GARI PROCESSING TECHNOLOGIES DEEP DIVE
GARI REVOLUTION PRESENTATION

October 2016
In 2014, the Gates Foundation approached the Context-Sahel team to conduct a deep dive of opportunities for mechanization in the gari processing sector.

The purpose of the study was to inform the Gates Foundation’s decision on where to invest in order to have the most impact. Our study made recommendations around:

- High potential technologies
- Best distribution models or paths to market (P2M)
- Possible funding formats for technology adoption
- High impact intervention designs

Our purpose today is to take you through our approach and present some practice examples as a prelude to the roadmap development working sessions.
According to NAERLS, as of 2013, Kogi, Imo, and Oyo are the 2nd, 5th, and 12th largest states by production respectively.

Kogi is also the 2nd largest state in terms of area grown.

Imo has the highest yield of the three and is 5th overall.

Each state is located in a separate zone: Kogi in North Central (largest), Oyo in South West (second largest), and Imo in the South East.

Cross River, Enugu, and Benue are the other top production states (#1, #3, #4).

1 Agricultural Performance Survey of 2013 Wet Season in Nigeria, by National Agricultural Extension and Research Services (NAERLS), 2013
TARGET TECHNOLOGIES WERE EVALUATED VIA A STAGEGATE APPROACH THAT INCLUDED ECONOMIC BENEFIT, P2M, INTERVENTION ANALYSIS

1. Initial Technology Viability Assessment & Screening
2. Economic Feasibility Analysis
4. Intervention Possibilities & Funding Format Options
5. Recommended Approaches
AN OVERVIEW OF STEPS IN TRADITIONAL GARI PROCESSING AND SELECTED AREAS FOR FURTHER EVALUATION

1. Peeling
   - Manual Peelers
   - Automated Peelers
2. Washing
3. Grating
   - Manual Graters
   - Automated Graters
4. Fermenting
5. Pressing
6. Sieving
   - Improved Pans
7. Frying
   - Chimi Chimi
   - Enclosed Fryers
8. Sieving
9. Milling
   (Optional, for uniform sizing)
10. Packaging

For this report, several manual (low-end) and automated (high-end) peeling, grating and frying technologies have been selected for evaluation.

Traditional Processing

- Gari processing is still very traditional and is primarily done using manual methods
- It is a time consuming and labor intensive process
- Manual methods are slower, and also increase losses
- Peeling is done with straight knives at an average rate of 25 kg/hr
- Manually grating one ton of cassava can take 10-15 days of effort (per person)
- Fermenting and pressing can take several (2-5) days

For further evaluation:

- Technology Economic Benefit Assessment
- Improved Pans
- Chimi Chimi
- Enclosed Fryers
- Industrial Roasters

References:
ASIDE FROM FRESH TUBERS AND TRANSPORT, FRYING IS THE LARGEST LABOR COST, FOLLOWED BY PEELING

**PROCESSOR EXAMPLES**

1. **Kogi State**
   - Traditional methods. Buy cassava at planting and manage until harvest.
   - *Efficiency:* 24%
   - *Price/kg:* N60
   - *Margin:* 9.6%
   - Cassava Processor Budgets
     - Cassava Transport: 7,000
     - Peeling: 1,200
     - Grating: 800
     - Pressing: 400
     - Frying: 1,920
     - Fuel: 13,020
     - Other: 14,400
     - Total Cost: 27,420
     - Total Revenue: 32,000

2. **Oyo State**
   - Traditional methods. Buy cassava from farmers and middle-men (transporters).
   - *Efficiency:* 19%
   - *Price/kg:* N60
   - *Margin:* 9.5%
   - Cassava Processor Budgets
     - Cassava Transport: 6,000
     - Peeling: 720
     - Grating: 400
     - Pressing: 200
     - Frying: 1,400
     - Fuel: 10,320
     - Other: 11,400
     - Total Cost: 21,720
     - Total Revenue: 32,000

3. **Ogun State**
   - Mix of manual and auto frying. Source direct from farmers or their own 40 Ha farm.
   - *Efficiency:* 33%
   - *Price/kg:* N96
   - *Margin:* 25.4%
   - Cassava Processor Budgets
     - Cassava Transport: 11,000
     - Peeling: 2,000
     - Grating: 844
     - Pressing: 4,500
     - Frying: 3,833
     - Fuel: 23,866
     - Other: 1,689
     - Total Cost: 35,555
     - Total Revenue: 32,000

*Source: Context Network 2015 (field research findings and analysis)*
WOMEN OCCUPY MAJOR ROLES IN PROCESSING: ANALYSIS NEEDS TO GO BEYOND ECONOMICS AND INCLUDE EQUITABLE TRANSITION STRATEGIES

Processing for Food and Income

- There is a complex interaction between cassava farming households, gari processors and markets.
- Often the women of the farming households are not only processing for household consumption, but also as laborers for micro-processing centers.
- These distinctions between processing for household consumption or for income create overlap in the segmentation of processors.
- Household processing tends to be less sophisticated, while MPCs sometimes adopt improved technologies (e.g. enclosed fryers).

