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Review Article

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Agro-Processing Value Chains Mapping and Technology Needs Assessment for Nyeri County, Kenya

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ABSTRACT

A sectoral value chain mapping of the County Government of Nyeri, Kenya was initiated and implemented with regard to agro-processing of various forms of plant resources: food crops, textile/natural products, honey/animal feeds/ bio-energy/ICT, environment & biotechnology, essential oils, engineering services and Blue Economy. In this case, the following value-chain processes were assessed: Tea, Coffee; Oil crops; Banana & Dairy products with the support of service providers and prototypic environments. It also looked into value-addition practices and other cross-cutting factors. The cross-sectional study uncovered distinctions and issues including variability in the power supply, absence of Standard Operating Procedures (SOPs), minimal value addition, existence of counterfeit inputs, and unsuitable equipment. Recommendations include provision of standby power supply, provision of standard operating procedures, potential innovation in value addition, procurement of adequate equipment, and formulation of measures concerning genuine farm inputs. Therefore, by providing an enabling environment and putting into practice the strategies articulated in the study, sustainable agricultural-based growth and hence economic development in Nyeri County will be inevitably achieved under the Kenya Vision 2030.

Keywords: Agro-processing, Value Chains, Mapping, Technology Needs

Introduction

Agriculture is a central determinant of socio-economic development and income generation in Kenya ensuing crop, livestock, blue economy and horticultural systems for cash and food. There are other similarly important national economic sectors in Kenya which include construction, manufacturing and development of Micro, Small, and Medium Enterprises (MSMEs).

On this premise, the Kenya Industrial Research and Development Institute (KIRDI), in collaboration with the Ministry of Investment, Trade, and Industry (MITI), developed a sectoral value chain mapping study in Nyeri County. The study conducted under the Kenya Industry and Entrepreneurship Project (KIEP) which was sponsored by the World Bank Group sought to focus on the industries in agro-processing such as plant resources: food crops including oil crops, nuts, fruits, vegetables, textiles, natural products, honey, animal feeds, bio-energy, information and communication technology (ICT), environment, bio-technology, essential oils, engineering services and the Blue Economy.

The Bottom-up Economic Transformation Agenda (BETA), as aligned with Kenya's development blue-print Vision 2030, AU Agenda 2063, and UN-SDGs, outline value chain development as a path to accelerating growth and competitiveness. Further, the value chain approach also incorporates the activities of producing, processing, marketing, trading in the finished products and the related forward as well as backward linkages. Analyzing these value chains necessitates the use of sectoral mapping to establish the various actors' actions from production to consumption.

The general concept of the sectoral value chain mapping was to support the development of local value chains and increase the sales of Kenyan MSMEs to large companies. This included activities like evaluating opportunities, threats, the feasibility of controlling each opportunity or threat, and the organizational characteristics of the environment, technology, society, and sustainability. Important activities in the value chain as well

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as providers who facilitate these activities were also assessed (value-chain enablers) and evaluated the external conditions in the environment namely political and legal, economic, technological, and social-cultural. Other cross-cutting factors in the value-addition practices in diverse value chains were also taken into account.

Review of Literature

Position, Size and Demographics

Nyeri County is found in the central region of Kenya, north of Nairobi; it has an area of 3,325 square kilometers and the population was estimated to be 759,164 according to the 2019 Kenya National Bureau of Statistics Census report. The geographical location of Nyeri is between longitudes 36°08' E and 37°20' E, and between the equator and 0°38' S; it is surrounded by Mt. Kenya in the South and Aberdare Ranges in the North. Nyeri is part of the Central Region Economic Block (CeREB), neighboring Nyandarua, Muranga, Laikipia, Meru and Kirinyaga. The administrative and commercial capital is Nyeri town.

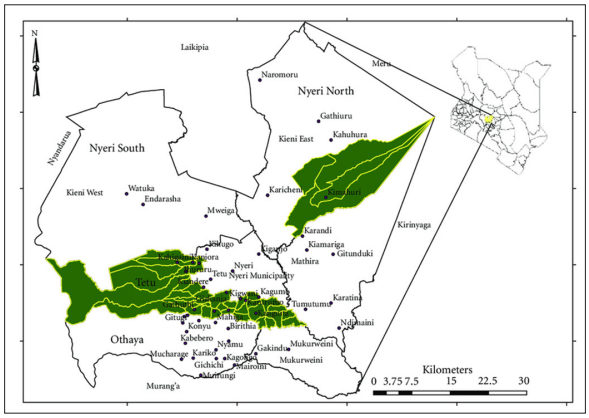

Figure 1: Showing Map of Nyeri County

Approximately 40% of the population is under 19, with 80.14% living in rural areas and 19.86% in urban areas. The labor force, comprising 62.98% of the population, mainly includes individuals aged 15-65 years. Agriculture employs over 30% of the population, with women forming a significant part of this workforce.

