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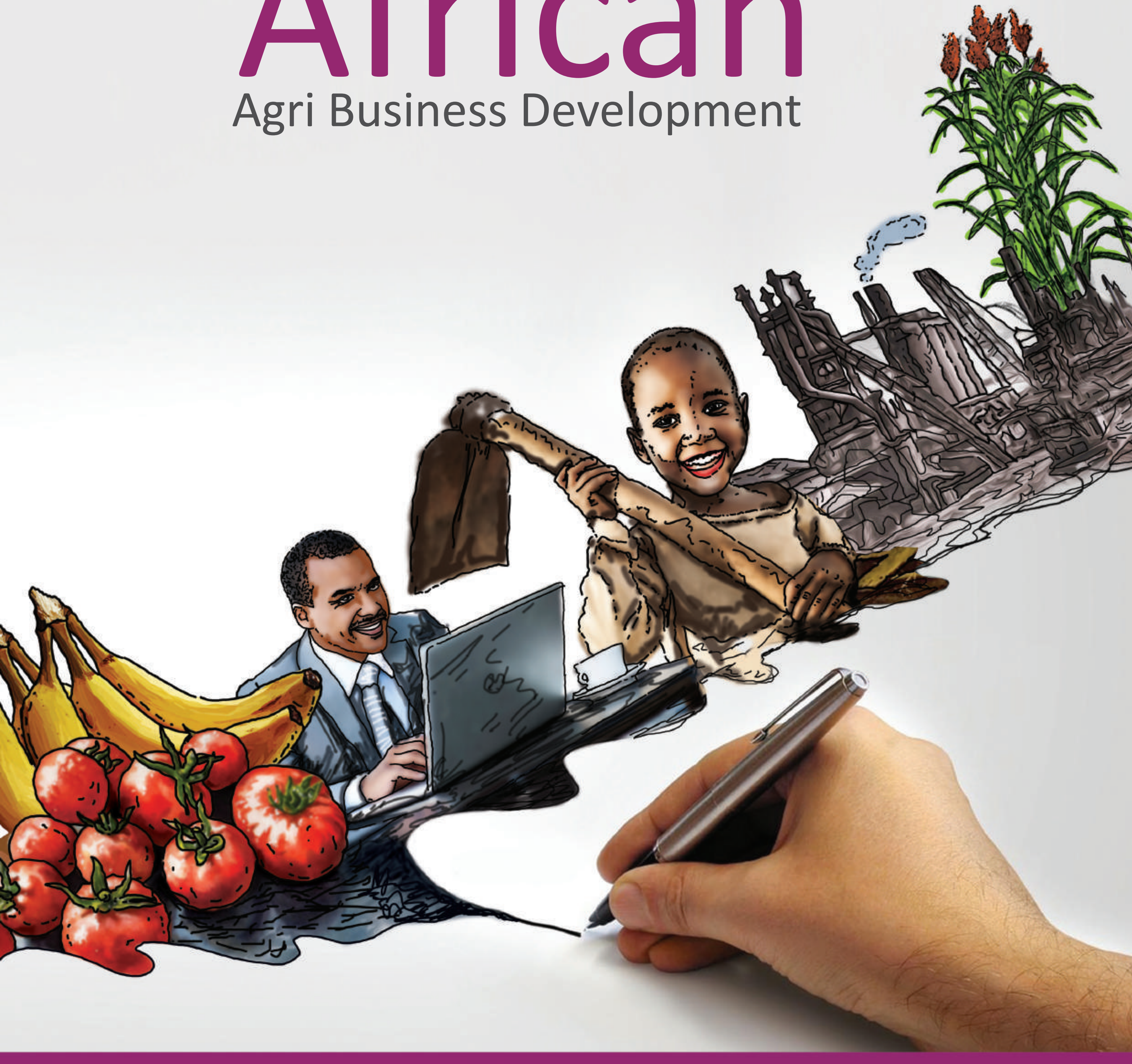
Forum for Agricultural Research in Africa

Danish International Development Agency (DANIDA)

UniBRAIN
Universities, Business and Research in Agricultural INnovation

# Technologies for African Agri Business Development



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Science with a human face
International Crops Research Institute for the Semi-Arid Tropics

## Citation:

Ariho Alex, SM Karuppanchetty, R Bhubesh Kumar 2014. “Technologies for African Agribusiness Development”. Agri-Business Incubation Program of Agribusiness and Innovation Platform, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru-502324, Telangana, India. _____ pp

**ISBN: 978-92-9066-561-8**

# Technologies for African Agri Business Development

Editorial Team

**Ariho Alex, SM Karuppanchetty, R Bhubesh Kumar,**

International Crops Research Institute for the Semi-Arid Tropics

# Foreword

African Entrepreneurship Study conducted by the International Development Research Center (IDRC) says that the levels of international entrepreneurship in Sub-Saharan Africa are high at an average of 53% and the perception that individuals have the skills necessary to start and successfully run a business are high and substantially higher than all other regions around the World, including those in developing economies. According to 2012 GEM (Global Entrepreneurship Monitor) Global Report, economies in Sub-Saharan Africa exhibit the lowest levels of fear of failure. This high entrepreneurship zeal and less fear of failure has to be capitalized and many enterprises have to be created in the African continent which is capable of contributing enormously to the development of African economies.

The best way to promote enterprises is through business incubation. The Forum for Agricultural Research in Africa (FARA) under the DANIDA funded UniBRAIN (Universities, Business and Research in Agricultural INnovation) initiative has established six Agribusiness Innovation Incubator Consortia (AIICs) in Kenya, Mali, Ghana, Uganda and Zambia promoting entrepreneurs in sorghum, forestry, animal husbandry, banana, coffee and horticultural crops value chains respectively. The UniBRAIN partners and AIICs are actively involved not only in promoting entrepreneurship but also in developing better agribusiness curriculum which could be adopted across all the African Universities, ultimately leading to creation of effective and skilled work force for the agricultural industries.

In the journey of supporting entrepreneurs, AIICs are shouldering the responsibility of providing due access to improved agro-technologies from different partnering Universities and Research organizations in the African continent. Under the mentorship from the Agri-Business Incubation (ABI) program of the Agribusiness and Innovation Platform (AIP) of the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), a compendium of African Agro-Technologies titled: “Technologies for African Agri-Business Development” which is a repository of improved agro-technologies which are available for commercialization through the six AIICs.

The technology details provided in this compendium will be of great use to all the budding agro-entrepreneurs in the continent and the commercial licenses for accessing the technologies could be obtained through the AIICs. I take this opportunity to appeal all the entrepreneurs to be aware of the technology details provided in this compendium and wish them to spin off business ventures using these technologies. I also congratulate all the AIICs, Universities and Research Organization who are generous in providing all the technology details without which it would have not been possible to bring out this technology compendium. My special thanks to the editorial team who has toiled incessantly in publishing this African agro-technology compendium.

**Dr Yemi Akinbamijo**
**Executive Director, FARA**

# Preface

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# Abbreviations and Acronyms

| | |
|---|---|
| ABP | Afri-Banana Products |
| AgBIT | Agri-Business Incubation Trust Limited |
| AIBP | Agro-Industrial By-Products |
| AKFED | Aga Khan Fund for Economic Development |
| ARI | Animal Research Institute |
| ARICUS | Animal Research Institute Credit Union |
| ATTRA | Appropriate Technology Transfer for Rural Areas |
| BEP | Break-Even Point |
| BSG | Brewers Spent Grain |
| CAGR | Compound Annual Growth Rate |
| CCLEAr | Creating Competitive Livestock Entrepreneurs in Agribusiness |
| CIRAD | Centre de Coopération Internationale en Recherche Agronomique pour le Dévelopement (Agricultural Research Centre for International Development) |
| CMS | Cytoplasmic-nuclear Male-Sterility |
| CSIR | Council of Scientific & Industrial Research |
| CURAD | Consortium for enhancing University Responsiveness to Agribusiness Development |
| CWD | Coffee Wilt Disease |
| DEEP-EA | Developing Energy Enterprises Project East Africa |
| DFCU | Development Finance Company of Uganda |
| DRC | Democratic Republic of Congo |
| DSCR | Debt Service Coverage Ratio |
| EABL | East African Breweries Limited |
| EBIT | Earnings before Interest and Tax |
| EBITDA | Earnings before Income Tax, Depreciation and Amortization |
| EBRD | European Bank for Reconstruction and Development |
| EBT | Earnings before Tax |
| ECA | Eastern and Central Africa |
| ECOWAS | Economic Community of West African States |
| EU | European Union |
| FAO | Food and Agriculture Organization |
| FAOSTAT | FAO Statistical Databases |
| FCFA | Central African Franc |
| FDA | Food & Drug Administration |
| FREVASEMA | Fresh Vacuum Sealed Matooke |
| GDP | Gross Domestic Product |
| GOG | Government of Ghana |
| GRAS | Generally Recognized as Safe |
| ICO | International Coffee Organization |
| ICRISAT | International Crops Research Institute for the Semi-Arid Tropics |
| IER | Institut d' economie Rurale (Institute of Rural Economy) |
| IFAD | International Fund for Agricultural Development |
| IFOAM | International Federation of Organic Agricultural Movements |
| IMO | Indigenous Micro Organisms |

# Abbreviations and Acronyms

| | |
|---|---|
| INTSORMIL-CRSP | International Sorghum and Millet Collaborative Research Support Program |
| IP | Intellectual Property |
| IRR | Internal Rate of Return |
| KARI | Kenya Agricultural Research Institute |
| KATC | Agricultural Training Centre |
| MEMD | Ministry of Energy and Mineral Development |
| MTBE | Methyl Tert-Butyl Ether |
| NARS | National Agricultural Research System |
| NEMA | National Environment Management Authority |
| NGO | Non-Governmental Organization |
| NOGAMU | National Organic Agricultural Movement of Uganda |
| NPV | Net Present Value |
| OAU/STRC | Organization of African Unity/ Scientific Technical and Research Commission |
| PAT | Profit after Tax |
| PBT | Profit before Tax |
| PBIT | Profit before Interest and Tax |
| PIBIP | Presidential Initiative for Banana Improvement Program |
| PKC | Palm Kernel Cake |
| Reb-A | Rebaudioside A |
| SADC | Southern African Development Community |
| SAFGRAD | Semi-Arid Food Grain Research and Development |
| SG&A | Selling, General & Administrative Expense |
| SIDA | Swedish International Development Cooperation Agency |
| SIFEM | Swiss Investment Fund for Emerging Markets |
| SMEs | Small and Medium Scale Enterprises |
| SOD | Super Oxide Dismutase |
| SSA | Sub-Saharan Africa |
| SVCDC | Sorghum Value-Chain Development Consortium |
| TC | Tissue Culture |
| TFO | Total Financial Outlay |
| UCDA | Uganda Coffee Development Authority |
| UIA | Uganda Investment Authority |
| UNB | United National Breweries |
| UNBS | Uganda National Bureau of Standards |
| UNDP | United Nations Development Programme |
| UNHS | Uganda National Household Survey |
| UNIDO | United Nations Industrial Development Organization |
| USAID- WAFP | United States Agency for International Development - West Africa Fertilizer Program |
| VAT | Value Added Tax |
| WAARI | West African Agribusiness Resource Incubator |
| WCA | West and Central Africa |
| ZARI | Zambia Agriculture Research Institute |

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# Universities Business and Research in Agricultural INnovation (UniBRAIN)

The Forum for Agricultural research in Africa (FARA) is an apex organization bringing together all the major stakeholders in agricultural research and development in Africa. It works in fostering capacities of Africa's agricultural science and innovation community. Established in 2001, FARA encompasses African and non-African stakeholders, who are committed to enable African agricultural development and contribute in achieving the Millennium Development Goals (MDG), especially MDG1 (eradicate extreme poverty and hunger) and MDG7 (ensure environmental stability).

**From 2014 FARA is repositioning itself to**

- **ensure the matching of human and institutional capacities with resource requirements**

- **sustain CAADP momentum, and the Science Agenda for Agriculture in Africa (S3A)**

- **promote agribusiness in the continent. UniBRAIN is one of the key priority programme for deliver on CAADP agenda.**


Our pan African presence

UniBRAIN is an initiative of the Africa Commission funded by the Government of Denmark. The initiative is led by FARA, assisted by six partner institutions: ANAFE, PanAAC, ABI-ICRISAT, ASARECA, CCARDESA and CORAF/WECARD. Together the seven partners service six agribusiness incubator consortia, each consisting of business, research and university institutions. Each partner has a defined role in facilitating various aspects of the Consortia's incubators and their clients. The six pilot Consortia located in five countries (Kenya, Ghana, Mali, Uganda and Zambia) deal in various value chains namely coffee, banana, sorghum, non-timber forest products, cereals, fruits and vegetables.

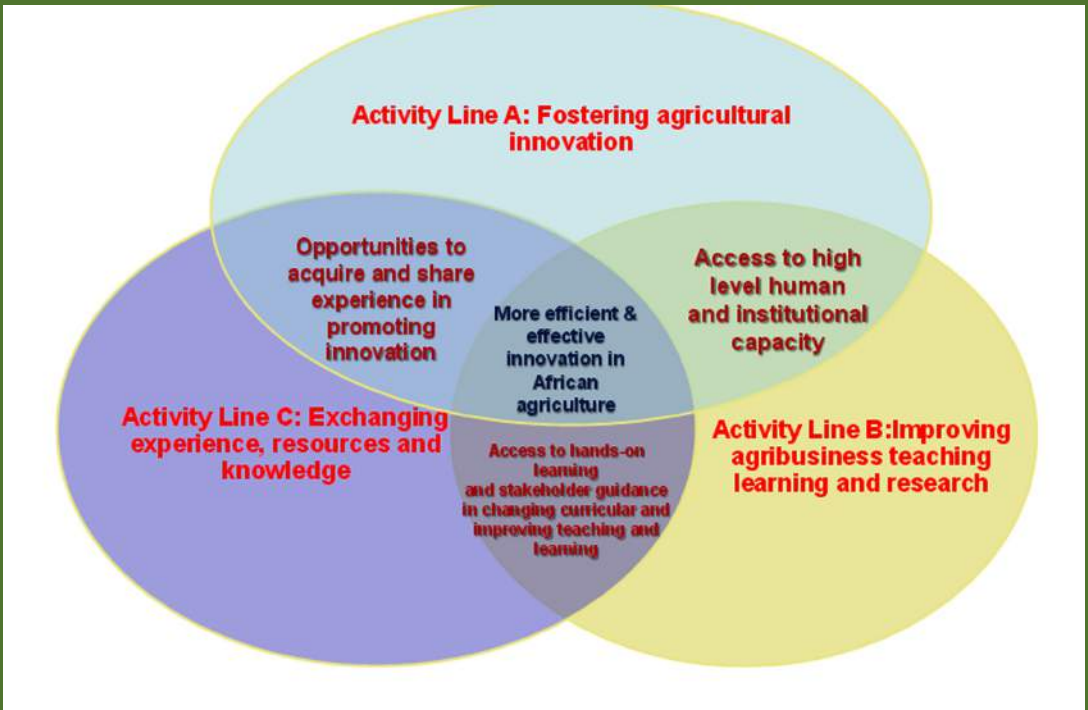
The main objective of UniBRAIN is to create jobs and increase incomes through sustainable agribusiness development. UniBRAIN is achieving this by creating mutually beneficial partnerships between universities, research and the private agribusiness sector to create profitable agribusiness while improving agribusiness education to produce readily employable graduate entrepreneurs. Three outputs envisaged from this collaborative effort are:

1)Commercialization of agribusiness innovations supported and promoted

2)Agribusiness graduates with the potential to become efficient entrepreneurs produced by tertiary educational institutions; and

3)UniBRAIN's innovative outputs, experiences and practices shared and up-scaled

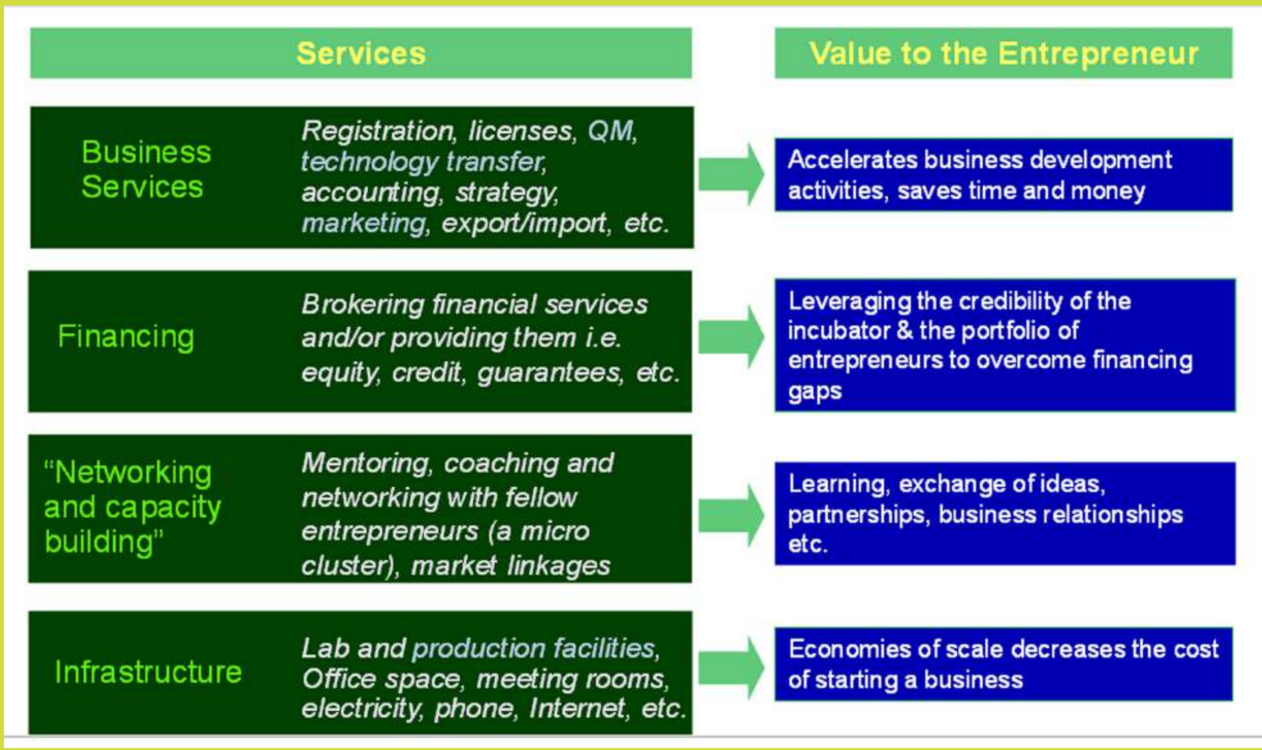
# UniBRAIN's unique synergies of interactions between the partners




The table below identifies the consortia, their specialties and achievements till date.

| Name of consortium | Location | Value chain | Achievements to date (August 2014) |
|---|---|---|---|
| Afri-Banana Products (ABP) Limited | Uganda | Banana | 6 technologies commercialized,54 interns, 31 incubatees, 106 jobs created |
| Agri-Business Incubation Trust AgBIT) | Zambia | Horticulture | 7 technologies commercialized,33 interns, 14 incubatees, 55 jobs created |
| Creating Competitive Livestock-based Entrepreneurs in Agribusiness (CCLEAr) | Ghana | Livestock | 4 technologies commercialized, 23 interns, 54 incubatees,240 jobs created |
| Consortium for enhancing University Responsiveness to Agribusiness Development (CURAD) | Uganda | Coffee | 8 technologies commercialized,81 interns, 18 incubatees, 195 jobs created |
| Sorghum Value-Chain Development Consortium (SVCDC) | Kenya | Sorghum | 4 technologies commercialized,26 interns, 29 incubatees, 150 jobs created |
| West African Agribusiness Resource Incubator (WAARI) | Mali | Non-timber | forestry products 6 technologies commer |
| Food Processing Business Incubation Centers (5 nos) funded by the Government of India under the India Africa Forum Summit-II | Uganda | Banana, Maize | Host country MoU signed with NARL (Host Institute), business plans prepared, Food processing equipment identified, staff appointed |
| | Cameroon | Cassava | Host country MoU signed, Business Plans prepared, food processing equipment purchase process started |
| | Ghana | Livestock | Host country MoU signing process initiated, host institute identified, business plan preparation in progress |
| | Mali | Forestry products | Government of India delegation to visit and study |
| | Angola | Tomato | Host country MoU signing process initiated, Host institute identified, business plan preparation in progress |

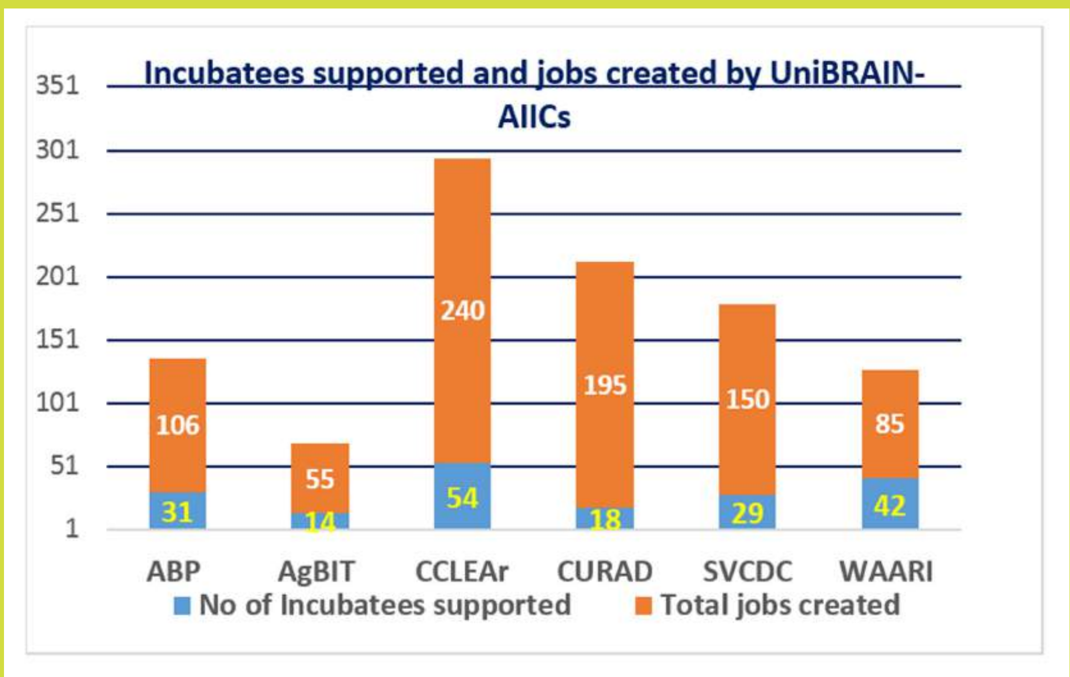
Core services and opportunities for Agribusiness incubation centers established in Africa.




# Impacting lives of SMEs

## Creating jobs for a better Africa

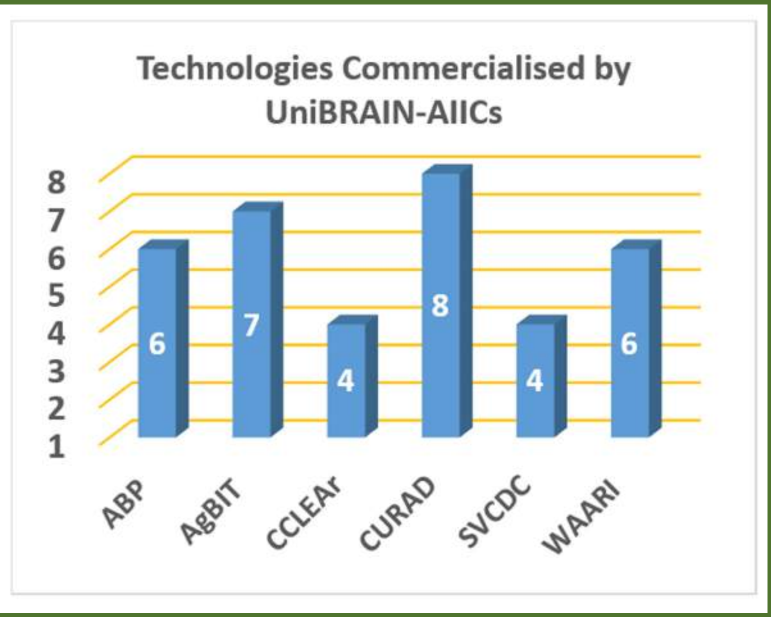
Success of development initiatives is measured by the impact created in the lives of beneficiaries. UniBRAIN, with its multi-thronged approach has created a greater impact in the lives of African agro-entrepreneurs and created many jobs. In a short span of two and half years UniBRAIN-AIICs (as on August 2014) have enrolled 188 entrepreneurs as its incubatees and are extending various incubation services which led to creation of 831 jobs.



## Taking technologies to entrepreneur's desk

Quest of African entrepreneurs for new technologies has never been addressed greatly by UniBRAIN. Technology oriented entrepreneurs have more chance of success in their ventures. UniBRAIN has ventured itself in identifying various agro technologies in Africa and Asia through its partner organizations and commercialize them through the incubatees of AIICs.

UniBRAIN has also created a database of agro technologies for African entrepreneurs and is in the process of releasing a compendium of African Agro technologies during the FARA's 15th year celebrations planned to be held in November 2014 in South Africa.




## Scaling up UniBRAIN operations

Experiencing a great success and spiraling demand from other non- beneficiary African countries UniBRAIN has initiated steps to scale up its activities and reach all the countries in the continent. The Government of India has initiated steps to establish five Food Processing Business Incubation Centers (FPBICs) in partnership with FARA-UniBRAIN, addressing different value chains under the India Africa Forum Summit-II.

| Country to establish FPBIC | Value chain |
|---|---|
| Uganda | Banana, Maize |
| Cameroon | Cassava |
| Ghana | Livestock |
| Mali | Forestry products |
| Angola | Tomato |

The African Union has bought into the UniBRAIN program and pledged support to raise funds for up-scaling. A five year US$ 150million African Agribusiness Incubation Program (AAIP) has been developed to roll out creation of new agribusiness incubators and support competitive SMEs in agribusiness. Discussions are underway with African Development Bank for support to up-scale the program. A number of Universities, research organizations, private sector, and governments have expressed interest to partner with FARA-UniBRAIN in agribusiness value chain development are replicate UniBRAIN model.

To provide a great fillip to the African Seed industry through agribusiness incubation, UniBRAIN has also started working with the Alliance for Green Revolution in Africa (AGRA) to pilot Seed Business Incubators in Ghana, Ethiopia, Senegal, Malawi, Mozambique and Tanzania and other countries will be added to the kitty from 2015.

UniBRAIN is engaged in creating jobs in the agricultural sector which employs over 65% of the continent's labor force and opening doors for new agribusiness avenues. Benefits from the ventures promoted have started trickling down to the bottom of the pyramid and benefitted thousands of households. This great momentum provided by UniBRAIN in creating a healthy agribusiness environment in five countries may be replicated in the rest which could definitely reduce Africa's dependence on agro imports through creation of new agro enterprises.

# Cashew processing

## technology-Mali

The ‘wonder crop’ in the most favourable and lucrative location

**Name Of institute:**
Institut d’ economie Rurale, (IER) Bamako, Mali

**Stage of development:**
Technology ready for commercialisation

**Patent status:** Not Applicable

Cashew, the ‘wonder crop’ as it is called can be grown in the adverse climatic conditions of drought and in hot climatic regions. The climate in Mali (a landlocked country in West Africa) is very favorable for cashew production. Mali is prone to numerous environmental challenges like deforestation, desertification, soil erosion and inadequate supply of potable water. These conditions can be put to good use by cultivating cashew crops. Cashew has high potential for maintaining a strong market demand and its sales are growing at a rate of around 7% per year which renders cashew production a very profitable business. It has the potential to increase earnings, create jobs, and increase exports. The annual global market for cashew exceeds USD 2 billion with a production of 2.1 million tons.

Mali is one of the chief producers of cashew in Africa with an annual production of around 2,900 tons and a productivity of 3.2 tons/ha. Mali has the potential to double its production with new plantations and by increasing the productivity of the old plantations. Though it has excellent production, raw nuts are currently being exported owing to the lack of processing facilities. However, the proximity to export markets in the West provides entrepreneurs with the unique opportunity of investing in cashew production, processing and export from Mali.

**The commercial process followed for Cashew processing is as follows:**

- Reception of raw nuts
- Warming and fragilization of nuts
- Cooling
- Decortication
- Drying
- Dehulling
- Vacuum packaging
- Packed nuts

## Background

Mali is a landlocked country in West Africa and its economy is dependent on agriculture and inland fishing. The country's climate ranges from tropical in the South to arid in the North. Mali is prone to numerous environmental challenges like deforestation, desertification, soil erosion and inadequate supply of potable water. These conditions can be used favourably to cultivate the wonder crop 'cashew'.

Cashew can be sold as raw nut, but processing and better packaging will yield a higher income for farmers. The processing technology developed by the Institut d' economie Rurale, Bamako, Mali could be a boon for all the cashew growers in the African continent. Processed cashew nuts fetch a price that is 50% higher than that of raw nuts.

## Benefits / Utility

1. Cashew has a high potential to maintain a strong market demand and its sales are growing at a rate of around 7% per year. Under the given market conditions cashew processing technology can help farmers realize better incomes.

2. Most of the markets are not controlled or organized into cartels, giving developing countries scope to enter the trade and capture a share of the market. Entry into the international market requires good quality nuts which could be produced using this technology

3. Mali's geographical location can be used to its advantage. Since it is surrounded by a few of the leading cashew producers like Côte d'Ivoire and Guinea, it can leverage on the technological capacities in these countries to increase its own yield.

4. Cashew is considered to be one of the most lucrative crops for small-scale producers, and the major need for labor comes at times which do not conflict with peak labor periods for food crops. Increased production coupled with better processing could increase earnings, create jobs, and increase exports.

## CountryContext

The Government of Mali is providing entrepreneurs with on board support through, land allotment and subsidy to establish processing facilities, and import tax duty exemption for imported cashew processing machinery.
This vast untapped potential along with government support from Mali makes this a lucrative venture for entrepreneurs.

## Scalability

The low prices of raw nuts compels cashew producers to process them into quality kernels which present better opportunities for sales in neighbouring countries like Algeria, Côte d'Ivoire, Mauritania, and Senegal. Attractive and durable packages or labels may allow Malian cashews to achieve higher prices in the retail market. The bulk market is probably easier to access and requires less investment in terms of partnerships and changed packaging.

## Potential investors to this technical innovation

1. Cashew growers' associations/cooperatives
2. Cashew exporters
3. NGOs
4. Small and Medium scale enterprises
5. Cashew traders
6. Retail chains

# Financials

Processing technology from Institut d' economie Rurale, (IER), Bamako, Mali could change the cashew production scenario in all the major production regions. The financials for cashew processing technology are: -

| Capacity | Amount (in USD) |
|---|---|
| Production and Selling Price: 36000 kgs cashew nuts @ USD12 | 4,32,000 |
| Fixed Cost | |
| Machineries | 52,213 |
| Preliminary & Pre-Operative Expenses | 107 |
| Total | 52,320 |
| Working Capital | |
| Raw material @28,000 kg per month @USD 0.85 | 2,86,426 |
| Labour | 13,574 |
| Utilities | 2,164 |
| Rent for the Land & Building | 1,180 |
| SG&A | 5,115 |
| Total (per annum) | 3,17,508 |
| Depreciation @ 15 % | 7,831 |
| Interest @ 12% (Term loan for USD 76,188 (Capital + a month of recuring expenditure) | 9,142 |
| **Total** | **3,34,481** |
| Cost of Production per annum | 3,34,481 |
| Revenue per annum | 4,32,000 |
| Net Profit | 97,519 |
| BEP (in %) | 46 |

## Business and Commercial Potential

In 2010 a ton of processed nuts exported from Nigeria would be sold at USD 4,248 while that from Mali would be sold for just USD 305.
An organized approach to the international market in the production and processing of nuts will help Mali realize its potential advantage over other countries which it currently lacks.
Average Kernel Price/kg (across African countries)

| | Raw nut Production MT* | Number of processors Large | Small | Processing capacity MT | MT processed in 2006 | Avg. kernel price/kg ($) supermarkets |
|---|---|---|---|---|---|---|
| Benin | 45,000 | 1 | 5 | 1,730 | 30-50 | $13.34 |
| Burkina Faso | <15,000 | 1 | 2 | 2,000 | 500 | $12.01 |
| Côte d'Ivoire | 200,000 | 2 | 3 | 10,100 | >5,000 | $20.22 |
| Ghana | 15,000 | 0 | 10 | 530 | 350 | $20.70 |
| The Gambia | <5,000 | 0 | 1 | ___ | ___ | $20.37 |
| Guinea-Bissau | 100,000 | 3 | 26 | 4,080 | ___ | $12.18 |
| Mali | <5,000 | 0 | 0 | ___ | ___ | $9.96 |
| Nigeria | 70,000 | 6 | 3 | 23,600 | 14,750 | $17.69 |
| Senegal | 15,000 | 0 | 15 | 350 | ___ | $16.94 |
| Togo | <5,000 | 0 | 1 | 80 | 80 | $16.34 |
| **TOTAL** | **<475,000** | **13** | **66** | **42,470** | | **$15.98** |

No Official statistics exist for raw nut production in any of these countries.These numbers are estimates based on recent studies on recent studies and interviews withtraders. sourse : WATH[2007]

The annual global market for cashew exceeds USD 2 billion with a produce of 2.1 million tons. The major producing countries are Nigeria, India, Vietnam, Guinea, Benin and Cote d'Ivoire to name a few. The majority (almost 70%) of the produce is from countries like India, Nigeria and Vietnam. Peru reported the highest yield for cashew production in 2010, at 5.27 tons/ha, nearly nine times the world average. The major cashew consuming countries are the US and Europe. Mali is one of the chief producers of cashew in Africa with an annual production of around 2,900 tons and a productivity of 3.2 tons/ha. Mali has the potential to double its production with new plantations and by increasing the productivity of its old plantations. However the main constraint is the low number of processing plants in the country. With support from the government this breakthrough technology can open new windows for development in Mali and other cashew growing countries in Africa.

## Target Market / Customer

Very few companies from West Africa are involved in cashew production. In 2010, seven West African countries including Mali exported 570 million tons of unshelled cashews which is one-third of the total West African production. They exported 21 million tons – only 1% of the West African production as shelled nuts. Thus, there is huge potential to allocate a larger part of the value chain to West African regions, once there is investment in technology, supply chain and capital allocation. Mali is one of the chief African countries producing cashew nuts, though its overall market share is very miniscule as there are no value addition based industries.
Its potential target market has developed naturally due to its proximity to export markets in the West which provides entrepreneurs the unique opportunity of investing in cashew production, processing and export from Mali.

## Limiting factors for large scale commercialization

1. Lack of access to capital presents a significant challenge. Despite Mali's stability and increased investment activity over the past year, the cost of capital is high in Africa and the situation is further exacerbated by exchange rate fluctuations. In particular, those without access to international capital experience difficulties and delays in obtaining finance, with some unable to meet the technical requirements imposed by financial institutions. Farmers have also been essentially excluded from traditional bank lending, which reduces their ability to expand production (thus limiting the demand for up- and downstream services). In the absence of a single entity driving rapid action on the ground and continued coordination across agricultural projects, investments may experience significant delays at all project stages.

2. Limited infrastructure development, including that related to electricity and the density and quality of the road network, increases transaction costs all along the value chain.

3. Costly imports to farming regions raise input costs, while inadequate storage facilities and roads reduce output profitability. Local farming groups have been particularly challenged by the insufficiency of storage and high rental costs, while the operating expenses for community aggregation projects have sometimes become prohibitive.

## Social impact of the technology

The decline in cashew production in African countries is attributed to socio-political factors. Post the 1980s, the decline in prices along with reduced production dissuaded many farmers from changing their cultivation habits. Cashew is considered by small-scale producers to be one of their most lucrative crops, and the work needed comes at times which do not conflict with peak labor periods for food crops. Thus it has the potential to increase earnings, create jobs, and increase exports. This technology will reduce the processing cost which in turn will enhance production as well as the profits of farmers and other producers.

## Malian Grades of Cashew are mentioned below

| Nut Number / Kg | Appreciation |
|---|---|
| 170 | Excellent |
| 180-190 | Very Good |
| 190-200 | Good |
| 200-210 | Average |
| 210-220 | Below Average |
| 230 | Just Acceptable |
| >230 | Bad |

## Yield vis-a-vis quality

| Yield / 80Kg bag | Appreciation |
|---|---|
| 48 pounds | Not Good |
| 49-50 pounds | Acceptable |
| 50-52 pounds | Good |
| 53-54 pounds | Nut count < 230 |
| 55 pounds | Nut count = 230 |

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# Mango Pulp/Nectar

## Production Technology-Mali

Adding value to African Mangoes

## Name Of institute:

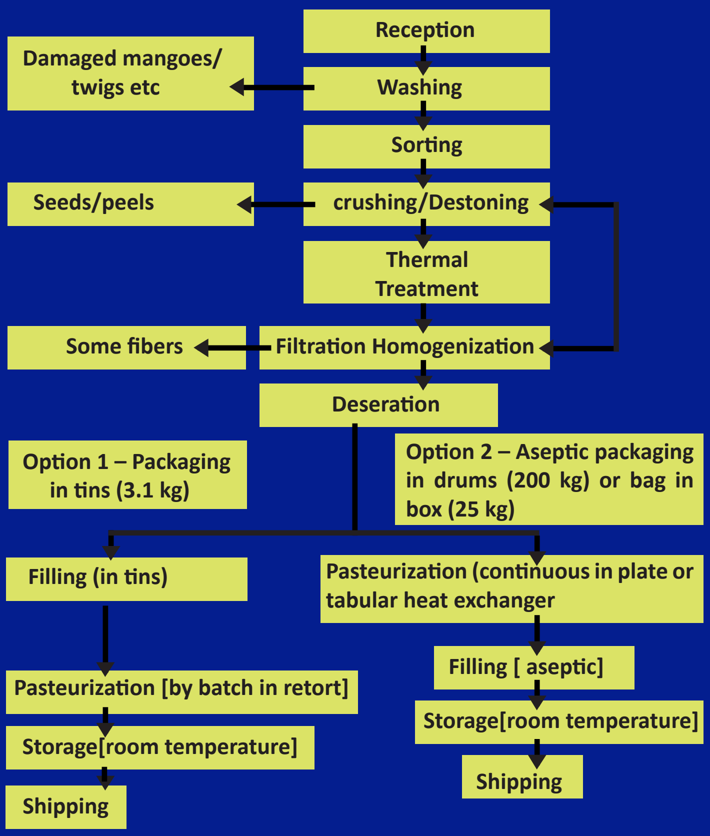
Institut d' economie Rurale, (IER) Bamako, Mali

**Stage of development:**
Technology ready for commercialisation

**Patent status:** Not Applicable

Mango is one of the most widely cultivated and consumed fruits in the world and in Sub-Saharan Africa. However, the seasonality of the fruit, and its high perishability pose a great problem to the Malian population since many small and medium scale enterprises (SMEs) have not fully exploited the potential benefits to be incurred in this lucrative business. This technology is designed to solve the ever growing over production, and poor post-harvest handling of mangoes which go bad either due to poor road infrastructure and poor marketing, or due to sheer ignorance and negligence. This technology also helps preserve the fruit for a longer time.

The production process involved in the production of mango nectar can be well explained by the following flow chart: -




## Background

Mango nectar is made by the dilution of pure, single strength mango pulp and contains sugar, water and preservatives. It is free of carbonation and contains relatively few preservatives. It is considered to be an excellent source of several important vitamins and minerals. Mango nectar is yellow orange in colour and can be consumed as such or mixed with other ingredients. The nectar should contain at least 25-30% of mango pulp as per the standard regulations set by the US and UK markets.Mali in West Africa, is a major grower of mangoes; its estimated production of fresh mangoes is 500,000 MT/yr. Yet most of the fruit is consumed locally - there is very little value addition to Mali's mango crop in terms of the production of mango pulp and nectar, despite the expanding

market for nectar in West Africa and the rest of the world. Malians currently consume mangoes at the rate of about 69 grams per year in the form of fresh, untransformed fruit. It is thought that the demand for mangoes could be extended beyond fresh mangoes and be diversified into jams, juices, marmalades and nectar, giving producers the opportunity to conserve and sell their produce during non-traditional mango seasons.

It is envisioned that the technology of processing mango nectar when adopted by the youth will go a long way in promoting development and the realization of the millennium development goals.

## Benefits / Utility

1. The technology if adopted by the youth and other small and medium enterprises will lead to self reliance, and solve the ever growing unemployment of the younger populations

2. This technology requires very little input which makes Mali a good option for investment. The raw material and ingredients are easily available and require less maintenance.

3. This technology also opens the gates for the production of other utility items like milkshake which can be made by combining nectar with milk and vanilla. It is nutritious and there is a good demand for it.

4. Mango nectar also aids the digestive process and is often touted as a comfort drink and an energetic pick-me-up, as feelings of relaxation and contentment often ensue after drinking it.

5. This technology also helps in reducing wastage of the produce due to over ripening. Over ripe mango fruit is not preferred by customers. But these mangoes could be easily converted into nectar which has very good market potential. This will provide an additional benefit to the mango producers of Mali.

## Country Context

Mango trees grow naturally in Mali given the agro-climatic conditions. The hot and arid climate is favourable for mango growth.

The Government of Mali is providing entrepreneurs with on board support through land allotment and subsidy to establish processing facilities, and import tax duty exemption for imported processing machinery.

This vast untapped potential along with support from the government makes this a lucrative venture for entrepreneurs to set up units. The government has also helped Malian people by providing financial help as well as training in mango nectar production. Improving the supply chain and establishing organized trade policies for import and export trade have helped Mali grow in business.

The Agricultural Trading and Processing Promotion Agency, an NGO established as an autonomous body under the Chamber of Agriculture in accordance with a government agreement, undertook the design and implementation of a project to promote Malian mango exports.

## Scalability

Mango pulp production in Mali is technically and financially feasible. There is a 12–40% profit margin in mango nectar production for the export market. Mango nectar production in Mali shows that processing mango by converting it to pulp can increase its value by a factor of 2.8 while converting it to a ready to drink beverage raises its value 17.8 times. Experts see a production potential of 500,000 metric tons a year, of which only 20,000 metric tons are currently exported. The value added per kilogram of fresh mango is greatest under mango nectar production at US$1.60/kg. The value addition for the conversion of fresh mango to mango pulp is just US$0.30. This therefore provides a great profitable and scalable opportunity.

## Business and Commercial Potential

GLOBAL DEMAND FOR MANGO PULP/NECTAR

| (tonnes) | 2003 demand | % of world | growth rate % | 2008 demand |
|---|---|---|---|---|
| Middle East | 69,364 | 25.1 | 0 | 69,400 |
| South-east Asia | 56,825 | 20.56 | 12 | 84,520 |
| North America | 39,301 | 14.22 | 8 | 55,000 |
| South Asia 38,004 | 13.75 | 15 | 66,500 | |
| Africa | 30,913 | 11.19 | 12 | 49,500 |
| South America | 21,724 | 7.86 | 10 | 32,600 |
| EU | 12,975 | 4.7 | 5 | 16,200 |
| Oceania | 2,353 | 0.85 | 5 | 3,000 |
| Far East | 2,157 | 0.78 | 5 | 2,700 |
| Europe(non EU) | 1,394 | 0.5 | 5 | 1,800 |
| Central America | 1,234 | 0.45 | 10 | 1,800 |
| Total | 276,310 | 100 | 8** | 383,020 |

Source: Parnav International from PAMCO, Pakistan

There is a great demand for mango pulp in the US due to its growing popularity. However, the US is not the target market for Malian mango pulp due to the high cost of transportation which would reduce the already low margins available on this product. Besides, Mexico and Columbia have a long-standing leadership position in this market and their proximity to the US will render Mali uncompetitive in this market.

Mali can tap European markets (EU) although they account for only 4.7% of the world exports. An upward trend is visible in the demand for mango pulp in the EU which can be favourable for Mali's entry into this market.

Mali produces around 500,000 MT of mango which includes mostly less popular varieties. It exports only 10,000 MT/year, which accounts for a mere 2% of its total production. It produces mango pulp on a very small scale and the prices of fresh mangoes during the peak season are barely remunerative. Mango pulp production is possible in Mali with the set up of the equipment and a reasonable initial investment cost.

The mango pulp market is estimated to grow further and there is a huge potential for the nectar market in Mali and other West African regions. This would serve as a good investment option for Mali. The potential production of mango pulp from Mali in the next 3–4 years could only be a small percentage of the world volume, no more than 15,000 MT, which is less than 15% of India's total production. This estimate is based on the establishment of three mango pulp facilities; two with an annual capacity of 2500 MT/yr (SudAgri and Yaffa et Freres) and one (Comafruit) at 10,000 MT/yr.

