# BoP Technology Study and Product Incubation: Agriculture Sector

*Phase 1: BoP Technology Selection*

THE SASAKAWA PEACE FOUNDATION

# Executive Summary (1/4)

**Context**

- BOP population have yearly income from agriculture of USD 2.0 to 2.5 trillion, with proportion of the labor force involved in agriculture ranging from 35% - 70% in many countries (e.g. India, China, Nigeria). This represents significant social and financial 'inclusive business' opportunities for corporations
- The BoP Technology Selection Project seeks to identify high-potential agricultural technologies and key success factors for business models commercializing these technologies. We conducted detailed reviews of two technology areas (Machinery and equipment; Post-farm primary processing, with a focus on rice processing) to assess the relevance of modern technologies for which Japanese companies have high competency and to identify models that could make these technologies accepted by BoP. We also conducted high-level reviews of additional areas (Seeds, Fertilizer, Cold chain) to identify innovative models of companies engaging with BoP in agriculture in these other technology areas

**Agricultural Mechanization**

- Today only 10% of farms in Sub-Saharan Africa and 40% of farms in Asia utilize tractor power. This lack of mechanization is a key driver of lower agricultural productivity in African and Asian countries, with lack of agricultural mechanization resulting in economic, environmental and social costs
- To target farmers in Asia and Africa, the majority of whom have <2ha of land, products and business models must be tailored to cater to small farm sizes. As Japanese farmers also typically have land holdings of <2ha, Japanese technology is likely a well suited starting point to address BoP farmer needs – though likely requiring simplification of functionality in combination with innovative business models
- Along each step in the agricultural process (e.g. land preparation, harvesting), a distinct landscape of technologies exists which can be used across farms with varying mechanization sources (human-powered, animal-powered, tractor-powered). Technology choice needs to be tailored to factors such land holding size, region, crop, available power sources, etc.

# Executive Summary (2/4)

**Agricultural Mechanization (cont.)**

- Among mechanized technologies, more advanced technologies relying on motorized power sources tend to have higher upfront cost but are more cost-effective to run per hectare in the long-run than traditional or manual technologies. Yet, these technologies tend to require greater complementary support and fuels – such as higher maintenance needs, higher complexity of operation that necessitates training, and fuel requirements – which makes adoption by BoP difficult. Higher upfront cost also makes it difficult for BoP farmers who do not have access to finance for machine purchase
- In order to enhance the market penetration of these modern technologies, innovative business models are necessary to address these challenges. A review of existing players revealed that these challenges are addressable with some innovation. Existing models are addressing these issues through focus on cost sharing with group usage/ rental models, spare parts availability and training of operators for equipment usage and servicing; review of existing players also highlights the importance of enabling environment factors such as presence of farmer organizations that enable efficient targeting of smallholders, availability of equipment financing focused on smallholder needs and training institutes

**Rice Processing**

- Today the majority of mills in leading rice-growing countries (e.g. China, India, Bangladesh, Indonesia) as well as growing rice producers/consumers (e.g. SSA countries) use non-mechanized processes. For example, only 25% of Indian mills and only ~5% of mills in SSA are semi-automatic or automatic
- The two basic processes of rice milling are hulling (husk removal) and whitening (bran removal). Mills that split these processes into two different stages typically have higher milling efficiency (higher recovery of edible rice). Fully automatic mills also have additional processes such as de-stoning, grading, mixing and mist polishing
- Generally, the landscape of available mill technologies can be classified by level of automation (reflected in number of included processes), capacity, milling efficiency and number of stages

# Executive Summary (3/4)

**Rice Processing (cont.)**

- Modern mechanized milling enables higher recovery of edible rice and produces higher quality rice; these advantages are reflected in higher sales volumes and prices, and lower waste. Modern milling typically represents less than 5% of costs in the overall value chain but can increase revenue per ton of paddy anywhere from 30-100% or more
- The full realization of price increase is typically only possible when modern milling is coupled with good market access, be that through wholesalers, collectors, millers, miller-traders, or corporate outgrowers. It is also critical to have proper drying and cleaning of paddy for advanced milling to produce high-quality rice. For many countries (e.g. in SSA) where distinct markets exist for local versus imported rice, modern milling combined with improved market access can enable rice from local smallholders to compete with the import market for rice, strengthening local smallholders' market position and moving the country toward enhanced rice self sufficiency
- Modern semi-automatic and automatic mills have higher upfront costs compared to more traditional mills and can have higher running costs per ton driven by fuel usage and need for skilled labour. However, overall cost of milling remains considerably lower than potential revenue gain achievable through an increase in the volume of rice recovered and sales price of rice sold. Once this return in the form of yield and price is considered, modern technology pays for itself with a fairly short pay-back period
- Among the modern mills with high milling efficiency (rubber roller de-huller, 2 stage compact mill and multi-stage automatic mills), multiple high potential technologies exist with no clear winner. Technology selection should be based on the needs and constraints of the community and miller
- A review of existing players highlights the need for improved linkages between millers and farmers to create a more structured market and improve the quality and uniformity of rice pre-milling. Mechanisms for group usage are also needed

**Other technology areas[1]**

- A broad, high-level review of the Seeds, Fertilizer, and Cold chain sectors was also included to identify innovative models of corporates engaging with BoP in agriculture in areas other than mechanization and primary processing

(1) Agribusiness is a very broad sector, with a wide range of technologies available across the value chain for inputs, production, processing and distribution/marketing. Given project scope, mechanization and primary processing were identified as focus areas based on their relevance to a broad audience of Japanese companies and their identification as potential high-impact areas for Japanese companies to contribute to agriculture for BOP. In sub-sectors beyond mechanization and primary processing, we believe that an opportunistic approach rather than top-down approach could work more efficiently

# Executive Summary (4/4)

**Recommendations**

- Japanese participation in BoP markets has been relatively limited due to lack of a mature enabling environment, limited knowledge of BoP market needs and lack of appreciation of market opportunity; to date, though several corporates are active in agricultural mechanization and processing in BoP countries, most have not adjusted their product offering or introduced relevant business models to specifically target smallholder BoP farmers. Cost competitiveness is a specific challenge for Japanese corporations in BoP markets, which may require corporates to explore innovative business models or designing cheaper products for BoP farmers
- Our recommendation for Sasakawa involvement of Japanese companies is threefold: (1) to partner with organizations that already have established local presence, (2) to adjust their products and business models to better suit BoP farmers and (3) to concentrate on a handful of promising technologies (e.g. laser leveler, mechanized rice transplanter, power weeder, mini combine, 2 wheel tractor, 2 stage compact mill, etc.)
- For agricultural mechanization, key candidates for type of partners include a) NGOs/social enterprises who rent out machinery, b) corporates who source from smallholder cooperatives and c) manufactures based in BoP countries; for rice processing, types of partners could include a) NGOs/MFIs who are involved in the milling space (e.g. building linkages between farmers and millers, financing community mill purchases, etc.) b) corporates who source from smallholder cooperatives and c) large milling companies. Options for type of partnership range from supply of products and training for technical personnel to technical collaborations. These partners themselves may need support to build their capacity on technical aspects as well as business management.

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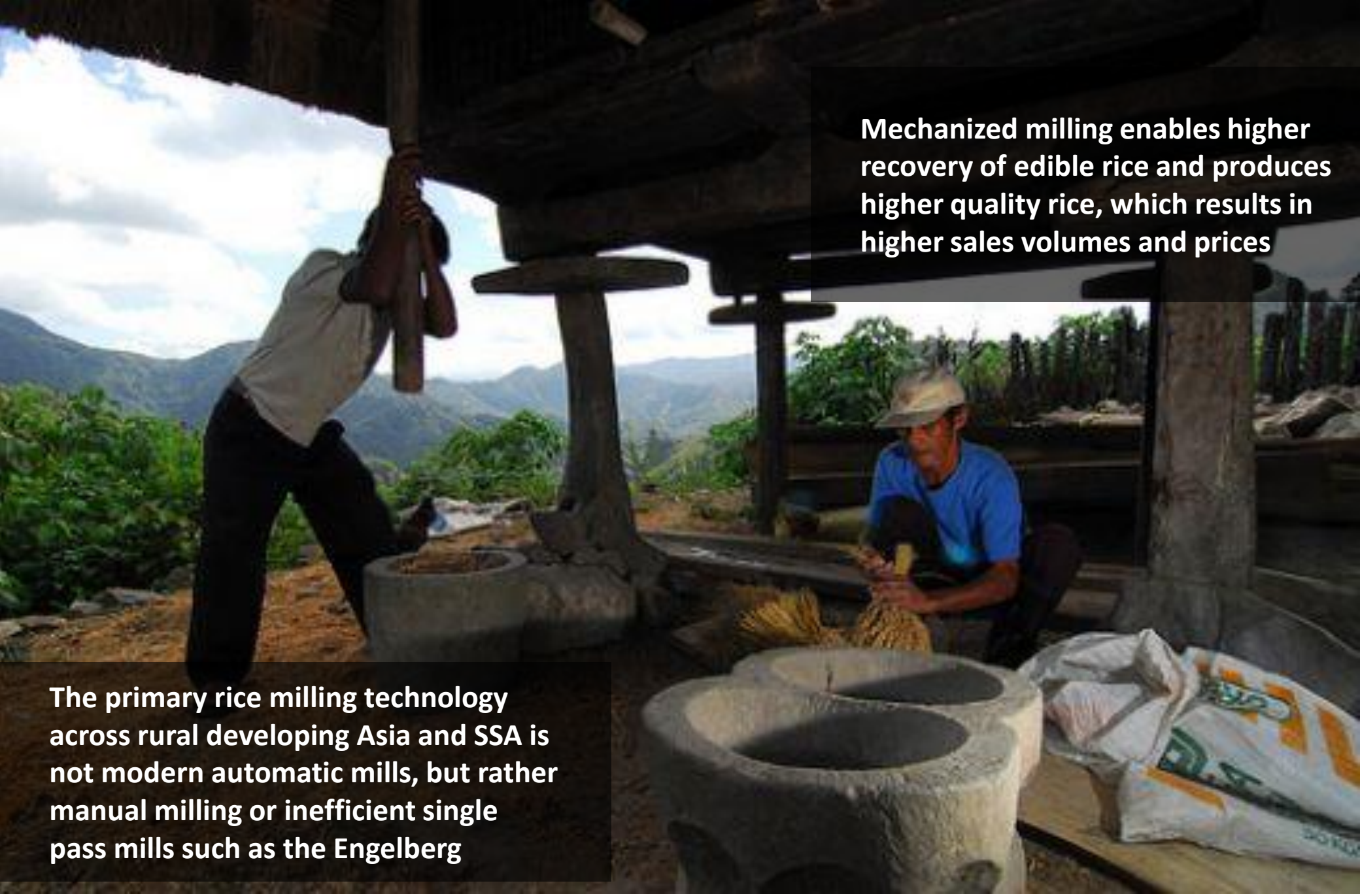
Source: World Census of Agriculture, FAO and Rural population, development and the Environment 2007, UNDESA

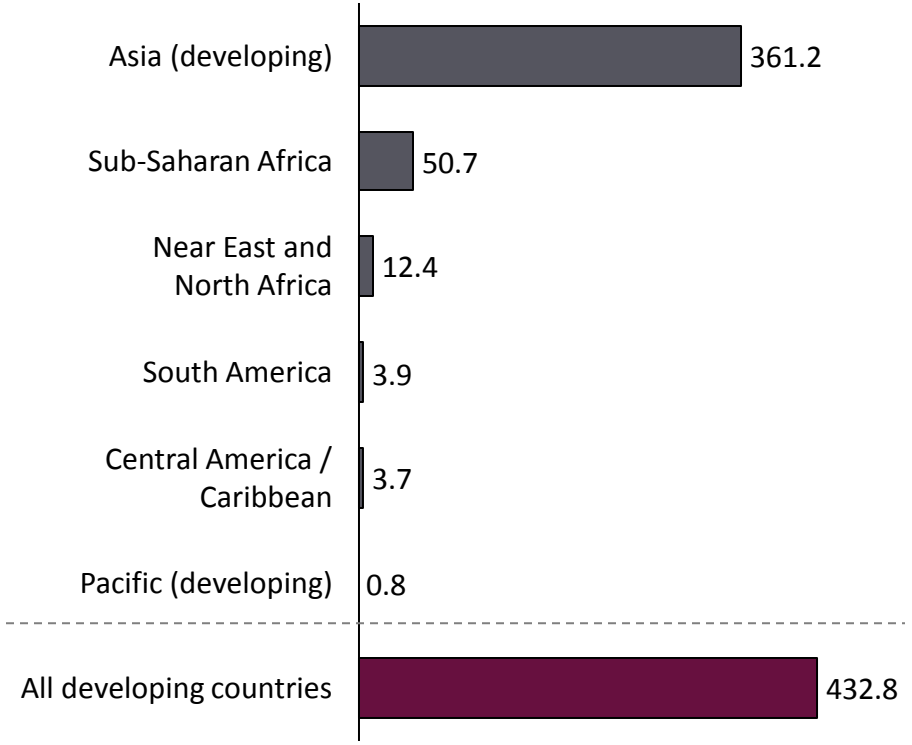



Source: Director Procurement (Food), Government of Bangladesh (2013); "Nutritious Value Chain in Bangladesh – Report on Technical Studies," GAIN (2013); Rwanda: AIRD (2009), Government of Uganda (2009), Journal of Assam University (1987); Dalberg analysis

# An increasing number of MNCs are finding innovative ways to target the over 400 million smallholder farmers in the developing world

## There are approximately 432 million smallholder farmers in developing countries, with largest population in developing Asia

**Global dispersion of smallholder farmers**
In millions of smallholder farms




## An increasing number of MNCs are finding innovative ways to tap this market and impact BoP populations

- BOP population have yearly income from agriculture of USD 2.0 to 2.5 trillion
- An increasing number of MNCs are finding innovative ways to tap this market and access new growth avenues, and this engagement has become visible across the agriculture value chain. Examples include:
  - Unilever and Coca-Cola (Direct sourcing models)
  - John Deere and Mahindra (Low cost machinery)
  - Yara (Credit for inputs and guaranteed purchase prices for Farmers' Associations)
- Japanese companies have well-recognized innovation capabilities and need new growth avenues, but have only recently begun to actively leverage their innovation capabilities for BoP users

Note: In the absence of a global definition of "smallholder," this analysis considers a smallholder a farmer who cultivates less than two hectares; There are approximately 13 Mn smallholder farmers outside the developing world

Source: World Census of Agriculture, FAO; Rural population, development and the Environment 2007, UNDESA; Dalberg analysis

# A growing number of Japanese companies are also starting to engage in agri-business in developing countries, sometimes through BoP-specific initiatives

**Agricultural machinery**

Kubota, YANMAR Solutioneering Together, ISEKI ISEKI & CO., LTD., MITSUBISHI, DAISHIN, ZENOAH, NET OFF

**Post-farm primary processing (rice processing)**

TAIWA, KANEKO AGRICULTURAL MACHINERY CO.,LTD., SATAKE, YANMAR Solutioneering Together

**Seeds**

SATAKE, PlaNet Finance JAPAN

**Secondary processing**

kikkoman, MITSUI & CO., LTD.

**Fertilizers**

SUMITOMO, UNICO INTERNATIONAL, SUMITOMO METALS, MITSUI & CO., LTD.

**Other**

AJINOMOTO, NISSIN, NEC, ITOCHU, YUKIGUNI MAITAKE

Source: Secondary research; Nomura reports; Dalberg analysis

# BoP Technology Study context and objectives

**Context**

- With yearly income from agriculture of 2.0 to 2.5 trillion, BoP in agriculture represent a massive market opportunity
- Some Japanese agribusiness players have existing sales and distribution networks in developing countries, though they have typically not explicitly targeted BoP populations as customers
- Over the last years, MNCs – including some Japanese MNCs – have become increasingly interested in and involved in the space and begun to experiment with BoP-specific products and business models

**Project objectives and work plan**

- Sasakawa Peace Foundation is supporting a project that seeks to identify impactful and viable opportunities for Japanese firms to participate in BoP markets for agriculture
- The objectives of the Technology Study are as follows:
  - Detailed sector reviews for Agricultural Mechanization and Primary Processing (with focus on rice processing):
    - Landscaping of existing and emerging technologies relevant for BoP engaged in agriculture and identification of high potential technologies
    - Identification of key success factors for commercialization of these technologies
    - High-level suggestions for potential pilots in the space
  - High-levels reviews of Seeds, Fertilizers and Cold Chain to highlight innovative models of involvement of MNCs in the space
- This document presents the study findings. Next steps include workshops with Japanese companies to present and discuss findings

**The goal of the BoP Technology Study is to identify promising technologies relevant to BoP populations engaged in agriculture and key success factors for commercializing these technologies**

# The BoP Technology Study had the following project stages

| | 1 Identify and agree on technology areas to focus in the study | 2 Collect data and develop landscape study | 3 Develop selection criteria and identify candidate for 2nd phase |
|---|---|---|---|
| **Timeframe** | ~ 1.5 week *(9 Oct.)* | ~ 7 weeks *(27 Nov.)* | ~ 3 weeks *(20 Dec.)* |
| **Activities** | • Hold kick-off meeting with Sasakawa team<br>– Confirm objectives, key stakeholders, work plan, deliverables and communication protocol<br>– Agree on the criteria used to narrow down the focus areas of the study<br>• Conduct high-level literature review and initial expert interviews to identify most relevant focus areas for the study | • Conduct further literature review on technology areas of focus<br>• Interview 10-15 representatives from industry and industry association (5), financial institutions and investors (3), NGOs (2), social enterprises (2) regarding critical technological factors and business models for delivering agriculture-related technologies to BoP<br>• Based on data collection, map:<br>– Range of technologies available<br>– Current market penetration<br>– Major business models<br>– Key players and actors in the space | • Synthesize analysis and identify factors that drive sustainability of technologies<br>• Develop prioritization framework based on the findings in Stage 2 of the project<br>• Prepare high level suggestions for pilots to potentially be taken to Phase 2, based on interest and capabilities of<br>- Japanese firms<br>- SPF<br>- High-performing local enterprises currently serving the BoP<br>• Draft final report |
| **Deliverables** | • High-level assessment of relevance of technology areas to the project | • Landscape analysis on selected technology areas<br>• Long list of technologies | • Prioritization framework<br>• Shortlist of technologies<br>• Draft final report for discussion with SPF |

# At initiation, mechanization and primary processing were identified as relevant high-impact areas for Japanese companies to contribute to agriculture for BOP

○ Low ● High

| Agricultural value chain | Technology area | Impact on farmer efficiency or productivity | No need for complementary infrastructure (e.g., energy) | Synergies with the Japanese companies in Asia and Africa | Low requirement for R&D to tailor the products to the BOP |
|---|---|---|---|---|---|
| Inputs | Seeds | ◕ | ◑ | ◕ | ◔ |
| | Fertilizers | ◑ | ◔ | ◑ | ◑ |
| | **Machinery and Equipment** | ◑ | ◑ | ● | ◕ |
| Production | Extension Support | ◕ | ◔ | ◔ | ◕ |
| Processing | **Post-farm primary processing (focusing on rice processing)** | ◑ | ◑ | ● | ◑ |
| | Cold Storage and Transportation | ◑ | ◔ | ● | ◑ |
| | Secondary Processing | ◔ | ◔ | ● | ◕ |
| Marketing | Trading and Retailing | ◑ | ◔ | ◑ | ◕ |

Note: Though the technology areas of Machinery & Equipment and Post-Farm Primary Processing were selected to be relevant to a broad audience in the sector and focus the project on high potential areas for Japanese companies given limited project scope, Japanese technologies are likely to be relevant and competitive in other technology areas as well. Cases of successful involvement of corporates in the Seeds, Fertilizers, and Cold Chain areas have also been included and represent potential models for involvement of Japanese companies in these areas

# With a focus on mechanization and primary processing of rice, we followed a three-step process to identify and analyze potential technologies

| Selection Steps | Methodology | Areas of analysis |
|---|---|---|
| **Step I: Understand the landscape of available and emerging technologies** | • Review of existing literature<br>• Interviews with industry experts | • Scale / nature of the issue faced by BoP<br>• Economic / environmental / health impacts of the issue<br>• Existing technologies[1] |
| **Step II: Analyze performance of technologies** | • Comparative performance analysis of existing technology | • Affordability and cost effectiveness (Upfront and running costs)[2]<br>• Ease of operation and maintenance<br>• Economic, environment and social impacts<br>• Ease of marketing, distribution and scale-up |
| **Step III: Identify key players and factors driving successful business models** | • Identification and categorization of key players<br>• Preparation of case studies (successful and unsuccessful business models)<br>• Identification of success factors | • Learning from successful and failed business models |

**Criteria for selection of high-potential technologies to meet BoP needs in mechanization and primary processing**



(1) Focus on technologies most relevant to BoP farmers and technologies relevant for cereal crops; (2) India has been taken as an example country for cost benchmarking

# The following long-list of criteria were considered in identification of high-potential technologies

| Category | Criteria |
|---|---|
| **Affordability and cost effectiveness[1]** | • Low upfront cost<br>• Low running cost (fuel, labour, spares, maintenance)<br>• High cost effectiveness (amortized cost per Ha plus running cost per Ha) |
| **Relevance of Japanese technologies** | • Relevance of existing Japanese technologies |
| **Potential market size** | • Wide applicability (e.g. across various crops; regions; land holding sizes)<br>• Low dependence on specific/advanced power sources |
| **Economic, environmental and social impact** | • Efficiency (e.g. hectares covered/hour)<br>• High water savings<br>• High saving on inputs such as seeds and pesticides<br>• Positive effect on agricultural yield<br>• Reduction in post-harvest/ processing losses<br>• Reduction in transportation requirements<br>• Low need for fuel and sustainability of type of energy source |
| **Ease of operation and maintenance** | • Ease of use/ limited skills required for operation<br>• Low dependence on specialized local servicing expertise |

**Cost effectiveness and efficiency have been identified as the most important criteria, and relevance of Japanese technologies has been taken as a prerequisite in identifying high-potential opportunities for Japanese companies**

Note: The above criteria exclude factors that require prior knowledge of local conditions, practices, socio-economic characteristics of the target market and exact product/solution characteristics. The above criteria are not relevant for each sector, and the individual sectors have been evaluated on specific criteria based on relevance and data availability

(1) India has been taken as a representative example country to allow for consistent comparative cost benchmarking

Source: Dalberg analysis

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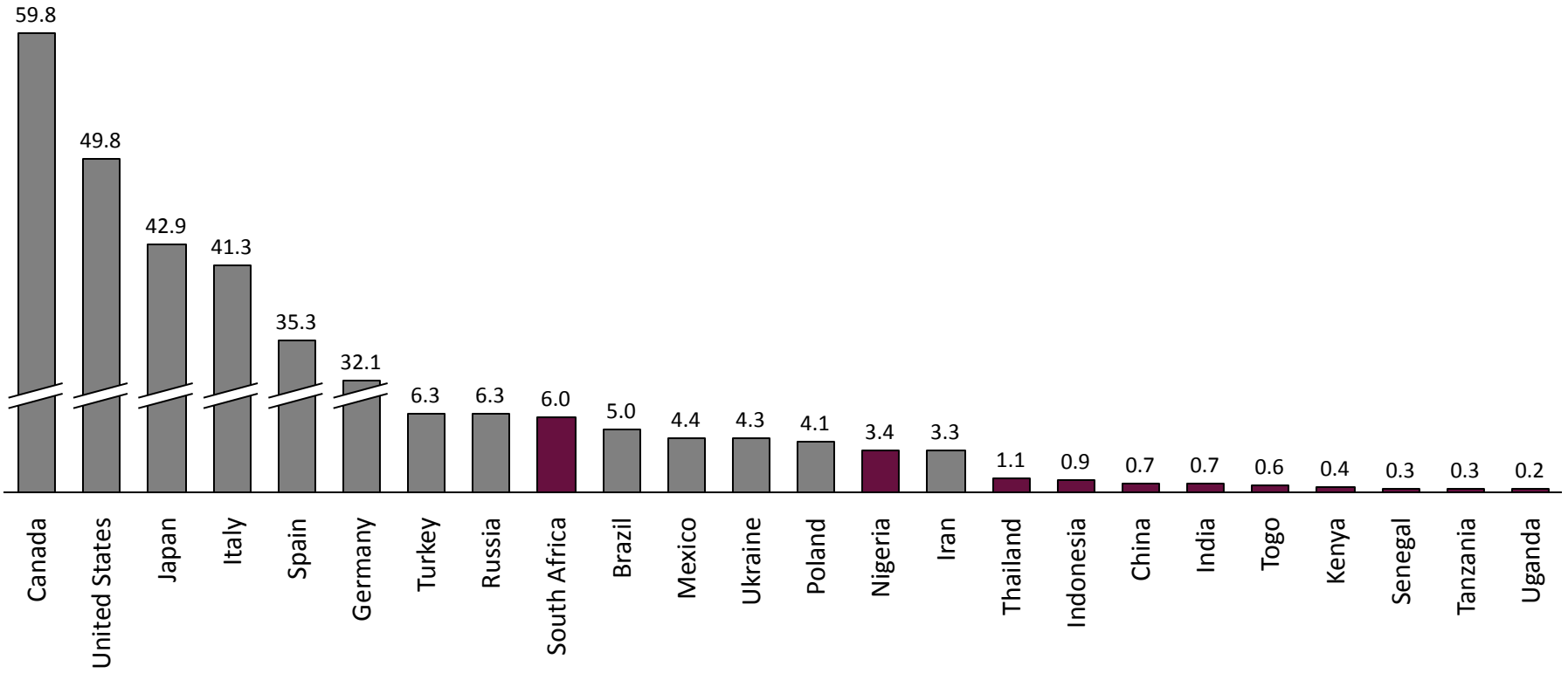
# Productivity in agricultural sector in Asia and Africa is much lower than in the rest of the world

**Agricultural value added per agricultural worker, by country**
In thousand $/person; most recent estimates available 2007-2012 (constant 2005 US$)

