{Cost of Capital}}{\text{Incremental Investment Required}}
\]

**Change in Net Income**

The change in net income of ($5.90) is calculated by subtracting the net income before using a jab planter (Baseline Net Income) from the net income resulting from the use of a jab planter (New Technology Net Income)

New Technology Net Income – Baseline Net Income = Change in Net Income

$81.60 – $75.70 = ($5.90)

**Technology-Specific Cost of Capital**

The financial model and analysis reflects the assumption that very little or no cash flow exists for them, and that therefore, the smallholder farmer must borrow 100% of the capital needed to purchase the herbicide and to hire the herbicide spraying service.

The Kenya Agency for Development of Enterprise and Technology (KADET), a microfinancing institution in Kenya, offers these types of loans at an effective annual interest rate of 30% (which includes transaction fees).

The farmer is assumed to get a loan of $30.00 to cover the cost of purchasing the jab planter.

The $9.00 cost of capital is therefore assumed to equal the interest (and fees) that
the farmer pays on the loan, or:

\[
\text{Cost of Capital} = \text{Interest/Fees} \times \text{Capital Needed} = 30\% \times 30.00 = 9.00
\]

**Return on Investment**

The Return on Investment from the smallholder farmer perspective is calculated as follows:

\[
\frac{\text{Change in Net Income} - \text{Cost of Capital}}{\text{Incremental Investment Required}} = \frac{5.90 - 9.00}{5.90} = -253\%
\]
### 3.3 ROI Summary and Conclusions

<table>
<thead>
<tr>
<th>Herbicide</th>
<th>Baseline</th>
<th>New Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revenue</td>
<td>$150.00</td>
<td>$150.00</td>
</tr>
<tr>
<td>Inputs</td>
<td>$12.50</td>
<td>$12.50</td>
</tr>
<tr>
<td>Equipment/Services</td>
<td>$10.00</td>
<td></td>
</tr>
<tr>
<td>Labor</td>
<td>$50.00</td>
<td>$45.90</td>
</tr>
<tr>
<td><strong>Total Expenses</strong></td>
<td>$62.50</td>
<td>$68.40</td>
</tr>
<tr>
<td>Net Income</td>
<td>$87.50</td>
<td>$81.60</td>
</tr>
<tr>
<td>Cost of Capital</td>
<td></td>
<td>$9.00</td>
</tr>
<tr>
<td>Incremental Investment</td>
<td></td>
<td>$5.90</td>
</tr>
<tr>
<td><strong>ROI</strong></td>
<td></td>
<td>-253%</td>
</tr>
</tbody>
</table>

Based on the financial modeling and detailed assumptions developed for this analysis, there is a negative Return on Investment for the smallholder farmer relative to using a jab planter on a standalone basis. This technology and modeling reflects a challenge presented as a result of consistently applying a methodology from the perspective of the smallholder farmer. When analyzed on a standalone basis, the jab planter will virtually always result in a negative ROI for the smallholder farmer, as there is not a direct impact that increases crop yield (revenue) or reduces expenses beyond a moderate level of labor-savings. In fact, purchasing the jab planter is a significant incremental investment.

In order for more value to be created for the smallholder farmer, this technology needs to be evaluated in combination with other technologies (e.g. herbicide) and as part of a longer-term effort towards promoting no-till and conservation agriculture, which includes longer-term benefits of improving crop yield on an ongoing basis.

*This report was prepared by Arthur D. Little, Inc. (“ADL”) under contract to Meridian Institute on terms specifically limiting ADL’s liability. Our conclusions are the results of our exercise of our best professional judgment, based in part upon materials and information provided to us by Meridian Institute, the Bill & Melinda Gates Foundation, and others. Use of this report by any party for whatever purpose should not and does not absolve such party from using due diligence.
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