## Potential investors to this technical innovation

a) medium to large scale entrepreneurs
b) Large scale farmers
c) NGOs
d) Farmers' cooperatives
e) Exporters

## Financials

**Establishment Cost: A turnkey project for mango pulp production can be set up in Mali with a capacity of 2.5 MT fresh fruit per hour for approximately US$840,000. A hot fill nectar packaging facility can also be installed to pack 200 ml product pouches. It would require an additional investment of approximately US$385,000.**

**Price and Margin: The price of the pulp depends mostly on the quality of the fruit and the cost of raw material. Depending on the variety of the mango the price of mango pulp can be more than US$1000/ MT. The pulp in Mali will be prepared form lesser known varieties of mango which will fetch a lower price. The recommended price point for pulp is FCFA 150 (US$0.32)/pouch. At this price the product is accessible to the mass market and also gives a wide profit margin to the producers. However, the price estimate of FCFA 100 (US$0.21)/pouch is attractive to the Malian consumer as it would cut the margins and hence increase the risk of failure. The profit margin based on world market prices is estimated to be around US$74,000 to US$242,000. The average cost of raw material for mango pulp in Mali is estimated to be 23% of the FOB sale price of the pulp. There is a 12-40% profit margin on mango pulp production for the export market.**

**Cost Analysis: Based on the analysis of USAID it is estimated that, a company producing mango nectar can be profitable under either scenario. The estimated profit margin is 43% under the optimistic scenario and 13% under the pessimistic scenario. These scenarios have taken into account both the raw material cost and the sale price of Mango nectar. Based on this the detailed analysis can be viewed as below:**

## Cost Analysis of Mango Pulp Production In Mali: Optimistic Pricing Scenario

| Average Annual Production | 2500 | | |
|---|---|---|---|
| | Cost/kg Pulp (FCFA) | % of FOB price | Notes |
| Price Pulp FOB Mali437 | | 100% | |
| Raw Material | 80 | 18.30% | Average delivery price to factory door. |
| Equipment Ammortization | 16 | 3.60% | Equipment depriciated linearly over 12 yrs. |
| Financing Equipment | 7 | 1.60% | Cost to finance 50% of the investment at 12% over 5 years. Capital paid at 20% peryear |
| Financing Working Capital | 5 | 1.10% | Annual raw material needs financed over 6 months each year |
| Labor | 11 | 2.50% | 3000 FCFA/day * 30 persons *100days ** 3 shifts/d divided by MT pulp/yr |
| Energy | 8 | 1.80% | 8 FCFA per kg mango pulp |
| Packaging | 114 | 26.20% | 24,000 FCFA/210L aseptic bag + barrel |
| Marketing | 11 | 2.40% | Salary+ Trade Fair+ Printed Materials |
| Sub Total | 251 | 57.50% | |
| Profit Margin | 186 | 42.50% | |

Variables

| Variables | |
|---|---|
| Pulp production/yr | 2500 |
| Exchange Rate(FCFA/$) | 480 |
| Price FOB Mali ($/MT) | 910 |
| Days of Operation/yr | 100 |
| Shifts | 3 |
| Daily labor salary | 3000 |
| Laborers/shift | 30 |
| Yield Pulp per Mango | 50% |
| Investments | 393,600,000 |
| Raw material cost/kg | 40 |
| Working Capital needs/mo | 50,000,000 |
| Marketing | 26,400,000 |
| Interest Rate(Investments) | 15% |
| Interest Rate(Working capital loan) | 12% |

Source: Eurostat

## Cost Analysis of Individually Packed Nectar Pouches

| | Cout/Pouch pulp (FCFA) | % of Retail Price | Total FCFA/Yr | Commentary |
|---|---|---|---|---|
| Production (Pouches/Yr) | | | | 14,310,000 |
| Retail Price Point (FCF/Pouch) | 100 | 100% | | |
| Mango Pulp | 12.6 | 12.60% | 179,786,915 | |
| Pouch | 33.6 | 33.60% | 480,816,000 | at $0.0700 per pouch |
| Cost sugar per pouch | 1.4 | 1.40% | 20,606,400 | |
| Depreciation of Equipment | 2.7 | 2.70% | 38,300,000 | |
| Labor | 0.8 | 0.80% | 11,925,000 | |
| Energy | 1 | 1% | 14,310,000 | |
| Marketing | 4.2 | 4.20% | 60,102,000 | About 5% of sales price |
| Distribution | 6.2 | 6.20% | 88,722,000 | About 8% of sales price |
| Factory Mark up | 5.5 | 5.50% | 78,705,000 | 7% of actual sales. Profit before taxes |
| Total Variable Cost | 12.2 | 18% | 175,189,197 | |
| Sub Total (price to retailer) | 80 | 80% | 1,148,462,512 | Sales |
| Retailer Mark up | 20 | 25.00% | 287,115,628 | |
| Price to Consumer | 100 | 100 | 1,435,578,140 | |

## Target Market /Customer

The mango pulp/nectar market is estimated to grow further and there is huge potential for the nectar market in Mali and other West African regions. The cost estimates for pulp production in Mali are almost the same as those for India. Hence Mali should focus on capturing markets that are faraway from India and it should target markets where India does not have a presence. The EU because of its geographic location can easily import from both Asia and South America. However, transportation costs are high. Mali is closer to the EU and can be a natural destination for EU imports which however account for only 4.7% of the world exports. An upward trend is visible in the demand for mango pulp in the EU which could be favorable for Mali's entry into this market.

| Suppliers | Years | | | | | | Growth | |
|---|---|---|---|---|---|---|---|---|
| | 2004 | 2005 | 2006 | 2007 | 2008 | 2009* | Annual | Total |
| Brazil | 69,319 | 82,293 | 84,858 | 82,993 | 96,870 | 69,590 | 9% | 40% |
| Peru | 19,817 | 26,394 | 41,027 | 36,854 | 50,756 | 25,062 | 27% | 156% |
| Pakistan | 10,938 | 12,306 | 10,120 | 13,224 | 12,941 | 12,913 | 4% | 18% |
| Israel | 8,059 | 12,548 | 11,181 | 14,808 | 12,261 | 12,606 | 0 | 52% |
| Cote d'Ivoire | 11,426 | 9,856 | 14,428 | 14,706 | 11,249 | 11,659 | 0% | -2% |
| USA | 7,612 | 6,894 | 5,971 | 7,404 | 7,516 | 5,536 | 0% | -1% |
| Senegal | 2,810 | 3,011 | 6,194 | 4,702 | 6,034 | 6,219 | 21% | 115% |
| Costa Rica | 3,983 | 6,271 | 7,545 | 4,664 | 5,360 | 5,685 | 8% | 35% |
| Mali | 2,096 | 2,560 | 3,477 | 4,317 | 4,902 | 3,480 | 24% | 134% |
| Dominican Rep | 1,228 | 1,591 | 1,618 | 2,767 | 4,307 | 4,179 | 37% | 251% |
| India | 915 | 1,720 | 2,472 | 2,425 | 2,557 | 2,470 | 30% | 182% |
| Burkina | 928 | 1,164 | 2,152 | 3,191 | 2,406 | 1,957 | 27% | 159% |
| Others | 23,516 | 20,035 | 19,786 | 19,003 | 13,209 | 12,893 | -13% | -44% |
| Total | 162,646 | 186,643 | 210,829 | 211,057 | 230,388 | 174,248 | 9% | 42% |

Source: Eurostat


## Contact

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## Limiting factors for large scale commercialization

1. Lack of access to capital presents a significant challenge to entrepreneurs establishing mango nectar producing units.
2. Poor infrastructural support from the government including that with regard to electricity and the density and quality of the road network, and the unwillingness to respond promptly and efficiently, notwithstanding its demonstrated enthusiasm for increased private investments.
3. Less effort from the government to promote the export of Mango nectar

## Social impact of the technology

- Mango being a smallholder crop, implementation of this technology for production could contribute to improving the livelihoods of many farmers and rural dwellers.
- Promotion of the export of mango nectar will boost the food processing industry in Mali

## Any other relevant information

- Mango pulp is mainly used as a food ingredient for juice and nectar manufacturing
- It is also used in dairy and bakery products
- Mango nectar can be mixed with alcoholic as well as non-alcoholic drinks to give a different flavor
- Mango nectar can be used in salad dressings and in confectioneries

# Pre Cooked Fonio- Mali

The time has come for the world's tastiest cereal to become a product of the 21st century and move around the world under the tag of 'Precooked Fonio'.

## Name Of institute:

Institut d' economie Rurale, (IER) Bamako, Mali

## Stage of development:

Technology ready for commercialisation

## Patent status: : To be filled

Fonio (Digitaria exilis) is regarded as the most ancient indigenous West African cereal in the category of traditional cereals dating back to 5000 BC. It has not received much attention until now in spite of its delicious taste and excellent nutrition and nutraceutical properties (helps in managing diabetes). It is either the staple or a major part of the diet in certain regions of Mali, Burkina Faso, Guinea, and Nigeria. Each year approximately 300,000 hectares of land are devoted by West African farmers to cultivate fonio, and the crop supplies food to 3-4 million people.

The production of this excellent crop suffers a serious setback because of the time consuming and extremely laborious post-harvest processing which includes dehusking and milling, and is mostly done in a traditional manner by the women.

Because of the lack of attention, fonio is still agronomically primitive. It suffers from small seeds, low yields, and seed shattering. In order to increase the market of this highly nutritious food grain, which is still limited to parts of West Africa and recently Europe, Pre- cooked Fonio or Processed Fonio was developed as an alternative to raw fonio, targeting the urban population who are interested in buying food items which can easily be cooked.

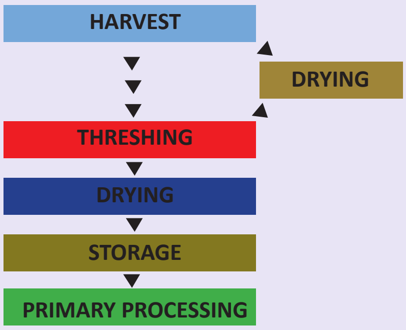
| Pre Cooked Fonio- Mali | |
|---|---|
| Main Components | |
| Moisture | 10 |
| Food energy (Kc) | 367 |
| Protein (g) | 9.0 |
| Carbohydrate (g) | 7.5 |
| Fat (g) | 1.8 |
| Fiber (g) | 3.3 |
| Ash (g) | 3.4 |
| Thiamin (mg) | 0.47 |
| Riboglavin (mg) | 0.10 |
| Niacin (mg) | 1.9 |
| Calcium (mg) | 44 |
| Iron (mg) | 8.5 |
| Phosphorus (mg) | 177 |

| Essential Amino Acids | |
|---|---|
| Cystine | 2.5 |
| Isoleucine | 4.0 |
| Leucine | 10.5 |
| Lysine | 2.5 |
| Methionine | 4.5 |
| Phenylalanine | 5.7 |
| Threomine | 3.7 |
| Tryptophan | 1.6 |
| Tyrosine | 3.5 |
| Valine | 5.5 |

**Pre-cooked or processed fonio is prepared by passing raw fonio through various stages such as cleaning and sieving, to eliminate waste and sand and then washing it before it is precooked with steam and dried in the sun. Finally, part of the shell is removed from the grain and the fonio so prepared is conditioned, sealed, packaged and sold in the market. In West Africa pre-cooked fonio is becoming more and more popular in urban areas because it is easy to prepare - a convenience highly valued by consumers in cities.**

## Production Process:

Processing of Fonio is done in the following manner:-




**The first stage of the Processing system is the Primary Processing which is carried out as follows:**
1. Primary Processing:- As with rice, processing fonio involves two successive operations within the primary processing process:
i. Hulling: Removal of husks from fonio (rough grain) to produce hulled grain (decorticated grain)
ii.Whitening: Removal of bran (pericarp and germ) to produce whitened fonio.

**After the primary processing is over, the next stage comes into play ie, the Secondary Processing. This stage basically covers two important steps:-**

i. Cooking or Steaming: - Before cooking or precooking milled fonio, all the bran, dust and sand are eliminated by multiple washing, which decreases processing time and effort.
ii. Drying and Packaging: - After it is cooked, the fonio is dried either under the sun or on grids in solar driers. Thereafter, it is packed and made ready to be sold in the market as precooked fonio.

## Background

Fonio is a crop, which grows very well on poor soils and even has the ability to produce seed on soils on which other crops cannot grow due to extremely high levels of aluminium, which make the soil toxic to other crops and renders it unsuitable for cultivation. Further, fonio can also be grown on dry Savannah lands where rains are brief and unreliable. It also grows under varying conditions ranging from poor dry upland soils to hydromorphic valleys suitable for rice production.
The crop has the potential to improve nutrition (grains are rich in methionine, cystine and other amino acids vital to human health which are deficient in today's major cereals: wheat, rice, maize, sorghum, barley and rye), boost food security, foster rural development and support sustainable land use. African farmers still value fonio highly because it is the only crop grown over centuries for its nutritious and extremely fast growing nature (reaches maturity in only 8 weeks) and thus can be considered as one of the strategies to help farmers increase food and nutritional security.
Today, fonio is produced by small enterprises and sold not only in local urban markets, but also to Africans who have emigrated to Europe and the United States. Indeed several small private enterprises, notably in Mali and Burkina Faso, have been set up to cater to the export markets. There is a strong consumer demand for fonio due to its nutritional qualities, and because it helps satisfy the demand for a more varied cereal diet.

Fonio is widely held to be the tastiest cereal, and its delicate flavor makes it an obvious choice for high days and holidays. It is easily digested, and is traditionally recommended for children, the elderly and the overweight.
Thus, fonio is a grain that possesses excellent nutrition and nutraceutical properties.
In Mali, Burkina Faso, Guinea and Senegal, private processors sell pre-cooked fonio in 500 g and 1 kg plastic bags as processed fonio which is highly preferred by people in the urban areas.

## Benefits / Utility

• Commonly known as findo, findi or acha (hungry rice), fonio serves as a great food security to the people of Africa.

• In West Africa pre-cooked fonio is becoming more and more popular in urban areas because it is easy to prepare, a convenience highly valued by consumers in cities.

• Precooked or processed fonio is at present the best fonio available in the market due to its excellent nutritional qualities and easy to prepare characteristics.

• It is used to make porridge and couscous.

• It can be ground and mixed with other flours to bake breads.

• It is also popularly used as a key ingredient in beer after it is popped and brewed.

• It is a great substitute for semolina when used in the preparation of pastas and shortbread biscuits.

## Country Context

Mali is a landlocked country in West Africa and its economy is dependent on agriculture and inland fishing. Fonio is regarded as the most ancient indigenous West African cereal in the category of traditional cereals dating back to 5000 BC and is the most nutritious and tastiest of all the cereals. It is either the staple or a major part of the diet in certain regions of Mali. The climate in Mali is very favorable for its production.
An upward trend is visible in the demand for pre-cooked fonio in certain regions of Africa and the United States which could be favourable for investors to enter this market.
The Government of Mali is providing entrepreneurs with boarding support through land allotment and subsidy to establish processing facilities and import tax duty exemption for imported processing machinery.
This vast untapped potential along with government support makes this a lucrative venture for entrepreneurs to set up units.

## Scalability

Though fonio as a crop is very easy to grow, there are problems with its processing due to its extremely small size. The processing which was earlier manual has now been replaced by machine-based processing to make fonio more competitive in the market in terms of quality and price. Institut D'Economie Rurale, Bamako along with several other national research institutes has come up with an adaptation of a thresher and the development of a dehusker that has an average capacity of 100 kilograms per hour. In addition, cleaning equipment has also been developed including a channel for winnowing, drum sieves and a machine to wash out sand.
This has increased productivity enormously and the quality of the product is high. The machine has a husking rate of 99 per cent and the fonio contains no impurities. Production of precooked fonio can be scaled up to the desired levels using this technology.

# Contact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## Business and Commercial Potential

Fonio is a "minor" product in terms of production (in Mali, for instance, it represents less than 1% of all the cereals consumed, and of the total production in Africa which is about 250,000 metric tons), but is well appreciated by most consumers who know about it, and is consumed occasionally for family or religious events. The market of this highly nutritious food grain, is still limited to parts of West Africa and has recently expanded to parts of Europe where the consumers of this grain are basically people living in the urban areas who prefer pre-cooked or processed fonio because of its ease of cooking.

In Mali, Burkina Faso, Guinea and Senegal, private processors sell pre-cooked fonio in 500 g and 1 kg plastic bags. In France, where these products are still not well known, except by exotic markets, the consumers are especially attracted by "Organic" or "Fair trade" labels.

For many years fonio was an under-utilized crop. Its small grains – each seed is only slightly larger than a grain of sand – made husking and processing a particularly tedious process. Unlike finger millet, African rice, sorghum, and other native grains, fonio is not in serious decline. Indeed, it is well positioned for improved production. Firstly, it is still widely cultivated and is well known. Secondly, it is highly esteemed. "In Nigeria's Plateau State, for example, the present 20,000-ton production is only a quarter of the projected state demand. ''

Traditional and new products differ mainly according to their place in a technological process (from less to more processed), but they are also sold in different places and to different people: traditional products are sold in markets, while precooked products are sold in small supermarkets or in small scale enterprises. There is a strong consumer demand for fonio due to its nutritional qualities, as it helps satisfy the demand for a more varied cereal diet.

The UN Food and Agricultural Organization (FAO) estimates an annual production of about 250,000 tons of fonio grown on 380,000 hectares of land in the lead-producing country Guinea, followed by Nigeria, Mali, Burkina Faso and Ivory Coast. Attention must be given to sensory attributes and consumer acceptance. This will also help create a consumer demand versus technology push in the development of a good quality product (Talukder and Sharma 2010) and an exportable value added product from this cereal grain.

## Potential investors to this technical innovation

a) Farmers' Cooperatives
b) Fonio traders and exporters
c) Super market chains
d) Government-Nutrition programs
e) NGOs
f) Small and Medium scale enterprises

## Financials

The investment cost for setting up a Fonio processing mill is tabulated below:

| Sl. No. | DESCRIPTION | COST (IN $US) |
|---|---|---|
| 1 | Land and Site Development | 2,32,525 |
| 2 | Building and Civil Works | 3,30,775 |
| 3 | Plant and Machinery | 4,56,862 |
| 4 | Electricity | 34,400 |
| 5 | Furniture and Fixtures | 8,200 |
| 6 | Expenses | 1,03,170 |
| 7 | Contingency @ 5% | 39,300 |
| 8 | Margin Money for Working capital | 2,16,150 |
| | TOTAL COST | 14,21,382 |

Means of Finance:

| SR.NO. | SOURCES OF FUNDS | COST (IN $US |
|---|---|---|
| 1 | Share Capital - Equity | 7,66,382 |
| 2 | Term Loan From Bank | 6,55,000 |
| | TOTAL | 14,21,382 |

The mill capacity is considered to be 19200 Metric Tonnes per annum. The profitability assumptions are as below:

| PARTICULARS | FONIO REQUIREMENT |
|---|---|
| Plant Capacity (TPH) | 4 |
| Number of Working Hours | 16 |
| Number of Days | 300 |
| Annual requirement (in MT) at installed capacity | 19200 |

## The Key Financial Indicators are as follows (in $US)

| SR.NO | PARTICULARS | YEAR1 | YEAR2 | YEAR3 | YEAR4 | YEAR5 | YEAR6 | YEAR7 |
|---|---|---|---|---|---|---|---|---|
| 1 | Sales | 2452975 | 3009725 | 3152188 | 3158738 | 3158738 | 3158738 | 3158738 |
| 2 | Total Expenditure | 2138575 | 2572512 | 2732987. | 2787025 | 2791937 | 2793575 | 2798487 |
| 3 | PBIDT | 316037 | 435575 | 419200 | 371712 | 366800 | 365162 | 360250 |
| 4 | PBT | 212875 | 227612 | 216150 | 181762 | 189950 | 204687 | 216150 |
| 5 | PAT | 171937 | 170300 | 157200 | 131000 | 134275 | 140825 | 145737 |
| 6 | Cash Accruals | 189950 | 207962 | 196500 | 168662 | 171937 | 178487 | 185037 |
| 7 | BEP @ Installed capacity | 24.11% | 30.57% | 35.83% | 37.07% | 34.67% | 31.32% | 28.14% |
| 8 | BEP@Operating Capacity | 34.44% | 38.21% | 42.15% | 43.61% | 40.79% | 36.85% | 33.11% |
| 9 | Debt Equity Ratio | 111350 | 93337 | 72050 | 49125 | 22925 | 0.00 | 0.00 |
| 10 | DSCR (Gross) | 381537 | 316037 | 286562 | 242350 | 232525 | 222700 | 280012 |
| 11 | Average DSCR | | | | | | | 2 ,75,100 |
| 12 | DSCR (Net) | 537100 | 478150 | 381537 | 286562 | 257087 | 234162 | 288200 |
| 13 | Average DSCR | | | | 3,73,350 | | | |
| 14 | IRR (%) | | | | 15.48% | | | |

*SOURCE: APITCO PROJECT PROFILE*

## Target Market / Customer

Fonio is widely held to be the tastiest cereal, and its delicate flavor makes it an obvious choice for high days and holidays. It is easily digested, and is traditionally recommended for children, the elderly and the overweight.

Its potential target market has developed naturally due to its proximity to export markets in the West which provides the entrepreneurs with the unique opportunity of investing in fonio production, processing and export from Mali. The main markets are West Africa, the United States and the European Union (mainly the United Kingdom). In West Africa pre-cooked fonio is becoming more and more popular in urban areas because it is easy to prepare, a convenience highly valued by consumers in cities.

## Limiting factors for large scale commercialization

1. Lack of access to capital presents a significant challenge. Despite Mali's stability and increased investment activity over the past year, the cost of capital is high in Africa, and is further exacerbated by exchange rate fluctuations. In particular, those without access to international capital experience difficulties and delays in obtaining finance, with some unable to meet the technical requirements imposed by financial institutions. Farmers have also been essentially excluded from traditional bank lending, which has reduced their ability to expand production (thus limiting the demand for up- and downstream services).
2. The government's capacity to respond promptly and efficiently, notwithstanding its demonstrated enthusiasm for increased investment, is hampered in areas such as land acquisition and tenure, by the lack of a cohesive platform through which to facilitate agricultural investment. In the absence of a single entity driving rapid action on the ground and continued coordination across agricultural projects, investments may experience significant delays at all project stages.
3. Limited infrastructure development, including that with regard to electricity and the density and quality of the road network, increases transaction costs all along the value chain. Costly imports to farming regions have raised input costs, while inadequate storage facilities and roads have reduced output profitability. Local farming groups have been particularly challenged by the insufficiency of storage and high rental costs, while the operating expenses for community aggregation projects have sometimes become prohibitive

## Social impact of the technology

The technology has huge potential to increase earnings, create jobs, and increase exports. It will reduce the processing cost and in turn will enhance the production as well as the profits of farmers and other producers. Mechanization through investment will ease the workload, mainly for women and children. The availability of fonio will contribute to food supply for certain populations, particularly in the rural areas where fonio plays an important role as an inter-harvest staple crop.

Supply will increase through the use of more efficient equipment that will increase the yield from dehulling by 50% to 60% and thereby contribute to the food supply for the local population. By mechanizing dehulling and washing operations, the consumer price of dehulled and washed fonio will decline by about 25%, which will increase the demand. The project impact at the production level will be an estimated additional 50,000 metric tons of fonio produced in West Africa which is the equivalent of a USD 12 million increase in income.

## Any other relevant information

The relative stagnation in the production of pre-cooked fonio is partly explained by a lack of research and development devoted to this product. In order to avoid the decline of this commodity, it is important to solve the many problems that are faced after harvest, particularly by perfecting post-harvesting techniques and by improving the quality and the follow-up of sales and distribution.

Clearly, fonio is important, has many agronomic and nutritional virtues, and could have an impressive future. This crop deserves much greater attention. Modern knowledge of cereal-crop improvement and dedicated investigations are likely (at modest cost) to make large advances and improvements.

## Nutritional Value of Fonio

- Highly rich in amino acids and iron, its tiny grains are very nutritious for pregnant women and children.
- The husked grain of fonio contains 8-10 % proteins, 85% carbohydrates, 4% fats and 1% ash.
- Fonio grains are immensely rich in methionine, cystine and other amino acids which play a vital role in nourishing human health. These nutrients are missing in today's major cereals.
- The protein analysis of white fonio in comparison with a whole egg is higher on the following counts: 7.3% of methionine, 46% lysine, 72% isoleucine, 90-100% of valine, tryptophan, threonine, and phenylalanine, 127% of leucine; 175% of total sulphur; and 189% of methionine.
- Furthermore, fonio does not contain any glutenin or gliadin proteins which are the constituents of gluten, making this cereal suitable for people with gluten intolerance

# Sebe Nectar –Mali

## Sebe Nectar – Tropical Gold

### Name Of institute:
Institut d' economie Rurale

### Stage of development:
Technology ready for commercialisation

### Patent status: To be filled

Sebe nectar is a product of purr or Borassus juice (Borassus aethiopum). Borassus is one of the nine native species of the African tropical regions. They are big high palm trees which develop a smooth and grey stripe and can grow up to 30 m in height. The fruits are gathered in light clusters. They are globular and yellow brown or orange in color.

Borassus aethiopum is a species of Borassus palm from Africa. In English it is variously referred to as African fan palm, African Palmyra palm, deleb palm, ron palm, toddy palm, black rhun palm, ronier palm (from French) and other names. It is widespread across much of tropical and southern Africa from Senegal to Ethiopia to Zimbabwe, and also grows in Madagascar and the Comoros. The process involved in the production of sebe nectar is given in the table below.

## Production Process:-

### Sebe Nectar –Mali

| Steps | Operations description |
|---|---|
| Reception/sorting out | The ripe fruits are sorted out and weighed |
| Stocking | The sorted out fruits are stocked in an airy place or in a refrigerated place, the stocking lasts for a short period |
| Washing | The fruits are washed with clean water and rinsed in disinfected water and if need be with 3 to 5 bleach drop |
| Feeling | The peeling is done with stainless stell on surfaces in plastic or hard worrd, easy to clean. Those surfaces are cleaned and disinfected at the end of the work |
| Precooking before crushing (optional) | Cook the pulp in water to soften it for 10 to 15 mn |
| Crushing | The pulp is crushed with a robot coupe |
| Dilution and filtration | Dilute the pulp according to the desired unctuousness filter through a thin mesling filter through a thin mesling filter of metal or plastic |
| Adjustment of the tast and PH | Adjust the sugar rate to clients taste. It varies from 1 to 15C adjust the ph to 3 – 3.5. The ph measures the products acidity. It strongly influence the pasteurization and conservation of the nectar. The ph is measured with a ph metre on ph paper. |
| Preparing the bottles in glasses of 33 cl | The bottles are washed and rinsed with bleach (3 drops/1) and pasteurized in water warming during 15 to 20 mn |
| Pasteurization of the bottles | The bottles are immerged in a container full of water and pasteurized for 15 mn up to 75 – 80c after boiling |
| Cooling | The pasteurized bottles should be cooled down in air |
| Labelling | The bottles are labelled (composition, production date, expiry date, name and address of the company ..) |
| Conservation | The nectar once conditioned this way gets conserved one year to ambient temperature |

## Background

Tropical forests are an important reservoir of biodiversity and they play a fundamental role in satisfying many needs of the people. Nowadays, non-timber forest products, exploited and consumed by local people are becoming very scarce due to high human pressure, over exploitation, insufficient silvicultural data and climate changes highlighted by the recurrent dry seasons. All these are factors that compromise the food security and income of the local people. Borassus aethiopium is a dioecious palm species native to Africa where it grows in the Savannas and woods. Borassus aethiopium is the latin name for 'Ethiopian' where the species is known; it is commonly called Palmyra palm, as are all the plants in the genus.

Borassus aethiopum is an economically and ecologically important palm tree of the Sahelian and Sudanian zones in Africa. Being a genuine multipurpose palm tree, it is a victim of its own high utilitarian value. Both human and natural factors are threatening the natural populations in Senegal. As long as the use of this valuable palm is not regulated, the situation will probably worsen. Only strict management of the remaining natural populations will save an important plant resource for future generations. The fruits of Borassus are rich in sugar which makes them more suitable for the production of nectar.

## Benefits / Utility

Sebe nectar is consumed for its nutritional and medicinal properties. The sap tapped from near the shoot apex is consumed as an alcoholic beverage.

## Country Context

In Mali, purrs are found in the dead delta, in the region of Segou and the Dogon land (Karadogou and Sana possessed 90% of purrs reserves of the region in the past).
The plant can be found in Benin, Burkina Faso, Congo, Cote d'Ivoire, the Democratic Republic of Congo, Ethiopia, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Liberia, Mali, Mozambique, Nigeria, Senegal, Sierra Leone, South Africa, Sudan, Tanzania, Togo, Uganda, Zambia, and Zimbabwe. The pan-African presence of these palms makes this technology more useful for the value addition of fruits

## Scalability

Drylands make up 60% of Africa's surface. The area of Africa is 30,221,532 km. square which makes the area under drylands equivalent to 18,132,919.2 km. square or 1,813,291,920 hectares. This means close to 2 billion hectares of dryland are available to grow Borassus aethiopium. Assuming 100 trees of Borassus aethiopium per hectare, there would be 200 billion trees in Africa. The fruits of these trees can then be used to extract sebe nectar.

## Business and Commercial Potential

There are presently no precise statistics but estimates show that just a small part of Mali's production has been transformed as of now. From interviews done with transformers, the quantity of sebe nectar produced yearly in Mali is estimated at 3,000 liters. EU fruit juice and nectar consumption stood at 10.7 billion liters in 2011. If Turkey, Norway and Switzerland are included, sales would rise to 11.8 billion liters, driven by the strong upward momentum in juice and nectar consumption in Turkey. 100% juice sales represented approximately two-thirds or 7.0 billion liters of total EU sales in 2011, with nectars (25-99% juice content) making up the remainder. The sale of nectar thus made up close to 2.5 billion liters of the total volume. Assuming the cost of one liter of juice to be US$1, the total sale value would be 2.5 billion US$. Even if 20% of the market segment is tapped by sebe nectar this would be equal to 500 million US$.

# Contact
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### Potential investors to this technical innovation

1. SMEs
2. Farmers' cooperatives
3. Food processing companies
4. Student Entrepreneurs

## Financials

Set up Cost: A turnkey project for sebe nectar production with a capacity of 2.5 MT fresh fruit per hour can be setup in Mali for approximately US$840,000. A hot fill nectar packaging facility can also be installed to pack 200 ml product pouches. It would require an additional investment of approximately US$385,000.

Price and Margin: The price of the pulp depends mostly on the quality of the fruit and the cost of raw material and can be more than US$1,000/ MT. The recommended price point for nectar is FCFA 150 (US$0.32) /pouch. At this price the product is accessible to the mass market and offers a wide profit margin to the producers. However, the price estimate of FCFA 100 (US$0.21) /pouch which is attractive to Malian consumers would cut the margins and hence increase the risk of failure. The profit margin based on world market prices is estimated to be around US$74,000 to US$242,000.The average cost of raw material for sebe nectar in Mali is estimated to be 23% of the FOB sale price of the nectar. There is 12-40% profit margin on sebe nectar production for the export market.

Cost Analysis: Based on the analysis of USAID it is estimated that, a company producing sebe nectar can be profitable under either scenario. The estimated profit margin is 43% under the optimistic scenario and 13% under the pessimistic scenario. Based on this the detailed analysis can be viewed as below:

| **Average Annual Production** | **2500** | |
|---|---|---|
| | **Cost/kg pulp** | **% of FOB** |
| **price** | | |
| **Price for Mali** | **437** | **100%** |
| **Raw Material** | **80** | **18.3%** |
| **Equipment Amortization** | **16** | **3.6%** |
| **Financing Equipment** | **7** | **1.6%** |
| **Financing Working Capital** | **5** | **1.1%** |
| **Labour** | **11** | **2.5%** |
| **Energy** | **8** | **1.8%** |
| **Packaging** | **114** | **26.2%** |
| **Marketing** | **11** | **2.4%** |
| **Sub Total** | **251** | **57.5%** |
| **Profit Margin** | **186** | **42.5%** |

| **VARIABLES** | |
|---|---|
| **Pulp production/yr** | **2500** |
| **Exchange Rate (FCFA/$)** | **480** |
| **Price FOB ($/MT)** | **910** |
| **Days of operation/yr** | **100** |
| **Shifts** | **3** |
| **Daily labour salary** | **3000** |
| **Labourers/shift** | **30** |
| **Yield/ fruit** | **50%** |
| **Investments** | **393,600,000** |
| **Raw Material Cost/Kg** | **40** |
| **Working Capital needs/mo** | **50,000,000** |
| **Marketing** | **26,400,000** |
| **Interest Rate (Investments)** | **15%** |
| **Interest Rate (Working Capital Ban)** | **12%** |

## Cost analysis

| | Production(Pouches per year) | | 2,36,373 |
|---|---|---|---|
| | Pouch Pulp | % of Retail Price | TOTAL FCFA/YR |
| Retail Price Point( FCF/Pouch) | 100 | 100% | |
| Sebe Nectar | 12.6 | 12.6% | 29,69,720 |
| Pouch | 33.6 | 33.6% | 79,42,118 |
| Cost Sugar Per Pouch | 1.4 | 1.4% | 3,40,377 |
| Depreciation Equipment | 2.7 | 2.7% | 6,32,640 |
| Labour | 0.8 | 0.8% | 1,96,977 |
| Energy | 1.0 | 1.0% | 2,36,373 |
| Marketing | 4.2 | 4.2% | 9,92,765 |
| Distribution | 6.2 | 6.2% | 14,65,510 |
| Factory Mark Up | 5.5 | 5.5% | 13,00,050 |
| TVA | 12.2 | 18.0% | 28,93,775 |
| Sub-Total | 80 | 80% | 1,89,70,305 |
| Retailer Mark Up | 20 | 25% | 47,42,575 |
| Price to Consumer | 100 | 100% | 2,37,12,880 |

Limiting factors for large scale commercialization

1. Access to capital presents a significant challenge to Malian entrepreneurs willing to establish a sebe nectar producing unit. The government's capacity to respond promptly and efficiently, notwithstanding its demonstrated enthusiasm for increased investment, is hampered in areas such as land acquisition and tenure by the lack of a cohesive platform through which to facilitate agricultural investment.
2. Non availability of processing facilities and storage structures.
3. Poor market information about the nectar trade

Target Market /Customer

The sebe nectar market is estimated to grow further and there is a huge potential nectar market in Mali and other West African regions. Since Africa is the only continent which can produce sebe nectar, it should focus on making this geographical advantage its market strength. EU is also geographically located in a way that it can import from Africa. Mali is closer to EU and can be a natural destination for EU imports which account for only 4.7% of the world exports. An upward trend is visible in the nectar demand in EU which could favor Mali's entry into this market.

Social impact of the technology

• The development of the production of this crop has contributed to improving the livelihoods of many farmers and rural dwellers.
• The cultivation of sebe provides an alternative cash crop to cotton, thus reducing widespread rural poverty.
• Sebe nectar production forms the main focus of the poverty reduction strategy – to increase rural incomes and generate employment opportunities.

Any other relevant information

Benefits of Barassus

• Purrs are economically very useful and extensively cultivated in tropical regions. Their fruit can be consumed, cooked or uncooked, green or ripe.
• The sebe sap is known for its medicinal importance. African fan palm roots are used as an anti asthmatic.
• Fruits and young leaves are sometimes browsed as fodder.
• The leaves are used by craftsmen to make many products. The petioles are used as fencing, firewood and the hypocotyls are edible.
• The male flowers are used as soil fertilizers and as fodder. They are considered as excellent fodder and their nutrient content is similar to that of ground nut and cow-pea haulm.
• The bole of the palm is used in carpentry for house and bridge building.
• Its wood is very resistant to termite and fungal attacks and to climate variations.
• The fruit of the Palmyra palm (Borassus aethiopum) can be classified amongst semi-arid zone resources as it is a good source of sugars, vitamin C, provitamin A, minerals and fibers and has valuable water content. Its output in flesh coupled with its biochemical features, make it a candidate for several potential technological transformations in the domain of food science - moderate drying or lyophilization to produce enriched flavor; extraction of the pulp to produce mash or to lace refreshing drinks; fermentation of the juice for the production of wine or vinegar; and finally the treatment of the pulp in order to produce jam and other candy products.

# Sorghum Beer-Kenya

**Name Of institute:**
Sorghum Value Chain Development Consortium

**Stage of development:**
Ready for commercialisation

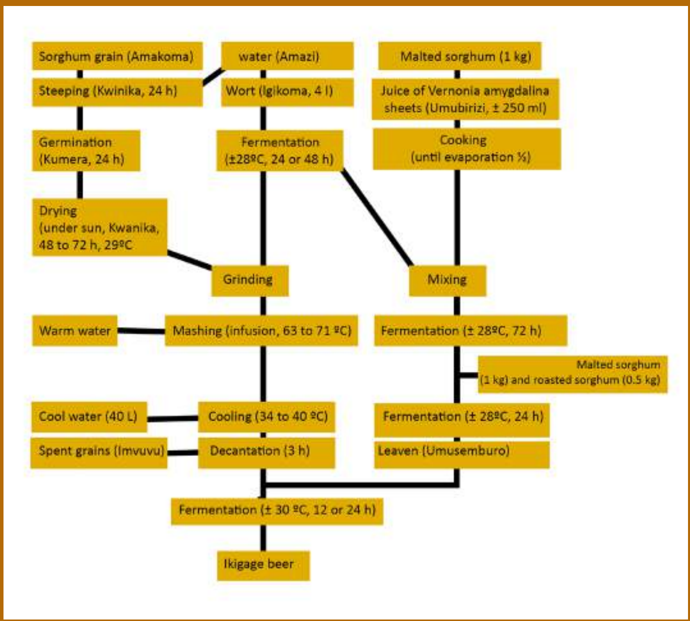
In Africa, sorghum is the major cereal crop used to produce the traditional “opaque” beers. However, only certain sorghum varieties (eg red grain) are used to produce sorghum beers. These beers are known as Ikigage in Rwanda, Tchoukoutou in Benin and Togo, Dolo in Burkina Faso, Pitoor burkutu in Nigeria and Ghana, Amgba in Cameroon, Doro or Chibuku in Zimbabwe, Merissa in Sudan, Mtama in Tanzania, Bili bili in Chad and Kaffir in South Africa.

These beers differ from European (lager) types in that lactic fermentation also occurs during sorghum beer processing. In addition, African traditional sorghum beer is consumed while it is still fermenting, and the drink contains large amounts of fragments of insoluble materials. These fragments are mainly starch residues and dextrins that are not digested during mashing and fermentation. Sorghum beers bear very little resemblance in appearance to the Western beers made with barley.

A variety of yeast and lactic acid bacteria have been found in African sorghum beers, although Saccharomyces cerevisiae and heterofermentative Lactobacillus usually predominate. Traditional African sorghum beers are very rich in calories, B-group vitamins including thiamine, folic acid, riboflavin, and nicotinic acid, and essential amino acids such as lysine. Sorghum beer is consumed at various festivals and African ceremonies (eg, marriage, birth, baptism, the handing over of a dowry, etc) and constitute a source of economic return for the female beer producers. However, in a majority of the African countries, traditional sorghum beers are less attractive than Western beers brewed with barley malt because of their poor hygienic quality, low ethanol content, organoleptic variation and limited shelf life.

## Production Process:-

The manufacturing process of African traditional sorghum beer essentially involves malting, drying, milling, souring, boiling, mashing and alcoholic fermentation, but variations may occur depending on the geographic location. All steps, with the exception of souring, can be compared to traditional beer brewing.




## Background

Sorghum beer has an ancient origin. The first mentions of sorghum beer or millet beer come from the Arab travellers who, in the 6th and 7th centuries, praised the merits of the beer manufactured in the Sahel region, in particular the Merissa beer of Sudan.

Sorghum beer manufacturing is a tradition preserved by African women brewers and passed down from one generation to the next. In the African tradition, sorghum beer symbolizes the woman, representing silence and a tacit acceptance of the “entente” between the peoples. In ancient times, royalties due to the local authorities were paid only in the form of sorghum or sorghum beer. Sorghum beer is an ancestral beverage widely used in various festivals and African ceremonies such as marriage, praying for rain, communication with ancestors, births, the handing-over of a dowry, circumcision, burial ceremonies, and the popular annual sorghum festival.

Traditional sorghum beer is also consumed after community work or meetings of mutual associations, in order to provide energy.
Traditional sorghum beer is mainly consumed by the poorest in society, and contributes significantly to the diet of millions of African people.

## Benefits / Utility

• The nutritional benefits of sorghum may be considered to assess the benefits of sorghum beer. Sorghum principally contains anti-oxidants. High-tannin sorghums, such as those grown and consumed in Africa, are very rich in anti-oxidants. Studies say that the “levels of polyphenolic compounds in the high-tannin sorghum varieties ranged from 23 to 62 mg of polyphenols per gram. For comparison, blueberries contain 5 mg of polyphenolics per gram, while pomegranate juice contains 2 to 3.5 mg per gram”.

• The liquor industry makes a significant contribution to the African economy, not only in terms of its contribution to GDP, but also through its payment of taxes such as company tax, VAT and excise duties, and as a provider of employment, supplier and user of a variety of goods and services, role player in the tourism industry and so forth.

## Financials

### Breakdown of mature Brewers cost

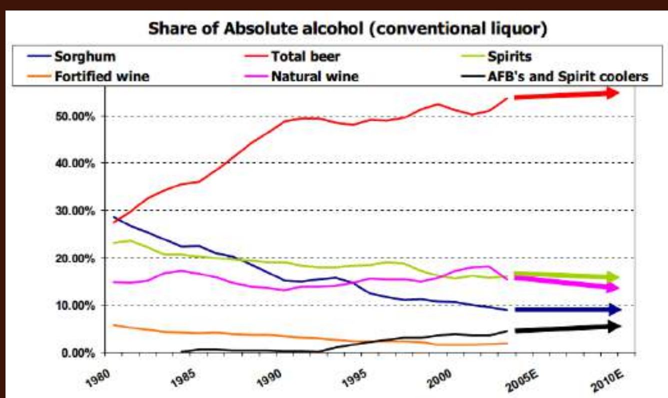
| Main Assumptions: 6,200 hectare of operation per year, with an actual processing capacity of 400,000 hl | | |
|---|---|---|
| ITEM | RATIO (PER HL BEER PRODUCED) | COST ($US/HL BEER PRODUCED) |
| Sorghum Grain | 18kg | 5.00 |
| Hops (Cones) | 0.15kg | 0.50 |
| Yeast (thick) | 0.6litre | 0 |
| Fuel | 150 MJ | 0.70 |
| Electricity | 12 kWh | 1.20 |
| Water | 0.7 m3 | 0.30 |
| Miscellanous Analysis | Lump Sum | 1.30 |
| Labour (120 people) | SD 20,000/ Year | 6.00 |
| TOTAL DIRECT OPERATING COSTS | | 17.30 |
| Source: FAO, UNIDO | | |

Breakdown of mature Brewers cost

| Sales Prices | Total Variable Cost | | Total fixed cost | | Depretion & Maintenance | Intersts | Taxes | Net profit |
|---|---|---|---|---|---|---|---|---|
| 1 | Raw Material | Transport | Selling General &Admin | Salaries | | | | |
| 100% | 28 | 4 | 24 | 24 | 8 | 2 | 4 | 6 |
| Source: The EBRD | | | | | | | | |

The South African brewing industry, for example, uses at least 70,000 metric tons of sorghum per year in the production of sorghum malt. Zimbabwe’s opaque beer industry uses about 17,000 metric tons of sorghum, and the smaller opaque beer industry in Botswana uses about 4,000 metric tons.

The formal sorghum beer industry, which is referred to as “traditional African beer”, is dominated by United National Breweries (SA) (UNB). This Indian-owned company is the successor of National Sorghum Breweries (NSB), and took management control of that company in 1996. In 2000, UNB also took over Traditional Beer Investments, the sorghum division of the then SA Breweries. The company holds a 90% share of the local market, producing around 400 mn liters per annum. However, this performance must be seen in the context of South Africa where more than three quarters of traditional African beer is brewed at home, the rest being industrial production. Also, the size of UNB’s brewing volume (0.4 bn liters) is substantially smaller than that of SABMiller’s South African operations (2.5 bn liters).




Source: SAB, CWSI, SAWIS, Customs and Excise, AC Neilsen
Listed agri-business Kakuzi is set to venture into large-scale growing of sorghum and is targeting clients such as breweries in the region. East African Breweries (EABL) is also stepping up its usage of sorghum as a grain as an alternative to the more expensive barley.

## Scalability

The demand for sorghum in Kenya has increased dramatically following a resolution by East African Breweries Limited to use sorghum to produce one of its beer brands. East African Breweries Limited has projected its demand for sorghum grains for the production of about 30 million metric tons of beer which gives a sense of the demand for sorghum beer.

## Potential investors to this technical innovation

Breweries

## Country Context

Sorghum is mainly used for food and beverage consumption, as malt and sorghum meal. Malt is used to manufacture sorghum beer (traditional African beer). Between 52% and 62% of the total domestic demand is used for malting/brewing. Sorghum meal, also known as "Mabele", competes directly with maize meal and is served as a breakfast cereal or as soured porridge "Ting". Sorghum rice, sometimes called "corn rice", is whole sorghum that has had the outer bran layers removed and is served instead of rice.

In South Africa and Botswana, sorghum malt is used as an important ingredient whereas elsewhere little or no sorghum is used (maize is mainly used) and the beer is more commonly known as opaque beer.

Rwanda has Primus Beer, or Urwagwa, which is a beer made from fermented banana juice and sorghum flour.

A southern Ugandan beer is the Nile Special, produced in and distributed from Jinja. Others are Club, Bell Lager, Eagle the local beer made using sorghum, as well as Guinness and Tusker.

Nigeria produces a version of Guinness Foreign Extra Stout that uses sorghum. A ban on the import of barley malt imposed in 1990 forced brewers to find ways to produce beer with locally available sorghum and maize.

## Target Market /Customer

• Sorghum beer is one of the most popular drinks in South Africa. The table shows a shift in the trend from other types of beer to sorghum beer.

| Consumers reasons for shifting to Eagle beer | Moshi Rural | | Karatu | | Average |
|---|---|---|---|---|---|
| | Response | Percent | Response | Percent | Percent |
| Reasonable price | 13 | 43.3 | 9 | 30.0 | 36.6 |
| Good taste | 11 | 36.7 | 6 | 20.0 | 28.4 |
| Alcoholic content is tolerable | 3 | 10.0 | 7 | 23.3 | 16.6 |
| No hangover in the morning | 2 | 6.7 | 6 | 20.0 | 13.4 |
| Eagle is an appetizer | 0 | 0.0 | 2 | 6.7 | 3.4 |
| Availability | 1 | 3.3 | 0 | 0.0 | 1.6 |
| Total | 30 | 100.0 | 30 | 100.0 | 100.0 |


## Contact

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• Kenya enjoys a well-developed domestic beer industry, based somewhat on imported raw materials. In addition, the country also imports barley malt extract, hops cones and a very small amount of hops extract.

• SABMiller has recently launched a variety of beer based on sorghum targeted towards African markets especially Uganda, Nigeria and South Africa.

• Sorghum beer is considered gluten free and hence is projected as a healthy alternative to beer made from other sources.