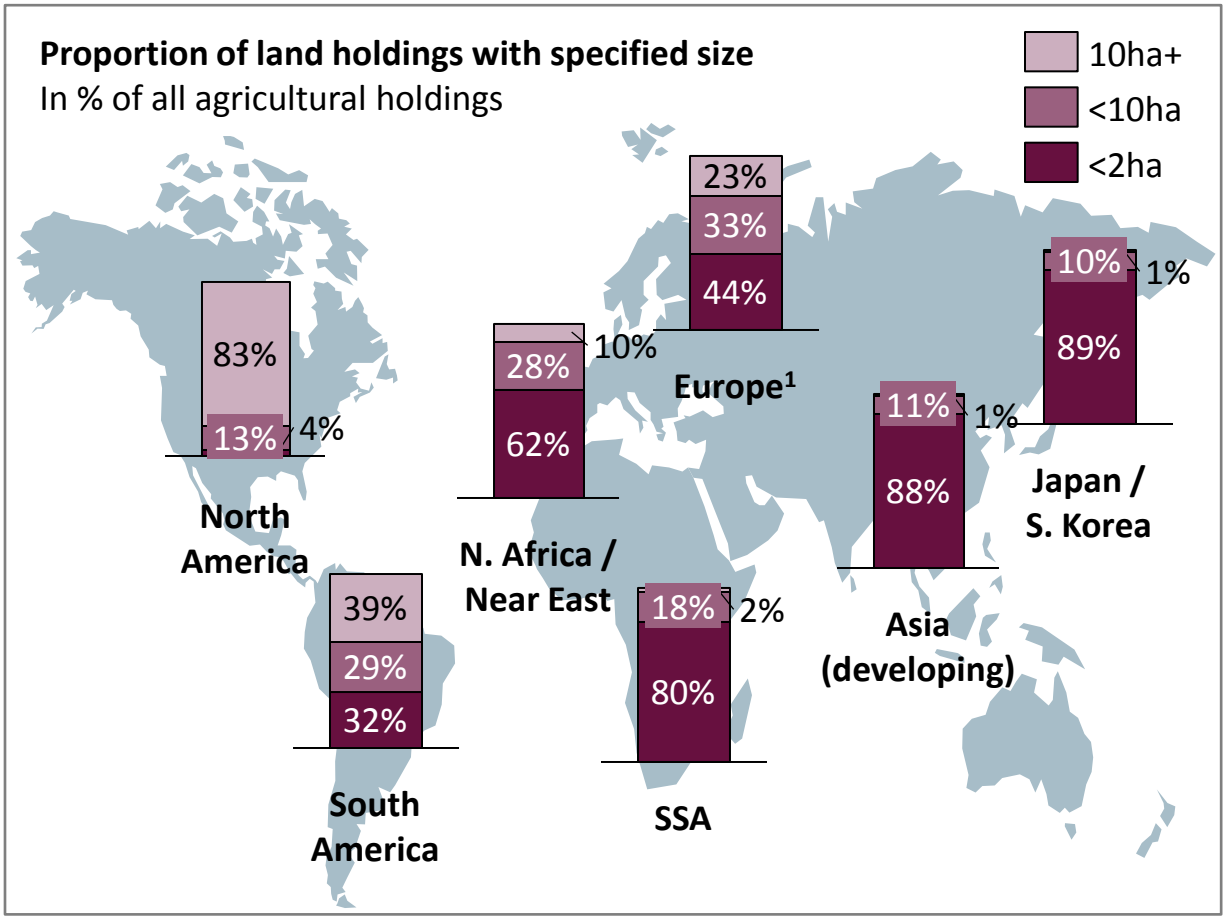


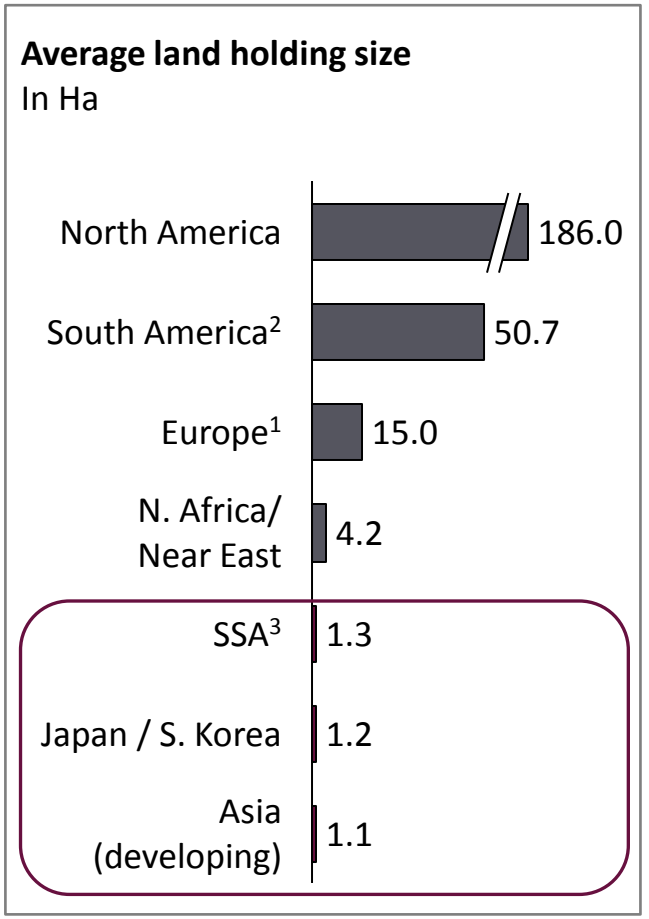

Lower levels of mechanization in Asia and Africa are a primary reason for lower agricultural productivity. Other drivers include land holding size, irrigation rates, seed types, and climatic factors



Source: World Bank Data Indicators

# The typically small land holding size of BoP farmers is a part of the reason for low productivity



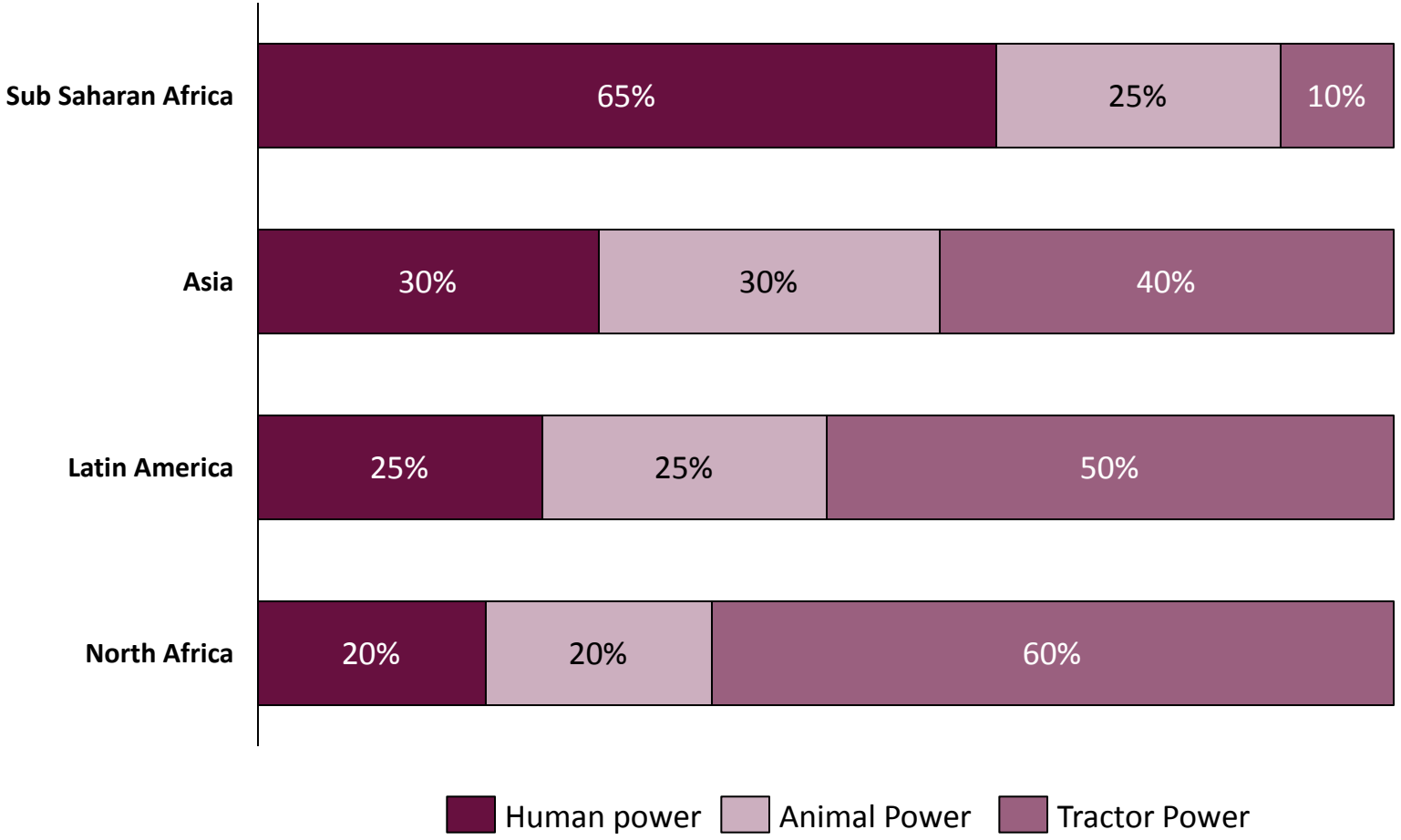

To target farmers in Asia and Africa, the majority of whom have <2ha of land, products and business models must be tailored to cater to small farm sizes; given small size of the typical Japanese land holding, existing Japanese technology may be more easily adaptable to fit BoP needs

(1) Incl. Russia; (2) Land use in "agricultural holdings" is very different in South America (only 13% cropland) than in Asia/Africa (>90% cropland); (3) Excl. SA

Source: *World Census of Agriculture*, FAO (most recent national census available between 1990 and 2008); *Rural Population, 2007*, UNDESA

# Yet, another part of the reason for low productivity is the low level of farm mechanization

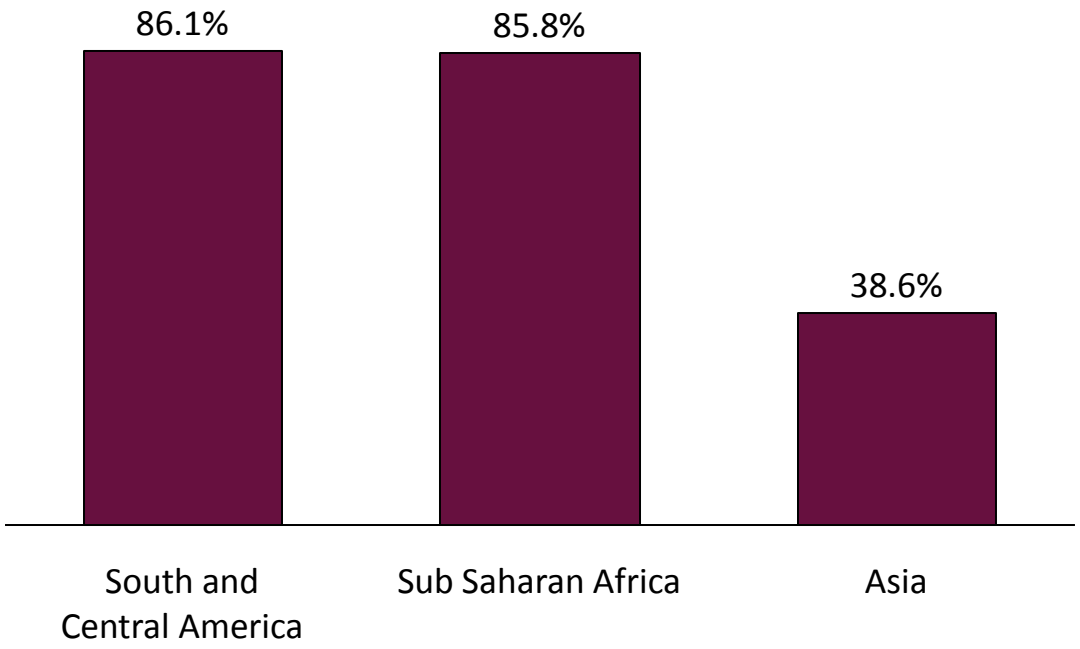
**Farm power sources: Agricultural mechanization rate**
In percentage by mechanization classification, in 2005




Source: 'Agricultural Mechanization in Africa…Time for action', FAO

# Looking at the high level of uncultivated arable land proves an opportunity to increase productivity through mechanization

**Percentage of arable land currently being cultivated**
In %




Use of agricultural machinery effectively enables each farmer to farm more land; With only a small percentage of arable land currently under cultivation in many developing regions, greater mechanization can therefore enable more land to be farmed and increase total production

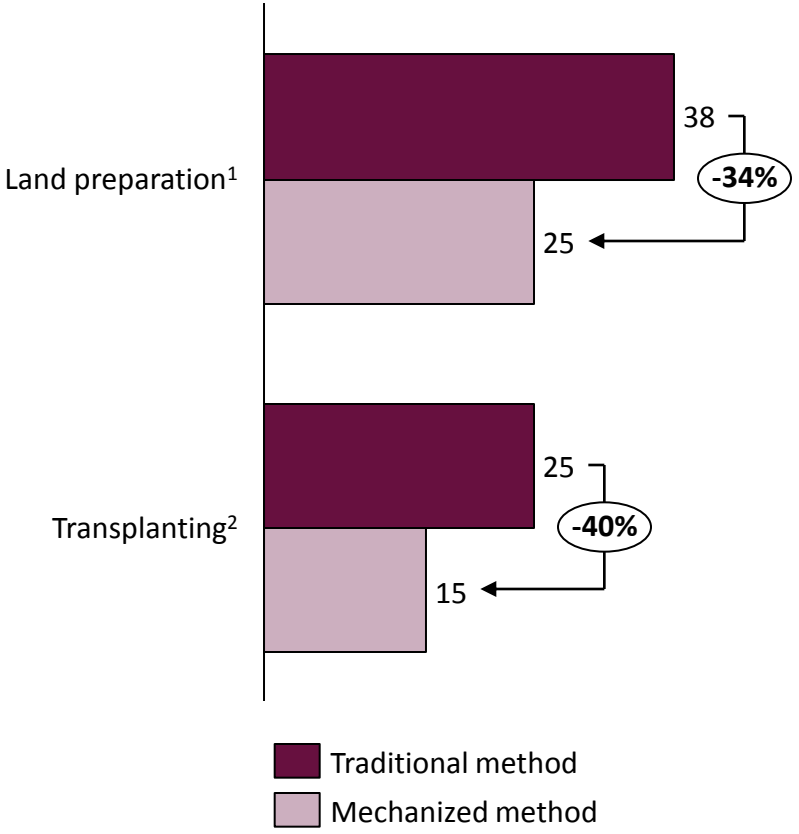


Source: Future Directions International; Dalberg analysis

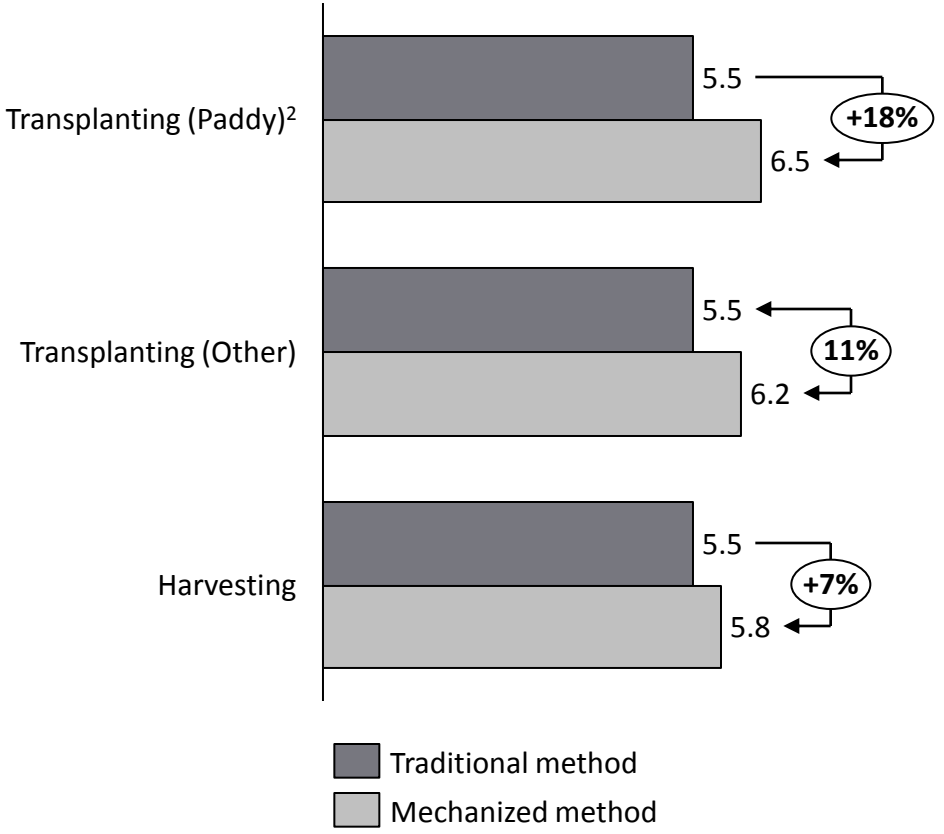
# Increased mechanization could enhance agricultural productivity of BoP farmers by reducing labour costs as well as by increasing agricultural yield

*DIRECTIONAL*

**Example savings in cost of cultivation**
In $/day, Traditional method vs. Mechanization, In India




**Example increase in average yield**
In tons/Ha, Traditional method vs. Mechanization, In India




(1) Assuming switch to bullock cart-drawn disc harrow to laser leveling, (2) Assuming switch from manual transplanter to mechanized rice transplanter

Note: Actual yield increases dependent on many variables; Yield increases displayed above are based on specific examples and are directional only

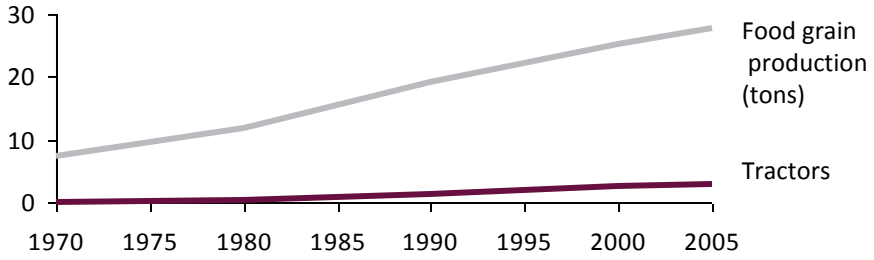
Source: CSISA Internship report; IRRI Study on Impact of Rice Transplanter; Expert and industry interviews; Dalberg analysis

# Increased mechanization levels could further drive a variety of economic, social and environmental impacts

## Economic impacts

- Increase in cultivated land and total production, particularly in Africa
  - More efficient techniques effectively enable each farmer to farm more land
  - With only a small percentage of arable land currently under cultivation, greater mechanization can therefore enable more land to be farmed

**Growth of tractors and food grain production in Punjab, India**
In millions




- Increase in profit margins for farmers achieved through decreases in cost and/or increases in yield
- Improved quality and uniformity of end agricultural product resulting in increased selling price and/or an expansion of product's potential market (e.g. export quality)
- Improved yields through timelier planting
- Reduction in post-harvest losses through more efficient and precise harvesting methods

## Environmental impact

- Savings on agricultural water usage by reduction in need for irrigation during various stages (e.g. land preparation)
- Reduction in pesticide use through more precise and improved weeding techniques
- Reduction in waste through more efficient and precise harvesting

## Social impact

- Reduction in physically demanding, drudgerous work
- Opportunity for increased food independence and increased in exports
- With world population growing as non-urban population shrinks, efficient agricultural techniques will be required to ensure food security

Source: Future Directions International Website; Secondary research; Expert and industry interviews; Punjab State Council for Science and Technology; Dalberg analysis

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# Mechanization technologies can be divided into 6 steps in the agricultural process; this study focused on 4 steps as well as relevant power sources

Focus of study

**Objectives**

| | | |
|---|---|---|
| **Land preparation** | • Land leveling and tilling operation of the land to provide the necessary land conditions which will enhance the successful establishment after sowing/transplanting |  |
| **Sowing and transplanting** | • Growing seedlings and transplanting them or manual sowing of the seeds |  |
| **Inter-culture operation** | • Cropping and removal of unwanted crops growing on the land |  |
| Irrigation[1] | • Periodic watering of the crops through various means |  |
| Manure / fertilizer application[1] | • Application of fertilizer and pesticide for plant protection |  |
| **Harvesting and threshing[2]** | • Gathering of a ripened crop and separation of seed from a harvested plant |  |

(1) Not studied further; (2) Study focus on harvesting tools, some of which have threshing capabilities

# A variety of products are available with relevance for a range of land sizes and power sources, with varying associated performance metrics

Focus of study

| | *Relevant land holding size (assuming equipment ownership)[2]* | | | *Applicable power sources* |
|---|---|---|---|---|
| | **<1Ha** | **1-5Ha** | **>5Ha** | |
| **Land preparation** | • Plough<br>• Cultivator- Bullock Drawn | • **Rotovator**<br>• **Cultivator- Tractor Drawn**<br>• **Disc Harrow- Tractor Drawn or Bullock Drawn** | • **Laser Leveler**<br>• **Rotovator** | • Animal drawn (e.g. bullock carts)<br>• Tractor |
| **Sowing and transplanting** | • Manual<br>• Broadcast seeding<br>• Seed Drill | • **Seed Drill**<br>• **Zero Till Drill**<br>• Manual Transplanter | • **Mechanized transplanter**<br>• Manual Transplanter<br>• **Seed Drill/Zero Till Drill** | • Power tiller<br>• Tractor<br>• Self-propelled<br>• Animal drawn |
| **Inter-culture operation** | • Basic Push Hoe<br>• Cono Weeder<br>• Wheel Hoe | • Wheel Hoe<br>• **Rotary Weeder**<br>• **Power Weeder** | • **Power Weeder (> 10 HP)** | • Power tiller |
| Irrigation[1] | • Micro Drip<br>• Flood Irrigation | • Drip Irrigation<br>• Sprinkler Systems | • Surface Irrigation<br>• Central Pivot Systems | • Pumps |
| Manure / fertilizer application[1] | • Mini Sprayer<br>• Knapsack Sprayer | • Power Sprayer | | • Motor for power sprayer |
| **Harvesting and threshing** | • Sickle<br>• Sythe<br>• Cutlass | • **Binder Reaper**<br>• **Vertical Reaper** | • **Mini Harvester**<br>• **Mini Combine**<br>• **Multi Crop Thresher**<br>• **Reaper- Tractor Drawn** | • NA (self propelled) |

Note: Tractor and power tiller-drawn machines in bold; (1) Not studied further; (2) Directional indication based on financial, mechanical and capacity suitability

Source: IFPRI "Agricultural Mechanization and Smallholder farmers in Nigeria"; Agricoop Indian Agriculture Mechanization, Dalberg Analysis

# Power sources: The various equipment types use different power sources according to the conditions and requirements of the equipment

| | Bullock Cart | Basic Power Tiller | Two Wheeled Self Propelled Tractor | Low Powered Tractors (10-30 HP[2]) | High Powered Tractors (>30 HP[2]) |
|---|---|---|---|---|---|
| |  |  |  |  |  |
| **Description** | • Oxen or any other cattle pulling a two to four wheeled vehicle | • Motorized hand-operated (typically diesel-powered) device used to maneuver low-powered farm equipment (e.g. cultivator, seed drill) | • Single-axle tractor, which is self-powered and self-propelled, and can pull and power various farm implements | • Low powered tractor used to power various farm equipment | • High powered tractor used to power various farm equipment |
| **Price range[3]** | • $400-$2,000 (depending on the type of cattle) | • $500-$1,000 (depending on the HP[2] of the machine used) | • $1,000-$2,000 (depending on the HP[2] of the machine used) | • $4,000-$14,000 (depending on the HP[2] of the machine used) | • > $14,000 |
| **Drawbacks** | • Low efficiency<br>• Needs significant additional investments in labour | • High fuel consumption, increasing with additional HP | • Can only be used as power source for low-powered equipment<br>• High unit costs | • Not suitable for large farms and high-powered equipment like laser levelers | • High upfront costs<br>• Highest fuel consumption |
| **Applicable land size [1]** | <1ha | 1-5ha | | >5ha | |

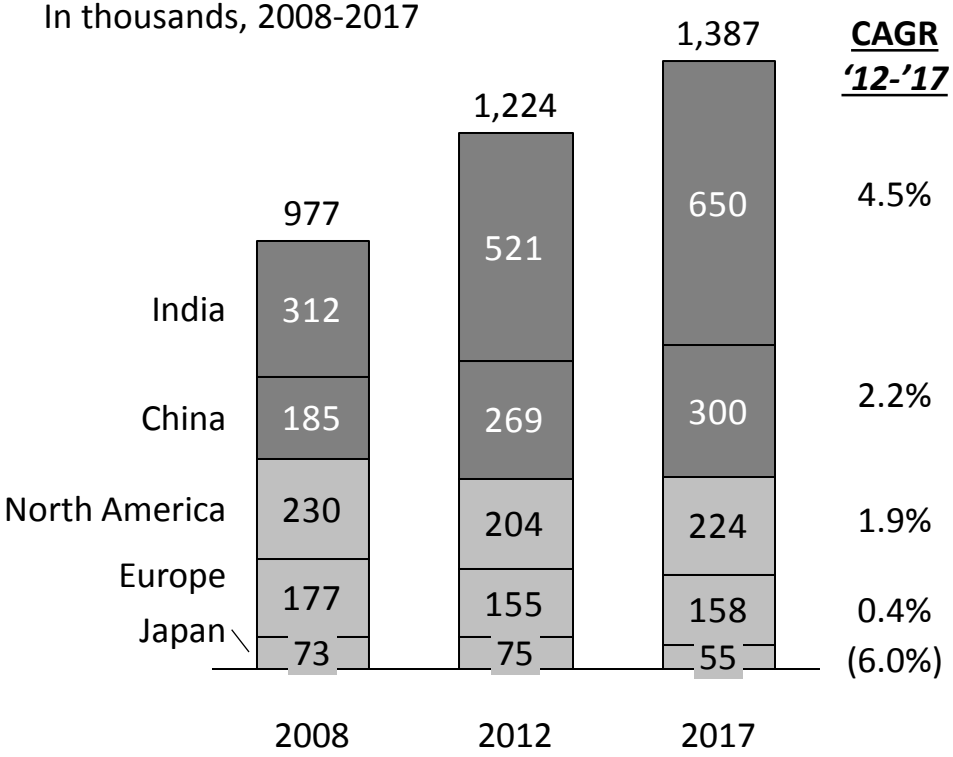
(1) Applicable land size for ownership model; (2) Horse power; (3) Prices quoted are relevant for Indian market to allow for consistent cost comparison

