



REPORT

TECHNICAL EVALUATION REPORT FOR MANGA HEART AND CECOME BANANA FIBRE PROJECTS IN KISHII AND NYAMIRA COUNTIES

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1.0 Introduction

Banana plant bears fruit only once in its lifetime. After harvesting, huge amounts of banana pseudo-stems are dumped as waste causing environmental hazards. Millions of tons of banana stems are dumped as waste and most farmers face challenges in disposing the accumulated banana stems. The extraction of banana fiber from the pseudo-stem is not a common practice in the banana growing areas in Kenya. The waste stems are not used in the production of fibers for commercial purposes. Banana fibers are completely biodegradable, recyclable and environmentally friendly. The organic products are becoming increasingly popular worldwide. The wasted banana stem can be used to produce sustainable industrial material for the production of commercially viable products which will have a huge impact on environment, economy and society. The increasing demand of bio-based products is a key factor and target markets are easy to identify. Banana fiber has the potential to replace the consumption of the cotton and jute fibers in many countries. Banana plant waste-based cottage industries can provide employment opportunities for youth and women. The employment could help improve their living standards. It could also help in motivating youth and women to engage in various sectors like agriculture, handicrafts, fiber extraction which will increase their household income.

The Banana fiber project in Kisii and Nyamira is a cooperation among CECOME, Manga Heart and ISF that aims to develop new source of income for vulnerable women. The Banana Fibre Project was initiated to explore the potential of banana pseudo stems as a sustainable and eco-friendly source of natural fibre. The project aimed to develop biodegradable products, promote rural livelihoods, and contribute to waste management. The project targets young vulnerable women, specifically survivors of partner violence, for whom new, innovative means of livelihoods is developed. The project promotes the utilization of banana fiber as a handicraft raw material. In cooperation with experts, the project develops the whole value chain from the banana field through product development to the customer. The project also maps out other ways to use banana by-products in order to improve women's livelihoods.

The project successfully established two extraction and value addition centres one in Nyamira county and the other in Kisii county and equipped the centres with facilities for fibre extraction and value addition. The project has also tested banana fiber processing techniques and technologies and equipped beneficiaries with skills in train women in fiber extraction, treatment and spinning techniques and technologies as well as in hand weaving and knitting techniques.

The banana fibre project therefore facilitates the emergence of new business ventures, local solutions, and products, as well as pilot the opportunities surrounding the circular economy-based business. By doing so, the project is expected to reduce poverty and promote women's employment targeting achieving of a long-term goal of achieving a gender violence-free community.

1.1 Purpose

The Purpose of the evaluation was to establish the readiness existing banana fibre processing centres for scaling them up to Knowledge and Innovation Centres for driving commercialization, skills development, and technology transfer.

1.2 Objectives

The objectives for the review were to;

1. Evaluate Infrastructure and Production Capacity: Assess current infrastructure, equipment, and production capacity (volumes, reliability, and quality) of the centres.
2. Assess Technical Processes: Examine technical processes used in fibre extraction, drying, softening, spinning, weaving, and waste management.
3. Review Skills and Management Systems: Evaluate skills, management systems, and operational efficiency.
4. Identify RDI Potential: Identify research, development, and innovation (RDI) potential, including linkages with universities, technical institutes, and industry.
5. Analyze Value Chain Integration: Analyze value chain integration – including access to banana biomass, fibre markets, and by-product utilization.

2.0 Methodology

2.1 Literature Review:

A review of available literature was used to collect data related to the project background, objectives and the overall goals of the project. The literature helped in the collection of data from other related projects for purposes of comparison and information triangulation. The tool also helped in the review of available documents and reports on the project at the banana fibre processing centres.

2.2 Key Informant Interviews (KIIs):

KIIs were used in the Interviews with key stakeholders, including project managers, centre managers, and technical staff. The tool was valuable in providing in-depth insights and detailed information from project managers, supervisors and who have specialized knowledge and experience related to the banana fibre project.

KIIs were used in the Interviews with key stakeholders, including project managers, centre managers, and technical staff from Manga Heart and CECOME. A total of 5 project managers and two partners were involved in the review they included.