## Limiting factors for large scale commercialization

• Traditionally-made sorghum beers have poor keeping quality. The limited shelf life (stability) of sorghum beers has been reported as the major problem confronting commercial brewers in Sudan, Tanzania, Nigeria and Rwanda. Pasteurization is the likely solution to the problem of spoilage but research will be needed to ensure that necessary refinements in the pasteurization process take place.

• The presence of unspecified microorganisms from traditional leaves complicates the control of the fermentation process and yields products of variable quality. Standardization is needed in this sense.

• More importantly, a change in mindset is required to facilitate the adoption of newer techniques as a commercial standard in the brewing process.

• Overall ownership in the beer and spirits sector is highly concentrated, largely due to historical reasons where this was condoned if not actively promoted. Despite various efforts by the government, the industry remains highly concentrated at the product segment level.

## Social impact of the technology

East African Breweries have brought out sorghum beer which has increased the demand for sorghum grain. In an effort to promote the farming of sorghum in the region, international agencies and the Kenyan Government are implementing strategies, that will enable farmers to have easy access to improved quality seed. A high demand from East African Breweries would help millions of Kenyan farmers realize better prices.

# Animal Feed Production-Kenya

Sorghum based animal feed – Lucrative Alternative Animal Feed option

**Name Of institute:**
Sorghum Value Chain Development Consortium

**Stage of development:**
Ready for commercialisation

**Patent status:**
IP filed

Raising livestock and the consumption of animal and animal products make a crucial contribution not only to the economic but also the nutritional wellbeing of millions of people around the world; hence it is important to keep these animals in a healthy condition with proper nutrition. Animal feed is the food given to domesticated animals and is usually of two basic types, fodder and forage. The word "feed" usually refers to fodder. The raw materials and the production process must both be carefully carried out under stringent quality control to maintain the quality of the final output. Ingredients used in animal feed include cereals, cereal by-products, proteins (from either vegetable or animals sources), co-products from human food manufacture, minerals, vitamins and feed additives.

Sorghum grain is an effective source of starch for dairy cattle. Starch is the primary energy source in dairy cow diets when the objective of feeding is to attain high levels of milk production. Optimum utilization of starch in the rumen is a primary concern for improving milk yield and efficiency of production. Feed produced using this technology is used as an alternative to maize in marginal areas with limited input and its adoption should be encouraged to increase food security, open up business opportunities and improve livelihoods. Use of sorghum grain as animal feed reduces the cost of livestock production to a great extent. It also offers the perfect solution to meet the problem of inadequate feed during dry and other seasons as it is obtained from sorghum which is a drought tolerant crop. This technology is the best and most viable option for the utilization of sorghum grain. By educating farmers on the utilization of this technology the market value of sorghum can be increased and farmers.

The process of sorghum based animal feed production includes the agrarian processes of land preparation, sowing seeds, fertilizing, weeding and harvesting the final crop. The grains have to be processed before being fed to cattle to remove the unpalatable bran which could cause digestive problems. Grinding is the simplest and least expensive method of preparing sorghum grain for cattle; however it is non-mechanised and may be difficult to carry out for large quantities. Automated methods include dry-rolling, steam-rolling, flaking and popping. All methods produce end products with different degrees of digestibility.

The production of virtually all sorghum feeds first involves milling of the grain. Sorghum milling generally involves two operations:
1) Debranning
2) Reducing the endosperm into a meal or flour

The process of converting sorghum grain into an animal feed also leads to the production of some other easily transportable products by which farmers are able to earn valuable additional income.

## Background

Animals contribute largely to household incomes and food security, as draught animals and through milk production. What is fed to animals can have large implications on human health due to the food chain and thus can eventually affect human health as well. A wide range of raw materials are allowed in the manufacture of animal feed and can range from plant sources (grains, molasses, oil seeds) to animal sources (dairy products, marine by-products, animal waste) to synthetic sources.

The population of animals is increasing with each passing day resulting in a higher demand for feed. Corn which is usually used for feeding purposes is expensive for small-scale farmers. This technology provides the option of replacing corn in animal diets with sorghum based feed which is similar to corn feed in nutrient composition.

Production of animal feed from sorghum involves processing which plays an important role. Processing of sorghum grain by grinding, rolling or steam flaking is necessary to disrupt the protein matrix surrounding the starch granules and to disorganize the starch granules. A greater disruption of the protein matrix and starch granules results from steam-flaking as compared to the other methods. This is because it combines moisture, pressure and heat in a consistent process, which renders a greater proportion of the starch available to the animals. Steam-flaking may increase the energy value of sorghum by as much as 20 percent. This additional energy can be utilized for greater milk production or in the case of late-lactation cows, reduce the amount of grain required in the diet. Increasing utilization of sorghum for feed purposes provides important income to poor dry-land farmers.

## Benefits / Utility

1. This technology helps farmers save on the cost of livestock production. The lower cost is likely to be the result of reduced seed costs and the ability to grow sorghum on much less water.

2. Grain use for animal feed is a dynamic element in the stimulation of global sorghum consumption. The demand for sorghum for use as animal feed has been the main driving force in raising global production and international trade.

3. This technology plays an important role in the semiarid tropics where the availability of concentrates is limited.

## Country Context

Sorghum is used for two distinct purposes: human food and animal feed. Consumption of sorghum as animal feed has more than doubled, from 30 to 60 percent, since the early 1960s. The average production of sorghum in Kenya in the year 2011 was 109,414 mt. The total sorghum consumption is about 81,000 mt of which 10% goes to the animal feed industry.
Approximately 290,000 mt of grain is used annually by animal feed manufacturers in African countries like Tanzania. Of this grain, 60% (about 172,000 mt per year) is used for the production of poultry feed, 30% (87,000 mt) for dairy feed, and 10% (31,000 mt) is used for pig feed. The total grain feed demand stands at around 5,000 mt per month or 60,000 mt per year. Most of this is believed to be used for chicken feed.

| Country | As animal feed | Average production |
|---|---|---|
| South Africa | 16,200 t | 250,000t |
| Nigeria | 25,000 t | 7,500,000t |
| Zimbabwe | 1,800 t | 100,000t |
| Tanzania | 750,000 t | 290,000 t |

## Scalability

Sorghum is a globally cultivated cereal, and is a major crop grown in the semi-arid and arid regions of Africa. It can be used as fuel, feed and as food. KARI together with the Ministry of Agriculture has developed better varieties that can be used as animal feed.
Studies have proved that sorghum can easily replace corn in the diet of animals. Sorghum feed can be an effective source of starch for dairy cattle. Starch is the primary energy source in dairy cow diets, when the purpose of feeding is to attain high levels of milk production. Scientists at the International Livestock Research Institute have shown that the feed quality of combined bagasse and stripped leaves from several sorghum hybrids is similar to that of premium stover from grain sorghum. Such combination feed is nutritious and readily digestible and cattle trials have demonstrated that palatability (feed intake) is also high.
In Kenya, the use of sorghum based feed reduces the cost of livestock production. In the case of poultry also, it was found that sorghum and corn feed are similar in nutrient composition.

## Business and Commercial Potential

- The world feed production is fast approaching an estimated 1 billion mt annually. The global commercial feed production gives an estimated annual turnover of over US$370 billion. Commercial production or sale of manufactured feed products not only provides employment to more than a quarter of a million skilled workers, technicians, managers and professionals, but also provides the necessary foreign exchange.
- According to the estimates of the UN Food and Agricultural Organisation (FAO) the world requirement will grow by 60% in 2050 with a doubling of meats from all origins and dairy, and a tripling of the fish requirement. This growth will require a proportional growth of the livestock industry as well.
- Nigeria is the second largest producer of sorghum, with most of the domestic production used for household consumption and fodder, apart from the traditional uses of human consumption. Africa itself is the highest consumer of sorghum followed by Asia and other developing nations.
- The business partnership with East African Breweries Limited (EABL) has led to a growth in the demand for sorghum. EABL has a requirement of 50,000 mt of sorghum and therefore requires commensurate production.
- The Sorghum Value Chain Development Consortium (SVCDC) is working with multiple stakeholders in order to commercialize new varieties of sorghum hybrids which are suitable specifically for feed production. It has also encouraged contract farming in the African continent.

## Contact - I


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### Limiting factors for large scale commercialization

• In Kenya, the problem of continued poor yields season after season has remained a paradoxical challenge, considering the significance of the crop for household food security and its unexploited potential in industrial uses.
• Farmers' preference for their own saved seed is very rigid and hence there is low adoption of improved seed varieties.
• Access to land was also identified as a major constraint of producers in Amhara and Tigray regions. Most farmers are not able to cultivate forage due to the scarcity of land.
• Weak skills and lack of technical assistance are a major drawback. Consumption is impeded by the inability of the industry to effectively serve the market at a widely affordable price.

### Potential investors to this technical innovation

a) Small-scale farmers
b) Small and medium-scale feed manufacturers
c) Farmers' cooperatives
d) Milk cooperatives
e) Student entrepreneurs
f) Large scale feed industries

### Financials

The capacity to produce animal feed is 2 mt per hour ie, 6,000 mt per year.
The machinery required are dry roller, grinder, steam flaker, pelletizer etc.

| Sl No | Items | Amount in USD |
|---|---|---|
| 1 | Capital cost | |
| | Machineries | 83333 |
| | Accessories including bins, conveyors, packing machineries etc) | 25000 |
| | Total capital cost | 108333 |
| 2 | Working capital | 0 |
| | Raw material | 25000 |
| | Man power cost | 23333 |
| | Packing material | 6667 |
| | Electricity and miscellaneous | 4167 |
| | Total Operational cost | 59167 |
| | Total cost | 167500 |
| Net profit @ USD 20 per mt | | 120000 |

### Target Market / Customer

• The world production of sorghum is directed towards two main sources – one for consumption by humans and the other towards consumption by livestock. Grain sorghum is the most important cereal crop grown in Africa with animal feeding as a major objective and it is the fifth most important cereal crop grown in the world.

• About 48 percent of world sorghum grain production is fed to livestock (human food use constitutes about 42 percent). While the human consumption of sorghum remains relatively stable, the consumption for animal feed is dynamic and depends on two factors: the income, which directly affects livestock consumption and the economics of animal feeds other than sorghum.

• The demand for animal feed is concentrated in the developed countries and in middle-income countries in Latin America and Asia, where the demand for meat is high and the livestock industry is correspondingly intensive. Three countries (the United States, Mexico and Japan) together absorb nearly 70 percent of the world's total animal feed.

• Livestock production is increasing in African countries like Zambia and this could act as a potential market for sorghum based animal feed.

• The increasing cost of corn in Africa could also lead to a higher replacement of corn with sorghum while producing animal feed.

### Social impact of the technology

Sorghum based animal feed production technology could be a boon for small and medium-scale farmers in arid and semiarid regions of Africa who primarily grow sorghum. Production of sorghum based animal feed will help them realize additional incomes and prepare their own feed for the cattle.

Large scale commercialization of this technology has led to the creation of a critical mass of trained sorghum producers, equipped for better management of sorghum enterprises, risks and farmer groups. It has also led to enhanced access to credit, which previously was out of reach for such cereal crops.

# Improved Sorghum Crop Varieties/ Hybrids-Kenya

## Improved Varieties of Sorghum – Answer to the Food Crisis

**Name Of institute:**
Sorghum Value Chain Development Consortium

**Stage of development:**
Ready for commercialisation

**Patent status:**
Not Applicable

Sorghum (Sorghum bicolor L. Moench) is the first self-pollinated cereal staple crop. Sorghum is the second most important cereal crop in Africa. It is grown in the harsh semi-arid tropics of Africa where inadequate rainfall and lack of irrigation make production of other cereal crops difficult to sustain. A general impression is that research to improve sorghum has lagged worldwide because it is not grown as a food crop in the developed world. In Africa, it is considered a 'poor man's crop.' In the past decade or two, therefore, activities of international research organizations such as ICRISAT and INTSORMIL-CRSP, have increased in the region and have been a major source of research support to African NARSs attempting to improve sorghum-based technologies.

Although heterosis (the improved or increased function of any biological quality in a hybrid offspring) was demonstrated as early as 1927 in sorghum (Conner and Karper 1927), its commercial exploitation was possible only after the discovery of a stable and heritable cytoplasmic-nuclear male-sterility (CMS) mechanism (Stephens and Holland 1954). This CMS system has been designated as A1 (Milo). Since then a large number of hybrids have been developed and released/marketed for commercial cultivation in Asia, the Americas, Australia and Africa. The hybrids have contributed significantly to increased grain and forage yields in several countries. The Kenya Agricultural Research Institute (KARI) has introduced many improved varieties and hybrids of sorghum. Special characteristics of these varieties/hybrids make them unique and suitable for varied commercial activities.

## Improved sorghum varieties of KARI and their special characteristics
## Species: Sorghum bicolour

| Variety name/code | Official Release Name | Owner(s) / Licensee | Maintainer | Optimal production altitude range (Masl) | Duration to maturity (months) | Grain (G)and/ or Forage(F) yield (t ha-1 ) | Special attributes |
|---|---|---|---|---|---|---|---|
| 1 Seredo | Seredo , | KARI/KSC | KARI/KSC | 250-1750 | 4 | 2.7 (G) | Wide adaptability, |
| 2. Serena | Serena | KARI/KSC | KARI/KSC | 250-1750 | 3 | 2.7 (G) | Wide adoptability, |
| 3. BJ28 | BJ28 | KARI | KARI-Lanet | 1750-2300 | 7 | 2.5-3.0 (G) | Dual purpose, |
| 4. 2K x 17 | 2K x 17 | KARI/KSC | KARI/KSC | 250-1500 | 3 | 2.5 (G) | Hard endosperm Dehulled to make a rice like product, |
| 5. IS76 | IS76 | KARI/KSC | KARI/KSC | 250-1500 | 3 | 2-3 (G) | Semi hard endosperm |
| 6. IS8595 | IS8595 | KARI | KARIKatu-mani | 250-1800 | 3 | 2.7 (G) | Grain covered by glum, Low bird damage |
| 7. Gadam | 1994 | KARI | KARI | 0-1500 | 3 | 2-2.5 (G) | Specially adapted to coastal and semi-arid lowlands, suit-able for brewing |
| 8. Ikinyaluka | Ikinyaluka | KARI | KARI Ka-kamega | 1750-2300 | 7 | 8 (F) | High quality forage |
| 9. IS 8193 | IS 8193 | KARI | KARI | 500-1600 | 4 | 2.5 (G) | Resistant to bird damage |
| 10. Kat/PRO I | Kat/PRO I | KARI/KSC | KARI/KSC | 1000-1700 – | - | - | |
| 11. KARIMta-ma-1 | KARI Mtama-1 | KARI | KARIKatu-mani | 250-1800 | 3-3.5 | 3.4 (G) | Tolerant to stem borer |
| 12. E1291 | E1291 | KARI | KARI-LANET | 1750-2300 | 7 | 2.7 (G) 2.7 (F) | Dual purpose Good beverage quality |
| 13. E 6518 | E 6518 | KARI | KARI-LANET | 1750-2300 | 8 | 3.4 (G) 7.2 (F) | High quality |
| 14. Sila | Sila | AgriSeedCo Ltd | SEEDCO Zambia | 250-1800 | 3-3 | .5 2-4 (G), 4(F) | Dual Purpose |
| 15. KARI 16 Mtama 2 | KARI 16 | KARI | KARI | 500-1200 | 3.5 | 3.5 | Resistant to birds |
| 16. legio | Mtama 2 | KARI | KARI | 1000-2000 | 4 | 4.5 | High yield |
| 17.Kaburu | legio | KARI | KARI-Ka-kamega | 500-1500 | 3.5 | 4 | High yield |
| 18. Kariash2 | Kaburu | KARI | KARI-Lanet | 1500-2000 | 5.5 | 4(G),8 (F) | Dual purpose, tolerant to rust and cold |
| 19. LDT 090 | Kariash2 | LELDET | LELDET | 1500-1800 | 4-5 | 3-4 | Wide adaptability |
| 20. P9518Ax-ICRS92074 | Kibuyu | KARI | KARI-Katu-mani | 900-1800 | 3-3.5 | 2-4 | Hybrid sorghum, 15% brix |
| 21. Ken-Sorgh2 | Hyibrid Mta-ma-1(KSBH-01) Ks-Sorg2 | Kenya seed Co | Kenya seed Co | 250-1750 | 2.5-3.5 | 2.0-3.0 | High milling , tolerant to ergot |


Contact - I

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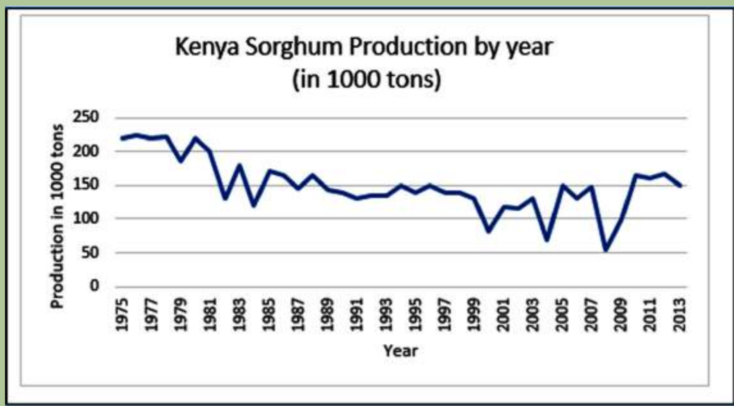
## Background

Sorghum is grown as a rainfed crop in diverse environments across tropical and sub-tropical agro ecologies in Africa, from the extreme lowland arid and semi-arid zones (of Libya, Sahel of West Africa and Botswana) to the sub-humid and humid lowlands (of southern Guinea Savanna of West Africa) and the mid highlands (of the Great Lakes Zone of East Africa). The semi-arid and sub-humid highlands are typified by the highlands of Ethiopia, Eastern and Central Africa (ECA) and Lesotho (where sorghum is cultivated around Mokhotbug at an altitude of 2400 m).

Sorghum breeding began in the late 1930s replacing traditional farmer selection activities. This led to the identification, selection and release of better landraces as “improved local selections”. At the same time, exotic germplasm lines were introduced, adapted and tested. Between 1948 and 1960, useful cultivars, local varieties and exotic germplasm lines were used in hybridization programs and initiated pedigree and bulk breeding programs.

Population development and its improvement through recurrent selection were possible with the availability of genetic male-sterility. Greater prominence was given to wide adaptation and increased productivity. Between 1930 and 1950, a multilateral collaboration in Eastern Africa involving Kenya, Uganda and Tanzania began (Doggett 1988). In the late 1970s, a regional approach to sorghum breeding was the Joint Project 31 of the Organization of African Unity/Scientific Technical and Research Commission (OAU/STRC) on Semi-Arid Food Grain Research and Development in Africa (SAFGRAD), which was initiated in 1976. Subsequently, regional sorghum breeding began at different periods in three regions - East and Central Africa (ECA), South African Development Community (SADC) and West and Central Africa (WCA). These regional breeding programs were set up with the objective of tackling different production constraints specific to different regions.

Sorghum Production in Kenya has dwindled over the years as depicted in the graph below.




This trend of decreasing production and increasing demand for sorghum grain have necessitated improved breeding programs and the introduction of high yielding varieties.

## Benefits / Utility

- The major objectives of sorghum improvement research at KARI have been to develop improved varieties that would be useful for developing hybrids for wider adaptation in Kenya and other African countries
- Introduction of improved varieties will ensure better yields
- The specific needs of the industry can be met by growing special varieties. For instance KARI has introduced the hybrid Mtama-1(KSBH-01) which could be used by breweries.

## Business and commercial potential

The demand for sorghum in Kenya has shot up dramatically following the decision by East Africa Breweries Limited (EABL) to use the produce for the manufacture of one of its beer brands.

Although the demand for the Gadam sorghum variety of KARI has now hit 32 million metric tons, the supply is very poor. East African Breweries Limited in partnership with KARI has come out with a program for large scale production of brewery-suitable sorghum varieties which will benefit around 25,000 farm families. Thus the improved varieties and hybrids to be commercialized by SVCDC have greater importance in contributing to the rising industrial demand.

Farmers, on an average, produced about 3.0 t ha-1 hybrid seed to obtain a profit of about Rs. 29,500 ($630). Between 1994–2002 seed production earned farmers, on an average, $30,6000 per annum

| Operations | Quantity | Unit Price ($) | USD$ |
|---|---|---|---|
| Ploughing | 1 ha | | 31.09 |
| Harrowing | 1 ha | | 15.54 |
| Ridging | 1 ha | | 15.54 |
| Seed | 8 kg | 0.62 | 4.97 |
| Planting | 5 man-days | 3.11 | 15.54 |
| First weeding/thinning | 20 man-days | 3.11 | 62.17 |
| Cost of fertilizer | 4 bags | 34.19 | 136.77 |
| Fertilizer application | 10 man-days | 3.11 | 31.09 |
| Harvesting | 10 man-days | 3.11 | 31.09 |
| Threshing | 20 man-days | 2.49 | 49.74 |
| Bags & labour for handling | 20 bags | 0.50 | 9.95 |
| Sub-total | | | 403.48 |
| Gross revenue per hectare | 2000 kg | 0.28 | 559.53 |
| Production costs per hectare | | | 403.48 |
| Gross margin | | | 156.05 |
| Benefit/cost ratio | | | 1.39 |
| Production costs per kg | | | 0.20 |
| Source: USAID, 2009 | Source: USAID, 2009 | Source: USAID, 2009 | Source: USAID, 2009 |

## Potential investors to this technical innovation

- Seed companies
- Breweries
- Farmers cooperatives
- Animal Feed manufacturers
- NGOs

## Target Market /Customer

Sorghum will remain a key food security crop in Africa for the foreseeable future. Productivity gains are essential to offset the prospects of continuing food production shortfalls in most semi-arid regions and the prospects of periodic famine in some. This in turn requires greater investment in technology development and dissemination.
Productivity gains will translate into income growth as farmers either shift land to more remunerative cash crops or target sorghum production for the commercial market. Since most sorghum is still grown by poorer small-scale farmers, investments in research and extension will contribute directly to poverty alleviation. Furthermore, in most middle and higher-income countries, sorghum will remain important as a feed grain uniquely suited to commercial production in hot, dry and drought-prone regions.
Sorghum is the fifth most important cereal crop and is the dietary staple of more than 500 million people in 30 countries. It is grown on 40 million ha in 105 countries of Africa, Asia, Oceania and the Americas. The USA, India, México, Nigeria, Sudan and Ethiopia are the major producers. Other sorghum producing countries include Australia, Brazil, Argentina, China, Burkina Faso, Mali, Egypt, Niger, Tanzania, Chad and Cameroon.

## Limiting factors for large scale commercialization

The prospects for greater sorghum trade are constrained by the variability in production levels and high costs of collection and transport from outlying production areas.

• A number of improved varieties have been developed, but dissemination has been poor, especially in Kenya, because of inadequacies in seed production and extension support.

## Social impact of the technology

Sorghum has the potential to produce grain containing high levels of iron (more than 70 ppm) and zinc (more than 50 ppm). Hence sorghum biofortification (genetic enhancement) of iron (Fe) and zinc (Zn) content of the grain, is targeted to complement other methods to reduce micronutrient malnutrition globally.

The hybrid parents developed at ICRISAT's African locations have good potential for developing hybrids adapted to regional production environments. Apart from hybrid parents, sharing appropriate genetic material for conducting strategic research and the information on strategic research findings have helped enhance the sorghum improvement efficiency at both ICRISAT and NARS.

There is an increase in yield when the hybrid version is adopted over the traditional method. Overall in West and Central Africa, an 80% improvement in productivity was seen from the early 1970s (700 kg/ha) to 2009 (1260 kg/ha). So if gross revenue per hectare is US$0.28 as per the USAID, 2009 financials above, then with the increase in yield the farmer will earn an additional US$156.80.

## Any other relevant information

• The most important biotic constraint for the production of sorghum in sub-Saharan Africa is probably Striga hermonthica. Striga currently affects an estimated 8 million hectares in Africa - almost 40 percent of the total sorghum area - and annual yield losses are estimated to be worth over US$90 million.
• Many new sorghum cultivars were introduced in the early 1970s as combinable, high-yielding cultivars (eg Dabar-1 and Gadam Elhamam-47; see Nichola and Sanders, 1996).
• Five basic races of cultivated sorghum - Bicolor, Kafir, Guinea, Caudatum and Durra - are recognized (Harlan and de Wet 1972). The Bicolor race is characterized by open inflorescences and long, clasping glumes that usually enclose the grain at maturity.
• Sorghum is a C4 plant with an excellent daily growth rate and biomass.
• Normally, sorghum grain is ground or pounded after the pigmented pericarp is removed. The flour is used to make porridge, bread or beer.
• Both the grain and stalk of sorghum have vast potential for industrial utilization. The technology to produce sugar, alcohol, starch, semolina and malt products from sorghum grain, is now available.

# Bioethanol from Sweet Sorghum-Kenya

Sweet sorghum – the sweet answer to world fuel crisis

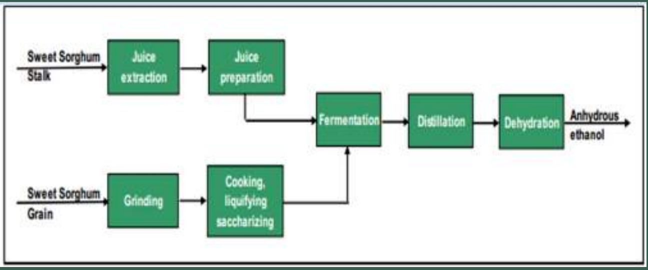
**Name Of institute:**
Sorghum Value Chain Development Consortium

**Stage of development:**
Ready for commercialisation

**Patent status:**
Non IP technology

The stock of conventional fuels is fast depleting and the World is left with no choice but to turn to the other options that are available. The consumption of bioethanol as a biofuel may reduce greenhouse gases as well as gasoline imports. It can also be replaced with lead or MTBE (Methyl tert-butyl ether) that are air and underground water pollutants, respectively. Plants are the best choice for meeting the projected bioethanol demands. Sweet sorghum [Sorghum bicolor (L.) Moench] is a special purpose sorghum with a sugar-rich stalk, almost like sugarcane. Besides having a rapid rate of growth, high sugar accumulation, and biomass production potential, sweet sorghum has wide adaptability to almost all climate types. Sweet sorghum can be grown with less irrigation and rainfall and purchased inputs than sugarcane. The sugar content in the juice extracted from sweet sorghum varies from 16–23% Brix (grams per milliliter of water). The silage after extraction of juice from sweet sorghum can be used for co-generation of power.

The technology for the production of bioethanol from various feedstocks has been tested and established. The process generally involves extraction of juice through crushing of plant stock, juice purification, fermentation, distillation and dehydration. This is identical to the technology used by distillery plants that produce ethanol for beverage companies and industrial users.




The process of production of bioethanol from sweet sorghum as illustrated above is:

1) Extraction of the Juice: The juice is extracted using a series of mills. This juice is first screened, sterilized at 100°C and then clarified. The step of juice purification is an optional step where the juice is purified to a higher degree.

2) Fermentation of the Juice: The juice so obtained in the above steps is fermented by the yeast Saccharomyces cerevisiae to convert it into alcohol. By-products like glycerol, aldehydes and ketones are obtained at this step.

3) Distillation of the Juice: The alcohol obtained from the fermented mash is concentrated up to 95% v/v. When there are several process columns in series the crude alcohol is purified to obtain the final product of the desired quality.

4) Dehydration: This process is used to obtain anhydrous alcohol. The final water content is reduced to about 0.05% wt using this process.

## Background

The, fossil energy resource in the World is reducing with each passing year and it is therefore important to find a substitute for it. There are many crops that can be used to produce energy. Sweet sorghum for example, not only produces food, but also energy (Reddy et al. 2005), feed and fiber.

Sorghum can be classified into sweet, grain and forage types. Sweet sorghum like grain sorghum produces grain in the range of 3 - 7 t/ha.

But the essence of sweet sorghum comes not from its seed, but from its stalk, which has a high sugar content. In general, the stalk produced is in the range of 54 - 69 tonnes/ha. The sugar content in the juice of sweet sorghum varies in different varieties. The Brix range in different varieties of sweet sorghum is 14.32 - 22.85%. Besides having a rapid growth rate, high sugar accumulation, and biomass production potential, sweet sorghum has wider adaptability. It is also well adapted to sub-tropical and temperate regions of the World and it is water efficient.

Sweet sorghum has many good characteristics such as drought resistance, waterlogging tolerance, salinity resistance and a high yield of biomass. In addition, sweet sorghum is a C4 crop with high photosynthetic efficiency. Thus development of sweet sorghum will play an important role in promoting the development of agricultural production, livestock husbandry, energy sources (biofuel), refining sugar, paper making etc.

The main product of the sweet sorghum bioethanol distillery is anhydrous alcohol which is 99.3% ethanol by volume and has a maximum water content of 0.05%. The alcohol can be blended with gasoline at 5% and 10% levels.

## Benefits / Utility

• Consumption of bioethanol as biofuel may reduce greenhouse gases and gasoline imports.

• 1 liter of bio-ethanol saves 2.2 Kg CO2.

• Production of ethanol from sweet sorghum will not only save an enormous amount of foreign exchange but will also reduce pollution and provide cleaner air for a constantly growing population.

• Use of bioethanol fuel is expected to encourage capital investment, create additional employment and livelihood activities especially in rural areas and promote economic development in the country.

## Country Context

West African countries produce sorghum in large quantities. These countries can reduce their dependency on oil imports for their energy needs. Overall, the African continent stands to benefit from additional jobs created, foreign exchange savings and a cleaner environment with the promotion of ethanol as fuel. The success of a biofuel program however is dependent on the country's access to a cheap and reliable feedstock. Sweet sorghum promises to provide a cheap and reliable source of bioethanol and should be promoted aggressively by the government if its biofuels program is to succeed.

## Scalability

| | Sweet Sorghum |
|---|---|
| Crop duration | 4 months |
| Water requirement | 4000 m3 |
| Ethanol Source | Juice Grain Stillage |
| Ethanol yield (kl ha-1) | 3.16 |
| Cost of cultivation (US$ ha-1) | 258 |
| Feedstock cost | 81.6 |

Based on bioethanol per hectare.

Source: Sweet Sorghum Bioethanol Technology, ICRISAT Report, 2007

| Requirements | Units |
|---|---|
| Ethanol day-1 (kl) | 35-40 |
| SS stalks required day-1 (t) | 800-875 |
| Stalks required for 105 days (t) per season | 84000 - 91875 |
| Area required (rainy season) ha | 2300-2600 |
| Area required (postrainy season) ha | 3700-4200 |
| Total sweet sorghum area required (ha) | 6000-6800 |
| No. of small farmers1 to be involved | 3000-3400 |

Source: Sweet Sorghum Bioethanol Technology, ICRISAT Report, 2007

The land deals in Africa affected are between 51,415,000 and 63,111,000 hectares. If only 10% of this is converted for cultivation – amount of ethanol produced would be between 1,627,057 kl/hectare – 1997185 kl/hectare.

## Business and Commercial Potential

Global fuel ethanol production has more than tripled between 1980 and 2000. The World's total production of bioethanol increased to 46 billion liters in 2005 and may reach 75 billion liters by 2015. Some countries such as Brazil and US started their biofuel programs very early on while and other countries are now trying to catch up and are looking seriously at investing in biofuel production. Some countries in fact have passed laws to attract investments. Biofuels feature strongly in scenarios predicting future energy supplies because they can be produced wherever plants grow, they are not intermittent and can supply liquid fuels to the transport sector without major modifications to the existing infrastructure. Sweet sorghum can be used to supply both electricity and liquid fuels (ie, ethanol) and recent agronomic and industrial trials in Europe, Asia and Africa have demonstrated its productive potential. The potential for the production of bioenergy in southern Africa using sweet sorghum is an important target.

USA is the world leader in terms of bioethanol production followed by Brazil and certain European countries. Brazil has a large number of cars customized to run on bioethanol and can be a major market for future growth. The governments of several developed and developing countries are now looking for potential replacements for fossil fuels for which bio-ethanol from sorghum could be a perfect match.

Comparison of sweet sorghum with other plant yields and prices:

| FEEDSTOCK | PRICE/MT ($US) | | LITER/ HECTARE/ YEAR | FEEDSTOCK/LITRE | |
|---|---|---|---|---|---|
| | MIN | MAX | | MIN | MAX |
| Sugar-cane | 76 | 84 | 6,120 | 13.89 | 15.28 |
| Molasses | 343 | 411 | 806 | 19.06 | 22.62 |
| Cassava | 115 | 442 | 5,549 | 8.38 | 32.40 |
| Sweet Sorghum | | | | 13.98 | 15.67 |
| Stalk | 42 | 46 | 5,625 | 12.22 | 13.33 |
| Grain | 457 | 533 | 2,513 | 17.91 | 20.90 |

Sources: GAIN Report on RP sugar industry

## Target Market /Customer

The demand for Ethanol has been increasing drastically in recent times as it is being blended with automotive fuels, which is desirable for emission of clean exhaust and for fuel sufficiency. The high cost of cultivation of sugarcane/beets, highly sensitive molasses rates, and instability in the price of ethanol have created grounds to search for an alternative source for ethanol production. Sweet sorghum has shown potential as a raw material for fuel-grade ethanol production due to its rapid growth rate and early maturity, greater water use efficiency, limited fertilizer requirement, high total value, and wide adaptability. Ethanol-producing companies, research institutions, and governments can coordinate with farmers to strategically develop value-added utilization of sweet sorghum. Fuel-grade ethanol production from sweet sorghum syrup can significantly reduce Africa's dependence on foreign oil and also minimize the environmental threat caused by fossil fuels.

There is great potential for using sweet sorghum as a source of feedstock for ethanol production given its high productivity and low production cost. Sweet sorghum is a cheaper and more reliable source of feedstock and bioethanol fuel for consumers. Being a short-cycle crop, it allows distilleries and farmers to quickly respond to the demands of the market. Furthermore, blending ethanol into gasoline has been shown to improve mileage and reduce toxic emissions and ethanol blended gasoline retails at a lower price than unleaded gasoline. With the greater predictability of production and supply of sweet sorghum, refineries, and hence the consumers, can be assured of a steady supply of cheap, gasoline-improving bioethanol. In addition, it can sequester carbon dioxide better than other crops and can be traded in the market. The feedstock cost for the distillery for sweet sorghum is low. With hybridization, crop productivity is expected to improve and bring down the cost of feedstock. Hence, while distillery investors can earn reasonable rates of return using the sweet sorghum OPV's as feedstock, they can look forward to improved incomes as new varieties are developed.

In terms of bioethanol productivity, ie, the ethanol yield per ton of feedstock, sweet sorghum is the most productive with a production of 425 liters/ha (50 liters/ton from stalks and 375 liters/ton from grains).

## Potential investors to this technical innovation

1. Sorghum Breweries
2. Biofuel companies

## Financials

| A. Yield | Assumptions |
|---|---|
| from stalks | 66.67% |
| from grains | 33.33% |
| ethanol production | 55 li/MT |
| water effluents | 13 li/liter of ethanol |
| ethanol | In final form Bioethanol as per PNS DOE 008 |
| By-Products | |
| CO2 | 95.90% of ethanol production (MT basis) |
| Carbon credits | sold at US $5/MT |
| Organic fertilizer | Sold at Php 0.25/li |
| B. The Distillery | Assumptions |
| | 10 years life span |
| Components of a multi-feedstock | Batch type fermentation and distillation unit, Liquefaction and saccharification unit with molecular sieve, Sugarcane milling unit |

## Breakeven Analysis of selling price conditions for a 40 KLD distillery plant:

| PARTICULARS | FIGURES (IN $US) |
|---|---|
| Total Sales ($US) | 3,05,35,009 |
| Total Cost of Raw Materials | 1,72,53,731 |
| Total Operating Expense | 39,52,062 |
| Income Before Interest and Tax | 78,86,272 |
| Income Before Tax | 78,86,272 |
| Tax | 26,81,332 |
| Net Income | 52,04,940 |

SENSITIVITY ANALYSIS:

| FINANCIAL | BASE CASE SCENARIO |
|---|---|
| Annual Income | 48,56,838 |
| NPV | 50,69,991 |
| IRR | 21 % |
| Payback Period (Years) | 9 |

Source:International Society for Southeast Asian Agricultural Sciences Report.

## Limiting factors for large scale commercialization

• The success of a biofuel program depends on three factors, namely - government policies and support, availability of the processing technology and sustainability of the feedstock supply. As long as the government does not help in the process, little development can take place.
• As with grain sorghum, various pests and diseases, as well as abiotic constraints, limit production of sweet sorghum which can then be converted to biofuel.
• The use of sweet sorghum as a food crop is in direct competition with its use as a fuel, thus dividing resource utilization.
• Production of biofuels from raw materials requires energy and has environmental consequences
• The process for usage of bioethanol can be technically challenging. It is not a petroleum-based fuel, so it will operate differently in engines designed for petroleum-based fuel. Conversion from one fuel to the other, in some cases, requires a range of new injectors, gaskets and fuel lines.

## Social impact of the technology

The yield of bioethanol from sweet sorghum is comparable to that of sugar cane and better than that of cassava. It is a short duration crop which can be grown for two cycles a year and can serve as a secondary crop for rice in rainfed rice growing areas. Furthermore, the input requirement such as fertilizers and irrigation water is low. It also provides substantial returns to farmers given the fact that they are able to sell both the grains and the stalks. Sweet sorghum ensures both food and energy security and a clean environment creating a win-win situation for both the farmer and the industry.
Bioethanol from sorghum empowers the dryland poor to benefit from emerging bio-energy opportunities. It ensures both food and energy security. It helps provide greater smallholder incomes and sustainable environments.

Production of bioethanol in the continent of Africa, will make the countries reeling under economic strain self sufficient. Reduction of dependence on exports and oil cartels worldwide will only help benefit the economies of all the nations.

## Any other relevant information

• Sweet sorghum juice does not require the long fermentation and cooking time that is needed to process corn ethanol.
• Some of the sorghum crop residue left after juice extraction (called bagasse) can be dried and burned to fuel ethanol distillation. These residues can also be used for animal feed, paper manufacture, or fuel pellets.
• Sorghum only needs 12-15 inches of rain during the growing season to make a crop. Therefore, it is suitable for dry land production or limited irrigation. If the crop receives more moisture, it will respond positively.
• The crop does not have to be grown on a farmer's best land, as it is able grow on poorer ground.
• The simplicity of ethanol production from sweet sorghum could lend itself to on-farm or small-cooperative efforts at fuel-making.

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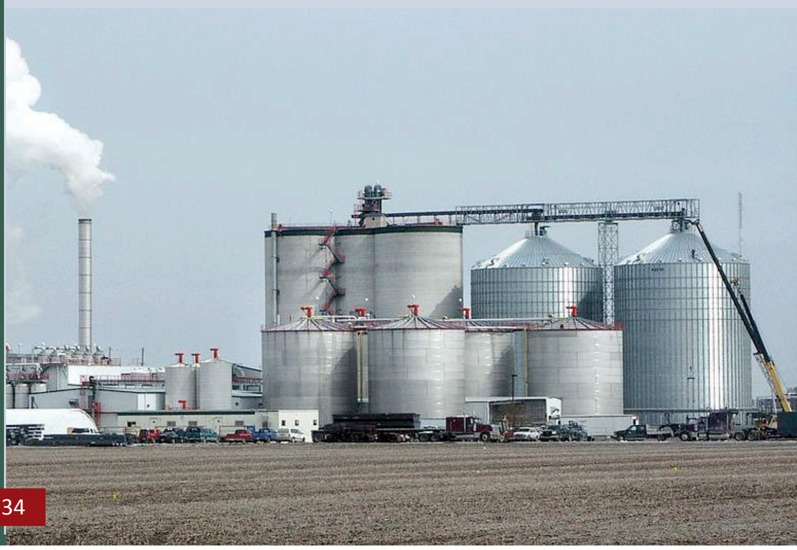

# Natural Coffee Sweetener Stevia-Uganda

## Wonder sweetener for your coffee

**Name Of institute:**
CURAD

**Stage of development:**
Ready for commercialisation

**Patent status:**
No IP protection

The genus Stevia which is native to subtropical and tropical regions from western North America to South America is a cluster of 240 plants belonging to the sunflower family (Asteraceae). The species Stevia rebaudiana is commonly grown for its sweet leaves that produce steviol glycosides (stevioside and rebaudioside A) which act as a sweetener and sugar substitute. The taste of stevia stays around for much longer and the glycosides are 30-300 times sweeter than sugar itself depending on the extent to which the leaves are processed. The leaves of the plant are an ideal sugar substitute for weight-watchers who are conscious of their sugar and carbohydrate intake. Glycosides have zero calories and are being recognized as a great replacement for sugar and other sweeteners.

The global market for non-sugar sweeteners in 2011 was at about $9.2 billion and is expected to rise at a compound annual growth rate (CAGR) of 1.1% and reach nearly $9.9 billion by 2016. The global market for artificial sweeteners is predicted to reach US$1.5 billion by the year 2015. The demand for artificial sweeteners is only expected to grow with the increase in the population of diabetic patients, cardio-vascular diseases, and health-conscious people concerned about an increasing waistline.

Growing stevia in a country like Uganda is a good backyard gardening activity for every household. Adoption of this technology is a perfect way to reduce the household consumption of sugar. Stevia could prove to be a great economically revolutionary crop for the farming community. It is a good crop to promote resilience from pest infestation and being a short term crop, it is a good candidate to strengthen climate change adaptation to mitigate its adverse impacts in agriculture. It can generate phenomenally high revenue and returns if cultivated systematically and correctly.

## Background

Stevia is a plant which requires short-day conditions with 11 to 13 hours being optimum. Long-days delay flowering and increase stevioside accumulation in the leaves. The leaves of the plant are oval or elliptic, lanceolate, small, simple, have a toothed edge or margin, sometimes occur in whorls, and are somewhat hairy. The stevia leaf is commercially the most important part of the plant since it contains the highest content of sweetener.
Growing stevia in Uganda is a promising activity as the market may shoot up due to the increased demand for natural foods. This technology is expected to help raise the income of farmers in Kenya and other countries.
The component glycosides of particular interest for the sweetening property of stevia leaf are stevioside and rebaudioside A. In terms of weight fraction, the four major steviol glycosides found in the tissue of the stevia plant are:

| Component | Content |
|---|---|
| Stevioside | 5–10% - (250–300X of sugar) |
| Rebaudioside A | 2–4% - most sweet (350–450X of sugar) and least bitter |
| Rebaudioside C | 1–2% |
| Dulcoside A | ½–1% |

## Benefits / Utility

1. The stevia extract is said to be 300 times sweeter than sugar. It has low carbohydrates and has almost no effect at all on blood glucose, making it an ideal sugar replacement for people with health problems like diabetes and obesity.

2. It is economically feasible to use compared to the normal ‘sweetener standard cost’, which is that of cane sugar (sucrose). That is, it can offer cost-savings compared to the use of sucrose.

3. It is attractive to ‘Marketing’, as it is ‘as natural as cane sugar’ in that it is obtained from plant extracts and is not a synthetic molecule.

4. Stevia leaves help regulate blood sugar; hence stevia extract is an ideal substitute to table sugar for people with diabetes or hypoglycemia. Stevia does not elevate one’s blood glucose and keeps its level within a safe range.

5. Stevia helps prevent cavities. Stevia prevents the formation of tooth decays by inhibiting bacterial growth inside the mouth. Companies that are into the dental care product manufacturing business have been considering the use of stevia extract in their products.

6. Stevia has health-promoting anti-oxidants like apiganin and kaempferol. These antioxidants in stevia extract help in combating free radicals that can cause cancer, and prevent colds and viral infections.

7. Antibacterial and antifungal properties have also been observed in stevia.

## Country Context

Stevia was first introduced in Uganda as a cash crop. Many farmers are now growing stevia due to the extensive work carried out by the company M/s Pure Circle. In Kenya, most of it is grown for export and the markets include China, Paraguay and Malaysia.

Stevia does not interfere with food security as only a small section of the land is used. Uganda and Kenya are expected to grow as future hubs to supply Europe, the Middle East and Africa, since they provide ideal growing conditions for proprietary varieties of Stevia.

## Scalability

Stevia has huge market potential for manufacturers of sweeteners and beverages as well as in the food industry etc. Stevia may prove to be profitable for small-scale growers who are willing to develop or cultivate a market through local farmers’ markets, other direct markets, or through the wholesale market to smaller distributors. Growers promoting an organically grown product could have a marketing edge. Manufacturers can achieve scalability due to its following benefits:

- Reliable, high purity
- Economic pricing - allows for cost efficiencies
- Scalable supply - available in large quantities to satisfy the global demand
- Produced through a sustainable supply chain
- Viable complement to other natural sweeteners - product formulation that is both natural and has reduced calories

## Business and Commercial Potential

The global market for stevia sweeteners is around $500 million currently and could easily reach around $10 billion with the US FDA and GRAS approval of rebaudioside A - one of the glycosides of stevia. Ever since the stevia extract, Rebaudioside A (Reb-A), received GRAS approval by the US Food and Drug Administration (FDA) on 17 December 2008 and the approval of the European Commission on 2 December 2011, food and beverage companies have gone into a frenzy to be the first to release their very own stevia based products. The Coca-Cola Company alone uses stevia sweeteners in more than 25 products worldwide either just by itself or, in combination with other sweeteners such as fruit juice, sugar and other low- and no-calorie sweeteners. Stevia was first introduced in the drink ‘Sprite’ as a sweetener and reduced its calorific value by 30%. The major market buyers of stevia are multinationals like Kraft, Coca-Cola, Unilever, Pepsi, Starbucks, Danone, Lipton, and Nestle with products like juices, yogurts, salad dressings, baked goods, table top sugar substitutes, carbonated soft drinks, mineral enriched water, flavored water, energy drinks etc. The demand is high and ever growing and stevia is slowly capturing a large international market


## Potential investors to this technical innovation

A. Small-, medium- and large-scale farmers
B. NGO’s
C. Development agencies
D. Student entrepreneurs
E. Farmers’ Cooperatives

## Financials

Initial investments include land preparation, purchase of seed or transplants, and installation of an irrigation system. Additional costs for a minor niche crop like stevia may include product and market development, advertising and consumer education. It has been noticed that the major costs are the field rent ($833) and the starter transplants ($1333). From this point, to reduce production costs it is suggested that focus be laid on producing stevia in newly reclaimed lands which will lead to a reduction in rent cost from 50% to 30%. Also a system for producing stevia seedlings (nurseries) to use as starter transplants could be adopted to reduce starter material costs by more than 50%. One more advantage of cultivating stevia in newly reclaimed lands is that it facilitates the easy use of mechanization and the setting up of modified irrigation systems and agriculture practices suitable for stevia.

| | YEAR 1 | YEAR 2 | YEAR 3 | YEAR 4 | TOTAL |
|---|---|---|---|---|---|
| TOTAL COST OF PRODUCTION/ YEAR (USD) | 3061.667 | 2611.667 | 2611.667 | 2611.667 | 10896.67 |
| AVERAGE PRODUCTION (TON)/YEAR | 2 | 2 | 2 | 2 | 8 |
| INTERNATIONAL PRICE (USD)/TON | 2000 | 2000 | 2000 | 2000 | 2000 |
| TOTAL INCOME | 4000 | 4000 | 4000 | 4000 | 16000 |
| NET PROFIT | 9833.333 | 1388.333 | 1388.333 | 1388.333 | 5103.333 |
| % OF PROFIT | 30.61 | 53.1 | 53.1 | 53.1 | 46.8 |

## Target Customer/ Market

Uganda and Kenya are the major producers of stevia in Africa and non-governmental organizations have slowly promoted the crop in other parts of the Rift Valley as a healthy product and also for export. Stevia powder is light and can be transported easily and hence, can be used anywhere in the formulation of various products. Stevia is available for use as both an additive and a dietary supplement in the countries of Canada, USA (rebaudioside A), the European Union and Indonesia. Statistics indicate that in some countries stevioside-like sweetness products account for up to 30 % of the sugar that is consumed.