Source: Dalberg analysis, Primary Interviews and India Mart Price List

# Tractor penetration among BoP in Asia expected to increase, supporting higher uptake of other agricultural machinery that requires tractor as power source

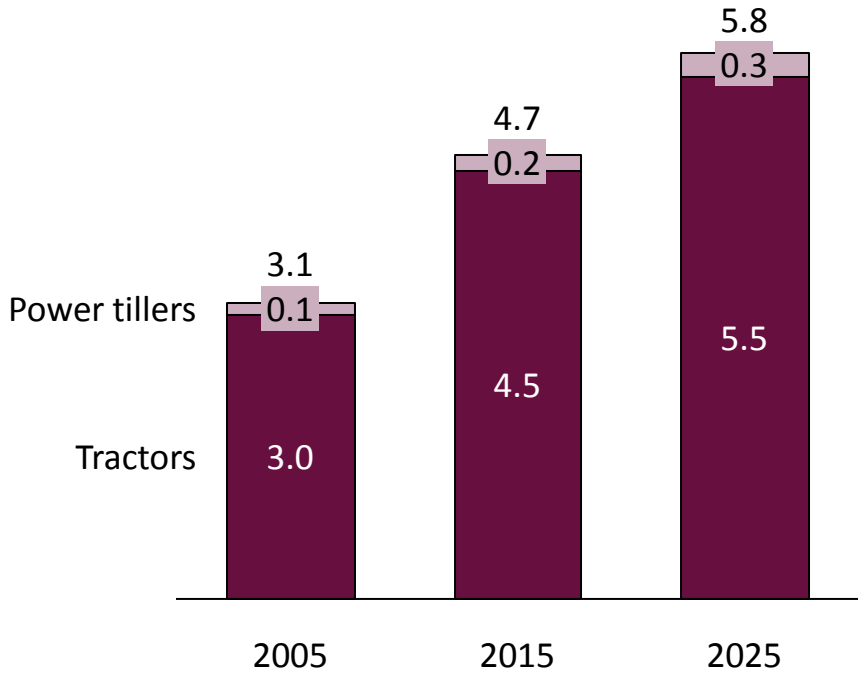
## Tractors sales in the developing world are expected to grow steadily in coming years

**Global tractor sales volumes**
In thousands, 2008-2017




## Penetration of power tillers is low compared to tractors but is growing quickly

**Example from India: Growth in installed base of machinery**
In millions, Tractors & power tillers, 2005-2025




The market for tractors is itself promising. Furthermore, as many types of machinery rely on the tractor as a power source, increased tractor penetration will support increasing mechanization across all steps in the agricultural process



Source: Alix Partners; 'Investment in Agricultural Mechanization in Africa', FAO

# Land Preparation: Landscape of technologies

| | Plough | Tiller/Cultivator | Disc Harrow | Rotovator | Laser Leveler |
|---|---|---|---|---|---|
| |  |  |  |  |  |
| **Description** | • Traditional tool used for loosening of the soil<br>• Five or more passes typically needed to loosen the soil | • Various types of improved ploughs which can go deeper into the soil<br>• At least three passes are needed | • Pulverizes soil, provides surface mulch<br>• Provides more effective pulverization of soil than plain discs<br>• Two passes are required | • Rotovators use rotating blades to loosen soil in only one pass and offer higher quality of tilling | • Uses improved laser technology to toil land at exact depths<br>• One tilling can last for up to three years |
| **Typical power sources** | • Manual<br>• Bullock cart | • Bullock cart<br>• Power tiller<br>• Tractor | • Bullock cart<br>• Tractor | • Tractor<br>• Power tiller<br>• Self propelled | • Tractor |
| **Drawbacks** | • High unit costs and irrigation costs<br>• Low quality soil | • High unit costs and Irrigation costs<br>• Low quality soil | • High irrigation costs<br>• Large land holding required for economies of scale | • Requires high powered tractors<br>• Large land holding required for economies of scale | • Requires high powered tractors<br>• Large land holding required for economies of scale |
| **Applicable land size [1]** | <1ha | 1-5ha | >5ha | | |

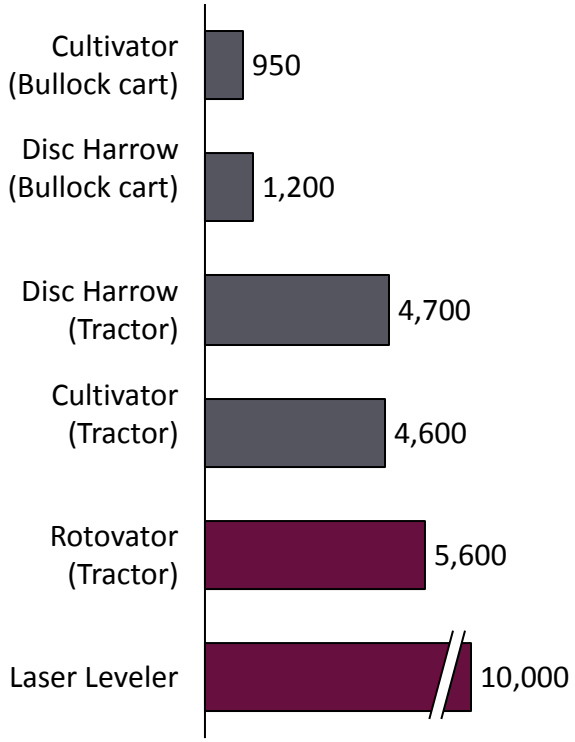
(1) Applicable land size for ownership model; Note: Technology landscape is not exhaustive but provides an overview of technologies most relevant for BoP

Source: Expert and industry interviews, Secondary sources, Dalberg analysis

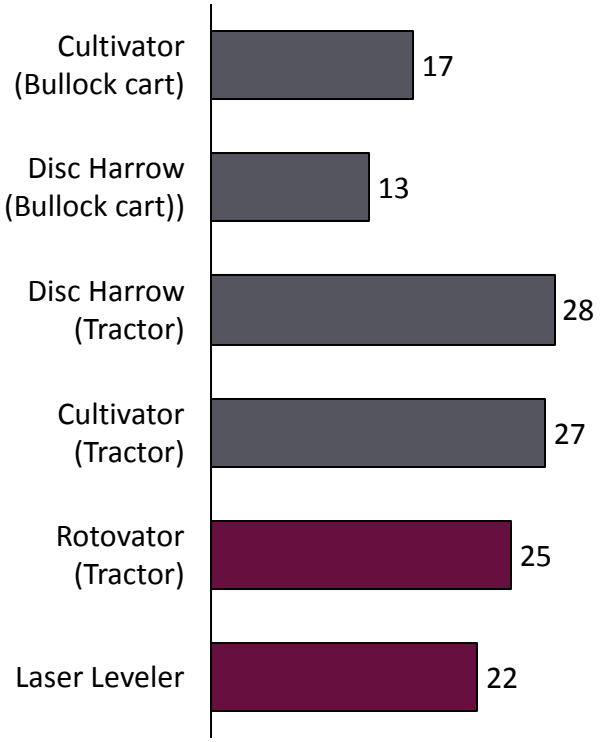
# Land Preparation: Laser levelers and rotovators are the most cost effective technologies in long run through upfront cost is high

*DIRECTIONAL*

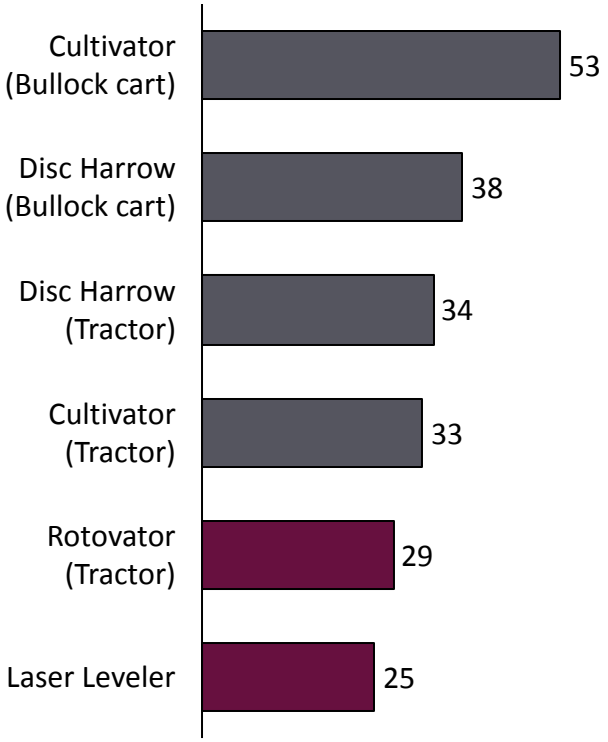
**Upfront cost**
In $




**Running cost[1]**
In $/Ha




**Total cost per Ha[2]**
Amortized cost[3] + running cost, In $/Ha




(1) Assumptions: Running costs consists of additional costs due to repeated passes for many equipment and irrigation cost for the field Irrigation. Costs assumed at 4 Irrigations of 2.5 hours each @ $0.5/ hour. Maintenance costs assumed at 10% of upfront cost per year; (2) Assumption: We are assuming capacity utilization during two 30-day seasons per year; (3) Assumption: Amortized costs consists of different salvage value, life and efficiency per equipment. Laser leveler salvage is considered similar to the high end tractor salvage value. Bullock cart salvage value is assumed at 5% after 3 years. Salvage values for other equipment are considered equivalent to the tractor's salvage value. Upfront cost includes upfront tractors and bullock prices

Note: Prices shown are for Indian market; India has been taken as a representative example country to allow for consistent comparative cost benchmarking; As comparison to rental rates currently on the market in India: a rotovator can be rented for approximately $40/Ha, and a laser leveller for a minimum of $65/Ha

Source: India Mart Price list for equipment; Secondary research; Expert interviews; Dalberg Analysis

# Land Preparation: Highly efficient laser levelers, with water and labour savings, are promising, but business models are needed to overcome high upfront cost

○ Low ● High

| Technology | Affordability and cost effectiveness | | | Economic, social and environment impact | | | Ease of operations and maintenance | | Potential market size |
|---|---|---|---|---|---|---|---|---|---|
| | *Low upfront costs* | *Low running costs (in $/Ha)* | *Low total costs per Ha (amortized plus running, in $/Ha )* | *High efficiency (Ha/Hr)* | *Low need for fuel* | *High water savings* | *Ease of operation* | *Low dependence on specialized local servicing* | *Low dependence on advanced power sources* |
| **Plough** | ◕ | ◑ | ◔ | ◔ | ● | ◔ | ◕ | ● | ● |
| **Cultivator (Bullock Cart)** | ◕ | ◕ | ◔ | ◔ | ● | ◔ | ◕ | ◕ | ◕ |
| **Cultivator (Tractor)** | ◑ | ◑ | ◑ | ◑ | ◔ | ◑ | ◑ | ◑ | ◑ |
| **Disc Harrow (Bullock Cart)** | ◕ | ◕ | ◑ | ◔ | ● | ◔ | ◕ | ◑ | ◕ |
| **Disc Harrow (Tractor)** | ◑ | ◑ | ◑ | ◑ | ◔ | ◑ | ◑ | ◑ | ◑ |
| **Rotovator** | ◑ | ◑ | ◕ | ◕ | ◑ | ◑ | ◑ | ◔ | ◑ |
| **Laser Leveler** | ◔ | ◑ | ◕ | ● | ◔ | ◕ | ◔ | ◔ | ◔ |

Modern efficient technologies are most cost-effective in long-run and enable productivity gains as well as water savings; however, business models are needed to address high upfront cost, difficulty of operations and dependence on advanced power sources

Note: Water savings is based on the irrigation need for the soil in case of land preparation; Fuel usage reflects Ltrs/Ha used by the equipment

Source: Industry and expert interviews, Secondary research, Dalberg analysis

# Sowing & Transplanting: Landscape of technologies

| | Broadcasting/Manual | Seed Drill | Zero Till Drill | Manual Transplanter | Crop-specific Mechanized Transplanter |
|---|---|---|---|---|---|
| |  |  |  |  |  |
| **Description** | • Traditional method wherein the seeds are sown manually by the farmers | • Seed drill consists of a hopper of seeds arranged above a series of tubes that can be set at selected distances from each other | • Instead of ploughing fields and then planting seeds, zero tillage deposits seeds into holes drilled into unploughed fields | • Manually operated transplanter which can transplant seedlings | • Specialized mechanized crop-specific transplanters which can transplant seedlings, e.g. Rice Transplanter |
| **Typical power sources** | • Manual | • Manual<br>• Bullock cart<br>• Power tiller<br>• Tractor | • Power tiller<br>• Tractor | • Manual | • Power tiller<br>• Tractor<br>• Self propelled |
| **Drawbacks** | • High labour costs<br>• Lack of precision in distancing seeds | • High Unit costs<br>• Manual seed drill increases the time required for planting | • Increases level of weeds and costs of inter-culture ops<br>• Applicable only for cereal crops | • High unit costs<br>• Lower quality transplanting | • High Upfront Costs |
| **Applicable land size [1]** | <1ha | 1-5ha | >5ha | | |

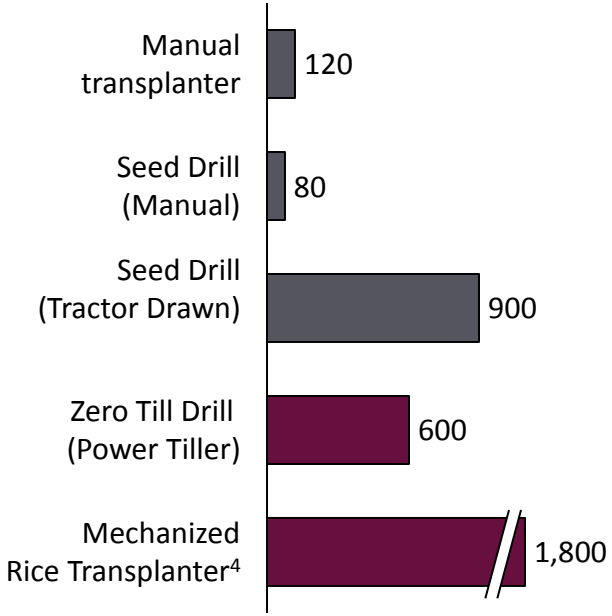
(1) Applicable land size for ownership model; Note: Technology landscape is not exhaustive but provides an overview of technologies most relevant for BoP

Source: Expert and industry interviews, Secondary sources, Dalberg analysis

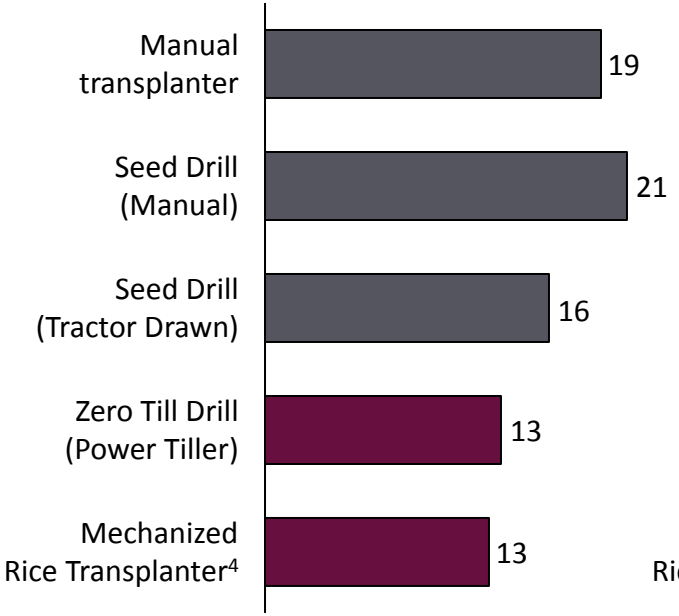
# Sowing & Transplanting: With high efficiency and labour savings, the zero till drill and mechanized crop transplanter are most cost effective

*DIRECTIONAL*

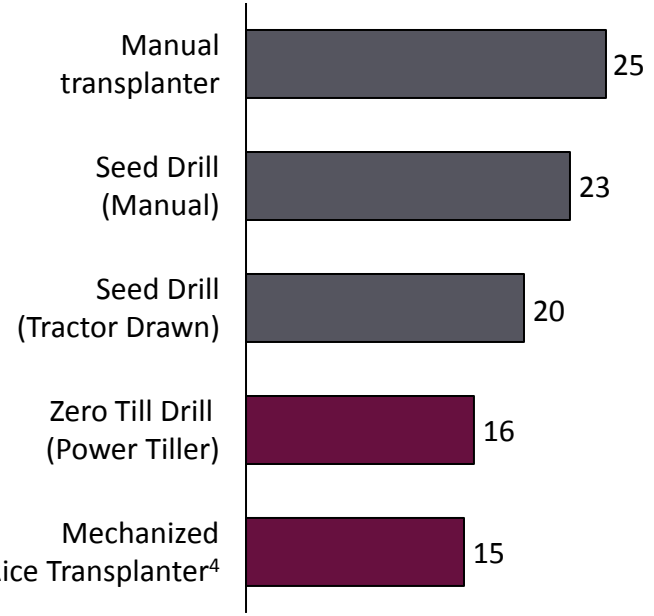
**Upfront cost**
In $




**Running cost[1]**
In $/Ha




**Total cost per Ha[2]**
Amortized cost[3] + running cost, In $/Ha




(1) Running costs include labour and fuel costs. Running costs for transplanting include significant additional labour costs for transplanting in the shortest period of time. Hence the manually operated/bullock equipment also have a additional labour costs for planting manually. Tractor-drawn seed drill, zero till drill and mechanized transplanter have no additional cost for this because low land preparation work with this equipment. Savings on inputs such as seeds and water with modern machinery not incl. in cost comparison; (2) Assumption: We are assuming capacity utilization during 1 30-day season per year; (3) Assumption1: Salvage value for equipment is based on the assessment from various dealers. Assumption2: The equipment is crop-specific and assumed to be used for one season annually. Upfront tractor cost not included unless self propelled; (4) Rice Transplanter used as a proxy for Crop-Specific Mechanized Transplanter

Note: Prices shown are for Indian market; India has been taken as a representative example country to allow for consistent comparative cost benchmarking

Source: Expert and industry interviews; Secondary research; Dalberg Analysis

# Sowing & Transplanting: Mechanized transplanters and zero till drills improve yield while enabling high savings on water, seeds and fertilizer

○ Low ● High

| Technology | Affordability and cost effectiveness | | | Economic, social and environment impact | | | | Ease of operations and maintenance | | Potential market size |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Low upfront costs* | *Low running costs (in $/Ha)* | *Low total costs per Ha (amortized plus running, in $/Ha )* | *High efficiency (Ha/Hr)* | *Low need for fuel* | *High savings on inputs (seeds, fertilizer, water, etc.)* | *Positive effect on yield* | *Ease of operation* | *Low dependence on specialized local servicing* | *Low dependence on advanced power sources* |
| **Manual / Broadcasting** | ● | ◑ | ◑ | ◔ | ● | ◔ | ○ | ● | ● | ◕ |
| **Seed Drill (Manual)** | ◕ | ◔ | ◑ | ◔ | ● | ◑ | ◔ | ◕ | ◕ | ◕ |
| **Seed Drill (Tractor)** | ◑ | ◕ | ◑ | ◕ | ◔ | ◑ | ◔ | ◑ | ◑ | ◔ |
| **Zero Till Drill (Power Tiller)** | ◑ | ◕ | ◕ | ◕ | ◑ | ◕ | ◑ | ◑ | ◑ | ◑ |
| **Manual Transplanter** | ◕ | ◑ | ◔ | ◔ | ● | ◑ | ◑ | ◕ | ◕ | ◕ |
| **Mech. Rice Transplanter[1]** | ◔ | ◕ | ◕ | ◕ | ◔ | ◕ | ◕ | ◔ | ◔ | ◔ |

The modern efficient technologies are most cost effective in the long-run, but innovative models are needed to address high upfront costs as well as dependence on power sources such as power tiller or tractors

(1) Rice Transplanter used as a proxy for Crop-Specific Mechanized Transplanter

Notes: Water savings is mainly a measure of the irrigation need during land preparation in case the equipment is being used; Fuel usage is based on ltrs/ha used by equipment

Source: Expert and industry interviews, Secondary sources, Dalberg analysis

# Inter-culture Operations: Landscape of technologies

| | Basic Push Hoe | Cono Weeder | Wheel Hoe | Rotary Weeder | Power Weeder |
|---|---|---|---|---|---|
| |  |  |  |  |  |
| **Description** | • A traditional hand tool consisting of blade set in a plane slightly inclined to the axis of the rod used as a handle | • Consists of two rotors, a float, a frame and a handle<br>• The orientation of the rotors create a back and forth movement in the top 3 cm of soil | • Comprised of wheel assembly, miniature tool frame, a set of replaceable tools and handle assembly to adjust according to size of weed | • Consists of several rows of discs mounted with a number of curved blades, which rotate to enable cutting and mulching of the soil<br>• Use can decrease overall need for chemical weedicides | • The V–shaped weeder consists of tool bars adjusting the depth of operation and locked in position for higher efficiency<br>• Efficient weeding can decrease overall use of chemical weedicides |
| **Typical power sources** | • Manual | • Manual | • Manual | • Power tiller | • Self propelled |
| **Drawbacks** | • Low quality weeding<br>• Inefficient and labour intensive | • Low quality weeding<br>• Additional labour costs | • Low quality weeding<br>• Applicable only for 2 row spacings | • High upfront costs | • High upfront costs and fuel costs |
| **Applicable land size [1]** | <1ha | | | | |
| | | 1-5ha | | | |
| | | | >5ha | | |

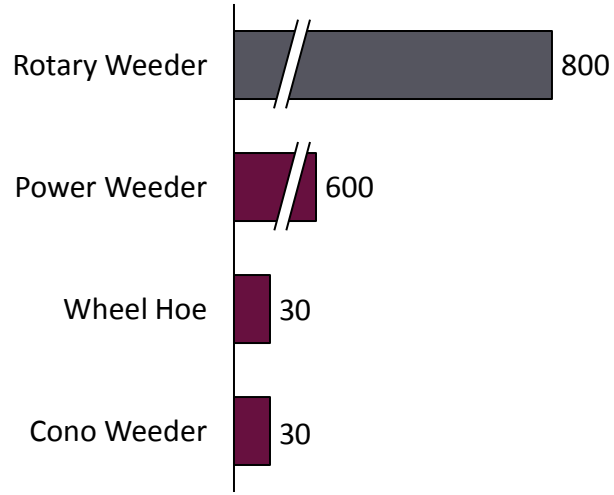
(1) Applicable land size for ownership model; Note: Technology landscape is not exhaustive but provides an overview of technologies most relevant for BoP

Source: Expert and industry interviews, Secondary sources, Dalberg analysis

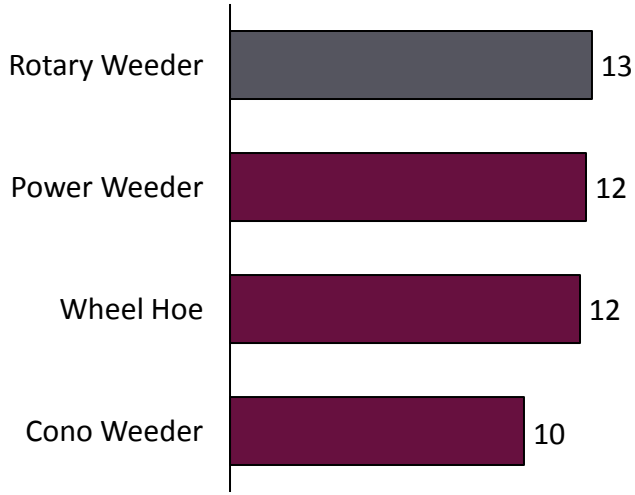
# Inter-culture Operations: Power weeders and rotary weeders have fuel costs but have cost savings from labor efficiency and a decreased need for weedicides

*DIRECTIONAL*

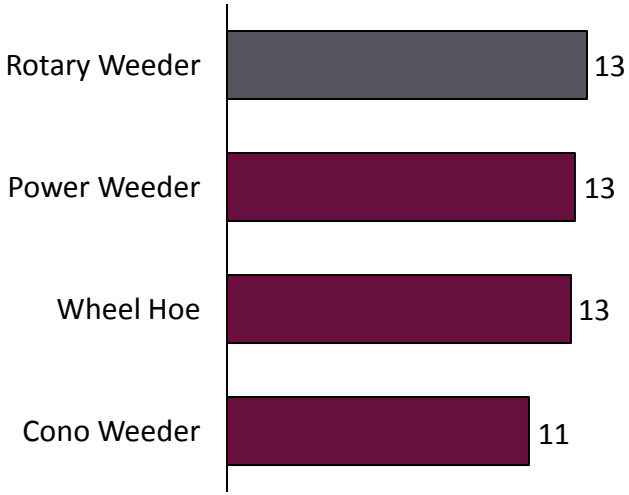
**Upfront cost**
In $




**Running cost[1]**
In $/Ha




**Total cost per Ha**
Amortized cost[2] + running cost, In $/Ha




(1) Assumption: Running Costs consist of fuel cost, additional chemical weeding costs and labour cost due to inefficiency in the equipment;

(2) Assumption: We are assuming capacity utilization during 2 30-day seasons per year

(3) Assumption: Salvage value for the power tiller equipment is considered equal to power tiller salvage value

Note: Prices shown are for Indian market; India has been taken as a representative example country to allow for consistent comparative cost benchmarking

Source: Expert and industry interviews; Secondary research; Dalberg Analysis

# Inter-culture Operations: Efficient manual and mechanized weeders increase efficiency and reduce need for chemical weedicides

○ Low ● High

| Technology | Affordability and cost effectiveness | | | Economic, social and environment impact | | | Ease of operations and maintenance | |
|---|---|---|---|---|---|---|---|---|
| | *Low upfront costs* | *Low running costs (in $/Ha)* | *Low total costs per Ha (amortized plus running, in $/Ha )* | *High efficiency (Ha/Hr)* | *Low need for fuel* | *Reduction in need for chemical weedicide* | *Ease of operation* | *Low dependence on specialized local servicing* |
| **Basic Push Hoe** | ● | ◔ | ◔ | ◔ | ● | ◔ | ● | ◕ |
| **Cono Weeder** | ◕ | ◑ | ◕ | ◑ | ● | ◑ | ● | ◕ |
| **Wheel Hoe** | ◕ | ◑ | ◑ | ◑ | ● | ◑ | ◕ | ◕ |
| **Rotary Weeder** | ◔ | ◑ | ◑ | ◕ | ◑ | ◕ | ◑ | ◔ |
| **Power weeder** | ◔ | ◑ | ◑ | ◕ | ◑ | ◕ | ◑ | ◔ |