1. Banana fibre project officer
2. Training assistant
3. Site volunteers
4. Project field officer
5. Agricultural officers from Nyamira and Kisii county governments
6. Director KIRDI
7. Cooperatives officers
8. Cooperative committee members

2.3 Focus Group Discussions (FGDs)

FGDs were important in gathering information from participants. It brought together diverse opinions, different viewpoints that aided the review to gather common issues and concerns among the groups of women farmers, fiber processors and banana fibre handicraft producers. The interactive setting encouraged participants to express their thoughts freely, leading to detailed and nuanced information.

2.4 Observation

Observation was a fundamental tool for data collection for the review. It provided direct and firsthand insights into the project and helped in observing activities at the extraction and banana processing sites. Physical visits to the Manga Heart and CECOME banana fibre project was important understand the environment, setting, and contextual factors influencing project activities in physical conditions in real-time.

3.0 Findings

3.1 Infrastructure and Production Capacity

Fibre Extraction facilities

The project has supported the two centres with a well-built banana fibre processing facilities strategically located within the banana growing communities of Kisii and Nyamira counties. The facilities have adequate space for production of various value-added products. The facility at the Manga Heart is under extension and will offer a wider space for more women to join in the production of banana fibre products. It is well equipped with sanitary facilities and is well fenced and gate provided. However, the extraction space is detached from the production facility and located along the main road about 500 meters away. The location of the extraction facility is not ideal for mass production of banana fibres. It is limited in terms of space. The extraction is done from outside under the sunshine which may not be ideal for the safety of the people extracting the fibres. The same situation was observed at the CECOME site. There is no shed provided for the extraction space. The extraction of fibre at CECOME is done from a sitting room of one of the members in the nearby homestead. This is highly not recommended and the machine has already impacted negatively on the living space of the member. The space also health hazard to the users and the household lining in that house.

Raw Material Storage Area

The findings showed that the two processing centres had spaces for banana stems storage. Stems deliveries were done by women who are members of the banana project. The raw materials were kept on open spaces awaiting the extraction. Some of the banana stems were drying up due to exposure to sunshine. There was no properly designated and organized space for sorting, separating and holding the banana sheaths for extraction.

Equipment

The centres were equipped with necessary equipment for fibre extraction and handlooms for handweaving rugs and fabrics/table mats. The fibre decorticators were in used and provided high quality fibres. The machines are well designed and safety features were in place. The review noted that decorticators did not have a provision for biomass and sap collection which is important for further applications. The

equipment was not well installed to curb the vibrations. The machinery was well maintained. However, there was need to train key users on frequent cleaning and servicing.

The handlooms were in good working condition and there was evidence of their usage in making banana fiber-based products. They were of good quality and highly industrial in terms of a cottage application.

Production capacity

The banana fiber decorticators that are in use at the project sites in Kisii and Nyamira are adequate for fiber production. The decorticators have capacity to produce 10kgs of banana fiber per day when effectively utilized. The two centers have a schedule for fiber extraction and making of products. The group members planned a week for fiber extraction and a week for product making. Once banana fiber is fully utilized to make products, members set another week for fiber extraction.

The two banana fiber groups are engaged in the production of rugs, table mats, and baskets. The production capacity of the final products (mats, table mats and floor rugs) is low given that most members were still perfecting the skills of production. Some of the skills like handloom weaving were introduced recently.

3.2 Technical Processes

Fibre extraction

The fibre extraction at the banana fibre project sites was ideal. There was evidence of skills acquisition in banana fibre extraction. The members used right procedures for fibre extraction. The handling of banana sheaths and the feeding into the machine was done well. The brushing / cleaning the fibre out of the machine was well done and clean fibres were achieved. However, the women involved in the extraction of fibre did not have the required personal protection equipment (PPEs). None was found with helmet, only dust coats which were not ideal for wet processing activities. A few had gum boots and none used gloves while extraction. This was identified as a potential safety hazard and a high risk to the members using the equipment. Safety guidelines for the project had not been shared with the members.

Banana fibre drying

There was no designated space for drying banana fibres. Extracted fibres were hang on a fence to dry. This practice reduced the quality of fibres. Some fibres that would be white turned brown, lowering the quality for the fibres processed and affecting the final products

Softening

Softening of banana fibre is usually done where the products are either hair extensions or banana fibre fabrics. Since the project as not focused on such products, there were no softening activities noted n hew banana fibre processing facilities.