## Contact - I

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Stevia produced in Uganda and neighboring countries could be processed and exported to the EU, USA and South East Asian countries. Uganda and neighboring countries could be processed and exported to EU, USA and South East Asian countries.

## Limiting factors for large scale commercialization

1. As the plant cannot tolerate drought, frequent irrigation is required. This increases the cost of irrigation which may not be affordable for small scale-farmers.

2. A stevia plant that has wilted, won't recover after watering and probably has soggy, rotting roots. This happens as a result of poor drainage and/or over watering. Fungal disease can be a problem too, in high humidity areas. To prevent this, overhead watering should be avoided and the plant should be harvested at the first signs of disease.

## Social impact of the technology

• Adoption of this technology helps the farmers to improve their livelihoods because they get an added income without having to compromise on growing other crops.

• This technology also aids the youth in the generation of modest income and helps reduce the rate of crime and the tendency to get drunk.

## Target Market / Customer

• Stevia is a natural antioxidant with many purported health benefits.

• Stevia can help reduce high blood pressure.

• Two tablespoons of stevia leaf powder is equivalent to one cup of sugar.

• One of the three known enzymes that have significant anti-oxidant activity, superoxide dismutase (SOD), is present in stevia. Cancerous cells have a deficiency or a complete lack of this enzyme. If you supplement your diet with stevia you will be helping your body avoid or manage cancer because anti-oxidants take care of free radicals and help stop or reduce cell mutation into the first stages of cancer.

## Any other relevant information

Stevia processing

The commercial process followed for stevia production is as follows:

1) Stevia leaves have the highest content of steviosides and are hence used specifically for the extraction of Steviol glycosides.

2) Water Extraction:

Leaves from different varieties of stevia plants are used for stevioside and rebaudioside A production. The stevia leaves are first dissolved in water and the solution so obtained is filtered. Ferric chloride and calcium hydroxide are added to the extract solution to facilitate precipitation. The extract solution is subjected to plate filtration followed by adsorption onto a resin; the glycosides are subsequently eluted with ethanol. The solution is decoloured with active carbon and concentrated with film evaporators. It is then decoloured again with active carbon and filtered. The concentrate is spray dried to obtain the primary stevia extracts rich in stevioside or Rebaudioside A.

3) Purification:

The extracts obtained from the first extraction are impure and need to be further processed in order to obtain high purity stevioside and rebaudioside A which have a greater sugar content. The higher the degree of processing the greater the sugar content that is attained.

## Stevia Extraction and purification process

- Purified water — Dried leaves
- Purified water & Ethanol — Infusion / filtration
- Adsorption/desorption
- Discoloration
- Liquid Concentration
- Purified water & Ethanol — Spray Drying
- Crystallization
- Centrifugation
- Spray Drying
- Packing and labeling

# Tea nursery

## Multiplication of clean and disease free tea planting materials

### Tea Multiplication Technology-Uganda

Name Of institute: CURAD

Stage of development: Ready for commercialisation

Patent status: IP not filed

### Background

Tea as a cash crop was introduced in Uganda over 100 years ago (1901). But it has not been grown in Northern Uganda since then despite the favourable climate and soil conditions. CURAD through its incubatee, have developed a program to grow some of the world's best tea in northern Uganda. Tea is one of the single best cancer fighters know. Young plants are raised from cuttings obtained from a mother bush and they are carefully tendered in special nursery beds until

Uganda is the third leading producer and exporter of tea in Africa (45,000MT) after Kenya (295,000MT) and Malawi (55,000MT) (MAAIF, 2010) but tea produced in Uganda is of a medium quality tea primarily used in blends with premium quality teas, such as those from Kenya.

Tea being an important export product, the Government of Uganda considers it as one key area through which the country's export earnings could be boosted. During the last decade, Uganda tea exports have been growing steadily by more than 40 percent from 30,477 ton in 2001 to 53,178 ton in 2010

Tea is now the third foreign exchange earner after coffee and fish and is one of the crops under the strategic export program. The tea value chain in Uganda, generally similar to tea value chains in other countries, is characterized by many producers but few downstream players. About 70 per cent of Uganda's tea is sold through auction in Mombasa, and 20 per cent through direct

Although tea growing has been in the country for some time, it has not been introduced in northern Uganda due to the instability in the region. However, currently there is peace in the region and a number of people have settled.

### Benefits / Utility

- This technology helps in the production tea planting materials.
- Creation of job opportunities along the tea value chain.


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# Essential oils

## Rose Geranium and Lemon Balm production

Production and extraction of oil technology – Uganda

Name Of institute: CURAD

Stage of development: Ready for commercialisation

Patent status: IP not filed


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### Background

Essential oils are very crucial in cosmetic industry. They are on high demand locally and internationally. An essential oil is a concentrated hydrophobic liquid containing volatile aroma compounds from plants. Essential oils are also known as volatile oils. Oil is "essential" in the sense that it contains the characteristic fragrance of the plant that it is taken from.

Essential oils are generally extracted by distillation. They are used in making pharmaceutical, perfumes, cosmetics, soaps and flavouring food and drink, adding scents to increase household cleaning products.

Essential oils have been used medicinally in history. Medical applications proposed by those who sell medicinal oils range from skin treatments to remedies for cancer and often are based solely on historical accounts of use of essential oils for these purposes.

CURAD in through its incubatee plan to establish 14 acres of essential oil garden in 5 phases;

Phase 1: establishment of mother gardens
Phase 2: establishment of nursery bed
Phase 3: establishment of first main garden
Phase 4: extraction of oil
Phase 5: marketing of the product.

# Agro-Industrial By-Products (AIBPs)

## Based Diets for Pigs-Ghana

Putting Agricultural By-Products to Good Use

**Name Of institute:**
CCLEAr AgriBusiness Incubator (CCLEAr)

**Stage of development:**
Technology ready for commercialisation

**Patent status:**
No IP protection

Pigs have been described as one of the most prolific and fast growing livestock species that can convert food waste to valuable products (Vicente et al. 2011). Pig production has been recommended as an alternative source of cheap, high quality dietary protein for the escalating human population. Pig production in the humid tropics is constrained by seasonal feed deficits and the high cost and erratic supply of feed ingredients. Technology on formulating Agro-Industrial By-Products (AIBP) - based diets is developed at the CSIR-Animal Research Institute. The use of agro-industrial by-products (AIBPs) is being exploited in pig feeding as a measure for sustainable livestock production and development. Although, some of the AIBPs may be nutritionally inferior to conventional feedstuffs, Preston and Leng (1987) suggested that livestock systems in developing countries should be matched with available feed resources in a way that aims at economic optimization rather than biological maximization.

## Production Process:-

Complete replacement of maize in formulated pig diets with AIBPs: Some of the AIBPs and non-conventional feed resources used for pigs in Ghana are given in the table below

| | |
|---|---|
| Brewers Spent grains (wet/dried) | Mucuna (raw, cooked, processed) |
| Cassava (foliage, peels and tuber) | Oil palm sludge |
| Citrus pulp | Palm kernel meal |
| Cocoa pod husk | Pawpaw peels and foliage |
| Copra cake | Rice bran |
| Groundnut cake | Rubber seed meal |
| Groundnut skins | Sheanut cake |
| Maize bran | Sorghum or Guinea corn |
| Mango kernel meal | Watermelon rind |
| Molasses (fresh/dried) | Wheat bran/offal |
| Source : Okai (2010) | |

Production process for AIBPs based pig feed

Production process for AIBPs-based pig feed

Storage and Selection of Raw Material

Weighing and grinding of the selected Raw Material

Mixing of the dry ingredients and addition of liquids

Pelleting of the mixed feed (optional )

Bagging, storage and dispatch of blended feed

## Background

Livestock production in Ghana has been severely constrained by the lack of feed of good quality and consistency. The condition is very grave for pigs which mostly depend on maize and fishmeal as the major sources of energy and protein. Maize-based diets are found to be uneconomical for pig production. The main constraint in pig production in Ghana is the inadequacy of feed arising from the unpredictable availability and high cost of cereals. Earlier studies on AIBPs in the country had indicated their potential to feed pigs.

An AIBP can be used as a source of one nutrient but it may be deficient in others. This hurdle could be overcome by combining several AIBPs to complement each other in diets. AIBPs which abound in the country offer potential alternatives as sources of nutrients for pigs. There is an increasing demand for agro-industrial by-products, with the aim of intensifying animal production to meet the increasing demand generated by growing populations and urbanization. Amongst agro-industrial by-products, there is a need to discern and use those generated from industrial processing (cotton, groundnut, soybean, wheat, rice and sugar cane) and those generated by small-scale processing (major local cereals: millets, sorghum and maize).

## Benefits / Utility

- High economy of gain and return on investment.
- The AIBP-based diet reduces the number of days as well as the feed cost of raising pigs to slaughter.
- It is a well-balanced grower-finisher diet for weaned pigs which can be used until they attain market weight.
- This diet, apart from being cheaper than other commercial diets, increases growth rate and achieves slaughter weight faster (at least by 50%) than the current methods used by most farmers.
- The fact that animal feed is produced at a high cost, mainly due to the elevated cost of maize, makes poultry and pig production very expensive, constituting 60 to 75% of the total cost of production. Due to the high cost, many farmers, particularly pig producers are shifting towards using agro-industrial by-products.
- Agricultural by-products are important sources of high-energy or high-protein feedstuffs and therefore can make a substantial contribution to feed supplies, particularly during the dry season when crop residues and natural pastures are scarce

## Country Context

Pig farming and animal husbandry is a large subsidiary occupation in the continent of Africa. While there is a general consensus that the lack of reliable and adequate feed resources imposes a major technical constraint on increasing livestock output in Sub-Saharan Africa, considerable quantities of agricultural by-products, particularly molasses, oilcakes and fishmeal are being exported or wasted.

Since agro-industrial by-products are being produced locally and within the West African sub-region in sizeable quantities, this feed resource could be fully utilized to reduce the cost of feed and also curb the problem of environmental pollution that accompanies its disposal. In the northern Savannah zones, pito mash, a by-product of millet brewing, forms the bulk of pig rations, while wheat bran is the mainstay of most commercial pig units in the forest and Savannah zones.

Cassava peels, maize bran and many other agro- industrial by-products of Ghana can be used to produce high nutrient pig feed. It would be a reasonably good economic feed for both ruminant and monogastric feeding.

## Scalability

The major constraint on pig production in Ghana has been the provision of adequate nutrition. Attention has been provided to agro-industrial based products (AIBPs) as a potential solution to the problem of feeding pigs. Prices of some of the few AIBPs already in use are escalating by the day due to intense demand. Others already evaluated but not in widespread use have to be properly packaged for adoption. Many experiments in Sub-Saharan Africa show that some form of mixed ration (roughage, oilcakes, and molasses) could increase the productivity of local breeds. This suggests that the introduction of exotic breeds is not a prerequisite for increasing livestock output in Sub-Saharan Africa. Therefore, improved feeding strategies which include agro-byproducts together with crop residues and natural pastures should allow greater technical efficiency to be achieved in Ghana's livestock sector.

Potential investors to this technical innovation

1. Individual pig farmers
2. Commercial piggery units
3. NGOs
4. Pig farmers cooperatives
5. Student entrepreneurs
6. Rural unemployed youth
7. Feed manufacturers

## Contact

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## Business and Commercial Potential

Traditionally, Europe, together with Japan and the United States, have been the major export destinations of African agro-industrial products. Among the ten leading importers are seven countries from the European Union

| | Importing country | 2000 | 2008 |
|---|---|---|---|
| 1 | France | 22.5 | 18.5 |
| 2 | Italy | 11.7 | 13.1 |
| 3 | United Kingdom | 10.1 | 6.8 |
| 4 | United States | 8.6 | 5.5 |
| 5 | Spain | 7.7 | 11.2 |
| 6 | Germany | 6.7 | 4.6 |
| 7 | South Africa | 4.5 | 2.8 |
| 8 | Netherlands | 3.2 | 3.4 |
| 9 | Belgium | 3.1 | 2.3 |
| 10 | Japan | 2.5 | 1.0 |
| | Sum of above | 80.6 | 69.3 |

Date Source : UN Comtrade, author's calculations

These huge quantities of AIBPs could be used for the production and sale of Pig feed.
Cassava (Manihot esculenta) is one of the main staple food crops grown by almost all farming families in Ghana, and accounts for a large proportion of the daily calorie intake of the population. The use of cassava peels and tubers as pig feed in Ghana could reduce the high cost of feed and increase livestock production. Several studies conducted in West Africa showed that cassava in its different forms has great potential as pig feed. In countries like Ghana where livestock production is largely constrained by the lack of good quality feed, the availability of alternate sources of feed like cassava is important.
Animal feed is produced at a high cost, that is, between 60 and 75% of the total cost of production, mainly due to the elevated cost of maize. This makes poultry and pig production very expensive. However the but also on the ratio of their prices. Such ratios, due to transport costs, national policies and differences in the balance between domestic supply and demand vary greatly between countries. For some African countries like Ghana it makes economic sense to use by-products as animal feed, to increase domestic livestock production. economic viability of feeds supplemented with AIBPs depends not only on the technical relations between feed input and livestock product

## Financials

The fixed capital cost on the initial fixed assets is estimated as follows (IN US$):

| | |
|---|---|
| Land and Building | 66,000 |
| Plant and Machinery | 16,700 |
| Furniture and Fixture | 1,155 |
| Vehicles | 10,717 |
| Pre Operating Expenses | 660 |
| Erection and Installation (5% of total machinery cost) | 833 |
| FIXED ASSETS | 96065 |

**Working Capital:**

| | |
|---|---|
| First Three Months Salaries | 2,226 |
| Admin and Marketing expenses | 1,195 |
| Inventories raw material | 73,590 |
| Misc expenses | 660 |
| Cash balance required | 2,475 |
| TOTAL | 80,146 |

The following Overheads are assumed to occur in the first year of production:

| | |
|---|---|
| Admin and Marketing salaries | 5,771 |
| Travel and conveyance | 742 |
| Utilities | 3,463 |
| Misc Expenses | 66 |
| TOTAL | 10,042 |

The product is anticipated to sell as detailed in the table below:

| PRODUCT | ANNUAL QUANTITY | RATE | AMOUNT (IN US$) |
|---|---|---|---|
| Animal Compound Feed | 4,800 Ton | 165 | 7,91,472 |
| Urea Molasses Block | 60,000 Blocks | 0.82 | 49,467 |
| TOTAL | | | 8,40,939 |

FINANCIAL SUMMARY:

| | |
|---|---|
| Sales | 8,24,450 |
| Gross Profit Margin | 18% |
| Net Profit Margin | 14% |
| Internal Rate of Return | 24% |
| Net Present Value (14%) | 24,511 |

Source: UNIDO

## Target Market / Customer

Pig farmers, feed millers and processors of agricultural produce are the main target customers for the Agro-Industrial By-product Diet for pigs. Attention is now being focussed on the use of AIBPs as an energy source in livestock feeding as alternatives to maize, which is relatively expensive. This is particularly so with pig farmers.

Many of the feeds are common to most countries and variations in nutritive value are normal and attributable to location specific differences. Demonstration of effective utilization in one country can enable application in another without recourse to expensive duplication or repetition of previous effort.

An initiative in Kampala shows the potential of waste products to make pig feeding affordable and to create employment opportunities along the supply chain. The idea to test banana-bran as pig feed arose from the observation that free-roaming pigs eat banana leaves thrown away by humans. At present, a local business has been set up with a feed mill that buys banana peels from local urban collectors. The banana peel bran that is produced is replacing maize bran which has increased in price in recent years, and is leading to an overall reduced price of pig feed with dietary characteristics similar to that of feed supplemented with maize bran.

## Limiting factors for large scale commercialization

• One major setback affecting the poultry and livestock enterprise is the preservation and storage of feed ingredients.
• A major constraint to the use of cassava products and by-products for livestock feeding in Ghana is the problem of obtaining sufficient amounts especially for large herds. Quiet often, the by-products are not produced in sufficiently large quantities at accessible spots for easy collection, to feed livestock on a large scale. At present, they can only be used by small-scale livestock farmers.
• Difficult access to available supplies and to marketing channels.
• Lack of legislation on their trade and use
•Extensive fluctuations in supply.

## Social impact of the technology

Ghana produces agricultural by-products which include Cassava peels and tuber, Brewers Dried Grains (BDG) and cotton seed in large quantities that have to be disposed. This low cost pig feed manufacturing technology could be a boon for the Government as it provides a way to dispose the accumulating waste.

Unemployed youth can involve themselves in producing this low cost pig feed and turn themselves into entrepreneurs.

Pigs provide income for women, strengthening their role in families as well as in local communities. The sick and disabled can participate in pig raising as it does not require excessive labor and is not too complex in its management. The low start-up costs and small investments required for buildings and equipment are recovered fairly quickly as slaughter can take place at about six to eight months from farrowing (birth), depending on the breed and the availability of feed. Pigs additionally can be considered as a store of wealth and a safety net in times of crisis. The feed requirements of such small piggery units could be met through this technology. Women entrepreneurs could also take up feed manufacturing as a new venture. Accumulation of Agro by-products for feed production also generates employment.

## Any other relevant information

• It is possible to exclude cereals, like maize, completely from the diets of all categories of pigs if adequately supplemented AIBPs could be packaged into economically feasible diets for pigs. The AIBPs evaluated have been shown to be potential sources of nutrients for high pig performance. The constraints associated with feeding pigs in Ghana could be removed using locally available AIBPs.

# ARIBRO Poultry Breed Technology
## Ghana

ARIBRO – Ghana's very own Poultry stock

**Name Of institute:**
CCLEAr AgriBusiness Incubator (CCLEAr)

**Stage of development:**
Technology ready for commercialisation

**Patent status:**
Non IP technology

The Animal Research Institute (ARI), of the CSIR, Ghana has introduced a new breed of chicken ARIBRO broilers, in order to reduce Africa's – especially Ghana's dependence on imported breeding stock. ARIBRO is a new breed of chicken that is well-adapted to local environmental conditions. The technology was developed to reduce the high cost of importing day-old chicks, broiler hatching eggs, and broiler parent stock. Fast growth, higher life span and adaptability to harsh local environmental conditions as compared to the foreign breeds are some of the characteristics of the ARIBRO breed. It took ARI about 30 years to develop the ARIBRO breed.

The ARIBRO breed, which has some of the features of the foreign broilers was created when certain poultry with specific genes were selected and made to mate. The ARIBRO breed is already on the market and the ARI at the moment produces about 2,300 ARIBRO chicks a week for the market. The ARIBRO Nucleus population of broiler parents have been developed as a renewable, sustainable source of day old chicks. Two traits were targeted in the development of this breed - growth rate and mortality. Advantage was also taken of correlated traits such as low fat deposition.

### Production Process:-

When recommended husbandry practices were followed, the ARIBRO birds had less than 2% mortality, as they were accustomed to the Ghanaian environment. The husbandry practices were not markedly different from those already practised: for one to three weeks the birds were given starter feed, followed by developer feed for two weeks, and finally finisher until sold.

## Background

The near collapse of Ghana's poultry industry was the most important motivating factor behind the development of the ARIBRO broiler chicks. Ghana's overreliance on foreign hatcheries contributed to high input and production, the nation's inability to compete in the poultry industry, and resultant losses in foreign exchange. The country's Veterinary Services Directorate estimated that about 220,000 hatching eggs and 1.5 million day-old chicks were imported into Ghana in 2008 (GNA 2009). The industry in Ghana could not stand the stiff competition from imported broiler meat.

Development activities in the poultry industry had virtually ceased and the hatcheries which kept parental stocks began importing commercial hatching eggs or day old chicks. This was a major set-back and as such, very expensive to the industry.

In 2009, the Animal Research Institute developed a nucleus breeding population as a source of parental and commercial chicks to contribute towards the revamping of the broiler industry in Ghana. The project also envisioned the possibility of exploiting the huge day old chick market existent in the West African sub-region. The outcome of the project is the new poultry breed (ARIBRO broilers) developed by the Animal Research Institute (ARI) of the CSIR.

## Benefits / Utility

- The breed was developed to reduce the high cost of importing day-old chicks, broiler hatching eggs, and broiler parent stock.
- Farmers have an advantage of acquiring relatively cheaper sources of day old chicks.
- Due to the impressive growth rate of the chicks, they are able to attain a high final body weight which attracts higher prices.
- It is now possible to produce 'parent lines' which hitherto would have been imported at a minimum of €3 per parent chick.
- ABRIBRO is acclimatized to African climate conditions and thus has a higher rate of survival than imported poultry.
- It helps reduce the dependence of African countries on imports and makes them self-sufficient in broiler production

## Scalability

Commercial poultry production in Ghana can be categorized into large-scale (over 10,000 birds), medium-scale (5,000-10,000 birds) and small-scale (50-5,000) enterprises. Currently there are less than twenty large-scale commercial poultry operators, producing mainly eggs with limited production of broilers (meat). Broiler birds produced by some commercial poultry farmers are targeted at festive seasons (Christmas, Easter), when Ghanaians would normally buy live chickens. Most of the poultry producers also sell off spent layer chickens during these festive occasions. The large commercial poultry farms are privately owned by individuals or a family. Most operate their own feed-mills. Some maintain a hatchery and a parent stock.

The supply of broilers in 2011/2012 was about 10% of the total market demand according to the Government of Ghana (GOG) and industry sources. According to industry sources, only 10,000 MT of broiler chickens (meat) and 12,400 MT of spent layers (meat) are supplied by domestic poultry producers. This is primarily due to the high cost of production (feed, drugs), inefficient production methods, limited knowledge of modern poultry management, and lack of processing facilities. Other constraints include high energy prices which continue to increase production costs by over 60%. The price of domestic broiler meat in the domestic market is thus not competitive. Imported poultry products tend to be 30-40% cheaper than locally produced chicken. However the GOG has continued to support the local poultry industry by removing customs duties on poultry inputs (feed, additives, drugs and vaccines) and facilitating improved access to veterinary services. Production of ARIBRO can remove Ghana's dependence on imported broiler chicks.

## Country Context

Poultry, including chickens, turkeys, guinea fowl and ducks have been produced and consumed in Ghana for many generations. Free roaming poultry are ubiquitous in rural areas; chicken is an essential part of 'traditional' dishes such as light soup, and for many people a chicken is the heart of Christmas and other festival meals. Chickens still play a role in the ritual lives of some people and places. Ghana was earlier heavily dependent on imports for meeting its requirement of poultry and this was causing great losses not only to poultry breeders but also to the country in terms of foreign revenue. Understanding the need for a local breed, the Animal Research Institute (ARI) of the CSIR developed the ARIBRO breed of chicken for the poultry industry in Ghana which had thus far been hugely dependent on imported day-old chicks, broiler hatching eggs, and broiler parent stock. The ARIBRO broiler launched in 2009, was well-adapted to the local environmental conditions and made it possible to produce day-old chicks domestically at a lower cost than the imported breeds. The ARIBRO broiler was made by combining and mating specific genes selected from foreign broilers.

## Business and Commercial Potential

Commercial farmers have patronized the technology since the year 2009. Broilers produced from ARIBRO day old chicks are of high quality in terms of leanness and tenderness. There are strong prospects for the sale of this technology in the West African sub region. Some poultry farmers from Togo have purchased ARIBRO day old chicks. There is also the possibility of out-grower programs for interested poultry farmers.

The principal scientist produced a list of poultry farms that have used ARIBRO chicks: Tako Farms, JB Farms, Adom Farms, MP Farm, and Friends City Farms, as well as the ARI Credit Union (ARICUS) farm. The ARICUS farm is owned jointly by ARI and the credit union, each with a 50% share. The discussion with informants suggested that farmers are willing to buy the chicks if they are made available, but to date the supply of birds has been limited. ARICUS farmers explained that they took three batches of 300 chicks and recorded a 100% survival rate.

ARIBRO broilers are able to withstand gumboro, a devastating disease which affects poultry birds even when vaccination is delayed by about a week. They were also reported to be less susceptible to paralysis. Compared to other stocks, which might have one paralyzed bird out of every 100 birds, the ARIBRO records only 5–10 paralyzed birds out of every 500. Though growth rate is dependent upon the feed used, the farmers claimed that ARIBRO broilers also grow faster than imported breeds. ARIBRO broilers exhibit outstanding feed efficiency and are expected to reach 3 kg in about eight weeks; however, they appear capable of reaching that weight in just six weeks.

Additionally, adoption of ARIBRO broilers remains constrained since production and supply of the breed remain strictly within the domain of ARI. ARI reports that, similar to all breeds, the ARIBRO broiler undergoes annual selective breeding and that they were able to produce about 2,300 chicks a week for the market. If the institute were to receive greater assistance from the government, however, it could produce even more (GNA 2009). Until the production and supply of the ARIBRO broiler is commercialized, the market demand will not be met. The number of hatcheries is insufficient, and the ARIBRO parent stock is aging. It should be noted that the project is in the process of acquiring its own hatchery, and with control over a nucleus population, production of day-old chicks can be expanded if the demand continues to increase. CCLEAr AgriBusiness Incubator is committed to commercialize this unique broiler breed in Ghana through its entrepreneurs.


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### Potential investors to this technical innovation

A. Individual poultry farmers
B. Commercial broiler units
C. Hatcheries
D. Broiler meat producing companies
E. NGOs
F. Poultry farmers' cooperatives
G. Student entrepreneurs
H. Rural unemployed youth

### Financials

The development of the ARIBRO parent lines made it possible to produce day-old chicks domestically at a lower cost than those produced by imported parent lines. In 2009, parent lines cost a minimum of three euros (equivalent to 4.29 USD) per parent chick (GNA 2009). ARIBRO chicks were sold at GHC 1.6 (1.10 USD) compared to imported chicks which were sold at GHC 2.2 (1.52 USD) - a saving of GHC 0.6 (0.41 USD) per bird for farmers.

Basis and Presumptions: Capacity: 1 lakh chicks per year

(i) Working hours/shift: 8 hrs
(ii) No. of shift/day: 1
(iii) Working days: 300
(iv) Total number of working hrs: 2400 hrs.
(v) Working efficiency: 75%
(vi) Time period for achieving maximum: 3 years capacity utilization
(vii) Margin Money: 25% of capital investment.
(viii) Rate of interest on working capital: 15% P.A.
(ix) Rate of interest on fixed capital: 15% P.A.
(x) Operative period of the project: 10 years
(xi) Value of machinery and equipment: Taken on the basis of a particular supplier of machinery & equipment

### FINANCIAL ASPECTS:

#### A. Fixed Capital:

| LAND AND BUILDING | AMOUNTS (IN $US) |
|---|---|
| 1) Land 20000 sq.ft | 11,540 |
| 2) Land Development | 1,923 |
| 3) Built Up Area and other Civil Works | 75,000 |
| 4) Machinery and Equipment | 1,47,200 |
| 5) Working Capital (for one month) | 12,555 |
| **TOTAL** | **2,48,218** |

### FINANCIAL ANALYSIS:

| | |
|---|---|
| 1) Cost of Production Per Year | 1,83,077 |
| 2) Turnover Per Year | 2,20,962 |
| 3) Net Profit (per year) (before Income Tax) | 37,885 |
| 4) Net Profit Ratio | 17% |
| 5) Rate of Return | 24% |
| 6) Fixed Cost | 50,026 |
| 7) Net Profit (Per Year) | 37,885 |
| 8) Break-Even Point | |

(Fixed cost × 100)/(Fixed cost + profit) = 57%

NOTE: by producing a mass production of 2 lakhs chicks per annum it is possible to bring down the cost of the poultry to $1.

## Limiting factors for large scale commercialization

• Huge gap between demand and supply, since only ARI produces ARIBRO chickens.

• High need for entrepreneurs who would invest in this technology.

• ARIBRO being a genetically modified breed, there are social pressures associated with it.

• Many farmers are not ready to move away from the traditional way of poultry farming to adopt newer age technology.

## Target Market / Customer

Day old ARIBRO chicks serve Ghanaian commercial poultry farmers and those in the West African Sub region. The main target market for this technology would be Ghana itself since the main focus during the development of the technology was to reduce the country's dependence on imports.

## Social impact of the technology

• ARIBRO will reduce Ghana's dependence on imports

• ARIBRO will reduce the amount of foreign exchange flowing from Ghana to other countries. The foreign exchange that is saved can then be utilized to make essential developmental changes within the country.

## Any other relevant information

• The ARIBRO broiler is Ghana's most efficient broiler.

• ARIBRO has the highest least conversion ratio, a superior growth rate and the ability to thrive well under tropical conditions

# IMO Pig Breeding Technology

## Ghana

Organic Piggery – Uganda now produces clean, odorless pigs

**Name Of institute:**
CCLEAr AgriBusiness Incubator (CCLEAr)

**Stage of development:**
Technology ready for commercialisation

**Patent status:**
Non IP technology

Pigs have been described as one of the most prolific and fast growing livestock species that can convert food waste to valuable products (Vicente et al. 2011). Pig production has been recommended as an alternative source of cheap, high quality dietary protein for the escalating human population. Prospective farmers both in urban and rural areas can no longer claim that they are unable to harvest money from piggery under the pretext of noise, bad odor and cost of feeding. Organic piggery, a cost effective farming system using Indigenous Microorganisms(IMO) is the way to go.

## Production Process:-

The technology involves digging a few centimeters into the ground, filling the pit with saw dust that is 0.5 centimeter in size and putting in the animals. The urine and any litter sink down into the ground while the faecal matter is retained. This is the reason why a concrete floor is not recommended and the roof must be leak proof. The saw dust can last for a production cycle of 6 to 8 months and can later be used as manure to fertilize crops.

IMO are simple microorganisms which occur naturally in the environment and can be multiplied by culture. They can be viruses, bacteria, fungi or any other organism. They can be put together in a specific combination depending on the type of microorganisms required, and cultured in the laboratory. The IMO is sprinkled over the animal faecal matter and saw dust. The saw dust is a source of cellulose and there is no enzyme in monogastric animals that can break it down. The microorganisms break down the cellulose locked up in the sawdust and make nutrients available to the animals to feed on.

The faecal matter of the animals is a rich source of protein which cannot be digested by them. So the microorganisms go ahead and break down the protein locked in the faecal matter and make it available for the animals to feed on. This cycled feeding caters to 30% of the feed requirement and the farmer provides the remaining 70% of the feed. During the fermentation or breakdown of saw dust and faeces into nutrients, a lot of heat is produced which raises the temperature of the litter to about 600C. This temperature is good enough to kill disease causing organisms. During fermentation the smell is minimized or eliminated and therefore no flies are attracted to the place.

For piggery production, pigs reared and managed under this type of farming have a thin fat layer and weigh more compared to those reared by the traditional/conventional method. Due to the warm temperature of the sty the pigs do not have to put on a thick layer of fat as protection against heat loss.

## Background

Natural pig farming is a high pig welfare, non-environmental polluting system of raising healthy, contented pigs that uses the activity of indigenous microorganisms (IMO's) in the deep bed flooring of the pen to rapidly decompose all the pig waste. This system of raising pigs is designed to enable pigs to carry out core natural behaviour within a healthy real world environment even though they are raised in pens.

Pigs were earlier produced in a typical structure which became a den for flies, rodents and many other pests. There would be a smell and this became a social problem. For this reason, the pig sties would eventually have to be moved outside the city.

However, this method of production has now been revolutionized by the introduction of IMO technology for pig farming leading to an organic way of pig rearing. The innovation involves the use of indigenous microorganisms in order to change the way the pigs eat so that pork of a better quality is produced, while the environment in which the pigs live becomes cleaner.

Under this technology, a farmer is capable of keeping many animals in a small piece land or unit. A construction of 3.8 meters can accommodate 25 pigs for up to 8 months hence saving on land and space. Compared to other methods, it is easier for farmers to make the microorganisms themselves. Thus this new technology is paving the way for a revolution in the field of pig farming making it less cumbersome and more desirable.

## Benefits / Utility

- The technology reduces feeding costs in piggery by 30%.

The organic piggery system also reduces the construction cost of the animal unit as there is no requirement for concrete or expensive material.

- It eliminates smell and flies in the piggery unit.
- Labor costs are also greatly reduced as one needs to come just once (A DAY???), to turn the saw dust, sprinkle the IMO or add feed staff.
- It helps generate manure for fertilizing crops in the form of saw dust.
- The IMO technology reduces noise as the animal is kept busy and is comfortable. The animal is not disturbed; it feeds all the time in a convenient sty. As such a farmer can keep pigs without the notice of the immediate neighbor because they don't make a noise.
- Cleaning the pig sty is easier.
- This method reduces the water used in cleaning, thus leading to conservation of water.
- The method also reduces the bad odor normally associated with pigs.
- Pigs so produced give clean quality pork which is desirable.

## Country Context

Pig farming is widely practised in all regions of Ghana with high concentrations around the Central region. Unlike other key agricultural enterprises, pig farming has experienced a fundamental improvement in the number of pigs reared and households that rear at least one pig over the last three decades. This has been possible despite the limited government support to the pig subsector and the fact that pigs are not considered among the 20 priority sectors of the country. About 17.8% of all households own at least one pig in Ghana. This increasing number of piggery units have opened new opportunities for this novel technology

## Scalability

Pig farmers in Ghana have joined hands to form the Pig Farmers Association of Ghana in December 2013. This institutional mechanism formed by the pig farmers will lead to easy commercialization of IMO technologies. Awareness of the technology is also increasing among pig farmers, paving the way to scale up this technology.

## Business and Commercial Potential

The piggery industry is a lucrative sector with high profit returns; yet it requires minimal capital investments in terms of land and feed. The piggery enterprise can easily be managed by various groups of people because it is not labor intensive. There is also a high demand for pork and pork products in Ghana and regionally but skills in production and value addition are still minimal. This industry has the potential to enhance income and alleviate poverty. Due to the increasing demand for pork and pork products, there is a need to increase pig production to sustain the supply. Therefore the piggery industry offers potential investment opportunities.

There has been a significant increase in the number of pigs in Ghana. In 1989 the pig population in Ghana stood at 550,000. It has multiplied to a million in recent years and thus provides great business potential for IMO technology. In addition to this Uganda is also experiencing a tremendous increase in the pig population which was 0.19 million in 1980, 1.7 million in 2002 and 3.2 million in 2008. The average number of pigs owned by livestock farmers is higher in the urban areas than in the rural areas of Uganda. According to Tatwangire (2012), the proportion of households owning pigs is highest in the Central region (56%), followed by 30.1% in the Western region, 28.8% in the Eastern region and 14.2% in the Northern region of Uganda.

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Potential investors to this technical innovation

A. Individual pig farmers
B. Commercial piggery units
C. NGOs
D. Pig farmers cooperatives'
E. Student entrepreneurs
F. Rural unemployed youth

## Economics of IMO Pig farming - Investment cost (10 Sows + 1 Boar)

| | | |
|---|---|---|
| 1. | Unit size | 10 sows with 1 boar |
| 2. | Systems of rearing | Semi-intensive system |
| 3. | Unit Cost ($US) | 3,080 |
| 4. | Bank Loan ($US) | 2,620 |
| 5. | Margin Money | 465 |
| 6. | Repayment Period | 5 with one year grace period |
| 7. | Interest Rate | 12% |
| 8. | BCR at 15% DF | 1.54:1 |
| 9. | NPW at 15 % DF ($US) | 3,265 |
| 10. | IRR (%) | 68 |

| SR.NO. | PARTICULARS | SPECIFICATIONS | PHYSICAL UNITS | UNIT COST($US) | TOTAL COST($US) |
|---|---|---|---|---|---|
| 1 | Shed and structures | 100 sq ft. | 400 sft | 1.15 | 462 |
| 2 | Water supply system (Bore well, electric motor pumpset - 1HP, water tank) | Lump sum | | | 250 |
| 3 | Cost of Equipment | Lump sum | | | 33 |
| 4 | Cost of breeding stock | | | | 340 |
| 5 | Capitalisation of recurring expenses for first one year | | | | 7,050 |
| 6 | Total financial out lay (TFO) | | | | 3,082 |
| 7 | Margin money @ 15% of TFO | | | | 463 |
| 8 | Bank loan @ 85% of TFO | | | | 2,620 |

## Target Market / Customer

The IMO Pig breeding technology finds takers even in the poor backyards of African farmers who can practise this occupation alongside any other occupation that they carry out. Looking at imports, Japan is expected to remain the number one pork-importing country, accounting for one-quarter of global pork imports. Other major pork importing countries are Russia at 11 percent, Mexico at 8 percent and South Korea at 5 percent of global pork imports. South Africa slaughters around 1.7 million pigs per annum; this accounts for less than 0.2 per cent of world pork production. South African pork exports to other African nations, the Far East and the European Union reached 0.35 metric tons in 2004, while over 20,000 metric tons of pork were imported in the same year, with ribs constituting close to 60 per cent of imports. Since feed comprises anywhere from 55 to 60 percent of the total cost of producing a market pig, the IMO technology can prove to be a useful one for reducing the costs borne by the producers and increasing their profit margins. Based on the FAO data (presented under World Pork Market), South Africa produced 338,000 metric tons of pork during 2010, representing 0.33 per cent of the world's pork production. These countries thus form the major target markets for IMO pig breeding technology. In the past three decades pork consumption in Uganda has increased from 0.19 to 3.2 million pigs.

## Limiting factors for large scale commercialization

- Farmers had problems related to funding for the purchase of breeding stocks, feed and construction of pig houses.
- The presence of African swine fever disease can create a problem while rearing pigs.
- There is a lack of technological resources to produce the microorganisms used in this method of pig rearing.

The lack of local processes that create capacity through enabling and facilitating learning, necessary local architecture that includes catalysts of change; of appropriate forums to consider and address specific problems; and of mechanisms to ensure group action by farmers and other value chain actors all prevent the technology from achieving economies of scale.

- There are low farm-gate prices, high transaction costs and there is a lack of innovation and policy advocacy platforms.

## Social impact of the technology

IMO technology is simple and can be adopted by backyard farmers, who want to raise pigs on a small-scale without much objection from the neighbour. This method should help get the urban poor out of poverty if they are willing to take it up since the demand for pork is very high.

## Any other relevant information

• The IMO method is commonly known as the non-wash pig's technology. It is an easy way to manage piggery on both large- and small-scale.

• The annual growth rate (3.8 %) of pigs is higher than that of the human population (2.3 - 2.8%).

• Pig production has been advocated as a short-term measure towards alleviating the animal protein calorie deficiency especially in areas where there are no religious edicts preventing their production and consumption.

# Pelletized Grasscutter Feed Technology-Ghana

Pelletizing – the new way to feed Grasscutters

**Name Of institute:**
CCLEAr AgriBusiness Incubator (CCLEAr)

**Stage of development:**
Technology ready for commercialisation

**Patent status:** Non IP technology

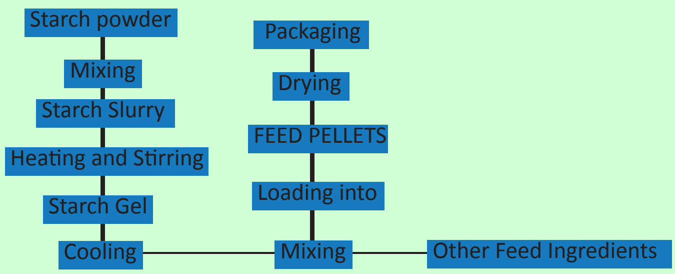
The grasscutter, also known as the cane rat or cutting grass, is one of the biggest rodents in Africa. However, the people of the region also utilize the cane rat as a source of food and consider the meat as a delicacy. Consequently, Grasscutters are beginning to be raised in cages and are being sold for their high protein content. Grasscutter farming is a relatively new venture in animal husbandry in Nigeria but has since been practised in many West African countries such as Ghana, the Republic of Benin, Togo, Cote d'Ivoire and many other countries in Central Africa.

In recent years, the use of pelleted animal feed to feed the animal has increased among farmers because of its numerous advantages which include wholesome delivery and increased nutritional utilization of the feed components among others. The pelletized Grasscutter feed technology has been developed to relieve grasscutter farmers of the drudgery of feeding their animals and has also enabled faster growth of grasscutters.

## Production Process:-

The technology involves selection and processing of feed materials into meals, mixing the feed ingredients according to predetermined formulations to produce balanced diets for the target animal, mixing the diets with an appropriate binder to produce a paste, pelletizing the diets using a pelleting machine with an appropriate pelleting disc and then drying them. The flow chart below illustrates the process:-

The flow chart below illustrates the process:-




The cold starch gel is prepared by mixing the required quantity of starch powder with water in the ratio (1:1) and heating it on a fire with constant stirring. It is then thoroughly mixed with the other feed ingredients (which have been previously milled separately using a hammer milling machine and mixed together) to form a dough. The dough is then divided into smaller quantities and fed into a locally fabricated hand-driven cold pelletizing machine which has an inlet trough through which the dough is fed into the machine. With the aid of a pestle the dough is pressed into the action zone (screw conveyor) where the feed is compressed and worked upon. It also helps to further mix the dough and move it towards the die (6 mm) where it is forced through a restricted opening to the discharge end of the screw while the handle of the machine is being turned. The pellet is then dried at 65°C for 6 hours in a cabinet dryer.

## Background

The grasscutter (Thryonomys swinderianus) is a wild rodent found only in Africa. It is the biggest rodent in Africa after the crested porcupine, and weighs 13 kg on an average. Captive grasscutter (Thryonomys swinderianus) has been identified as a potential source of animal protein for both rural and urban people. It plays an important role in supporting the government’s effort towards achieving wealth creation and poverty reduction. However, its commercial production has been confronted with several challenges, such as, low productivity and dry season feeding challenges as a result of dependence on forages. Stakeholders have over the past decade demanded research intervention into the production of feed packages for commercial grasscutter rearing. Pelletizing feeds ensures increased feed utilization and supply to livestock. The physical quality of pellets is largely affected by the quality of the raw material, and with the increasing trend towards bulk delivery and automated handling systems, pellet quality has now become an important factor in feed marketing. Binders are now increasingly being used by feed millers and compounders to produce good quality pellets that do not crumble upon handling and this has significantly increased the role of feed binders in animal feed. However, the high cost of conventional synthetic binders makes pellet feed production a difficult exercise especially for small and medium scale farmers. So the utilization of cassava which is abundant in sub-Saharan Africa will provide an appropriate local alternative to feed millers and farmers as this would enhance micro-livestock feed production by rendering feed production affordable and attainable.

## Benefits / Utility

- The pelletized feed technology ensures wholesome delivery of feed.

It leads to increased utilization of feed and reduces feed wastage.

- Usage of pelletized feed ensures a sustainable supply of feed.
- It provides an opportunity to provide balanced diets to meet the various physiological states of the animal.
- The technology ensures improved and uniform animal performance based on the diet.
- Usage of the technology has been shown to reduce production costs.

## Country Context

The grasscutter is found in grasslands and wooded Savannah throughout the humid and sub-humid areas, south of the Sahara, specifically from Senegal to parts of the Cape Province in South Africa. The giant cane rat can also be found wherever there is dense grass, especially reedy grass growing in damp or wet places. It does not inhabit the rain forest, dry scrub or desert regions. Its distribution is determined basically by the availability of adequate or preferred grass species for food.

Similarly in Ghana, the grasscutter has penetrated the high forest where there is intensive maize, cassava, sugarcane, young cocoa, coconut, oil-palm, pineapple and eggplant cultivation. However, Thryonomys swinderianus has often been encountered in the vicinity of water courses and have also been found in the same environment in East Africa. Owing to the high protein content in its meat, the grasscutter is commercially grown in cages and the rearing technology has been perfected by the CSIR-Animal Research Institute, Ghana. Commercial rearing of grasscutters requires high efficiency feed which could be prepared using this novel technology.