OPPORTUNITY: Target MPCs for adoption of improved low-end technologies (e.g. enclosed fryers and manual peelers). Employees will use the MPCs technology and hopefully adopt for personal household use as well – increasing market penetration.
Figure 3.2: A Conceptual Framework for Enhanced Cassava Processing in Nigeria

Source: Adapted from Tiffin, (1997); Arnold and Bell, (2001); Ragasa et al., 2010; Siyanbola, (2010)

Key linkages between primary support sectors are needed to achieve sustainable technology adoption.

**Evaluation of Technological Capability and Innovations in the Nigeria Cassava Processing Industry**

**Key Linkages**

- **Knowledge Institution Sector**
  - R&D Capability
  - Innovation Capability
  - Linkage Capability
  - Commercialization Capability

- **Cassava Farm Sector**
  - Investment Capability
  - Production Capability

- **Cassava Processing Industrial Sector**
  - Investment Capability
  - Production Capability
  - R&D Capability
  - Innovation Capability
  - Product Innovation
  - Process Innovation
  - Market Innovation
  - Organizational Innovation

- **Government Sector**
  - Policy
  - Infrastructure
  - Finance

- **Finance Sector**
  - Agric. Bank
  - Industrial Banks
  - Commercial Banks
  - Venture Capital

**Enhanced Cassava Processing Industry**

- Sales Turnover on Cassava Utilization
- Market Share
- Manufacturing Value Added per Capital Investment on Cassava
- Increased Products Exportation
- Employment Generation

Source: Evaluation of Technological Capability and Innovations in the Nigeria Cassava Processing Industry; Abolaji Dauda Dada; August 2012
MAXIMUM IMPACT AND UPTAKE IS ACHIEVED WHEN INTERVENTIONS ARE IMPLEMENTED TOGETHER

**Integrated VC Improvement**
Linking Interventions to Bolster Impact and Adoption along the VC

Program inclusion and access to benefits can be predicated on reqs. for each player group in order to create synergy between interventions and maximize impact.

**BENEFIT**
- Access to Designs, Materials & Training
- Access to Credit
- Access to Extension & Improved Varieties

**REQUIREMENT**
- Must Meet Certification Standards
- Purchasing from Organized Farmer Groups/Co-ops
- Dedicate a Portion of Land to Growing Improved Seeds

Source: Interviews conducted with key stakeholders (including NRI, C:AVA, AATF, NRCRI, Burro, focus state ADPs, CIAT, GCP, and others)
**SELECTED TECHNOLOGIES MUST BE ADAPTIVE IN ORDER TO PENETRATE RURAL MARKETS AND AFFECT SMALL PROCESSORS AND SHFS**

**PROCESSOR SEGMENTATION**

<table>
<thead>
<tr>
<th>% of Total Processors</th>
<th># of Employees(^1)</th>
<th>Locale</th>
<th>Total Volume Processed(^2)</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1%</td>
<td>10-30</td>
<td>Major Urban Centers</td>
<td>5-100 T/day</td>
<td>Own large fields; N100-500 million invested in equipment</td>
</tr>
<tr>
<td>5-10%</td>
<td>3-10 (operation of equipment)</td>
<td>Regional Centers</td>
<td>1 T/day</td>
<td>At least N10 million invested in equipment; automated vs. labor</td>
</tr>
<tr>
<td>20-30%</td>
<td>Varies (labor for processing)</td>
<td>Rural Towns &amp; Villages</td>
<td>200 kg/day</td>
<td>Own a shed, grater, 1-2 presses and a modern roaster; mostly labor</td>
</tr>
<tr>
<td>60-75%</td>
<td>Family Labor</td>
<td>Individual Farms</td>
<td>30-50 kg/day</td>
<td>Women and children workers; artisanal, manual processing</td>
</tr>
</tbody>
</table>