Spinning

The fibre spinning was done by hand which involved twisting two strands of banana fibre to make a twine which was used for handcraft making. The handspun twine was used to make baskets and other decorative products.

Handweaving

There were evident weaving activities at the two centres. Women were weaving rugs and, baskets and mat using banana fibres. The techniques included tapestry, pile, twining and macramé weaving techniques. The women demonstrated acquisition of weaving skills and despite having woven for a short period of time, there was potential seen in the works that they have produced so far. The creative products were seen. The women have integrated banana fibre in reproducing locally made cultural products like mats and baskets and simple jewelry.

Waste management.

Banana fibre processing produces a lot of biomass inform of solid matter and liquid sap. For every 1 kg of fibre processed, there is 3 kg of biomass and approximately 9 liters of sap. The hand weaving process also generates cutting waste. The project is utilizing the waste effectively. The solid biomass is being composted into manure and sent back to the gardens to nourish the soils. The sap is applied to the crops as organic fertilizer. This waste management practice is very good for the rural agricultural areas like Nyamira and Kisii. The members did not seem to have been trained on the value

addition of the waste generated. They relied on their knowledge and experiences for the value addition. A scientific approach to the use of sap and solid biomass would be required. There was no proper means of waste collection and different centres used different methods of collection. There was an attempt to modify the decorticator equipment to collect the waste but the fabrication wasn't effectively done on the machine.

3.3 Skills and Management Systems

Management systems

A comprehensive management system for the banana fiber project ensures efficient operations, high quality, sustainability, and profitability. It includes key components such as project planning, supply chain management, daily operations, quality control, environmental and waste management, financial oversight, human resources, marketing, research, monitoring, documentation, and technology use. These elements work together to streamline processes, maintain standards, and support continuous improvement.

The project is led by a team of highly skilled and passionate persons who are qualified for the management positions that they hold. The Project has a comprehensive management system for a banana fiber project that ensures smooth operations, quality control, sustainability, and profitability. Interviews with Key informants revealed that there was an efficient Project Planning and Coordination activities by the management of the Manga Heart and CECOME. There is a well-defined goals, objectives and timelines for the project. The management team had workplans and coordinated well with difference stakeholders.

The communication channel between project management and the beneficiaries was effective. There was evidence of frequent communication between management and the producers. The management conducted frequent meetings with beneficiaries as need arose. Records on the procurement of equipment, supply of banana stems, production and marketing were evident.

Operational

The project management has ensured sustained daily activity at the banana fibre extraction, there was evidence of a day-to-day banana fiber production activities, machinery maintenance, and workforce deployment. They implement standard operating procedures (SOPs) for each process stage despite that some members did not adhere to the use of SOPs. There was evidence of basic safety guidelines for banana fibers processors which involved use of dustcoats and gumboots. However, there was need for comprehensive safety awareness.

The quality of banana fibres seen on the extraction facilities was of high quality despite a few cases of poor storage. Respondents indicated that there was regular inspection to maintain fiber quality. The management team kept records of operations, sales, quality tests, and trade compliance documents. Record-keeping of raw materials, fibres and products was evident and ensured traceability and continuous improvement. The management team ensured sustainable practices, including waste recycling and eco-friendly disposal and monitored environmental impact and compliance with national and county trade regulations.

The review looked at the Financial Management and was impressed with the budgeting, accounting, and financial reporting. There was consideration for cost control and pricing strategies for the banana fibre products. The team also shown interest in seeking funding or subsidies where available. A marketing strategy for the banana fibre and fibre product is in place which include development of product branding, marketing strategies, and customer outreach and creation of distribution channels and sales targets. There was a regular project monitoring for Regularly reviewing project progress against targets which aided in use of feedback for adjustments and improvements.

3.4 Research, Development and Innovation Potential (RDI)

The RDI potential in banana fiber projects is high, offering opportunities to establish a competitive edge through innovation, sustainability, and product diversification. Continuous research can lead to new markets, higher-value products, and more sustainable practices, making the project more profitable and environmentally friendly. The RDI potential for a banana the fiber project a Kisii and Nyamira is quite significant

and can lead to innovation, improved processes, and new product development.