Nyeri County has 21,860 individuals with disabilities, primarily physical, making up about 2.4% of Kenya's disabled population. This highlights the need to include at least 5% of PLWDs in the beneficiaries of the KIEP project interventions and ensure accessible employment opportunities for them.

County Programmes and Projects

Agriculture, Livestock and Fisheries

The county government has initiated and implemented several projects including:

a). Greening Initiative Program: Distributed 250,000 seedlings of grafted Hass avocado, macadamia, tissue culture bananas, and mangoes to farmers. This aligns with the government's goal of increasing tree cover and promoting agroforestry [1].

b). Food Security Initiatives: Provided 6,176 50kg bags of Irish potatoes, 377,140 kg of certified beans, 550 drip kits, 3,857 water tanks, 1,250 knapsack sprayers, and manual hand planters to promote agricultural mechanization. These inputs are crucial for improving productivity and reducing post-harvest losses [2].

c). Coffee Sector Improvement: Issued 42,500 coffee seedlings, 676 tonnes of fertilizers, rehabilitated coffee drying tables and collection sheds, and trained youth in coffee pruning and spraying. Investments in the coffee value chain can enhance incomes for smallholder farmers [3].

d). Dairy Improvement: Supplied 29 milk coolers to cooperatives and self-help groups, two pasteurizers, free artificial insemination services, vaccinations, 300 dairy cows, and 85 forage choppers. These interventions aim to boost milk production and quality [4].

e). Indigenous Poultry Promotion: Provided 246,700 indigenous chicks, 30 incubators and brooders, five feed mixers, and Black Soldier Fly (BSF) kits for poultry protein. Promoting indigenous chicken can improve household nutrition and income [5].

f). Dairy Goat and Sheep Farming: Enhanced breeding by distributing 3,290 dairy goats and 1,500 sheep. Dairy goats and sheep are important sources of milk and meat for smallholder farmers [6].

g). Bee Keeping Project: Supported youth with beekeeping starter kits (300 hives, harvesting gear, and value addition equipment). Beekeeping can generate income and promote environmental conservation [7].

h). Aquaculture Development: Rehabilitated 486 fishponds, stocked ponds and public dams with 1,046,000 fingerlings, promoted cage cultures in three dams, and provided 1,340 25kg bags of fish feed and 210 pond liners. Aquaculture can contribute to food security and income generation [8].

i). Irrigation Agriculture: De-silted and rehabilitated three dams, expanded three water intakes and irrigation schemes, and constructed three water storage tanks. Irrigation is crucial for enhancing agricultural productivity and resilience to climate change [9].

j). Nyeri County Enterprise Fund (NCEF): Issued loans at 5% interest, distributing Ksh. 64,149,613.00 to 199 beneficiaries in 2022, including 107 males, 78 women, 14 companies, and two PLWDs. Access to affordable credit can promote entrepreneurship and job creation [10].

k). Market Development: Constructed 17 new market shades, renovated six market shades, fenced four markets, built 239 new stalls and established 12 market ablution blocks. The Chaka Market includes national government involvement and a proposed KIRDI value addition room. Investing in market infrastructure can improve efficiency and reduce post-harvest losses [11].

l). Energy Initiatives: Installed energy-saving jikos in government institutions and biogas systems in 18 households in Aguthi Gaaki Ward. Promoting clean energy can reduce deforestation and improve household welfare [12].

Methodology

The sectorial value chain mapping and technology needs assessment was conducted in Nyeri County from the 23rd to the 30th of October, 2023.

Data Collection Tools

The sectoral value chain mapping and the technology needs assessment tools were developed by KIRDI's technical personnel at the KIRDI Western Region Centre (KWRC) in

Kisumu County [13]. The developed tools were evaluated and validated through a stakeholder workshop held at the Panari Hotel in Nairobi.