\(^1\) Capacity Innovations in Cassava Production, Harvesting and Processing in Nigeria; Abolaji D. Dada et al.; 2007
\(^2\) Cassava Value Chain Analysis in the Niger Delta; Foundation for Partnership Initiatives in the Niger Delta (PIND); 2011

**Automated Peelers & Fryers Focus**

**Manual Peelers & Enclosed Fryers Focus**

**Large & SMEs**

**MPCs**
## Adoption Constraints Help Inform Success Criteria for Potential Investments and Interventions

<table>
<thead>
<tr>
<th>Adoption Constraints</th>
<th>Success Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perception/Awareness of Benefit</td>
<td>A) Efficiency and Profitability Research</td>
</tr>
<tr>
<td></td>
<td>B) Quality Standards for Technologies</td>
</tr>
<tr>
<td>Access to Credit/Capital</td>
<td>Financial Products for Small Business Loans</td>
</tr>
<tr>
<td>Access to Repair Services</td>
<td>Fabricator Know-how and Spare Parts</td>
</tr>
<tr>
<td>Supply Consistency</td>
<td>A) Organized Supply Channels</td>
</tr>
<tr>
<td></td>
<td>B) Access to Improved Seed Varieties</td>
</tr>
<tr>
<td>Ability to Market Additional Supply</td>
<td>Pre-Arranged Downstream Demand Outlets</td>
</tr>
<tr>
<td>Social/Cultural Hurdles</td>
<td>Impactful Adaptive Technologies</td>
</tr>
<tr>
<td>Gender/Labor Equitability</td>
<td>Inclusive technology transition strategies</td>
</tr>
</tbody>
</table>

- **Farmers**
- **Fabricators**
- **Processors**
- **NGOs & Programs**
- **Welders & Mechanics**
- **Co-op Lending & Micro Finance**
PEELER EXAMPLE: DEVELOPING FEE-BASED SERVICE MODEL WILL BUILD AWARENESS, CHANGE NEGATIVE PERCEPTIONS AND REDUCE COSTS

Augmenting the service operators’ offerings with automated peelers for SHFs and processors

Description

- While they address a critical pain point in processing, there are mixed perceptions of automated peelers due to varying qualities of machines from fabricators.
- Automated peelers require training for both fabrication and operation, as well as consistent water supply.
- High investment requirements restrict purchase of automated peelers by individuals and MPCs, though SMEs and commercial processors can afford.
- Offering peeling services via a fee-based service model would make usage available to all customer levels and help build awareness and change perceptions.

Funding Mechanics

- Create a financing program for service operators giving access to funds for peeling machines with payment schedule based on monthly tonnage peeled.
- Focus on identifying existing graters and millers in dense processing hubs.
- Link manufacturers directly to the operators for service, support and training, as well as iterative designing.

Advantages

- Provides automated peeling services without the prohibitive up front investment.
- Employs a familiar fee-based service model and existing community touchpoints.
- Builds awareness of automated peeling benefits and changes negative perceptions.
- Offers an avenue for iterative testing of new models via manufacturer-operator linkages.
- Fosters a hub based around high-volume processing services – peeling, grating, jacking, milling.

Drawbacks

- Peelers require access to consistent water supply.
- Complex success requirements depend on linking quality equipment manufacturers to operators with access to credit and building strong demand for services (co-locating in processing hubs).
- Educating customers on the time savings of automated peeling – 80-120kg in 4 minutes followed by minor finishing – even though cost per kg can be equivalent.

ALTERNATIVES: sell automated peelers to local SMEs for their own use, but can augment their income by renting it once they have hit capacity
AUTOMATED PEELED: LARGEST IMPACT RADIUS PER MACHINE DUE TO HIGH DAILY VOLUME AND FEE-BASED SERVICE MODEL

**Automated Peelers**

**Stakeholder Impact Assessment**

- **Owner/Operator**
  - See benefits listed below in table.