The potential includes;

- a) Development of a more efficient and cost-effective methods for decorticating and retting banana fibres.
- b) Improving fiber purity, strength, and flexibility through innovative treatments.
- c) Exploring environmentally friendly and chemical-free processing techniques.
- d) Product Innovation. Creating new products such as textiles, composites, biodegradable packaging, and eco-friendly textiles.
- e) Developing blended fibers with other natural or synthetic fibers for enhanced properties.
- f) Designing innovative applications like composites for automotive or construction industries.
- g) Standardizing fiber quality parameters.
- h) Enhancing fiber durability, moisture resistance, and color retention.
- i) Developing testing methods and quality assurance protocols.
- j) RDI on waste management, recycling, and composting banana stalks and other by-products.
- k) Investigating the environmental footprint of processing methods and optimizing for sustainability.
- l) Developing biodegradable or eco-friendly finishing treatments.
- m) Automating and scaling up processes to reduce labor and energy costs.
- n) Exploring new machinery or modifications for better efficiency.
- o) Conducting market research to identify new opportunities.
- p) Developing tailored fiber qualities for specific markets like fashion, home textiles, or industrial uses.

Project linkages

Project linkages for the banana fiber project refer to the interconnected relationships with various stakeholders, sectors, and industries that can support, enhance, and benefit from the project. Establishing strong linkages ensures sustainability, market access, resource availability, and knowledge sharing. The banana fibre project a Kisii and Nyamira has an existing linkage with KIRDI in Kisii County and The Ministry of Cooperatives in Nyamira County. Many other linkages can be established to deal with the following areas of interest;

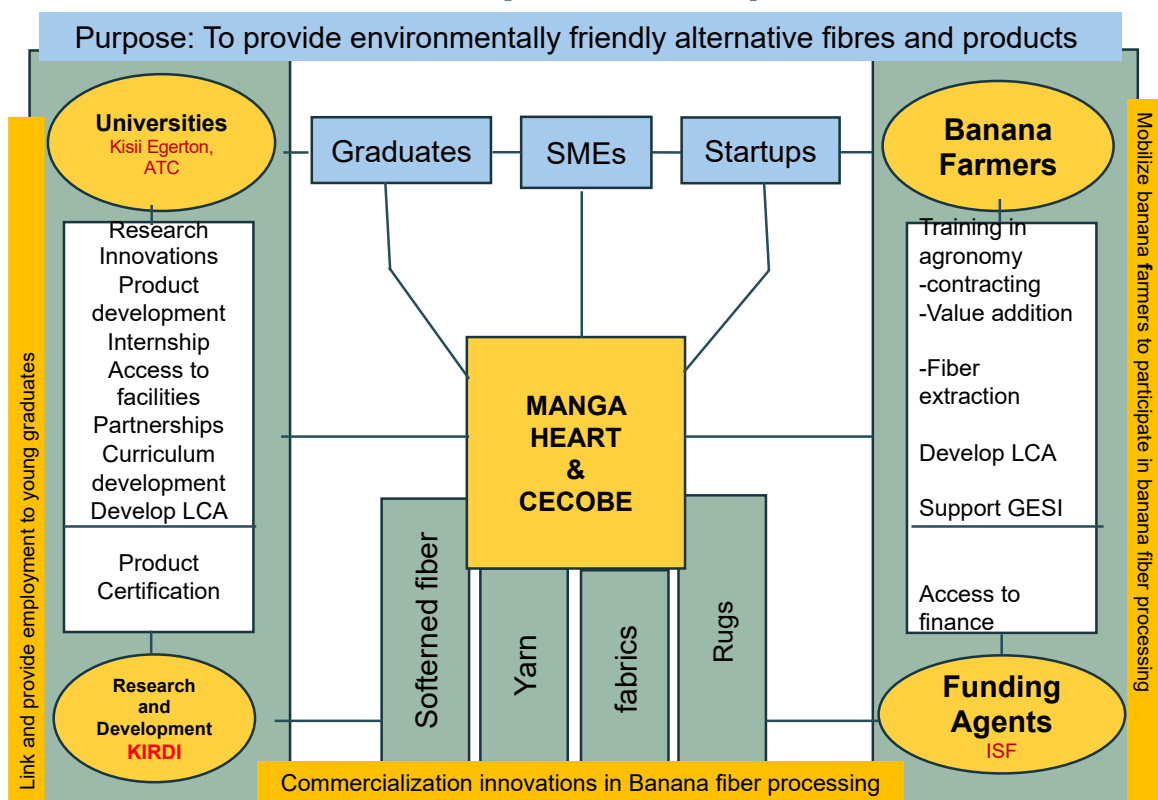
- a) **Raw Material Suppliers:** A linkage with banana farmers and cooperatives providing banana pseudo-stems stalks. A possibility of establish banana farmers groups at target banana growing areas where farmers are not organized in groups.
- b) **Agro-input suppliers supporting cultivation and harvesting:** To ensure high value of banana fruit and the stem, a linkage with County government and local NGOs who deal in promoting banana growing.
- c) **Research and Development Institutions:** Universities, technical institutes and research organisation are key for RDI collaboration. Currently the project has an informal collaboration with KIRDI and should seek collaborations with innovation centers focusing on natural fibers and sustainable materials. The project can explore linkages with Kisii University, Kisii National Polytechnic, Egerton University, KARLO and Agricultural Training Centre (ATC) among others in the region.
- d) **Processing and Manufacturing Units:** Other banana fibre players within the region may be a good target for linkages. Organisations like Ecobana who process banana fibre eco sanitary pads be an ideal linkage for supply of fibre and future scaling into supply of pretreated/softened fibre.
- e) **Government Agencies and Policy Makers:** Counties and national government agencies promoting agro-based industries and sustainable development would be ideal for a collaboration and access to grants, subsidies, and technical support.
- f) **Financial Institutions:** Banks and microfinance institutions for funding and credit facilities are avenues for raising capital and ensuring sustainability of the banana fibre project. There are Investors and venture capitalists interested in sustainable projects and banana fibre project would apply.
- g) **Market and End-Users:** Textile, garment, and fashion industries, Automotive, construction, and packaging industries using fiber composites would have the opportunity to try out banana fibre as alternative materials.
- h) **Environmental and Sustainability Bodies:** NGOs and environmental organizations promoting eco-friendly materials. This also includes Certification agencies for organic or sustainable products both at local and international levels.