Team Preparation and Field Activities

Before the sectoral mapping exercise, the team members were adequately briefed on the terms of reference and the developed tools for data collection at KIRDI, South C, Nairobi [14]. The data collection team held a fieldwork planning and strategizing meeting to firm up the itinerary and logistics before the start of the exercise.

The validated tools were used to collect primary data from the value chain actors and stakeholders including the County Government of Nyeri (CGN), producers (farmers), processors, service providers (marketers, distributors, wholesalers, retailers) academia, research and development, innovators and value chain facilitators (financial institutions) and consumers. The stakeholders were identified based on priority value chains and their critical importance in the value chains [15]. The primary information collected was corroborated using secondary literature from Nyeri County and other sources.

Sectorial Value Chain Mapping Findings

Solid Waste Management

The county provides a clean environment by ensuring daily street sweeping, clearing of overgrown vegetation, unclogging of stormwater drains and garbage collection. Annually, the county managed to collect 35,000 tonnes of solid waste which accounts for 85% of total garbage generated [16]. The remaining waste is used by recyclers and farmers to feed their livestock [17].

Dumpsite Management

The county ensures periodic pushing and compacting of garbage in the dumpsites. Murram is spread quarterly to ensure that roads inside the dumpsites remain motorable throughout the year [18]. The county has established four (4) Public-Private Partnerships (PPPs) to enhance sustainable solid waste management. The PPPs have resulted in the promotion of a circular economy where recyclable and biodegradable waste is recovered and repurposed into usable products. This is in line with mainstreaming circular business models in their operations that embrace the 3Rs: Reduce, Reuse, and Recycle. The companies include Biogas International, Jupiter Neon, Kenya PET Recycling Company (PETCO), and Waste Electrical and Electronic Equipment (WEEE) Centre.

Priority Value Chains

Tea and Coffee

The growing of tea and coffee by small and large-scale estates accounts for the largest proportion of export-oriented cash crops from Nyeri County. The crops are considered national crops since they are well developed, highly controlled and destined mainly for the export markets. The value chain actors are aligned to operate in structured and well-defined functional roles. Smallholder and large-scale commercial farms engaged in the production of the crops. The smallholder farms are organized in cooperatives where they supply the raw materials for bulking and first-level processing. The aggregated materials are supplied to the processing factories for further processing, packaging and distribution. The large-scale farms may supply the factories directly or they process and market their produce in local and export markets. The produce is mainly handled by multinational companies including the international auction. The tea cooperatives in Nyeri are members of the giant Kenya Tea Development Authority (KTDA) that collects, processes and exports the tea at the auction in Mombasa.

Although these crops are of significant importance to the County and Kenya at large, the nature of operations, levels of government intervention and value chain controls indicated that they were already at an advanced stage during the mapping exercise. The coffee sector improvement program by the County through the provision of seedlings, fertilizers, rehabilitation of coffee drying tables, coffee collection sheds, and promotion of youth engagement in coffee in pruning and spraying services. The County Government in addition mentioned that they were increasing the export marketing of the crops such as through direct exports to target destinations and not through auction. The county was organizing a coffee tourism and marketing expo where tourists were going to visit coffee estates in Nyeri County and secure direct deals. The county was also assisting other value chain actors in meeting statutory and regulatory requirements for the export of other horticultural crops.

Oil Crops Value Chain

The key oil crops in Nyeri County are sunflower, canola, and avocado. Avocado, particularly the Hass variety, is the most widely grown and is primarily exported, with limited local consumption. There is growing interest in processing avocado oil for both edible and cosmetic uses. The county is also promoting sunflower cultivation for oil production and livestock feed, providing certified seeds and oil-pressing equipment to farmer groups.