- **Processors**
  - Reduced labor and less wastage; fee-based service.¹

- **SHFs**
  - SHFs affected varies based on average yields in states.²

**Waste Reduction** 38%

**Time Reduction**³ 85%

**Peeling Cost Reduction** 61%

**Margin Increase**⁴ ≈1-3%

**COSTS**

<table>
<thead>
<tr>
<th></th>
<th>Cost</th>
<th>Output</th>
<th>Cost/Kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automated Peeler</td>
<td>N350-950,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ex #1: Manual</td>
<td>100</td>
<td>120 kg/hour</td>
<td>0.83</td>
</tr>
<tr>
<td>Ex #2: Manual</td>
<td>N3,000/1.5 tons</td>
<td>300-500 kg/day</td>
<td>2.00</td>
</tr>
<tr>
<td>Ex #3: Diesel</td>
<td>1.5L @ N150</td>
<td>150 kg/hr</td>
<td>1.50</td>
</tr>
<tr>
<td>Ex #4: Electric</td>
<td>N450</td>
<td>2,000 kg/hr</td>
<td>0.23</td>
</tr>
<tr>
<td>Auxiliary Staff</td>
<td>N1,900/day</td>
<td>16 T/day</td>
<td>0.12</td>
</tr>
<tr>
<td>Ex #5: Electric</td>
<td>5,500</td>
<td>900 kg/hr</td>
<td>0.76</td>
</tr>
</tbody>
</table>

**Average Manual**  Average Electric  Average ALL

| Cost/T Range ($) | $7.46   | $2.91   | $5.73   |
| Cost Savings     | $4.54   |         |         |
| Breakeven (Tons) | N500,000 converted @ N190=$1 | 579     |
| Breakeven (Days) | T/Day @ 50%= 3.6 | 161     |

**Source:** Context Network 2015 (field research findings and analysis)

¹ Assumes that services are provided to local MPCs and SMEs (requirements ranging from 1.0-2.5 tons of fresh root peeling per day) @ max capacity

² Assumes average yields and farm sizes (12.2 T/Ha and 0.58 Ha) and converts daily volume demand to annual fresh tonnage requirements

³ Assumes highest manual rate (120 kg/hr) and lowest automated rate (800 kg/hr) to be as conservative as possible

⁴ Since peeling costs are already a small portion of Total Cost (about 6-9%), even large reductions have small margin impact
**RECOMMENDATION: FEE-BASED SERVICES FOR AUTOMATED PEElers**

**Key Recommendation:** Partner with BOI CAP Fund to foster adoption of automated peelers with millers and graters.

**Key Intervention Elements**

1) Partner BOI CAP Fund in SCPZ target zones (includes Oyo and Kogi)
2) Work with grating and milling service providers to access credit, purchase peelers and provide fee-based services to SHFs and local processors
3) Wide base of customers can help address supply consistency issues
4) Capacity building, SON training and certification for fabricators

**Reasons to Believe:**

- Uses a familiar model (fee service) to build awareness
- Low cost option (fees) for SHFs and processors
- Existing base of customers (service providers/processors)
- Addresses key pain point - peeling (manual methods)

**Risk Considerations:**

- Relatively large capital investment requirements
- Adoption limited by access to water supply
- Mixed perceptions of peeling technologies
- Still requires ≈25% labor for operators and finishing peelers

**Funding Format**

Loan Guarantees under the BOI CAP Fund system; PRIs for training and certification efforts

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1 **Assumptions:** 800-1,000 kg output per hour for 8 hours a day; running at 50% capacity; 300 day/year operation
2 **Assumptions:** 0.58 Ha average farm size; 11.1-15.9 T/Ha average yield; 70% of production sold for gari processing; 33.3% per state weighting

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**Oyo, Kogi & Imo**

SHFs: 966,000
Yield: 11-16
T/Ha
Area: 560k Ha
Prod: 8.0MMT

<table>
<thead>
<tr>
<th>Targets</th>
<th>Peelers</th>
<th>Throughput</th>
<th>Fresh Tons</th>
<th>SHFs Req’d</th>
<th>Laborers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1,000</td>
<td>0.8-1.0 T/hr</td>
<td>1.08 MMT (14%)</td>
<td>191,000</td>
<td>2-3,000</td>
</tr>
</tbody>
</table>
QUESTIONS FOR CONSIDERATION IN WORKING SESSIONS ON ROADMAP DEVELOPMENT

Key Questions:

- What are the biggest constraints/pain points that need to be addressed to improve gari processing in your specific topic area?
- What potential solutions or initiatives should be considered? What technologies are best positioned for adoption?
- How would you evaluate their feasibility? How would you evaluate their sustainability? What quantitative and qualitative analysis would need to be done to determine how actionable they can be? How would you measure impact?
- What ecosystem actors need to be involved? What role should they play? Which partnerships and/or linkages would be needed?
- What other factors should be considered to promote equitable change? What are some of the ways a potential program could address gender issues in gari processing? How will potential solutions impact the labor market? How can we develop a plan for labor transition strategies? (e.g. jobs for turning peels into feed)
- How would you sequence and prioritize these potential solutions?
**FARMER/PROCESSOR TYPE IS PREVALENT IN NIGERIA WITH STRONG REPRESENTATION IN AREAS WITH FRAGMENTED PRODUCTION (SWAMP)**