- i) **Training and Capacity Building Organizations:** Skill development centers for workers and entrepreneurs. Extension services for farmers and processors.
- j) **Logistics and Infrastructure:** As the project plans to scale up, partnerships with transport providers would ensure raw material and product movement including warehousing and storage facilities.
- k) **Community and Social Groups:** Local communities for employment and livelihood enhancement. Cooperative societies for collective bargaining and resource sharing.

Strong linkages across these sectors would create a holistic ecosystem that supports the banana fiber project from farm to market, ensuring sustainability, innovation, and profitability. Building these relationships early is crucial for project success.

Certainly! Here's a detailed plan for establishing banana fiber project linkages, presented as a step-by-step process. Following that, I will describe a visual diagram structure that illustrates these linkages.

Banana fiber partnership model



3.5 Value Chain Integration

Access to banana biomass: The project has adequate access to the waste banana pseudo stems. Kisii and Nyamira are key areas where production of banana is very high. Linkages with banana farmers have been established at the piloting level and has potential to be expanded once the project reaches a scale p level.

- **Banana Fibre markets:** Banana fibre is a new alternative fibre for many applications and it is being sought for locally and internationally. The project has established such markets with companies like Mifuko Limited.
- **Banana Fibre by-product utilization.** There is a successful use of the waste generated from the banana fibre processing. The biomass is used for composting as organic manure and the sap is used as organic fertilizer for horticultural crops by the fibre processing groups. However, there is room for product diversification.

4.0. Challenges

The banana fibre processing project is faced with several challenges. This is attributed being the first banana fibre project of its kind in the region if not in the country. The following challenges were identified;

- a) **Inconsistent raw material supply:** The supply of banana pseudo stems depended on the willing farmers. The farmers were not paid for the stems they provided. The farmers carried the stems to the extraction sites manually and some stems were quite heavy for the women to carry on a hilly terrain.
- b) **Extraction and processing difficulties:** A labor-intensive extraction processes. An automatic and specialized machinery for fibre extraction could be required for scaling up the project, which also solve the problem of difficulty in obtaining high-quality, uniform fibres.
- c) **Environmental factors:** Managing waste and effluents from processing. Ensuring environmentally friendly practices. At the extraction sites, most of the sap was not collected due to poor means of liquid collection. Sap collection facility. Banana sap may require storage and fermentation

before usage as organic fertilizer. A storage facility would be useful. Sap was left to flow on the ground due to lack of proper catchment of the sap.