The power weeder is an efficient and cost-effective inter-culture machine. The key obstacle for its scale up is the high upfront cost. Of manual inter-culture technologies, cono weeder offers an efficient and cost effective solution with fewer barriers to scale up

Notes: Fuel usage based on ltrs/ha used by equipment; "Low dependence on advanced power sources" removed as machines are manual or self-propelled so this is reflected in upfront cost; "High water savings" removed as technologies not typically associated with water savings

Source: Expert and industry interviews, Secondary sources, Dalberg analysis

# Harvesting: Landscape of technologies

| | Sickle/sythe/cutlass/ manual picking | Binder Reaper | Vertical Reaper | Harvester- Mini Combine |
|---|---|---|---|---|
| |  |  |  |  |
| **Description** | • Hand-held with a variously curved blade used for harvesting crops<br>• Blade may or may not be serrated | • Walk-behind binder reaper<br>• Used for harvesting crops | • Walk-behind vertical reaper<br>• Tractor-enabled combine harvester for harvesting, threshing and reaping | • Walk-behind mini combine<br>• Mini combine can do harvesting, reaping and threshing in a single process |
| **Typical power sources** | • Manual | • Self propelled | • Self propelled | • Self propelled |
| **Drawbacks** | • Labour intensive<br>• Low harvesting quality (inconsistent or broken crop) | • High unit cost<br>• Low efficiency in cutting | • High unit cost as compared to combine | • High upfront costs<br>• With ownership model, only suitable for large land holding s |
| **Applicable land size [1]** | <2ha | 2-5ha | | >5ha |

Note: Focus of harvesting and threshing analysis is on harvesters, some of which can perform threshing functionality

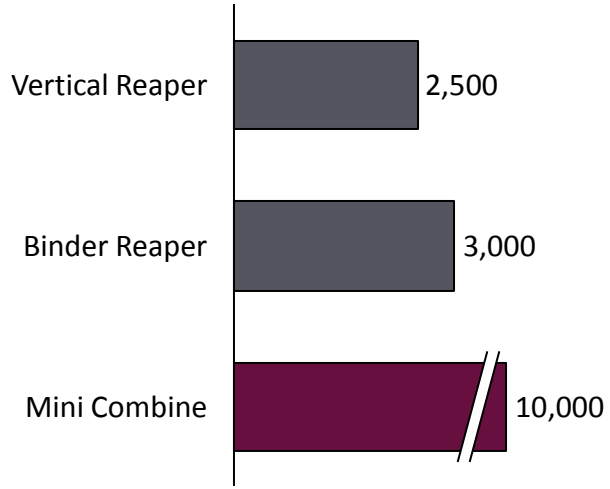
(1) Applicable land size for ownership model; Note: Technology landscape is not exhaustive but provides an overview of technologies most relevant for BoP

Source: Expert and industry interviews, Secondary sources, Dalberg analysis

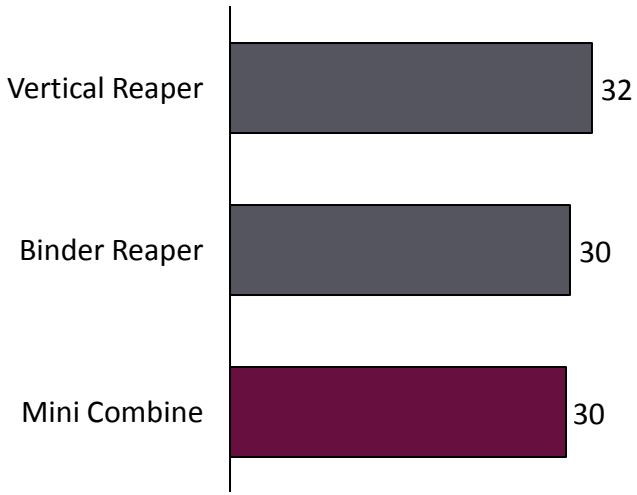
# Harvesting: Mini combine is most cost effective option due to its high efficiency and combination of multiple operations of reaping, harvesting and threshing

*DIRECTIONAL*

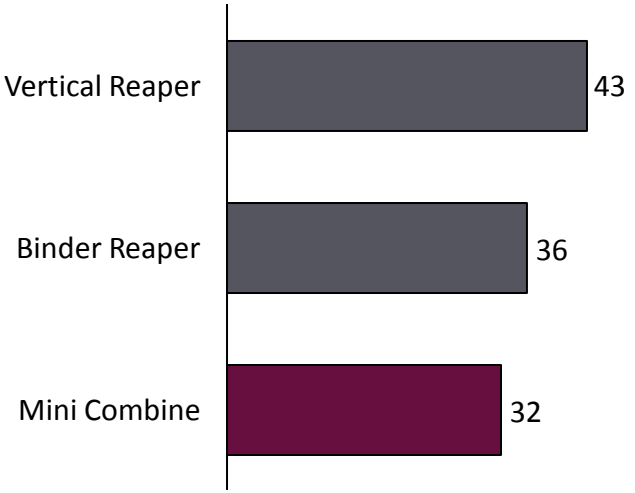
**Upfront cost**
In $




**Running cost[1]**
In $/Ha




**Total cost per Ha**
Amortized cost[2] + running cost, In $/Ha




(1) Assumption: Additional labour cost in running cost consists of Threshing cost

(2) Assumption: We are assuming capacity utilization during relevant seasons

(3) Assumption: Salvage value of equipment is considered equal to HP equivalent tractors

Note: Prices shown are for Indian market; India has been taken as a representative example country to allow for consistent comparative cost benchmarking

Source: Expert and industry interviews; Agricoop publication on harvesters; Secondary research; Dalberg Analysis

# Harvesting: Mini combine is a promising technology, but high fuel costs are a drawback and high upfront cost is another limiting factor of adoption

○ Low ● High

| Technology | Affordability and cost effectiveness | | | Economic, social and environment impact | | | Ease of operations and maintenance | |
|---|---|---|---|---|---|---|---|---|
| | *Low upfront costs* | *Low running costs (in $/Ha)* | *Low total costs per Ha (amortized plus running, in S/Ha )* | *High efficiency (Ha/Hr)* | *Low need for fuel* | *Reduction in post-harvest losses* | *Ease of operation* | *Low dependence on specialized local servicing* |
| **Sickle** | ● | ◑ | ◔ | ○ | ● | ◔ | ◕ | ● |
| **Binder Reaper** | ◑ | ◑ | ◑ | ◑ | ◑ | ◑ | ◑ | ◔ |
| **Vertical Harvester** | ◑ | ◑ | ◔ | ◕ | ◑ | ◑ | ◑ | ◔ |
| **Mini Combine** | ◔ | ◑ | ◑ | ● | ◔ | ◕ | ◑ | ◔ |

Modern mechanized harvesting options improve efficiency and reduce post-harvest losses. However, solutions are needed to overcome the high upfront cost and dependence on specialized local servicing

Notes: Fuel usage based on ltrs/ha used by equipment; "Low dependence on advanced power sources" removed as machines are manual or self-propelled so this is reflected in upfront cost; "High water savings" removed as technologies not typically associated with water savings

Source: Expert and industry interviews, Secondary sources, Dalberg analysis

# Table of Contents

# While modern efficient agricultural machinery is cost-effective in the long run, there are various challenges to be addressed through business models

## Key advantages of modern agricultural machinery

- Cost effective in the long-term
- High efficiency, which enables productivity gains and can support seasonally on-time planting
- Savings on inputs such as water, seeds or pesticides which supports efficiency, cost effectiveness and positive environmental impact
- Some technologies in specific technology areas also associated with yield improvement and reduction in post-harvest losses

## Key challenges to be addressed through business model and ecosystem development

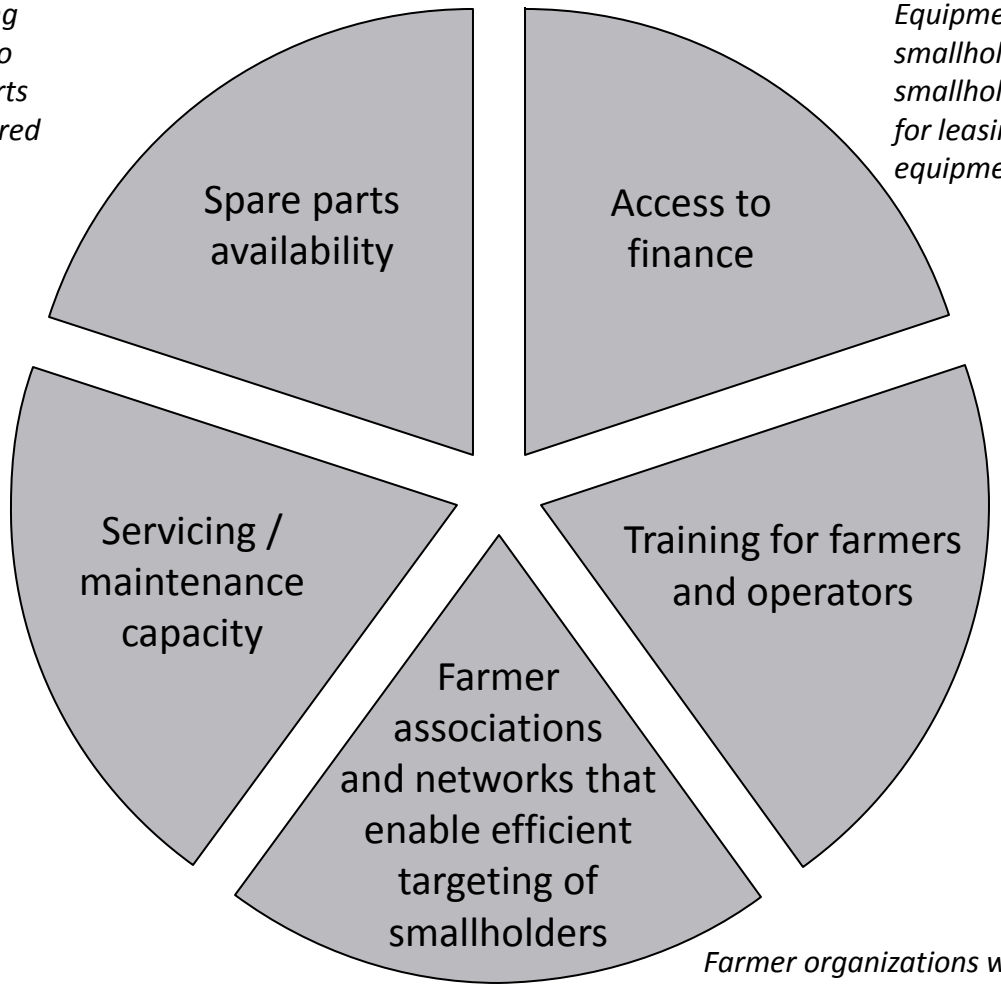
- High up-front cost
  - Access to finance and mechanisms for cost sharing through group usage required
- High capacity of operation needed to achieve cost effectiveness
  - Mechanisms for cost sharing through group usage required, e.g. rental models
- Dependence on power sources
  - Targeting of farmers who have access to advanced power sources, through rental, lease or ownership models
- Necessity of training for proper operation
  - Mechanisms for farmer education and training
- Dependence on local servicing expertise
  - Local service and maintenance capability
  - Local spare parts availability

**Modern agriculture machinery tends to have high cost effectiveness and efficiency, but also various obstacles for a BoP setting. Review of obstacles underscores need for supportive enabling environment and innovate business models**



Source: Dalberg analysis

# A comprehensive enabling ecosystem supports promotion of agricultural mechanization among smallholders




*Dealers providing reliable access to replacement parts through registered distributors*

*Equipment financing focused on smallholder needs to provide smallholders with financing options for leasing and purchasing equipment*

*Service centers that provide reliable access to skilled technicians to ensure equipment remains in good working condition*

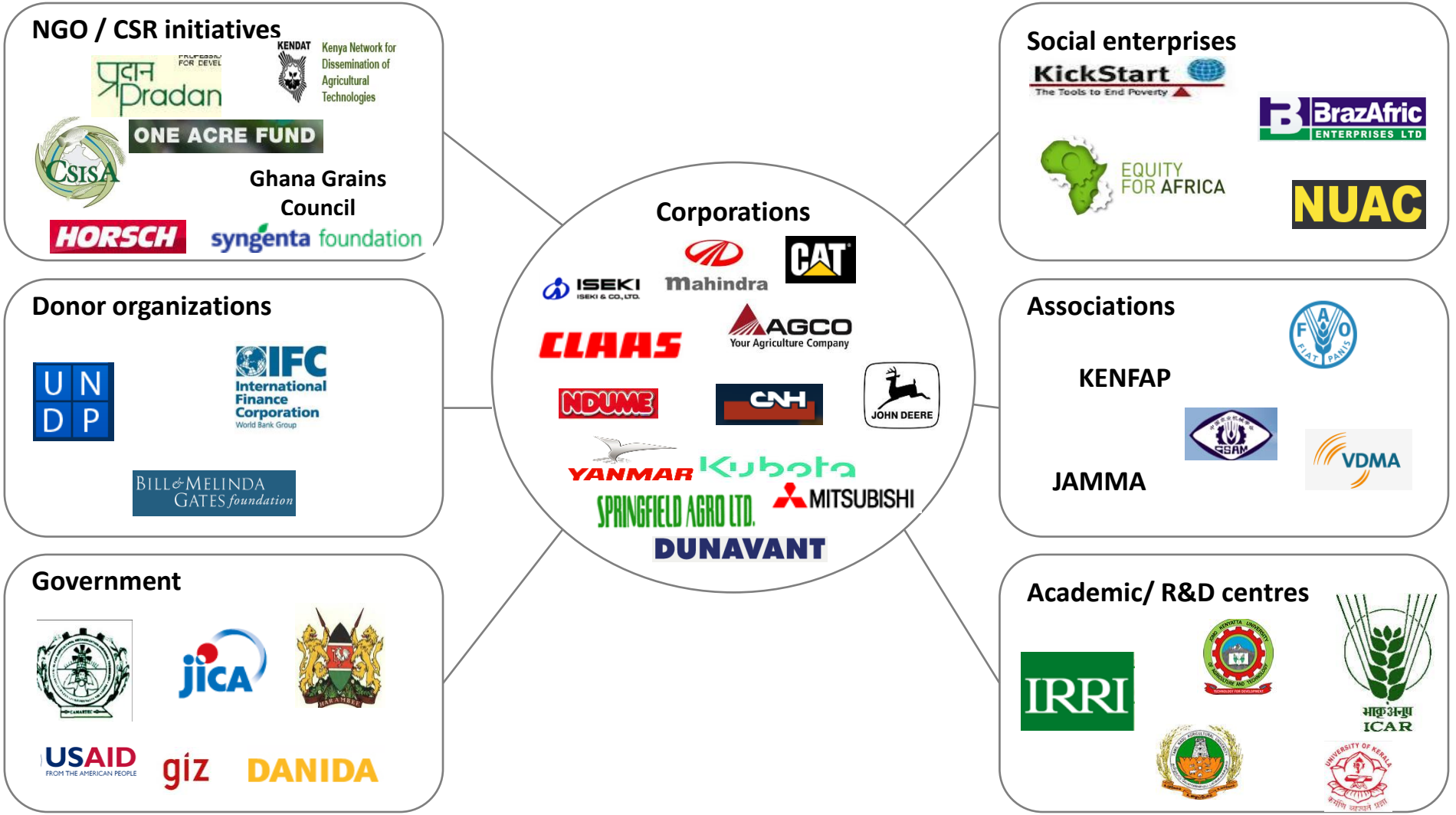
*Agriculture universities and academic institutions providing training on mechanization*

*Farmer organizations which can generate awareness and demand, enable group usage and play an important role in equipment financing*



Source: Expert and industry interviews; Secondary research; Dalberg analysis

# Examples of key players across the global Agriculture Mechanization ecosystem




Source: Dalberg analysis

# A variety of players are implementing innovative models to promote mechanized agricultural machinery

● Case studies presented

| Organization | Type | Nature of solution | Geography | Sales | Lease | Rental | Other | |
|---|---|---|---|---|---|---|---|---|
| Mahindra | Corporate | Manufacturers in technical collaboration with Mitsubishi | Global (India) | X | | | | ● |
| John Deere | Corporate | Equipment leasing model | Global | X | X | | | ● |
| AgCo | Corporate | Equipment leasing model; Partnership with WAAB and Rabobank | Global (Africa) | X | X | | | |
| MachineFinder.Com | Corporate (John Deere) | Selling of second hand tractors through Internet database | Global | X | | | | |
| Dunavant Cotton | Corporate | Leasing tractors to outgrower tillage service providers | Zambia | | X | | | ● |
| KENDAT | NGO | One-stop service center model | Kenya | X | | X | | ● |
| Pradan | NGO | Empowerment/productivity programs | India | | | | | |
| CSISA | NGO | Equipment rental model | India | | | X | | ● |
| BrazAfric | Social enterprise | Lease-to-own model | East Africa | | X | | | ● |
| NUAC | Social enterprise | Service-hire model (rental model with operation by trained operator) | Uganda | | X | X | | ● |
| Kenya Ministry of Agriculture | Gov't | Rental of second hand farm equipment at below-market rates | Kenya | | | | X | ● |



Source: Expert and industry interviews; Secondary research; Dalberg analysis

# Mahindra has a technology transfer agreement with Mitsubishi for manufacturing rice transplanters to be sold in India and abroad

## Model

- Mahindra and Mahindra, a farm equipment and utility vehicle major, sought to expand its range of products to include **crop-specific agricultural implements** to help raise the level of agricultural mechanization in India
- Mitsubishi Agriculture Machinery, a unit of Mitsubishi Corporation, applied its expertise in **a technical collaboration to enable Mahindra's manufacturing capabilities**, with a technology transfer agreement signed in 2010

## Profile of customers

Initially targeting rice farmers; eventual goal to target farmers with other crop-specific machinery

## Scale

Mahindra has a network of dealers across India. In 2010, it aimed to sell around 5,000 units a year domestically, and also export to China and SAARC nations. A full range of Mahindra crop-specific implements are now available across India

## Cost to customers

N/A

## Technology Used

Mitsubishi's proprietary technology, through a licensing and technology transfer agreement, enabled Mahindra to manufacture rice transplanters with low operating costs, which can improve crop yields by up to 20%

## Innovation

**Innovative partnership between a local company with an extensive, nationwide customer and distribution network and a Japanese company with advanced technology** to support expanding the product range to include a range of end-to-end mechanization solutions to increase productivity of rice and sugarcane farming

## Challenges

- Implements need to be priced at a price point that it is cost-effective for smallholders
- Marketing crop-specific implements to farmers with low awareness is a challenge

Source: : Economic Times, Mahindra

# John Deere is a large MNC that has explored the equipment leasing model in developing countries, but has not yet tailored its offering to BoP farmers

## Model

John Deere is a corporate manufacturer and distributer. Through their leasing model, **equipment is leased to farmers on a seasonal basis at pre-determined rate**

## Profile of customers

Mainly medium scale farmers, predominantly in India / South Asia

## Cost to customers

**Bank financing for leasing equipment at rates around 6%.** Example bank partners include NABARD and YES BANK

## Technology Used

Mainly Tractors and Combines; Product offering not specifically tailored for small land holdings (e.g. tractor with lowest power has 35 HP)

## Scale

NA

## Innovation

**Bank linkages to facilitate financing and monitoring of the equipment**

## Challenges

Challenges include establishing finance linkages at scale and overcoming lack of proper servicing during peak season



Source: Secondary research

# Dunavant Cotton has set up an innovative financing scheme using its outgrower network, leasing tractors to trusted outgrowers

DUNAVANT

USAID
FROM THE AMERICAN PEOPLE

## Model

- Dunavant Zambia is an **international cotton trading company** that supports smallholder farmers[1] growing cotton; purchases and processes seed cotton from contract farmers; and sells the cotton lint internationally
- USAID supported creation of **"tillage service providers (TSPs)," farmers who till other fields for a fee,** helping improve farm productivity; Dunavant Cotton purchased the tractors and leased to select outgrower TSPs

## Profile of customers

**Trusted Dunavant outgrowers** who were interested in becoming tillage service providers with a rental-service hire model

## Scale

Dunavant has the largest ginning capacity in Zambia and is the largest cotton buyer. Given the structure of the Zambian cotton market[1], the majority of sourcing is from farmers with relatively small land holdings

## Technology Used

Low-powered tractors used to operate tillage and spray machinery. Low per hectare yield is a challenge faced in the Zambian cotton market and this technology can improve yield

## Innovation

**Dunavant is a pioneer in granting loans to small-scale farmers for tractors without any form of security**, and banks are now willing to give unsecured small-scale farmers tractor loans as a result of the Dunavant pilot

## Challenges

- USAID initially offered a loan guarantee to earn buy-in from Dunavant
- Achieving scale is a challenge

(1) Over 98% of Zambia's cotton is grown by farms smaller than 5 hectares

Source: UNDP, USAID, IFC, World Food Programme, Dalberg analysis

# KENDAT is setting up a service center model with one-stop agri-business health shops offering equipment rentals and demos

KENDAT Kenya Network for Dissemination of Agricultural Technologies

## Model

A tech transfer NGO that promotes sustained development through advancing capacity for smallholder farmers . They plan to set up center that acts as a "one-stop-shops" called **Agri-business Health Shops,** where farmers can hire out a range of equipment, see a demo of the farm equipment, learn about maintenance requirements, acquire spare parts and attend talks by various experts

## Profile of customers

Typical smallholder farmers (1-5ha); Contract farmers tend to have most interest

## Cost to customers

The new model would enable customers to hire out the technology instead of paying upfront cost. Typical upfront cost for a 5HP two wheel tractor (without attachment) is ~$1000, while upfront cost of a 20HP two wheel tractor is ~$4500

## Technology Used

Equipment that promotes conservation agriculture. Planning to source equipment from India and/or Brazil. KENDAT planning on using **two-wheeled tractors** with a number attachments which allows for multiple uses cases

## Scale

Have worked with ~8000 farmers in Kenya; Plan to start new agri-business shops in two Kenyan districts

## Innovation

Having one area in which farmers can not only hire but also see the equipment in action without having to incur all upfront costs of equipment. It also addresses the issue of farmers not having enough capital to acquire machinery

## Challenges

Scaling up an all inclusive model like this may be difficult given costs of set-up; Hoping to partner with private sector to ensure commercial viability



Source: Interview with Dr. Pascal Kaumbutho and Dr. Joseph Mutua; Secondary research

# CSISA has experimented with a service center model, offering rental-hire options targeted to smallholder farmers

## Model

The Cereal System Initiative South Asia is a project to increase food and income security. Donors include Gates Foundation and USAID. **CSISA runs service centers to promote rental options** for various equipment for the small and medium farmers

## Profile of customers

Focus is in India and Bangladesh. Typical smallholder farmers (1-5ha); Contract farmers tend to have most interest

## Cost to customers

Rent varies depending on the equipment. Ranges from $20- $50 /Ha

## Technology Used

- Zero Till Drill
- Self Propelled Transplanter
- Two Wheeled Tractor
- Combines

## Scale

Service centers are designed to serve 1000 Ha/ season- However, on a average 250 Ha/ season is being utilized by a service center

## Innovation

Demand pooling through rental model

## Challenges

Challenges include low farmer awareness, seasonal demand trends and lack of efficient linkage with companies for space parts



Source: Secondary research

# NUAC introduced the service-hire model through which farmers hire both the equipment and the operator, based on challenges with the typical rental model

NUAC

## Model

NUAC (Northern Ugandan Agricultural Centre) have **a service- hire model where farmers can hire both the tractor and the driver** to prepare their land. They intervene during the harvest season allowing famers to produce more. This is mostly for rice and maize

## Profile of customers

Currently focused on farmers in Northern Uganda whose farm sizes can range from 4- 400 ha

## Cost to customers

NA

## Technology Used

Small scale tractors which can handle between 100-200 acres per season

## Scale

Currently only operating in Northern Uganda; hopes to expand into manufacturing; Also working on a model to give farmers machinery and have them pay over 3 years (currently small scale)

## Innovation

The service-hire model; Introduced because they **typical rental model was not working as the equipment was difficult to keep track of and cost of maintenance went up as farmers did not know how to use or maintain it**

## Challenges

Scalability is a challenge



Source: Interview with Kim Johansen, Dalberg analysis

# BrazAfric's rent-to-own model targets farmer co-operatives; however, ensuring buyer creditworthiness and promoting regular servicing are challenges

## Model

BrazAfric import technologies from South America, Europe and Asia. **They provide buyer financing and conduct due diligence on prospective customers** to ensure that they are credit worthy

## Profile of customers

Sell to corporates e.g. Mumias Sugar as well as farmer co-operatives for larger pieces of equipment

## Cost to customers

Depending on the type of equipment the customer will pay an initial down payment and be able to take the equipment with them. Over a fixed period the customer will pay the full price in increments

## Technology Used

Bigger bulkier pieces of processing equipment and packaging equipment

## Scale

BrazAfric operates in a number of countries in East Africa including Kenya , Rwanda and Uganda

## Innovation

Farmers and farmer groups often have difficulty being able to invest for these costlier pieces of equipment so **BrazAfric incorporates a buyer-financing model**

## Challenges

BrazAfric plans to stop this model. Ensuring buyers credit worthy and clarifying responsibility for machine service issues has proved to be difficult, with a number of clients defaulting on payment

Source: Secondary research

# Kenya's Ministry of Agriculture runs a subsidized used tractor hire model; however, tractors are poorly suited to smallholder plots and not well maintained


## Model

The Kenya Ministry of Agriculture introduced a program through which **previously-owned agricultural machinery is imported by by the government and distributed to different districts for the farmers to rent out** under a subsidized rental model

## Profile of customers

Small holder farmers in under served areas

## Cost to customers

Farmers can use the tractor at a subsidized fee of ~1/2 of what a private tractor owner would charge them

## Technology Used

Mostly four wheeled tractors that were unsuitable to smallholder farmers

## Scale

Anticipated to serve the entire country

## Innovation

Subsidized user tractor hire model. The aim was to disseminate mechanization quickly and ensure that there would be no cost barriers to farmers using the machinery

## Challenges

As the equipment was inappropriate for small holder farmers and machines badly maintained (government did not provide money for maintenance and spare parts were difficult to come by), the machines quickly fell into disrepair and are currently not being used