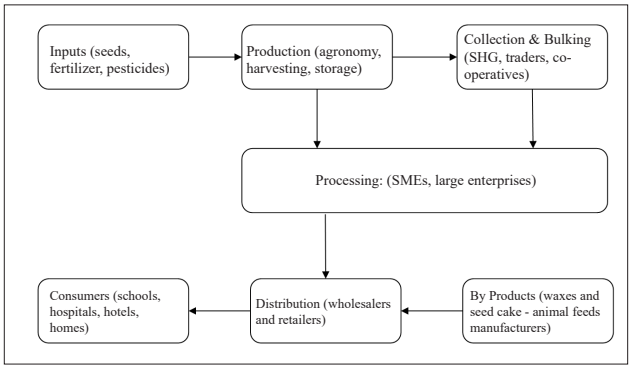

Figure 2: Oil crops Value Chain framework

- **Oil Crops Inputs**
  The various inputs required for oil crop production, such as seeds, seedlings, fertilizers, and agrochemicals, are readily available from agro-vet stores across the county and are easily accessible to farmers.
- **Oil Crops Production**
  Oil crops are grown on the slopes and ridges of Nyeri, as well as in the lower flat lands, taking advantage of the diverse microclimates. While the sector is gaining popularity, it remains largely underexploited. Canola is an emerging oil crop, primarily grown as a rotational crop with wheat by large-scale farms in the Mt. Kenya region and parts of the Rift Valley.

- **Oil Crops Collection and Bulking**
  Avocados are sourced at the farm gate by middlemen, who then supply the exporters and local markets. Other oil seeds, such as canola, are collected directly from farms and grain traders, especially suppliers of animal feeds.
- **Oil Crops Processing**
  Kieni Canola Oil is a pioneering small-scale agro-processor in Nyeri, recognized by various agencies. The enterprise processes a variety of oil seeds, including pumpkin, black seed, flax seed, sesame, castor, and shea. Agventure Limited's "Pure Mountain" is another established canola oil processor in the Mt. Kenya region. The main challenge for these SMEs is access to finance.
- **Oil Distribution**
  Kieni Canola Oil is KEBS-certified and marketed through small outlets, agricultural shows, and exhibitions. Agventure Limited's canola oil is sold through supermarket chains and online platforms, both locally and for export.
- **Oil Consumption**
  Vegetable oils are consumed for various purposes, including salad dressings, cooking, frying, baking, and as ingredients in other products. Cosmetic oil applications are also in high demand.
- **Oil Crops By-Products**
  The by-products from the vegetable oil industry, such as seed cakes, have a ready market in the animal feed industry, with no waste as they are highly demanded.

Banana Value Chain Analysis

Following the Nyeri County field survey, this value chain analysis focuses on the banana produce and associated value-added products.

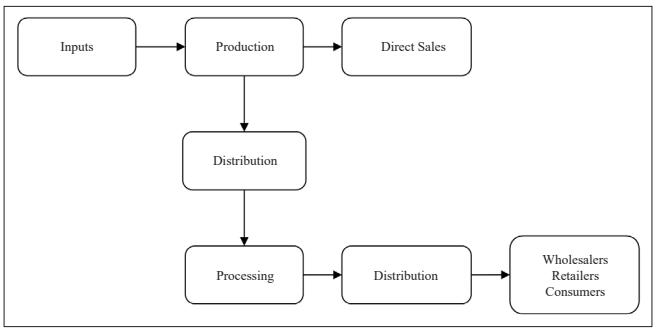

Figure 3: Banana Value Chain Framework

- **Banana Inputs**
  Readily available planting materials, fertilizers and agrochemicals are easily accessible to farmers.
- **Banana Production**
  Nyeri's slopes and ridges are well-suited for growing various banana varieties. The production relies on labor, manure, electricity and machinery. Farmers sell mature produce to markets and processors.
- **Banana Marketing and Distribution**
  Banana farmers sell either directly to the market for consumption or to startups and MSMEs for further processing into value-added products such as composite flours.
- **Banana Processing**
  Bananas are sourced raw and fresh directly from farms or markets. The main utilization is ripening for direct consumption as ripe, ready-to-eat bananas. Unripe bananas are sold for cooking or processed into value-added products like composite flour for porridge and "ugali", or deep-fried into crisps. Natural Ways Food Supplement Ltd, based in Tetu, has a full set of banana processing infrastructure and produces composite porridge flour by mixing banana flour with pumpkin, millet and sorghum flour.
  Processors face challenges such as frequent power interruptions, difficulties in achieving desired dehydration during cold weather when using solar dryers, and lack of technological competence for raw material handling. They mostly depend on external technical support for machinery and equipment, lacking well-documented maintenance schedules
- **Distribution and Consumers**
  Banana value chains have direct and indirect distribution approaches. They locally distribute composite flour through sales teams and have stores outside the county that serve as collection points for retailers and wholesalers. Most products are channeled to different supermarkets.