- d) **Skill and knowledge gaps:** Limited expertise in banana fibre processing techniques like tufted weaving, tapestry methods, macrame knotting systems and product design skills. There is need for further skills training and capacity building.
- e) **Quality control:** Ensuring consistent fibre quality. The fibre extracted is not graded according to any established parameters. Prior to extraction, the stems should be sorted according to different varieties. The outer sheathes of the banana stems are separated and extracted separately as grade two fiber. Grade one is comprised of the inner sheaths which produce stronger and whiter fibre. The banana fibre industry is still young; it doesn't have formal quality parameters.
- f) **Market development:** Finding a market niche and appropriate product development. Bringing products to local markets requires a lot of effort; the products need to be appealing and of high quality, and broader distribution demands professional management.
- g) **Scaling into a profitable business:** The current project is due for scale up. However, this requires resources, training, and sustained effort.

5.0 Recommendations

The banana fibre project has demonstrated substantial potential as a sustainable resource for eco-friendly products. With strategic investments and capacity building, it can become a significant livelihood enhancer and environmental conservation initiative. This report recommends the following actions;

- a) A better logistic approach can be put in place and supply chain roles should be differentiated. Women themselves transport the stems that slows down the supply and the production.
- b) A proper storage for banana stems to prevent degradation and facilitate easy access for processing.
- c) Stems should be trimmed to only required sections to avoid unwanted biomass to the centres.
- d) The decorticators used are domestic in nature and are suitable for small

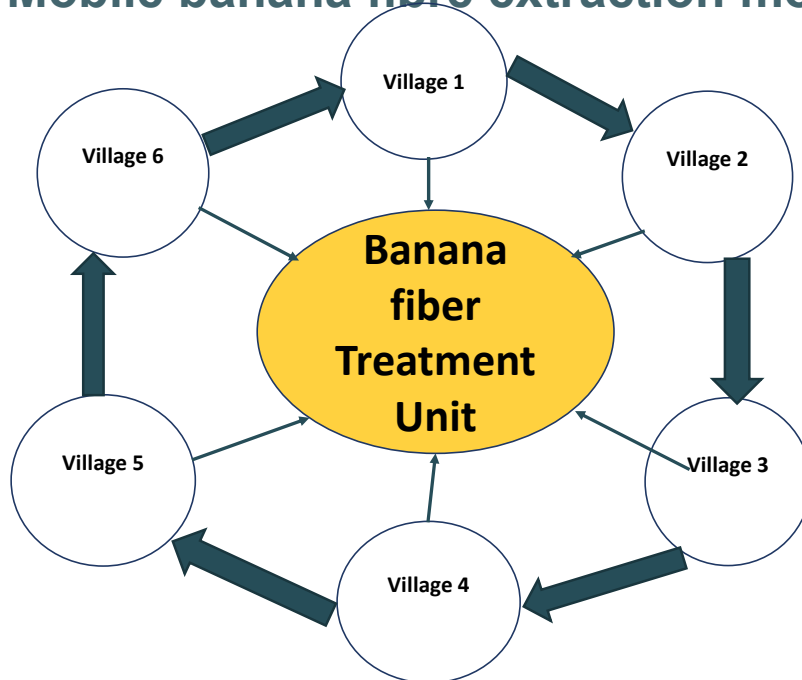
scale cottage industry. A modern fibre extraction and processing equipment would be required at scale up phase. Alternatively, the decorticators can be redesigned to further enhance safety features and reduce the vibrations which could damage or wear out the equipment.

- e) The women should be further trained in handloom weaving.
- f) Training members on the importance of safety and safeguarding is paramount.
- g) Organize a training for equipment users in general handling and maintenance.
- h) Organize a daily banana fibre extraction. If possible, create a community group whose work is only to extract and supply banana fibre to the value addition centres.
- i) Use a storage tank to store banana sap for further processing into bio fertilizer.
- j) Diversify on fibre waste uses like making of banana bloom (mulching material), substrate for mushroom production or paper making.
- k) Create more linkages, and formalise the linkages with KRDI and the Ministry of Cooperatives in Nyamira county.
- l) Conduct awareness campaigns to promote banana fibre products.
- m) Facilitate training programs for local producers.