Source: Stakeholder interviews; Dalberg analysis

# Key factors of success have been identified from review of existing ownership, leasing and rental delivery models

| Key characteristics of successful solutions | | Findings | Implications |
|---|---|---|---|
| *Operational* | Training of operators for equipment usage and servicing | Many types of equipment, e.g. mini combines, necessitate significant operational training so as to adequately control usage cost. Lack of training increases cost and leads to negative farmer perception of the equipment | • Invest in training operators on correct usage methods and servicing requirements<br>• Set up service-hire models with trained operators<br>• For out-growers, consider set up of nucleus farms to support community education |
| | Spare parts availability | Farm equipment is in demand for only limited time of the year, and expedient repairs need to be possible during the peak demand time. Lack of spare parts availability restricts equipment uptake due to fear of breakdown | • Set us spare parts centers and supply chain for quick repairs<br>• Manufacture equipment with locally available materials<br>• Invest in training for local mechanics |
| *Financial* | Cost sharing through group usage | Many types of equipment with high upfront costs could find improved uptake through group usage. However, service delivery models for group usage are lacking in many places | • Partner with farmers organizations and cooperatives to promote group usage<br>• Explore opportunities into sell to other demand aggregators, such as out-grower programs, who commit to purchase at given price levels<br>• Set up service-hire rental models with trained operators |
| | Low upfront cost or availability of finance | Small and medium farmers are often unable to afford the most efficient equipment types due to high upfront costs and lack of financing options | • Partner with banks/MFIs/outgrowers to make financing available<br>• Set up operationally viable leasing and rental models<br>• Utilize low cost material for manufacturing and streamline design |

Source: Interviews with Schneider Electric, Simpa networks, and Greenlight Planet; Dalberg analysis

# Innovative financing mechanisms tailored to smallholder needs are emerging and can better enable smallholders to pay upfront or rental equipment costs

| Financing mechanism | Mechanism / description | Examples |
|---|---|---|
| **Bundled support packages** | Offtakers provide comprehensive inputs and services on credit to farmers in their supply chain, including seeds, fertilizer, extension support, access to equipment, etc., in order to increase farmer loyalty to offtaker | • Ghana Grains Partnership, Ghana: Growers Association is offtaker for maize farmers, guaranteeing minimum price and providing inputs on credit, training, and business management services |
| **Purchase order finance** | Offtakers (e.g., processors) offer purchase orders to smallholders that are used as collateral for a working capital loan. Accounts receivable are transferred to the lending institution. Upon delivery, offtaker pays lender, who transfers net proceeds to the producer | • FIE (MFI), Bolivia: Coffee and dairy buyers place orders through brokers with small producers; producers request loans from FIE in exchange for accounts receivable; buyer pays FIE for the goods |
| **Wholesale lending** | Banks lend indirectly to smallholders via cooperatives or other aggregators. Cross-guarantees serve as collateral, though cash collateral is often collected in addition. Direct integration of input suppliers reduces cash transactions and can improve security | • Zanaco (National Bank), Zambia: Zanaco lends to District Farmer Associations for aggregate purchase of inputs for all members; farmers put up 50% cash collateral; Offtakers buy maize, paying Zanaco, who pass on net proceeds to farmers |
| **Commitment savings** | Farmers choose to deposit money from crop proceeds at harvest immediately upon payment and the money is locked until the next seasonal purchase of inputs. A similar approach offers farmers the opportunity to purchase vouchers at harvest for future inputs, which are delivered at next planting | • OIBM and the World Bank, Zambia: Farmer specifies duration for which funds are locked—typically until the next planting season; funds are released with interest earnings<br>• Innovations for Poverty Action, Kenya: Farmers can purchase vouchers for future fertilizer to be delivered next season |
| **New leasing models** | New leasing models are emerging for cooperative leasing and centralized service providers to make leasing more affordable for smallholders | • PROFIT, Zambia: USAID supported creation of "tillage service providers (TSPs)," farmers who till other fields for a fee; Dunavant Cotton purchased the tractors and leased to select outgrower TSPs |



Source: IFC & GPFI, USAID, Dalberg analysis

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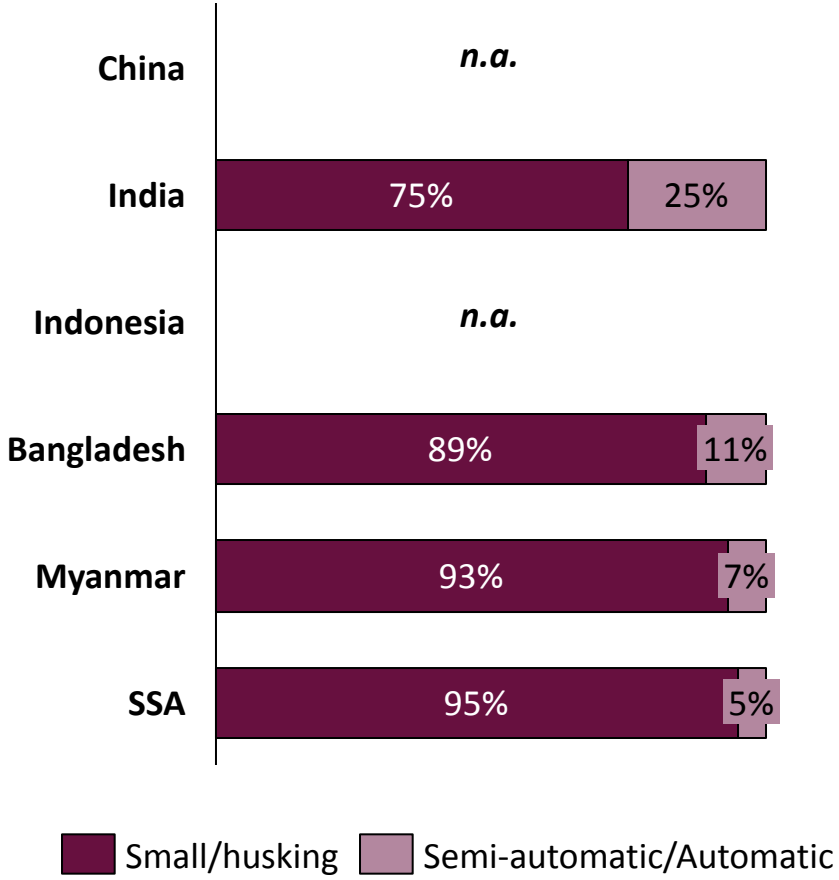
# The vast majority of rice mills use non-mechanized processes, with lowest mechanization rates in Sub-Saharan Africa and some South Asian countries

## Differences among the three types of mills[1]

| Typology | Brief description |
|---|---|
| 1 Small / husking mills | • Use non-automated milling processes only<br>• Low quality of milling. Low white rice yield and high percentage of brokens<br>• Cater to a largely rural consumer base |
| 2 Semi-automatic mills | • Some processing mechanisms are automated, but not all processes are included<br>• Moderate level of white rice yield<br>• Cater to both rural and urban customers |
| 3 Automatic mills | • Processing is fully automated with multiple processes including, resulting in highest quality rice output<br>• Highest white rice yield<br>• Cater to both rural and urban customers |

## Proportion of mills by mill typology

In %



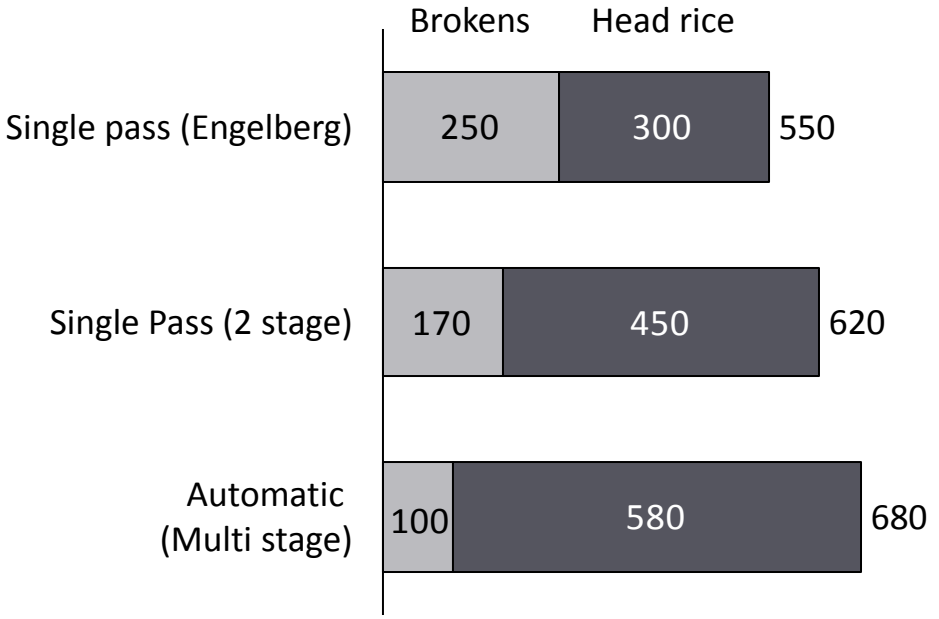

Note: Focus of this section is exclusively on rice milling (not incl. threshing, drying, storage, etc.)

Source: Director Procurement (Food), Government of Bangladesh (2013); "Nutritious Value Chain in Bangladesh – Report on Technical Studies," GAIN (2013); Rwanda: AIRD (2009), Government of Uganda (2009), Journal of Assam University (1987); Dalberg analysis

# Mechanized milling enables higher recovery of edible rice and produces higher quality rice, which results in higher sales volumes and prices

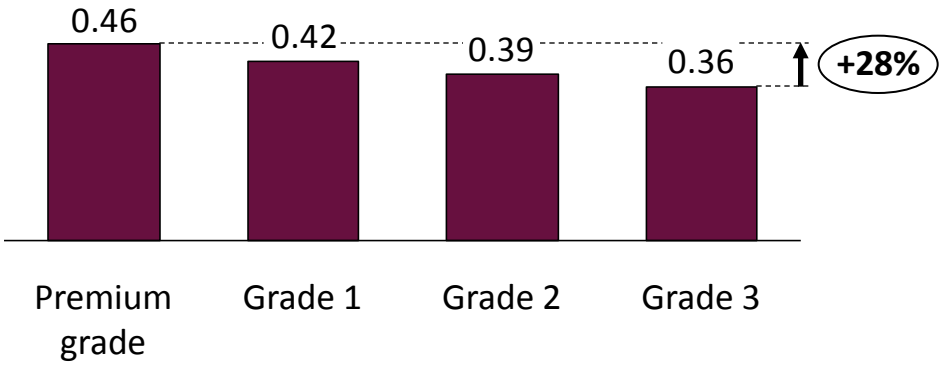
## Automatic mills enable higher overall recovery of white rice with higher percentage of head rice and fewer brokens

**Indicative: Breakdown of rice recovery per 1 kg of milled rice[1]**
In grams of rice recovered




## Selling price of rice varies notably by grade. A primary consideration in grade determination is composition in terms of head rice versus brokens[2]

**Example from Philippines: Price by grade**
In USD/kg; Year: 2000




- *Indications suggest price differential between non-graded low quality rice and graded rice may be even more substantial, e.g. +>60% in Tanzania*

Automatic rice milling increases revenue generated per ton of rough rice through two main mechanisms: (i) by increasing the overall recovery of edible rice and (ii) by improving the quality of the rice mixture

(1) Varies based on multiple factors, directional only; (2) In grade of rice, percentage of head rice vs. brokens is a primary consideration. Other quality factors include moisture content, percentage of yellow rice, percentage of damaged rice, percentage of red rice, varietal purity, percentage of immature and chalky grains

Sources: 'Rice Science: Innovations and Impact', IRRI; The Rice Economy of Asia; IRRI Rice Knowledge Bank; Secondary research; Dalberg analysis

# Improved milling can enable a significant increase in revenue from rice sales, while remaining a relatively minor cost in the overall rice value chain

## Modern milling offers the chance to considerably increase revenue from rice sales...

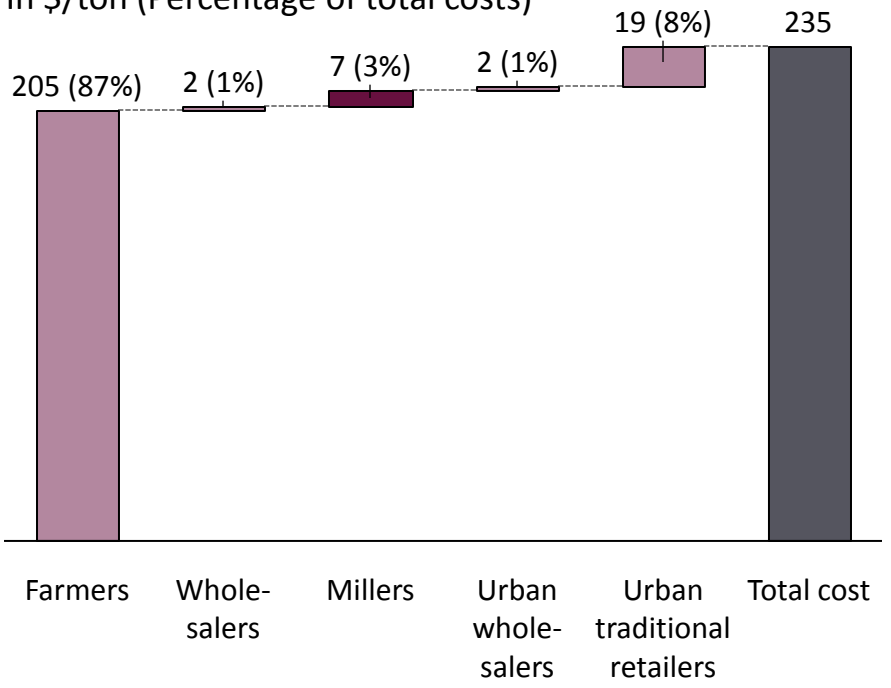
### Mechanisms for increased revenue from modern milling

| Mechanism | Details | Revenue impact |
|---|---|---|
| **Increased rice recovery** | • 55% recovery with Engelberg vs. 68% recovery with automatic multi-stage | • Max of +~25% rice volume |
| **Higher sales price based on higher quality rice** | • Rice with higher grading demands higher price (e.g. Grade A vs. Grade C)<br>• Previously ungraded rice that becomes graded and achieves market access also demands significantly higher price | • Typical ranges of 20%-60% increase in price |

## ...while constituting only a relatively minor fraction of costs across the rice value chain

### Example: Cost structure of rice value chain in Bangladesh

In $/ton (Percentage of total costs)




Switch to proper milling can increase revenues from between approximately 30% to 100%, while milling itself remains a relatively minor cost in the full rice value chain, for example 3% of total costs in the above example value chain

(1) The retail cost of a ton of common rice in Dhaka (2009) was $444.23

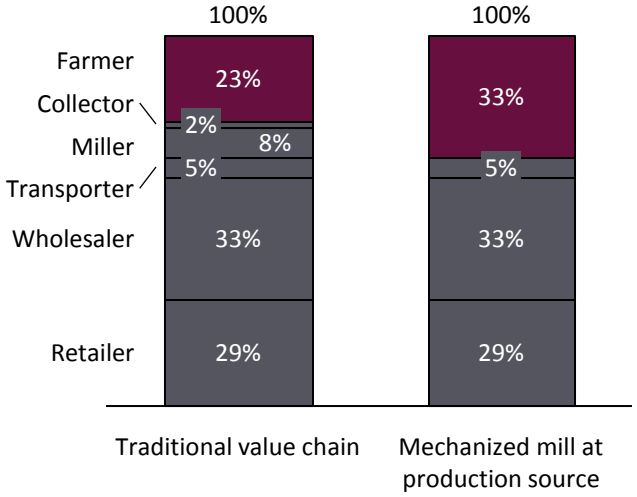
Source: 'The Transformation of Rice Value Chains in Bangladesh and India: Implications for Food Security', ADB

# Increased use of mechanized mills would drive a variety of positive economic, social and environmental impacts

## Economic impacts

- Purchase of a village mill can help smallholders who have previously paid a middleman for rice milling to cut out the middleman and increase their profit margins

**Example: Breakup of margin per unit in Vietnam rice value chain**
In % of margin




- Reduction in post harvest processing losses
- Improved quality and uniformity of end agricultural product (e.g. fewer brokens) resulting in increased selling price and/or an expansion of product's potential market (e.g. competitive with import market)
- Localized processing enabled by higher prevalence of mechanized technology in villages can reduce shipping cost based on shipment of post-processed rice

## Environmental impact

- Reduction in waste through more efficient and precise harvesting
- Reduction in environmental impact of shipping based on shipment of processed rice that has been processed locally at production source

## Social impact

- Opportunity for increased food independence and increased rice exports
- Reduction in physically demanding, drudgerous work (e.g. pounding )
- As processing is one of the most critical steps in determining nutritional value of rice; optimization of rice from nutritional perspective can best be achieved through centralized automated mills (e.g. enabling parboiling pre milling)
- With overall world population growing while non-urban population shrinks, efficient agricultural techniques will be required to ensure food security

Source: Future Directions International Website; Secondary research; Expert and industry interviews; World Bank; Dalberg analysis

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# The key steps for both manual and automatic milling are hulling and whitening of the rice; for each, a broad set of traditional and advanced solutions exist

| | Traditional | Advanced |
|---|---|---|
| **Hulling** (husk removal) | • Pestle and mortar<br>• Manually operated hammer beam pounder<br>• Manual husking machines<br>• Steel roller husker (Engelberg mill) | • Under-run disc sheller<br>• Stone dehuller<br>• Centrifugal husker<br>• Rubber roller dehullers |
| + | | |
| **Whitening** (bran removal) | • Pestle and mortar<br>• Manually operated hammer beam pounder<br>• Engelberg whitener (steel friction) | • Pearling or whitening friction cone<br>• Horizontal abrasive whitener<br>• Vertical whitener<br>• Iron roll friction whitening machine |

More advanced milling methods separate the hulling and whitening steps, whereas traditional methods combine these steps, either with one-pass machines or ongoing pounding until both are achieved

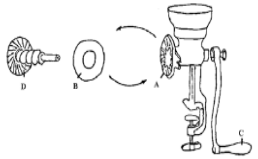
Source: Dalberg Analysis

# Automatic machines include more automated processing steps which enable production of higher quality, standardized rice

| Process | Description | Example components | |
|---|---|---|---|
| Husk removal (Hulling) | Removal of the husk from the paddy rice. Husk represents approx. 18%-28% of the total paddy weight | • Rubber roller |  |
| Paddy separation | The paddy separator separates unhusked paddy rice from the brown rice | • Compartment separator<br>• Tray separator<br>• Sieve or Gravity separator |  |
| De-stoning | Separation of brown rice from various impurities like stones | • Destoners |  |
| Whitening / polishing | White rice is produced by removing the bran layer and the germ from the brown rice. Rice is then polished by removing loose bran adhering to the surface of milled rice and improving its translucency | • Pearling or whitening friction cone<br>• Horizontal abrasive whitener<br>• Iron roll friction whitening machine |  |
| Grading and mixing | After polishing, the white rice is separated into head rice, large and small broken rice and “brewers” and mixed in appropriate ratios | • Sifter<br>• Rotary sieve |  |
| Mist polishing | Mixing a fine mist of water with the dust on the whitened rice improves the shine of the rice | • Mist polisher |  |

Note: The process followed is post paddy cleaning and drying. Most paddy cleaning is done in farms by the farmers

# Landscape of rice milling technologies (1/2)

| | MANUAL | | SEMI-AUTOMATIC | | |
|---|---|---|---|---|---|
| | **Pounding** | **Manual husking machines** | **Steel dehuller (Engelberg)** | **Centrifugal husker** | **Disc sheller** |
| |   |  |  |  |  |
| **Description** | Methods include beam hammer with pounder or mortar and pestle. Dehusking and polishing by repeated pounding of the paddy | E.g. Hand-operated steel husker, wooden manual husker, Bamboo clay husker. Paddy is fed into machine and hulled as it flows between cones/on the surface of adhesive cylinders. Some manual huskers also include whitening | One stage mill using steel rollers to remove the husk; single cast iron cylinder with a bumpy surface that turns inside a metal casing with steel blade mounted in the casing; sheering action hulls and whitens | One stage mill consisting of a rotating disc, a rubber-coated ring, and a pulley and belt drive from an engine power source; impact on the inside of the rubber-lined spring removes the husk | One stage mill consisting of two horizontal emery-faced discs, the upper disc, stationary and the lower rotating on a vertical axis; friction between the disc removes the husk |
| **Typical capacity** | • Around 3-6 kg/hr per person | • Around 12 kg/hr | • Around 300-500 kg/hr[1] | • Around 500 kg/hr | • Around 400 kg/hr |
| **Drawbacks** | • Laborious<br>• High percentage brokens and high grain loss and by-product loss | • Laborious<br>• Some produce brown rice (more nutritious, but not consumer preference) | • Low white rice recovery and highest breakage rates of semi-automatic mills | • High percentage brokens<br>• Produces brown rice<br>• Disc wears out quickly | • High level of grain breakage<br>• Produces brown rice when used alone |

(1) Machines with lower capacity also readily available

Source: IRRI, FAO, Secondary research, Dalberg analysis

# Landscape of rice milling technologies (2/2)

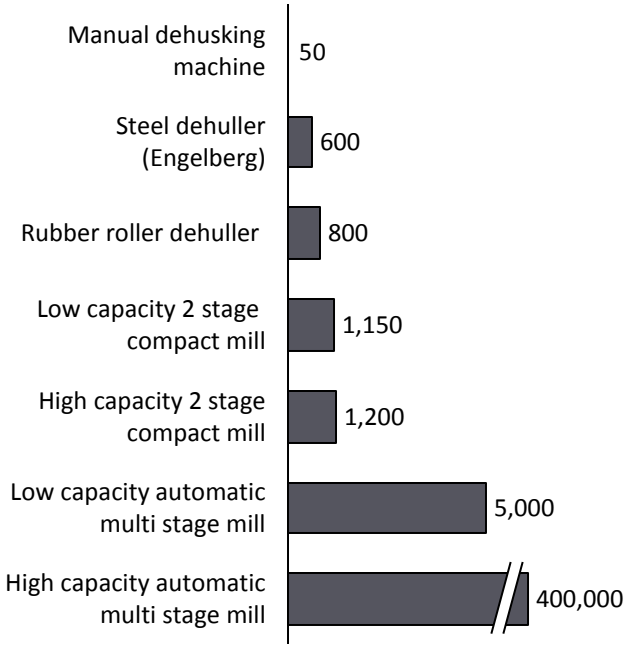
| | SEMI AUTOMATIC (cont.) | | AUTOMATIC | |
|---|---|---|---|---|
| | **Rubber roller dehuller** | **2 stage compact mill** | **Multi stage commercial mill (< 25 tons/day)** | **Multi stage commercial mill (25+ tons/day)** |
| |  |  |   |     |
| **Description** | One stage single pass huller using rubber rollers to reduce the amount of breakage of grains; Modern alternative to steel dehuller; Often used to enable storage of brown rice vs. rough rice | Typically a rubber holler with steel friction milling; abrasive milling can alternatively be included. Separate passes for hulling and whitening | Multi-stage mill including separate processes for husk removal, paddy separation, de-stoning and polishing | Multi-stage mill including separate processes for husk removal, paddy separation, de-stoning, polishing and other processes; Often including multiple whitening steps |
| **Typical capacity** | • Around 400 kg/hr | • Around 0.5-1.5 ton/hr | • 1-3 ton/hr | • 3.75-5 ton/hr |
| **Drawbacks** | • More expensive and less widely available than Engelberg mill<br>• High cost and frequency of replacing rubber rolls | • Lower capacity, lower quality and more manual work required compared to with automatic mill<br>• Upfront cost | • Higher power requirements to cover multiple processes<br>• Upfront cost<br>• Large scale required | • Higher power requirements to cover multiple processes<br>• Upfront cost<br>• Large scale required |

Source: IRRI, FAO, Secondary research, Dalberg analysis

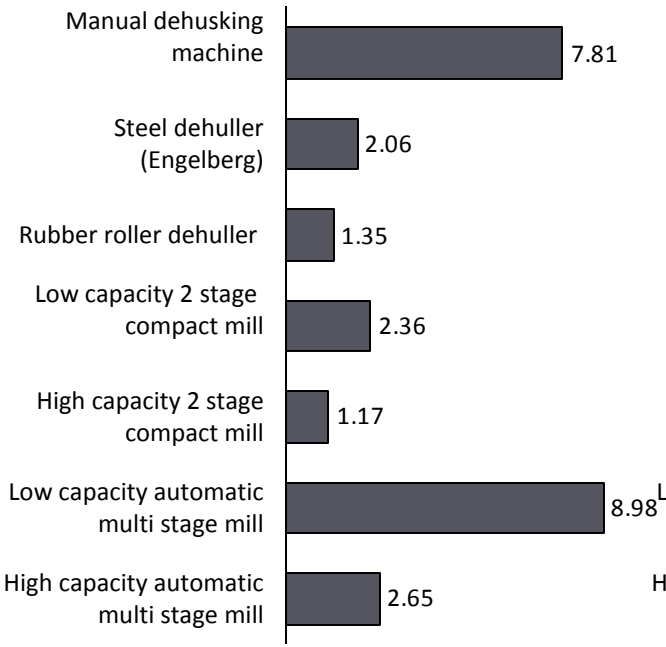
# Mill types have varying basic cost structures based on upfront capital expenditure, mill capacity, mill life span, electricity costs, and labour costs