Table 1: Showing Intervention Matrix for the Banana Value Chain

Challenges and Opportunities	Interventions	Activities	Expected Outcomes
Lack of effective SOPs	Ensure satisfactory SOPs are to be followed all the time during product processing.	Development of SOPs with the help of reliable institutions, such as KIRDI	Distinguishing between wet and dry operations. Improved process flow to ascertain the proper movement of materials by removing unusable facilities and materials.
Lack of effective waste management practices, such as throwing waste banana peels	Reusing the banana peels as animal feeds rather than disposing.	Development of animal feed formulation from banana peels with the help of reliable institutions like KIRDI	Increased waste management practices
Unstable power sources	Ensuring reliable power use regardless of climatic changes	Development of a hybrid power source to serve both day and night.	Prevented power failure

Figure 4: Showing solar drier with pumpkin seeds and bananas drying at the Natural Ways Food Supplement Ltd based in Tetu, Nyeri County.

Dairy Value Chain

Dairy farming in Nyeri County is the main income earner for the majority of small-scale farmers. Nyeri County produces over 100 million liters of raw cow milk per year from approximately 171,288 dairy animals. The county is among the leading counties in milk production in Kenya. The County has a good network of dairy cooperatives that collect, chill and supply bulk milk to processors and also market milk to other consumers. The major processors such as the New Kenya Cooperative Creameries (NKCC) and Brookside Dairy Ltd purchase fluid milk from Nyeri mainly through cooperatives. During high production seasons, there is a milk glut, hence depressed farm gate prices, high postharvest losses yet the milk could be collected and preserved for use during lean times. The NKCC Kiganjo plant among other processors has established its processing facilities in Nyeri. Characteristically, there is minimal value addition of milk to higher value products such as cheese, ghee, butter, yoghurt, ice-cream and flavoured condensed milk. Although the established factories process various milk products for the market. Despite the investments in dairy, most milk from the county is still marketed as raw milk.

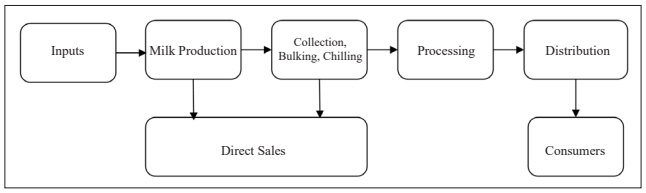

Figure 5: Dairy Value Chain Framework

- **Dairy Inputs:** The inputs in dairy production are animal feeds, artificial insemination and veterinary services. The inputs are readily available to the producing farms due to the expansive network of service providers and cooperative societies. Most co-operatives societies had the inputs including the provision of extension services to their members. Some cooperatives conducted farmer education, organized exchange visits and brought onboard sector experts for capacity development. The notable challenge was fake inputs in the market from unscrupulous sources especially due to high demand for products and services.
- **Milk Production:** Milk is produced at the farmer's premises. Some of the milk may be sold directly to consumers or taken to collection centers for bulking, chilling and selling to processors.
- **Milk collection, bulking and chilling:** The centers are mainly owned by cooperatives of community-based organizations. They aim to aid in selling the milk on behalf of their members. The centers also carry our quality control and grading of milk. They preserve the milk for processors to collect in bulk. Preservation involves chilling.
- **Milk Processing:** The processors' value-add milk into various products, including yoghurt, sour milk, cheese and ultra-heated long-life milk.
- **Milk Distribution:** Distribution is done by appointed dealers who buy from processors in bulk and sell to wholesalers as well as retailers who in turn sell to the final consumer.

Table 2: Showing Intervention Matrix for milk

Challenges and Opportunities for KIRDI	Interventions	Activities	Expected Outcomes
lack of knowledge on value addition	Training on the value addition of milk	Training	Improved livelihoods, less wastage, empowered farmers
Lack of equipment for value addition	Provision of a common manufacturing facility for dairy value addition	Site selection, Procurement of CMF equipment, installation and testing, training on equipment use	CMF facility
Quality control of milk due to poor animal feed formulation	Training on dairy feed formulation	Training	Knowledgeable farmers, good quality milk
Poor sizing of equipment leads to losses in energy	Training on equipment selection and maintenance	Training, consultancy on the acquisition of the right equipment, fabrication of equipment and after-sales service	Right-sized equipment, reliable after-sales service hence less downtime