Recommended Banana fibre extraction models for scaling up

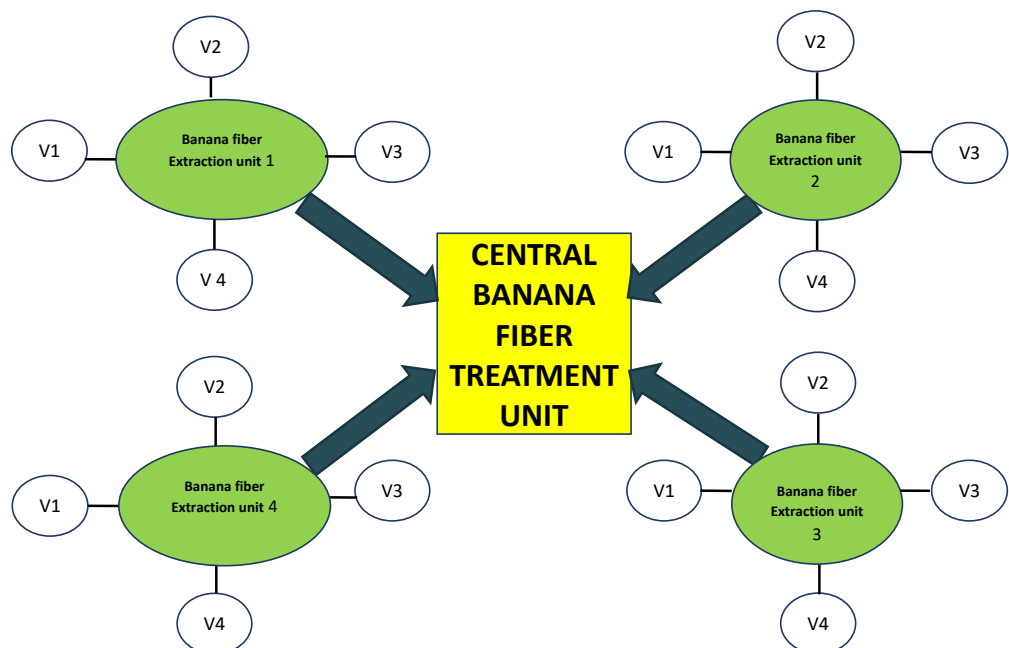
BANANA FIBER EXTRATION MODELS

1. Mobile banana fibre extraction model



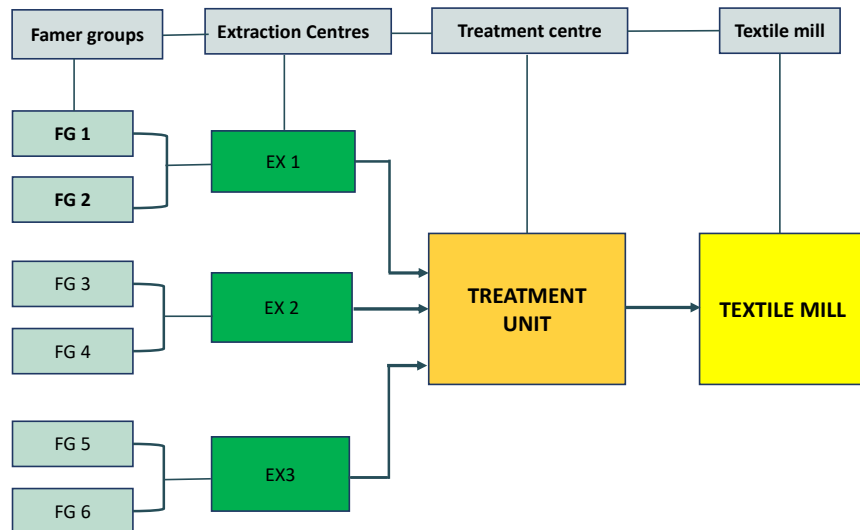
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2. Fixed Banana fiber extraction Model



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3. Farmer group banana fiber extraction model



6.0 Conclusion

The evaluation of banana fiber as a sustainable and eco-friendly material demonstrates its significant potential across various industrial applications. The fiber exhibits commendable mechanical properties, biodegradability, and versatility, making it a promising alternative to synthetic fibers. The extraction and processing methods, although still evolving, show potential for scalability with further technological advancements and optimization. Additionally, the utilization of banana fiber can contribute to rural livelihoods by creating new value chains and promoting sustainable agricultural practices.