*DIRECTIONAL*

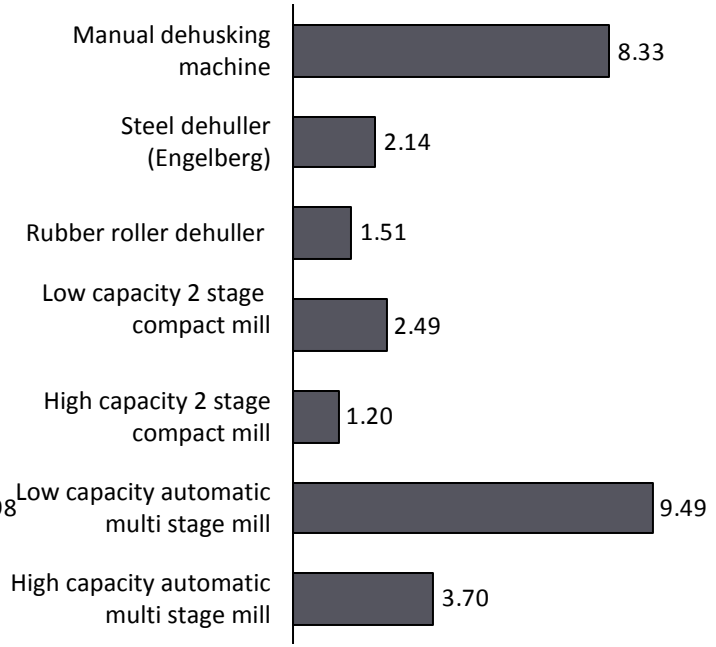
**Upfront cost**
In $, excl. land costs




**Running cost[2]**
In $/ton, excl. maintenance and financing costs




**Total cost per ton**
Amortized cost[1]+ running cost, In $/ton




- Based on a $165 minimum supported price for 1 ton of rice in India, all of the above costs for mechanized milling are consistent with milling costs representing 5% of selling price or less
- Though modern rice milling methods can be more expensive, cross-technology evaluation must consider that the resulting higher yield and higher quality of output can generate significant additional revenue

(1) Assumption: Lifespan of mills between 7 and 20 years, distinct by mill type; (2) Assumption: Running cost is taken as cost of electricity and labour; electricity assumed at .08 USD / kW. It does not include the cost of servicing and spare parts; Assumption operating 250 days per year at 80% capacity

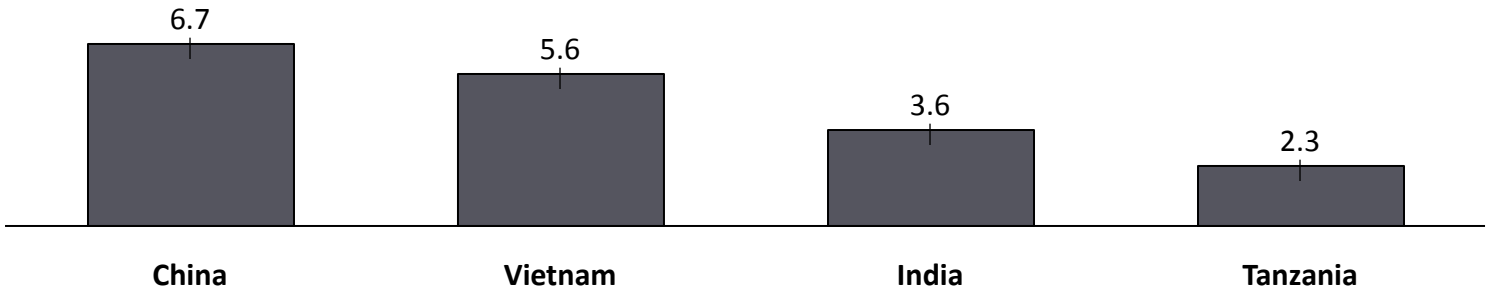
Note: Prices shown are for Indian market; India has been taken as a representative example country to allow for consistent comparative cost benchmarking; Multiple models used for bottom-up cost benchmarking; Prices are exclusively for milling and do not include drying, transport, etc. More advanced mills include higher number of processes before rice is ready for distribution and therefore produces higher quality rice; Comparison is at milling level, not process level. Does not include costs for land, margins or financing

Source: Secondary research; Dalberg analysis

# Payback period based on additional revenue from modern milling, given typical yields, is relatively short for most mills – when farmers are considered in groups

**Annual rice paddy yield per hectare, 2012**

In ton/Ha




**Payback period by mill type and by country**

*Calculated based on additional revenue earnings from rice sales[1]*

| | | | | |
|---|---|---|---|---|
| **Low capacity 2 stage compact mill[2]** *(Group of 30 1 Ha farmers)* | **0.5 years** | **0.5 years** | **1 year** | **2.5 years** |
| **Low capacity multi stage mill[3]** *(Group of 60 1 Ha farmers )* | **0.5 years** | **1 year** | **2 years** | **12.5 years** |
| **High capacity multi stage mill[4]** *(Group of 1,000 1 Ha farmers)* | **3 years** | **3.5 years** | **6.5 years** | **15 years** |

(1) Assuming switch from Engelberg 1 stage mill; (2) Capacity of ~0.4 tons/hour, (3) Capacity of ~0.3 tons/hour, (4) Capacity of ~4.5 tons/hour

Note: Yield improvement of 10% taken for 2 stage mill and 20% for multi-stage mills; Price improvement of 30% assumed; Starting yield of 55% assumed and starting base price of ~$80/ton (half of Indian minimum support price for market rice); Smallholder farm size of 1 Ha assumed; Running costs calculated based on capacity usage associated only with farmers in the group (If farmer groups offered milling services to additional farmers, pay back period would decrease)

Source: FAO; Dalberg analysis

# While no one technology emerges as the single most promising, switch to more advanced milling machines reduces losses, improves quality and can increase profits

○ Low ● High

| Technology | Potential market size | Economic, social and environment impact | | Ease of operations and maintenance | | | Affordability | | | Ease of marketing/ distribution | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Wide applic-ability (based on mill capacity)* | *Reduction in processing losses* | *Reduction in trans-portation require-ments* | *Low skill required for operation* | *Low dependence on specialized local servicing* | *High labour savings* | *Low upfront costs* | *Low running costs* | *Revenue per starting weight of paddy* | *Scalability of product design* | *Improved quality of end product* |
| **Pounding** | ● | ○ | ◑ | ◕ | ◕ | ○ | ● | ○ | ○ | ◕ | ○ |
| **Manual husking machines** | ● | ○ | ◑ | ◕ | ◕ | ◔ | ● | ○ | ◔ | ◑ | ◔ |
| **Steel dehuller (Engelberg)** | ◕ | ◔ | ◕ | ◕ | ◑ | ◕ | ◕ | ◑ | ◔ | ◕ | ◔ |
| **Rubber roller dehuller** | ◕ | ◑ | ◑ | ◑ | ◑ | ◕ | ◕ | ◕ | ◑ | ◕ | ◑ |
| **2 stage compact mill** | ◕ | ◑ | ◕ | ◑ | ◑ | ◕ | ◑ | ◕ | ◕ | ◕ | ◑ |
| **Automatic multi-stage mill** | ◑ | ◕ | ◑ | ◔ | ◔ | ◑ | ◔ | ◑ | ● | ◑ | ◕ |



Source: Secondary, industry interviews, Dalberg analysis

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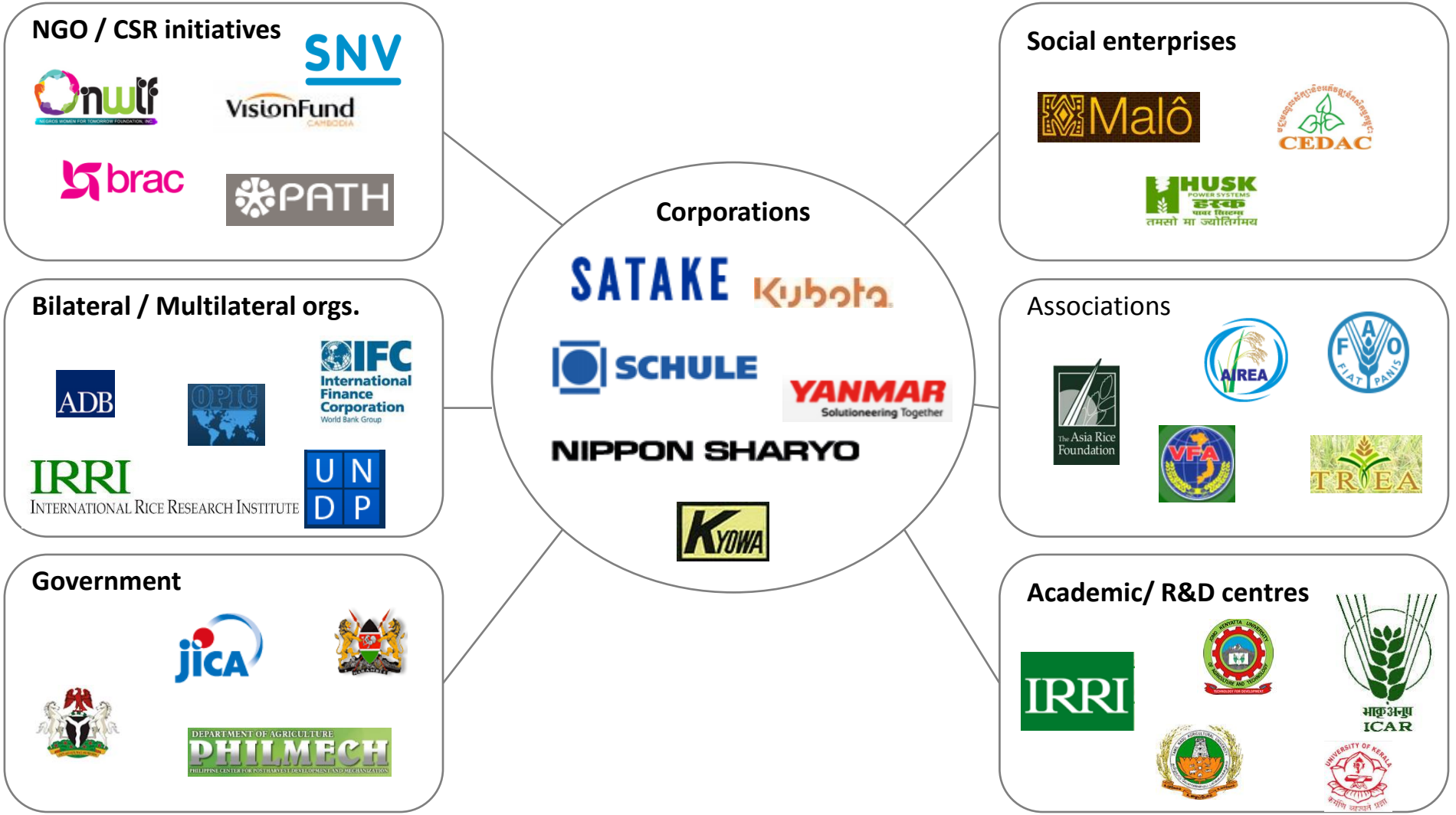
# Examples of key players across the global Rice Processing Ecosystem




Source: Dalberg analysis

# A variety of players are implementing innovative models to promote more advanced mills for processing of rice and other crops

Case studies presented

| Organization | Type | Nature of solution | Geography | Mill sales | Mill financing | Mill operation | Other |
|---|---|---|---|---|---|---|---|
| NWTF | MFI | Provides loan to villages for purchase of semi-automatic mills | Philippines | | X | | |
| VisionFund Cambodia | MFI | Provides loans to rice mill cooperatives for purchase of rice mills | Cambodia | | X | | |
| Kenyan government | Gov't | Set up revolving fund for purchase of small-scale rice mills by farmer groups following initial donation by JICA | Kenya | | | | X |
| PhilMech | Gov't | Supports qualified farmer cooperatives in purchasing modern mills | Philippines | | X | | |
| Malo | Social enterprise | Operates modern mill with innovative storage and micronutrient fortification | Mali | | | X | |
| SNV | Non-profit | Builds linkages between large mills and farmer cooperatives through outgrower agreements with embedded services | Global (Tanzania) | | | | X |
| SABMiller (PPP) | Corporation | Developed mobile cassava processing unit to link smallholders to markets | Nigeria, Ghana, Mozambique | | | X | |
| Bühler | Corporation | Provides compact mill to aid small-scale milling sector | South Africa | X | | | |
| NEDO (PPP) | Corporation | Built a demonstration rice husk gasification decentralized power generation system | Cambodia | | | | X |
| An Giang Plant Protection Joint Stock Company | Corporation | Brought in advanced technology for automatic mill through JV for tech transfer with Satake Corporation | Vietnam | | | X | |
| Kaneko | Corporation | International distribution of single and multi-pass rice mills, incl. mini size mill | Indonesia | X | | | |

Source: Secondary research; Dalberg analysis

# NWTF enables sales of village-level semi-automatic mills by providing microfinance community loans to rice mill cooperatives

## Model

- Negro Women for Tomorrow Foundation (NWTF), a **large MFI in the Philippines**, provides community loans for investments that are chosen by a cooperative. The cooperative then repays the loan through its communal fund
- In this case, **loans are given to enable rice farming communities to buy village rice mills**

## Profile of customers

Rice mill cooperatives composed of smallholder farmers (~1 hectare of land) who do not produce enough rice individually to justify investing in a rice mill

## Cost to customers

Repayment of principal loan amount with interest

## Technology Used

Semi-automatic rice mill consisting of a sifter, hopper, blower, bran chute, brewers chute, grain chute and air duct

## Scale

While this project was limited to rice-farming communities in the Philippines, similar financing mechanisms have also been used in other South-East Asian countries (e.g. similar VisionFund initiative in Cambodia)

## Innovation

By providing financing to cooperatives for rice mills, **NWTF has enabled farmers to cut out middlemen, increase margins and be self-sufficient**. The extra income generated is more than enough to pay off the loan, and cooperatives are also able to earn money by providing milling services to surrounding communities

## Challenges

Community-run projects such as these often face challenges such as coordination, accountability and maintenance

Source: Kiva; Secondary research

# Philippine Center for Postharvest Development and Mechanization promotes rice-mill modernization by providing financial assistance to farmer co-ops

## Model

Philippine Center for Postharvest Development and Mechanization (PhilMech), an attached agency of the Philippines Department of Agriculture, makes available mills with multi-pass technology available to qualified farmer cooperatives, who will **get a grant equivalent to 75% of the cost of the multi-pass rice mill**

## Profile of customers

Cooperatives of rice farmers (consisting of smallholders) who are registered with the Cooperative Development Authority and are willing to shoulder pre-construction expenses. 85% of farms in the Philippines have < 5 hectares

## Cost to customers

25% of the cost of the multi-pass rice mill to be borne by the farmer cooperative through loans and capital outlay, along with pre-construction expenses such as land filling, compacting and clearing

## Technology Used

A multi-pass rice mill has a 65%-70% recovery rate of un-husked rice, as opposed to single pass mills which have a 50%-57% recovery rate. A compact multi-pass rice mill has a capacity of 1-2 tons per hour while a large-scale multi-pass mill has a capacity of 5-10 tons per hour

## Scale

Rice farmer cooperatives across the Philippines are eligible for this scheme

## Innovation

By substantially lowering the upfront cost of a modern mill for farmers, **PhilMech has supported farmers in upgrading from traditional milling while ensuring they retain ownership of and a sense of responsibility for their rice mills**

## Challenges

Community-run projects which are sponsored by the government often face challenges related to accountability and maintenance



Source: GMA News; Philmech; 'Efforts to improve rice quality both on-farm and down the value chain', Philippine Rice Research Institute 2012

# SNV strives to build linkages between large mills and farmer cooperatives through outgrower agreements with embedded services

## Model

SNV Tanzania is a non-profit capacity strengthening organization with engagement in the Tanzanian rice sector focused on increasing market competitiveness through development of a more structured market. **SNV strives to build better linkages between large mills and farmer cooperatives.** By establishing mechanisms such that millers can provide purchase guarantees, clear guidelines on type of rice they want to source, and embedded services (e.g. provision of high quality seeds), SNV aims to enable farmers and millers to achieve better business results

## Profile of customers

SNV strives to strengthen linkages between smallholder and large mills (40-70 tons/day capacity, sourcing from 800-1000 smallholders)

## Cost to customers

NA

## Technology Used

Large mills use automatic multi-stage mills, with capacity of 40-70 tons per day

## Scale

SNV Tanzania operates across the country. Initiatives in rice space include activities with multiple large mills and other associations

## Innovation

Rather than focusing on directly increasing rice output as has often been a focus in Tanzania, **SNV focuses on improving market structure so that the market becomes attractive for smallholders**. Specifically, they strive to improve linkages between mills and producers (e.g. contract farming) **so farmers have clear signals on market needs and inputs to meet these** (e.g. seeds)

## Challenges

Navigating and improving policy environment; Achieving change in smallholder mentality that rice production in not only for household consumption but can be an income source

Source: Interview with Monsiapile Kajimbwa

# DADTCO's mobile cassava processing unit has linked smallholders to markets while providing a longer shelf-life for processed cassava

## Model

- DADTCO, a socially-focused Dutch agriculture company, has developed a '**split processing' technology that enables cassava to be processed into a longer-lasting cake**. DADTCO has created an **Autonomous Mobile Production Unit (AMPU) employing this technology housed on a mobile trailer**
- AMPUs have been developed and rolled out through **Public-Private-Partnerships** (PPPs) in partnership with multinational brewer SABMiller (in Mozambique and Ghana), the Dutch government, Africa Enterprise Challenge Fund, and the International Fertilizer Fund

## Profile of customers

Public sector organisations and large corporate customers such as SABMiller interested in directly procuring and processing cassava from smallholder farmers, thereby improving market linkages

## Cost to customers

N/A

## Technology Used

Utilizing 'split processing technology', the Autonomous Mobile Production Unit washes, peels, chops, grates and removes the moisture from cassava. The resulting cassava cake has a high dry matter content. The AMPU is housed in a 40-foot mobile trailer that can be driven to the local collection point and quickly installed

## Scale

Currently in use across three countries: Nigeria (for high quality cassava flour), Mozambique (cassava beer) and Ghana (cassava beer)

## Innovation

The AMPU roll-out is an example of **effective scaling across countries through demand-driven PPPs**. By increasing the shelf-life of cassava, the AMPU model improves linkages of smallholders to the market, raising incomes and incentivising adoption of improved cassava varieties

## Challenges

Adapting for supply of improved cassava seed varieties based on dynamic demands of markets

Source: 'Scaling Cassava by Linking Farmers to Markets', Shoham and Boettiger; DADTCO

# Bühler's mobile compact maize mill, Isigayo, is helping develop the SME milling sector and strengthen rural economies in South Africa

## Model

A global food processing plant and equipment supplier, Bühler aims to address the need in South Africa for a small-scale maize milling sector to complement the production of maize in the country. It has thus launched a compact maize mill, Isigayo, which is a downscaled version of the a mill that is used at an industrial flour production site. **The mill requires little infrastructure, is pre-engineered as a complete milling plant, and is easily transportable**

## Profile of customers

Due to its reduced startup costs, the Isigayo mill targets SME millers, commercial farmers, farming communities, as well as entrepreneurs, government organizations and NGOs

## Cost to customers

As of April 2013, 24 units had been sold to the Foundation for African Business and Consumer services at $500,000 apiece

## Technology Used

The Isigayo maize mill is essentially a simplified version of its industrial counterpart, with a capacity of 2 tons per hour. It can run for 24 hours a day, 7 days a week. The setup includes: aspiration systems, mill pneumatic, elevators, screw conveyors, spouting, and aspiration ducts all pre-assembled in two containers

## Scale

Currently available in South Africa

## Innovation

By cutting out the middlemen and concentrating harvesting, production and consumption of maize in one place, **it gives rural milling a competitive advantage over urban, industrial mills. Its quick installation and minimal training requirements are also likely to bring new entrants into the market**

## Challenges

Farming communities are likely to require significant financing to purchase this product



Source: Bühler South Africa; Engineering News; Food & Beverage Reporter

# Key factors of success have been identified from review of existing models

| Key characteristics of successful solutions | | Findings | Implications |
|---|---|---|---|
| *Operational* | Tight linkage between millers and producers | The use of low quality and inadequate inputs by farmers, poor farming practices, and poor post-harvest handling lead to lower quality output pre- and post-milling, impacting profits and market reach of both farmers and millers | • Establish linkages between millers and farmers, ideally with purchase guarantees and embedded services (e.g. seed financing)<br>• Improve availability of information to farmers, e.g. regarding type of rice demand by local millers |
| | Market access | Although milled rice does command a higher price, a lack of market access for farmer-millers and millers can impede the realization of higher prices and consequently margins. Such situations are more likely in countries/areas with underdeveloped supply chains | • Improve market access through the development of adequate wholesale markets<br>• Establish purchase guarantees between large scale consumers and millers<br>• In the absence of a well developed supply chain, local demand for milled rice should be a prerequisite for establishing mills |
| *Financial* | Mechanisms for group usage | Due to high upfront costs of mills and low quantities of rice production on smallholder farms, it is usually not feasible for smallholders to invest in mills. Therefore, mechanisms for group usage are required – either in the form of a miller traders who aggregate rice or in the form of rice mill cooperatives/ community mills | • Develop viable models for community/rice cooperative mills<br>• Establish outgrower schemes, potentially centered around nucleus farms which provide a reliable base load for processing and ideally with embedded services to help ensure uniformity of input rice |
| | Access to finance | Financing is often not available to establish modern milling facilities at the small scale/cooperative level | • Develop innovative financing solutions for financing for cooperatives for establishing mills<br>• Find models for mill provision through MFIs<br>• Develop solutions for existing mills (e.g. Engelberg) to upgrade to modern technology |

Source: Interview with SNV Netherlands Development Organisation; Secondary research; Dalberg analysis

# Enabling technologies also represent a key lever for successful scale up by creating opportunities for more efficient delivery models

| Constraints to efficient delivery | Description of enabling technologies | Players |
|---|---|---|
| **Lack of mill automation, creating additional labour requirements** | • Software solutions designed to help automate processes of a rice mill such as arrivals, production, sales and stocks. In particular, the use of Programmable Logic Controllers (PLC), data acquisition packages, and Human Machine Interfaces (HMI) raise efficiency manifold<br>• In the production process, sensors can be used to control inflow and outflow mechanisms, and to regulate temperatures | SATAKE<br>BÜHLER |
| **Lack of reliable grid power, creating need for decentralized power sources** | • **Solar energy** can provide solutions for powering both small-scale and larger rice mills. For example, Far West Mills, California uses a 1 MW array consisting of solar panels from Mitsubishi<br>• **Rice husk gasification** is a feasible option to produce energy from husk produced during the milling process, particularly in developing countries where many rice-growing regions are off-grid. For example, NEDO constructed such a system for the government of Cambodia which is to be deployed and demonstrated countrywide<br>• **Micro-hydro power plants** can power rice mills in off-grid regions, such as those installed by SITMO in the Philippines<br>• **Diesel generators** remain a commonly used decentralized power source | NEDO |
| **Lack of efficient water management** | • Rice mills require large amounts of water, particularly for the parboiling pre processing, which also discharges a large amount of wastewater which needs to be treated<br>• Parboiling rice mills thus require integrated water management solutions which can incorporate effluent treatment plants, reverse osmosis/ demineralization, water recycling, pH controllers and filtration | FONTUS<br>HITACHI<br>Inspire the Next |

Sources: Satake India; CNET news; NEDO; Iseki; Ashden; Fontus Water; Modern Rice Mills

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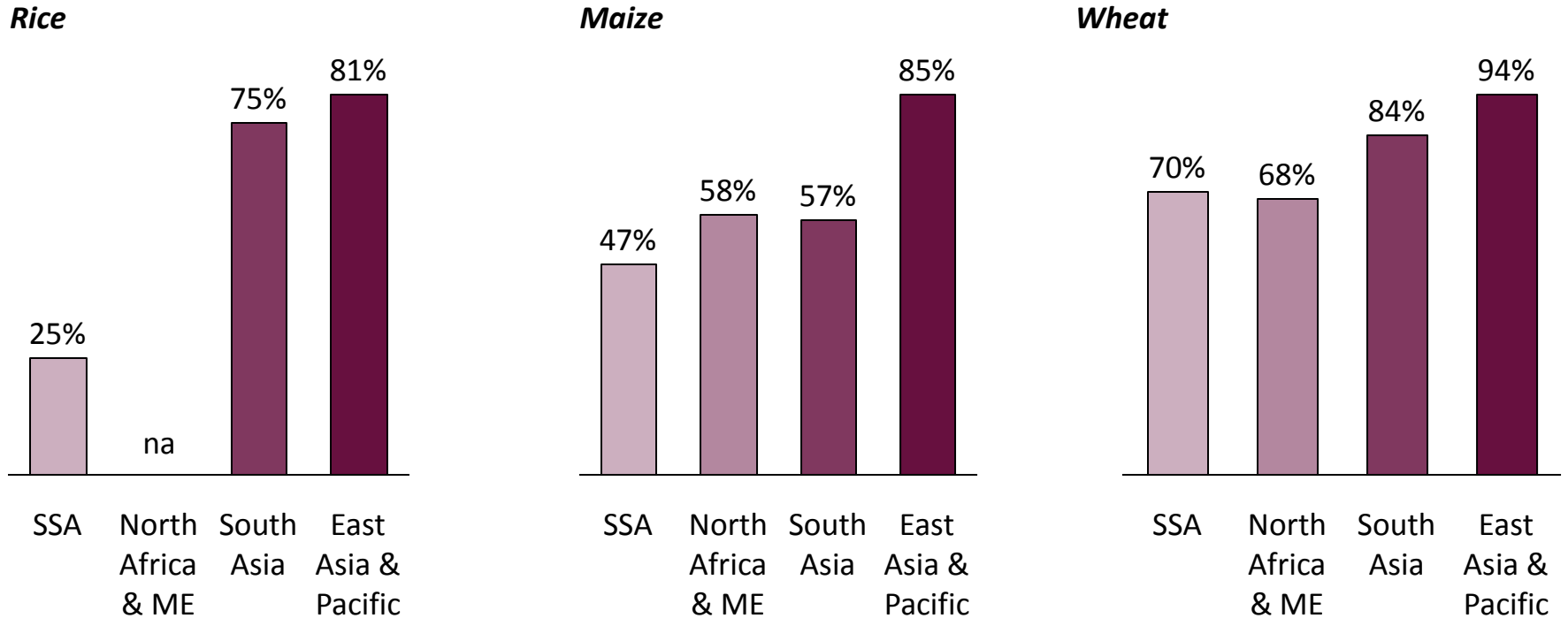
# Improved seed varieties have been relatively widely adopted in much of the developing world, except in Sub-Saharan Africa