## Scalability

Today, the grasscutter, amongst all other animals reared for commercial purposes, is enjoying increasing patronage and acceptability owing to the fact that it is a viable, profitable and sustainable income earner. The average income of a grasscutter farmer is highly appreciable as shown below:

### Initial Start-up: (in $US)

Initial Start-up: (in US$)
1 family = 5 grasscutters (1male and 4 females) @ = US$440
Starting with 5 families = 25 grasscutters @ =US$4175
Cage / Housing = US$470 for 5 families
Food supplements (soya bean, crushed animal bone, PKC) = US$190

TOTAL = US$2900

Expected Income: (in US$)
1 female gives birth to an average of 4 animals within 6 months.
4 females will give an average of 16 grasscutters within 6 months.
16 grasscutters x 5 families = 80 grasscutters within 6 months.
In 1 year, around 160 grasscutters are expected.
The grasscutters weigh between 6-10 kg at maturity.
Assuming that each is sold for US$38
38 * 160 = 6080

### Business and Commercial Potential

High income realization in grasscutter rearing makes it more attractive for the farmers. Feeding the grasscutter with better feed will increase its weight and provide good quality meat. The technology of producing pelleted feed is highly scalable owing to the increase in the number of grasscutter farms in the county

## Contact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### Potential investors to this technical innovation

a) Small scale grasscuter farmers
b) Small and medium scale feed manufacturers
c) Farmers' cooperatives
d) Student entrepreneurs
e) Large scale feed industries

### Financials

Assumptions:
Capacity: 30000 MT/ year
Capacity Utilization: 85%
Raw material wastage: 1%

| **Particulars (in USD)** | **Amount** |
|---|---|
| Capital Cost | 223639.34 |
| Factory Over heads (per year) | 49,180.32 |
| Repairs and Maintenance (per year) | 3934.42 |
| Administrative overheads (per year) | 54,098.36 |
| Selling & Distribution overheads (per year) | 44,262.29 |
| Human Resource (per year) | 26,163.93 |
| **Average cost of raw materials (per MT)** | **89.06** |
| Power & Fuel (per MT) | 2.62 |
| Packaging Material (per MT) | 5 |
| Wages | 0.63 |
| Average sales price (per MT) | 113.24 |
| IRR | 32.65% |
| BCR | 1.02 |

### Target Market / Customer

Pelletized grasscutter feed technology is targeted at grasscutter farmers and feed millers in the West African Sub-region.

Since the grasscutter is an extremely important animal in terms of protein content for Africa and is found only in Africa, the target market for this technology is restricted to the countries of the African continent. Both Ghana and Nigeria are heavily involved in grasscutter farming and hence are the most important target market for pelletized grasscutter feed.

### Limiting factors for large scale commercialization

• The high cost of conventional synthetic binders makes pellet feed production a difficult exercise especially for small and medium scale farmers.

• Meeting the certification requirements and quality standards of an external market for livestock can be extremely demanding for many African countries that are just developing their standards of organic certification.

• Low funding and NGO support are hampering the accessibility of this technology to the masses.

• Lack of subsidies makes it difficult for marginally earning farmers to be able to afford this technology.

• Lack of widespread awareness programs makes it difficult to spread the technology to those who really require it.

### Social impact of the technology

• Grasscutter farming can serve as a profitable occupation for a lot of people in Africa. In West Africa, commercial farmers generally no longer want to buy feed from feed companies – they are increasingly producing their own feed, the most efficient form of which is pellets.

## Any other relevant information

### Cost economics of Grasscutter farming

•SMALL SCALE

*1 family of grasscutters (4 females, 1 male) cost N 45,000 (US$278)
*Housing N 5,000 (US$31)
*Feeding (annual) N 5,000 (US$31)
*Total cost of farming = N 55,000 (US$340)

MEDIUM SCALE

*3 Families (3 males and 12 females) = N 135,000 (US$832)
*Housing = N 15,000 (US$93)
*Feeding (annual) = N 15,000 (US$93)
*Total cost of farming = N 165,000 (US$1017)

LARGE SCALE

*10 families (10 males and 40 females) = N 450,000 (US$2775)
*Housing = N 100,000 (US$617)
*Feeding (annual) = N 50,000 (US$310)
*Total cost of farming = N 600,000 (US$3700)

An investment of US$340 on a small scale, earns a farmer US$2220 as income at the end of the year. An investment of US$1017 earns US$6600, while investment of US$3700 earns US$22200 at the end of the year. This income tends to increase twofold the following year due to the increase in the number of families and procreating grasscutters.

# Improved Cassava Processing Technology
## Zambia

Cassava Processing - Generating Better Outputs

**Name Of institute:**
AgBIT

**Stage of development:**
Technology ready for commercialisation

Cassava is the second most important staple crop with an estimated 92 % of total production been utilized as human food in Zambia. It is also a major source of income for smallholder farmers and a food security crop for 30% of the Zambia's population. Africans consume at least 80 different types of processed cassava (Ugwu, 1993). Fresh cassava roots rot within 3-4 days after harvest. Perishability and high water content (70%)of the fresh cassava roots make transportation of fresh roots from rural areas to urban markets expensive and difficult.

## Technology description:

Improving processing methods reduce high post-harvest losses, increases productivity , it is labour efficiency and improves standard of living for farmers and urban poor. Thus, the process is an essential marketing activity in remote areas because it reduces cost and improves shelf-life. The technology involves Harvesting of Cassava roots which are then peeled, washed and graded . The cassava mash is then dewatered and pulverized before drying them. The dried cassava mash is then milled to obtain the fine flour as the final product.

## Production Process:-

Diagrammatically, the technology can be summarized as shown below:

| |
|---|
| Harvesting The Cassava Roots |
| Peeling |
| Washing |
| Harvesting The Cassava Roots |
| Dewatering |
| Pulverishing of the Dewatered Mash |
| Drying |
| Milling |
| Flour |

## Background

Cassava is one of the most important staple food crops grown in tropical Africa. It plays a major role in efforts to alleviate the African food crisis because of its efficient production of food energy, year-round availability, tolerance to extreme stress conditions, and suitability to present farming and food systems in Africa. Traditionally, cassava roots are processed by various methods into numerous products and utilized in various ways according to local customs and preferences. In some countries, leaves are consumed as vegetables, and many traditional foods are processed from cassava roots and leaves.Improvement of cassava processing and utilization techniques would greatly increase labour efficiency, incomes, and living standards of cassava farmers and the urban poor, as well as enhance the-shelf life of products, facilitate their transportation, increase marketing opportunities, and help improve human and livestock nutrition. A recent study on cassava shows that it accounts for about 70% of the total calories intake of more than half of the population. A major limitation of cassava production is the rapid post-harvest deterioration of its roots which usually prevents their storage in the fresh state for more than a few days. Cassava processing technology will help minimize and keep this loss to a minimum.

## Benefits / Utility

- Technology can be used in processing high or low Cayogenic Potential Cassava roots
- Reduction in labour required for processing cassava.
- Increase volume of production
- Processing products of consistent quality.
- Reduced post-harvest losses.
- Also the technology will benefit Industrial users in food and non food sectors.
- It encourages large scale use of high-yield production technologies.
- It improves palatability, adds value and extends market especially to medium income urban consumers.
- The Processing Technology will contribute directly to understanding the food security impacts of growing cassava as well as changes in relative prices of competing food staples and industrial products such as livestock feeds and processing material for wood, pharmaceuticals and textiles to name a few.

## Country Context

Cassava is widely grown in many tropical countries for its edible roots. In Zambia, From the early 1980's to the second half of the 2000's, per capita cassava production has increased from about 55 kg per person to about 85, equivalent to a 10 kg gain in dry weight.Farm households consume about 92% of national cassava production and sell the remaining 8%.

Sales of fresh cassava account for about 3% of national production. As cassava roots deteriorate within 48 hours after harvesting, most fresh sales travel not more than about 50 kilometers from field to final market.

For this reason, fresh sales are well established in northern Zambia. They are also growing steadily in the maize belt, where virtually all marketed cassava is sold in fresh form. Trade in dried cassava roots accounts for the remaining 5% of total production. Most of the dried cassava traded in Zambia emanates from the northern cassava belt, where roadside depots assemble 50 kg bags of dried roots, and a network of traders purchase and transport them to urban markets and to deficit rural zones such as the fishing villages in the swamps of northern Zambia. Small volumes of dried cassava travel long distances to supplymarkets in Lusaka, DRC and even Angola.

## Scalability

The major future market for increased cassava production is as livestock feed. Cassava has long been recognized by researchers in Africa as an appropriate animal feed and it has been used as an important and cheap feed in many European countries. Both roots and leaves are used as feed to livestock. Cassava is one of the most drought tolerant crops and can be successfully grown on marginal soils, giving reasonable yields where many other crops cannot do well. It is estimated that approximately 4 million tonnes of cassava peeling-useful as livestock feed-are annually produced as a by-product in Nigeria alone during processing of cassava roots. Therefore, cassava offers tremendous potentials as a cheap source of feed for animals, provided it is well balanced with other nutrients. There is a great deal of current interest in supplementing feeding of animals with cassava in Africa.

| Product | Sector Using Product | Quantity Used (MT) | Cassa-va-Based Substi-tute | Level of Substitu-tion | Potential Quantity Needed (MT/ Year) | Cassava Root Required (MT/Year) |
|---|---|---|---|---|---|---|
| Wheat Flour | Plywood industry | 1,681 | Flour | 100% | 1,681 | 8,405 |
| | Other (bread, biscuits, snacks) | 208,549 | Flour | 10% | 20,855 | 104,275 |
| Starches (maize, wheat, potato) | Pharmaceuticals | 687 | Starch | 5% | 34 | 170 |
| | Textiles | 187 | Flour/ Starch | 100% | 187 | 935 |
| | Other (paper, processed foods, etc.) | 380 | Modified flour/ starch | 50% | 190 | 950 |
| Ethanol | Pharmaceuticals | 265 | Industrial alcohol | 100% | 265 | 4,732 |
| | Others (medical, beverage, scientific) | 9,315 | Industrial | 100% | 9,315 | 166,339 |
| Glucose/ Glucose syrup | Pharmaceuticals | 35 | alcohol | 100% | 35 | 175 |
| | Others (confec-tionery, biscuits, etc.) | 877 | Glucose syrup | 75% | 657.75 | 3,288.75 |
| Maize Flour | Livestock feed | 1,882 | Glucose syrup | 10-20% | 1,782.3 | 8,911.5 |
| | | | Chips/ pellets | | | |

## Business and Commercial Potential

Fresh cassava roots cannot be stored for long hours because they rot within 3-4 days of harvest. They are bulky with about 70% moisture content, and therefore transportation of tubers to urban markets is difficult and expensive. The roots and leaves contain varying amounts of cyanide which is toxic to humans and animals, while the raw cassava roots and uncooked leaves are not palatable. Therefore, cassava must be processed into various forms in order to increase the shelf life of the products, facilitate transportation and marketing, reduce cyanide content and improve palatability. The nutritional status of cassava can also be improved through fortification with other protein-rich crops. Processing reduces food losses and stabilizes seasonal fluctuations in the supply of the crop.

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The technology possesses the following business potential:

• Improved market access of cassava products as the quality improves
• Increase in the incomes of cassava producers and processors
• Increase in the incomes of small scale equipment Fabricators

Apart from local demand, there is a high demand for cassava based products in foreign countries- starch, cassava chips, adhesive and other derivatives. However, the current supply of the cassava may not be able to satisfy foreign market demand (IFAD and FAO, 2005).

The future of cassava depends very much upon development of improved processing technologies and of improved products that can meet the changing needs of urban people, and, on its suitability for alternative uses such as animal feeds. Also important is the overall ratings of different products to meet the expectations of producers, transporters and consumers. Whereas the future is bright, more quantitative information on postharvest aspects of cassava culture in tropical Africa will help scientists to orient their efforts to satisfy needs of both rural and urban dwellers.

While processed cassava has a wide range of potential food and industrial applications, the most common product manufactured through cassava processing is High-Quality Cassava Flour(HQCF). HQCF is produced by flash-drying cassava that has been intermediately processed into another form, such as cassava cake or mash.
Recent initiatives to develop the market, combined with analog data from the flour market as a whole, however, depict the local HQCF market as new but fast-growing with high potential. In 2010, it is estimated that 650 metric tons of HQCF was sold in Ghana, while total demand for the year equalled 1,765 metric tons; processors could not meet demand due to insufficient working capital.

Looking forward, the growth of the HQCF market in Ghana is expected to closely mirror the growth in demand for all flour in Ghana. Flour consumption in Ghana is expected to grow at a CAGR of 7.5% between 2009 and 2015, reaching more than 430,000 metric tons by 2015. HQCF is approximately one-third of the price of imported wheat flour and locally-milled flour made from imported wheat, the dominant form of flour consumed in Ghana. A conservative estimate that HQCF's share of the flour market will increase by 0.5% per year results in an estimated HQCF market size of more than 25,000 metric tons in 2015. With 25,000 metric tons in demand annually, there is a significant gap in processing capacity in the HQCF market, making it an attractive competitive landscape as additional processing will be required to fulfill unmet local demand.

| | 2011P | 2012P | 2013P | 2014P | 2015P |
|---|---|---|---|---|---|
| Flour Consumption (MT) | 322,289 | 346,460 | 372,445 | 400,378 | 430,407 |
| HQCF Market Size (MT) | 12,450 | 15,116 | 18,111 | 21,472 | 25,235 |

## CAPITAL EXPENDITURE

| | USD$ |
|---|---|
| Land | 10,000 |
| Buildings / infrastructure | 550,000 |
| Dryer building costs | 2,474,921 |
| Tanks / boreholes / etc | 50,000 |
| AMPU (3) | 2,318,661 |
| AMPU site costs (6) | 408,000 |
| Pre-start-up costs | 792,620 |
| Contingency | 50,000 |
| Vehicles (3) | 370,000 |
| Office equipment | 50,000 |
| Total investment | 7,074,202 |

## Potential investors to this technical innovation

• Farmer cooperatives
• Food Processing companies
• Start up entrepreneurs
• Export companies
• Retail chains
• Beauty product manufacturers

## Projected Sales Volumes and Prices, Years 1–5

| | | | | | |
|---|---|---|---|---|---|
| Sales volume (MT) | 8,000 | 10,000 | 12,000 | 12,000 | 12,000 |
| Sales price / MT (GHC) | 1,175 | 1,278 | 1,391 | 1,513 | 1,646 |
| Sales price / MT (US$) | 664 | 664 | 664 | 663 | 663 |
| Revenue (GHC) | 9,400,000 | 12,784,000 | 16,690,790 | 18,159,580 | 19,757,623 |
| Revenue (US$) | 5,310,734 | 6,636,983 | 7,968,000 | 7,968,000 | 7,968,000 |

## Forecast Income Statement, Years 1–5 (US$)

| | | | | | |
|---|---|---|---|---|---|
| Revenue | 5,310,734 | 6,636,983 | 7,962,657 | 7,960,936 | 7,959,214 |
| Cost of Goods Sold | 3,205,200 | 4,086,630 | 5,002,036 | 5,102,076 | 5,204,118 |
| Production Losses | 64,104 | 81,733 | 100,041 | 102,042 | 104,082 |
| Gross Margin | 2,041,430 | 2,468,620 | 2,860,581 | 2,756,818 | 2,651,014 |
| SG&A | 703,786 | 725,208 | 743,881 | 722,861 | 704,331 |
| EBITDA | 1,337,644 | 1,743,412 | 2,116,700 | 2,033,957 | 1,946,683 |
| EBITDA % | 25% | 26% | 26% | 26% | 25% |
| Depreciation | 499,903 | 574,213 | 633,186 | 587,589 | 551,925 |
| EBIT | 837,741 | 1,169,199 | 1,483,513 | 1,446,368 | 1,394,758 |
| Total finance costs | 510,375 | 466,467 | 419,001 | 297,013 | 193,199 |
| EBT | 327,366 | 702,732 | 1,064,513 | 1,149,355 | 1,201,559 |
| Tax | 81,842 | 175,683 | 266,128 | 287,339 | 300,390 |
| Net Income | 245,525 | 527,049 | 798,384 | 862,016 | 901,169 |
| Net Income Margin | 4.6% | 7.9% | 10.0% | 10.8% | 11.3% |

## Projected Sales Volumes and Prices, Years 1–5

| | |
|---|---|
| NPV of Equity Investment | $6.2 million (GHC 11.1 million) |
| IRR | 38% |
| Payback period | 4 years |

## Target Market / Customer

The main target consumers are individual entrepreneurs / farmers / industries / cooperatives / processors, etc.The target clientele for this technology are mainly Equipment Fabricators and Cassava processors both Individuals and Cooperative processors, respectively.Africa is the largest cassava producing region in the world. About 93 percent of the produce is consumed as food (in contrast to Latin America and Asia where less than half is utilised for food consumption). Millions of African farmers grow cassava mainly for home consumption and local markets.The market for cassava products exist nationwide and the demand has increased phenomenally since the beginning of the twentieth century. Production of cassava products and utilization has also expanded appreciably.Therefore,it is important to sensitise our local cassava farmers in Zambia about the cassava technology which will change their mindset and hence increase cassava productivity in the country.

## Limiting factors for large scale commercialization

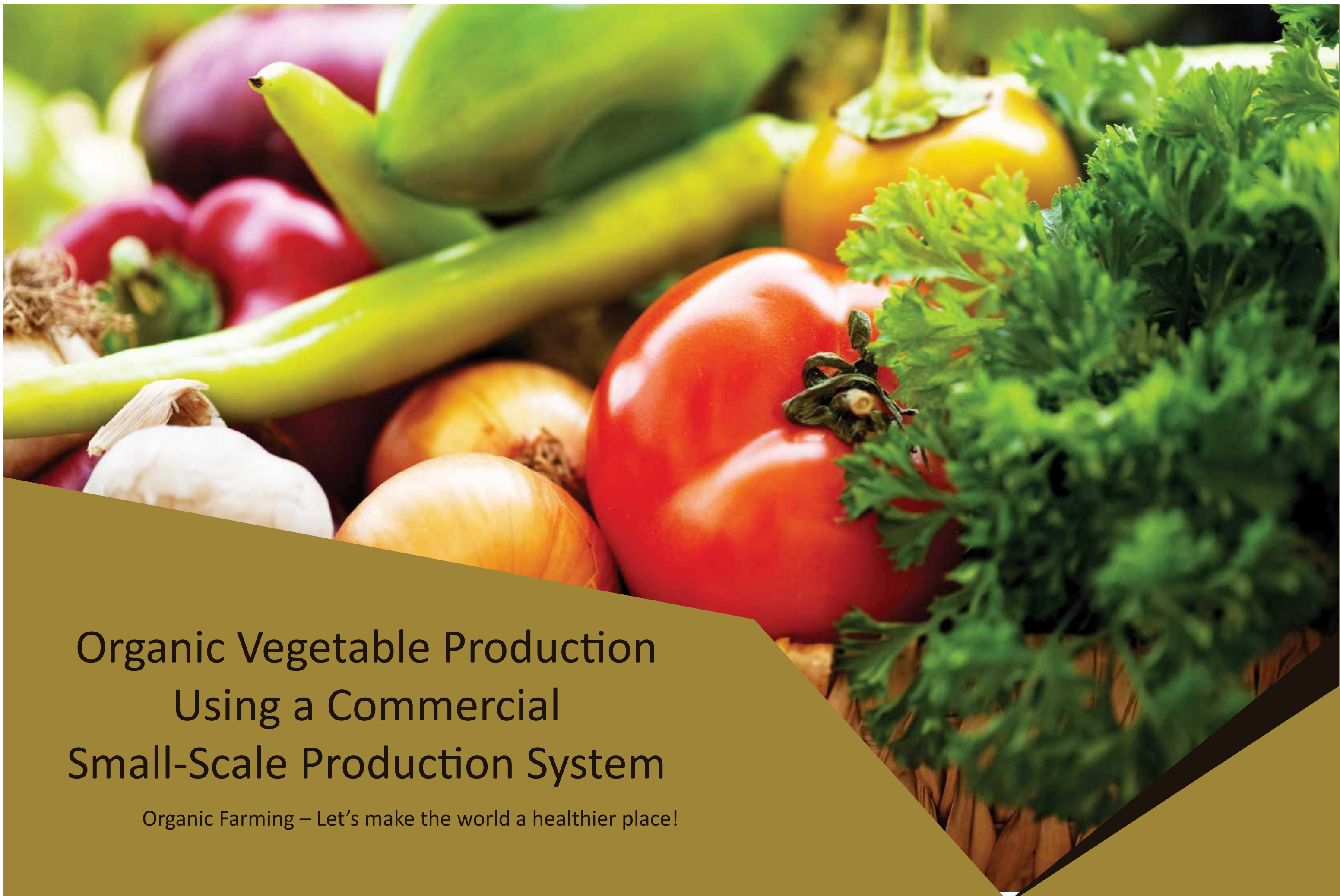
- The bulk of cassava grown in Zambia is produced by peasant smallholders under traditional agricultural practices. Consequently, the average yield is low, ranging from 5 tonnes per hectare, which is much lower than the world average of 30-40 tonnes per hectare.
- Moreover, the cost of cassava has been unstable during the last five years. Increased labour wages for planting and harvesting and increased cost of transporting harvested tubers to processing plants as well as erratic climatic patterns seem to have affected the price of cassava.
- Another constraint of utilizing cassava for feed is the competition for cassava by man for food and industry. Cassava is utilized in the production of gari, fufu, cassava flour for human consumption, and for industrial starch used in textile industry. About 92% of cassava roots are consumed by households. Thus, the amount of cassava available for production of animal feed is very much reduced.
- Cassava is produced in dry areas where intensive livestock production is not practiced and the main livestock species are ruminants.
- High price of cassava makes its use in livestock feeds uneconomical.
- Cassava has low nutritive value. Hence diets from it require high protein fortification or amino acid supplementation due to low amino acid content. This would therefore make cassava diets too expensive.
- Harvesting, processing and handling of cassava is difficult and inconvenient, and this discourages large scale farmers from planting cassava for live-stock feeding.
- The key constraints are unavailability of cassava roots, shortage of water and competition due to the increase in number of new entrants.

## Social impact of the technology

Cassava provides the livelihood of up to 500 million households, countless processors and traders around the World. It is the basic staple food of many people in the tropical and sub-tropical belt and raw material for numerous industrial applications, including food, feed and starch. Cassava production is closely allied with poor farm households, a relationship perceived to exist because poor households are marginalized and often live in marginalized areas where cassava performs well. Development of market opportunities for cassava can therefore increase food security, especially for resource-constrained households, and contribute substantially to poverty alleviation.Cassava technology will break the notion people have around the world that cassava production is closely allied with poor farm households because more value will be added to the product.

## Any other relevant information

Processed cassava, either in the form of flour, wet pulp or gari is cooked or eaten in three main food forms: “fufu”, “eba” and “chickwangue”. The “fufu” group includes “amala” in Nigeria, “fufu” in Zaire, Congo, Cameroon and Gabon, “ugali” and “kowon” in Uganda and Tanzania, “nchima” in Mozambique, “nsima” in Malawi, “ubugali” in Rwanda, and “funge” in Angola.
Gari can be eaten dry or it may be soaked in cold water to which sugar is added. “Eba” is a very popular food in Nigeria and is gaining popularity in Cameroon, Benin, Ghana, Liberia and Sierra Leone because of its fast and easy reconstitution into a convenient food.
“Chickwangue” is a very stiff paste or porridge and is much stiffer than “fufu” and “eba”. The size, shape and texture of the “chickwangue” food group vary among countries. “Myondo” and “bobolo” in Cameroon are essentially the same as “chickwangue” in preparation although shapes and sizes are different. “Chickwangue” and its analogues are produced from more hygienic procedures and contain less cyanide but they require much more labour for processing and preparation.



# Organic Vegetable Production Using a Commercial Small-Scale Production System

Organic Farming – Let's make the world a healthier place!

**Name Of institute:**
AgBIT

**Stage of development:**
Technology ready for commercialisation

Vegetable production without the use of chemical fertilizers and pesticides is the oldest form of agriculture. The main objective is to use a production system that relies on biological processes and natural materials to manage soil fertility and pest populations.

The International Federation of Organic Agricultural Movements (IFOAM) defines "organic agriculture" as: "A production system that sustains the health of soils, ecosystems and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects. Organic agriculture combines tradition, innovation and science to benefit the shared environment and promote fair relationships and a good quality of life for all involved." IFOAM regards any system that uses organic methods and is based on the principles of organic agriculture as "organic agriculture" and any farmer practicing such a system as an "organic farmer".

## Production Process:

In this process, one hundred small-scale farmers are allocated 1200 m2 of land each, under a centre pivot covering an area of about 50 ha. The small-scale farmers grow assorted organic vegetables on 12 ha of this land, while commercial production continues on the remaining 38 ha. The farmers are grouped into two cooperatives, each having two planting groups. Through sales of their produce, farmers are expected to cover their cost of production and contribute to the cost of operation of the centre pivot. The cooperatives maintain sales records for each individual farmer and farmers get their dues once monthly.

Organic vegetable production:

Organic fruit and vegetable production entails a holistic production management system that aims at sustaining the health of soils, ecosystems and people. This production system relies on ecological processes, biodiversity, cycles adapted to local conditions, and the use of on-farm and local inputs. Organic agriculture in general combines tradition, innovation and science, to benefit the shared environment and promote fair relationships and good quality of life for all involved. The main techniques to be followed during organic farming include:

1) Mulching: This involves covering the soil with dead plant material in order to supply the soil with essential nutrients from waste and to reduce weed growth.
2) Intercropping: This involves growing two annual crops together, commonly a leguminous crop like beans or green manure in alternating rows. This diversifies production and ensures maximum benefit from the land.
3) Composting: Application of natural compost and biomass requires a low investment and gives better returns.
4) Sustainable Pest Management: Pests which normally affect the crop are not harmed using pesticides but rather by the use of bio-control agents or natural remedies.
5) Planting of Leguminous Trees: Leguminous trees, such as glyricidia and calliandra, provide shade and are sources of mulch which enrich the soil with nitrogen, phosphorus, and potassium requirements.

## Background

Although 64.5% of the agricultural land in Zambia is cultivated by small-scale farmers, most of it is limited to areas with naturally occurring water bodies, and plots are usually small due to problems of water extraction and irrigation methods. Poor market access, high cost of production and the inability of most small-scale farmers to meet bulk demands are problems common to most small-scale production systems. These problems, combined with environmental concerns associated with conventional farming, and the increasing demand for healthy and nutritious foodstuff, led to the development of an organic production system in which a commercial irrigation scheme could also cater to small scale-farmers.
In the past several years there has been evidence of substantial growth in certified organic land in Ghana, Ethiopia, Kenya, Tanzania, Uganda and Zambia. Organic cultivation is aimed at a healthy environment, healthy food and healthy consumers. If vegetables are cultivated in a healthy environment, the product will be healthier and the consumers using the product will also be healthier and will be able to build a better immunity in their bodies to fight against diseases. Organic agriculture use natural and environmentally friendly methods and materials. No chemical fertilizers, pesticides, inputs or materials which are of inorganic origin are used. A variety of crops or plants are planted together to increase the biodiversity within this production system. It differs from biological agriculture, in that organic agriculture systems are more strictly controlled. Organic farmers make a conscious effort to improve the quality of the soil.

## Benefits / Utility

- Reduced cost of production through the use of organic methods.
- Access to irrigation facility for farmers who don't have natural water sources (streams, rivers, etc).
- Grouping of farmers enhances the ability to meet market requirements in terms of quantity and consistency of produce.
- Production of high value, nutritious and healthy products
- Reduced negative impact on the environment through the application of sound economic and environmental principles and practices for food production.
- Organic production of fruits and vegetables is a form of value addition as these products tend to sell at a higher price.

## Country Context

Organic production in Zambia took an important step forward during the second part of the nineties. It was triggered by the increased demand for organic products from supermarkets in the United Kingdom. Two commercial vegetable farmers currently use organic production methods and are handling the majority of exports. There are also two small-scale farmers' groups producing organic non-perishable products, such as honey, dried mushrooms and dried fruits.

Zambia is a large land-locked country (more than 752 000 km2) in Southern Africa with high transport costs. Port cities in neighbouring countries are far from agricultural production centres. The transport costs make it difficult to compete with South Africa on bulk fruit and vegetable trade, as they have superior transport linkages with overseas markets. Zambia has a large area of virgin arable land. It has good climate and enough rainfall/water available to grow crops year round. Labour costs are still reasonably low, which is a competitive advantage. The export organic market is growing very fast and as long as the quality and quantity can be assured on a continuous basis it is a potential new market for the Zambian farming sector.

Local markets for certified organic products are growing especially in Egypt, South Africa, Uganda, Kenya and Tanzania.
At present Tunisia is the only African country with its own organic (EU compatible) standards, certification and inspection systems. Egypt and South Africa have both made significant progress in this direction.

## Scalability

Domestic markets for organic produce are developing in Egypt and South Africa, both reasonably prosperous countries by African standards. Sekem, the pioneer of the organic movement in Egypt, has developed a substantial domestic market for a range of products, including herbal teas, fruits and vegetables and organic cotton. Domestic sales now account for more than half of its certified production. In other countries, and particularly in the larger cities, there are reports of demand for "naturally" grown produce. The popularity of these products is often due to better taste than their intensively grown counterparts. The potential of applying organic approaches to urban farming, , is also being explored in some African cities.

Various methods for commercializing organic fruit and vegetable production are already being tested and used by Kasisi Agricultural Training Centre (KATC) and others, and as such are ready to be adopted on a larger scale. There is, however, a need to conduct cost-benefit analyses of different methods. For AgBIT and other engaged stakeholders, the first step is to facilitate training of potential organic producers (small scale farmers) in selected courses such as agribusiness, cooperative management, organic vegetable production and fruit tree production. Completing the value chain by linking organic producers with food processors would be another area that AgBIT could facilitate.

Instances of organic production in ecosystems with low-productivity have demonstrated the potential to double or triple average yields through traditional management systems. If similar results were to be scaled into many of the less developed regions of the world, present food deficits could be partly resolved. Increased yields are more likely to be achieved if the departure point is a traditional system, even if degraded, rather than a modern system.
Most organic produce is destined for export markets in Europe, USA and Japan. The export value of organic products was USD 42 million in 2010/11; up from USD 4.6million in 2002/03.

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## Business and Commercial Potential

There is high business and market potential for fruits and vegetables grown organically, as seen from the different markets that small-scale farmers in the "Integrated small-scale commercial irrigation system" are able to access.

Organic agriculture is showing itself to be a viable and sustainable development option for Africa. Adopting organic agriculture does not mean a regression to a form of low technology, backward or traditional agriculture – but instead involves pursuing a blend of innovations originating from a participatory collaboration between scientists and farmers. The organic farming system emphasizes management over technology, and biological relations and natural processes over chemically intensive methods. Organic farming in Africa must be viewed beyond the perspective of providing commodities for the global market. Rather it should be seen as an agricultural system that "enhances" and "manages" the complexity of the ecosystem, rather than reducing and simplifying the biophysical interactions on which agricultural production depends. It consciously integrates and takes advantage of naturally occurring beneficial interactions and rich layers of indigenous knowledge.

Most importantly, organic farming in Africa must be seen as a process of learning and adaptation which results in meeting household objectives for sustainable and adequate food supply, increasing environmental resilience, and growing social capacity. In recent years, some policy makers and donors have started to recognize the potential of export oriented organic agriculture as a means of generating foreign exchange and increasing incomes

.For most sub-Saharan African countries, the best potential for organic exports lies in low volume, high value crops (such as coffee, herbs, spices, medicinal and beauty products), non-perishable items, and those which offer opportunities for adding value locally, such as tropical fruits (which can be dried or juiced). The fact that traditional African agriculture is low external input agriculture, although not necessarily organic, provides a potential basis for organic agriculture becoming a viable development option.

Organic farming practices deliberately integrate traditional farming practices and make use of locally available resources. As such, they are highly relevant to many African farmers, who have often resisted Green Revolution methods, seeing them as unsustainable, risky, and inaccessible. The overriding priority for African agriculture is to achieve sustainable food security. Organic agriculture has a huge potential in helping meet this aim, which is only just beginning to be recognized.
The total cost of growing organic wheat has been observed at USD$122.02/acre, whereas the cost of growing inorganic wheat was USD$128.66/acre.

The net returns over variable cost of organic wheat was observed at USD$363.89/acre, while it was and USD$277.55/acre for inorganic growers. The lower crop yield in organic wheat (6.7q/acre less) was well compensated by the higher price it fetched in the market

## Potential investors to this technical innovation

- Individual farmers
- FarmerGroups/Associations /Federations/Cooperatives
- Organic product exporters
- Retail chains
- Food processing industries

## Financials

The cost of commercialization will greatly depend on the chosen method of production and, of course, whether one would want to invest right from scratch or to invest in an already existing system. For the "Integrated small scale-commercial irrigation system," for instance, starting the system from scratch would require high investment in capital items such as the centre pivot, the dam, and other irrigation facilities. Investing in an already existing system might only need the training and organization of farmers and other logistical costs.

Although the cost of certification and the time and labour involved in managing the system are high, returns can also be, on average, 20% higher than conventionally produced products, provided that a market exists.

The estimated cost of producing a crop can be calculated after determining the cost of each input. Returns are computed by multiplying the estimated yield in units by the expected price per unit. The main method of setting the retail price is supply vs. demand. If the commodity is one in which freshness is valued and distinguishable, such as with sweet corn and strawberries, a price comparable to the retail price in a supermarket may be set. With other commodities and with U-Pick, consumers will expect lower prices to compensate for the extra time and energy they expend within the grower's market. Budgets will vary from grower to grower because of differences in the production methods, costs, yields, and markets.

Returns must be high enough to pay for all variable costs or the crop should not be produced. Returns should pay for all fixed costs such as tractor payments, land charges, building depreciation, insurance, and taxes, which are present whether or not a crop is grown.

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| INPUT | USED QUANTITY | UNIT COST (USD$) | TOTAL COST/ PRODUCTION CYCLE (USD$) |
|---|---|---|---|
| Seed | 5g packet | 0.83 | 0.83 |
| Labour | 90 man-days | 0.47 | 42.36 |
| Watering Can | 2 | 2.82 | 0.94 |
| Knapsack Sprayer | 1 | 17.65 | 1.18 |
| Hoe | 1 | 0.83 | 0.06 |
| Cutlass | 1 | 1.06 | 0.17 |
| Spade/Shovel | 1 | 1.24 | 0.20 |
| Hand Fork | 1 | 0.53 | 0.06 |
| Wellington Boot | 1 | 2.47 | 0.14 |
| Total | | | 47.88 |

## Target Market /Customer

The target customers include food retailers, supermarkets, hotels and lodges, as well as food processors. Since 1990 the market for organic food and other products has grown rapidly, reaching $63 billion worldwide in 2012. Organic production is a system that lends itself well to small-scale and part-time farming operations. The direct marketing of farm foods from producer to consumer, without the assistance of packers, shippers, processors, wholesalers, or retailers, can be an important outlet for small farms. Most certified organic production in Africa is geared towards export markets, with the large majority being exported to the EU, which is Africa's largest market for agricultural produce (and the world's largest organic market). Currently only Tunisia can meet the requirements for EU standards.

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## Limiting factors for large scale commercialization

- The small-scale farming sector in Zambia is well versed in the use and "abuse" of agro-chemicals since seventies. Applications are often done by hand with a brush or with old knapsack sprayers thus presenting a real danger to health. Concentrations are often incorrectly measured and become a hazard to the environment. Worst of all, the old ways (traditional farming) are quickly forgotten, which could be a source of information for local organic agricultural methods. This fact makes conversion to organic methods difficult.
- The roads in Zambia are in mediocre repair. It is, therefore, very difficult to compete with surrounding countries. However, there are excellent cold room facilities at the airport. Producing "high-value/low volume/low weight" products (e.g. fresh baby vegetables) to transport by air is a target for Zambian producers.
- In general, however, the potential of organic approaches, even those geared to premium export markets, has not yet been recognized by the majority of African governments. In consequence the organic sector in most African countries is reliant upon both foreign standards and certifying bodies. This is a major constraint on the development of the organic sector, creating a "chicken and egg" situation, where the market does not develop because the necessary infrastructure is not in place.
- Possibly, the single biggest constraint to the development of organic agriculture is that most people, including scientists, researchers, extension officers and politicians, strongly believe that organic agriculture is not a feasible option to improve food security.

## Social impact of the technology

•Increasing yields through the use of affordable inputs increases the income of farmers.
For example; yield of eggplant has increased from about 170 kg to 400 kg per one hundred square meters by use of organic techniques. This provides a richer and more varied diet and local food security. It has helped to improve livelihoods and food security.

•It has decreased financial risk by replacing expensive chemical inputs with locally available renewable resources.
•It has helped to integrate traditional farming practices.
•It has allowed farmers access to new market opportunities, both at home and abroad.
•It has helped provide much greater resilience to farming systems in times of climatic extremes, such as drought and heavy rains.
•It has helped improve human health and maximize environmental benefits.

## Any other relevant information

•The Swedish Development Agency, SIDA, is currently funding a program to develop local certification and inspection capacity in Southern and Eastern Africa (covering Uganda, Tanzania, Zambia and Kenya). The absence of local certification and inspection capacity is a critical bottleneck that needs to be overcome in order to develop the potential of African organic exports.

- There is undoubtedly room for a substantial increase in certified organic production in Africa, and smallholders engaged in it often derive significant benefits, improving their incomes as a result. Yet there are also significant constraints on the potential for developing. In part these are external: The costs of certification, problems of infrastructure, maintaining links with distant markets and the vagaries of world markets. Yet, there are also internal factors: The over-riding priority for African agriculture is that of achieving sustainable food security. Organic agriculture has a huge potential in helping meet this aim, which is only just beginning to be recognized.

# Rootstock- Scion compatibility protocol developed through grafting (Oranges)-Zambia

## Grafting – The solution to increasing Orange yields

**Name Of institute:**

Stage of development:

Patent status:

**Scientific Experts:**

1. Name + Designation

2. Name + Designation

3. Name + Designation

A rootstock is part of a plant, often an underground part, from which new above-ground growth can be produced. In grafting, it refers to a plant, sometimes just a stump, which already has an established, healthy root system, onto which a cutting or a bud from another plant is grafted. Rootstock play an important role in the life of fruit trees with respect to plant vigour, yield, fruit quality, resistance to pests and diseases and adaptability to various agro climatic conditions. The plant part grafted onto the rootstock is usually called the scion. The ability of two different plants, grafted together, to produce a successful union and to develop satisfactorily into one composite plant is termed graft compatibility. The ideal citrus rootstock must be compatible with the scion, adaptable to the appropriate soil and climatic factors and should improve one or more of the following characteristics; pest and disease resistance, cold tolerance, internal and external fruit quality, yield and post harvest quality. Ultimately, the value of a rootstock lies in its ability to improve production and/or quality of the fruit. Background to the development of Orange Rootstock trials was the fact that there is no single rootstock which is suitable for all sites or for all varieties of oranges.

## Production Process

| |
|---|
| Cut a number of 10- to 12-inch long bud graft branches from a healthy tree |
| Place the bud grafts about six to 10 inches off the ground, not higher |
| Make a 1½-inch cut in the shape of a "T" at the grafting location |
| Pick up the first bud graft branch and choose the biggest bud. With a sharp knife, gently excise the bud and a thick splinter of wood--as well as bark--to which it is attached |
| Uncover the wood and underneath the "T" cut in your orange tree by gently lifting up the bark |
| Gently insert the wood sliver with the attached bud. Start at the top of the "T" and move downward. The bud will be held in place by the target tree's bark |
| Wrap budding tape underneath and above the graft |
| Repeat Steps for each graft you want to insert into your orange trees |
| Remove the budding tape after 21 to 28 days |

## Country Context

Citrus is widely cultivated in tropical as well as subtropical African countries. While fresh fruit for the market is produced preferably in subtropical climates (e.g. South Africa) and Mediterranean climates (e.g. Tunisia, Egypt, Morocco, Libya). Citrus for juice production is predominant in tropical climates because of the possibility for higher sugar content. Zambia produced 44000 tons of citrus fruits in 2012 which is only 0.04% of the World production. This low production may be attributed to poor yields.

Grafting has helped in producing new varieties in large quantities, but also taking just 2 years. Citrus represents one of suitable and potential agro-commodities by value and by volume. Production occurs mainly in the Limpopo, Western Cape, Mpumalanga, Eastern Cape, and KwaZulu-Natal provinces. Within the Southern African Development Community (SADC) region Zimbabwe, Swaziland and Mozambique also produce citrus, although in much smaller volumes. Swaziland had 1,764 ha of land under citrus cultivation in 2010

## Scalability

Orange production has been on the increase since the 2005 production season. The increase has been mainly due to good climatic conditions in leading production areas. Production of oranges however experienced a 10% decline in 2009 when compared with 2008 and increased again to just over 1.4 million tons in 2010. In 2010, 73% (1,045,254 tons) of all oranges produced (1,428,027 tons) was exported. This indicates the important of export markets to South Africa's production of oranges. The second most important market for South African oranges is the processing sector. The sector absorbed 19% (279,449 tons) of total orange production in 2010 while the remaining 8% was sold through the local markets.

Competitiveness is described as an industry's capacity to create superior value for its customers and improved profits for the stakeholders in the value chain. The driving force in sustaining a competitive position is productivity that is output efficiency in relation to specific inputs with regard to human, capital and natural resources.

In 2010 South African orange exports represented 13.34% of world exports and its ranking on the world exports was number 2. South African lemon and lime exports represented 5.59% of world exports and its ranking on the world exports was number 7. South African grapefruit exports represented 10.96% of world exports and its ranking on the world exports was number 4. South African naartjie exports represented 2.40% of world exports and its ranking on the world exports was number 8.

The compatibility protocol technology is ready for commercialisation.

## Business and Commercial Potential

The South African citrus industry is known for excellent overall quality for fruit (strong reputation in major international markets). The industry's export operations and leading players are well established. An efficient export infrastructure exists and market access has been improved. Sound communication mechanisms to majority of industrial participants along with high level of investment in current technology within pack houses and cold chain facilities have taken place. Industry has all traceability systems in place, as required by accreditation protocols.

Rootstocks can affect both time of harvest and fruit quality and both of these factors can have a big effect on the profitability of the business of citrus farmers. Factors such as the time of harvest, fruit quality, tolerance to harsh conditions such as salts and pests/diseases are important in citrus production. Thus the importance of these research findings to a citrus farmer of entrepreneur cannot be over emphasised, this is because a farmer is able to improve fruit quality and shorten the time of harvest using this technology.

This technology has business potential especially for nursery owners and farmers who are able to supply good quality seedling which will later produce good quality fruits which are easy to sell. All farmers want the period from plantation to fruition reduced so that they can earn sooner.

Three main nursery types were identified in the survey: private nurseries, women's group nurseries and school nurseries. Together these accounted for over 80% of the nurseries surveyed. The objectives of the nursery managers varied greatly. The primary objective of private nurseries, which by and large were managed by males, was the generation of cash income. One of the main observations made with regard to private nurseries was that they tended to produce few species.

In contrast, women's groups appeared to be more eager to diversify. Since the shortage of fuel wood and other wood products was greatest in the main coffee-growing zone, the women's groups established a particularly large number of tree nurseries in this zone.

School nurseries served the purpose of educating young people in tree planting and management techniques in order to help overcome environmental problems such as deforestation and soil erosion which were becoming more serious with the increasing population.

Because of the large number of nurseries in the region there is an element of competition among them, which has had a negative impact on the viability of some of the nurseries by decreasing market size and sales. However, competition has also encouraged more intensive management and the production of higher-quality planting stock, leading to fewer losses on the farms. It has also increased diversification, as nursery managers have realized that they have to secure a market. Because of a lack of knowledge about alternative species, especially within the farming community, a vicious circle has developed in which nurseries only supply what farmers want, and lack of knowledge prevents the farmers from demanding alternative and potentially more beneficial multipurpose trees. The establishment of a communication network among agricultural extension agents, forestry extension agents, nursery managers and farmers is required to eliminate this lack of understanding.

In summary, private nurseries, run on a commercial basis, mainly by male managers, were more efficient and cost effective than other types. However, these private nurseries lacked many of the positive traits of nurseries run by women's groups. Thus the ideal nursery would appear to be one run on a private commercial basis, yet under the influence of women's knowledge and concern for social and environmental

## Potential investors to this technical innovation

a) Aga Khan Fund for Economic Development (AKFED)
b) Swiss Investment Fund for Emerging Markets (SIFEM)
c) The Africa Enterprise Challenge Fund
d) Jacana Partners
e) Wennovation Hub
f) ZARI. Mount Makulu Research Station, P/Bag, 7, Chilanga.

## Contact

a) http://www.akdn.org/mali
b) http://www.sifem.ch/
c) http://www.aecfafrica.org/about-aecf
d) http://www.jacanapartners.com/
e) http://www.wennovationhub.com/

### Limiting factors for large scale commercialization

1. The protocol is only possible in dicot plants. Not all plants can be grafted. Generally, only plants closely related botanically form a good graft union. Grafting is not a means of developing new varieties. The stock and scion must be compatible. Incompatible grafts may not form a union, or the union may be weak. A poor union results in plants that either grow poorly, break off or eventually die.

2. Labour extensive, grafting is a manual process which takes time, the process of grafting itself takes 21-28 days followed by the regular growth period of the tree so a farmer needs to be patient for the same.

3. Given the current market cycle of the industry and limited planting of grafted vines, there is not a high demand for information, so putting effort into developing packages of information and disseminating it may not result in increased adoption of rootstocks at this stage.

### Target Market / Customer

The target groups are farmers and farmer co-operatives and private entrepreneurs in form of private nursery owners who are able to supply good quality seedling which will later produce good quality fruits which are easy to sell. No farmer wants a tree that will take for ever to start giving him income. He wants the period from planting to fruition reduced. And the new technology seems to be the best option for just this. African farmers would be more than happy to adopt it.