### Nigerian Cassava Farmer Typology Overview

**Percentage of farmers and volume produced**

*(estimated based on commentary from farmers in Oyo and Benue)*

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Sales Criteria</th>
<th>% of Farmers</th>
<th>% of Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TYPE 1</strong></td>
<td>Weight-Based Seller</td>
<td>by weight only</td>
<td>15%</td>
<td>17%</td>
</tr>
<tr>
<td><strong>TYPE 2</strong></td>
<td>Weight &amp; Variety Seller</td>
<td>by weight and variety</td>
<td>25%</td>
<td>25%</td>
</tr>
<tr>
<td><strong>TYPE 3</strong></td>
<td>Farmer/Processors</td>
<td>sell processed products</td>
<td>55%</td>
<td>50%</td>
</tr>
<tr>
<td><strong>TYPE 4</strong></td>
<td>Industrial Sellers</td>
<td>by starch content</td>
<td>5%</td>
<td>8%</td>
</tr>
</tbody>
</table>

| **TYPE 1** | Mainly sell fresh tubers based on weight to collectors operating their own transport. Collectors organized and paid for the harvest, unless tubers were sold to processors. | **Current Situation:** High yielding may not be high starch content. Farmers may make good income, but processors get low gari yields, thus have low or no profit in season with low recovery rate. |
| **TYPE 2** | Located in villages where half of the people grow cassava, and the other half processes. As a result, variety matters. Roots sold via transporters, or directly to processors. | **Current Situation:** Farmers get paid higher prices for higher gari yields and get good income. Processors also make good profit from good gari yields. |
| **TYPE 3** | Process into gari and akpu for sale primarily to local collectors, as well as some local retail. Understand conversion rates and grow varieties with highest DMC. | **Current Situation:** Farmers/processors choose local varieties with high starch yield and good income. Processors make reasonable income from good gari and akpu yields. |
| **TYPE 4** | Sold by starch content directly to processing industries such as flour, starch or ethanol factories. Transporters were involved as a service, hired by one party or the other. | **Current Situation:** Cassava with low starch content is sold to local processors and high starch content sold to factories for high income. Local processors suffer from low-yielding var. |

* May be overstated since this type was exclusively reported in Benue, Type 1, 2, and 4 were in Oyo as well as Benue.

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1. Cassava Value Chain Assessment in Oyo and Benue States, Nigeria; Dai Peters Report to CRS-Nigeria; February 2014
2. Estimate is in line with findings from “Dynamics of the Rural Technology Adoption Process in Rural-Based Cassava Processing Systems in Southwestern Nigeria”; K. Adebayo, April 2006 (estimates 50% of processors have farming as their main occupation)
NOT ALL TECHNOLOGY IMPROVEMENTS DIRECTLY BENEFIT SHFS; SOME PASS-THROUGH BENEFITS FROM PROCESSORS ARE EXPECTED THOUGH

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Benefit Description (for SHFs)</th>
<th>Farmers Affected</th>
</tr>
</thead>
</table>
| 1) Improved Manual Tools & Enclosed Fryers | Ø Higher income from sale of processed goods (volume increase from improved efficiency)  
Ø Lower processing losses (from peeling)  
Ø Lower fuel costs (from enclosed fryers)  
Ø Improved labor conditions | Type 3 (direct)  
Type 1 & 2 (indirect – through labor as peelers and roasters) |
| 2) Organizing Rental Services | Ø Exposure to new technologies  
Ø Training on usage and benefits  
Ø Training for rental owners (how to run as a business)  
Ø Time and labor savings | Type 3 (immediate – new processing service options)  
Type 1 & 2 (long term – additional demand from local processors) |
| 3) Capacity Building with Fabricators | Ø Demand for higher starch or DMC varieties (better prices)  
Ø Lower PHL Losses (more volume sold)  
Ø Higher Efficiency (more volume sold)  
Ø Increasing Technology Adoption (more volume sold)  
Ø Linkage to Processors (fewer middlemen = better margins/prices) | All Types  
Type 2 (direct – higher in-village demand source)  
Type 3 (direct – loans for better processing equipment)  
Type 1 & 4 (direct – additional demand and better prices) |
| 4) Financing for Processors | | |