**Areas planted with improved seed varieties**
In % of crop area, 2000-2005



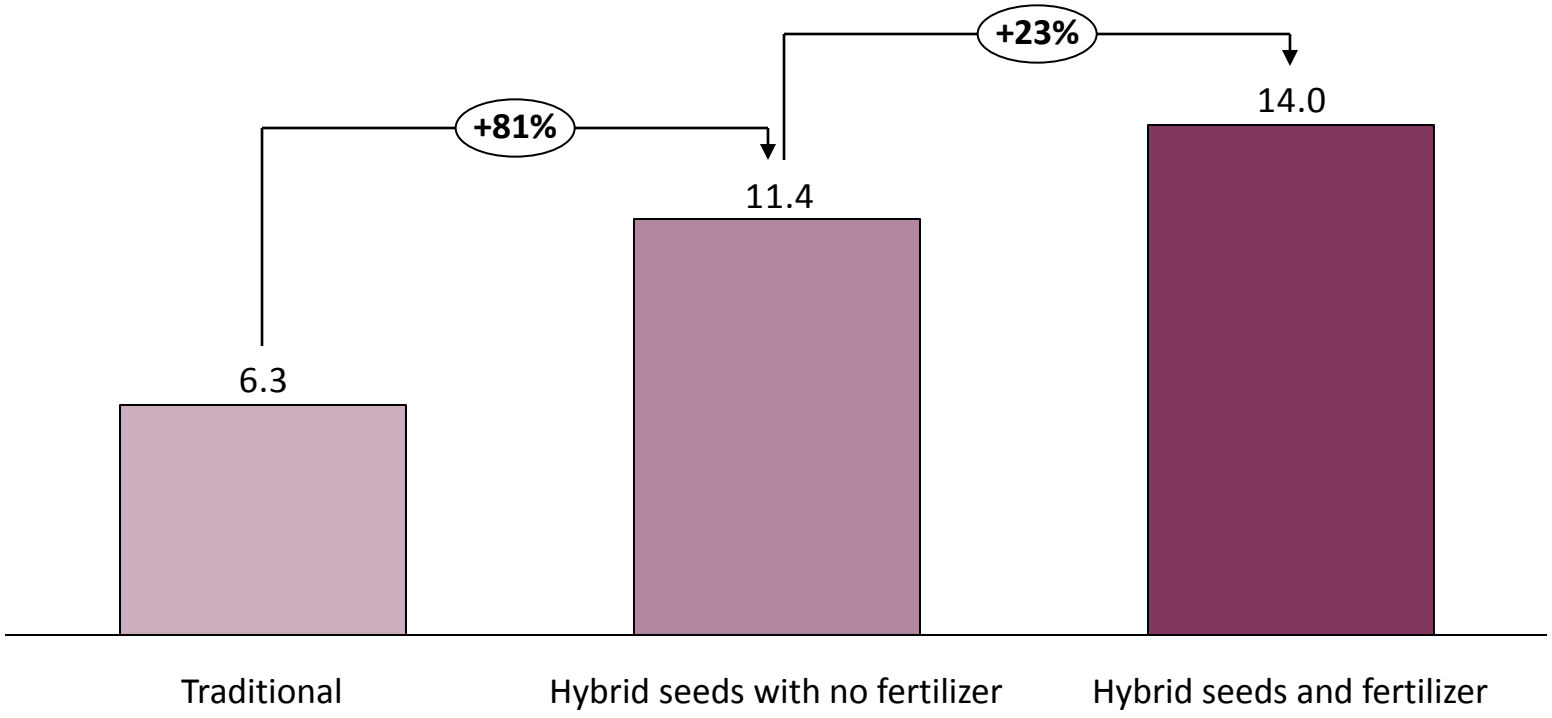

Level of improved seed usage varies notably by region and crop, but is generally lowest in Sub-Saharan Africa; BoP farmers' usage rates are likely lower than the overall percentage of crop area planted with improved seed varieties



Source: Agriculture for Development, WDR 2008

# Use of improved seed varieties has the potential to significantly improve yield for smallholder farmers

**Yield improvement based on use of improved inputs: Maize yields in Kenya**
In tons per hectare, 2007






Source: Economic Commission for Africa, Agricultural Input Business Development in Africa: Opportunities, Issues and Challenges; Agira et al. 2009

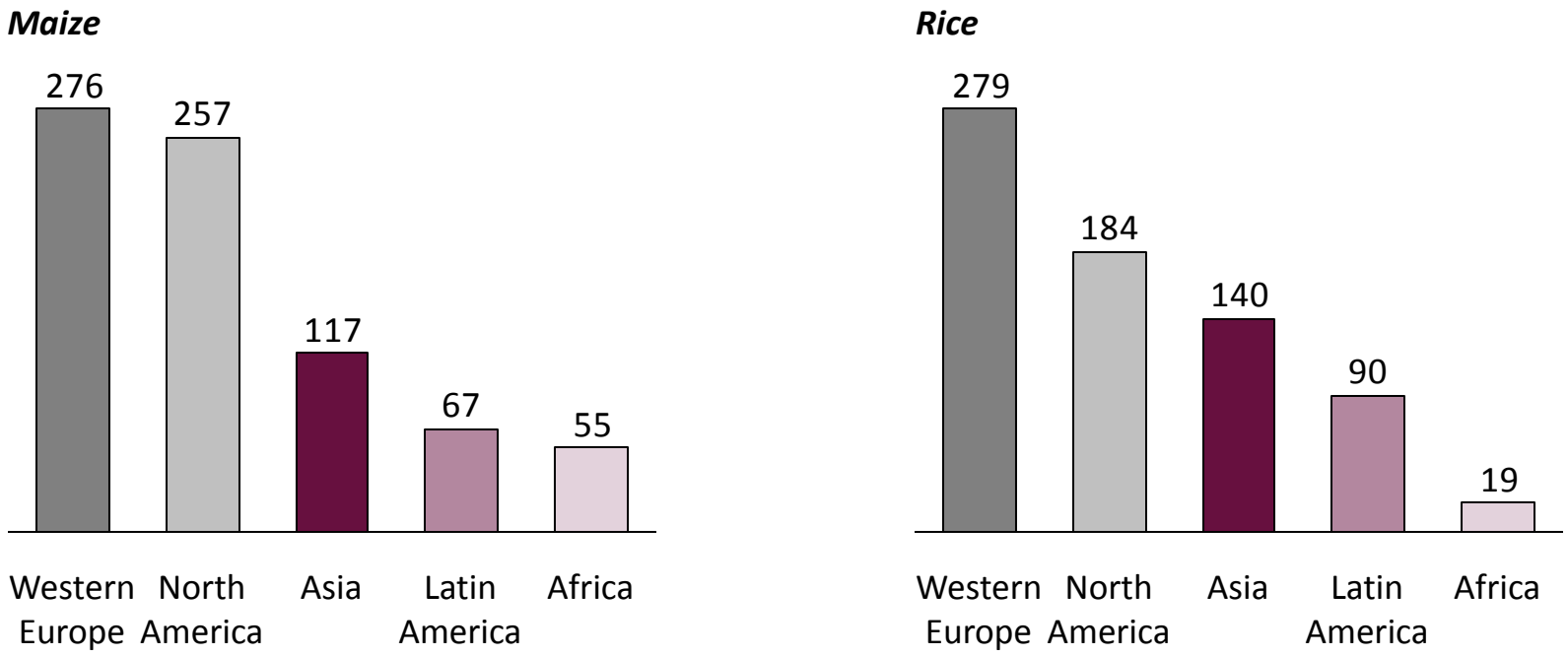
# Seed value chain: Improved distribution and marketing are high-level key needs in the seed value chains in many developing countries


| | Variety adaptation, development and maintenance | Pre-basic and basic seed production | Multiplication of certified seeds | Storage, processing and transportation | Marketing and distribution |
|---|---|---|---|---|---|
| ***Key needs*** | • In-country seeds research capacity<br>• Technology transfer<br>• Integrated seed systems development | • Improved in-country seed production technologies | • Adherence to quality standards<br>• Clear quality signals to reduce prevalence of counterfeit products<br>• Integrated seed systems development<br>• Reliable supply channels | • Improved transportation and warehouse infrastructure | • Cost-effective marketing and education on proper use/benefits<br>• Improved affordability<br>– Innovative financing mechanisms<br>– Smaller packaging<br>• Formal seed markets<br>• Efficient distribution<br>• Village-level promoters<br>• Harmonization of seed and fertilizer trade |
| ***Primary stake-holders*** | • Private companies<br>• Universities | • Government seed agencies<br>• Private companies<br>• Universities | • Government seed agencies<br>• Private companies<br>• State farms<br>• Universities | • Government seed agencies / facilities<br>• Agro-dealers<br>• Local entrepreneurs | • Government seed agencies<br>• Agro-dealers<br>• Local entrepreneurs |

Source: Secondary research

# Fertilizer usage is still below efficient levels in much of the developing world, in regions dominated by smallholder farmers

**Fertilizer usage rate**
In kg/H



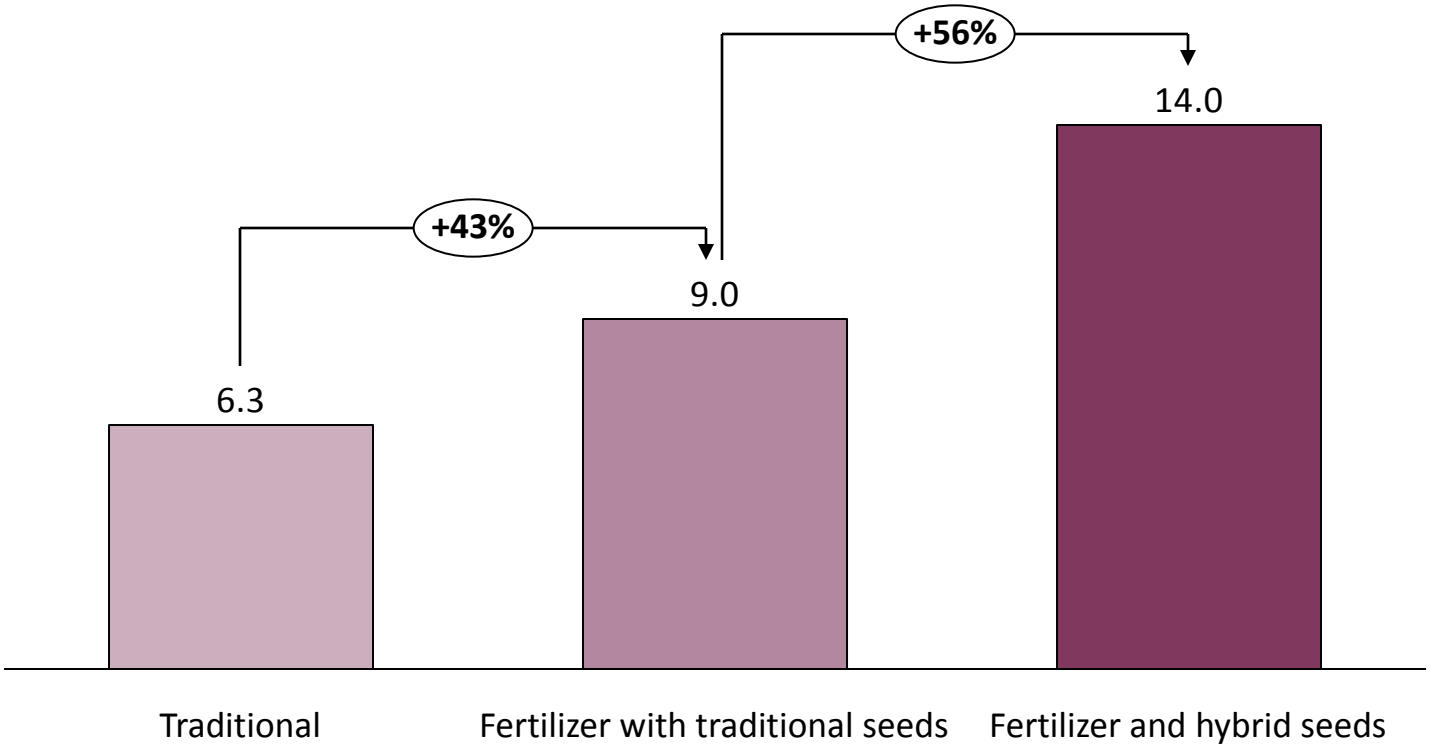

Insufficient fertilizer penetration is due to a number of factors that include low awareness, poor distribution and a lack of fertilizer packages suited to the requirements of smallholders



Source: FAO Fertilizer and Plant Nutrition Bulletin

# Use of fertilizer offers opportunity to significantly improve yields for smallholder farmers

**Yield improvement based on use of improved inputs: Maize yields in Kenya**
In tons per hectare, 2007




Though exact impact of fertilizer varies by crop, region and land type, potential yield improvements from increased fertilizer usage are significant – especially when used in combination with hybrid seeds



Source: Economic Commission for Africa, Agricultural Input Business Development in Africa: Opportunities, Issues and Challenges; Agira et al. 2009

# Fertilizer value chain: Key needs include improved in-country production capacity, technology transfer and stronger links between key stakeholders


| | Procurement of raw materials | Production process | Transportation and import | Storage and processing in country | Marketing and distribution |
|---|---|---|---|---|---|
| ***Key needs*** | • Improved access to relevant raw materials | • In-country research and production capacity<br>• Technology transfer | • Supportive political ecosystem (e.g. low import duties)<br>• Improved transportation infrastructure<br>• Organization of importers/ agrodealers into purchasing groups to enable bulk purchasing | • Improved storage infrastructure, e.g. Warehouses<br>• Reliable supply channel<br>• Stronger links btwn certified agrodealers and fertilizer importers/ suppliers | • Stronger linkages between farms and input and output markets<br>• Cost-effective marketing and education on proper use/benefits<br>• Improved affordability<br>– Innovative financing mechanisms<br>– Smaller packaging<br>• Better trained retailers<br>• Harmonization of seed and fertilizer trade |
| ***Primary stake-holders*** | • Fertilizer manufacturers | • Fertilizer manufacturers<br>• Gas companies | • Local importers<br>• Traders<br>• Shipping companies<br>• Government procurement agencies<br>• Financial institutions | • Government facilities<br>• Agro-dealers | • Agro-dealers<br>• State-owned agriculture marketing firms<br>• Local entrepreneurs (rural retailers) |



Source: 'Mineral Fertilizer Distribution and the Environment, UNEP'; 'Improving Regional Fertilizer Markets in West Africa

# Various large corporates are pursuing innovative inclusive business models and partnerships in this space

| Organization | Type | Partners | Innovation | Geography |
|---|---|---|---|---|
| Yara | Corporate MNC | • 10 private and public sector players | • Coupling of credit with purchase guarantees for affiliated Farmers' Associations | Ghana, Tanzania, Malawi |
| Monsanto | Corporate MNC | • USAID<br>• AGRA | • Innovative partnership to tackle low awareness, need for policy reform and fragmented nature of seed markets | West Africa |
| Amiran | Corporate | • Equity Bank | • Integrated product financing and bundling of products into the Amiran Farmer's Kit to simplify marketing, distribution and farmer education | Kenya |
| FIPS – Africa | Non-profit | • ARM<br>• Western Seed Company<br>• Kenya Seed Company<br>• Monsanto | • Innovative distribution strategy offering small-size fertilizer packages coupled with free seed sample packages to enable smallholders to test inputs at affordable prices | Africa |
| Notore | Corporate | • Mitsubishi | • Innovative partnership between a local company with an extensive customer network (with significant presence of smallholders in customer base) and a Japanese company with advanced technology to support scale up | Nigeria |

The seeds and fertilizers sectors are very complex, challenging and often political. The purpose of the following cases is to not to comprehensively review potential technologies and interventions, but rather to introduce some innovative business models that are working in this space and that could be relevant for Japanese companies

# Yara-led Ghana Grain Partnership gives smallholders access to high-yield seeds through innovative financing, while simultaneously unlocking new markets

## Problem solved

The Ghana Grain Partnership focuses on improving transaction efficiency and distribution options at the demand end of the value chain. Specifically, the Ghana Grain Partnership offers organized Farmers' Associations credit for inputs such as seeds and guaranteed purchase prices for outputs

## Players

*Private sector players:* Yara International – a Norwegian-based chemical company – leads the partnership; 10 private and public sector players are involved

*Donors:* Africa Enterprise Challenge Fund

## Scale and region

The association in 2012 was Ghana's biggest maize producer with 8,300 farmers on 11,600 ha of land. Yara has similar programs in Tanzania and Malawi

## Mechanism

Yara set up a rolling fund for input credits to allow associated Farmers' Association to access credit for purchase of high quality inputs. Yara then purchases the farmers' entire maize crop and pays them for the maize supplied, minus the cost of inputs they have received

## Innovation

*Innovative financing mechanism:* Through credit to Farmers' Associations coupled with purchase guarantees, Yara helps the smallholders of affiliated Farmers' Association to achieve yield improvements and improve their business results. Consequently, Yara not only supports the farmers but also grows the market for their products



Source: Secondary research, Dalberg analysis

# Monsanto's participation in West Africa Seed Alliance offers smallholders access to high quality seeds and helps Monsanto break into West African market

## Problem solved

The goal of the West Africa Seed Alliance (WASA) is to establish a sustainable commercial seed industry capable of ensuring that small-scale farmers have affordable, timely and reliable access to adapted genetics and traits in high quality seeds and planting materials

## Players

*Private sector players:* Monsanto – an American multinational chemical and agricultural biotechnology corporation
*Donors:* USAID, AGRA (established by Bill and Melinda Gates Foundation)

## Scale and region

Regional focus includes 5 West African countries (Ghana, Mali, Nigeria, Niger, Burkina Faso)

## Mechanism

To support the development of a private sector seed industry, parallel initiatives were undertaken including the following:

- Developing a strong network of agrodealers/stockists
- Setting up demonstration plots for training purposes to be managed by agrodealers
- Supporting relevant policy reform

## Innovation

*Innovative partnership*: Many large seed companies had struggled to break into the West African market. WASA brought together the right partners to support in developing a structured seed industry in West Africa by overcoming the obstacles of low awareness, a diverse region composed of a large number of relatively small markets (other than Nigeria) and the need for policy reform

Source: Secondary research, Dalberg analysis

# Equity Bank and Amiran Kenya have partnered to offer farmers access to credit to purchase modern agricultural inputs through the Amiran Farmer's Kit

## Problem solved

Under this partnership, Kenya's smallholder farmers can access credit from Equity Bank to finance modern agricultural inputs sold by Amiran Kenya. These high-quality inputs include fertilizers, agro-chemicals, greenhouse kits and drip irrigation systems packaged into the Amiran Farmer's Kit, along with tailored training from Amiran's team of agronomists

## Players

- Amiran Kenya is a private firm that provides agri-solutions such as products, services, training and capacity building. Amiran's Farmer's Kit contains modern agricultural equipment suited to smallholders' needs
- Equity Bank – a Kenya-based private bank that is engaged in retail banking and microfinance. It has rolled out affordable financial products to support farmers' switch to commercialized farming by purchasing the Farmer's Kit

## Mechanism[1]

Equity Bank provided affordable credit to smallholder farmers who could use it to purchase the Amiran Farmer's Kit

## Scale and region

This program was launched in 2009 to be applicable to small-scale farmers in Kenya. Amiran's technologies such as greenhouse kits have been widely adopted by Kenyan farmers

## Innovation

*Integrated financing*: By partnering with Equity Bank and offering integrated affordable credit to farmers, Amiran was able to expand the market for its product. Furthermore, by bundling products together into the Amiran Farmer's Kit, Amiran simplified marketing, distribution and farmer education

(1) Specifics regarding the mechanism are unavailable. However, in the past, Equity Bank has partnered with Alliance for a Green Revolution in Africa (AGRA), the International Fund for Agricultural Development (IFAD) and the Government of Kenya to launch Kilimo Biashara, a credit facility to assist small scale Kenyan grain farmer's access to affordable credit

Sources: Amiran Kenya, Equity Bank, Joto Afrika

# FIPS has demonstrated the potential for using small-sized seed and fertilizer packaging as an effective way to drive demand from smallholders

## Problem solved

Farm Input Promotions Africa (FIPS) is a non-profit that has partnered with private sector seed and fertilizer suppliers to enable smallholder farmers to purchase fertilizer in small package sizes (e.g. 1kg) and test seeds given out in small free sample packages. FIPS also runs demonstration plots for education

## Players

*Social players:* FIPS – a non-profit company aiming at improving productivity of smallholders in SSA through dissemination of farm inputs and education – leads the initiative

*Private sector players:* ARM – a mineral extraction firm marketing fertilizers in Africa – works with FIPS to provide smaller package sizes; Western Seed Company, Kenya Seed Company and Monsanto – agricultural corporates – donate 150g maize seed mini-packs to FIPS for promotions

## Mechanism

FIPS sold farmers small 1kg bags of fertilizers at on-farm demonstrational plots and promotional events. Farmers also received a free pack of Western Seeds/Kenya Seeds/Monsanto hybrid maize seeds, so both could be tested together

## Scale and region

In 2010, FIPS-Africa had capacity to package 1.5 Mn small packs of seed and provide companies with business exposure to over150,000 farmers through 186 village based advisors, each with a target to reach 1000 farmers. For ARM, fertilizer sales in target areas grew from almost nothing to over 800 tons in 2004 post-FIPS pilot program

## Innovation

*Innovative distribution*: It is often unfeasible for smallholders to purchase modern seed and fertilizer packs as their landholdings are too small to use the large pre-packaged quantities typically available. FIPS effectively conveyed this need and opportunity to suppliers and worked with them to offer small fertilizer package sizes and free seed sample packages – enabling smallholders to test inputs at affordable prices and private sector players to reach a new market segment

Sources: New Agriculturalist, FIPS-Africa, 'Lesson learning study of the FIPS project in Kenya,' DFID, Research Into Use

# Notore Chemical Industries achieved capacity by selling its fertilizer directly to Nigerian smallholder farmers, and is seeking Mitsubishi's expertise to scale up

## Problem solved

Mitsubishi will help Notore scale up by jointly developing an ammonia, urea and other petrochemicals plant at its existing facility. Notore had achieved capacity of its existing urea factory after successful penetration into the Nigerian fertilizer market by establishing a distribution and sales network aimed at supplying directly to Nigeria's smallholder farmers. A key ingredient of Notore's success was their marketing of 1kg and 10kg bags of fertilizer, which were more relevant to smallholder farms

## Players

- Notore Chemical Industries Limited, a Nigerian fertilizer company that makes fertilizer more accessible to farmers through its supply chain and pricing, is seeking to build a new fertilizer plant
- Mitsubishi Corporation, a global integrated business enterprise, will be using its expertise and technology to develop the new plant through a joint venture signed in 2012

## Mechanism

Mitsubishi's will help Notore expand its existing fertilizer plant. In the next plant, natural gas, which is currently being flared in Nigeria, will be used as raw material for production of relevant chemicals

## Scale and region

The new plant, when operational in 2016, will contribute significantly to providing fertilizers in Nigeria and Africa. Notore plans to push 1.75million MT of urea and 1 million MT of NPK products into the market by 2016. The plant is expected to create about 1,000 direct jobs and 10,500 indirect jobs

## Innovation

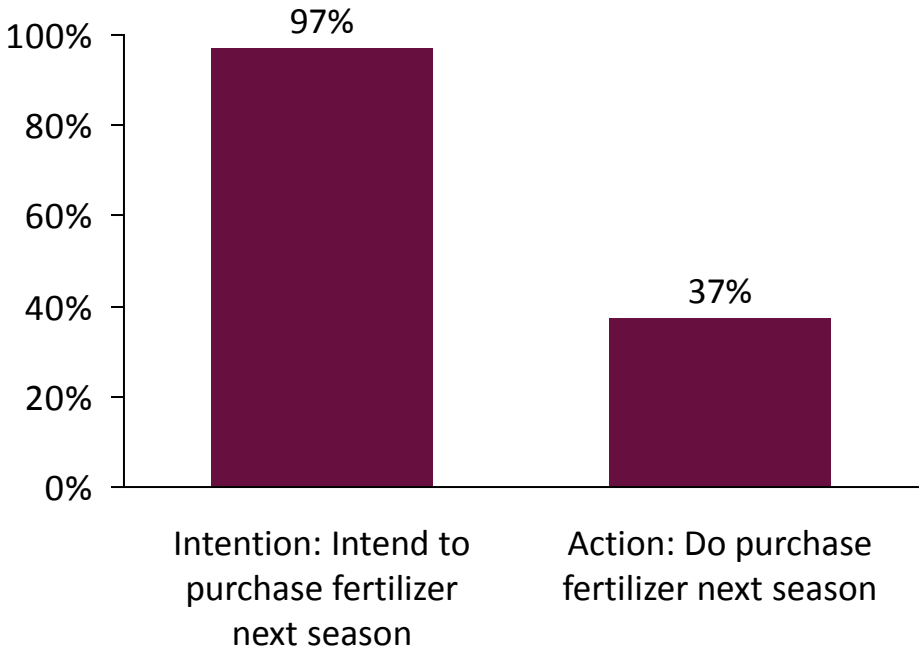
- *Innovative partnership* between a local company with an extensive customer network (with significant presence of smallholders in customer base) and a Japanese company with advanced technology to support scale up
- *Innovative distribution*: Initial reach of Notore achieved partially through successful marketing of small-size fertilizer bags (1kg and 10kg) directly to smallholders

Source: AgroNews

# Understanding key factors in smallholder purchasing decisions and accordingly developing creative sales solutions can help overcome barriers to scalability

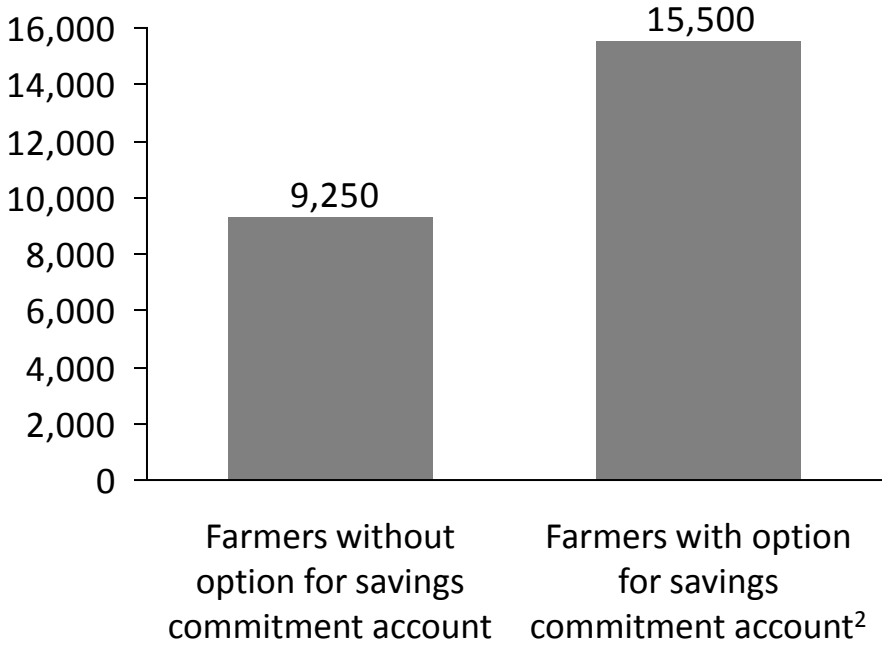
## Though 97% of the farmers surveyed intended to buy fertilizer for use in the following season, only 37% ultimately did purchase fertilizer