### Financials

| Sl. | Particulars | Quantity | Rate | Total |
|---|---|---|---|---|
| No. | Fencing | 400 Sq.m. | USD$ | USD$ |
| 01 | Workshed | 20 Sq.m. | 0.66 | 264 |
| 02 | Mother Plant Block | 6000 Sq.m. | 8.31 | 166.20 |
| 03 | Irrigation with pipeline | 10000 Sq.m. | 0.08 | 480 |
| 04 | Office cum Store | 27 Sq.m. | 0.22 | 2200 |
| 05 | Shadenet House | 400 Sq.m. | 8.31 | 224.37 |
| 06 | Polyhouse | 200 Sq.m. | 4.57 | 1828 |
| 07 | Mist Chamber | 15 Sq.m. | 8.31 | 1662 |
| 08 | Polytunnel | 150 Sq.m. | 4.16 | 62.4 |
| 09 | Land preparation, nursery beds, internal roads, pathways, potting yard | 2000 Sq.m. | 4.16 | 624 |
| 10 | Water Storage | 1 unit | 0.17 | 340 |
| 11 | Total | | - | - |
| | | | | 7850.97 |

| Sl. No. | Items | Quantity | Rate $ | Total $ |
|---|---|---|---|---|
| 01 | Manures and organic fertilizers | 10 brass | 16.62 | 166.20 |
| 02 | Riverbed soil | 40 brass | 16.62 | 664.80 |
| 03 | Seeds | - | - | 83.10 |
| 04 | Plastic material for Polybag | 27 Sq.m. | 0.22 | 2200 |
| (15cm x 10cm x 150 Gauge), strips, etc. | 250 kg | 1.66 | 415.50 | 224.37 |
| 05 | Fertilizers for saplings and mother plants | 500 kg | 0.20 | 99.72 |
| 06 | Water charges | - | - | 33.24 |
| 07 | Electricity | - | - | 166.20 |
| 08 | Plant Protection | - | - | 83.10 |
| 09 | Label and stationery | - | - | 166.20 |
| 10 | Maintenance & Supervision | - | - | 332.40 |
| 11 | • Publicity & Advertisement | • - | • - | 166.20 |
| 12 | • Interest on Capital @ 12% | • - | • - | 1212.60 |
| | • Total | | | 3589.26 |

## Social impact of the technology

Increase in income for farmers hence direct social impact through following ways

a) Through high yield:  The yield per hectare is 35,500 kg in comparison with conventional varieties which has a yield of 20,500-kg. The productivity is 4000 fruits per tree per year compared to 2500-3000 fruits in ordinary variety and it takes 135 days to mature (from flowering to harvest, in summer) and 150 days in winter.

b) The root system is highly developed, penetrating the soil up to five to six feet in depth compared to a maximum of two feet in the ordinary grafted variety. This makes it less prone to natural calamities/ disasters.

c) Since the root is deeper, the water requirement is 20 % less than that of the conventional variety

d) 90 % of the fruits produced are first grade fruits compared to only 60 % of the fruits of the conventional variety.

e) Grafted variety comes to bearing from the 3rd year onwards as compared to the other varieties which comes to bearing from the 5th year onwards.

f) Disease resistant root-scion prevents mass wipe out of the crop. This enhances the livelihood security for the farming community.

## Any other relevant information

• Budding has helped create a booming orange industry, with delicious fruits that are hardy in a variety of situations.

• The orange is a hybrid, possibly between pomelo (Citrus maxima) and mandarin (Citrus reticulata), which has been cultivated since ancient times.

• Oranges are commonly peeled and eaten fresh, or squeezed for juice. It has a thick bitter rind that is usually discarded, but can be processed into animal feed by removing water, using pressure and heat. It is also used in certain recipes as flavouring or a garnish. The outer most layer of the rind is grated or thinly veneered with a tool called a zester, to produce orange zest, popular in cooking because it has a flavour similar to the fleshy inner part of the orange.

•A seedling will tend to grow upright, tending toward a single trunk, and becoming quite thorny. A grafted tree will be more highly branched. The seedling tree will not fruit for 6-7 years, contrasted to the 3-4 years for a grafted tree. The earlier fruiting of the grafted tree is partly responsible for the more highly branched form of growth

# Spot Fertilizer Applicator

Spot Fertilizer Applicator – Old use, new technique.

**Name Of institute:**
AgBIT
**Stage of development:**
Prototype stage
**Patent status:**
Patent submitted
**Scientific Experts:**
Mr Musenga Silwawa-Agricultural Engineer

According to the population projections of the World Bank, the world's population will increase from 6 billion people in 1999 to 7 billion people in 2020. With the increase in the population, the food demand has also increased which has necessitated better field operations in terms of land use, irrigation facilities, fertilizers and pesticides. Fertilizer (or fertiliser) is any organic or inorganic material of natural or synthetic origin (other than liming materials) that is added to soil to supply one or more plant nutrients essential to the growth of plants. Conservative estimates report 30 to 50% of crop yields are attributed to natural or synthetic commercial fertilizer. Fertilizer application is required to replace crop land nutrients that have been consumed by previous plant growth. It is essential for economic yields. Fertilizers typically provide, in varying proportions nitrogen, phosphorus, potassium, calcium, magnesium, sulphur, boron, chlorine, copper, iron, manganese, molybdenum, zinc and nickel.

When localized fertilizer placement (putting the fertilizer only in selected places in the field) is used, the fertilizer is concentrated in specified parts of the soil during planting, which may be either in bands or strips under the surface of the soil or to the side of, and below, the seed. This can be done either by hand or by special planting and/or fertilizer drilling equipment (spot fertilizer applicator). It is preferably used for row crops, which have relatively large spaces between rows (maize, cotton, and sugar cane); or on soils with a tendency to phosphate and potassium fixation; or where relatively small amounts of fertilizer are used on soils with low fertility levels. Where crops are cultivated by hand and planted in the hills, the recommended number of grams of fertilizer are placed in the row or planting hole, under, or beside the seed and covered with soil.

## Production Process:-

The spot fertilizer applicator comprises the following:

- A hallow cylindrical pipe casing defining a pre-dispensing chamber.
- A spring loaded reciprocating spherical ball valve fertilize flow control system at the out let.

A spring loaded movable bottom disc that provides the resistance to the soil/growth media that is attached to the spherical ball and provides the reciprocating movement and a fixed disc at the top that provides support to the spring loading capacity of the valve system.
The technology has a calibration/dispensing and control/valve mechanism with a range of 4 to 15 grams. This mechanism ensures consistent dispensing of set quantities of fertilizer. The operator carries the pack or straps the container. Dry fertilizer is applied as a side dressing after plants are up and growing. Fertilizer is also scattered on both sides of the row 6 to 8 inches from the plants and then raked in and watered thoroughly.

## Benefits / Utility

- Increased agricultural productivity and saves on labour by eliminating labourers. Cuts production costs.
- In risky environments, spot application of small amounts of N fertilizers improves fertilizer effectiveness.
- When the fertilizer is placed, there is minimum contact between the soil and the fertilizer, and thus fixation of nutrients is greatly reduced.
- The weeds all over the field cannot make use of the fertilizers and hence the soil is saved from weed growth.
- Residual response of fertilizers is usually higher.
- Utilization of fertilizers by the plants is higher.
- Loss of nitrogen by leaching is reduced.
- Being immobile, phosphates are better utilized when placed.
- Correct fertilizer placement in the root zone can greatly enhance plant nutrient uptake and minimize losses.

## Country Context

Many initiatives have been launched in Africa to remove fertilizer market distortions and harness the power of the private sector to procure fertilizer and deliver it to farmers, yet use of fertilizer continues to grow very slowly in most African countries.
Growth in fertilizer consumption in Kenya is occurring on smallholder farms—it is not driven by large-scale or estate sector agriculture. The proportion of smallholder farmers using fertilizer increased from 43% in the 1995/96 cropping season, to 51% in the 1996/97 cropping season, to 65% in the 1999/2000 cropping season, to 69% in the 2003/04 cropping season.
In every region of the world, the intensification of crop-based agriculture has been associated with a sharp increase in the use of chemical fertilizer. Given the generally low levels of fertilizer use in Africa, there can be little doubt that fertilizer use must increase in Africa if the region is to meet its agricultural growth targets, poverty reduction goals, and environmental sustainability objectives.
Ghanaian agriculture is overwhelmingly dominated by smallholders; many commodities—including cocoa, maize, and cassava—are produced predominantly on small farms.
USAID WAFP seeks to significantly increase food security and reduce poverty and hunger in West Africa. The program will increase the regional availability and use of appropriate and affordable fertilizers through: an increased regional supply and distribution of fertilizers by the private sector; increased knowledge and use of improved agricultural technologies and methods; improved efficiency of regional market transactions; and an improved enabling environment for fertilizer policy and regulatory framework development.

## Scalability

Although there has been some progress in agricultural productivity growth in Sub-Saharan African (SSA) during the past several decades, current growth lags far behind that in other regions of the world and is well below that required to meet SSA food security and poverty reduction goals. The slow growth is not surprising given SSA's less favourable agro-ecological conditions, lower investment in irrigation, and much lower use of fertilizer—only 9 kg of nutrients per ha compared to 73 in Latin America and 100–135 in Asia, where as much as 50% of the Green Revolution yield growth is attributed to fertilizer use.

The spot fertiliser applicator technology is at prototype stage requiring further development. A Patent application was submitted on 15th October 2013. In considering possible entry points for public interventions to increase fertilizer use in Africa, it is important to adopt a long-term perspective.

The demand for fertilizer depends on (a) the price of the crop, (b) the price of fertilizer, (c) prices of other inputs that substitute for or complement fertilizer, and (d) the parameters of the fertilizer production function. In a world of perfect information and well-functioning markets, a farmer would demand the amount of fertilizer that maximizes financial returns.

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## Business and Commercial Potential

Demand for fertilizer is often weak in Africa because incentives to use fertilizer are undermined by the low level and high variability of crop yields on the one hand and the high level of fertilizer prices relative to crop prices on the other. The demand-depressing effects of unfavourable price incentives are aggravated by many other factors, including the general lack of market information about the availability and cost of fertilizer, the inability of many farmers to raise the resources needed to purchase fertilizer, and the lack of knowledge on the part of many farmers about how to use fertilizer efficiently.

The technology aims to increase the efficiency with which fertiliser is applied, and therefore cut costs. This has enough potential to be marketed. The majority of farmers active in the food crop sector of developing countries are small-scale farmers who form part of the rural poor. The issue of introducing agricultural systems and improved technologies is particularly important for them since improved productivity provides not only more food but also an income. With the increase in population our compulsion would be not only to stabilize agricultural production but also to increase it further in sustainable manner. Excessive use over years of agro-chemicals like pesticides and fertilizers may affect the soil health and lead to declining of crop yields and quality of products. Hence, a natural balance needs to be maintained at all cost for existence of life and property. The obvious choice would be judicious use of agro-chemicals and more and more use of naturally occurring material in farming systems

These constraints on the demand side are mirrored on the supply side by factors that reduce the timely availability of affordable fertilizer in the market. In many African countries, private investment in fertilizer distribution is discouraged by an unfavourable business climate characterized by excessive regulations, an abundance of taxes and fees, and high levels of rent seeking. As a result, fertilizer marketing is left mainly in the hands of inefficient public agencies. More fundamentally—and regardless of whether it is being done by public agencies or private firms—fertilizer distribution is unprofitable in many parts of Africa because of the weak and dispersed nature of demand, the small market size, high transportation costs stemming from inadequate road and rail infrastructure, and the limited availability and high cost of financing.

A fertigation unit averagely costs USD$ 415.50 as compared to a spot fertilizer which is for only USD $20 hence, making the fertigation unit beyond the reach of a small farmer in terms of cost. Also a spot fertilizer applicator uses less labour as compared to a fertigation unit which is labour extensive.

## Potential investors to this technical innovation

a) Aga Khan Fund for Economic Development (AKFED)
b) Swiss Investment Fund for Emerging Markets (SIFEM)
c) The Africa Enterprise Challenge Fund
d) Jacana Partners
e) Wennovation Hub
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e) http://www.wennovationhub.com/

## Financials

### Profit & Loss Proforma USD$

| | YEAR 1 | YEAR 2 | YEAR 3 | YEAR 4 | YEAR 5 |
|---|---|---|---|---|---|
| Sales | 462547.98 | 508802.78 | 559683.06 | 61561.02 | 677216.13 |
| Direct Cost of Sales | 286042.57 | 315750.57 | 343120.52 | 377433.75 | 415176.45 |
| Production Costs for Patented Planters | 14929.07 | 16421.97 | 18065.01 | 19870 | 21857.16 |
| Total Cost of Sales | 300971.64 | 332172.54 | 3611.85.53 | 397303.75 | 437033.62 |
| Gross Margin | 161576.34 | 176630.24 | 198.497.52 | 218347.28 | 240182.51 |
| Gross Margin % | 34.93% | 34.71% | 35.47% | 35.47% | 35.47% |
| Total Operating Expenses | 122767.52 | 116989.89 | 120279.34 | 121596.81 | 126826.20 |
| PBIT | 38808.82 | 59640.35 | 78218.18 | 96750.46 | 113356.31 |
| EBITDA | 53128.92 | 74741.48 | 93319.31 | 108108.36 | 124714.20 |
| Interest Expense | 9807.64 | 8147.73 | 6413.59 | 4681.15 | 2947.01 |
| Taxes Incurred | 3189.93 | 5664.61 | 7898.07 | 10128.15 | 12145.68 |
| Net Profit | 25811.26 | 45828.01 | 63906.52 | 81942.85 | 98263.61 (98,263.61) |

Break-even Analysis
Monthly Revenue Break-even USD $ (add a colon) 26809.90 (26,809.90)
Assumptions:
Average Percent Variable Cost (add a colon) 62%

## Social impact of the technology

he work carried out by One Acre Fund, for example, bundles the timely, local distribution of inputs like fertilizers and improved seeds with three other interventions a farmer requires – namely, credit, training to improve farmers' profits and links to a market to sell their produce. This model has been shown to double beneficiaries' yields, giving those farmers not only the food and nutrition security they need, but also a resilient livelihood.

Fertilizer also has an important role to play in terms of levelling the field for female farmers. FAO has recorded women's use of fertilizer as being significantly lower than men's, mainly due to lack of access to this vital input. This is a major factor that contributes to their yields being around 20-30% lower than men's. It has been cited that this gap could be bridged sizably by improving women's access to fertilizer and such an intervention could feed a further 150 million people.

## Target Market / Customer

The main takers of this technology would be Individual entrepreneurs / farmers / industries / cooperatives / processors based out of Africa. The technology is ideal small holder farmers in Africa and is being developed for their use especially.

## Limiting factors for large scale commercialization

- In an environment characterized by erratic rainfall pattern and inadequate amount of rainfall, spot application of fertilizer-nitrogen could limit the availability of applied fertilizer-nitrogen to cassava resulting in low recovery of fertilizer –nitrogen.
- Great care has to be taken that no fertilizer is placed either too close to the seed or to the germinating plant to avoid toxicity, i.e. salt damage to the seedling (burning of the roots).


## Social impact of the technology

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1. Cost of fertilizers 10 x 80 = Rs.800= USD$13.26
2. Micronutrient mixture 24 x 80 = 1920=USD$31.82
3. Cost of labour = Rs.80 x 2 = 160=USD$2.65

2,880=USD$47.73

### As compared to a cost of a spot fertilizer-

1. Cost of fertilizers USD$20
2. Micronutrient mixture 24 x 80 = Rs. 1920=USD$31.82
3. Cost of labour = Rs.80 x 1 = Rs. 80=USD$1.33

USD$53.15

The Additional cost of USD$5.42 for a spot fertilizer applicator provides us with a higher yield as well as eliminates additional labour requirements, as a spot fertilizer applicator only need one labourer and hence lowers cost of production. Being a one time purchase, in the future it reduces the cost of production since only the initial investment is high which will be recovered in the first few years via lower cost of production itself and hence more savings and higher income to farmer.

## Any other relevant information

Applying fertilizer as side-dressing is the practice of putting it to the side of widely spaced plants grown in rows such as maize, cotton and sugar cane. Trees or other perennial crops also are normally side-dressed.


# Value Addition Protocol

Value Addition Protocols – Additional Sustenance for the African

**Name Of institute:**

Stage of development:

Patent status:

**Scientific Experts:**

1. Name + Designation
2. Name + Designation
3. Name + Designation

Value-added agriculture refers most generally to manufacturing processes that increase the value of primary agricultural commodities. Value-added agriculture may also refer to increasing the economic value of a commodity through particular production processes. Value-added agriculture entails changing a raw agricultural product into something new through packaging, processing, cooling, drying, extracting or any other type of process that differentiates the product from the original raw commodity. Examples of value added agricultural products include garlic braids, bagged salad mix, artisan bread, lavender soaps and sausages. For instance, most of the Mango fruits in Africa go to waste when they are in season. Coupled with lack of processing facilities, most farmers are discouraged to go into commercial mango production. In principle, there is potential for increasing the processing of fruits into many other products such as juices or jams.

## Production Process:-

Adding value to products can be accomplished in a number of different ways, but generally falls into one of two main types: Innovation or Coordination. In general, the problem is to evaluate what, where, how and who can efficiently perform the marketing functions

## Innovation:

Innovation focuses on improving existing processes, procedures, products and services or creating new ones. Innovative value-added activities developed on farms or at agricultural experiment stations are sources of national growth through changes either in the kind of product or in the technology of production. By encouraging innovative ideas, adding value becomes a reality.

Innovation can also come from research about alternative crops that can be grown successfully by producers to replace traditional crops. Value-added producers are able to economically profit by growing these alternative crops instead of traditional crops. Some alternative crops that show promise include industrial hemp for its fibre, kenaf for fibre, and castor bean for its oil.

## Industrial Innovation:

A specific type of innovation is industrial innovation, which is processing traditional crops into non-food end uses. These value-adding innovative activities use the research and emphasis that has been placed on finding industrial, non-food uses for common agricultural products. Examples of these ventures include producing ethanol from corn, biodiesel from soybeans and particleboard from straw.

## Co-ordination:

Coordination focuses on arrangements among those that produce and market farm products. Horizontal coordination involves pooling or consolidation among individuals or companies from the same level of the food chain. An example would be hog producers combining their market hogs to make a truckload. Vertical coordination includes contracting, strategic alliances, licensing agreements and single ownership of multiple market stages in different levels of the food chain. Vertical coordination, either through ownership integration or contractual arrangements, is necessary to link production processes and product characteristics to the preferences of consumers and processors.

Fundamental changes through coordination are altering traditional marketing relationships that link consumers, food retailers and wholesalers, food processors and producers. A coordinated effort is needed to increase market efficiency or (and?) cost reduction.

## Background

Value-added agriculture entails changing a raw agricultural product into something new through packaging, processing, cooling, drying, extracting or any other type of process that differentiates the product from the original raw commodity.
A broad definition of value added agriculture is to economically add value to a product by changing its current place, time, and from one set of characteristics to another set of characteristics that are more preferred in the marketplace. As a specific example, a more narrow definition would be to economically add value to an agricultural product (such as wheat) by processing it into a product (such as flour) desired by customers (such as bread bakers).
Producers involved in adding value should think of themselves as members of a food company that processes and markets product to consumers. Often, this involves building processing plants in the producers' geographical regions to process locally produced crops or animals. However, another model has occurred, which involves building the processing plant wherever it is most feasible and profitable, such as closer to where the final products will be marketed.
Value added products are unique, less price sensitive, and consumer oriented.

## Benefits / Utility

- Value addition is very important in that. It will solve the problem of wastage of fruits when they are in season. The seasonality will not really be an issue with regard to consumption of the fruit in that they could still be accessed even when the fruit is not in season.
- Once completed, the technology will have a lot of potential in benefiting the farmers and other business people as it would be a source of income. This income will also increase compared to just selling the fresh fruits only when they are in fruition/season.
- Producers involved with adding value will become more than commodity producers absorbing all the shocks brought about by global markets in this transitional period of agriculture. They will think of themselves as producing products for end users, instead of producing only raw commodities. For example, beef producers produce table-ready meat instead of finished (slaughter-ready) animals.
- Agricultural producers might be able to command higher prices for commodities by adapting new varieties that yield a more uniform commodity, thus reducing the need for sorting at the processing level. Since the processor no longer has to incur this cost, a portion of the savings could be passed on to the grower in the form of higher commodity prices.
- Converting raw materials into finished products increases the usability of the product.
- It helps to deliver the product at a particular desired time without having any seasonal or crop restraints.

## Country Context

The innovation system - bringing actors together to promote action learning and promote value addition along the chain from agricultural research right through to consumption, whilst promoting linkage to markets, linkage to policy issues is the way forward for Africa.
Adding value to agricultural produce is critical to increasing income and job creation in Nigeria, the Managing Director of United States Agency for International Development (USAID) MARKETS, Mr. Timothy Prewitt has said.
Prewitt, who made the assertion in an interview with the News Agency of Nigeria (NAN) in Abuja, also urged Nigerian farmers to see farming as a business and reduce dependence on the government and donors.
A total of 989 farmers (438 M, 551 F) have been trained in food processing and utilisation in the districts of Kasungu, Mzimba, Machinga, Mangochi, and Balaka.
The value chain already exists as a traditional production frame in most of the countries in ECOWAS. It became professionalised in the recent years, mainly to develop export markets. Within this value chain, operators are active in export and willing to promote its development. to adopt a long-term perspective.

The demand for fertilizer depends on (a) the price of the crop, (b) the price of fertilizer, (c) prices of other inputs that substitute for or complement fertilizer, and (d) the parameters of the fertilizer production function. In a world of perfect information and well-functioning markets, a farmer would demand the amount of fertilizer that maximizes financial returns.

## Scalability

The technology is still in its infancy stage and not ready for commercialisation. Starting a value-added agricultural business is an exciting opportunity for the small farmer interested in diversifying and exploring new markets, but starting small and finding your niche is the key to your long-term success.

FAO is undertaking various initiatives to assist government promote value addition at both high and local level.

Value added agricultural business can also be defined as any activity an agricultural producer performs outside of traditional commodity production to receive a higher return per unit of commodity sold. This includes activities such as agro-tourism and entertainment agriculture.
This wider definition has several implications. First, it implies that a value added initiative qualifies if the net return per unit of the commodity sold increases. A case in point is where an agricultural producer provides farm tours (agro-tourism) as a means of increasing net farm income. Even if the price of the commodity remains the same, as long as the overall net income increases, the initiative is considered to be value added. Second, an activity is only considered to be value added if someone is willing to pay for it.
Hence, at the end of the day, the costs incurred for carrying out the activity should be less than the benefits received. Third, while such activities are aimed at increasing net returns to the farm business, they do not necessarily imply a reduction in the levels of risk faced by the producers. In fact, they often increase the level of risk exposure since, by definition, they imply undertaking activities not traditionally performed by the producers. This implies the need to acquire additional skills where needed and to adopt risk management tools to minimize the level of risk as much as possible.

## Business and Commercial Potential

The produce-and-then-sell mentality of the commodity business is being replaced by the strategy of first determining what attributes consumers want in their food products and then creating or manufacturing products with those attributes. With the continuous shifting to a global economy, the international market for value-added products is growing. Market forces have led to greater opportunities for product differentiation and added value to raw commodities because of ncreased consumer demands regarding health, nutrition and convenience efforts by food processors to improve their productivity; and technological advances that enable producers to produce what consumers and processors desire.

No longer content to sell raw commodities, some producers are striving for a larger share of the food dollar. These projects range from adding value to hogs, cattle, bison, fish, and eggs to marketing crops like organically grown grains, potatoes, carrots, beans, tomatoes, and corn for sweeteners and fuels, to producing specialty cheese and even alfalfa-based biomass for a local power plant.

Adding value to agricultural products is a worthwhile endeavour because of the higher returns that come with the investment, the opportunity to open new markets and extend the producer's marketing season, as well as the ability to create new recognition for the farm. Increasingly, value-added products are hitting the local market as producers take advantage of high-demand product niches. This is the key to success in value added agriculture—niche markets are where smaller producers can be most successful in creating value and establishing a profitable business.

Agriculture in ECOWAS Member States is very diversified and complementary, because of agro-climatic conditions and agricultural specialisations. Member States have a great potential in terms of arable land, grazing space, water and human resources, consisting mainly of small-sized family holdings (generally below 10 ha). The ECOWAS agricultural sector plays a key role in national trade, specifically in ensuring employment, income for rural households, and food security. Furthermore, it contributes significantly to the balance of trade among Member States. In the past years, West African agriculture experienced profound changes.

Overall, the increase in production followed population growth. However, this growth is based on an extensive model of production, with low productivity, high consumption of natural resources and low returns for farmers. There are proactive production and support policies to agricultural sectors, leading to significant improvement in productivity (cotton, rice and maize production has doubled) in all Sahel countries leading to increased export volumes of products like cotton, coffee and cocoa.

ECOWAS, 4% of the volume harvested creates 18% of value. Thanks to a developed value chain, the results could be improved: 8% of the volume can create 27% of value. Moreover, the top and first qualities are generally exported and earn foreign currency. Unfortunately, decision-makers hardly think of the second quality even if the value chain is developed. Over 50% of the value generated by the mango value chain comes from sales from the second quality in the local market. Presently, in the ECOWAS region, 76% of the value generated by the mango value chain comes from sales from the second quality in the local market. With developed value chains, thanks to the reduction of post-harvest losses, the available quantity of mangoes intended for the food processing industry increases, and this industry can thus benefit from it. In 2010, the value created by the third quality was barely 6% whereas with the introduction of a developed value chain, this figure can reach 20%.

The main conclusion from this analysis confirms that the region should seize the opportunity to penetrate the export market, with quality tasteful varieties of mango. The dominant variety is gradually losing its leadership position. In the next ten years, more and more European consumers will prefer organoleptic qualities to external qualities, and because of the taste, demand for West African varieties of mango will increase.

## Potential investors to this technical innovation

a) Aga Khan Fund for Economic Development (AKFED)
b) Swiss Investment Fund for Emerging Markets (SIFEM)
c) The Africa Enterprise Challenge Fund
d) Jacana Partners
e) Wennovation Hub

## Table 20 – Profitability of mango pulp exports of 16 brix by ship

| | USD per ton | | | USD per year | |
|---|---|---|---|---|---|
| Price (C&F Rotterdam) | 800 | 100% | Turnover | 1,011,905 | |
| Sea freight | 176 | 22% | Total costs | 1,341,155 | |
| P (EXW) | 219 | 27% | Profit before tax | -329,250 | |
| | 405 | 51% | Profit % | -33% | |
| Price (delivered mangoes) | 104 | | Investment value | 840,000 | |
| Processing ration | 2.00 | | Depreciation % | 6.7% | |
| Cost of raw materials | 208 | 44% | FC1 | 56,000 | 39% |
| Other ingredients | 5 | 1% | | | |
| VC1 | 213 | 45% | Debts | 336,000 | |
| | | | Interest rate, financial charges | 12.0% | |
| Cost of production per hour | 30 | | FC2 | 40,320 | 28% |
| Volume of production per hour | 1.25 | | | | |
| VC2 | 24 | 5% | Number of FTE employed | 30 | |
| | | | Permanent salaries, social contributions | 18,750 | 13% |
| | | | Other fixed charges | 30,000 | 21% |
| Cost of packaging (aseptic sac, drum, label) | 52 | | FC3 | 48,750 | 34% |
| Number of drums per ton | 4.5 | | | | |
| VC3 | 236 | 49% | FC | 145,070 | 100% |
| | | | FC | 100.0% | |
| Loss of finished products | 1.0% | | FC % attributed to the product | | |
| VC | 478 | 100% | FC (attributed to the product) | 145,070 | |
| Gross margin | -74 | | Q Volume sold in kg | 2,500 | |
| Gross margin % | -18% | | Contribution | 184,180 | |
| VC | 478 | 89% | Break-even volume | 1,969 | |
| | | | Raw materials purchased | 5,000 | |
| FC / q | 58 | 11% | | | |
| | | | Input capacity per hour in KG | 1.25 | |
| TC / q | 536 | 100% | Working hours per day | 22 | |
| | | | Production season in days | 100 | |
| Profit / q | -132 | | Max. Input capacity per year in kg | 2,750 | |
| | | | Capacity utilization % | 90.9% | |

Note : Figure in blue Are assumption; figures in pink are calculated on another sheet; figure in black are formulas.

## Table 21 – Profitability of mango juice 25% pulp on the local market

CIGAR BOX 1 – Mango juice, (25% pulp) packaged in 200 ml sachets, 25 per sac (5 kg)

| | USD per ton | | | USD per year | |
|---|---|---|---|---|---|
| Price (delivered in Bamako | 1600 | 100% | Turnover | 3,669,173 | |
| Freight within the country | 266 | 18% | Total costs | 2,911,953 | |
| Sales Commission, 33% | 397 | 25% | Profit before tax | 757,220 | |
| P (EXW) | 917 | 57% | Profit % | 21% | |
| | | | | | |
| Price (mango pulp) | 536 | | Investment value | 384,000 | |
| Processing ratio | 0.25 | | Depreciation % | 6.7% | |
| Cost of raw materials | 134 | 19% | FC1 | 25,600 | 30% |
| Other ingredients | 150 | 21% | | | |
| VC1 | 284 | 40% | Debts | 153,600 | |
| | | | Interest rate, financial charges | 12.0% | |
| Cost of production per hour | 30 | | FC2 | 18,432 | 22% |
| Volume of production per hour | 0.54 | | | | |
| VC2 | 56 | 8% | Number of FTE employed | 5 | |
| | | | Permanent salaries, social contributions | 11.250 | 13% |
| | | | Other fixed charges | 30,000 | 35% |
| Cost of packaging (sachets, sac) | 1.6 | | FC3 | 41,250 | 48% |
| Number of drums per ton | 200.0 | | | | |
| VC3 | 360 | 51% | FC | 85,282 | 100% |
| | | | FC | 100.0% | |
| Loss of finished products | 1.0% | | FC % attributed to the product | | |
| VC | 767 | 100% | FC (attributed to the product) | 85,282 | |
| | | | | | |
| Gross margin | 211 | | Q Volume sold in kg | 4,000 | |
| Gross margin % | 23% | | Contribution | 842,502 | |
| | | | | | |
| VC | 707 | 97% | Break-even volume | 405 | |
| | | | Raw materials purchased | 1,000 | |
| FC / q | 21 | 3% | | | |
| | | | Input capacity per hour in KG | 0.54 | |
| TC / q | 728 | 100% | Working hours per day | 22 | |
| | | | Production season in days | 360 | |
| Profit / q | 189 | | Max. Input capacity per year in kg | 4,277 | |
| | | | Capacity utilization % | 93.5% | |

Note : Figure in blue Are assumption; figures in pink are calculated on another sheet; figure in black are formulas.

## Table 21 – Profitability of dried mango exports

CIGAR BOX 1 – Cabinet Dried Organic Mango Slices in bag of 100g. 50 per carton box (5 kg)

| | USD per ton | | | USD per year | |
|---|---|---|---|---|---|
| Price (C&F Le havre) | 10,000 | 100% | Turnover | 3,669,173 | |
| Commission 5% | 500 | 5% | Total costs | 2,911,953 | |
| Transport | 224 | 2% | Profit before tax | 757,220 | |
| P (EXW Bobodioulasso) | 9,276 | 93% | Profit % | 21% | |
| Price (Raw Mango, delivered factory) | 200 | | Investment value | 384,000 | |
| Processing ratio | 15.0 | | Depreciation % | 6.7% | |
| Cost of raw materials | 3,000 | 70% | FC1 | 25,600 | 30% |
| Other ingredients | - | 0% | | | |
| VC1 | 3,000 | 70% | Debts | 153,600 | |
| | | | Interest rate, financial charges | 12.0% | |
| Production Cost per batch per cabinet | 35 | | FC2 | 18,432 | 22% |
| Production volume (ton per batch) | 0.050 | | | | |
| VC2 | 700 | 16% | Number of FTE employed | 5 | |
| | | | Permanent salaries, social contributions | 11.250 | 13% |
| | | | Other fixed charges | 30,000 | 35% |
| Cost of packaging bag, label, box | 2.95 | | FC3 | 41,250 | 48% |
| Number of boxes per ton | 200.0 | | | | |
| VC3 | 590 | 14% | FC | 85,282 | 100% |
| | | | FC | 100.0% | |
| VC | 4,290 | 100% | FC (attributed to the product) | 85,282 | |
| Gross margin | 4,986 | | Volume sold q (ton) | 5.9 | |
| Gross margin % | 54% | | Contribution | 29,620 | |
| | | | Break even volume (sales) | 4.3 | |
| FC / q | 3,570 | 45% | Break even volume (raw material | 64 | |
| | | | Output capacity per batch in ton | 0.050 | |
| TC / q | 7,860 | 100% | Drying time per batch in days | 0.75 | |
| | | | Length of harvesting season in days | 120 | |
| Profit / q | 1,417 | | Max. Input capacity per year | 7.9 | |
| | | | Capacity utilization % | 75.0% | |

## Target Market / Customer

Once completed, the target group will be the farmers, industry, entrepreneurs, and Co-operatives. Africa depends heavily on Agriculture for its subsistence and development of value addition protocols could benefit most agrarian countries in Africa.

South Africa is characterised by high levels of poverty, especially in rural areas where approximately 70 % of South Africa's poor people reside. Their incomes are constrained because the rural economy is not sufficiently vibrant to provide them with remunerative jobs or self-employment opportunities. A range of value-adding technologies to extract future value will help not only South Africa but also countries like Zambia, Nigeria and Tanzania.

Value-adding agro-processing of food commodities increases food security in four major ways; namely:

i) Reduction of post-harvest losses which are currently estimated by several organisations (FAO, CIRAD, NRI and UNIDO) to be as high as 30% in cereals, 50% in roots and tubers, and up to 70% in fruits and vegetables;

ii) Extending the shelf-life of food, making most food especially perishables tradable and easier to move over long distances from areas with surplus to areas with deficits; (could use rewording)

iii) Enhance incomes and creation of employment along the food chain from production to marketing; and

iv) Improving the quality and safety of foods through appropriate certification, traceability systems and harmonisation of standards, thus improving access to markets.

All these make African markets most suitable for value addition protocols.

## Limiting factors for large scale commercialisation

- Value added agriculture is not without its challenges to farmers. One of the largest hurdles to overcome is that of food business and safety regulations. For example, if you are interested in taking your organic blueberries and turning them into a high quality jam that you can sell at the local farmers' market, you must be a licensed commercial kitchen in order to produce that product and sell to local consumers. You will also need to carry liability insurance if you are selling at the farmers' market to cover any sort of illness or other food safety issues that may arise.

- Another example of a significant challenge for starting a value-added business is putting together your recipes or formulations for the product you are developing. For instance, making soap from your lavender flowers requires time and effort in finding the right recipe for high-quality soap.

- Markets for value added food commodities are thin. Marketed surplus of smallholders is small, and selling in distant markets increases transaction costs. This acts as a disincentive to smallholders to add value to agricultural commodities.

# Contact

a) http://www.akdn.org/mali
b) http://www.sifem.ch/
c) http://www.aecfafrica.org/about-aecf
d) http://www.jacanapartners.com/
e) http://www.wennovationhub.com/

## Social impact of the technology

Once completed, the technology will have a lot of potential in benefiting the farmers and other business people as it would be a source of income. This income will also increase compared to just selling the fresh fruits only when they are in fruition/season. In today's global economy characterised by fierce competition, it is becoming extremely difficult for agricultural producers to focus solely on producing primary commodities and still expect to realise a decent standard of living. Adding value to agriculture is a logical way to stem the decline in farm income. The technology will provide a way to provide for an alternative source of income for poverty ridden African households.

A study of fourteen farmers in the Southern US, conducted by ATTRA and the Southern Sustainable Agriculture Working Group, identified ten keys to success when pursuing a value-added business. These include: starting small and growing naturally; making decisions based on good records; creating a high-quality product; following demand-driven production; getting the whole family or partners involved; staying informed; planning for the future; continuing evaluation; persevering; and having adequate capitalisation

## Any Other relevant information

• Before producers examine value-added processing and marketing, cost minimisation in production must be achieved. Only low cost and efficient producers will be able to survive and compete in production agriculture. Adding value cannot take the place of reaching the efficiencies of production attainable through technology and economies of scale.

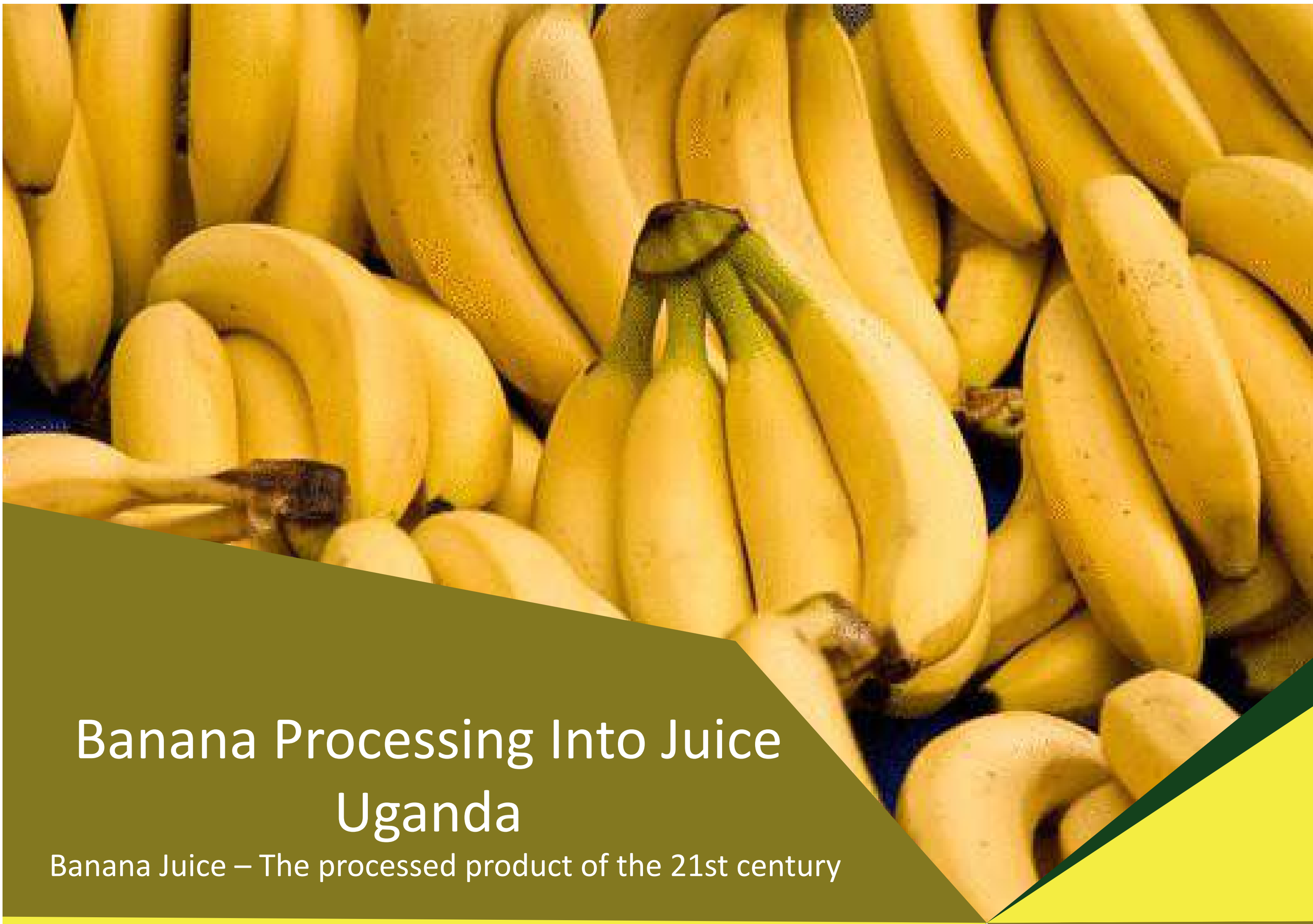
• Types of value-added products included (in order of frequency. Note that some respondents are doing several of these):

Condiments (jam, jelly, hot sauce, vinegars, seasonings) (5)

Baked Goods (pies, biscuits, cookies, etc.) (4)

Cheeses (3)

- Entrees (jambalaya/bean soup mixes) (2)
- Health/Beauty (soap/bath, lip balm, hand cream) (2)
- Salad mix (packaged for retail)
- Beef (hormone/antibiotic-free)
- Rice (packaged organic jasmine)
- Popcorn (popped, whole-kernel, nuts/syrup)
- Crafts using on-farm inputs
- Cut flowers
- Pickled foods
- Agro-entertainment (B&B, tours, workshops)



# Banana Processing Into Juice Uganda

## Banana Juice – The processed product of the 21st century

### Name Of institute:
Afri Banana Products Ltd

### Stage of development:
Ready for commercialization

**Patent status:** IP filed

Uganda, a landlocked country in East Africa is one of the world's top banana-growing countries, with a production amounting to as much as 10 million tons of the fruit each year. South Western Uganda alone accounts for 60% of the bananas produced in the country. However, the banana market is under-exploited and its potential is under-utilized and therefore there is a need for innovation in the way the fruit is produced, consumed and marketed. Attractive opportunities could then be used to lure ambitious entrepreneurs into increasing the market's capacity. With increased capacity, the banana market could also act as a bastion of food security. Owing to the great importance of bananas and their wide production in several parts of Uganda, more income could be realized from processed and value added plain fresh banana Juice. Therefore, for higher returns in the economy and better living conditions for the people, there is a need to develop and make use of simple technologies in Banana Juice Processing. It is also important to develop mechanical means of juice extraction so as to increase the output capacity and the hygiene standard of the juice and reduce the drudgery and other problems associated with the traditional manual method.

## Production Process:

The production process for Banana Juice can be well explained by the following flow charts: -

### Traditional Method

- Peeling ripe bananas and cutting them into pieces
- Mashing banana pieces and spear grass to a pulp The role of the added spear grass is to modify the rheological properties of the pulp thus its use is amust if banana pulp mass is to release the juice
- Continuous pressing, folding and turning the pulp mash mixed with spear grass until juice starts to appear
- Filteration of Juice extracted
- Packaging of the juice for sale in markets after pasteurization

### Enzymatic Method

- Peeling ripe bananas and cutting them into pieces
- Blanching for about 2 minutes in steam
- Mashing blanched banana pieces to a pulp
- Adding 'Pectolytic Enzyme' (At a concentration of 2 gm per 1 kg pulp)
- Heating the concentrated pulp atabout 60 to 65°C and 2.7 to 5.5 pH for30 min followed by Centrifugation,Filtration and Packaging

In the traditional method, extraction on a small scale is done using a bucket or source pan by bare hands. Specific kinds of bananas are used by the farmers for juice extraction because of their unique ability to release juice when processed by this method.

## Background

Banana is grown by about 75% of the country's farmers on as much as 40% of the total arable land in Uganda. The fertile soils and favorable climate guarantee production for the greater part of the year.

Cooking banana commonly known as matooke (also used for Juice Production), a staple food of the large population in the country is harvested and transported in bulk to urban areas. However during this transportation process, for every 100 kg transported, 40 kg are just stalks and peelings (waste) which raise the cost of waste disposal.

On a daily basis, large trucks of fresh bananas are transported from the western region to Kampala (the Capital city of Uganda) due to the high demand. Because of the bulky nature and perishability of fresh banana and the long distance to the market, the margin between farm gate and the Kampala retail price is usually very high, above 50%. Since farmers do not add value to bananas, they receive only a small margin, inspite of investing in the production of the crop.

Despite the excellent production potential, processing of this fruit is unfortunately low and the potential for extraction of juice (as one of the viable and profitable processing options) which can expand this market considerably remains under-utilized. This in turn hampers the development of the country leaving farmers in poverty. A regular supply of bananas is very important for banana-juice production.

Although this technology has been in the country for some time, its use in the region has been limited and thus it has a great potential for development in the urban markets of Uganda, other African countries and International markets.

## Benefits / Utility

- Value addition in the form of banana juice helps reduce bulk storage space, and increases shelf life and the income earned by farmers and other players in the value chain.
- There are high post-harvest losses during peak seasons (when prices can be as low as USD 0.5 for a bunch weighing 18-20 Kilograms). The high perishability of the commodity, poor post-harvest handling and poor road networks limit timely market access. Banana Juice Processing technology eliminates these challenges because ripened bananas are processed and the juice is sold in the markets at much higher prices. The higher prices ensure protection against perishability and post-harvest losses, and thereby increase the margins available on the crop even further.
- This technology also helps in poverty alleviation by providing employment to people. It improves their incomes, enabling them to access their basic needs and facilitates better house hold savings, etc.

## Scalability

Though, Uganda is Africa's largest banana producer with an estimated annual production of over 10 million t/year, currently, only 20% of the banana produced in the country is suitable for processing into beer/juice. Banana juice is a special juice prepared by a traditional technology but its marketing is limited to the villages. In order to meet the growing demand, fruit juice is imported into the country. This is a strong indication of the existence of investment opportunities in fruit juice processing, for local and export markets and indicates the scalability of the business.

## Country Context

Agriculture is the most important sector of Uganda's economy and employs over 80% of the work force, with banana as its staple crop. The country's per capita consumption of bananas ranges between 220 kg and 460 kg per year which is the highest in the world. The reality however is that the sector has been confined to the back-seat in terms of priority. Despite all these statistics, agricultural productivity in the country is still low and most farmers are still struggling, living a substandard life and depending on a subsistence form of production. Although processing is still considered low due to limited extraction and packaging of juice, the positive strides witnessed in the last two years signal improvement as both juice production and farmers' involvement has grown.

Table- 1 Production of bananas in Uganda (tonnes)

| Banana type | Year 1995/1996 | Year 1999/2000 | % production 1999/2000 |
|---|---|---|---|
| Cooking bananas | 7,908,984 | 5,545,134 | 90 |
| Brewing bananas | 1,164,887 | 538,304 | 9 |
| Sweet (dessert) bananas | 383,949 | 46,286 | 1 |
| Total | 9,457,820 | 6,129,724 | 100 |

Source: Ugandan National Household Survey 1999/2000

Uganda has a number of advantages which is why the big fruit companies are currently very interested in banana processing in the country. Banana production can be done at a low cost here because labor costs are low and raw material is easily available. Another very important reason is to do with trade and trade policy since at present Africa has free access to the European market which is not the case with Latin America.

Furthermore, the Ugandan Government has also provided their support to the co-operative sector especially regarding the provision of loans to farmers, through their agreement with the DFCU Bank, Uganda. This serves as yet another incentive for investors to invest in juice extraction which is coming up as a very promising option in the country.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## Business and Commercial Potential

The market in Uganda has been a struggling one, but it is promising. Fruit juices are popular in the country especially among the well-to-do class which includes the upper income class, some of the working class and the expatriate community. The rest of the local population is not in tune with the consumption of processed packaged fruit juice.
Urbanization which will increase demand, and any income growth especially by poorer and middle-income families is viewed as beneficial to Banana Juice market prospects as it could effectively tap the unexpressed demand. Urbanization is rising with 16% of the population living in urban areas in 2000 and predictions that this figure will rise to 22% by 2017. An increasingly urban population will lead to higher volumes of juice being consumed in both rural and urban areas.