Conclusions and Recommendations

The primary research work undertaken in this study involved conducting a value chain study across agricultural and industrial sectors in Nyeri County, Kenya to capture the distinctive features of each of them as well as the challenges faced, which are important to understand and support direct change initiatives Major issues include interruptions in power supply affecting the business processes; absence of standard operating procedures to conduct verification and improve efficiency; minimum levels of processing of raw agricultural produce; counterfeits available in the market which compromise product quality and output; and the availability of unsuitable or outdated tools that slow down the operations. Given these challenges and to exploit opportunities in each value chain, the study suggests the following: ensure adequate power supply, ensuring process standardization by developing and implementing proper SOPs, improving on value addition, enhancing quality assurance to get rid of counterfeit farm inputs, and get proper technology through the purchase of functional and efficient equipment. Through the provision of a conducive environment and application of the aforementioned activities, the study intends to promote sustainable agricultural-based development as well as economic growth in Nyeri County hence supporting the achievement of Vision 2030 of Kenya.

Acknowledgements

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Table 3: Agro-Processing Value-Chain assessment summary for Nyeri County.

S/NO.	Requirement	Findings	Remarks
1.	Value chain actors	• Presence of smallholder and large-scale farmers • A good network of fresh produce markets • Constructed markets like Chaka market • CAIP site identified and development initiated • Individuals, cooperatives and large corporates value addition and processing infrastructure	• Lack of affordable business credit/ capital • Weak cooperative governance structures • Low levels of aggregation, value addition, ICT adoption • Inadequate extension officers, crop pests and diseases • Low access to agricultural inputs due to high cost, counterfeits
2.	Production and value-addition practices	• Artisanal and modern value-addition systems	• Opportunity for equipment fabrication and capacity development
3.	Existing markets	• Products access local, regional and export markets	• Opportunities for standardization, branding and marketing
4.	Gaps and constraints	• Unreliable raw material supplies, fluctuating prices • High cost of infrastructure and machinery	• Promote supplier contracts and tax compliance • Reverse engineering for machinery
5.	Gender integration	• Men have better access to resources and financial decisions • Women mainly in manual, repetitive tasks	• Capacity development for gender integration • Women empowerment strategies
6.	Value chain mapping	• Dairy: inputs, equipment, milk handling, renewable energy • Oil crops: equipment, processing, packaging, feeds • Banana: equipment, postharvest, dehydration, frying • Tea and Coffee: value addition technologies	• Opportunities for training, capacity development, equipment fabrication, standardization, incubation
7.	Sustainability	• County aware of climate change adaptation and mitigation • Solid waste management problems from markets	• Opportunity for capacity development of agro-processors • Partnership for municipal solid waste management
8.	Prioritized value chains	• Dairy value chain • Banana value chain	• Opportunity to deploy KIRDI's technical interventions
9.	Supporting functions	• Dairy: cooperatives, technical colleges, local markets • Banana: technical colleges, local markets	• Opportunity for various clients to be on-boarded for KIEP technical interventions

Table 4: Technology needs assessment for Nyeri County.

S/no	Enterprise	Skills Gaps	Interventions	Challenges for Women and Youth
1	Kiba Housing	• Outdated, labor-intensive technologies • No standardization • Outdated equipment	• Artisanal fabrication training • Training on waste management, product improvement, standardization	• Lack of appropriate technologies • Unreliable power • Lack of proper equipment • No formal or business training • Not aware of IP
2	Nyeri National Polytechnic	• IP commercialization • Technology transfer and extension services	• Collaboration and partnership with KIRDI	• Limited research funding • Low knowledge of IP registration and commercialization
3	ABYSSINIA	• IP registration • Appropriate technology	• Agro-processing training by KIRDI - Limited updated technologies	• Limited updated technologies • Products not KEBS certified • Limited space for operations • No financial training • Not aware of IP
4	Enable Youth Enterprises	• IP, modern technology	• Agro-processing training by KIRDI	• Limited updated technologies • Products not KEBS certified • Limited space for operations • No financial and technical training
5	Mt. Kenya Hub	Entrepreneurship	• Collaboration and partnership with KIRDI	• Limitation on formal training and funding to actualize ideas

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