**Drop-off between intention and action of fertilizer purchase**
In % of farmers, Kenyan farmers surveyed




## Giving farmers the option to use a savings commitment account to save for the purchase of agricultural inputs can lead to higher usage levels

**Amount[1] spent on fertilizer and other inputs**
In Malawian Kacha, Malawian farmers surveyed




Identifying purchasing barriers and designing innovative delivery and financing approaches, such as offering savings commitment accounts or home-delivery options[3], can have significant impacts on a smallholder's likelihood to purchase agricultural inputs

(1)Approximate amount; (2) This group includes all farmers provided the option for the savings commitment account, not only farmers who used the account;
(3) Offering home delivery options increased fertilizer use by 70% in a study conducted with Kenyan farmers

Source: 'Behavioural Design: A New Approach to Development Policy', Datta and Mullainathan

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# Key cold chain needs focus on solutions for cold transportation and on-site chilling/freezing that are better adapted to BoP needs and constraints

## Context

Approximately 30%-50% of global food is wasted (1.2-2 billion tons). In developing countries, a major cause of such wastage is that fresh products like fruits, vegetables, dairy products, meat and fish straight from the farm or after the catch spoil in hot climates due to a lack of cold chain infrastructure

### Transportation

- Infrastructure such as refrigerated and insulated trucks preserve food between the farm and processing facility, as well as during distribution of the final product
- Innovative products that can enable a cold transportation infrastructure without the heavy investment required for refrigerated trucks would provide low-cost alternatives for operators in developing countries

### Chilling and freezing

- In the absence of refrigerated transportation, chilling and cold storage units near the point of production (e.g. at the community level) will help prevent perishables such as milk and meats from spoiling by minimizing time spent in warm temperatures
- Large-scale cold freezers and warehouses will enable long-term preservation and prevent food stocks from spoiling
- Affordable power back-ups fro refrigeration at the local level can provide a buffer against erratic supply of electricity

### Across the cold chain

- Development of knowledge and capacity of food chain operators to apply safe food handling practices
- Engineering of reliable electricity supplies using renewable energy
- Reliable systems for measurement, monitoring and continual management of the cold chain



Sources: FAO; 'Global Food: Waste not, want not', Institute of Mechanical Engineers

# Promethean Power Systems enables dairy processors and farmers to enhance profits through more economical and effective milk chilling

## Problem solved

Efficient cold storage is the missing link in the milk supply chain. Post milk production, it can either be cooled at a central processing plant (which is usually far away), or at source. Traditional refrigeration requires constant electricity, which often comes from expensive diesel generators. Promethean's Rapid Milk Chilling (RMC) solution, using a unique thermal energy storage technology, aims to replace village-level refrigeration alternatives in a convenient, cost-saving manner

## Players

Promethean Power Systems is a Boston-based company that leverages research from MIT and Boston College. Its joint venture in India, Promethean Spenta Technologies, aims to offer Indian farmers and food processors affordable cold-storage equipment for perishable food items

## Scale and region

Promethean is currently focused on the Indian market, where the RMC and its battery is manufactured. It has delivered large orders of demonstration units to major Indian dairy processors such as Amul, Mother Dairy and Hatsun, and aims to expand its customer base to reach smaller dairy players and individual farmers

## Mechanism

RMC's thermal energy storage technology ensures that chilling of milk is possible at the time when it is required. It requires a 'single pass' of milk to cool it to 4$^{o}$C, leading to higher quality chilled milk. In comparison, the conventional process involves adding warm milk incrementally to a refrigeration device that contains already cooled milk, which can lead to bacterial contamination

## Innovation

Promethean's battery provides an extremely modular and low-cost chilling solution for developing countries. It addresses the power deficit these countries face while being widely applicable even at low levels of capacity (such as 500 liters), potentially benefitting milk producers even at a village level

Sources: Promethean Power Systems; Villgro Innovations Foundation; Intellecap; Secondary research

# Innovation Thru Energy's IceBattery System provides a cost-effective, energy-saving cold storage solution with wide-ranging potential BoP applications

## Problem solved

Efficient cold storage is a missing link in food supply chains across developing countries. For example, 18% of fruit and vegetable produced in India is wasted due to the lack of proper cold chain storage infrastructure. A large part of this wastage takes place while transporting perishable items over long distances in trucks. IceBattery is a portable freezer system that can provide a constant temperature while consuming significantly less energy

## Players

Innovation Thru Energy is a **Japan-based private company** founded in 2007, with other offices in India, USA and Taiwan. It aims to market its IceBattery technology while extending its applications beyond food preservation to life science, military and air cargo

## Mechanism

IceBattery refrigerant plates are placed in a freezer for 10-12 hours and then put in IceBattery boxes with goods to be transported. A constant temperature (within 0.6C) can be maintained for up to 72 hours. Opening and closing of doors makes a minimal difference to temperature and humidity levels

## Scale and region

Innovation Thru Energy is currently focused on the Taiwanese and Japanese markets. Their current clients include Starbucks Taiwan, 7-Eleven Taiwan, Taiwan Blood Bank and Japan Airlines

## Innovation

This potentially disruptive innovation can eliminate the need for insulated or refrigerated trucks by allowing a common carrier truck to carry frozen, refrigerated and non-refrigerated food together at the same time. Moreover, in comparison, a refrigerator truck has a 35% higher fuel cost, 50% higher overall cost of running the truck, and significantly less flexibility



Sources: Indian Express; Energy Thru Innovation; Ice Battery website; Secondary research

# Godrej's ChotuKool refrigerator provides quality cooling to the BoP at half the price of an entry-level conventional refrigerator

## Problem solved

A lack of affordable refrigeration leads to food spoilage across developing countries. Godrej's ChotuKool, a low-cost low-power refrigerator, provides smallholder farmers, dairy producers, shops and BoP families with an effective, affordable solution to meet their cooling needs. ChotuKool's high-end insulation also enables it to stay cool for hours without power, providing a buffer against an erratic power supply

## Players

The Godrej Group is an Indian conglomerate operating in a number of sectors including appliances. ChotuKool is part of its attempt to provide innovative products for the BoP population

## Mechanism

Instead of traditional compressors, ChotuKool is based on a thermoelectric chip that maintains a cool temperature on a 12-volt DC current or an external battery. The unconventional opening ensures cold air settles down in the cabinet to minimize heat loss and power consumption. The unit is highly portable and provides 30/45 liters of volume in a plastic body while weighing less than 10 pounds

## Scale and region

Having moved beyond a single-state test market in India, Godrej is in the process of expanding distribution across India using community networks (which include self-help groups, small-scale entrepreneurs and women), and aims to sell 100,000 ChotuKools in what is its second full year on the market

## Innovation

ChotuKool puts quality refrigeration within the reach of an under-served segment of the population with its $69 price. Potential applications range from cooling items in homes and shops, chilling milk between the production and processing stages, storing small amounts of produce, and even vaccine refrigeration



Sources: Innosight; Godrej; Gizmag

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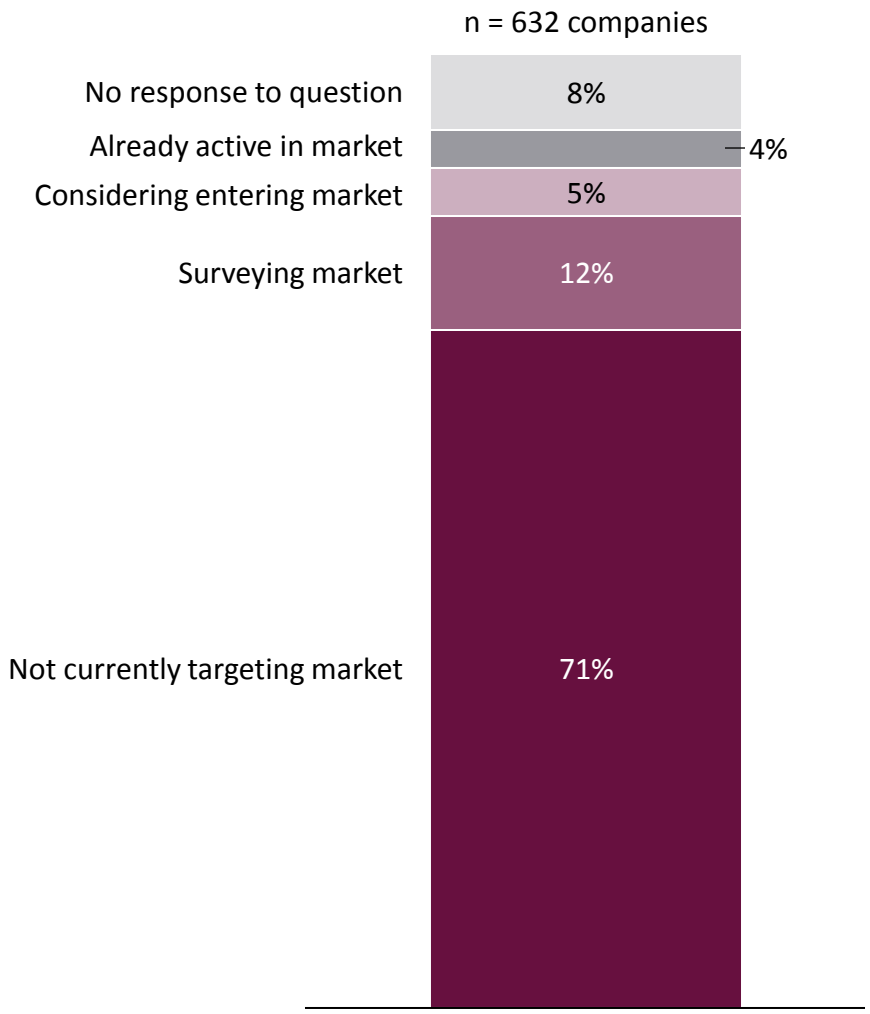
# Japanese participation in BoP markets has been historically low, due to lack of adequate channels and limited knowledge of BoP market needs

## Japanese companies' participation in the BoP market




## Key reasons for limited participation in the BoP market

**Lack of adequate channels for BoP market participation.** Japanese companies have had limited channels through which to connect to BoP markets in developing countries. Only over the last couple of years are more companies trying to build strong partnerships with public agencies and NGOs to target the BoP market in developing countries

**Limited knowledge and experience.** Few Japanese organizations have experience working in the BoP market and limited research has been undertaken by Japanese organizations to understand BoP household constraints, habits and preferences

**Negative impact on brand**. Japanese organizations known for high quality, have been wary of the negative impact of associating their brand with BoP products that are often considered "low cost, low quality" goods and services

**Lack of appreciation of large opportunity.** Many Japanese organizations do not view the BoP as potential targets for financially viable business ventures

Source: Japan Management Association "Survey of Management Studies", 2010; Fujitsu Research Institute

# Around 2009, several public agencies initiated programs to support involvement of Japanese private sector players with the BoP

**JICA**

- Supports feasibility studies, conducted by private companies, in BoP markets. Currently supporting 65 projects, largely in Asia and Africa
- Connects private entities with local governments, NGOs and other development partners
- Provides technical assistance for strengthening public-private partnership legal/regulatory frameworks
- Provides debt and equity financing for BoP-focused projects of private companies

**METI**

- Provides funding to private companies for conducting feasibility studies in developing countries for BoP-related business
- Connects private companies with potential local partners in developing countries
- Researches BoP related business in the context of public-private partnerships
- Raises awareness about inclusive business concepts through forums, symposiums and seminars

**JETRO**

- Supports Japanese companies in developing their BoP-targeted businesses in developing countries through its BoP consultation service desk
- Dispatches business missions to developing countries to understand the lifestyle and needs of the BoP segment and investigates potential for developing BoP-focused business models
- Introduces potential local business partners to private companies
- Supports test marketing and trial development of products and services in BoP markets

Source: JETRO; JICA; Nomura Research Institute, "Does BoP business approach fit in the Japanese framework?: Developing BoP Business as the Principal Strategy in Emerging and Developing Economies", 2012

# Participation of Japanese companies in Agricultural Mechanization in BoP markets predominantly through international sales centers and distributors

| | Organization | Description of initiative | Region | Public agency / partner | Year initiated |
|---|---|---|---|---|---|
| BoP-specific initiatives | Toyota Tsusho / Yanmar | Promoting cultivators for small rice farmers through mutual microfinance | Tanzania | JICA; Japan Agro-Marketing Institute | 2011 |
| | NETOFF Inc. | Promoting agricultural mechanization with used farm equipment | Cambodia | JICA | 2012 |
| Corporate activities | Daishin Industries Ltd. | International sales centers | China, Korea | - | n/a |
| | Hasqvanq Zenoah Ltd. | International distributors | South East Asia | - | n/a |
| | Iseki & Co., Ltd. | Distributors across South East Asia; Subsidiaries in China; Joint venture with PT Rutan in Indonesia | South East Asia | PT Rutan | n/a |
| | Ihi Shibaura Machinery Co. | International partnerships | South Asia, Africa | n/a | n/a |
| | Kubota Corporation | International sales centers | South East Asia | - | n/a |
| | Mitsubishi Agricultural Machinery Co. | Technical collaboration with Mahindra & Mahindra; Distributors across South East Asia | South East Asia | Mahindra & Mahindra | 2010 |
| | Yanmar | International sales centers | Global | - | n/a |

Though various corporates are active in BoP countries, most have not adjusted their product offering or introduced relevant business models to specifically target smallholder BoP farmers



Source: JICA press releases; Nomura Research Institute; Company websites; Industry interviews

# Participation of Japanese companies in Rice Milling in BoP markets predominantly in South East Asia with presence of small number of players

| | Organization | Description of initiative | Region | Public agency / partner | Year initiated |
|---|---|---|---|---|---|
| BoP-specific initiatives | Taiwa Seiki | Survey on developing business model of Rice Mill manufacturing, selling and exporting | Cambodia | JICA | 2012 |
| Corporate activities | Kaneko Agricultural Machinery Ltd. | International distribution through SEACOM of single pass and multi pass mills and mini rice miller option | Indonesia | - | Since 30+ yrs |
| | Satake Corporation | JV in Indonesia. Satake carries out large scale business while sales and after sales for small-scale machines is carried out by partner. Supplies components to largest rice mill in Vietnam | South East Asia (Indonesia, Malaysia, Philippines, Vietnam, etc.) | Indonesia: Gobel Group | n/a |
| | Yamamoto Co., Ltd. | International sales presence with sales of BoP relevant machines, e.g. small scale mobile rice mill | South East Asia (Korea, Taiwan, China); US | - | n/a |
| | Yanmar | International sales presence (small size millers, hullers, polishers) | Indonesia | n/a | n/a |

Several Japanese corporates have sales networks for their rice mills in South East Asia; most offer semi-automatic solutions that are relevant for BoP farmers as part of their product offering

Source: JICA press releases; Nomura Research Institute; Company websites; Industry interviews

# Japanese companies have initiated several projects along other steps in the value chain such as seeds, fertilizers and secondary processing...

| | Organization | Description of initiative | Region | Public agency / partner | Year initiated |
|---|---|---|---|---|---|
| Seed | Satake Seed Corporation | Preparatory survey on incubation program for emerging small-scale vegetable farmers through production and business training | South Africa | JICA, PlaNet Finance Japan | 2012 |
| Fertilizers | Sumitomo Corporation | Preparatory survey on urea fertilizer complex | Mozambique | JICA PPP, Oriental Consultants Co., Toyo Engineering Co. | 2011 |
| | Sumitomo Metal Industries, Ltd. | Study on steel slag soil improvement agent / slag fertilizer in peat bog areas | Indonesia | JICA, Sumitomo Forestry Co., Ltd. | 2010 |
| | UNICO International Corporation | New fertilizer plant | Iraq | JICA PPP, Mitsui & Co., Ltd., Toyo Engineering Co. | 2011 |
| Cold Chain | Innovation Thru Energy[1] | Invented a low-cost portable freezer system, IceBattery, which can maintain a constant temperature; Pilot project for Taiwanese blood bank | Taiwan | n/a | 2007 |
| Secondary processing | Kikkoman Corporation | Preparatory survey on improving nutrition for infants, mothers and patients by using traditional Japanese fermentation technologies | Kenya | JICA | 2013 |
| | Mitsui Syokuhin Kogyo Co.,Ltd. | Preparatory survey on development and marketing of high added-value processed agricultural products | Nepal | JICA, Love Green Japan, TAC International Inc. | 2013 |

Several large Japanese corporations have explored BoP initiatives targeting specific steps in the agricultural value chain in Africa, South Asia and the Middle East

(1) Innovation Thru Energy is a commercial business without public agency funding

Source: JICA press releases; Nomura Research Institute; Company websites; Industry interviews

# ..though the majority of Japanese BoP initiatives in Agriculture have focused on general supply chain creation

Supply chain creation

| Organization | Description of initiative | Region | Public agency / partner | Year initiated |
|---|---|---|---|---|
| Farmdo Co., Ltd. | Preparatory survey on BoP business on agricultural income generation | Mongolia | JICA | 2013 |
| Ajinomoto Co., Inc. | Nutrition improvement food | Ghana | METI | 2009 |
| Ajinomoto Co., Inc. | Nutrition-enriched food during weaning period | Ghana | JICA | 2010 |
| Nissin Foods Holdings Co., Ltd. | Preparatory survey on BoP business on utilizing sorghum to produce low cost preserved food | Kenya | JICA; Pricewaterhouse Coopers Aarata | 2013 |
| PEAR Carbon Offset Initiative, Ltd. | Preparatory survey on BoP business on subsistence farming using castor | Sri Lanka | JICA; Green Materials Research Corporation Ltd.; Nippon Koei Co., Ltd | 2012 |
| NEC | Organic strawberry cultivation using imported seedlings from Japan | India | GRA | 2012 |
| Earth Biochemical Co., Ltd. | Development of food with nutritional supplements | India | JICA; Global Link Management; PADECO Co., Ltd. | 2011 |
| Yukiguni Maitake | Development of production systems for green mung bean | Bangladesh | JICA; Kyushu University; Grameen Krishi Fdn. | 2011 |
| Retail Branding Co., Ltd | Preparatory survey on BoP business on development of food supply chains in Myanmar | Myanmar | JICA; Nippon Koei Co., Ltd. | 2012 |

Many BoP initiatives by Japanese corporations focus more generally on supply chain creation rather than targeting a specific technology or step in the value chain

Note: List is not exhaustive

Source: JICA press releases; Nomura Research Institute; Company websites; Industry interviews

# Based on learnings from previous Japanese efforts in BoP markets, various key success factors have been identified

| | |
|---|---|
| Partnering with established local organizations | Established local organizations or international organizations who have already established local presence not only understand market needs but also have enabling ecosystems already in place. Established local organizations can help implement business plans effectively, analyze customer segments, manage risks and increase market reach |
| Learning by doing | Understanding of BoP markets can be developed through secondary research and educational workshops/seminars. However, as companies strive to build on-ground expertise, there is no substitute to learning by doing with on-ground pilot projects, exchange with local organizations and development of initial market entry strategies |
| Leveraging enabling environment organizations | The established network and knowledge of public agencies, NGOs and multinational organizations can serve as a valuable guide to companies as they enter BoP markets, and partnerships with enabling environment organizations can help companies increase market reach and effectively implement business plans |
| Developing a separate BoP business model | Modern agricultural technologies tend to be more efficient and more cost effective than traditional technologies, but also have a variety of obstacles in a BoP context, e.g. higher upfront cost, higher complexity, higher maintenance needs, higher capacities. Innovative business models are necessary to address these challenges |
| Adjusting to market-specific challenges and opportunities | Country/region-specific approaches and product offering should be developed based on market-specific characteristics such as typical land holding sizes, market structure (e.g. in some markets, technology transfer may be the most feasible mode of engagement), crop-specific needs, policy constraints (e.g. some countries apply high tariffs to raw material components of agricultural machineries, making local production costly), etc. |

Source: Does BoP business approach fit in the Japanese framework?; Developing BoP Business as the Principal Strategy in Emerging and Developing Economies, Nomura Research Institute

# Cost competitiveness and product modularity are specific challenges in BoP markets, which may require a more flexible approach from corporations

## Market observations

### Product applicability for BoP

- BoP product design from large Western corporations often does not factor in the needs specific to BoP contexts or consider how these needs might evolve rapidly over time
- Furthermore, such design often does not take into account that supporting infrastructure and other exogenous factors may not be present in rural areas

### Product affordability for BoP

- Large corporates may have trouble achieving cost-competitiveness of products while complying with the same quality standards they adhere to in developed countries
- However, lowering price by diluting quality comes with the risk of threatening public perception of the corporation's brand

## Implications

- Large corporations should explore creating separate units within their organizations which have an exclusive focus on targeting the BoP
- Large corporations should also consider acquiring small young firms in developing countries with in-depth market knowledge and/or innovative low-cost technologies

- A potential way forward is to explore potential for marketing of more cost-effective BoP-targeted products under a separate brand name, to allow for differentiation of product quality standards and prevent dilution of parent brand



Source: Dalberg analysis

# Within sectors, Japanese companies can focus on a handful of promising technologies in each sector

| Sector | Focus technologies | Rationale |
|---|---|---|
| **Agricultural Mechanization** | • *Land preparation*: Rotovator; Laser leveler<br>• *Sowing & transplanting*: Mechanized crop-specific transplanter; Zero till drill<br>• *Inter culture operations*: Cono weeder, Power weeder<br>• *Harvesting & threshing*: Mini combine | • Cost-effective agricultural machinery which minimize total cost per Ha, taking into account amortized upfront cost per Ha and running costs per Ha<br>• Efficient technologies with respect to Ha covered/hour which enable productivity gains<br>• Support water savings, saving on inputs such as seeds and pesticides, and positive effect on agricultural yield<br>• High applicability of existing Japanese technologies |
| **Rice Processing** | • *Semi automatic*: 2 stage compact mill, Rubber roller dehuller (1 stage)<br>• *Automatic*: Multi-stage mill | • Efficient milling recovery and reduction in processing losses<br>• High quality end product<br>• Operating at reasonable scale (aggregating from groups of smallholders), costs can be lower than or roughly competitive with costs of more traditional methods (e.g. Engelberg), while rice revenues should increase considerably based on higher recovery of edible rice and higher sales price associated with higher quality rice<br>• High applicability of existing Japanese technologies |

Source: Dalberg analysis

# Agricultural mechanization: Based on identification of several high potential technologies, relevant options for potential pilot projects have been identified

**Relevant Japanese companies**

DAISHIN
Kubota
ISEKI
ISEKI & CO., LTD.
YANMAR
Solutioneering Together
MITSUBISHI
FUJIKIKAI

**Potential pilot projects**

- Partnership with NGO or social enterprise using a rental or sales model to supply machinery and train maintenance personnel
- Partnership with a corporate food and beverage company that uses an out-grower scheme to source inputs from smallholder farmers, to develop model to increase mechanization of farmers from whom they source
- Technical collaboration with BoP manufacturing partner for a strategic transfer of agricultural machinery technology
- Partnership with a BoP manufacturing partner to supply key components (e.g. components for 5HP tractors)

**Relevant players serving BoP market**

KENDAT Kenya Network for Dissemination of Agricultural Technologies
Pradan
CSISA
BrazAfric ENTERPRISES LTD
NUAC
ADM
Nestlé
syngenta
AMAR
NDUME

Source: Organization websites; Literature review; Dalberg analysis

# Rice processing: Based on identification of several high potential technologies, relevant options for potential pilot projects have been identified

**Relevant Japanese companies**

TAIWA
KANEKO AGRICULTURAL MACHINERY CO.,LTD.
Yanmar
Kubota
ISEKI ISEKI & CO., LTD.
YANMAR Solutioneering Together
Panasonic ideas for life
NEDO

**Potential pilot projects**

- Supply of 2 stage village-level rice mills to farmer cooperatives through MFIs / NGOs
- Supply of village-level mills or mobile mills through rural social entrepreneur model in partnership with an NGO
- Supply of rice mills through an NGO working with millers to set up outgrower agreements with embedded services
- Partnership with a corporate using an out-grower scheme for rice sourcing to develop model to upgrade centralized or decentralized (local) milling technologies
- Supply of component technologies for automatic mills to large rice milling companies / exporters
- JV for technology transfer to large rice processors
- Development of appropriate decentralized power solutions

**Relevant players serving BoP market**

VisionFund CAMBODIA
UNIDO
SNV
Onwi NEGROS WOMEN FOR TOMORROW FOUNDATION, INC.
Malô
**An Giang Plant Protection Stock Company**
Yambeeji Zambia
AgDevCo
OLAM

Source: Organization websites; Literature review; Dalberg analysis

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# List of interviewees

| Name | Designation | Organization | Key activity |
|---|---|---|---|
| Juan Guardado | COO | Equity for Africa | Agriculture equipment financing & TA (Tanzania) |
| Dr. Pascal Kaumbutho; Dr. Joseph Mutua | CEO | Kenya Network for the Dissemination of Agricultural Technologies (KENDAT) | Agriculture technology transfer NGO (Kenya) |
| Jagan Totat | - | Yes Bank | Agriculture equipment financing & TA (India) |
| Raman Sharma | Project Officer Agriculture Mechanization | Cereal Systems Initiative for South Asia (CSISA) project | Project to decrease hunger and malnutrition and to increase food and income security of resource-poor farm families (South Asia) |
| Dr. Ganeshan | Principal Scientist | Indian Council of Agricultural Research (ICAR) | Governmental body for coordinating, guiding and managing research and education in agriculture (India) |
| Manish Pradhan | Business Manager | Claas | Manufacturers and sells agricultural equipment esp. harvesters (Global) |
| Kelly Winquest | Manager: Business and Government relationship | John Deere | Manufactures and sells range of agricultural equipment (Global) |
| Amar Singh | - | Amar Agriculture | Largest thresher manufacturer in India (Asia; Africa) |
| Rajesh Patel | - | Captain Tractors | One of the largest manufacturers of low powered mini tractors in India (India; Africa) |
| Shah | - | Teerath Agro | Largest Rotovator manufacturer and exporter in India |
| Monsiapile Kajimbwa | Senior Advisor / Sector Leader Agriculture | SNV | Global capacity building organization; Strengthening links between farmers and rice millers (Tanzania) |

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