## Potential investors to this technical innovation

1. Small and Medium scale enterprises
2. Food processing companies
3. Banana farmers' cooperatives
4. Non-Governmental Organizations
5. Export houses
6. Retail chains
7. Student entrepreneurs

## Financials

The fixed assets required for a Banana Juice Processing Plant in Uganda are as follows:-

1. Complete stainless steel processing equipment, comprising of a processing unit, ripening room and a blower costing approximately US$ 40,000
2. Viable commercialization of juice processing technologies would require an investment of between US$ 50,000-200,000
3. At US$ 50,000, the processing of juice would be labor-intensive and packaging would be in plastic bottles whereas at US$ 200,000, the system of production would be automated and packaging would be in tetra packs

As per the report generated by the Uganda Investment Authority, the estimates for fresh fruit juice processing are as follows:

- The total investment is estimated at US$ 2,445,856
- The plant has the capacity to produce 292,000 liters per year
- The Payback period is estimated at one (1) year

## Target Market / Customer

A fast growing middle class and a more health conscious population is spearheading the increased consumption of fruit juices. More Ugandans are consuming fruit juice even though its price remains slightly higher compared to other soft drinks. However, packed fruit juices have become popular with consumers only in the last decade.

Prior to that, it was rare to find people taking fruit juice as it was labelled as expensive and was limited to a certain section of the population. This is however changing, as more people embrace packed fruit juices. Even though there are hardly any statistics to quantify this trend, the growing investors' interest in the sub-sector confirms the growth in consumption especially among school-going children, in supermarkets and in social gatherings such as weddings. Currently, the demand for Uganda's organic products in the integrated market is close to 7 times higher than the supply and this presents a high opportunity for export of organic fruit juice from Uganda.

## Limiting factors for large scale commercialization

1. Poor access to capital presents a significant challenge to entrepreneurs.
2.Limited knowledge of the consumers about the product, lack of storage facilities and irregular supply of bananas are some of the important problems which need to be addressed for proper functioning of the Juice producing value chains in the country. To produce large volumes in peak fruit season without a ready market can greatly tie up badly needed working capital which is yet another problem for producers.

3. To operate commercially, a certification is required from the Bureau of Standards, the cost of which is quite prohibitive for a start-up company.

4. Less market information among the SMEs involved in fruit juice production

## Social impact of the technology

1. Value addition of Banana into juice will significantly contribute to Uganda's development. Adding value to what the majority of the people of the country grow helps alleviate their living standard, thereby moving them out of poverty and enabling them to access their basic needs.

2. Establishment of banana processing plants will create employment opportunities in rural areas ranging from low skilled jobs like banana production and transportation to skilled ones such as sales and marketing.

3. Processing of banana will reduce the post-harvest losses.

## Any other relevant information

Banana varieties suitable for juice production
The different Banana varieties growing in Africa and their juice content can be summarized as follows:

| Banana Variety | Juice Content | Yield |
|---|---|---|
| Pisang Awak | 50% | Low |
| FHIA25 | 50% | High |
| Cavendish | 15% | High |
| FHIA1 | 15% | High |

# Banana Charcoal Briquettes Technology-Uganda

## Banana Charcoal Briquette: - Use of Waste to save Uganda's future

**Name Of institute:**
Afri Banana Products Ltd

**Stage of development:**
Ready for commercialization

**Patent status:** No IP protection

Uganda is the largest banana producing country in Africa. About 75% of the country's farmers grow it on as high as 40% of the total arable land. Waste in the form of banana peels and stalks (about 40%) poses a big problem of garbage accumulation (510 ton per day just in Kampala) and its disposal is very expensive and takes up a lot of time.

Furthermore, as electricity supply is very expensive and limited, about 98% of the energy consumption requirement of rural and urban areas in Uganda is met through biomass sources derived from forest and crop residues. These give out a lot of smoke which has a direct negative impact on health and the environment, especially by causing eye and respiratory diseases. With the population explosion, the demand for energy is increasing at a rate of 10% annually (Uganda Ministry of Energy and Mineral Development (MEMD). Biomass has historically been a cheap and accessible source of fuel for Uganda's population but this is unlikely to continue since the high dependency is raising concerns about the sustainability of these resources, as human populations and competing demands increase.

One of the feasible solutions to this problem is to recycle banana peels which are produced in every home as waste (due to the high levels of banana consumption). They can be used to produce 'Clean Briquettes' as a substitute to the commonly used fuel -wood/charcoal which are considered the prime factor for the fast depletion of green forests that is causing imbalance in the ecosystem.

This technology started in Lungujja near Kampala, the capital city of Uganda , where a woman named Namusoke Immaculate, the founder of Bakyala Tweyune women's group, has innovated a new method of alternative fuel by turning banana peelings into charcoal briquettes.

## Production Process:

The production process involved in the production of Banana Charcoal Briquettes can be well explained by the following flow charts:

### Domestic Production Process

Mashing banana skins and leaves to a pulp

Mixing the pulp, charcoal dust and fine sand in a ratio of 2:1:1, to create a mouldable material

Cutting the pulp mix into smaller portions and then drying in the sun (Drying period: 3-7 days)

### Commercial Production Process

Preparing a mixture of sun dried and semi-burned banana peels, clay soil and starch

Pouring the mixture into a mould or a briquette press for shaping the briquettes

Drying in the sun

## Background

With only 5% of the rural population having access to electricity, more than 90% of the country's total energy needs in Uganda come from biomass sources. Of this, wood accounts for 80%, charcoal 10% and crop residues nearly 4%. Approximately 4 million tons of wood (15% of the total) are consumed to meet the annual demand for charcoal, which in 2010 was estimated by different sources to be between 7,00,000 and 8,50,000 tones. In Kampala alone the charcoal demand was 2,05,852 tones. According to the reports of FAO, Uganda lost 26% of its forests between 1990 and 2005 (78% in areas around Kampala), which are now estimated to constitute 24% of the total land cover. The National Environment Management Authority (NEMA) in the report 'State of the Environment Uganda 2008' has predicted that this deficit will lead to complete depletion of the nation's forests by 2050.

Used mainly in urban areas, charcoal consumption is estimated to increase at 6% per year, which matches the rate of urbanization. The availability of cheap (and often free) firewood and charcoal has been part of the reason why such biomass has prevailed as the dominant source of energy in developing countries. However in recent years Uganda has faced significant increases in charcoal prices.

Renewable energy sources such as Banana Charcoal Briquettes provide a feasible energy supply option in rural areas and urban centers that is cleaner in terms of emission than fuel wood and also meets the concerns of social justice by employing poor people and youth in biomass collection, briquette production and marketing. The production technology of Banana Briquettes makes energy out of waste, ie, it utilizes unwanted biomass resources such as banana peels which constitute about 50% of the urban waste and converts it into briquettes to substitute the use of fuel wood and charcoal, which is the major cause of deforestation and environmental degradation in Uganda.

The technology is suitable for promotion in both urban and rural set-ups in Uganda since on the one hand, Banana waste is a common menace, while on the other, the present sources of energy such as charcoal are becoming more and more expensive.

Although this technology has been in the country for some time, its use in the region has been limited and thus it has great potential in the urban markets of Uganda and other African countries.

## Benefits / Utility

- Banana Charcoal Briquettes offer an innovative way to use waste from bananas which pose serious disposal problems and high costs because over 7 million people consume bananas on a daily basis, generating waste amounting to over 500 tons in the urban areas alone. The huge waste has high cost implications in terms of appropriate disposal. For instance, the Kampala Council spends approximately USD 7 per ton, to dispose of urban waste. This means that, the cost of banana waste disposal is USD 3,500 per day or more .

- This technology also aims at saving the environment by considerably reducing the use of charcoal and traditional firewood as a source of energy. Traditional firewood and charcoal which are used by a majority of the Ugandan population, lead to air pollution, deforestation, global climate change and soil erosion among others.

- Due to the lack of other sources of energy, charcoal and firewood are most frequently used. They produce a lot of smoke that has a direct negative impact on health, especially by causing eye and respiratory diseases among women and children. Banana Charcoal briquettes are the best alternative fuel to charcoal and firewood

- Creation of employment opportunities in rural areas ranging from unskilled jobs like waste collection and transportation, to skilled ones such as sale and marketing of briquettes, thereby empowering people.

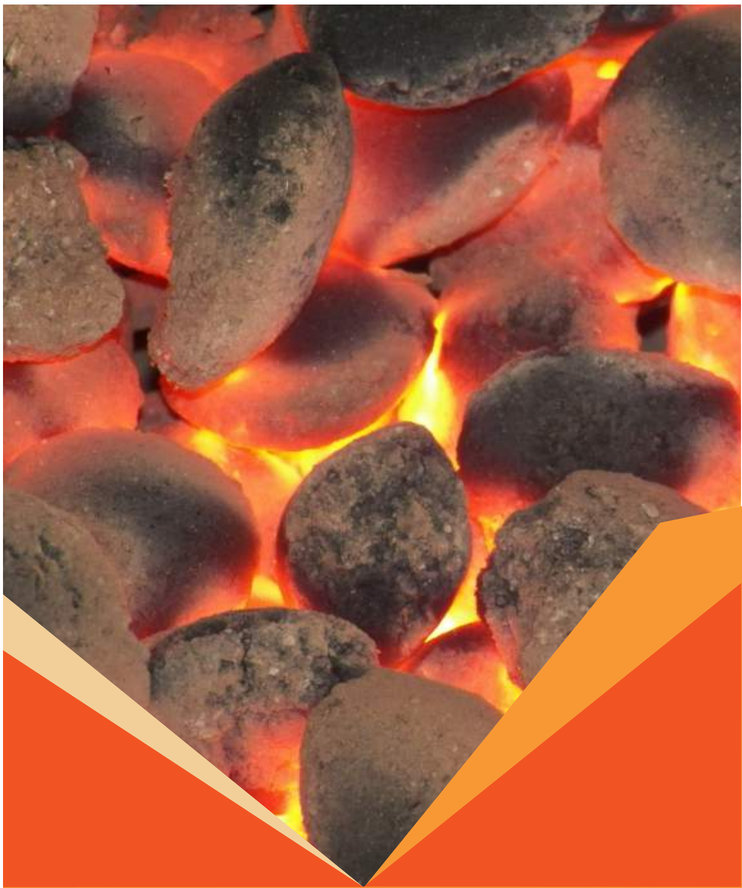
- This technology would also help in poverty alleviation by improving incomes and enabling people to access their basic needs and facilitating better house hold savings, etc.

## Scalability

In 2008 the average price of a 40 kg sack of charcoal was USh 15,000 (US$6) and during 2009 it rose to USh 25,000 (US$10), an increase of 66% in just twelve months. Prices increased substantially again in 2011, with the cost of a sack in the capital Kampala reaching USh 60,000 (US$24). Meanwhile, 4 pieces of firewood (which is estimated to substitute 3.3 kg of charcoal) were sold for Ush 2,000 (US$0.8). Research by the Uganda LPG Association expects Ush 80,000 (US$33) of charcoal to last for 2 weeks and Ush 80,000 of LPG to last for 4 to 10 weeks, depending on the family size and cooking frequency. For the purpose of comparison, the assumption that briquettes can replace charcoal weight for weight means that Ush 80,000 could last for 2 to 4 weeks. Such price trends are beginning to make an economic case for briquettes which can cost between Ush 32,000 (US$13) and Ush 40,000 (US$16) for a similar 40 kg sack and often last longer than traditional charcoal. The usage of briquettes is comparatively lower – around 3 kgs a week which costs around USh 1500 (US$0.64). Further briquettes do not produce any smoke, making them an eco-friendly alternative. With the spiralling demand for alternate fuels, the production of charcoal briquettes could be scaled-up by involving rural and urban entrepreneurs.

## Country Context

Large quantities of Banana peels and stalks (about 40% of the waste produced in Uganda) accumulate every day in Uganda. The city of Kampala alone produces banana waste of about 510 tons per day and its disposal is very expensive and time consuming. Given the degree of waste accumulation charcoal briquette technology will pave the way for a better energy source to Ugandans and also help in effectively disposing the waste



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## Business and Commercial Potential

The contribution of firewood and charcoal to Uganda's GDP is estimated at USD 48 million and USD 26.8 million respectively (UNDP, 2011). In terms of employment, biomass production creates nearly 20,000 jobs for Ugandans. In terms of quantity, the household consumption of firewood and wood for charcoal was estimated at 22.2 million tons in 2006, with small industries consuming a further 5.5 million tons creating a total annual biomass demand of 27.7 million tons nationwide. The annual biomass consumption per capita is estimated, for rural and urban areas respectively, at 680 kg and 240 kg of firewood and 4 kg and 120 kg of charcoal. Approximately 4 million tons of wood (15% of the total) are consumed to meet the annual demand for charcoal, which in 2010 was estimated by different sources to be between 7,00,000 and 8,50,000 tons. In Kampala alone the charcoal demand was 2,05,852 tons. Nonetheless these economic activities are also accumulating significant costs as a result of environmental degradation. Millions of Ugandan shillings are estimated to be lost each year as a result of biodiversity loss and degradation of soil resources.
Thus, with the depletion of forests in Uganda along with other major problems resulting from the high demand for firewood, the technology of producing Banana Briquettes as a source of energy to substitute charcoal and firewood has huge business potential in the country, as an excellent opportunity for emerging companies, to target the local and regional urban markets.
It has also been established by reports that biomass briquettes from waste could only contribute a maximum of 6% of the country's total wood consumption and 50% of the charcoal trade and therefore cannot be the only solution to addressing the sustainability problems of biomass use in Uganda. However, if production can be scaled up, then biomass briquettes can certainly play an important part and represent commercial opportunities at multiple scales of operation in the domestic and institutional fuel markets.
Although briquetting technology has been present in Uganda for over twenty years, the wide availability of biomass for energy purposes has meant that the extra processing steps involved in producing briquettes have never allowed then to compete on a commercial scale. However, with the current rate of increase in charcoal prices, lack of firewood and further deforestation concerns leading to increases in the levies on charcoal burners, briquette production is becoming more viable financially and more ventures are beginning to appear.
The briquette industry in Uganda is still young; nevertheless appropriate interventions can enable it to expand to a scale that can significantly impact the fuel market. Opportunities exist for all scales of businesses to grow and tap into the available markets and with targeted support, the Ugandan briquette industry can be developed from a sporadic spread of small enterprises into a widespread and self-supporting industry. Areas of intervention include improving the available technology, fostering the skills of entrepreneurs, facilitating capital and developing the delivery network.

## Potential investors to this technical innovation

1. **Large banana growing farmers**
2. **Farmers' cooperatives**
3. **Student entrepreneurs**
4. **Biomass fuel producing companies**
5. **NGOs**
6. **Rural unemployed youth**

## Financials

The main costs associated with this technology would be acquisition and maintenance of a banana press or moulding equipment. Raw material, ie, Banana waste is locally available; thus a kilo of banana charcoal briquettes would retail for approximately US$0.35, way below an equivalent amount of conventional wood charcoal retailing at approximately US$0.85.
Selling Price - US$240 and US$50 (per ton of Banana Charcoal Briquette)
Small Briquette Press - USD 2,500 (approximately)
The indicative investment analysis for briquette production is provided in the table below:

| Assets | No of units | Cost (in USD) | Income (in USD) |
|---|---|---|---|
| Manual Press (capacity 100 kg per day) | 1 | 500 | 0 |
| Working capital Rent | 1 month | 300 | 0 |
| Transport (raw material + product) | 2.5 tons | 40 | 0 |
| Labour | 30 days | 200 | 0 |
| Packaging | 1250 packs | 70 | |
| Possible sales 2 kg packets of briquettes | 1250 per month | 0 | $750 |
| **Total** | | **$500 +$610** | **$750** |

## Target Market / Customer

Banana Charcoal Briquettes can substitute charcoal in domestic and institutional uses such as cooking and heating, where they are favored for being near-smokeless. In comparison to charcoal, they have a more consistent heat output, which is preferred by certain market segments such as restaurants, hospitals and schools (whose average consumption of bananas is 3 metric tons/month in Uganda) and they also burn for a longer duration. One of the target industries for briquettes can be the Poultry farming industry in Uganda, which requires longer burning and smokeless briquettes to heat cages overnight when temperatures are low. Briquettes can serve as a cheaper alternative to electric heating lamps. Secondly, due to significant rises in the price of charcoal in recent years, domestic users among rural populations as well as the urban and peri-urban poor can adopt briquettes to replace charcoal for cooking.

In terms of burning characteristics, institutions like schools and households have similar requirements as both
need fuel for cooking. The size and shape however may be different because institutions typically have larger stoves. Other target consumers of briquettes can be roadside food vendors, charcoal vendors and urban households with medium to high income.

## Limiting factors for large scale commercialization

• Lack of access to capital presents a significant challenge for entrepreneurs interested in producing charcoal briquettes

• Packaging material is still a challenge. The packaging material available in Uganda cannot sustain transportation of charcoal briquettes over long distances. When packed in sisal bags, they usually crash against each other.

• Although large quantities of charcoal briquettes have been produced, there is lack of a readily available market to motivate more production. Therefore, the majority of what is produced is used for home consumption.

• The local population does not understand the new technology and need to be informed if they are to shift from using ordinary charcoal and wood fuel to Banana charcoal briquettes.

• Most people undertake charcoal briquette production as a side business even though a lot of time is required to produce briquettes in large quantities. Therefore, there is always a tradeoff between full time jobs and charcoal briquette production.

## Social impact of the technology

• The value addition which is done through this technology will significantly contribute to development in Uganda. Adding value to what a majority of the people in the country grow helps alleviate their living standard, moves them out of poverty and enables them to access their basic needs besides facilitating improved house hold savings and providing other benefits.

• Due to the lack of other sources of energy, charcoal and firewood are largely used. They produce a lot of smoke that has a direct negative impact on health, especially by causing eye and respiratory diseases among women and children. Production and use of Briquettes which are clean in this sense will protect people from serious health disorders.

• Creation of employment opportunities in rural areas ranging from low skilled jobs like waste collection and transportation to skilled ones such as the sale and marketing of briquettes.

• Significant use of the waste product of banana will help reduce the consequences of waste decomposition. Moreover, creating an energy product from waste will generate revenue which can contribute to the GDP of the country.

## Any other relevant information

Sun drying of briquettes

Drying is always a great challenge for briquette manufacturers. During sun drying, handling at multiple levels results in a number of broken briquettes which have to be recycled again. This also makes the drying process labor intensive because the entire batch of briquettes that has been produced has to be moved by hand every morning, every evening and before and after every rain pour. The long drying time also makes briquette handling challenging with the risk of mixing up the wet briquettes produced on different days. Hot air driers can be used to overcome this challenge.

Mechanising briquette production in Uganda
81% of the entrepreneurs use hand-made methods to make briquettes and only 3% use motorised machines. The maximum production rate achieved by hand is around 8 kg per day whereas a motorised machine can produce up to 1,000 kg per day. Afri Banana Products Ltd has taken steps to commercialize this technology for the benefit of entrepreneurs.

# Banana Wine Technology Uganda

Adding a twist to traditional banana
Uganda's most important export

## Name Of institute:

Afri Banana Products Ltd

## Stage of development:

Ready for commercialization

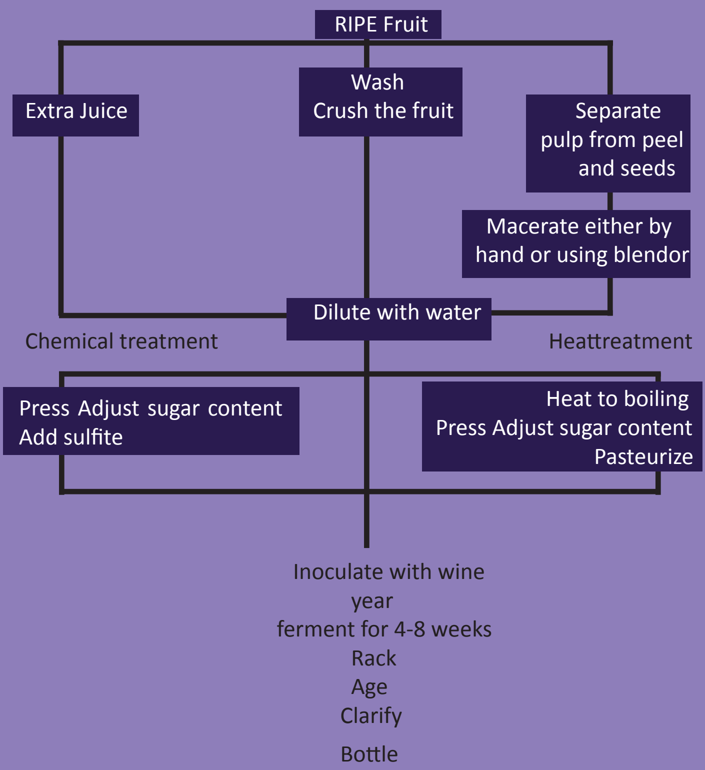
## Patent status: No IP protection

Sub Saharan Africa contributes a third of the global banana production which provides more than 25% of the food energy requirements for around 70 million people. Uganda is the World's leading producer of the cooking type banana (plantain) and ranks second in total banana production after India (Bazirake, 2008) with its total banana production valued at US$1.6 Billion in 2011, (FAOSTAT, 2013). Uganda is closely followed by Tanzania and Rwanda as exporters with Tanzania having the highest yields over the years. In 2011, banana was ranked as the most important food and agricultural commodity (ranked by value) in Uganda, followed by cassava and maize respectively (FAOSTAT, 2013). Banana can be processed into many value added products among which banana wine technology has immense business potential.

## Process of making Banana wine:

1. Preparation of Must: Raw banana is cut into small pieces to ensure maximum extraction of juice. The fruit may need to be boiled depending on how hard it is. The extracted juice from the fruit is called 'Must'. The must may need to be diluted to adjust the pH or to increase the volume.
2. Chemical Treatment of Must: Sodium metabisulphite is used in order to prevent the growth of micro-organisms and browning of the bananas. It is added at the rate of 5 ml of 10% sodium metabisulphite solution per gallon of fruit must.
3. Heat Treatment of Must: This is an optional process where fruits with low pectin content are boiled in order to solubilize the pectin content.

4. Adjustment of Sugar Content and Acidity of Must: Sugar is an essential constituent of all wine as it is required by yeast in order to ferment alcohol. Sucrose or redefined sugar is the most commonly used sugar in wine making. The recommended sugar content is 20% for dry wines and 25% for sweet wines. The acidity which contributes greatly to the production of good quality wine, is maintained by adding citric acid, tartaric acid and malic acid. Dry wines have an optimum pH of 3.0 – 4.0, while for sweet wines the optimum pH is around 3.5 – 4.5.
5. Preparation of Yeast Inoculum: Saccharomyces cerevisiae is the preferred yeast inoculum. Commercial yeast starters are available both in pellet and in liquid form. For preparation of the starter, 20% of the must is separated, placed in containers and pasteurized for 30 minutes by boiling at 80 – 85oC. The solution is then cooled to 40 – 50 oC and aseptically inoculated with the yeast. After 24 to 48 hours this solution is added to the remainder of the must. Fermentation is now allowed to take place for 4 to 6 weeks or till the wine has become clear and has a specific gravity reading between 0.990 and 0.998.
6. Post Fermentation Processing: The wine is decanted in a process known as racking to remove the deposit of dead yeast cells and other insoluble matter which has built up. The wine so prepared can be bottled and marketed.




## Background

Banana occupies over 40% of arable land in Uganda, with over 7 million people consuming bananas on a daily basis as the main staple food. In addition to cooking bananas, there are four other types of bananas that are produced here. These include dessert bananas, the roasting type and juice bananas. Banana wine is a traditional drink of East Africa, and it plays a role in social events and cultural rituals in Buganda. It is a recent entrant in global markets, as a processed banana product. Banana wine has also been marketed as an efficient way to preserve this highly perishable fruit.

## Benefits / Utility

• Banana wine - an alcoholic drink with the nutritive benefits of both unfiltered malt and yeast, has been locally preferred and consumed since the ages for its unique taste and flavor.
• Like other wines, Banana wine can be stored for a long time without any fear of spoilage.
• Banana wine is traditionally considered a pre-requisite in solemn occasions like funerals and also in weddings and social gatherings.
• Banana was observed to be associated with a reduction in the risk of colorectal cancer, breast cancer and renal cell carcinoma in women. Thus, a wine produced from banana is a worthwhile venture.
• Banana wine production has the potential to be a subsidiary occupation for many households in Africa, to supplement their income.

## Country Context

In the Great Lakes states of Rwanda and Burundi, East African highland beer bananas predominate and are used for production of fermented banana products which account for US$81 million in Rwanda. In Kenya too, the industry is growing fast. This industry is already meeting the urban market demands in Nairobi, Mombasa and other large cities along the coast. Banana wine is one of the fastest growing processed products of banana to enter the market in Africa, especially in Malawi.

## Scalability

While banana is the second most important food and cash crop in Rwanda, covering about 25% of the country's arable land, its potential has not been fully exploited to reap commensurate economic benefits. Generally, 24 banana bunches produce 8.25 to 9 liters of banana wine. In a year, there is potential to produce between 30 and 300 liters of banana wine per family. On an average 297 liters /household can be produced, with an expenditure of US$300 to US$335/household/year for banana wine processing.

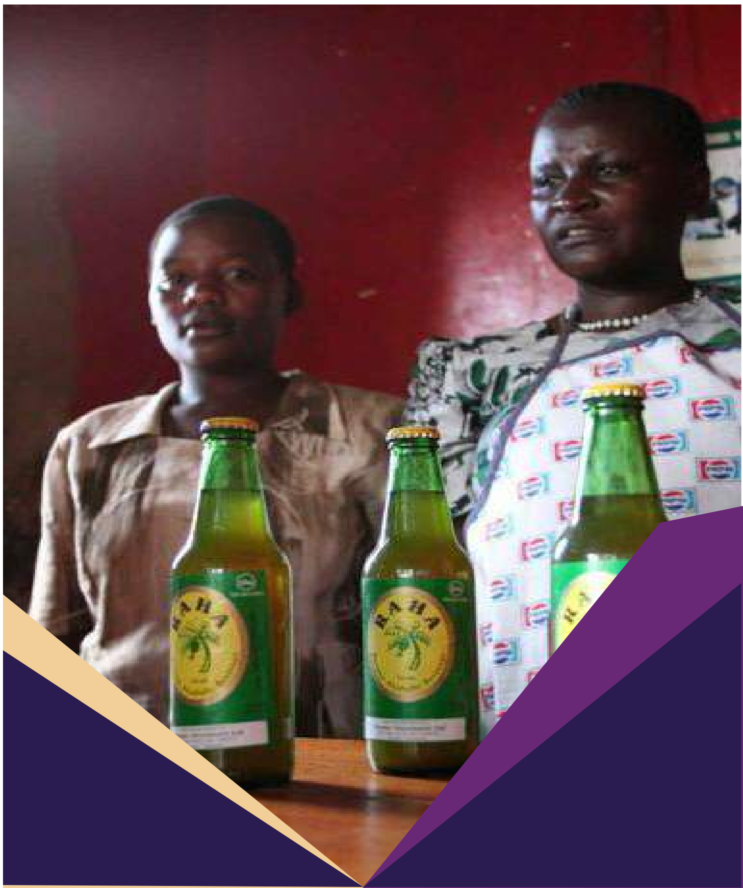
## Business and Commercial Potential

Banana is one of the most important commercial fruits in global markets. Most of the banana exported worldwide is from commercial producers in South and Central America, the Caribbean and South East Asia. Only a negligible proportion is exported from Africa despite the region's current production of about 38.7% of the global output. This is because the primary aim is to produce a staple food and only the excess that remains is sold in international markets. The average yield in these systems ranges from 4-10 tons per hectare, which falls far below the potential levels of 10-20 tons/ha obtained under research conditions. This compares well with other crops such as maize, millet, sorghum, beans and groundnut.

Export prospects for the crop have improved over the last decade and a number of entrepreneurs are exporting banana fruit and processed products, tapping into the organic market in Europe. The banana plantation industry in Uganda has caught the attention of many national, regional and international organizations, who have invested in resources for the development of different aspects of the value chain. For instance, the government of Uganda has developed a banana sector policy and approved the national biotechnology and bio-safety policy which are expected to spur investments such as, the Presidential Initiative for Banana Improvement Program (PIBIP), in the banana value chain.

## Potential investors to this technical innovation

A. NGO,s
B. Cooperatives
C. Large scale entrepreneurs
D. Exporters
E. Local breweries



## Contact - I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The production cost of Banana wine is estimated at US$1.16/liter. The main factors increasing the cost of production are the addition of sugar and the packaging. The selling price of the product is US$2.86 per liter of wine. The details of projected incomes and expenditures for, and the profits from the production of Banana wine (400 liters) are given in the table below.

## Financials

Source: CPWild and World Agroforestry Centre
Based on an annual production of 4,800 liters of wine the breakeven price is ± US$1.17 per liter. For a fixed price of ± US$2.86 the breakeven quantity is approximately 34 liters of wine per day.
The total capital investment cost for a banana wine processing subproject is US$65,000 of which, US$23,400 or 40% of the capital investment cost is allocated for year 1, US$23,400 (or 40%) for year 2 and US$11,700 (or 20%) for year 3. In addition, the routine and periodic maintenance costs are 2% or US$1,170 and 8% or US$4,680 respectively per year. The Cash flow statement for a wine production unit is given below.
Source: Banana Wine Processing Support Project, 2010

Cash flow statement for a wine production unit is given below.

| Wine | Unit | Value |
|---|---|---|
| Income | USD | 13,750.00 |
| Expenditure | USD | 5,515.28 |
| Profit | USD | 8,134.72 |
| Profit | % | 59.16 |

Source: CPWild and World Agroforestry Centre

## Table 7 : Economic Cash Flows

| Year | Capital Costs (US$) | Maintenance cost Routine 1/ | Maintenance Cost Periodic 3/ | Total costs (US$) | Phased incremental benefits 1/ "Banana Wine" | Total Benefits (US$) | Net Benefits (US$) | EIRR | ENPV (US$) | B/C RATIO |
|---|---|---|---|---|---|---|---|---|---|---|
| Yr1 2011 | 23,400 | - | - | 23,400 | - | - | 23,400 | - | - | - |
| Yr2 2012 | 23,400 | - | - | 23,400 | 4,784 | 4,784 | 18,616 | - | - | - |
| Yr3 2013 | 11,700 | 1,170 | - | 12,870 | 9,568 | 9,568 | 3,302 | - | - | - |
| Yr4 2014 | - | 1,170 | - | 1,170 | 14,352 | 14,352 | 13,182 | - | - | - |
| Yr5 2015 | - | 1,170 | - | 1,170 | 19,136 | 19,136 | 17,966 | - | - | - |
| Yr6 2016 | - | 1,170 | - | 1,170 | 19,136 | 19,136 | 17,966 | 2.3% | 10,410 | 0.8 |
| Yr7 2017 | - | - | 4,680 | 4,680 | 19,136 | 19,136 | 14,456 | 9.0% | 3,871 | 0.9 |
| Yr8 2018 | - | 1,170 | - | 1,170 | 19,136 | 19,136 | 17,966 | 14.2% | 3,385 | 1.1 |
| Yr9 2019 | - | 1,170 | - | 1,170 | 19,136 | 19,136 | 17,966 | 17.6% | 9,864 | 1.2 |
| Yr10 2020 | - | 1,170 | - | 1,170 | 19,136 | 19,136 | 17,966 | 19.9% | 15,649 | 1.3 |
| Yr11 2021 | - | 1,170 | - | 1,170 | 19,136 | 19,136 | 17,966 | 21.5% | 20,813 | 1.4 |
| Yr12 2022 | - | 1,170 | - | 1,170 | 19,136 | 19,136 | 17,966 | 22.6% | 25,425 | 1.5 |
| Yr13 2023 | - | 1,170 | - | 1,170 | 19,136 | 19,136 | 17,966 | 23.4% | 29,542 | 1.5 |
| Yr14 2024 | - | - | 4,680 | 4,680 | 19,136 | 19,136 | 14,456 | 23.9% | 32,500 | 1.6 |
| Yr15 2025 | - | 1,170 | - | 1,170 | 19,136 | 19,136 | 17,966 | 24.4% | 35,782 | 1.6 |
| Yr16 2026 | - | 1,170 | - | 1,170 | 19,136 | 19,136 | 17,966 | 24.7% | 38,713 | 1.7 |
| Yr17 2027 | - | 1,170 | - | 1,170 | 19,136 | 19,136 | 17,966 | 25.0% | 41,330 | 1.7 |
| Yr18 2028 | - | 1,170 | - | 1,170 | 19,136 | 19,136 | 17,966 | 25.2% | 43,666 | 1.8 |
| Yr19 2029 | - | 1,170 | - | 1,170 | 19,136 | 19,136 | 17,966 | 25.4% | 45,752 | 1.8 |
| Yr20 2030 | - | 1,170 | - | 1,170 | 19,136 | 19,136 | 17,966 | 25.5% | 47,614 | 1.8 |
| Yr21 2031 | - | - | 4,680 | 4,680 | 19,136 | 19,136 | 14,456 | 25.6% | 48,952 | 1.9 |
| Yr22 2032 | - | 1,170 | - | 1,170 | 19,136 | 19,136 | 17,966 | 25.7% | 50,437 | 1.9 |
| Yr23 2033 | - | 1,170 | - | 1,170 | 19,136 | 19,136 | 17,966 | 25.7% | 51,763 | 1.9 |
| Yr24 2034 | - | 1,170 | - | 1,170 | 19,136 | 19,136 | 17,966 | 25.8% | 52,946 | 1.9 |
| Yr25 2035 | - | 1,170 | - | 1,170 | 19,136 | 19,136 | 17,966 | 25.8% | 54,003 | 1.9 |
| EIRR | | | | | | | 25.8% | 25.8% | 54,003 | |
| ENPY | | | | | | | 54,003 | | | |
| B/C ratio | | | | | | | 1.9 | | | 1.9 |

## Target Market / Customer

Selling involves delivery of products to specified distributors, who sell them to retailers (Bar Owners), who in turn sell them to customers. The target consumers are mostly low and medium income earners who cannot always afford to drink normal malt beers, and grape wines.

| Type of banana or plantain product | Cultivars | Main Points of Sale |
| --- | --- | --- |
| Small-scale banana wine | EAHB (cooking and beer types) , 'Pisang awak', 'Gros Michel', Apple bananas | Urban beer clubs, village beer clubs and at production sites |
| Large-scale banana wine | 'Mtwishe' ('Cavendish') | Urban hotels, bars and village clubs |

Banana Wine is considered a delicacy in the African continent and forms a part of many rituals. Banana Wine finds large markets in Rwanda, Uganda, Tanzania, and Egypt. Currently South Africa and USA are the main markets outside of Africa.

## Limiting factors for large scale commercialization

1. Limited availability of good quality bananas.

2. Lack of access to capital: The cost of capital is high in Uganda and there are frequent fluctuations in the exchange rate. Farmers fail to meet the technical requirements of financial institutions and are also excluded from traditional bank lending, which reduces their ability to expand production.

3. Infrastructure: Production units, electricity and power shortages, the scarce and undeveloped road network and inadequate storage facilities are the factors that reduce output profitability.

## Social impact of the technology

• A co-operative in Rwanda, managed by Christine Murebwayire started off with 5 women in the year 2004 dealing with production of banana wine and banana fibre. The cooperative's annual sales have grown from 6,000,000 Rwandan francs (US$10,516) in 2004 to 106,975,000 Rwandan francs (US$187,506) in 2009 as it continues to reach out to more customers.

• Banana wine making technology can help in reducing the post harvest losses ultimately leading to the increased income and also saving through waste reduction

## Any other relevant information

Banana is the one of the largest exports of the African continent and is mainly classified into four types depending upon its use:

1. Cooking Bananas (Matooke): These green fruits are used for eating and constitute the majority of the East African Highland Bananas.

2. Brewing bananas (Mbidde): The mature fruit pulp is allowed to ferment with sorghum to make beer. These bananas are also used to make banana wine.

3. Roasting bananas: These belong to the plantain group where the fruit is harvested and ripened before roasting and eating.

4. Sweet (Dessert) bananas: These are eaten when ripe.

# Fresh Vacuum Sealed Matooke - Uganda

Staple food of Uganda processed to cross the local boundaries

**Name Of institute:**
Afri Banana Products Ltd

**Stage of development:**
Ready for commercialization

**Patent status:**
IP awarded

Banana, as a crop enjoys a very important position in Uganda, a landlocked country in East Africa. In spite of being the world's largest producer of cooking banana (locally referred to as 'Matooke'), Uganda ranks 70th in terms of the global banana trade because of the many challenges that the industry faces. These include low productivity, lack of diversification among small scale producers as well as severe price fluctuation, relatively low production as a result of overdependence on rainfed production, slow adaptation of productivity enhancement technologies and long market chains resulting in increased transaction costs.

The annual production of matooke in Uganda goes as high as 12 million metric tons but the lack of value addition leads to acute losses of up to 25% of the crop. It therefore becomes uneconomical and a big burden for farmers and traders to transport unpeeled matooke on the poor road network, at high fuel prices using reconditioned trucks. The banana peels (about 40%) which are also transported to urban areas pose a big problem of garbage accumulation (510 metric tons per day in Kampala only) which in turn costs a lot of money and time for disposal. Moreover, this process of transporting unpeeled bananas also deprives the very plantations that produce matooke of green manure in the form of banana peels and stalks.

In a bid to mitigate these environmental and marketing problems, a technology popularly known as FREVASEMA technology was developed by Dr. Byarugaba Bazirake (Senior lecturer at Kyambogo University, Uganda) to reduce spoilage of green bananas while being transported to markets and to reduce bulkiness which translates to a high cost of transportation. This technology of processing matooke therefore lays attention on establishing ways to industrialize post-harvested matooke in a fresh form. Processing makes the transportation of bananas easier, both locally and internationally, firstly by increasing their shelf life and secondly by reducing the burden of transporting bulk matooke by 40% through removal of peels and stalks. Through this processing, only the 60% of matooke that is actually required is transported to the market/consumer. The peels and stalks which constitute 40% of the matooke are processed into other by-products like bio-degradable bags, textile materials, briquettes, wine, enriched animal feeds, vinegar and others.

## Production Process:-

The production process involved in the production of fresh vacuum sealed matooke can be well explained by the following flow chart: -

Peeling of bananas

▼

Use of Inactivating enzyme (Polyphenol oxydase) on the peeled bananas to avoid browing and spoilage

▼

Vacuum sealing of matooke

▼

Storage under low temperatures even during transportation

## Background

Green cooking banana, locally known as 'Matooke' in Uganda is the predominant variety of banana produced in the country that caters to the demand of over 7 million people including two thirds of the urban population. Matooke being a staple food for a big population in the country is harvested and transported in bulk to urban areas. However, during this transportation process, for every 100 kg transported, 40 kg are in the form of stalks and peels (waste).

To address the problem of waste disposal along with the several environmental as well as marketing problems associated with its sale which range from irregular market prices and limited options for value addition drives to the poor transportation system and low shelf life, a technology named FREVASEMA was developed. This technology makes it possible to process peeled matooke and pack it in vacuum sealed containers to meet the demand of the urban consumers which has risen with time.

Matooke is vacuum sealed in food grade processing bags to guarantee a long shelf life of up to a month under chilled conditions. This technology at the same time encourages production of a range of banana products including vinegar, enriched animal feeds, dietetic menu and wine as by-products.

## Benefits / Utility

• Adding value to matooke by prolonging its shelf life and easing marketing locally and internationally, thereby widening the scope of markets and meeting the rising demand by consumers across the world.

• Elimination of 40% of the weight associated with transporting unpeeled matooke, hence reducing garbage such as peels and stalks and their disposal costs in urban areas.

• Production of other by-products like bio-degradable bags, textile materials, briquettes and wine among others.

• Creation of employment opportunities in rural areas thereby empowering people.

## Scalability

The Vacuum Sealed Matooke technology can be scaled up to improve entrepreneurial skills for banana production with emphasis on increased capacity for production, training to SMEs and small holder farmers, in marketing banana and its value added products. The worldwide production of banana (Musa spp.) is around 104.3 million mt/year. Africa contributes just under one third of this (32.2 million mt/year). The wastage in banana production due to lack of post harvest technology is approximately 20%. The price of banana is US$960/mt. Assuming 50% of the wastage is avoided by fresh sealed vacuum technology, the quantity saved would be 16.1 million mt/year and approximately 15 billion US$/ year.

## Country Context

The high demand for matooke throughout the year is an indication that banana is a very important crop in Uganda. It is given so much importance in some parts of Uganda that matooke becomes synonymous to both 'banana' and 'food', contributing about 35% of the total food expenditure .The country's per capita consumption of banana ranges between 220 kg and 460 kg per year which is the highest in the world.

| Banana type | Year (1995/1996) | Year (1999/2000) | % production (1999/2000) |
|---|---|---|---|
| Cooking bananas (matooke) | 7,908,984 | 5,545,134 | 90 |
| Brewing bananas | 1,164,887 | 538,304 | 9 |
| Sweet (dessert) bananas | 383,949 | 46,286 | 1 |
| Total | 9,457,820 | 6,129,724 | 100 |

Source: Ugandan National Household Survey 1999/2000

Despite production of matooke on such a large scale annually in Uganda, the lack of value addition causes losses of up to 25 percent of the crop. Most of the bananas are consumed locally. Although Uganda is the world's largest producer of cooking bananas, it is ranked 70th in the world's total banana production because of various production and marketing difficulties.
Thus banana production in Uganda does not correlate with expected commercial returns. However with the use of FREVASEMA technology, advancements can be brought about and the demands of the consumers can be met in Uganda and elsewhere in the world.
Thus, there exists a huge business potential for emerging companies, to target the local and regional urban market as well as to cater to the demands of consumers all over the world.

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### Business and Commercial Potential

Uganda has not had its fair share of the banana trade because of the bulkiness of the bunches which increases freight charges. Bananas also have a short shelf life, so they can easily ripen before they reach the export market. Fresh Vacuum Sealed Matooke technology reduces that bulk by peeling so that only the 60 percent that is supposed to reach the end user is transported. Fresh peeled vacuum sealed banana is just one of the many initiatives in Uganda towards value addition.

In Uganda, urbanization is occurring with 16% of the population living in urban areas in 2000 and predictions that this figure will rise to 22% by 2010. An increasingly urban population will lead to higher volumes of bananas being consumed which will need to be transported from rural to urban areas.

The FAO estimated average per capita consumption at 207 kg/year in 1999. With a total population of 22 million people this suggests a total consumption of 4,554,000 mt. International banana markets are becoming increasingly competitive. Recent changes in the European Union banana policy reducing preferential access are seen to further increase competition. Sales of matooke to Europe have almost doubled in the past five years with potential seen for further increase. UK matooke sales show a rising trend for volume with constant prices. Sale volumes of fresh matooke exported to the UK have almost doubled in the past five years. Matooke volumes into the UK have increased by eighty five percent (85%) to 832 mt from 1997 to 2001. UK matooke prices have been stable over the last two years. Future growth in the sales of matooke in the UK, West Indian and Belgium Congolese ethnic markets is predicted.

Removal of EU tariffs under the ‘Everything but Arms’ measure should assist further growth by removing a barrier to European mainland markets. The Rwandan banana market survey (Ferris et al. 2002) suggests a growing market for Ugandan matooke in Rwanda.

Thus, the business and commercial potential of fresh vacuum sealed matooke has enormous chances of growing in the coming years both in the local as well as the international markets.
years in the local as well as the international markets.

### Financials

The average weekly export of Fresh vacuum sealed matooke to the US market is 0.25 mt. The revenue stream for the product in the year 2012 was estimated to be US$138,685 while in the period between March and August 2013, 6,107 kgs were exported leading to a revenue of US$10,496. The cost of construction of the factory facility, installation of electricity, water and cooling systems (including water storage tanks), capital cost of equipment and a 5% contingency, will require a total capital expenditure of approximately US$63,000.Major construction may not be necessary at existing, established chips factories, commercial sites, and farm or home businesses. However, modifications may be necessary.

### Operational cost per week

| PRODUCTION ITEMS | COST($US/WEEK) |
|---|---|
| Raw Materials | 4,000 |
| Wages | 1,000 |
| Overheads | 200 |
| Consumables | 100 |
| Electricity | 100 |
| Water | 52 |
| Maintenance of trucks | 34 |
| Maintenance of Cool Room | 14 |
| TOTAL | 5,500 |

Revenue per week

| TOTAL WEEKLY BUDGET | $US PER WEEK |
|---|---|
| Income | 8,920 |
| Recurrent Cost | 5,500 |
| Profit | 3,420 |

Source: Vacuum Pack Manual, March 2003

### Potential investors to this technical innovation

1. Banana farmers’ cooperatives
2. Food processing industries
3. Retail chains
4. NGOs
5. Student entrepreneurs

### Target Market /Customer

Matooke is consumed by many African countries including, Nigeria, Ghana and Kenya. Thus, fresh vacuum sealed matooke has an excellent market in these countries. Removal of EU tariffs under the ‘Everything but Arms’ measure should assist further growth by removing a barrier to European mainland markets. The local target market is urban consumers who increasingly have a high preference for peeled hygienic matooke, which in turn speeds up meal preparation time and saves time since it can be bought in bulk to last a month.

Sales of matooke to Europe have almost doubled in the past five years with potential seen for further increase. UK matooke sales show a rising trend for volume with constant prices. Sale volumes of fresh matooke exported to the UK have almost doubled in the past five years.
Thus, the market for the product has considerably increased in the past few years and has a great potential.

## Limiting factors for large scale commercialization

1. Poor access to capital presents a significant challenge to promote this commercially viable technology. The cost of capital is high in Uganda and
exchange rate fluctuations make it more challenging to entrepreneurs.

2. Airfreight charges from Entebbe to London are currently US$1.50 to 1.70 / kg and Uganda is unable to compete with Caribbean countries that have better access to the sea ports as a cheaper means of transport. Sea freight from Mombassa to Felixstowe costs approximately $0.40 / kg.

3. To sell organic produce in Europe a certificate of authentication is required. This has a high cost (US$ 5,000 per farm) and is controlled by European institutions. The process of attaining a certificate can take from one to five years. The National Organic Agricultural Movement of Uganda (NOGAMU) is currently active in drawing up a Ugandan national standard with local group accreditation to reduce certification costs.