To fully realize its potential, continued research and development, along with supportive policy frameworks and market linkage strategies, are essential. Overall, banana fiber presents a viable, environmentally sustainable option that aligns with global trends toward green materials and circular economies.

7.0 Action Plan

The action plan presents a detailed plan with recommendations for technological upgrading, RDI development, staff and management training, and partnerships.

Proposed requirements make the banana processing centres of excellence during the scale up

Action	Target numbers	Remarks
Quantity of fibre	Each processing centre should target producing 250kgs of fibre per day.	He current production is 10kgs per day per center
Number machines needed	Each centre should have 5 machines with capacity of a least 50kg per day. The fixed banana extraction model (provided) is recommended. 1 banana splitter machine for every centre is required.	Procure a high-capacity decorticator with capacity of 50kgs per day be procured The splitter makes the work of splitting banana stems easy and risk free. It is ideal for mass preparation for extraction
Staffing levels	-2 male staff for operating splitter stems (4 for 2 sites) -2 male staff for each extractor machine (10). -5 male casual staff identified for collecting stems for each centre. -100 Producers per centre	Each centre should have 4 male employees to handle the splitting and extraction work. Women should be left to project management and production. Handcraft is a very slow production that require numbers to manufacture volumes of products.
Technical expertise	1 electrician 1 mechanical engineer	The technicians can be sourced as needs occur.

Action	Target numbers	Remarks
Marketing structures and avenues	1 product outlet in Kisii 1 outlet in Nairobi 1 marketing officer Open website and social media accounts	Improve on quality of products to meet international standards.
Partnerships and collaborations needed	1 University: Kisii University 1 Research organization: KARLO 1 Technical Institution: ATC 1 incubator: KIRDI	Involving universities, research organisations and business incubators for business growth and innovations development and commercialization.
Quality control and certifications	Seek local production certification e.g. KEBS.	Acquire guidelines stipulation products requirements for certification.

Phase	Activities	Responsible Parties	Timeline	Remarks
1. Feasibility Study & Planning	-Conduct market research -Identify potential stakeholders - Assess raw material availability	Project team, consultants	Months 1-2	Establish project scope and objectives
2. Stakeholder Engagement	- Organize stakeholder meetings - Build partnerships with farmers, research institutes, industries	Project coordinators	Months 2-3	Ensure buy-in and collaboration
3.	- Train farmers on	Extension	Months	Focus on

Phase	Activities	Responsible Parties	Timeline	Remarks
Capacity Building & Training	banana stalk harvesting - Train local entrepreneurs on fiber extraction	services, NGOs	3-4	sustainable practices
4. Raw Material Supply Chain Development	- Formalize agreements with banana farmers -Set up collection and storage systems	Farmers, cooperatives	Months 4-5	Secure consistent supply of stalks
5. Technology & Process Development	- Pilot fiber extraction techniques - Optimize processing methods	R&D institutions, technical partners	Months 5-7	Improve fiber quality and yield
6. Infrastructure Setup	- Upgrade fiber processing units - Procure necessary equipment	Investors, local authorities	Months 6-8	Ensure operational readiness
7. Product Development & Testing	- Develop prototype products - Conduct quality testing	Product designers, labs	Months 8-10	Adapt products to market needs
8. Market Linkages & Promotion	- Identify target markets - Develop marketing strategies	Marketing teams, entrepreneurs	Months 10-12	Build market demand and awareness

Phase	Activities	Responsible Parties	Timeline	Remarks
9. Financial & Policy Support	<ul style="list-style-type: none"> - Secure funding and grants - Engage with policymakers for supportive policies 	Financial institutions, government	Months 4-12	Facilitate project sustainability
10. Monitoring & Evaluation	<ul style="list-style-type: none"> - Track progress and impact - Adjust strategies based on feedback 	Project management team	Ongoing	Ensure continuous improvement