4. Limited infrastructure development, including poor electricity supply and inadequate storage facilities and roads reduces output profitability.


## Social impact of the technology

The value addition which is done through this technology will contribute significantly to Uganda’s development. Adding value to what the majority of the people in the country grow helps alleviate their living standard, thereby moving them out of poverty.
Smallholder matooke producers can be transformed from subsistence to commercial producers and can earn incremental incomes by participating in more efficient fresh matooke value chains. Hence banana production and marketing can be used for improved food security and to increase household incomes for the rural poor.
In addition, location of the technology at the point of production will enhance year-round market access for smallholder farmers, who would otherwise be prone to exploitation by middlemen.

## Any other relevant information

Uganda Investment Authority

The Uganda Investment Authority (UIA) is an agency set up by an Act of Parliament (Investment Code 1991) to promote and facilitate private sector investment in prospective technology based ventures.

The agency serves to:
• Provide firsthand information on investment opportunities in Uganda
• Issue Investment Licenses
• Assist in securing other licenses and secondary approvals for investors
• Help investors implement their project ideas through assistance in locating relevant project support services
• Provide assistance in the acquisition of industrial land
• Help obtain work permits and special passes for investors and their expatriate staff
• Arrange contacts for potential investors and organize itineraries for visiting foreign missions in the country
• Assist investors in seeking joint venture partners and funding
• Review and make policy recommendations to the Government about investment.

# Banana Fiber Making Technology - Uganda

Banana Fiber – The answer to synthetic fiber replacements

**Name Of institute:**
Afri Banana Products Ltd

**Stage of development:**
Ready for commercialization

**Patent status:**
No IP protection

Banana is an edible fruit produced by several kinds of large herbaceous flowering plants belonging to the genus Musa. Almost all African countries produce a significant amount of bananas, but only a few actually export them. Production in the East African region has grown rapidly over the past 15 years and now accounts for around 4% of the world's banana trade. A vast majority of these bananas are sold in Europe, mainly in France and the UK. The psuedostem of banana which is disposed after harvest could be used as a source of fiber which could be extracted and processed into many value added products.

Banana fiber is a natural fiber with high strength, which can be blended easily with cotton fiber to produce blended fabric and textiles. Banana fiber is extracted from the waste stalk of the banana plant. Due to the relatively high cost of synthetic fibers and the health hazards associated with them, it has become necessary to explore natural fiber. Banana fiber is a good option for this. Banana fiber is ecofriendly, chemical free and odor free. It is grease proof, water, fire and heat resistant and also totally bio-degradable. This fiber is better than other organic fibers in terms of spinability and tensile strength. This technology has immense potential to generate employment and offer higher earnings to farmers.

## Production Process:-

Generally, banana fiber is situated near the outer surface of the sheath and can be peeled off easily in ribbons of strips, 5-8 cm wide and 2-4 mm thick along the entire length of the sheath. The stripping process is known as tuxying and the strips are called tuxies. The production process involved in the extraction of banana fiber can be well explained by the following flow charts: -

Banana Fibre

Manual Stripping

Tuxying

Bacnis Method

Trunks are pulled apart and the sheath is separated as per their position in stalk

Flattened and the fibre is stripped from the stem by cutting the pulpy part and pulling away the tuxy

Loenit method

Tuxies are pulled off the stalk from one sheath at a time

Tuxies are bundled into bundles of 23-27 kg & brought to the stripping knife for cleaning

At last fibre is air dried and bundled for subsequent grading and bailing

Machine Stripping

Trunks are cut into sections of 120-180 cm in length

The sections (one half the length at a time) are then crushed between rolls

The pulpy tissues are separated, by two large revolving drums

Scrapping blade which peels-off the sheath while it is pressed against a bed plate, oven dried, graded and baled

## Background

Banana is grown by about 75% of the country's farmers on as high as 40% of the total arable land in Uganda. The fertile soils and favorable climate guarantee its production for the greater part of the year.

Banana fiber is the best natural fiber. The appearance of banana fiber is similar to that of bamboo fiber and ramie fiber, but its fineness and spinability are superior. The chemical composition of banana fiber is cellulose, hemi-cellulose, and lignin. It is a highly strong fiber, which is light in weight. It has a somewhat shiny appearance depending upon the extraction and spinning process. It has a strong moisture absorption quality - it absorbs as well as releases moisture very fast. It is bio-degradable and has no negative effect on the environment and thus can be categorized as an eco-friendly fiber. Its average fineness is 2400 Nm. It can be spun using almost all the methods of spinning including ring spinning, open-end spinning, best fiber spinning, and semi-worsted spinning among others.

This technology includes the scientific knowledge, processes, and the machinery and equipment necessary to convert banana tree trunk into fiber. The technology is unique and fits between the conventional pulp and paper technology and the lumber veneering and custom wood technologies. It has several distinct market advantages such as a commercially viable cost structure, superior product and positive environmental benefits.

## Benefits / Utility

• Banana fiber is eco-friendly in nature and provides a good alternative to synthetic fiber which is renewable in nature.

• The fiber obtained from banana helps in the production of various utility items.

• Banana fiber has a low specific weight, which results in a higher specific strength and stiffness than glass. This proves to be an advantage for designing parts with stiffness in bending.

• Banana fiber can be produced at low cost; the technology requires low investment and hence is a good option for low wage countries.

• Banana fiber has good thermal and acoustic insulation or soundproofing properties.

• Banana fiber is a natural fiber with high strength, which can be blended easily with cotton fiber or other synthetic fibers to produce blended fabric and textiles.

• Banana fiber is being used to weave attractive pieces of clothing, rugs, sarees, hats, photo frames, hand bags etc.

• Banana fiber also finds use in high quality security/ currency paper, packing cloth for agriculture produce, ship towing ropes, wet drilling cables and others.

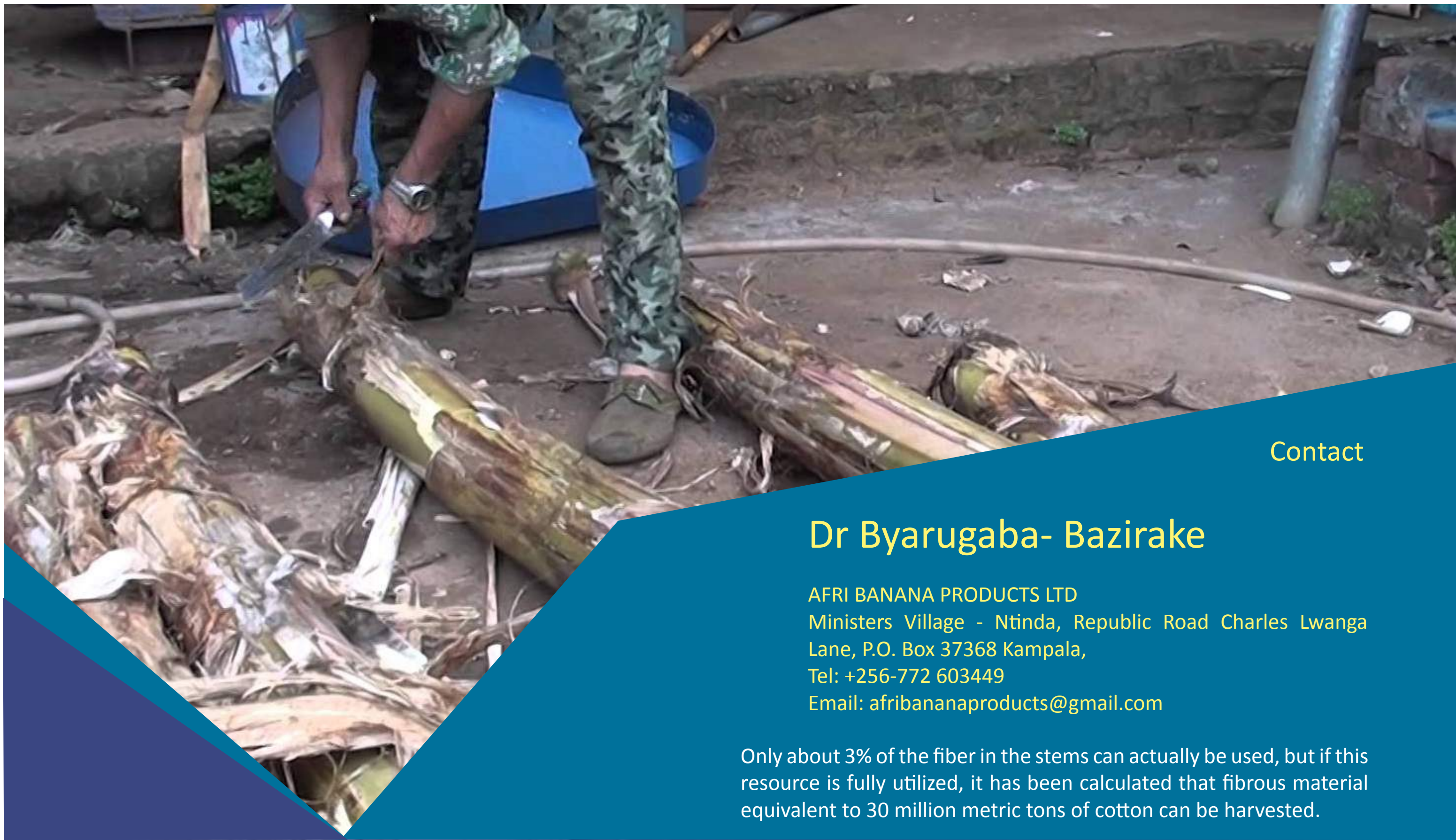
## Scalability

Uganda and India, two of the leading producers in the world have already joined hands for research on the textile potential of banana fiber. Both the countries have huge export potential for banana fiber. Uganda can tie up with various international markets to export the banana fiber produced in the country. A pilot run of the extraction and production facility at the Afri Banana Products Limited helps Uganda add value to its banana crops. This will give the farmers confidence and assurance about the value of their crops. Currently, 50%-70% of the farmers in Uganda are involved in banana cultivation. However, a very small proportion of the fiber is produced. So Uganda has potential to tap its internal markets to process banana fiber and also contribute to recycling the waste from banana plants.

| | Cooking Banana | Brewing Banana | Dessert Banana |
|---|---|---|---|
| Production of banana in million tonnes | 5.54 | 0.54 | 0.04 |
| No of hectares under cultivation | 138628.35 | 13457.6 | 1207.15 |
| No of plants/ hectare: Assuming each hectare has 3000 plants) | 415885050 | 40372800 | 9053625 |
| Amount of Fibre obtained in kilograms (Assuming amount of Fibre obtained per plant is 2.5 kilograms) | 103971262 | 100932000 | 22634062.5 |

## Country Context

Banana has long been an important subsistence food for African countries. Banana fiber has two main uses in the form of textiles and paper. Nepal, India and many South East Asian countries are pioneers in the field of banana processing technologies. Bananas and plantains provide food security and income for small-scale farmers who represent the majority of producers in Africa.



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Only about 3% of the fiber in the stems can actually be used, but if this resource is fully utilized, it has been calculated that fibrous material equivalent to 30 million metric tons of cotton can be harvested.

Uganda is the second largest producer of bananas after India. The country's per capita consumption of bananas ranges between 220 kg and 460 kg per year which is the highest in the World.

There are two peak seasons in banana production in Uganda. During the peak seasons, farm-gate prices fluctuate down to as low as USD 0.5 per bunch weighing 18-20 kg. However, the same bunch is sold for USD 10-15 in the city (Kampala).

Uganda has a number of advantages which is why the big fruit companies are currently interested in banana processing in the country. Production can be done at low cost because labor is cheap and raw material is easily available. Another very important reason is to do with trade and trade policy - Africa has free access to the European market which is not the case with Latin America. Furthermore, the Ugandan Government has also provided their support to the co-operative sector especially by providing loans to farmers through their agreement with the DFCU Bank

## Business and commercial potential

Bananas and plantains are an important food source for over 100 million people in Sub-Saharan Africa. In the East African highlands and most of the Great Lakes region, bananas are a major staple food and a source of income for over 50 million smallholder farmers. East Africa produces 16.4 million metric tons per year which is about 20% of the world output. Therefore, it is but natural to try and find other uses for the banana plant rather than considering it merely as a source of food.

Banana fiber has a major proportion (60-65%) of cellulose and the length of a single fiber is 80-200 mm. Other elements are hemicelluloses and lignin. Its elongation is 3% and its mechanical and physical properties are similar to fiber from flax seeds.

About 100 million metric tons of bananas are harvested annually worldwide, but the stems on which they grow are pruned off, as they are no longer productive. About a billion metric tons of pruned stems are assumed to be left to rot every year and they ultimately become compost in the soil. However, these stems contain high quality fibers.

Uganda is the second largest producer of banana, the first being India. Currently, only a small quantity of the banana fiber, which is harvested by pulling or cutting from the stem, is being used to make handicraft items like baskets, mats, table mats, decorations and as cooking fuel. Although banana plants and fibers are available in tropical regions in abundance, their application potential has not been exploited fully.

Paper is made from banana fiber. Large banana producing countries are seen to have a competitive advantage in international markets. At the local level, the market which has tourists, expatriates and wealthy Ugandans as its customers, is relatively small. Future growth in Ugandan incomes and tourism are expected to influence the market potential for these product types.

## Potential Investors to this technical innovation

A. Small and medium scale enterprises
B. NGO,s
C. Cooperatives
D. Student entrepreneurs
E. Exporters

## Financials

The project cost for setting up a banana fiber making plant to utilize the products of the variety of banana plantations with a capacity of approximately 150 Kg per day (46,800 kg per year) is US$4,325 and the revenue estimates stand at US$93,600 annually with a net profit margin of 72%.

Capital Investment Requirement in US $:

| Capital Investment Item | Qty | @ | Amount |
|---|---|---|---|
| Two roll Crusher | 1 | 1000 | 1,000 |
| Drying Chambers | 1 | 800 | 800 |
| Weighing balance | 1 | 25 | 25 |
| Cutting and Splitting equipment | 2 | 1,000 | 2,000 |
| Open Vat | 1 | 500 | 500 |
| Total | | | 4325 |

| Cost Item | Units | @ | Qty | Pdn cost | Pdn |
|---|---|---|---|---|---|
| Direct Cost | Direct Cost | Direct Cost | Direct Cost | Direct Cost | Direct Cost |
| Banana pseudo stem | Kgms | 0.03 | 321 | 8.01 | 208.3 |
| Chemical | Litres | 5 | 0.6 | 3.2 | 83.2 |
| Paper/Plastic roll stems | Rolls | 2 | 3 | 4.5 | 117 |
| Polythene bags/ sacks | packets | 0.4 | 3.2 | 1.33 | 34.65 |
| Other materials | | | | | 10 |
| Sub-total | | | | 17 | 453.2 |

| General Overheads in US $ | |
|---|---|
| Labor | 625 |
| Selling & distribution | 150 |
| Utilities | 250 |
| Rent | 350 |
| Administration expenses | 65 |
| Miscellaneous expenses | 150 |
| Depriciation | 163 |
| Sub-total | 1,753 |
| Total Operating Costs | 2,206 |

Profitability Item in US$

| Profitability Item | Per day | Per month | Per year |
|---|---|---|---|
| Revenue | 300 | 7,800 | 93,600 |
| Less: Production and operating costs | 39 | 1,018 | 26,477 |
| Profit | 261 | 6,782 | 67,123 |

## Target Market/ Customer

The Philippines and Japan are the major banana fiber producing countries involved in the large scale manufacture of textile items made from banana fiber. The Philippines is also exporting a huge quantity of ready-made garments manufactured from banana fiber to Japan, Singapore, Taiwan and other Far East Asian countries.
The Philippines is the world's largest producer of abaca fiber, which belongs to the same family as banana fiber. Abaca fiber has been used successfully in the Philippines since decades and hence is also known as Manila Hemp. However, the crop is also cultivated in Ecuador and other Southeast Asian countries.

A number of different processes for making clothes out of banana fiber already exist in Japan. For example, Nisshinbo Industries - a famous textile leader in Japan makes jeans, shirts, towels, suits and other clothing with 15-30 percent banana fiber content, and has also started catalogue sales of women's clothing. Currently, only the Philippines is supplying Nisshinbo with banana fiber, and struggling to meet their demands. Hence, Kenya, Rwanda and Uganda present a good possibility of becoming new banana fiber suppliers. Nigeria, Ghana, Gabon, Cameroon, Malawi, Madagascar and the Côte d'Ivoire are the countries that are planning to launch banana fiber production projects.

Banana fiber products can be exported to Europe and the American countries. Banana paper could be used as packaging material in the organic cotton industry. Banana fiber handicrafts are in high demand in export markets due to their affordability and eco-friendly nature.

## Limiting factors for large scale commercialization

1. Banana fiber is primarily extracted manually, at high labor costs and with low yields. This makes the, supply irregular, leading to higher prices of banana fibers.
2. Lack of access to capital presents a significant challenge. The high cost of capital in Uganda, is further exacerbated by exchange rate fluctuations. In particular, those without access to international capital experience difficulties and delays in obtaining finance, with some unable to meet the technical requirements imposed by financial institutions. Farmers have also been essentially excluded from traditional bank lending which reduces their ability to expand production, thus limiting the demand for up- and downstream services.

3. Limited infrastructure development, including that with regard to electricity and the quality of the road network, increases transaction costs all along the value chain. Inadequate storage facilities and roads reduce output profitability. Local farming groups have been particularly challenged by the insufficiency of storage and high rental costs, while operating expenses for community aggregation projects have sometimes become prohibitive.

4. The unpredictable influence of the weather, agricultural policies and harvests also affect the quality and quantity of the banana fiber that is obtained.

## Social Impact of the Technology

1. It will help build the capacity of women banana farmers to add value to the fibers at the household level.
2. The technology will contribute to the country's foreign exchange earnings as some of these items have a good demand in international markets.
3. A great amount of value addition is done using this technology, which will significantly contribute to the development of the country. It will help in alleviating the living standard of farmers, thereby moving them out of poverty and enabling them to access their basic needs and will also improve house hold savings.
4. The technology creates employment opportunities in rural areas ranging from low skilled jobs like banana fiber extraction and transportation to skilled ones such as sales and marketing.
5. It also opens up opportunities for education and training in the field of Banana fiber technology research and product development.

## Any Other Relevant Information

• Godfrey Atuheire, a Ugandan Scientist associated with Afri Banana Products Ltd has been developing the technology of hand-made paper and fiber processing, and has expanded his research into banana-fiber sanitary pads. This technology is expected to bring about a two to threefold reduction in the price.

# Tissue culture banana technology Uganda

## The Scientific Rebirth of the staple crop of the Country

**Name Of institute:**
Afri Banana Products Ltd

**Stage of development:**
Ready for commercialisation

**Patent status:**
Not Applicable

Bananas (Musa spp.) provide millions of people throughout the tropics and subtropics with staple food and are one of the most widely exported fruits in the world. Uganda is the second largest producer of bananas in the world accounting for around 8% of the global production (annual production at 11.1 million metric tons). The per capita annual consumption of bananas in Uganda which stands at 0.70 kg (1.5 lb) daily per person is the highest in the world. However, banana production has been on the decline. This decline is largely attributed to insect pests such as the banana weevil (Cosmopolites sordidus), nematodes (Radopholus similis, Pratylenchus goodeyi and Helicotylenchus multicintus), fungal diseases such as Banana wilt (caused by Fusarium oxysporum f. sp. cubense' tropical race 4'), poor crop husbandry and low soil fertility. Economic success is acutely limited by low yields. The quality of banana fruits is strongly reduced by soil moisture deficit and poor soil fertility, which deny the farmer access to export and local urban markets.

The diseases cannot be chemically controlled and methods to limit their spread are expensive. In this context, biotechnology plays a major role in the production of high quality planting materials, thereby commercializing crops, creating new jobs and earning foreign exchange. Tissue culture (TC) technology offers mass propagation and clean planting material. The planting materials are cheaper to transport than conventional suckers and coupling with virus indexing allows for safe movement, exchange and conservation of germplasm. In addition, banana plants produced using this technology are more vigorous, high yielding and produce better quality fruits than those produced by traditional means. TC has been shown to bring down the cost of controlling foliar diseases by half. Once the new banana plantlets sprout, they are nurtured in the laboratory for a couple of weeks or so before being taken to a greenhouse for further growth. Tissue culture needs to be combined with a comprehensive training package that includes business, marketing and farmer group formation to reap the full benefits. It is a simple technology that could be put to better use to enhance the prosperity of the country. In Uganda, this technology is used alongside transgenic technology, where genetically modified crops are bred in laboratories by transfer of disease- and pest-resistant genes; genetically modified crops however, are still confined to field trials.

## Production Process:-

The production process involved in the production of Tissue Culture Banana can be well explained by the following flow chart: -

| |
|---|
| Vessels and planting materials are cleaned in the cleaning area |
| Media is prepared, stored and streilized in the media preparation room |
| Initiation and sub-culturing of plantlets is done for multiplicaton |
| Light and temperature as required is provided to plantlets |
| Plantlets are hardened in the Primary Hardening area |
| Secondary hardening process takes place for further growth and hardening |

## Background

Bananas are an important food source for over 100 million people in SSA. In the East African highlands and most of the Great Lakes region, bananas are a major staple food and a source of income for over 50 million smallholder farmers. East Africa produces about 20 percent of the world output. However, many living and non-living factors greatly reduce the productivity of banana cultivated under traditional African farming systems.

Tissue culture technology can continuously improve the productivity, profitability, stability, and sustainability of the farming system. In tissue culture when a group of undifferentiated and meristematically active cells called tissue is aseptically dissected out and put into a medium containing nutrients and incubated under conducive controlled conditions of light and temperature, it establishes itself and starts growth. This is called a culture and the concept of 'tissue culture' was thus conceived.

This technology is an indispensable tool for the facilitation of quick, and en masse, multiplication of adequate planting material of indigenous and exotic banana (Musa spp.) clones and production of disease-free planting material. The technology also rejuvenates the plants resulting in more vigorous growth, higher yields, better quality fruits, earlier fruiting and more uniform crop than those produced by conventional means.

## Benefits / Utility

• Planting materials produced through this technique are more vigorous, allowing faster and superior yields. Being uniform they facilitate better marketing and can also be produced in huge quantities in short periods of time

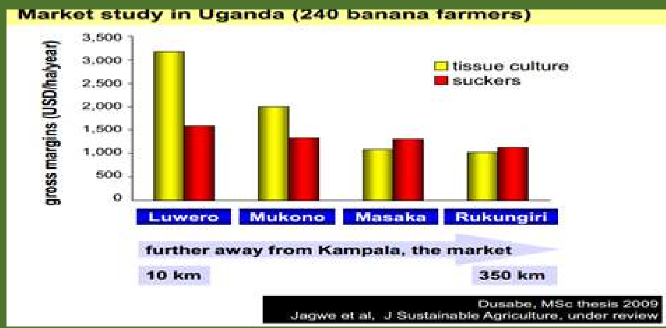
• This technology produces pest and disease free crops which reduce the costs involved in production and lead to greater profit margins. It will also result in healthy food production and elevate the health condition of the people.

• Climate change as one of the production constraints has made rainfall unpredictable with both extremes - drought and flooding. Therefore, development of improved crop varieties and efficient distribution of clean disease free planting material are considered the most sustainable solution to sustaining agricultural productivity in Uganda.

• This technology would also help in poverty alleviation by improving incomes and enabling people not only to access their basic needs but also to have improved house hold savings, etc

## Scalability

Study conducted by Dubios for East Africa Banana Production shows that Tissue culture has gained importance over the years. Uganda has great share in Banana Tissue culture technology. The gross margins achieved by Tissue Culture Banana in Uganda can be seen below




In Uganda around 1,500,000 plantlets are produced per year and its cross boundary flow is made to nearby countries like Sudan and Rwanda. There are many other nearby countries like Kenya, Tanzania, DR Congo where the Tissue Plantlets can be transferred for production.

Around 1066 farmers and 99 Nursery operators have been trained for Tissue Culture technology. Uganda being an agrarian economy there is still a large group of farmers who can be trained for this technology.

## Country Context

Agriculture is the most important sector of Uganda's economy and employs over 80% of the work force, with banana as its staple crop. The country's per capita consumption of bananas ranges between 220kg and 460 kg per year which is the highest in the World. Green cooking banana, locally known as 'Matooke' in Uganda is the predominant variety of banana produced in the country which caters to the demand of over 7 million people among which two thirds of the urban population is also covered.

Table 1: Production of bananas in Uganda (million metric tons)

| Banana type | Year 1995/1996 | Year 1999/2000 | % production 1999/2000 |
|---|---|---|---|
| Cooking bananas | 7.90 | 5.54 | 90 |
| Brewing bananas | 1.16 | 0.54 | 9 |
| Sweet (dessert) bananas | 0.38 | 0.04 | 1 |
| Total | 9.45 | 6.16 | 100 |

Source: Ugandan National Household Survey 1999/2000

## Contact - I

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Bananas are also exported in the form of Fresh Vacuum Sealed Matooke and Banana Juice and therefore a constant supply of good quality bananas is needed throughout the year. UK Matooke sales show a rising trend in volume with constant prices. Removal of EU tariffs under the ‘Everything but Arms’ measure should assist further growth by removing a barrier to European mainland markets. International banana markets appear as increasingly competitive. Recent changes in European Union banana policy reducing preferential access are likely to further increase competition. Sales of Matooke to Europe have almost doubled in the past five years with potential seen for further increase.

## Business and Commercial Potential

It is estimated that TC banana seedlings have a market share of between 80% and 85% (Alex, NARO). This is a timely opportunity for private companies and ABP consortia to invest in the ready market for TC banana seedlings in the major producing areas. Uganda’s per capita GDP measured in constant prices has risen by an average of 3.2 % per annum from 1990 to 2000. The local Ugandan market is viewed to be stable with low levels of volume growth and continuously falling prices causing no serious disturbance to production. Urbanization will increase demand with any income growth especially by poorer- and middle-income families viewed as beneficial to banana market prospects by tapping the suppressed demand. Urbanization is occurring with 16% of the population living in urban areas in 2000 and predictions that this will rise to 22% by 2010. A growing urban population will lead to higher volumes of bananas being transported from rural to urban areas.
The FAO estimated average per capita consumption to be 207 kg/year in 1999. With a total population of twenty two million people this suggests a total consumption of 4,554,000 metric tons. Uganda is the major producer of banana among the East African Countries.

Banana production in major East African countries

| | Production (MT /year) | % of total African Production |
|---|---|---|
| Burundi | 1.53 | 4.9 |
| Kenya | 1.20 | 3.8 |
| Uganda | 9.67 | 30.5 |

Source: Tissue Culture Banana for Small Holder Farmers: East Africa ‘2010’

Studies done in Uganda indicate that by using TC banana planting materials, the gross gain from bananas increased to USD 1,315.798 (per hectare per year) as opposed to using suckers with a gross of USD 864.6885 (from each hectare per year). Therefore, there is a need to prepare for the anticipated increase in demand by expanding the currently limited human resource capacity to run banana TC laboratories and nurseries in Africa. The costs of establishing both laboratories and TC banana nurseries are high, since most of the equipment and facilities are imported. Equally, the cost of propagation media is high because local industries are not able to manufacture the chemicals, forcing the laboratories to import them. It is also important to establish institutions responsible for the establishment of standards for good quality TC bananas to enable safe exchange of this material within and across Africa.

In Burundi, the production is almost 1.5 million metric tons/year. Productivity of banana is 50-60 metric tons per hectare which makes the area under banana cultivation 30,000 hectares. Each hectare requires about 4,000 TC seedlings and hence the projected demand for tissue culture seedlings will be one hundred and twenty million. It can be assumed that the area under TC production would be 30% of the total area and hence the actual demand could be around thirty six million seedlings/hectare.
Similarly the projected demand with 30% of the total area covered by TC seedlings is 28.8 million seedlings for Kenya and 232 million seedlings for Uganda.

## Potential investors to this technical innovation

A. Large scale farmer’s
B. Development Agencies
C. NGO’s
D. Medium scale enterprises
E. Input companies
F. Cooperatives
G. Student entrepreneurs

## Financials

The retail price of one TC banana seedling ranges between US$0.75-1.5 compared to the conventional suckers which sell at less than US$0.5. Between March and August, 2013, ABP consortia produced 3,000 seedlings through TC technology, which fetched US$3600 (ABP, 2013).

According to a report by Kamau et al., (2011), crop establishment costs rose threefold (from US$200 to 600) with TC technology adoption for orchard management. However, the marketing cost reduced significantly due to uniformity, which can only be afforded through TC technology. There is also ease in production and marketing coordination, especially for farmer groups because of the opportunity for uniform plantation establishment, which is made possible by mass multiplication of disease-free seedlings. In addition, the harvest cycle of TC banana plants is significantly reduced, to 12-16 months compared to 18-24 months for conventionally produced bananas.

On the reverse, the price per metric ton increased by 66% due to improved quality, generating large positive net returns (Kamau et al., 2011), while the TC banana yields have been found to increase from 22-33 lbs to an average of 66 lbs per bunch (Africa Harvest, 2011). This implies higher incomes for banana farmers and improvement in livelihoods.

Establishment of a TC facility includes the cost of land, construction, electrical installation and plumbing. If the available funds are limited, well-designed laboratories can be established by modifying existing structures. The initial investment required for setting up a low cost, medium scale TC laboratory (ca. 195 m2) is given below. If hardened tissue-cultured plants are the end products, an additional investment of US$20,000 would be required to erect a greenhouse. If production is limited to in-agar and ex-agar products (rooted or non-rooted micro-cuttings), a greenhouse would not be required. Besides the fixed capital, a commercial tissue culture unit has the recurring expenses of rent, building maintenance, electricity and overheads.

| REQUIREMENT | RENTED BUILDING (IN $) | PURCHASED BUILDING (IN $) |
|---|---|---|
| INFRASTRUCTURE | 2750 | 62437 |
| EQUIPMENT | 13885 | 13885 |
| FURNITURE | 7333 | 7333 |
| MISCELLANOUS | 4714 | 4714 |
| TOTAL | 28682 | 88369 |

*Figures are indicative.

## Target Market / Custome

Banana is consumed by the entire Asian and African community as well as the Nigerians, Ghanaians and Kenyans. Removal of EU tariffs under the 'Everything but Arms' measure should assist further growth by removing a barrier to European mainland markets in the form of Banana Juice and Fresh Vacuum sealed matooke. The local target market comprises of both rural and urban consumers who have banana as their staple food.

Sales of Matooke to Europe have almost doubled in the past five years with huge potential seen for further increase. UK Matooke sales show a rising trend for volume with constant prices. Sale volumes of fresh matooke exported to the UK have almost doubled in the past five years.

## Limiting factors for large scale commercialization

1. One of the greatest potential dangers for sustainable commercial TC plant production is the limited use of certification for plant quality and health, which is especially important in order to avoid the spread of viruses. Additionally, TC plant nurseries are important components, as they provide essential distribution hubs connecting TC producers with farmers.

2. Lack of access to capital presents a significant challenge. The cost of capital is high in Uganda, and is further exacerbated by exchange rate fluctuations. In particular, those without access to international capital experience difficulties and delays in obtaining finance, with some unable to meet the technical requirements imposed by financial institutions. Farmers have also been essentially excluded from traditional bank lending which reduces their ability to expand production (and thus limits the demand for up- and downstream services).
3. Limited infrastructure development, including electricity and the quality of the road network, increases transaction costs all along the value chain. Local farming groups have been particularly challenged by the insufficiency of storage and high rental costs, while the operating expenses for community aggregation projects have sometimes become prohibitive.
4. The technology enables the removal of fungi and bacteria from the plants but does not eliminate viruses. Therefore, farmers may acquire TC plantlets that are virus infected, leading to virus disease epidemics.
5. The local people do not understand the new technology and need awareness.
6. Tissue culture plantlets are fragile, and their thriving depends on good management by nursery operators and farmers especially in the early stages. At present, this knowledge is mostly lacking.

## Social impact of the technology

1. An increase in banana production at the farm level has increased food security at the household level. Some farm families who have adopted TC banana did not need food aid for the first time in their lives when there was a drought and food aid was required in the area.
2. Higher income from TC banana cultivation has allowed families to improve their quality of life by being able, to give their children a better education, afford housing, and diversify their income to take up other supplementary enterprises like poultry.
3. The TC-banana adopter families revealed a distinct empowerment of farm women because in the majority of households, banana produce and income belongs to the domain of women.
4. Formation of cohesive farmer groups has empowered the groups to address not only agronomic issues related to banana but also other issues of community interest. The farmer groups have been effective in addressing anti-social behaviour within the community.

## Any other relevant information

Organizing banana farmers into groups has long been considered advantageous, because of increased buying and selling power, reduced economic and social risk, increased economies of scale, and improved access to credit and inputs by formally certified groups.
In Uganda and other East African countries, distribution of superior planting material alone will not ensure a good crop. Commercial farmers are skilled in juggling the inputs and efforts needed to produce crops and make a profit but smallholder farmers are constrained by factors such as a lack of land and capital, access to technology, and good marketing infrastructure. Therefore, efficient distribution systems will be needed to deliver TC plants as part of a package which includes training and access to microcredit.

The Uganda Investment Authority (UIA) is an agency set up by an Act of Parliament (Investment Code 1991) to promote and facilitate private sector investment in Uganda.

The agency serves to:

- Provide first hand information on investment opportunities in Uganda
- Issue Investment Licenses
- Assist in securing other licenses and secondary approvals for investors
- Help investors implement their project ideas through assistance in locating relevant project support services
- Provide assistance in the acquisition of industrial land
- Help obtain work permits and special passes for investors and their expatriate staff
- Arrange contacts for potential investors and organize itineraries for visiting foreign missions in the country
- Assist investors in seeking joint venture partners and funding
- Review and make policy recommendations to the Government about investment.

# Tissue Culture Coffee Clones Technology - Uganda

## Tissue Culture: Ensuring Clean Coffee in its birthplace

### Name Of institute:
Afri Banana Products Ltd

### **Stage of development:**
Ready for commercialization

**Patent status:** IP filed

Coffee (Coffea spp) is one of the most important agricultural products in international markets. It is an important cash crop in Uganda that earns foreign currency for the country. However, its importance has diminished due to a number of factors the most important being reduced productivity, low quality and low international prices. Moreover most of the trees are old, diseased and are attacked by pests. Propagation of coffee by vegetative cuttings guarantees uniformity but cuttings generate relatively low multiplication rates. Multiplication by Tissue Culture could provide a viable alternative to these traditional methods.

Tissue culture technology allows production of a large number of genetically identical plants from a single mother stock . Plant production via tissue culture is advantageous over traditional propagation methods because it leads to the production of disease and virus free plants. It allows the production of a high number of plants, in a short period of time and in very limited propagation space. In addition, a rapid multiplication rate of plants that are difficult to propagate conventionally can be easily achieved using tissue culture technology.

## Production Process:-

The process involved in the production of Tissue Culture Coffee Clones can be well explained by the following flow chart: -

Vessels and planting material are cleaned in the cleaning area

Media is prepared, stored and sterilized in the media preparation room

Initiation and sub-culturing of plantlets is done for multiplicaton

Light and temperature are provided to the plantlets as required

Plantlets are hardened in the Primary Hardening area

The secondary hardening process takes place for further growth and hardening

## Background

In the International trade market, coffee is one of the most widespread permanent crops of the world and assumes decisive importance in the economics of a number of developing countries. It is grown in 80 countries around the world and 70% is produced by smallholder farmers. The total global production of green coffee was above 134.16 million bags (60 kg capacity) with a retail sales value in excess of $22.7 billion during 2010-11 in the world market.

The lack of clean planting material is a major constraint for coffee production in Uganda as plantations are regularly attacked by pests and diseases because of the climate which is largely tropical, hot and wet and creates a unique environment suitable for many crop-pest and disease organisms to flourish. Wilt is now a major problem for coffee farmers in many parts of Uganda, DRC, Tanzania and Ethiopia as it has spread to all Robusta growing districts in Uganda killing an estimated 14 million trees.

The main objective of using tissue culture techniques for coffee is to introduce new traits into elite coffee genotypes, develop new cultivars with desirable traits such as pest and disease resistance, herbicide resistance, drought and frost tolerance, and improved quality, which are not possible to incorporate using traditional breeding techniques.

Although this technology has been in the country for some time, its use in the region has been limited and thus it has great potential in the urban markets of Uganda and other African countries.

## Benefits / Utility

• This technology helps in the production of virus and disease free coffee clones with higher multiplication rates and also ensures the availability of high quality clones.

• Tissue Culture technology ensures mass multiplication of coffee clones which alongside an innovative system of distribution ensures quality and fair prices to farmers. It is applied in the mass multiplication of improved varieties of coffee clones, for yield improvement.

• Climate change as one of the production constraints has made rainfall unpredictable, with both the extremes - drought and flooding. Further, continuous consumption of starchy staples has led to various diseases like anaemia, blindness and stunting among children. Therefore, development of improved crop varieties, animal breeds and the efficient distribution of clean disease free planting material are considered the most practical solution for sustaining agricultural productivity in Uganda.

• Creation of job opportunities for young professional scientists.

• This technology would also help in poverty alleviation by improving incomes and enabling people to access their basic needs and facilitating better house hold savings, etc.

## Scalability

Coffee together with tea and cotton constitute Uganda's traditional export crops and coffee has been Uganda's most important export crop since it overtook cotton in the 1950s. The total area under coffee production is 272, 000 hectares, with Robusta at 250,000 hectares and Arabica at 22,000 hectares. Coffee production in Uganda grows at the rate of 2.2% per year. Currently, through conventional means, the centre can only generate 100 plantlets per year from each seedling as opposed to tissue culture multiplication through which more than 3,000 plantlets can be generated per leaf

Kenya's coffee consumption is increasing, making it a good market for Ugandan export, as are Ecuador, Tunisia and Algeria.

| KEY AREA/COUNTRY | UGANDA |
|---|---|
| ANNUAL BUDGET(US$) | 200000 |
| ANNUAL COFFEE PRODUCTION (IN METRIC TONS) | 200000 |
| EXPORT RECEIPTS IN US$ | 338400000 |

Ugandan coffee production is 200,000 mt/year and assuming a yield of 0.8 mt/hectare, the area under cultivation is around 250,,000 hectares. Each hectare requires 2,500 seedlings of tissue culture material and thus the demand turns out to be six hundred and twenty five million plantlets. The projected demand being 30% of the total demand would be around one hundred and eighty seven million seedlings.

## Country Context

Uganda is predominantly an agricultural country with more than 80% of the population engaged in production, trade, processing and marketing of agricultural products. A third of the land area (about 6.8 million hectares) is under cultivation and most of the production is for subsistence and local food and income security. Coffee has its origins in Africa. Ethiopia is the birthplace of Arabica coffee, while Uganda is the birthplace of Robusta coffee. With an average export of 3 million bags in the past five years, Uganda is Africa's second-biggest coffee producer and the continent's largest Robusta exporter. Uganda has over a century-long tradition of coffee production. The crop is grown by smallholder farmers in most of the country, with the exception of the arid North-East. It is estimated that one third of all rural households, or roughly 1.2 million families, are involved in producing coffee. As coffee producing households are significantly less poor, growing coffee is an important strategy for rural Ugandans to climb out of poverty.

## Contact


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But the reality here is that the sector has been confined to the back-seat in terms of priority. Despite all these statistics, agricultural productivity in the country is still low and most farmers are still struggling, living a substandard life. In the early 2000s, Uganda saw a dramatic reduction in its crop yields across the nation, mostly due to a devastating host of pests and diseases. Half of Uganda's Robusta coffee trees were killed by Coffee Wilt Disease (CWD), leaving farmers in distress. As coffee is one of the most important cash crops in Uganda playing a major role in the livelihoods of many poor people, the demand for clean, disease free planting material has grown. These could tackle the fungus affecting coffee plantations and at the same time ensure mass multiplication of the coffee clones. Furthermore, when coupled with an innovative system of distribution, clean and disease free planting material could also ensure quality and fair prices to farmers.

## Business and Commercial Potential

Uganda's coffee export volumes grew by 30% from 126,000 mt in 2006 to 265,853 mt in 2007. Values grew by 40% from USD 189 million in 2006 to USD 265.8 million in 2007. The Uganda Coffee Development Authority report for the year 2006 indicated that yields and international prices of coffee were expected to increase in 2008, offering significant opportunities for investment in the sector.

Coffee consumption in developing countries is projected to grow from 1.7 mt in 1998 - 2000 to 1.9 mt in 2010, at an annual rate of 1.3%, while its share in the world market is expected to increase from 26% in the base period to 28% in 2010. The projected higher growth rate for developing countries compared to developed countries is due mainly to the higher income and population growth in developing countries, with increased coffee consumption continuing to be concentrated in the major coffee producing countries. Finally, world production for coffee in the crop year 2006/07 (April-March) was 121.57 m bags, an increase of 11% over the previous season, while consumption was forecast at 116 m bags, according to the International Coffee Organization (IOC).

## Coffee Production in Uganda

| Year | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|---|---|
| Value (US$) | 96626 | 100233 | 124237 | 172942 | 189830 | 265853 |
| Volume (mt) | 21059 | 146299 | 159983 | 142514 | 126887 | 164540 |

Source: UEPB

As shown above, the data and information available indicates that the coffee sector possesses significant opportunities for investment.

Most of Uganda's coffee in the 2006/07 season was exported to the European Union which accounted for 72% of the market share of total exports. The main country destinations were: The UK, Netherlands, Spain, Italy, Denmark and Norway. Outside the European Union, the main importing countries were Sudan, Singapore and China. A total of 2,726,249, sixty-kilo bags of coffee valued at USD 392,698,138 were exported during the year, while 3,114,363 sixty-kilo bags were procured at the exporter level. The weighted average price at export level was at USD 2.40 per kilo showing an increase of 2 US cents from the previous year when it was USD 2.38 per kilo.

The Ugandan coffee exports to the Arab world increased to 480,057 bags accounting for a market share of 17.61% of the total exports. The coffee also continued to penetrate new markets directly with exports to China, Russia and the Far East reaching 51,426 bags. This performance is a result of sustained promotions carried out in these new markets.

The projected demand for tissue culture seedlings is around one hundred and eighty seven million. The current national capacity of producing clonal seedlings and maintaining genetic purity and CWD resistance is way below one million per year. This has left a big supply gap, which presents an opportunity for investment in Tissue Culture technology which can achieve mass multiplication of clonal seedlings within a relatively shorter period of time.

## Financials

The retail price of one tissue culture banana seedling ranges between US$0.75-1.5 compared to the conventional suckers which sell at less than US$0.5. Between March and August, 2013, CURAD consortia produced 3,000 seedlings through tissue culture technology, which fetched US$3,600.
To run a successful tissue culture laboratory enterprise, there is a need for each laboratory to develop or have access to expertise in biotechnology, plant pathology, plant breeding and agronomy, besides infrastructure.

The capacity of production is estimated to be 15 lakh plants per year.Raw materials consist of good disease free and location specific coffee plants.Equipment consists of Air conditioners, autoclave, Laminar air flow, Water

## Purification System and culture trays.

| S.No | Particulars | Amount (US$) |
|---|---|---|
| 1 | Building Construction | 25424 |
| 2 | Equipment | 122033 |
| 3 | Media Equipment | 9322 |
| 4 | Green house | 18644 |
| 5 | Office Equipment | 3389 |
| 6 | Sub total | 178812 |
| | **Recurring expenses** | |
| 7 | Media chemicals and consumables | 40677 |
| 8 | Operating expenses | 44067 |
| | Sub total | 84744 |
| | Grand total | 263556 |
| 9 | Income received | 737288 |
| 10 | IRR | 37% |
| 11 | Profitability index | 3% |

## Target Market /Customer

Coffee farmers in Uganda are the potential customers for this technology. The demand for quality tissue culture seedlings is huge in the country. Bridging this huge gap may take many years.

## Potential investors to this technical innovation

A. Large scale farmers
B. NGO's
C. Development agencies

## Limiting factors for large scale commercialization

1. Basic infrastructure and facilities even for the simplest tissue culture techniques such as micro propagation are not available. This seriously hampers the acquisition of relevant and necessary knowledge, and the application of plant biotechnology which is a rapidly changing and developing field.
2. Lack of access to capital presents a significant challenge. The high cost of capital in Uganda is further exacerbated by exchange rate fluctuations.
3. A serious deficit of skilled human resources in the plant sciences and biotechnology is evident in Uganda. Building up such knowledge and the development of human resource capacity is necessary to produce improved varieties through the use of biotechnology as well as to handle imported engineered varieties that also demand changes in agricultural management.
4. The funds to pay salaries and absorb running costs of projects are either limiting or inadequate thus contributing to reduced availability of skilled personnel in the country.
5. Lack of support from the Government to put in place policies to support and promote new agricultural technologies coupled with weak enforcement of coffee regulations.
6. Lack of sufficient distribution networks together with the escalating cost of laboratory equipment and chemicals poses another hindrance to large scale commercialization.

## Social impact of the technology

1. Producing pest and disease free crops will also reduce the costs involved in producing crops and will lead to greater profit margins. It will also lead to healthy food production and will thereby elevate the health condition of the people.

2 Lack of improved agricultural planting material is a major bottleneck for many farming communities in Uganda. And yet access to high quality planting material which includes multiplication and propagation is essential for wealth creation and alleviation of poverty in the rural areas where the majority of farmers live.

3. Investment in this technology will lead to creation of job opportunities for young professional scientists.

## Any other relevant information

The government of Uganda, through UCDA has developed plans to replace over 200 million plants of Robusta coffee with the seven new CWD resistance clones. In line with the government policy framework stipulated in the National Development Plan and Development Strategic Investment Plan, UCDA's emphasis for the Coffee Year 2011/12 was placed on the following:

- Production of planting material; particularly the 7 Coffee Wilt Disease (CWD) resistant lines using tissue culture and nodal cuttings
- Promotion of Domestic Coffee Consumption
- Supporting Coffee Research and development
- Supporting coffee development in Northern Uganda
- Promotion of coffee replanting and rehabilitation
- Quality assurance and Value addition
- Quality improvement through Technical Extension services and collaboration with stakeholders
- Efficient utilization of assets and resources
- Development of the National Coffee Strategy to commission the National Coffee Policy

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